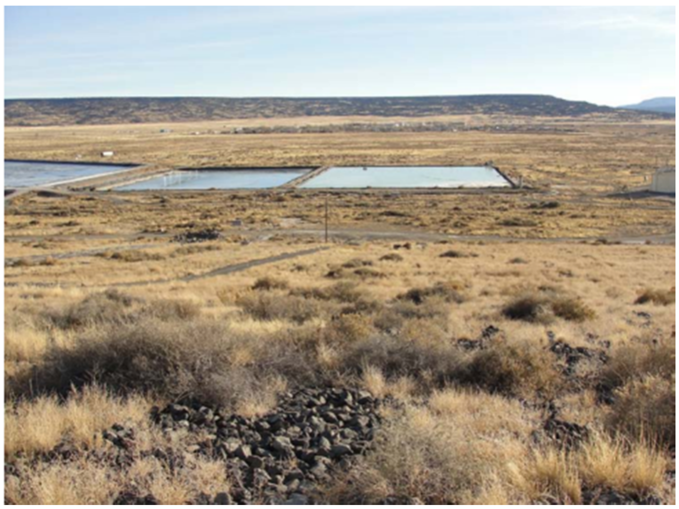


Final Remedial Investigation Report

Homestake Mining Company Superfund Site

Operable Unit 1: Tailings Seepage Contamination of Groundwater Aquifers

Operable Unit 2: Long-Term Tailings Stabilization, Surface Reclamation and Site Closure

Near Grants, New Mexico

June 22, 2020

100021754

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

ABSd	dermal absorption factor
ACM	asbestos containing materials
ACOE	U.S. Army Corps of Engineers
ACZ	ACZ Laboratories, Inc., of Steamboat Springs, Colorado
AF	dermal adherence factor
ARARs	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	Area Use Factor
bgs	below ground surface
BKG	background
°C	Degrees Celsius
CDI	cancer daily dose intake
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cm	centimeters
cm^2	centimeters squared
COC(s)	contaminant(s) of concern
COPC(s)	chemicals of potential concern
cpm	counts per minute
CR	cancer risk
Cs-137	Cesium 137
CSF	cancer slope factor
CSF_{ABS}	absorbed cancer slope factor
CSM	conceptual site model
DAD	dermally absorbed dose
DIR	Dietary Ingestion Rate
DL	detection limits
DOE	Department of Energy
DP	Discharge Permit
d/y	days per year
ED	exposure duration
EF	exposure frequency
Energy	Energy Laboratories, Inc., of Billings Montana and Casper, Wyoming

EP	Evaporation Pond
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ERG	Environmental Restoration Group, Inc.
ERT	Electrical resistivity tomography
ESV(s)	ecological screening value(s)
ET	exposure time
°F	Degrees Fahrenheit
ft	feet
ft/day	feet per day
ft/ft	foot per foot
gpd/ft	gallons per day per foot
GSF	Gamma Shielding Factor
GI_{ABS}	gastrointestinal absorption factor
gpm	gallon per minute
H	Henry's Law
HDPE	high-density polyethylene
HHRA	human health risk assessment
HMC	Homestake Mining Company
HPRO	high pressure reverse osmosis
HQ	hazard quotient
HSCM	Hydrogeologic Site Conceptual Model
IUR	inhalation unit risk
IRS	soil ingestion rate
IRIS	Integrated Risk Information System
K-40	potassium-40
KM	Kaplan-Meier
Kp	dermal permeability coefficients
LANL	Los Alamos National Laboratory Ecorisk Database
LOAEL	Lowest Observed Adverse Effect Levels
LPRO	low pressure reverse osmosis
LTP	Large Tailings Pile
LTA(s)	Land Treatment Area(s)
m^3/kg	cubic meters per kilogram
MCL(s)	EPA Maximum Contaminant Level(s)

MDC	minimum detectable concentration
m/sec	meter per second
MDL(s)	method detection limit(s)
µCi/ml	micro Curie per milliliter
mg/cm^2	milligram per centimeter squared
mg/kg	milligram per kilogram
mg/kg-d	milligram per kilogram body weight per day
mg/L	milligram per liter
ml/d	milliliter per day
mg/m^3	milligram chemical per cubic meter of air
mrem/yr	millirem per year
msl	mean sea level
n	number
N	No
NA	not applicable
NAREL	EPA National Air and Radiation Environmental Laboratory in Montgomery, Alabama
NAWQC	National Ambient Water Quality Criteria
ND	not detected
NHNM	Natural Heritage New Mexico
NM	New Mexico
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
NMSU	New Mexico State University
NOAEL	No Observed Adverse Effect Levels
NRC	Nuclear Regulatory Commission
NWS	National Weather Station
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
OSL	optically stimulated luminescence
OU	Operable Unit
Pb-212	Lead-212
pCi/g	picoCurie per gram
pCi/L	picoCurie per liter
pCi/m^{2}s	picoCurie per square meter per second
PEF	particulate emission factor

PRG(s)	Preliminary Remediation Goal(s)
Ra-223	Radium 223
Ra-226	Radium-226
Ra-228	Radium-228
RadPRG(s)	Radionuclide Preliminary Remediation Goal(s)
RAGS	Risk Assessment Guidance for Superfund
RAOs	Remedial Action Objectives
RESL(s)	Radioecological Screening Level(s)
RfC	reference concentration
RfD	reference dose
RFD_{ABS}	absorbed reference dose
RI	Remedial Investigation
RL(s)	reporting limit(s)
RME	reasonable maximum exposure
RMM	reformulated mixing model
Rn-222	Radon 222
RO	reverse osmosis
ROD	Record of Decision
ROPC(s)	radionuclide(s) of potential concern
RR	risk ratio
RSLs	regional screening levels
SA	skin surface area
SAG	San Andres-Glorietta
SE	stripping efficiency
SFi	cancer slope factor - inhalation
SFo	cancer slope factor – oral
Site	Homestake Mining Company Superfund Site, Cibola County, New Mexico
SLERA	Screening Level Ecological Risk Assessment
SMC	San Mateo Creek
SMDP	Scientific/Management Decision Point
spp	species
SLs	screening levels
SM	silty sand
SP-SM	poorly graded sand to silty sand
SSL(s)	soil screening level(s)

STP	Small Tailings Pile
SW	surface water
TDS	total dissolved solids
TEDE	total effective dose equivalent
Th-228	Thorium 228
Th-230	Thorium-230
Th-232	Thorium 232
Th-234	Thorium 234
Tl-208	Thallium 208
tpd	ton per day
TRV	toxicity reference value
U	uranium
U-234	Uranium 234
U-235	Uranium 235
U-238	Uranium 238
µg/kg	microgram per kilogram
µg/L	microgram per liter
U_3O_8	triuranium octoxide
UCL	upper confidence limit
UCL95(s)	upper 95th percentile confidence limit(s)
U-nat	Uranium natural
UN-HP	United Nuclear-Homestake Partners
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USL	upper simultaneous limit
V	vanadium
WIR	Water Ingestion Rate
WRCC	Western Regional Climate Center
Y	Yes

1 Introduction

1.1 Purpose of the Report

This Remedial Investigation (RI) Report describes the nature and extent of uranium mill-related contamination in soil and groundwater at the Homestake Mining Company Superfund Site, Cibola County, New Mexico (Site). Refer to Figure 1-1 for a plan view of the Site that is the subject of this RI Report. The basis for this RI Report are the documents in the administrative record that describe prior response actions and data collection activities that have been completed at the Site.

Administratively, the Site has been divided into three Operable Units (OUs):

- OU1: Tailings seepage contamination of groundwater aquifers
- OU2: Long-term tailings stabilization, surface reclamation and Site closure
- OU3: Radon concentrations in neighboring subdivisions

OU1 and OU2 are addressed together in this RI Report. In 1989, the United States Environmental Protection Agency (EPA) issued a Record of Decision (ROD) for OU3.

1.2 Site Location and Ownership

The Site is located approximately 5.5 miles north of Milan, New Mexico, in Cibola County (refer to Figure 1-1).

Homestake Mining Company of California (HMC) opened and began operating the mill facility in 1958 under two partnerships, with HMC acting as operating partner for both. Beginning in 1981, HMC became both the sole owner and operator. In 2001, HMC merged with Barrick Gold Corporation. Currently, HMC is a wholly owned subsidiary of Barrick Gold Corporation and owns the Homestake Facility.

1.3 Site Description

The Site includes:

- The former uranium milling operation areas, tailings piles, and facilities used for on-going closure operations, including collection and evaporation ponds, water treatment plant, and support facilities. These features are fenced and included within an area licensed by the Nuclear Regulatory Commission (NRC) for uranium milling and closure activities. The license boundary includes approximately 1,085 acres (refer to Figure 1-2). This area is referred to as the Homestake Facility.
- The location of the release (or releases) of hazardous substances and CERCLA eligible pollutants and contaminants associated with the Homestake Facility and wherever those hazardous substances, pollutants and contaminants have come to be located.
- Four hay fields, referred to as land treatment areas (LTAs), which were historically irrigated with groundwater extracted as part of on-going remediation activities at the Site. Land

treatment has occurred at two fields using flood irrigation (120 and 24 acres) and two fields using center pivot units (100 and 150 acres). Locations of LTAs are shown on Figure 1-2.

1.4 Site History

The Site is located within the Grants Mineral Belt in New Mexico, which produced more uranium than any other district in the world during the period of 1951-1980 (McLemore and Chenoweth, 1989). Situated within the San Mateo Creek (SMC) Basin, more than 85 legacy uranium mines with recorded production are located upgradient of the Site (NMED 2009a). Refer to Figure 1-3 for a location of some of the mines in relation to the Site. A number of legacy uranium mines generated liquid wastes that included water produced from mine dewatering operations that were discharged to the surface.

Uranium milling operations occurred at the Homestake Facility from 1958 until 1990. Currently there are closure activities occurring at the Site, including security, groundwater remediation operations, and environmental monitoring. The following paragraphs provide an overview of Site history, including:

- Mill operation history, focusing on the deposition of tailings, which are the primary contamination source material at the Site
- Decommissioning and closure activities completed to date
- Groundwater remediation activities completed to date

1.4.1 Mill Operation History

There were originally two separate mills that operated independently: the larger mill with a nominal milling capacity of 1,750 tons per day (tpd) and a smaller mill with a nominal milling capacity of 750 tpd. Each had separate tailings piles. The smaller of the two piles is called the Small Tailings Pile (STP) and the larger is called the Large Tailings Pile (LTP). In 1961, the two milling facilities were combined and milling capacity expanded to a combined 3,400 tpd.

Originally, tailings were deposited into only one cell of the LTP. In 1966, a cell adjacent to and west of the existing cell was added. From 1966 until 1990, tailings disposal alternated between the two cells to maintain optimal operating conditions. The initial perimeter dike for the LTP was constructed by compacting 6-inch lifts of natural soils excavated from within the tailings pile area. The starter dike was constructed to a height of approximately 10 feet and a width of approximately 10 to 15 feet at the crest and 25 to 30 feet at the base. During operations, the perimeter dike was raised to add volume for deposition of tailings.

The tailings piped to the LTP were separated using hydrocyclone equipment. Hydrocycloning separated the tailings by grain size, into a coarse fraction comprised mostly of sand and a fine fraction that contained mostly silt. The coarse fraction was deposited downstream of the dike crest to raise the dike, and the fine fraction was deposited upstream of the dike crest toward the center of each cell. The tailings liquid was recovered through the use of two decant towers and the water reused in the mill process. When production rates were low during the latter stages of mill operations, hydrocyclone separation was not used. Instead, the tailings slurry was discharged directly into the tailings pond. This method of operation confined disposal to a single cell, while the other cell was used for evaporation.

Tailings deposited within the STP were contained by an embankment dike composed of compacted natural soils. The embankment dike was compacted by heavy equipment and raised to a height of 20 to 25 feet. The crest was a minimum of 10 feet wide and the base approximately 40 feet wide.

Both mills were alkaline leach-caustic precipitation processes designed to concentrate uranium oxide from ores with average grades of 0.05 to 0.30 percent triuranium octoxide (U_3O_8). A detailed summary of the milling operation, including process chemistry, tailings characteristics, and slope stability analysis for the tailings piles is provided in Appendix A to this document (HMC 2012).

1.4.2 Description of Completed Decommissioning Activities

Milling operations ceased on February 2, 1990. In January 1991, HMC submitted a proposed tailings reclamation and mill decommissioning plan to NRC (AKG et al. 1991). On October 29, 1993, HMC submitted an Updated Reclamation Plan that superseded the 1991 submittal (AKG and Jenkins 1993). Mill decommissioning and reclamation activities for soil cleanup began in 1993.

1.4.2.1 Mill Decommissioning and Burial

Demolition activities began on May 5, 1992, with removal of asbestos-containing materials (ACM) from various mill facilities prior to demolition. The New Mexico Environment Department (NMED) approved burial of the asbestos in the tailing impoundment (AKG 1996). The ACM was disposed of in a disposal pit at the toe of the original slope of the LTP (refer to Figure 1-4). Residual byproduct and scale materials were removed from milling process components before these components were demolished and buried. Byproduct materials consisting primarily of scale, sludge, and tailings in tank precipitators were removed by mechanized equipment and by hand tools and hauled to the LTP for burial. Demolition of milling facilities was accomplished using heavy equipment and was completed by March 1995 (AKG 1996). Mill decommissioning at the Site met applicable standards in 10 CFR Part 40 and applicable license conditions (HMC 2013a).

Mill debris was buried in pits located within the mill area or south of the LTP (refer to Figure 1-4). Burial pits were excavated using heavy equipment and debris was placed into pits in lifts up to 5 feet thick. Slurry grout was poured into the pit until it had filled the voids and reached a level approximately equal to the top of the debris lift. This process was repeated until each pit was filled with debris and slurry. Debris pits were capped with up to 4 feet of soil (AKG 1996).

1.4.2.2 Removal of Windblown Tailings Contamination Areas

In 1987, HMC committed to a contaminated soil cleanup effort in which soil exceeding 5 picocuries per gram (pCi/g) Radium 226 (Ra-226) above background in the top 15 centimeters (cm) of soil (HMC 1987) would be remediated in accordance with 10 CFR 40 Appendix A Criterion 6 (6). Background for Ra-226 was calculated to be 5.5 pCi/g. Thus, the cleanup level was set at 10.5 pCi/g (5.5 pCi/g background + 5 pCi/g). The cleanup of windblown contaminated soils began early in 1988 (Environmental Restoration Group, Inc. [ERG] 1995). In February 16, 1989, a plan approved by NRC as License Condition No. 19 committed HMC to remediating certain areas near the tailings piles that exceeded the 10.5 pCi/g cleanup criterion for Ra-226 (ERG 1995) in the top 15 cm of soil. At depths greater than 15 cm below the surface, the Ra-226 cleanup criterion was 20.5 pCi/g (5.5 pCi/g background + 15 pCi/g) in accordance with 10 CFR 40 Appendix A Criterion 6 (6). There was a period of inaction during soil cleanup due to decommissioning activities. After the mill decommissioning was complete, cleanup of the windblown contamination and other off-pile

contaminated materials resumed in 1993 under Licence Condition 29C, which also required the cleanup be completed in accordance with 10 CFR 40 Appendix A Criterion 6 (6).

Surface soils from approximately 1,200 acres of land were removed (refer to Figure 1-5). Most of the excavated soils were placed on the eastern side slope of the LTP, but significant quantities were placed on the southern end of the STP and the aprons of the LTP. Subsequent to placement, deposited soils were covered with soil and rock as described in the section below.

1.4.2.3 Placement of Cover Materials

Cover materials were placed on the former mill area, the LTP, and the STP as part of the mill decommissioning efforts completed in the mid-1990s:

- At the STP, 1 foot of cover material was placed in areas outside of Evaporation Pond (EP) 1.
- At the LTP, extensive regrading was completed to fill in the tailings ponds and flatten the side slopes to improve stability. Cover material was placed on the side slopes at a thickness varying from 2 to 3.8 feet, as needed to effectively buffer radon emissions. In addition, 6 to 9 inches of rock cover was placed on the side slopes for erosion protection. On the top of the LTP, HMC placed 1 foot of cover material. Since this initial placement, additional cover has been placed on the LTP to fill depressions caused by settlement, to improve drainage, and to address specific areas with elevated radon flux measurements.
- At the former mill area, located southeast of the LTP (refer to Figure 1-2), an average of 2 feet of contaminated soil (containing radium levels above the cleanup standard) was removed following completion of mill demolition. Excavated soils were transported to the east end of the LTP or the south end of the STP for burial. Areas that had been excavated were backfilled with clean alluvial soils. After backfilling, at least 2 feet of clean soil was placed over the entire mill area. The average thickness of material placed was 4.7 feet. The rock was the same crushed basalt used for erosion protection on the impoundment surfaces. During the period of November 16, 1995, to December 10, 1995, this rock was applied in a single lift of 2 to 6 inches, and then mixed with the underlying soil to a depth of not more than two times the rock lift thickness. After the mill cover material was placed, gamma surveys were conducted to verify gamma emission rates were acceptable at the cover surface.

Cover materials were obtained from borrow areas near the LTP, STP, mill area, and evaporation and collection ponds. Figure 1-5 is a plan view which shows borrow area locations.

Drainage was reestablished following soil cleanup activities, with the work being conducted in 1994 and 1995. Drainage areas within the Homestake Facility (including areas adjacent to the LTP, mill and ore storage areas, windblown soil cleanup areas, and borrow areas) were regraded and surface channels established for drainage. Constructed surface channels are shown on Figure 1-6.

1.4.3 Groundwater Remediation Activities Completed to Date

In 1975, at the request of the New Mexico Environmental Improvement Division (NMEID), EPA undertook a study of the impacts resulting from uranium mining and milling activities in the Grants Mineral Belt. EPA determined that groundwater in the alluvial aquifer, which was being used for domestic use, had elevated selenium levels. Based on these findings, a Groundwater Protection

Plan was signed in 1976 between NMEID and United Nuclear-Homestake Partners (UN-HP), which was the owner of the Homestake Facility at that time (NMEID and UN-HP 1976).

In 1976, UN-HP determined that there was a contaminant plume in the alluvial aquifer that originated from the LTP and was moving to the south and west (HMC and Hydro-Engineering 2010). UN-HP installed and operated a line of groundwater wells along the southern facility boundary between the LTP and the downgradient residential subdivisions in 1977 to create a hydraulic barrier to limit movement of the alluvial aquifer contaminant plume across the facility boundary (MFG 2006). Since 1977, HMC has continually improved and expanded the scope and operation of this remediation system. A comprehensive history of the changes made to the system is provided in the *Grants Reclamation Project Corrective Action Program* (CAP) which was submitted to NRC in 2019. The following is a brief summary of the changes and improvements made to the groundwater remediation system:

- 1977–1983—Multiple hydraulic containment and collection wells were installed in the alluvial aquifer.
- 1984—Hydraulic containment of the Upper Chinle aquifer was initiated.
- 1986—Installation of extension of the Milan water supply for Broadview Acres, Felice Acres, Murray Acres, and Pleasant Valley Estates subdivisions.
- 1990—EP-1 was constructed within the footprint of the STP to assist in the dewatering of the LTP and to hold water pumped from the collection wells. Additional hydraulic containment and collection wells were installed in the alluvial aquifer.
- 1992—Toe drains were installed around the tailings.
- 1993–2000—During this period, corrective action and monitoring well networks were revised through addition and abandonment of wells.
- 1996—Use of EP-2 began in March.
- 1999—The reverse osmosis (RO) treatment unit was added; treated water is used for hydraulic containment of the alluvial aquifer.
- 2000—Irrigation of 270 acres as a means to manage extracted groundwater was initiated.
- 2002—60 acres of irrigation area were added and RO plant capacity increased from 300 gallons per minute (gpm) (one unit) to 600 gpm (two units).
- 2002–2009—During this period, corrective action, and monitoring well networks were revised through addition and abandonment of wells.
- 2004–2005—64 acres of irrigation area were added.
- 2010—EP-3 was constructed and commissioned.
- 2012—Land Application program ceased operation
- 2012—300 Zeolite pilot treatment started operation.
- 2015—RO Plant was expanded to a maximum throughput of 1200 gpm with the addition of a 600 gpm low pressure skid, a 250 gpm high pressure skid, and two microfiltration skids to replace the existing sand filters amongst other updates.

- 2016—1200 GPM Zeolite system started operation for off-Site water treatment.

Groundwater remediation at the Site is ongoing. The current system includes multiple components that are frequently adjusted based on evaluation of monitoring data. Figure 1-7 provides a diagram of the water balance for the remediation system, based on 2018 data. Quantities displayed in Figure 1-7 vary from year to year based on operational changes, local conditions, and other factors. The following provides a brief description of the components:

- Hydraulic Containment. Water is added into the alluvial, Upper Chinle, and Middle Chinle aquifers to create a hydraulic barrier to limit the movement of contaminated groundwater. The hydraulic barrier in the alluvial aquifer is created and maintained downgradient of the LTP with dozens of wells used to introduce the water into the alluvium and more than 6,000 linear feet of infiltration lines (HMC 2012). Water added to the alluvial formation to create a hydraulic gradient is derived from several sources, including the RO plant product water, less contaminated areas of the alluvial aquifer, the Middle Chinle aquifer, and the San Andres-Glorietta (SAG) aquifer. In 2018, an average of 678 gpm was introduced into the alluvial aquifer to maintain the hydraulic barriers. In addition, an average of 21 gpm and 46 gpm was introduced into the Upper Chinle and Middle Chinle aquifers, respectively (HMC 2019a).
- Tailings Flushing. Starting in 2000 and continuing through mid-2015, water was introduced into the LTP to expedite the mass flux of contaminants from the tailings.
- RO Treatment. The RO treatment plant removes contaminant mass from groundwater extracted upgradient of the hydraulic barrier. Plant influent is composed primarily of groundwater from the alluvial, Upper Chinle, and Middle Chinle aquifers (approximately 90 percent) and collection pond water (approximately 10 percent), which receives water from the RO plant (miscellaneous overflows). In 2018, approximately 279 gpm of RO plant influent came from the alluvial aquifer collection wells, 48 gpm from the collection ponds, 130 gpm from Upper Chinle aquifer extraction wells, and 34.3 came from Middle Chinle aquifer extraction wells. As indicated on Figure 1-8, the RO plant treatment process includes lime clarification and microfiltration as pre-treatment to the RO treatment units. There are four RO treatment trains. The first is a low pressure RO #1 (LPRO#1) skid (300 gpm capacity) that also has a high pressure RO (HPRO) skid (75 gpm capacity) to treat the brine from LPRO#1. The second train, LPRO#2, only has an LPRO treatment skid (300 gpm). The third unit has a 600 gpm low-pressure RO skid and a 250 gpm high-pressure skid. The clarifier, sand filters (which has been replaced with microfiltration), LPRO#1, and HPRO treatment systems were originally designed and constructed in 1999 for 300 gpm treatment capacity. LPRO#2 was added in in 2003 and the third unit was added in 2015, bringing the maximum theoretical RO plant treatment capacity to 1,200 gpm. Accounting for scheduled and unscheduled maintenance, the functional capacity of RO treatment based on the last four years of operations is about 500 gallons per minute (gpm).
- Evaporation. There are three lined evaporation ponds (EP-1, EP-2, and EP-3) in use at the Homestake Facility (refer to Figure 1-2) to concentrate uranium and other contaminants. The evaporation system receives water from the extraction wells in the alluvial and Upper Chinle aquifers and brine from the RO plant. In 2018, average evaporation from the ponds was approximately 200 gpm, while receiving an average of 33 gpm from the collection

ponds, 85 gpm of brine from the RO plant, 23 gpm from the zeolite treatment plant, and 28 gpm from precipitation.

- Zeolite Treatment. Zeolite beds have been used since 2016 to remove the uranium from off-site collection water because uranium is the only site constituent that exceeds the site standards in this collected water. There are two zeolite treatment plants that have a combined functional operational capacity of approximately 250 gpm based on the last four years of operations.

1.4.4 HMC Supply of Drinking Water to Residential Subdivision

Pursuant to the 1983 Agreement between HMC and the EPA, HMC financed the extension of the Village of Milan's municipal water supply to the residences of the subdivisions and made payments to the Village of Milan for the residents' water usage over a period of ten years. The extension of the water supply was completed in 1985 (EPA 2006). In late 2018, HMC restarted the water supply payment program for the subdivisions downgradient of the Site.

The New Mexico Environment Department and HMC entered into a Memorandum of Agreement pursuant to which HMC voluntarily agreed to connect residents within a designated area near the Site to the Village of Milan's water system on January 21, 2009 (NMED 2009b). This work has been completed.

1.5 Regulatory History and Authorities

The following paragraphs provide a summary of the regulatory history for the Site and a brief description of regulatory authorities. A complete discussion of regulatory authority at the Site is available in the *Decommissioning and Reclamation Plan Update 2013* (HMC 2013a), submitted to NRC in 2013.

Uranium milling and closure operations at the Homestake Facility have been regulated through radioactive materials licenses since milling operations began at the Homestake Facility in 1958:

- From 1958 through 1974, the Homestake Facility was regulated by the Atomic Energy Commission under License Number SUA-708.
- In 1974, regulatory authority was granted to the New Mexico Environmental Improvement Board.
- In 1986, regulatory authority over uranium milling and closure operations at the Homestake Facility was transferred to NRC from the State of New Mexico and the Homestake Facility was granted license SUA-1471, replacing license SUA-708.

In 1983, at the request of the State of New Mexico, the Site was added to EPA's Superfund National Priorities List. As a result, the Site's cleanup activities are being overseen under EPA's Superfund Program, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Pursuant to a 1993 memorandum of understanding between EPA and NRC, NRC is designated as the lead regulatory agency for reclamation and closure activities, while EPA has responsibility to monitor reclamation activities to assure attainment of applicable or relevant and appropriate requirements under CERCLA.

The State of New Mexico asserts regulatory authority at the Site through a number of state environmental statutes and regulations. Currently the Site maintains groundwater discharge permit DP-200, which regulates several aspects of the ongoing groundwater cleanup program and related RO water treatment system. A former Discharge Permit (DP-725) that regulated the discharge to the evaporation ponds and two existing collection ponds has been rolled into DP-200. The New Mexico Office of State Engineer regulates construction and operation of the evaporation ponds, tailing piles, water appropriations, and well permits.

The State of New Mexico is also supporting EPA for CERCLA compliance.

1.6 Report Organization

This report is generally organized as suggested in the EPA guidance document entitled *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988). Usually RI Reports includes a section describing the field activities completed for the RI. Because this RI presents data collected from numerous field activities over a long period of time, the section describing field activities is omitted.

The RI Report is organized into the following major sections:

Section 1.0 – Introduction – This section describes the purpose of the RI and summarizes Site setting, Site history, and prior work completed at the Site.

Section 2.0 – Site Characteristics – This section provides a brief description of the environmental setting.

Section 3.0 – Nature and Extent of Contamination – This section provides a description of the contaminants present at the Site due to milling operations and the extent of the contaminants.

Section 4.0 – Contaminant Fate and Transport – This section provides a qualitative discussion of contaminant migration routes and persistence in the environment.

Section 5.0 –Risk Analyses – This section discusses human and ecological risks present at the Site.

Section 6.0 – Conclusions – This section presents general conclusions.

Section 7.0 – References – This section provides full references for all citations in the body of the report.

2 Site Characteristics

2.1 Surface Features

A brief description of the major Site surface features is provided in the following paragraphs.

- Large Tailings Pile: The LTP contains approximately 21 million tons of tailings, occupies approximately 215 acres, and is approximately 70 to 90 feet tall with side slopes of 5.0 horizontal and 1.0 vertical.
- Small Tailings Pile: The STP contains approximately 1.2 million tons of tailings, occupies approximately 40 acres, is approximately 20 to 25 feet tall, and has similar side slopes as the LTP.
- EP-1: EP-1 was constructed on top of the STP in 1990 to assist with dewatering the LTP. It has a capacity of approximately 285 acre-feet and covers 26.2 acres. It is lined with a non-woven fabric impregnated and overlain with petroleum-based asphaltic material.
- EP-2: EP-2 was designed and constructed in 1995 to increase storage and treatment capacity for contaminated groundwater. The pond is located between the STP on the east and the collection ponds on the west, has an area of 17.48 acres, and a maximum storage capacity of 317.43 acre-feet. It is lined with an upper primary liner (60 mil thick high-density polyethylene [HDPE]), an intermediate layer (the detection or geogrid layer), and a secondary liner (bottom) that is 40 mil HDPE.
- EP-3: EP-3 is located north of the LTP and was constructed in 2010. It consists of two cells—each approximately 13.3 acres (total of 26.6 acres) of water surface at maximum pool level, and a total capacity of approximately 286 acre-feet. The pond is lined with a three-part liner system consisting of two HDPE membranes (primary and secondary liners) and an HDPE geonet leak detection/drainage layer between the two membranes. The primary liner membrane is 60 mil thick, the secondary liner is 40 mil thick, and the geonet is a minimum of 0.20 inch thick.
- West and East Collection Ponds: The collection ponds are each approximately 2.5 acres and are lined with a non-woven fabric impregnated and overlain with petroleum-based asphaltic material. They are located west of the STP and were constructed in 1985 to support water treatment operations.

Other surface features at the Site include administration buildings northeast of the LTP, a water treatment building west of the collection ponds, two water towers southeast of the LTP, and a meteorological station south of EP-2.

2.2 Topography

The Site is located in a semi-circular valley defined by a series of mesas that are approximately 7,000 to 8,000 feet above mean sea level (msl). The Site elevation is approximately 6,600 feet above msl. Local topography in the valley is generally flat with some low, rolling hills and shallow arroyos. The Site is located near the confluence of the ephemeral Lobo Creek and SMC drainages, both tributaries of the Rio San Jose.

2.3 Climate

The climate of western New Mexico and the Site is generally a mild, arid to semi-arid, continental climate characterized by low precipitation, abundant sunshine, low relative humidity, and a large annual and diurnal (day and night) temperature range. Temperature and precipitation are largely controlled by elevation and slope aspect. Summer precipitation generally falls due to southeasterly circulation from the Gulf of Mexico, whereas winter precipitation is generally associated with fronts moving eastward from the Pacific Ocean (New Mexico State University [NMSU] 2013). Most precipitation falls in the form of rain during the late summer and early autumn. Severe thunderstorms are not common in the area, but short-lived cloudbursts during the summer can produce flash flood conditions in nearby drainages and may be accompanied by significant lightning and hail events.

Climate data was collected from the following sources:

- The National Weather Station (NWS) at Grants Airport, located approximately 5.5 miles south of the Site at an elevation of approximately 6,530 feet above msl.
- An on-Site meteorological station maintained by HMC located south of EP-2 (refer to Figure 1-2) and equipped to measure horizontal wind speed and wind direction at 10 meters, temperature at 9.5 meters, solar radiation at 9.5 meters, relative humidity at 9.5 meters, precipitation at 0.4 meter, and barometric pressure at 8.8 meters.

2.3.1 Temperature

Long-term historical average monthly maximum and minimum temperatures measured at the Grants Airport NWS are presented in Table 2-1.

Table 2-1 Average Monthly Max. and Min. Temperatures at Grants, NM

Month	Grants, NM[1] °F		Month	Grants, NM[1] °F	
January	Max	56.1	July	Max	89.5
	Min	17.9		Min	52.3
February	Max	58.3	August	Max	85.5
	Min	20.9		Min	50.4
March	Max	66.2	September	Max	81.2
	Min	25.0		Min	44.2
April	Max	71.7	October	Max	73.5
	Min	30.4		Min	34.3
May	Max	80.5	November	Max	63.9
	Min	38.0		Min	25.0
June	Max	89.6	December	Max	56.9
	Min	47.4		Min	18.3
Period of Record	January 1986 to December 2018		Annual Average	Max	73.1
				Min	33.9

Source: WRCC 2019
1. Grants Airport NWS
°F = degrees Fahrenheit

2.3.2 Precipitation

Long-term historical average monthly precipitation and annual precipitation are summarized for the Grants Airport NWS in Table 2-2.

Table 2-2 Average Monthly Precipitation

Month	Grants, NM[1] inches	Month	Grants, NM[1] inches
Period of Record: January 1986 to December 2018			
January	0.65	August	2.63
February	0.70	September	1.47
March	0.76	October	1.11
April	0.85	November	0.69
May	0.75	December	0.70
June	0.66	Average Annual Precipitation Total	13.6
July	2.62		

Source: WRCC 2019
1. Grants Airport NWS

Precipitation in the area averages approximately 14 inches per year. The majority of annual precipitation typically occurs during July, August, and September. Summer precipitation is typically associated with thunderstorms, which form with the arrival of warm, moist air from the Gulf of Mexico. Evaporation is highest in May, June, and early July; the onset of the rainy season, usually in mid-July, reduces evaporation in the latter summer months. Winter precipitation in the form of

snowfall usually occurs when storms move eastward from the Pacific Ocean or northeast from the Gulf of California (NRC 2008).

2.3.3 Wind

The prevailing wind direction at the Grants Airport, located 5.5 miles south of the Site, is from the northwest (WRCC 2019). Surface wind speeds at the Grants Airport are highest in the spring, with a maximum monthly average of 14 miles per hour during April (New Mexico Climate Center 2013).

Wind speed and wind direction are measured hourly at the on-Site meteorological station. Wind roses for daytime and nighttime from 2009-2012 are shown on Figures 2-1 and 2-2, respectively. The hourly average wind speed exceeded 8.8 meters per second (m/sec) and 11.1 m/sec 4.25 percent and 1.34 percent of the time, respectively (HMC 2013a).

Historic data indicates that dominant (strongest) winds are from the west and southwest and are associated with frontal systems moving from the Pacific Ocean. High spring winds in the area are known to create periods of dusty conditions, which may occur for several days during the months of March, April, and May. Moderate winds from the south-southeast are common and typically associated with summer storms sourced in the Gulf of Mexico. Most of the light northeasterly breezes occur at night. Nighttime is relatively calm compared to daytime hours (HMC 2013a).

2.4 Soils

Surface soils at the Site are composed of San Mateo alluvium with lesser amounts of aeolian deposits (NRC 2008). Alluvial sediments beyond the Site boundaries consist of the Lobo Canyon alluvium to the east and the Rio San Jose alluvium to the west. Alluvial sediments at and in the vicinity of the Site were deposited on an uneven bedrock surface composed of the Chinle Formation.

2.5 Geology

The Site is located in the southeastern part of the Colorado Plateau physiographic province and is mostly on the south flank of the San Juan Basin. Figure 2-3 presents a portion of the geologic map of the Grants quadrangle (Dillinger 1990). The region experienced minor structural deformation (regional folding and block uplift) associated with formation of the Zuni Uplift, which is characterized by a northwest-trending anticline composed of Precambrian crystalline basement rocks overlain by Permian to Jurassic sedimentary rocks. Regional structural features are shown on Figure 2-4. Sedimentary rocks were uplifted during the Laramide Orogeny near the end of the Late Cretaceous through the Eocene, approximately 40 million to 80 million years before present (Cooley et al. 1969; Anderson et al. 2003; Lorenz and Cooper 2003). Bedrock units at the Site consist of the Glorietta Sandstone (Early Permian), San Andres Limestone (Early Permian), and Chinle Formation (Late Triassic). As a result of Laramide deformation, these bedrock units have a shallow northeastern dip direction of approximately 3 to 10 degrees (Kelley 1967).

The development of more recent northeast-trending, high-angle normal faulting associated with the Rio Grande Rift resulted in minor fault displacements in this part of New Mexico. The large northeast-striking San Mateo normal fault located northeast of the Site has a vertical displacement of as much as 450 feet (Santos 1970). Two small-scale normal faults near the Site (referred to as the West Fault and the East Fault) are shown on Figure 2-3. The West Fault and East Fault are part of

the San Mateo fault zone or may be part of the San Mateo fault zone (Thaden et. al., 1967). These two faults are approximately vertical, exhibit an east-side-down sense of shear, and act as impermeable barriers to groundwater flow within the permeable units of the Chinle Formation near the Site. However, the East Fault entirely loses slip displacement immediately south of the Felice Acres subdivision (that is, aquifer units are not vertically offset) (HMC and Hydro-Engineering 2010). With the exception of the southern terminus of the East Fault, structural offset within the Chinle Formation has resulted in the juxtaposition of permeable sandstones with impermeable mudstones and siltstones across the two faults. The magnitude of structural offset of the underlying SAG regional aquifer is much lower than the vertical thickness of the unit and does not appear to significantly affect groundwater flow.

In general, progressively older units of Cretaceous through Permian bedrock outcrop from northeast to southwest as a result of regional deformation and subsequent erosion. The overlying Tertiary units consist predominantly of widely scattered Middle Tertiary (Pliocene and Miocene) andesite and basalt surficial flows related to the Mount Taylor volcanic field cap. The Quaternary units consist of localized andesite and basalt flows and widespread alluvium, which is composed of eroded bedrock materials in the vicinity.

The Quaternary alluvium directly overlies the Chinle Formation and San Andres Limestone above a pronounced angular unconformity. As a result, sandstone units within the underlying Chinle Formation are abruptly truncated at the base of the alluvium. The Chinle Formation sandstone units are laterally continuous and separated by thick sections of low permeability shale. The Quaternary alluvial materials at the Site were partly derived from the erosion of ore-bearing bedrock. As a result, the alluvium contains significant concentrations of naturally occurring uranium, as well as selenium and molybdenum, which are typically present in uranium deposits (HMC 2012). Widespread Quaternary andesite and basalt flows are interbedded with the alluvial deposits. These localized volcanic flows were encountered during drilling investigations to the west of the Large Tailings Pile (LTP) and are limited to the area west of the Pleasant Valley Estates neighborhood. The thickness of the basalt encountered during drilling has a maximum thickness of 109 feet (average 49 feet).

Depictions of the three-dimensional geology and hydrogeology at the Site are illustrated on Figure 2-5, and detailed hydrogeological cross-sections A-A’ through D-D’ are depicted in Figures 2-6 through 2-10.

2.6 Hydrogeology

The Site is underlain by unconsolidated alluvial materials resting on the incised surface of the Late Triassic Chinle Formation. The alluvial materials are a heterogeneous mixture of sand, silt, clay, and gravel and comprise an aquifer with estimated hydraulic conductivities ranging from 10 to over 200 feet per day (ft/day) (HMC and Hydro-Engineering 2010). Depth to groundwater is 40 to 60 feet below ground surface at the Site. The thickness and extent of the saturated portion of the alluvial aquifer is shown on Figure 2-11 (HMC 2012).

Though the Chinle Formation is largely comprised of shale, there are three water-bearing units within the Chinle, including the Upper and Middle Chinle sandstone aquifer, and the Lower Chinle aquifer consisting of a zone of enhanced water yield within the shale formation. The extent of the Upper, Middle, and Lower Chinle aquifers are presented on Figure 2-12, Figure 2-13, and Figure 2-

14, respectively. A regional aquifer, the Permian-age San Andres Formation, exists at depth below the Site, and predominantly consists of limestone with subsidiary sandstones and shale. The extent of the SAG aquifer is shown in Figure 2-15.

Bedrock units have tilted and faulted near the Site. As a result, all three Chinle aquifers subcrop with the overlying alluvial aquifer. Water exchange occurs between the alluvial aquifer and the Chinle aquifers creating mixing zones. In the mixing zones, there is hydraulic communication between aquifers (U.S. Army Corps of Engineers [ACOE] 2010).

The following paragraphs describe Site aquifers.

2.6.1 Alluvial Aquifer System

The shallow unconfined aquifer in the area, the alluvial aquifer, includes the Quaternary Alluvium and surficial and interbedded volcanic flows. The alluvial aquifer near the Site consists of three distinct but connected alluvial systems: the San Mateo, Rio San Jose, and Rio Lobo alluvial systems, which represent the uppermost aquifer in the local groundwater system. The alluvial aquifer extends from northeast of the Site to the south and southwest, eventually joining with the more extensive Rio San Jose alluvial system (Figure 2-11).

Recent revisions were made to the interpreted extent of the Rio Lobo alluvial system. Due primarily to the ephemeral nature of the Lobo Creek, which was responsible for the deposition of the fluvial sediments that compose the Rio Lobo alluvial system, the saturated extent of this portion of the alluvial aquifer is limited to the east (Figure 2-11), where groundwater in the Rio Lobo alluvial system is directed to the southwest into a narrow alluvial channel.

Geologic information for the depth to the top of bedrock was obtained for historic borehole locations advanced in 1995 through the Rio Lobo alluvium along Lobo Creek, located more than one mile east of the Broadview Acres subdivision. The supplemental depth to bedrock information was integrated into the same 3-D geologic model that was used to model the extent of the saturated alluvium presented in the CAP submitted in 2012. The boundaries of the alluvial aquifer are defined by the intersection of the base of the alluvium (i.e., top of bedrock) with the groundwater surface. The 3-D groundwater surface (Feb 2010) that was used to bound the upper surface of the saturated portion of the alluvium presented in the 2012 CAP, was similarly used to revise the interpreted extent of the Rio Lobo alluvial system. The revised thickness and lateral extent of the saturated portion of the alluvial aquifer is shown on Figure 2-11.

2.6.1.1 San Mateo Alluvial Aquifer

The San Mateo alluvial aquifer occurs as an alluvial valley extending through the Site generally from north to south. Figure 2-4 presents the regional drainage basins including the San Mateo basin and the regional geology for the drainage areas contributing to the Site. The alluvial aquifer in and around the Site has been characterized by extensive drilling and well installation. Figure 2-16 provides the current alluvial well locations. Figures 2-17 through 2-20 are provided to present the well information in areas where data is too dense for scale of Figure 2-16. The locations of the additional maps are shown on Figure 2-16

Appendix B includes representative well logs for San Mateo alluvial aquifer. Well logs indicate the alluvial material is a very fine to coarse sand with relatively small and discontinuous silt and clay lenses. The characterization of the alluvial aquifer materials was extensive for the near up-gradient

wells with sieve analysis of drill cuttings. The well logs for wells to the south and west of the LTP indicate that materials in the alluvial aquifer throughout the Site are generally similar. The base of the alluvial aquifer for the majority of the Site occurs as a contact with the Chinle shale. Refer to Figure 2-21 for contours that represent the base of the alluvium across the Site.

Groundwater flow in the San Mateo alluvial aquifer is generally north to the south upgradient the LTP and to the southwest in the area of the LTP. Refer to Figures 2-22 through 2-26 for interpretation of alluvial groundwater flow directions based on data collected during 2014. An artificial hydraulic barrier that is part of the current remediation system creates a zone on the southern and western sides of the LTP area where the natural gradient is artificially interrupted by a combination of collection and injection operations.

The San Mateo alluvial system at the northern portion of the site along County Road 63 is characterized by a deeper paleochannel under the western portion of the LTP with a gradual slope to the east and a bedrock ridge creating a discontinuity in the alluvial sediments to the west. These features are shown in the base of alluvium mapping depicted on Figure 2-21 and in cross sections interpreted from geophysics on Figures 2-47 and 2-48. The bedrock ridge, which trends roughly north-south, was encountered in a number of borings, including SX, SW, S12, S and, most recently, BK4. Refer to Figure 2-46 for the location of the borings. At boring BK4 a sandstone unit was encountered at 35 feet bgs. The sandstone is permeable and saturated at 43 feet bgs. However, at historical water levels and likely future water levels, the ridge may have some effect on alluvial ground water flow coming into the site from the north, especially when considering that historic water levels of the alluvial aquifer were significantly lower than they are today. The lower water levels measured in 1960 by Chavez indicate that the ridge would have been a more pronounced barrier to ground water flow than it is today, possibly resulting in local braiding of the alluvial aquifer at the northwest corner of the LTP. See cross-section shown on Figure 2-30.

At “steady state” conditions, an area of high bedrock southwest and downgradient of the LTP results in a local branching of the San Mateo alluvial aquifer downgradient of the LTP. A branch extends to the west to a confluence with the Rio San Jose alluvial aquifer, and a branch extends to the south to a confluence with the Lobo alluvium, which eventually leads to a confluence with the Rio San Jose alluvial aquifer.

Since the inception of monitoring by HMC, saturation of the San Mateo alluvium has increased both upgradient and downgradient of the LTP. Increased saturation upgradient of the LTP is thought to be primarily attributable to recharge from the surface discharge of fluids from upgradient mines (refer to Figure 1-3. Below and downgradient of the LTP, mill operation is likely a large contribution to increased saturation.

The San Mateo alluvial aquifer generally behaves as an unconfined aquifer with specific yields ranging from 0.038 to 0.28. A specific yield of 0.1 is assumed to best represent the alluvial aquifer at the Site (HMC 2019d). Measured hydraulic conductivity values range from less than 1 to more than 200 ft/day. Figure 2-27 presents the hydraulic conductivities measured for the alluvial aquifer from pump tests. These values are, in general, locally consistent and are likely derived from the depositional environment. Specific examples of this consistency are areas where basalt is interbedded within the alluvium and generates high hydraulic conductivities in the Rio San Jose alluvium and the western extents of the San Mateo Creek alluvium, and low values found in areas adjacent to the historical streambed during deposition that likely received finer grained material such as the area due west of the LTP. This area of low hydraulic conductivity is also downgradient of the

bedrock ridge described in the preceding paragraph. Low hydraulic conductivity found in this area support the interpretation of fine grained deposition in areas beyond the extent of the paleochannel. Groundwater elevations within the alluvial aquifer ranged from approximately 6,427 to 6,604 feet above msl during December 2010. Groundwater flows in the alluvial aquifer at the Site generally follow topography to the southwest (HMC 2012).

2.6.1.2 Lobo Alluvium

The Lobo Creek drainage area is depicted on Figure 2-4. The area is approximately 56 square miles while the drainage area of SMC to the tailings is 240 square miles. The Lobo alluvium is typically a sandy material with minor clay and silt layers of limited continuity. The parent materials for the Lobo alluvium and San Mateo alluvium are generally similar and thus the physical characteristics of the alluvium are expected to be similar for the two drainage basins.

Nine test holes were drilled across the Lobo Creek alluvium to define saturation in the Lobo alluvium in 1995. Figure 2-28 presents the locations of these test holes and the elevation of the base of the alluvium in each of these drill holes. No saturation was found in any of these test holes with the lowest base of alluvium elevation of 6563 ft-MSL. The boring logs for these holes are presented in Appendix B. Based on this investigation, it is estimated that while some saturation may exist in the Lobo alluvium southeast of the LTP, it is likely confined to narrow sections where the alluvium was deposited within incised channels that have not been discovered by test hole drilling done to date. It may also be that a subcrop of pervious bedrock drains the alluvial aquifer upgradient of the confluence with the San Mateo. Alluvial saturation further to the north has also not been encountered, as evidenced by Chinle wells 929 through 934 located east of the LTP (refer to Figures 2-32, 2-37, and 2-42 for Chinle well locations) and alluvial wells 1N, 1I and 1O. Given the differences identified in water type in well ND as well as the differences identified in borehole BK3 in comparison to the rest of the background wells in the San Mateo Creek alluvium, it is possible that the confluence of the Lobo Creek and San Mateo Creek alluviums is in the vicinity of well ND and thus farther north than previous borehole attempts to intercept it (HMC 2019b). Based on the lack of alluvial saturation encountered in the Lobo drainage basin, the quantity of Lobo alluvial water entering the Site, if any, is thought to be only a small fraction of the quantity from the San Mateo alluvial aquifer.

2.6.1.3 Rio San Jose Alluvial Aquifer

Rio San Jose alluvium is generally sand and gravel with a wide range of transmissivity. Groundwater in the Rio San Jose alluvium flows southeast from the Bluewater site and merges with SMC alluvial groundwater. The combined flow continues southeast toward Milan (DOE 2014). A depiction of the groundwater flow is provided in Figure 2-29 (DOE 2014). Detailed description of San Jose alluvium and its origin is presented in *Groundwater Flow and Contaminant Transport in the Vicinity of the Bluewater, New Mexico, Disposal Site*, published by the DOE in November 2014.

2.6.2 Upper Chinle Aquifer

The Upper Chinle aquifer, one of three aquifers in the Chinle Formation, is a northeast-dipping, confined aquifer composed of a laterally continuous sandstone unit. Structural elevation contours of the top of the Upper Chinle aquifer indicate minor variations in the steepness of the northeasterly dip, particularly in the area immediately south of the LTP. The aquifer unit is hydraulically bounded from other Chinle Formation aquifer units by competent overlying and underlying shale that has

been structurally offset by the West and East Faults at the Site. The average thickness of the sandstone is approximately 35 feet (HMC 2012).

The Upper Chinle aquifer subcrops at the base of the alluvium on both sides of the East Fault, most notably at the base of the western side of the LTP. However, the sandstone subcrop does not occur west of the West Fault, rather, the subcrop was offset farther north as a result of the most recent high-angle normal faulting and northeast-dipping bed surface. The sandstone encountered in borehole BK4 is likely the same standstone as what makes up the Upper Chinle, but appears to be eroded between the ridge and the Upper Chinle subcrop as depicted in the cross section shown in Figure 2-30. The location of the wells used in this cross-section are best discplayed on Figure 2-46.

The water quality of the Upper Chinle aquifer is influenced by the water quality of the alluvial aquifer as a result of the alluvial aquifer discharging to the Upper Chinle east of the East Fault and in the vicinity near and north of the LTP (HMC 2012).

Aquifer properties vary significantly within the bedrock units due to the effects of secondary permeability; specifically, fracturing of the sandstone related to faulting. As a result, a narrow band (several hundred feet wide) of elevated transmissivity exists on both sides of the East Fault. Estimated transmissivity values along the western side of the East Fault exceed 10,000 gallons per day per foot (gpd/ft). Estimated transmissivity values on the eastern side of the East Fault exceeds 2,000 gpd/ft, but generally ranges between approximately 100 to 2,000 gpd/ft (HMC and Hydro-Engineering 2010). In contrast, estimated transmissivity values are much lower in the region between the West and East Faults, where the aquifer unit is not fractured and finer grain size was noted. Figure 2-31 provides a plan view showing Upper Chinle aquifer transmissivities. The hydraulic conductivity of the Upper Chinle ranges from less than 0.1 ft/day to more than 100 ft/day (HMC and Hydro-Engineering 2010).

HMC wells in the Upper Chinle aquifer are shown on Figures 2-32 and 2-33. The saturated thickness of the aquifer ranges from 15 to 65 feet thick with an average thickness of approximately 35 feet near the Site.

Groundwater flow direction in the Upper Chinle aquifer based on measurements completed in 2014 are provided on Figures 2-34 and 2-35. Flow directions are greatly influenced by remedial actions that are ongoing to remediate groundwater including fresh-water injection into the Upper Chinle at wells CW4R, CW5, CW13 and CW25 and collection from wells CE2, CE5, CE6, CE11 and CE12.

Well CW13, an injection well on the east side of the East Fault, is in the high permeability zone of the Upper Chinle aquifer that parallels the East Fault. This high permeability zone extends to a distance of at least 1000 feet parallel and adjacent to the East Fault near well CW18. Injection of fresh water has created a piezometric-surface mound along the east side of the East Fault. The permeability is much smaller at greater distances to the east of the East Fault and, therefore, an easterly gradient occurs in the Upper Chinle away from the East Fault near injection well CW13. The CW13 injection affects water levels on the west side of the East Fault in the area of Upper Chinle well CW53 in Felice Acres. Water level changes in well CW53 respond quickly to change in levels in well CW13 showing that a good connection exists in the Upper Chinle where the East Fault pinches out south of well CW53.

Injection of fresh water into Upper Chinle well CW5 is causing ground water flow to the north and south of this area. The flow that moves to the south discharges to the alluvial aquifer in the subcrop

area of the Upper Chinle, and the flow that moves to the north converge toward collection wells CE2, CE5, CE6, CE11 or CE12.

Injection into Upper Chinle well CW25 was started in 2000, and this injection are causing ground water to flow from this well back toward these collection wells. The naturally occurring flow direction in the Upper Chinle aquifer west of the East Fault is from the north.

2.6.3 Middle Chinle Aquifer

The Middle Chinle aquifer is an east to northeast-dipping, confined aquifer composed of laterally continuous sandstone. The aquifer unit is similar to the Upper Chinle aquifer and is hydraulically bounded from other Chinle Formation aquifer units by competent overlying and underlying shale. The Middle Chinle aquifer is generally the thickest of the sandstone units in the Chinle Formation and has a saturated thickness ranging from 10 to 80 feet with an average thickness of approximately 44 feet near the Site (HMC 2012).

The Middle Chinle aquifer exists as three fault-bound groundwater systems separated by the West and East Faults (HMC and Hydro-Engineering 2010). All three systems for the Middle Chinle aquifer subcrop at the base of the alluvium. The subcrops on either side of the West Fault have been laterally offset by approximately 5,400 feet due to fault slip along the West Fault. Hydraulic connectivity with the overlying alluvial aquifer exists on the west side of the West Fault. Hydraulic connectivity also exists with the alluvial aquifer between the West and East Faults at an isolated subcrop location within a confined alluvial channel south of the Felice Acres subdivision (HMC 2012).

Hydraulic properties of the Middle Chinle aquifer vary significantly due to the effects of reduced permeability associated with faulting, groundwater pumping, and containment measures (HMC and Hydro-Engineering 2010). Adjacent to the east side of the East Fault, Middle Chinle aquifer transmissivity is approximately 500 gpd/ft but decreases to less than 100 gal/day/ft east of this area. Areas of transmissivity above 5,000 gpd/ft have been observed in the Middle Chinle aquifer west of the East Fault in the western portion of the LTP, eastern Murray Acres and western Broadview and Felice Acres. Figure 2-36 provides a plan view showing Middle Chinle aquifer transmissivities.

The head in the Middle Chinle aquifer on each side of the two faults is significantly different from the head between the two faults, which demonstrates that the groundwater is not readily connected across fault boundaries. The West Fault represents a significant barrier to groundwater flow within the Middle Chinle aquifer, with up to 110 feet of hydraulic head difference across the fault in the area west of the LTP.

HMC wells in the Middle Chinle aquifer are shown on Figures 2-37 and 2-38 and the inferred direction of groundwater flow in the Middle Chinle is shown on Figures 2-39 and 2-40. The hydraulic gradient in the Middle Chinle aquifer is steeper in its alluvial subcrop area in the southern portion of Felice Acres near wells 498, CW45 and CW46.

Pumping of Middle Chinle South Collection wells Y7 and Y23 developed a depression in the Middle Chinle water surface that extends nearly 500 feet to the northeast and southwest of well Y7. This depression intercepts flow in the Middle Chinle that flowing in this portion of South Felice Acres. A steep gradient was developed to the southeast of collection well Y7 due to changes in transmissivity in this area. This increase in gradient is due to an influx of water to the Middle Chinle aquifer from the alluvial aquifer.

Flow on the east side of the East Fault is mainly toward well CW28.

Ground water flow west of the West Fault in the Middle Chinle aquifer is historically to the southwest, and it discharges into the alluvial aquifer. This prevented the impacted alluvial aquifer from affecting the water quality of the Middle Chinle aquifer on the west side of the West Fault. Middle Chinle water flows from upgradient of the Site into the area west of the LTP. The hydraulic contact that allows for alluvial recharge upgradient of the site is likely relatively close to the site given that the major ion water quality of the Middle Chinle wells west of the west fault is similar to that of the alluvial water rather than the non-mixing zone wells east of the west fault in the Chinle aquifers that becomes prevalent a certain distance beyond the subcrop. Alluvial injection in the northern portion of Section 27 temporarily reversed the gradient in the Middle Chinle during 2006 through 2014. Collection in well CW62 started in 2016 has created a depression in the water level surface that draws water from the Middle Chinle to the north and from the alluvial aquifer through the subcrop to the south.

The remainder of the Middle Chinle aquifer is recharged by the alluvial aquifer south of Felice Acres. The injection of fresh water into wells CW14 (north of Broadview Acres) and CW30 (west of Felice Acres) has created ground water mounds in their respective areas. These mounds cause the ground water to flow both north and south from these two wells. The head in the Middle Chinle aquifer on each side of the two faults is significantly different from the head between the two faults, which demonstrates that the ground water is not readily connected on each side of these faults.

2.6.4 Lower Chinle Aquifer

The confined Lower Chinle aquifer is the deepest permeable zone within the Chinle Formation and is generally located approximately 200 feet above the geologic contact with the San Andres limestone. The aquifer is hydraulically isolated from the overlying Middle Chinle aquifer and underlying SAG regional aquifer. In contrast with the overlying Chinle aquifers, the Lower Chinle aquifer is composed of shale with enough developed secondary permeability to behave as a limited aquifer (HMC and Hydro-Engineering 2010). The permeability of the aquifer is not consistently high enough to serve as a viable aquifer, and areas exist where the aquifer is effectively absent.

The Lower Chinle aquifer subcrops at the base of the alluvium on either side of the West Fault, which has been laterally offset by approximately 3,000 feet due to slip displacement along the West Fault. Direct hydraulic connectivity with the overlying alluvial aquifer exists in the area between the West and East Faults southwest of the Felice Acres subdivision and immediately west of the Valley Verde and Pleasant Valley subdivisions on the west side of the West Fault. The Lower Chinle aquifer is presumed to be laterally continuous immediately south of the terminus of the East Fault, where the aquifer functions as a single hydrologic unit (HMC 2012).

The hydraulic properties of the Lower Chinle aquifer are highly variable and largely depend on secondary permeability within the shale. The ability of the Lower Chinle aquifer to produce water is much lower and less consistent than overlying Chinle sandstone aquifers. Hydraulic conductivity ranges from 0.1 to more than 50 ft/day (HMC and Hydro-Engineering 2010). Estimated transmissivity values for the aquifer are generally higher than 100 gpd/ft near subcrop locations (HMC and Hydro-Engineering 2010). However, selected areas near subcrop locations exceed 1,000 gpd/ft. Figure 2-41 provides a plan view showing Lower Chinle aquifer transmissivities.

HMC wells in the Lower Chinle aquifer are shown on Figures 2-42 and the inferred direction of groundwater flow in the Lower Chinle is shown on Figures 2-43. Groundwater elevations for the aquifer ranged from approximately 6,426 to 6,488 feet above msl during December 2010 (HMC and Hydro-Engineering 2010). Flow west of the West Fault in the Lower Chinle is mainly to the northeast. Flow between the two faults is to the northeast in the area of the tailings. The flow is to the northwest in the southern portion of the Lower Chinle aquifer between the faults. The northwesterly flow direction in this area indicates that the Lower Chinle water moves across the West Fault in the area west of Broadview Acres. Hydraulic head is higher in the alluvial aquifer than in the Lower Chinle aquifer with the exception of the subcrop locations, where the hydraulic communication occurs.

In general, the Lower Chinle aquifer is only viable as a water resource near the subcrop locations in connection with the alluvial aquifer, where adequate secondary permeability has likely resulted from weathering and faulting (HMC 2012).

2.6.5 San Andres-Glorietta Regional Aquifer

The SAG aquifer is the most important regional aquifer in the Site area, consisting of the San Andres Limestone and Glorietta Sandstone with a total thickness that exceeds 200 feet (HMC and Hydro-Engineering 2010). Similar to the Chinle Formation aquifers, the regional aquifer is mildly folded and dips to the east and northeast as a result of regional tectonic deformation. Refer to Figure 2-44 for a plan view of the Site area showing well locations, measured ground water elevations and inferred contours from 2014 measurements. The aquifer has been used by HMC as the source of unimpacted clean water used for hydraulic containment of the alluvial aquifer and Chinle Formation aquifers. Thus, some of the water level elevations shown on Figure 2-44 are depressed due to pumping (wells 951R 943 #1 and #2). The contours shown are based in part on wells that are not shown on Figure 2-44, including well 951 and DOE wells further upgradient.

Groundwater elevations near the Site ranged from 6,420 to 6,433 feet above msl during December 2010 (HMC and Hydro-Engineering 2010). Flow direction is to the east-southeast. The water-level elevations measured during 2014 show a very flat piezometric surface. The continuity of the gradient across the Site indicates that the East and West Faults do not significantly affect the ground water flow in the SAG aquifer. It is believed that the displacement at the faults is not large enough to completely displace the entire thickness of this aquifer system. The increase in gradient across the Site also indicates a decrease in transmissivity in the area of the steeper gradient. The faults may cause a decrease in the transmitting ability of the SAG aquifer.

The U.S. Geological Survey (USGS) suggested an average transmissivity of 374,000 gpd/ft (Baldwin and Anderholm 1992; Frenzel 1992). An average groundwater velocity of 4 ft/day is estimated based on a hydraulic conductivity of 615 ft/day, a gradient of 0.00086 foot per foot (ft/ft), and an assumed effective porosity of 0.1 (HMC and Hydro-Engineering 2010). The groundwater velocity is likely to vary greatly in this type of aquifer due to a very wide variation of hydraulic conductivity and effective porosity.

The SAG regional aquifer and the alluvial aquifer are separated by the Chinle formation that acts as an aquitard (approximately 800 feet) at the Site. Refer to Figure 2-45 for a cross-section showing the bedrock formations across a portion of the Site. The plan location of the cross-section is shown on Figure 2-44. Interpretation of the piezometric head for the alluvial and SAG aquifers is shown on Figure 2-45. Difference in the head between the two aquifers confirms that the Chinle formation is

acting as an aquitard. As shown on Figure 2-44, the SAG aquifer subcrops the alluvial aquifer in Sections 5 and 32 west of the Site.

2.7 Historic Mining Impact to the San Mateo Creek Alluvium

As described in Section 1.4 and shown on Figure 1-3, the Site is located within the Grants Mineral Belt, where significant uranium mining and milling occurred starting in the early 1950s. Over many years, studies have evaluated the impact of historic mining and milling within the SMC Basin, with emphasis on groundwater impacts. Figure 1-3 provides a view of the SMC Basin, and the location of mines and mills within the basin. The potential impacts to the SMC alluvial aquifer are relevant to the Site given that it is the upgradient groundwater quality has changed over the period of monitoring and may continue to change in the future. The source and extent of these water quality changes lacks characterization.

2.7.1 Phase 2 Ground-Water Investigation Report for the San Mateo Creek Basin

The *Phase 2 Ground-Water Investigation Report for the San Mateo Creek Basin Legacy Uranium Mines Site Cibola and McKinley Counties, New Mexico* (Phase 2 Report) was completed by EPA to further the characterization of shallow ground-water quality and assess potential impacts from legacy uranium mining industry activities within the SMC Basin (EPA 2018). A brief summary of the evaluations and conclusions EPA developed relevant to the Site is presented in the bullets below.

- Alluvial Saturation: The Phase 2 Report uses alluvial saturation isopach maps from three time periods to demonstrate that discharge from approximately 30 mines during the late 1950s to the late-1970s was substantial and led to a rise in the static water level of approximately 45 to 55 feet in alluvial wells located near the junction of State Highways 605 and 509 (known locally as the "Crossroads") and the northern part of the SMC floodplain. By 2015, saturation in alluvial wells in the Crossroads area and northern part of the Lower Basin SMC floodplain have returned to near pre-mine discharge levels.

  In the southern part of the floodplain, north of the Site, there was little rise in static water levels of alluvial wells (approximately 1-2 feet) by 1976-77. Since that time, static water levels increased by approximately ten feet by 2015.
- Alluvial Water Quality Assessment: EPA review of historic and recent water quality data suggest that plumes of uranium and selenium groundwater migrated to the south SMC floodplain of the lower basin in the early 1980s and 1990s (EPA 2018). However, a concentration that indicates the presence of mine discharge water in the Lower Basin Alluvium could not be established based on the data (EPA 2018). It is also important to note that pre-mining background water quality for uranium and selenium are not available, which makes it difficult to establish that the plumes are the result of a release without using other lines of evidence.

- Geochemical Analysis: Major ion concentration comparisons including total dissolved solids (TDS), sulfate, chloride, and uranium were evaluated to identify the chemical character of mine discharge water recharge. Indicator values were established for the SMC Upper Basin groundwater, but the data did not support the use of the values for Lower Basin groundwater

(EPA 2018). EPA's examination of the light sulfur isotope ratio ($\delta^{34}S$) suggests the presence of mine discharge water in both Upper and Lower Basin groundwater, but the conclusion was not definitive (EPA 2018).

2.7.2 Controls on Groundwater Background Constituent Concentrations due to Mineralogy Local to Monitoring Wells

In 2018 a white paper entitled *Controls on Groundwater Background Constituent Concentrations due to Mineralogy Local to Monitoring Wells: Grants, New Mexico* was developed. The white paper evaluated the water quality in the SMC Lower Basin through field and laboratory evaluation of geology, mineralogy and geochemistry of sediments and groundwater local to a set of groundwater monitoring wells (HMC 2018a). The wells evaluated have historically been used to measure background water quality for the Site. For a discussion of these wells and the development of background concentrations for the SMC alluvium, refer to Section 3.2.1. The study included the following elements:

- Sediment sampling and analysis: Two boreholes were completed in 2018 adjacent to existing upgradient wells DD and DD2 in the background area at the Site and samples from these boreholes were collected for analyses. Sample analyses included metal concentrations, leachability, grain size distribution, optical evaluation of mineralogy, and x-ray diffraction.

- Geophysical assessment: Geophysical data collected from the two borings described above, and from six monitoring wells completed in the alluvial aquifer (near DD, DD2, MV, ND, Q, T-11) by the USGS in 2016. Geophysical techniques used by USGS on the six wells included measurement of well construction and integrity (caliper, optical televiewer), groundwater/aquifer physical characteristics (induction, electromagnetic flowmeter, fluid temperature, and conductivity), and radioactivity of the material surrounding the well (natural gamma ray and natural gamma ray spectroscopy). Geophysical methods employed on two borings completed in 2018 included natural gamma ray, natural gamma ray spectroscopy, and induction conductivity.

The following conclusions were drawn from the study:

- Sediment cores lithologically logged from the two boreholes (DD-BK and DD2-BK) indicate significant vertical heterogeneity including an alternating sequence of clays, silts, silty-sands, sandy-silts, sands with various amounts of gravel, and occasional gravel layers. Previous drilling logs based on lower-resolution sampling and visual soil descriptions suggest that the alluvium was uniform with very low variability in lithology.
- Heterogeneity is also noted in the variable levels of gamma radiation measured at different lithological layers throughout each borehole. Zones of fine-grained material correlate with elevated uranium based on spectral gamma analysis.
- Mineralogical analyses suggested that materials encountered at DD-BK and DD2-BK are associated with source rock that contains unaltered feldspars, claystones that include kaolinite, and arkosic sandstones. These materials are also found at the upgradient northern boundary of the basin in the Westwater Canyon and Brushy Basin Members of the Morrison Formation, each of which contain uranium in concentrations of economic value (ore-grade).

This provides evidence that local bedrock is likely the source of uranium deposited into SMC alluvial sediments, rather than from groundwater impacted from historic mining.

- Geochemical testing, both total metal and leachability analyses, show that uranium and other constituents are primarily associated with fine-grained materials (clay and silt). Thus, the material in which a well is screened may affect the well chemistry.

2.7.3 Supplemental Background Soil and Groundwater Investigation Report

In 2019 additional field investigations were conducted by HMC to expand the extent of characterization of the soils east of wells DD and DD2, across the alluvial channel. The field investigation was documented in the report entitled, *Draft Supplemental Background Soil and Groundwater Investigation Report Grants Reclamation Project, Cibola County, New Mexico*. The investigation included:

- Installation of two well pairs and two boreholes. Refer to Figure 2-46 for a plan view of the well pairs and boreholes. Wells and boreholes were advanced using rotosonic drilling, which allowed for detailed geological logging.
- Soil sampling over a wide range of lithologies and mineralogical characteristics and analyzed for uranium and other metals, water quality parameters, mineralogical analysis, and isotope analysis.
- Groundwater sampling from each of the new wells and analysis for total and filtered metals, anions, nitrate, ammonia, isotopic uranium, total organic carbon, dissolved organic carbon, phosphate, and stable sulfur isotope analysis.
- Electrical resistivity tomography (ERT) assessment to map the alluvial channel geometry and internal variations within the alluvium. Two transect alignments of ERT were performed to provide a continuous image of the alluvial channel geometry and resistivity data on the sediments. Refer to Figure 2-46 for the transect locations.
- Borehole geophysical logging.

The investigation completed in 2019 reinforced the findings of the 2018 report and white paper, and added the following conclusions (HMC 2019b):

- A sandstone bedrock ridge is located northwest of the LTP, at borehole location BK4, which extends above the water table. There is evidence that the sandstone is permeable.
- The highest uranium concentrations encountered are in the unsaturated zone, indicating that uranium in alluvial soils is naturally occurring due to transport and deposition of naturally uranium-rich materials throughout geologic time, not from deposition from uranium-bearing groundwater.
- Geochemical analyses indicate that uranium and vanadium are generally correlated with each other.
- ERT data revealed higher resistivity alluvium, which is typical of coarse-grained materials, between the center and the western edge of the alluvial channel. Coarse-

grained sediments may conduct groundwater more effectively through the center-west portion of the alluvium compared to the eastern side of the basin. Figures 2-47 and 2-48 are vertical cross-sectional portrayals of modelled electrical resistivity roughly from the ground surface.

- The variability and heterogeneity of the alluvial system is therefore captured by the current upgradient (background) well network situated across the basin and represents the range of natural uranium concentration variation in groundwater prior to the alluvial system moving on-Site. The location of the monitoring points established to develop the Site background groundwater standards is therefore appropriate, as is the numerical approach as it included all of the groundwater quality data at these monitoring points distributed across the alluvial valley. It is noted that the EPA and New Mexico Environment Department do not agree with this conclusion in Homestake's 2019 supplemental background investigation and continue to independently reassess background at the Site. EPA will determine the appropriate background concentrations and, ultimately, the preliminary remediation goals (PRGs) developed for groundwater of the alluvial and Chinle aquifers during the CERCLA RI/FS Equivalency process.

2.8 Surface Water

The natural land surface gradients of the Site are usually less than 1 percent; the average grade is 0.1 percent. Surface drainage across the Site is predominately directed to the southwest, although there are generally no established drainage courses or signs of active erosion. Ponding may occur after significant precipitation events, but this water either evaporates or infiltrates the alluvium (HMC 2012).

San Mateo Creek and Lobo Creek basins both drain onto the Homestake Facility. Two Lobo Creek drainage paths enter the east side of the Homestake Facility (refer to Figure 1-1). A diversion levee was constructed to the north of the mill area to divert surface water discharges from the northern branch of Lobo Creek (refer to Figure 1-6). During flood events, the levee diverts Lobo Creek water to the North Diversion Channel located north of the LTP, preventing discharges from flowing across the mill area. The levee was constructed of uncontaminated soils from the North Borrow Area and generally consists of clayey sands and sandy clays. The slopes of the levee are protected against erosion using the same cover specified for the tailings pile top surfaces (HMC 2013a). San Mateo Creek drainage enters the Homestake Facility from the north, and is diverted by the North Diversion Channel west around the LTP.

2.9 Demographics and Land Use

The Site is situated in Cibola County, which encompasses a land area of 4,539 square miles (City-Data 2019a). Cibola County was created by a division of Valencia County in 1981; therefore, population data for the new county before 1981 are estimated. In 1970, the county's population was 20,125, rising to 30,109 in 1980 and falling to 20,794 in 1990. The population changes were mainly related to uranium mining activity in the area. The population was estimated at 27,351 in 2016 with a population density of six people per square mile (City-Data 2019a).

The average household size in the county in 2016 was 2.0 people compared to 3 people for the State of New Mexico (City-Data 2019a). The estimated median household income in 2016 was

$37,010, compared to the state median income of $46,748 (City-Data 2019a). Industries providing employment in Cibola County as of 2016 were: educational, health, and social services (36.7%); professional, scientific, management, administrative, and waste management services (11.9%); agriculture, forestry, fishing and hunting, and mining (11.4%); and public administration (14.1 percent) (City-Data 2019a).

The most common industries for males are (City-Data 2019a):

- Health care and social assistance (23%)
- Educational services (13%)
- Retail trade (12%)
- Accommodation and food services (10%)
- Arts, entertainment, and recreation (9%)
- Public administration (8%)
- Other services, except public administration (3%)

The most common industries for females are (City-Data 2019a):

- Health care and social assistance (25%)
- Educational services (14%)
- Retail trade (13%)
- Accommodation and food services (10%)
- Arts, entertainment, and recreation (10%)
- Public administration (9%)
- Other services, except public administration (4%))

Ethnicity (by percentage) in Cibola County for the year 2016 is displayed in Table 2-3 (City-Data 2019a).

Table 2-3 Cibola County, New Mexico Ethnicities

Ethnicity	Percentage[1]
White Non-Hispanic Alone	19.9%
Hispanic or Latino	38.4%
American Indian and Alaska Native Alone	38.1%
Persons reporting two or more races	1.8%
Black Non-Hispanic Alone	0.9%
Asian Alone	0.6%

Source: City-Data 2019a

The median resident age is 36.3 years, compared to the state median age of 37.7 years (City-Data 2019a).

A mix of rural and industrial activities has characterized the Cibola County economy. Uranium mining has been the biggest factor in the boom cycles of the 1950s, 1960s, and 1970s and the bust

cycle in the 1980s. The location of the federal and state prisons in the county has helped buffer some of the past economic downturn.

The City of Grants is the largest incorporated area near the Site and is the county seat of Cibola County. The City of Grants began as a railroad camp in the 1880s and now encompasses a land area of approximately 14.86 square miles with a population of 9,241 in 2014 (City-Data 2019b). The estimated median household income for the City of Grants in 2016 was $36,606, compared to $30,652 in 2000 (City-Data 2019b). The Village of Milan is a suburb of the City of Grants and had a population of 3,255 as of 2014 (City-Data 2019c).

Current major land uses south and southwest of the Site consist of residential development, agriculture, and livestock raising (EPA 2011). Five residential subdivisions near the Site include Felice Acres, Broadview Acres, Murray Acres, Pleasant Valley Estates, and Valle Verde. There are large areas north, east, and west of the Site that are mostly unused except for livestock grazing (ACOE 2010). According to the United States Department of Agriculture (USDA), cattle are the main livestock produced in Cibola County, followed by sheep (USDA 2007).

2.10 Ecology

2.10.1 Regional Setting

The Site is located within the Semiarid Tablelands ecoregion of the Arizona and New Mexico plateau that contains areas of high relief and some low relief plains (EPA 2010a). It is characterized by canyons, valleys, mesas, and plateaus formed primarily from flat to gently sloping sedimentary rocks, and areas of Tertiary and Quaternary volcanic fields. Bedrock exposures are common features in this ecoregion. The tablelands are vegetated with woodland, shrubs, and grass. Shallow, stony soils supporting scattered to dense stands of junipers (*Juniperus species [spp.]*), and pinyon-juniper woodland is common in some areas. Other characteristic vegetation includes saltbush (*Atriplex spp.*), alkali sacaton (*Sporobolus airoides*), sand dropseed (*Sporobolus cryptandrus*), and mixed grama grasses (*Bouteloua spp.*). Vegetation is not as sparse as in the San Juan/Chaco Tablelands and Mesas ecoregion to the north or the Albuquerque Basin ecoregion to the east. The Semiarid Table lands ecoregion lacks the dense pine forests typical of the higher-elevation Arizona and New Mexico Mountains ecoregion (EPA 2010a).

2.10.2 Vegetation

The Site and surrounding area generally consists of desert and semi-desert habitat. Vegetation communities are predominately Inter-Mountain Basins Mixed Salt Desert Scrub and Inter-Mountain Basins Semi-Desert Grasslands, with smaller, patchy areas of Inter-Mountain Basins Semi-Desert Shrub Steppe (HMC 2018b).

Vegetation types within the Site and immediate vicinity consist largely of semi-desert grassland, mixed salt desert scrub, and greasewood flat (Southwest Regional Gap Analysis Project 2004). The Site has been subject to human disturbance for more than 50 years. In 1995, much of the Homestake Facility was bladed and reseeded with a seed mixture consisting of western wheatgrass (*Pascopyrum smithii*), blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), Indian ricegrass (*Achnatherum hymenoides*), alkali sacaton (*Sporobolus airoides*), and fourwing saltbush (*Atriplex canescens*) (NRC 1993). Groundcover varies from 79 percent to 99 percent.

Other common plant species found within the Homestake Facility include kochia (*Kochia spp.*), bottlebrush squirreltail (*Elymus elymoides*), Russian thistle (*Salsola tragus*), broom snakeweed (*Gutierrezia sarothrae*), three-awn (*Aristida spp.*), spike dropseed (*Sporobolus contractus*), galleta grasses (*Pleuraphis spp.*), greasewood (*Sarcobatus vermiculatus*), sand sage (*Artemisia filifolia*), and narrowleaf yucca (*Yucca angustissima*). Limited areas of saltcedar (*Tamarix ramosissima*) are present along the ephemeral San Mateo Creek (HMC 1982; Bridges and Meyer 2007; NRC 2008).

2.10.3 Wildlife

Characteristic species include desert cottontails, jack rabbits, pocket gophers, meadowlarks, and western rattlesnakes. Table 2-4 lists species known to occur within the Site or immediate vicinity. Results of bird surveys conducted in 2018 in the Site area are included in Table 2-4. In addition to the species in Table 2-4, various species of shorebirds and waterfowl have been observed using the evaporation ponds at the Site during spring and fall migration (HMC 1982; Bridges and Meyer 2007).

Table 2-4 Wildlife Species Known to Occur in the HMC Superfund Site Area

Common Name	Scientific Name
Mammals	
Desert cottontail	*Sylvilagus audubonii*
Black-tailed jackrabbit	*Lepus californicus*
Silky pocket mouse	*Perognathus flavus*
Botta’s pocket gopher	*Thomomys bottae*
Deer mouse	*Peromyscus maniculatus*
Ord’s kangaroo rat	*Dipodomys ordii*
White-throated woodrat	*Neotoma albigula*
Mexican woodrat	*Neotoma mexicana*
Spotted ground squirrel	*Spermophilus spilosoma*
Rock squirrel	*Spermophilus variegatus*
Black-tailed prairie dog	*Cynomys ludovicianus*
Coyote	*Canis latrans*
Mule deer	*Odocoileus hemionus*
Birds	
American robin	*Turdus migratorius*
American kestrel	*Falco sparverius*
Barn swallow	*Hirundo rustica*
Bewick's wren	*Thryomanes bewickii*
Brewer's sparrow	*Spizella breweri*
Brown-headed cowbird	*Molothrus ater*
Bullock's oriole	*Icterus bullockii*
Burrowing owl	*Athene cunicularia*
Common raven	*Corvus corax*
Eastern meadowlark	*Sturnella magna*
Eurasian collared-dove	*Streptopelia decaocto*
European starling	*Sturnus vulgaris*
Ferruginous hawk	*Buteo regalis*
Golden eagle	*Aquila chrysaetos*

Table 2-4 Wildlife Species Known to Occur in the HMC Superfund Site Area (Con't)

Common Name	Scientific Name
Great blue heron	*Ardea herodias*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*
House finch	*Haemorhous mexicanus*
House sparrow	*Passer domesticus*
Loggerhead shrike	*Lanius ludovicianus*
Mourning dove	*Zenaida macroura*
Northern mockingbird	*Mimus polyglottos*
Olive-sided flycatcher	*Contopus cooperi*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Sage thrasher	*Oreoscoptes montanus*
Sagebrush sparrow	*Artemisiospiza nevadensis*
Say's phoebe	*Sayornis saya*
Scaled quail	*Callipepla squamata*
Turkey vulture	*Cathartes aura*
Vesper sparrow	*Pooecetes gramineus*
Violet-green swallow	*Tachycineta thalassina*
Western kingbird	*Tyrannus verticalis*
Western meadowlark	*Sturnella neglecta*
White-crowned sparrow	*Zonotrichia leucophrys*
Yellow-rumped warbler	*Setophaga coronata*
Reptiles	
Western rattlesnake	*Crotalus oreganus*
Lesser earless lizard	*Holbrookia maculata*
Horned lizard	*Phrynosoma* spp.

Sources: HMC 2013a; HMC 1982; Salter 1990; Bridges and Meyer 2007, HMC 2018b

2.10.4 Aquatic Ecology

The ephemeral San Mateo Creek exists within the Site, but flows infrequently and only after heavy precipitation events or snowmelt. There is no distinct channel for this drainage within the Site (Bridges and Meyer 2007).

The evaporation ponds are man-made, engineered structures designed to concentrate Site contaminants. Therefore, they do not have a natural aquatic ecosystem, and are not suitable for aquatic habitats for community-level receptor groups such as fish or invertebrates.

The significant aquatic habitat nearest to the Site is Bluewater Lake, a man-made impoundment of Bluewater Creek, located about 14 miles to the west.

2.10.5 Threatened and Endangered Species and Species of Concern

Threatened and endangered species and species of concern known to occur in Cibola County are listed in Table 2-5 with a description of their potential for occurrence near the Site (HMC 2013a).

No species currently listed as endangered by the federal government or the State of New Mexico are expected near the Site. The majority of listed species and species of concern have no potential to occur in the project area due to a lack of suitable habitat. A survey by biologist Louis Bridges, who has extensive experience with western threatened and endangered species evaluations, confirmed the lack of suitable habitat for listed plant and animal species (Bridges and Meyer 2007). The exceptions are American peregrine falcons, arctic peregrine falcons, and bald eagles, which may occasionally pass through the project area during migration; cinder phacelia, mountain plovers, and western burrowing owls, which can inhabit disturbed areas and areas near people; and spotted bats, which may occasionally forage at the Site (HMC 2013a).

Table 2-5 Known or Suspected Threatened, Endangered, and Candidate Species

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat	Potential for Occurrence
Acoma fleabane	Erigeron acomanus	Species of Concern	None	Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone Formation in piñon-juniper woodland; 2,100-2,170 m (msl)	None; there is no suitable habitat in the project area and the project area is located below the elevational range for this species.
American peregrine falcon	Falco peregrinus anatum	Species of Concern	Threatened	Cliffs in forested or wooded habitats	Low; there is no suitable nesting habitat in or near the project area. Individuals may pass through when migrating or foraging.
Arctic peregrine falcon	Falco peregrinus tundrius	Species of Concern	Threatened	Forested or wooded montane habitats	Low; individuals may pass through when migrating.
Bald Eagle	Haliaeetus leucocephal us alascanus	None	Threatened	Timbered areas along coasts, rivers, and large lakes	Low; there is no suitable nesting or roosting habitat in or near the project area. Individuals may pass through when migrating.
Black- footed ferret	Mustela nigripes	Endangere d	None	Large prairie dog colonies (more than 40 hectares in size)	None; the prairie dog colonies in and near the project area are small (<40 hectares) and therefore not suitable for this species.
Cebolleta southern pocket gopher	Thomomys umbrinus paguatae	Species of Concern	None	Sycamore, cottonwood, and rabbitbrush riparian habitats	None; there is no suitable habitat in or near the project area.
Cinder phacelia	Phacelia serrate	Species of Concern	None	Volcanic cinders; also roadcuts and abandoned quarries in open, sunny locations; near ponderosa pine and piñon-juniper woodlands; 1,800-2,200 m	Low; there is some potential for this species to be found within disturbed areas, but the habitat is not ideal.
Gray vireo	Vireo vicinior	None	Threatened	Open woodlands and shrublands	None; there is no suitable habitat in or near the project area.
Gypsum phacelia	Phacelia sp. nov.	Species of Concern	None	Weathered gypsum outcrops and gypsiferous and pure gypsum soils in woodland and desert scrub at elevations of 1,600-2,300 m (msl)	None; there is no suitable habitat in or near the project area.

Table 2-5 Known or Suspected Threatened, Endangered, and Candidate Species (Con't)

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat	Potential for Occurrence
Mountain plover	Charadrius montanus	None	Sensitive	Shortgrass prairie, barren ground, disturbed areas, especially areas of flat topography and with no nearby surface water	Low; there is some potential for nesting in disturbed areas in and around the project area, but the habitat is not ideal.
New Mexico silverspot butterfly	Speyeria nokomis nitocris	Species of Concern	None	Alpine meadows	None; there is no suitable habitat in or near the project area.
Northern goshawk	Accipiter gentilis	Species of Concern	None	Various forest types, especially mature, closed-canopy forest	None; there is no suitable habitat in or near the project area.
Parish's alkali grass	Puccinellia parishii	None	Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes at 800-2,200 m	None; there is no suitable habitat in the project area.
Pecos sunflower	Helianthus paradoxus	Threatened	Endangered	Saturated saline soils of desert wetlands. Usually associated with desert springs (cienegas) or the wetlands created from modifying desert springs; 1,000-2,000 m	None; there is no suitable habitat in or near the project area.
Rio Grande sucker	Catostomus plebeius	Species of Concern	None	Pools, runs, and riffles of small to moderately large streams	None; this species is believed to be extirpated from the Rio San Jose watershed and there are no suitable aquatic habitats in the project area.
Southwestern willow flycatcher	Empidonax traillii extimus	Endangere d	Endangered	Riparian habitats	None; there is no suitable habitat in or near the project area.
Spotted bat	Euderma maculatum	None	Threatened	Subalpine coniferous forest, montane forest, pinyon-juniper woodland, open semi- desert shrubland. Roosts in crevices in cliffs and canyons.	Low; there is some potential for this species to forage in the project area although there are no suitable roosting sites.

Table 2-5 Known or Suspected Threatened, Endangered, and Candidate Species (Con't)

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat	Potential for Occurrence
Western burrowing owl	Athene cunicularia hypugaea	Species of Concern	None	Open land with small mammal burrows, especially prairie dog burrows	Moderate; there is some potential for this species to use prairie dog or ground squirrel burrows within the project area. Few individuals would be expected based on the lack of extensive prairie dog colonies.
Yellow- billed cuckoo	Coccyzus americanus	Candidate	None	Lowland riparian woodlands	None; there is no suitable habitat in or near the project area.
Zuni bluehead sucker	Catostomus discobolus yarrow	Candidate	Endangered	Headwater streams to large rivers with moderate to fast flowing water above a rubble-rock substrate	None; there are no known occurrences of this species in the Rio San Jose watershed where this project is located, and there are no suitable aquatic habitats in the project area.
Zuni fleabane	Erigeron rhizomatus	Threatened	None	Nearly barren detrital clay hillsides with soils derived from shales of the Chinle or Baca formations; most often on north or east-facing slopes in open piñon-juniper woodlands at 2,200-2,400 m	None; there is no suitable habitat in the project area and the project area is located below the elevational range for this species.

Sources: HMC 2013a; Natural Heritage New Mexico (NHNM) 2011; NatureServe 2010; U.S. Fish and Wildlife Service 2010; Biota Information System of New Mexico 2009; New Mexico Rare Plant Technical Council 1999.

3 Nature and Extent of Contamination

Nature and extent of contamination is described for two areas: the Homestake Facility and the LTAs. These areas are evaluated separately because they are not contiguous and the direct source of the contamination is dissimilar, as described in the following subsection.

3.1 Source Material

3.1.1 Primary Sources

The primary sources of contaminants at the Site are the two tailings piles referred to as the LTP and STP. As described in Section 2.2, the LTP and STP contain approximately 21 million tons and 1.2 million tons of uranium mill tailings, respectively. Throughout most of the mill operations, tailings were deposited after particle size separation by a cyclone operation. Tailings were deposited hydraulically, with progressively finer particles being deposited further away from the cyclone, which was moved along the crest of the embankment, creating overlapping fields of deposition. Thus, no distinct interface existed between the coarse and fine tailings (HMC 1982).

The finer fraction, which generally consisted of silt and clay particles, made up approximately 30 percent of the tailings deposited. The coarse fraction, generally consisting of sand, made up the remaining 70 percent of the tailings (HMC 1982). On the Unified Soil Classification System, the finer tailings are classified as silty sand (SM) with 13 – 50 percent silt by weight. The coarser tailings are classified as poorly graded sand to silty sand (SP-SM) with 5 to 12 percent silt by weight (HMC 2012).

Finer fraction tailings exhibited a higher concentration of radioactive elements than coarser tailings, as displayed in Table 3-1 below.

Table 3-1 Nuclide Concentrations in Deposited Tailings

Contaminant	Fine Tailings	Coarse Tailings
Radium 226	630 pCi/g	65 pCi/g
Thorium 230	0.081 pCi/g	0.0116 pCi/g
Lead 210	840 pCi/g	99 pCi/g
Triuranium octoxide (U3O8)	0.011%	0.004%

Source: HMC 1982
pCi/g = picocuries per gram

Debris from the mill operating facilities, which is buried south of the tailings piles (refer to Figure 1-4) is also a primary source of potential contamination. Comparatively, the buried debris pits are much smaller than the tailings piles.

3.1.2 Homestake Facility Secondary Sources

Secondary sources are media or physical features impacted by the primary sources and can serve as sources of contamination to media and ultimately receptors. Homestake Facility secondary sources include:

- Radon-222 gas and dust, can be transported through the movement of wind

- Surface and subsurface soils, which are a source to plants and animals, and can transfer contaminants to other media, such as precipitation
- Two collection ponds, three evaporation ponds, and the RO groundwater treatment system, which can spread contaminants if containment measures are compromised
- Groundwater/aquifers, which can spread contaminants and potentially be used as potable or nonpotable water sources in the future

3.1.3 Land Treatment Area Secondary Sources

In the LTAs, while the primary sources of the contamination for the Site are the tailings pile and contaminated debris, the fields are being included as part of this RI Report because of the application of irrigation water that contained low concentrations of uranium and other contaminants. During the period of 2000 to 2012, approximately 9,551 acre-feet of water was used for irrigation. Land application was part of the Site remediation system that was approved by the New Mexico Environment Department (NMED), NRC, and EPA. HMC elected to discontinue the land treatment program after the 2012 irrigation season. Following HMC suspension of the land application program, NMED withdrew regulatory support for the program. Table 3-2 summarizes the yearly quantity of water used, the total area irrigated, and the fields irrigated.

Two pipelines were used to supply irrigation water; one for the flood irrigation fields and the 150-acre center pivot (Section 33/34 Pipeline) and one for the 100-acre center pivot irrigation field (Section 28 Pipeline). Each of the pipelines drew water from various wells. A plan view of each of the Section 33/34 Pipeline and the Section 28 Pipeline are shown on Figures 3-1 and 3-2, respectively. The figures include the location and identifying number of the wells used in 2012 for water supply. During the course of the irrigation period (2000 to 2012) the number and locations of wells used have varied. Generally, wells used for water supply are screened in the alluvium, though some are screened in the Chinle aquifers.

Table 3-2 Land Treatment Locations and Quantities, by Year

Year	Water Applied (acre-feet)	Irrigated Area (acre)	Fields Irrigated
2000	715	270	150-Acre Center Pivot 120-Acre Flood Irrigation
2001	695	270	150-Acre Center Pivot 120-Acre Flood Irrigation
2002	995	330	150-Acre Center Pivot 120-Acre Flood Irrigation 100-Acre Center Pivot
2003	949	330	150-Acre Center Pivot 120-Acre Flood Irrigation 100-Acre Center Pivot
2004	1,028	354	150-Acre Center Pivot 24-Acre Flood Irrigation 120-Acre Flood Irrigation 100-Acre Center Pivot
2005	1,034	394	150-Acre Center Pivot 24-Acre Flood Irrigation 120-Acre Flood Irrigation 100-Acre Center Pivot
2006	837	370	150-Acre Center Pivot 120-Acre Flood Irrigation 100-Acre Center Pivot
2007	789	370	150-Acre Center Pivot 120-Acre Flood Irrigation 100-Acre Center Pivot
2008	1,054	394	150-Acre Center Pivot 24-Acre Flood Irrigation 120-Acre Flood Irrigation 100-Acre Center Pivot
2009	731	394	150-Acre Center Pivot 24-Acre Flood Irrigation 120-Acre Flood Irrigation 100-Acre Center Pivot
2010	201	120	120-Acre Flood Irrigation
2011	213	100	100-Acre Center Pivot
2012	310	220	100-Acre Center Pivot 120-Acre Flood Irrigation
2013	0	0	None

Source: HMC 2014

Tables 3-3 and 3-5 present the concentrations of uranium, selenium, TDS, sulfate, molybdenum, and chloride in the 2000 to 2012 irrigation water from the Section 33/34 Pipeline and the Section 28 Pipeline, respectively. Yearly averages are also presented in the tables. In addition, concentrations of Ra-226, Radium 228 (Ra-228), vanadium (V) and Thorium 230 (Th-230) were measured for Section 33/34 irrigation water in 2010 and 2012 and for Section 33/34 irrigation water in 2011 and 2012. Concentrations of these elements and isotopes are included in Tables 3-4 and 3-6.

Based on the quantities of water applied during irrigation (Table 3-2) and the average concentrations shown in Tables 3-3 through 3-5, the mass of uranium, selenium, and sulfate applied to the irrigation fields is estimated in Table 3-7.

Table 3-3 Sections 33/34 Irrigation Water: Average Concentrations 2000 – 2010, 2012

Year	Parameter (mg/L)					
	Uranium	Selenium	TDS	Sulfate	Chloride	Molybdenum
2000	0.27	0.12	1549	624	107	<0.03
2001	0.26	0.1	1570	642	113	0.04
2002	0.23	0.1	1564	705	126	<0.03
2003	0.22	0.08	1600	732		
2004	0.26	0.09	1553	679	131	<0.03
2005	0.27	0.06	1546	732	162	<0.03
2006	0.29	0.07	1650	716	151	0.04
2007	0.28	0.06	1584	666	134	<0.03
2008	0.24	0.05	1550	702	137	<0.03
2009	0.24	0.05	1673	709	161	<0.03
2010	0.14	0.045	1711	739	167	<0.03
2012	0.12	0.06	1690	689	162	<0.03

Source: HMC 2014
mg/L = milligrams per liter

Table 3-4 Sections 33/34 Irrigation Water: Average Concentrations of Ra-226, Ra-228, V, and Th-230 in 2010, 2012

Year	Date	Ra-226 (pCi/L)	Ra-228 (pCi/L)	V (mg/L)	Th-230 (pCi/L)
2010	November 1, 2010	-0.02	0.07	<0.01	0.04
2012	October 11, 2012	0.38	1.4	<0.01	0.03

Source: HMC 2014
pCi/L = picocuries per liter
mg/L = milligrams per liter

Table 3-5 Section 28 Irrigation Water: Average Concentrations 2000 – 2009, 2011, 2012

Year	Sampling Date	Parameter (mg/L)					
		Uranium	Selenium	TDS	Sulfate	Chloride	Molybdenum
2002	October 2, 2002	0.23	0.08	2070	881		
2003	May 14, 2003	0.24	<1.005	2070	936	184	<0.03
2004	Average	0.27	0.07	2115	919	185	<0.03
2005	Average	0.35	0.08	2109	927	180	0.040
2006	Average	0.35	0.08	1986	882	175	0.04
2007	Average	0.36	0.08	2122	921	171	0.04
2008	Average	0.36	0.07	1917	927	133	0.04
2009	Average	0.38	0.07	2029	894	174	0.05
2011	Average	0.14	0.03	1409	608	121	<0.03
2012	Average	0.14	0.036	1846	756	189	<0.03

Source: HMC 2014
mg/L = milligrams per liter

Table 3-6 Section 28 Irrigation Water: Average Concentrations of Ra-226, Ra-228, V, and Th-230 in 2011, 2012

Year	Date	Ra-226 (pCi/L)	Ra-228 (pCi/L)	V (mg/L)	Th-230 (pCi/L)
2011	October 12, 2011	0.39	-0.40	<0.01	0.05
2012	October 2, 2012	0.08	0.1	<0.01	0.05

Source: HMC 2014
pCi/L = picocuries per liter
mg/L = milligrams per liter

Table 3-7 Estimated Mass of Uranium, Selenium, and Sulfate Applied During Irrigation

Year	System	Uranium Mass (lbs)	Selenium Mass (lbs)	Sulfate Mass (lbs)
2000	Section 28			
	Sections 33 and 34	525.4	233.5	1,214,286
2001	Section 28			
	Sections 33 and 34	491.1	188.9	1,212,646
2002	Section 28	82.6	28.7	316,284
	Sections 33 and 34	538.6	234.2	1,650,893
2003	Section 28	100.7	1	392,543
	Sections 33 and 34	475	172.7	1,580,334
2004	Section 28	133.9	34.7	455,897
	Sections 33 and 34	597.8	206.9	1,561,090
2005	Section 28	226.6	51.8	600,044
	Sections 33 and 34	584.7	129.9	1,585,232
2006	Section 28	221.8	50.7	558,922
	Sections 33 and 34	476.5	115	1,176,577
2007	Section 28	236.9	52.7	606,180
	Sections 33 and 34	416.3	89.2	990,081
2008	Section 28	270.2	52.5	695,850
	Sections 33 and 34	510.2	106.3	1,492,312
2009	Section 28	196.2	35.2	449,817
	Sections 33 and 34	355.9	74.1	1,051,344
2010	Section 28			
	Sections 33 and 34	74.1	24.5	402,781
2011	Section 28	81.1	17.4	345,844
	Sections 33 and 34			
2012	Section 28	60.9	17.4	329,007
	Sections 33 and 34	47.3	16.3	280,778

Other LTA secondary sources include:

- Dust, which can transport contaminants through wind erosion
- Surface and subsurface soils, which are a source to plants and animals, and can transfer contaminants to other media, such as irrigated water or precipitation
- Vegetation, which can uptake contaminants and serve as a source to herbivores

3.2 Nature and Extent of Contamination from the Homestake Facility

The following subsections describe the nature and extent of contamination based on data collected by HMC at the Site and information collected by the EPA for its Human Health Risk Assessment (HHRA) (EPA 2014a). Available data relevant to the nature and extent has been carried forward to the risk assessment.

3.2.1 Groundwater Impacts from the Homestake Facility

Seepage from the tailings piles has resulted in the contamination of groundwater at the Site. Beginning in 1977, HMC has operated a remediation system to mitigate the impact of seepage from tailings to groundwater. Groundwater impacts from mill tailing operations have been identified in the alluvial, Upper, Middle, and Lower Chinle aquifers. Nature and extent of impact to each of the aquifers is described in this section. The description is not geographically limited to the Homestake Facility.

The EPA and NMED have collected and analyzed samples from domestic wells located in the subdivisions on multiple occasions, leading to interim actions to provide water from the City of Milan drinking water system as described in Section 1.4. Domestic wells are not used to characterize the nature and extent of groundwater contamination since well logs and well construction diagrams are not available for many of these wells.

Groundwater data is compared to standards established for Site's NRC license, most of which are based on upgradient background concentrations that were calculated from historic data. A summary of the background calculations and the establishment of groundwater cleanup standards for the NRC license are provided in this section.

3.2.1.1 Chemicals and Radionuclides of Potential Concern and Cleanup Levels Developed for NRC License

NRC, EPA, and NMED agreed upon the chemicals of potential concern (COPCs) and radionuclides of potential concern (ROPCs) and cleanup levels for groundwater in 2006. Specifically, NRC approved these cleanup levels in 2006 in License Condition 35.B; EPA approved the levels via letter to NRC dated September 27, 2005; and the NMED approved these levels in DP-200.

The COPCs/ ROPCs and cleanup levels established for the Site by NRC are listed in Table 3-8.

Table 3-8 NRC Site Cleanup Levels

Constituent	Alluvial Aquifer	Chinle Mixing Zone	Upper Chinle Non-Mixing Zone	Middle Chinle Non-Mixing Zone	Lower Chinle Non-Mixing Zone
Selenium (mg/L)	0.32	0.14	0.06	0.07	0.32
Uranium (mg/L)	0.16	0.18	0.09	0.07	0.03
Molybdenum (mg/L)	0.10	0.10	0.10	0.10	0.10
Sulfate (mg/L)	1,500	1,750	914	857	2,000
Chloride (mg/L)	250	250	412	250	634
Total Dissolved Solids (mg/L)	2,734	3,140	2,010	1,560	4,140
Nitrate (mg/L)	12	15	*	*	*
Vanadium (mg/L)	0.02	0.01	0.01	*	*
Thorium-230 (pCi/L)	0.3	*	*	*	*
Radium-226 and Radium-228 (pCi/L)	5	*	*	*	*

Source: HMC 2012
* No standard for the constituent in the indicated zone
mg/L = milligrams per liter
pCi/L = picocuries per liter

NRC Site Cleanup Levels represent the culmination of previous work conducted to characterize contamination at the Site and establish background concentrations. As explained in detail below, the majority of these NRC Site Cleanup Levels are based on the background levels of contaminants in the various environmental media at the Site. Others represent levels of contaminants in environmental media that have been deemed acceptable through previous study and regulatory action. NRC Site Cleanup Levels provide a benchmark against which sampling can be judged to determine where contaminants are present at unacceptable levels.

NRC Site Cleanup Levels for each of the aquifers impacted by the Site were finalized in 2006 after background water quality was evaluated. Background concentrations were calculated at the 95 percent upper tolerance limit using data from 1995 through 2004. The uranium, selenium, sulfate, TDS, and nitrate cleanup levels were set at the calculated background concentration. Vanadium was set at the analytical detection limit (DL), since it had not been detected from 1995 through 2004. The molybdenum standard was adopted from 40 Code of Federal Regulations (CFR) Part 192 - Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites. For chloride, the NRC Site Cleanup Levels for the alluvial aquifer, Middle Chinle non-mixing zone, and Chinle mixing zone, were set at the secondary drinking water standard (40 CFR Part 143). In the Upper Chinle non- mixing zone and the Lower Chinle non-mixing zone, the NRC Site Cleanup Levels for chloride were set at the calculated background.

Background concentrations for the SMC alluvial aquifer were developed using nine near up-gradient wells: DD, ND, P, P1, P2, P3, P4, Q, and R. Refer to Figure 2-20 for a view of the well locations. Statistical methodology used in evaluating background concentration data complies with EPA guidance for calculating background concentrations (EPA 1992). Although water-quality data is available from as early as 1976, NMED directed that the period of record for the alluvial aquifer background analysis be limited to data from years 1995 through 2004. .

Mixing zones occur in Chinle aquifers from the intrusion of alluvial ground water into the Chinle aquifer at subcrop locations. Alluvial ground water typically has a much higher calcium concentration than the Chinle aquifers' ground water. A calcium concentration of greater than 30 mg/l is generally used to define which wells are in the mixing zone. Therefore, mixing zone ground water within the Chinle aquifers is characterized by an elevated calcium concentration, and for the purposes of defining background water quality, the mixing zone is considered a separate hydrologic system. Areas of the Chinle aquifers where the water quality has not been affected by the intrusion of alluvial ground water are referred to as the "non-mixing" zones.

These standards are assessed at five point of compliance wells (three are screened in the alluvial aquifer and two in the Upper Chinle aquifer). In addition, HMC regularly monitors additional wells to comply with federal and state licenses and permits. Table 3-9 provides a list of compliance monitoring wells that are routinely monitored. Analyses performed for the compliance monitoring are provided in Table 3-10.

Table 3-9 Summary of Groundwater Compliance Monitoring Program

Well	Parameter List Code[1]	Frequency of Monitoring
Alluvial Background Wells		
Background Wells P, Q, 921	B, F	Annual
Operational Monitoring		
Collection system wells	Total Volume	Monthly
Injection system wells	Total Volume	Monthly
Reversal wells B, BA, KZ, DZ, SM, SN, S2, S5	Water Level	Weekly
San Andres Wells		
Deep #1R, Deep #2R, 943M, 951R	B, F H	Annual Semiannual
Alluvial Compliance Monitoring Wells		
On-Site Monitoring Wells (Evap. Ponds) DD, DD2, X	B, F plus Mn H	Annual Quarterly
Additonal On-Site Monitoring Wells 1A, 1K, 639, 802, B11, D1, F, FB, GH, GN, L, L5, K9, M3, MX, MB, MQ, NC, S4, SUB3, T2, T19, T23, T41, T54	B, F	Annual
South Off-Site Wells 490, 497, 540, 631, 643#, 644, 864, 869, Q5, R3, SUB2	B, F	Annual
Section 34 Land application wells 555, 556, 557, 844, 845, 846	B, F	Annual
North Off-Site Wells(includes Section 28 Land application wells) 688, 881, 882, 883, 884, 886, 888, 893, 659, H2A, MR, H55, MO	B, F	Annual
Western Portion of North Off-Site Wells (Includes Section 33 Land application wells) 541, 551, 647, 649, 654, 899, 996	B, F	Annual
Chinle Wells		
Upper Chinle Wells 494, CE2, CE8, CE9, CE15, CF4, CW3, CW13#, CW18, CW25#	B, F	Annual
Middle Chinle Wells 493, ACW, CW17, CW2, CW28, CW45, CW55, CW62, CW76, R3, Y7	B, F	Annual
Lower Chinle Wells CW29, CW32, CW41, CW42, CW43, V6	B, F	Annual

Source: HMC 2019d

1. Refer to Table 3-10 for parameters associated with list codes

= Monitoring will start after well ceasing to be used for injection

Table 3-10 Summary of Groundwater Compliance Monitoring Program

Parameter List Code	Included Parameters (Dissolved)	Method	Reporting Limits	Units
B	Water level			
	pH	A4500-HB	0.01	s.u.
	TDS	A2540 C	20	mg/L
	Sulfate (SO4)	E300.0	4	mg/L
	Chloride (Cl)	E300.0	1	mg/L
	Bicarbonate (HCO3)	A2320 B	5	mg/L
	Carbonate (CO3)	A2320 B	5	mg/L
	Sodium (Na)	E200.7	0.9	mg/L
	Calcium (Ca)	E200.7	0.5	mg/L
	Magnesium (Mg)	E200.7	0.5	mg/L
	Potassium (K)	E200.7	0.5	mg/L
	Nitrate (NO3)	E353.2	0.1	mg/L
	Uranium (U)	E200.8	0.0003	mg/L
	Selenium (Se)	E200.8	0.005	mg/L
	Molybdenum (Mo)	E200.8	0.03	mg/L
	Radium-226 (Ra-226)	E903.0	Precision Variable	pCi/L
F	Vanadium	E200.8	0.01	mg/L
	Radium-228	RA-05	Precision Variable	pCi/L
	Thorium-230	E908.0	Precision Variable	pCi/L
H	Water Level			
	TDS	A2540 C	20	mg/L
	SO4	E300.0	4	mg/L
	U	E200.8	0.0003	mg/L
	Se	E200.8	0.005	mg/L
	Mo	E200.8	0.03	mg/L
	Cl	E300.0	1	mg/L

Source: HMC 2019d

For the purposes of this RI, the NRC Site Cleanup Levels will be considered preliminary remediation goals (PRGs).

3.2.1.2 Groundwater COPCs/ROPCs and Preliminary Remediation Goals for Remedial Investigation

As part of the CERCLA process, COPC/ROPCs are identified in the RI and preliminary remediation goals (PRGs) for the COPCs/ROPCs are developed based on screening levels established by applicable or relevant and appropriate requirements (ARARs) or by risk-based information or criteria. At this stage, PRGs are preliminary and are finalized at the end of the CERCLA process, which is the signing of the ROD.

Table 3-11 lists other potential PRGs for the COPC/ROPCs that are the most stringent of potential chemical-specific ARARs. A complete list of chemical-specific ARARs will be included and discussed in the Feasibility Study. Note that chloride and TDS, which are regulated in the NRC license, are not considered contaminants by EPA; however, they are regulated by the State of New Mexico pursuant to the Clean Water Act.

Table 3-11 Groundwater COPCs/ROPCs and Potential ARARs

Constituent	Other Potential PRGs	Source
Selenium (mg/L)	0.05	NMAC 20.6.2.3103A/EPA Primary Maximum Contaminant Level
Uranium (mg/L)	0.03	NMAC 20.6.2.3103A/EPA Primary Maximum Contaminant Level
Molybdenum (mg/L)	0.08	EPA risk-based value selected in the Molycorp Inc. ROD (EPA 2010b)
Sulfate (mg/L)	600	NMAC 20.6.2.3103B
Nitrate (mg/L)	10	NMAC 20.6.2.3103A/EPA Primary Maximum Contaminant Level
Vanadium (mg/L)	-	No applicable chemical specific ARARs are available for vanadium
Thorium-230 (pCi/L)	15	EPA Primary Maximum Contaminant Level for alpha emitters
Radium-226 and Radium-228 (pCi/L)	5	EPA Primary Maximum Contaminant Level
Chloride (mg/L)	250	NMED, DP-200 permit.
TDS (mg/L)	2,734	NMED, DP-200 permit.

When appropriate, background levels for environmental media are established and compared to PRGs. Where background levels exceed the PRG, it is EPA's policy to clean up sites to background levels. At the Site, remediation is ongoing based on cleanup levels established in the NRC license that has been issued. As described in the previous subsection of this Report, many of the cleanup levels are based on background concentrations that have been scientifically calculated based on data and methodologies that met regulatory guidance and was approved by the applicable regulatory agencies, including NRC, NMED, and EPA.

Table 3-12 provides a summary of the groundwater COPCs/ROPCs cleanup levels in the NRC license and the basis of the cleanup level.

Table 3-12 Comparison of NRC License Cleanup Level (Alluvial Aquifer) and Other Potential PRGs

Constituent	Other Potential PRGs	NRC License Cleanup Level	Basis of NRC Cleanup Level
Selenium (mg/L)	0.05	0.32	Background
Uranium (mg/L)	0.03	0.16	Background
Molybdenum (mg/L)	0.08	0.10	40 CFR Part 192 – Standards for Control of Residual Radioactive Materials from Inactive Uranium Processing Sites
Sulfate (mg/L)	600	1,500	Background
Nitrate (mg/L)	10	12	Background
Vanadium (mg/L)	-	0.02	Analytical Detection Limit
Thorium-230 (pCi/L)	15	0. 3	Analytical Detection Limit
Radium-226 and Radium-228 (pCi/L)	5	5	40 CFR Part 192 – Standards for Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

Based on the comparison in Table 3-12, molybdenum is the only COPC/ROPC where other potential PRGs are more stringent than the NRC License Cleanup Levels, excluding those where the NRC License Cleanup Levels was set to background.

For the nature and extent description of COPCs/ROPCs in groundwater, the NRC License Cleanup Levels are used for comparison to measured levels.

3.2.2 Alluvial Aquifer Impacts from the Homestake Facility

Nature and extent of groundwater impacts to the alluvial aquifer from milling operations are presented in this section. A more detailed presentation of the nature extent of alluvial groundwater impacts and contaminant trends is presented in *2018 Annual Monitoring Report / Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200,* which is the source for this abbreviated description (HMC 2019a).

3.2.2.1 COPCs/ROPCs in the Alluvial Aquifer

Figure 3-3 presents uranium data and contours collected in 2018. The light yellow/green pattern on Figure 3-3 shows areas where uranium concentrations are elevated, which includes the LTP, the STP, and the area to the west extending into Section 28. Additional areas where uranium concentrations in the alluvium were greater than the NRC Site Cleanup Levels in 2018 exist south of the STP along Highway 605, and in Felice Acres. The area of elevated concentrations in Felice Acres extends southwest approximately 2,600 feet from the southwest corner of Felice Acres. Figures 3-4 through 3-6 are detail maps showing uranium concentrations in the alluvial aquifer.

A closer look at the uranium concentrations in the Rio San Jose is provided in Figure 3-7 which presents the 2017 uranium concentrations measured for the Rio San Jose alluvial aquifer and the San Mateo alluvial aquifer in an area extending from the confluence of the alluvial aquifers to the south. Higher uranium concentrations exist in the Rio San Jose alluvial aquifer to the northwest of the San Mateo confluence.

Selenium concentrations throughout the Site in 2018 are presented in Figure 3-8. Concentrations of selenium in the alluvial aquifer above the NRC Site Cleanup Levels are located with the Homestake Facility, with the exception of an area east of Highway 605 located southeast of the LTP. Selenium concentrations in the nearby subdivisions are below the NRC Site Cleanup Levels. Figures 3-9 through 3-11 are detail maps showing selenium concentrations in the alluvial aquifer.

Figure 3-12 presents data and contours of molybdenum concentrations in the alluvial aquifer during 2018. The NRC Site Cleanup Levels for molybdenum is 0.10 mg/l. Significant molybdenum concentrations extend approximately ¼ mile west of the LTP and to the southeast of the STP along Highway 605. A 10 mg/l contour extends around the LTP and to the west side of the STP. Figures 3-13 through 3-15 are detail maps showing molybdenum concentrations in the alluvial aquifer.

Figures 3-16 and 3-17 present Ra-226 and Ra-228 concentrations for the alluvial groundwater near the Site. Ra-226 and Ra-228 concentrations above the NRC Site Cleanup Levels in the alluvial aquifer are limited to areas directly underneath the LTP. Vanadium and Th-230 concentrations are presented on Figures 3-18 and 3-19, respectively. Vanadium concentrations were above or equal to the NRC Site Cleanup Level of 0.02 mg/L in four of the seven alluvial wells located within the footprint of the LTP, one well near the southwest corner of the LTP and three wells located near the perimeter of STP. Thorium-230 was present above the NRC Site Cleanup Level of 0.3 pCi/L in three of the five alluvial wells sampled within the footprint of the LTP. In addition three wells near the perimeter of the LTP also exhibited Th-230 concentrations above the 0.3 pCi/L: one to the north, one to the east and one near the southwest corner.

Sulfate concentration contours for the alluvial aquifer during 2018 are presented on Figure 3-20. Areas where sulfate exceed the NRC Site Cleanup Levels include below the LTP, approximately 0.25 mile west of the LTP, within the 120-acre flood irrigation field, and south of the Murray Acres subdivision. Figures 3-21 through 3-23 are detail maps showing sulfate concentrations in the alluvial aquifer.

Nitrate concentrations measured in the alluvial aquifer in 2018 near the Site are presented in Figures 3-24, 3-25 and 3-26. Areas where the nitrate concentrations exceeded the NRC Site Cleanup Level of 12 mg/L include within the footprint of the LTP (6 out of 30 wells), between the LTP and STP (three wells), and in one well located within the 120-acre flood irrigation field. Nitrate concentrations in all of the alluvial subdivision wells were below 12 mg/L.

3.2.3 Upper Chinle Aquifer Impacts from the Homestake Facility

Nature and extent of groundwater impacts to the Upper Chinle aquifer from milling operations are presented in this section. A more detail presentation of the nature extent of groundwater impacts to the Upper Chinle aquifer and contaminant trends is presented in *2018 Annual Monitoring Report / Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200,* which is the source for this abbreviated description (HMC 2019a).

NRC Site Cleanup Levels for the Upper Chinle aquifer have been established for the mixing zone and the non-mixing zone, as shown in Table 3-8. The mixing zone is defined as the area of the aquifer adjacent to subcrop locations where the alluvial aquifer has had an impact on water quality in the Chinle aquifer. Non-mixing zone areas are where the alluvial aquifer has not had an impact on water quality in the Chinle aquifer. Figure 3-27 displays the extent of the Upper Chinle Mixing Zone impacts.

3.2.3.1 COPCs in the in Upper Chinle Aquifer

Figures 3-28 and 3-29 present contours of uranium concentrations in the Upper Chinle aquifer for 2018. Uranium concentrations exceed the corresponding mixing or non-mixing zone NRC Site Cleanup Level in the LTP area extending down to the south of the Collection Ponds in the Upper Chinle aquifer in 2018. One uranium value exceeds the mixing zone NRC Site Cleanup Level of 0.18 mg/l just north of Broadview Acres and two values in Felice Acres also exceed this NRC Site Cleanup Level.

Selenium concentrations in the Upper Chinle aquifer are presented on Figures 3-30 and 3-31. In 2018, the selenium concentrations are less than the mixing-zone NRC Site Cleanup Level of 0.14 mg/l with the exception of wells in and near the subcrop area near the LTP and extending down to the Collection Ponds. The non-mixing zone NRC Site Cleanup Level of 0.06 mg/l is not exceeded in 2018.

Figures 3-32 and 3-33 present the molybdenum concentrations in the Upper Chinle aquifer during 2018. Molybdenum concentrations near and underlying the LTP exceeded both the mixing and non-mixing zone NRC Site Cleanup Levels of 0.1 mg/L. Concentrations greater than 1.0 mg/L were observed in a region extending from the Upper Chinle-alluvium subcrop area, below the LTP, toward the east side of the LTP and to the south of Evaporation Pond 2 and the Collection Ponds. The NRC Site Cleanup Levels is exceeded in one well north of Broadview Acres. Molybdenum concentrations from Broadview Acres to the south and east of the East Fault were equal or below NRC Site Cleanup Levels in 2018.

Vanadium concentrations measured in 2018 are presented in Figure 3-34. A vanadium concentration of 0.02 mg/L, which is above the NRC Site Cleanup Level of 0.01 mg/L, was detected in well CW3. Well CW3 is located northwest of the HMC office. Remaining measurements were equal to or less than the NRC Site Cleanup Levels.

Figures 3-35 and 3-36 present the radium-226 (Ra-226) and the radium-228 (Ra-228) values measured in 2018. None of the values exceed the EPA Maximum Contaminant Level (MCL). The largest Ra-226 concentration measured in the Upper Chinle wells in 2018 was 3.7 pCi/l in well CW3. The largest Ra-228value was 2.9 pCi/l in well CW18.

Sulfate concentrations in the Upper Chinle aquifer during 2018 are presented in Figures 3-37 and 3-38. Only wells below and near the LTP area exceeded the NRC Site Cleanup Level for the mixing zone of 1750 mg/l. The non-mixing zone NRC Site Cleanup Level of 914 mg/l in the Upper Chinle in 2018 is also exceeded in the eastern portion of the LTP.

Nitrate concentrations in the Upper Chinle aquifer measured in 2018 are presented in Figures 3-39 and 40. All measured nitrate concentrations in the Upper Chinle aquifer in 2018 are less than the NRC Site Cleanup Level except for well T32 at 18.7 mg/l.

3.2.4 Middle Chinle Aquifer Impacts from the Homestake Facility

Nature and extent of groundwater impacts to the Middle Chinle aquifer from milling operations are presented in this section. A more detailed presentation of the nature extent of groundwater impacts to the Middle Chinle aquifer and contaminant trends is presented in *2018 Annual Monitoring Report / Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200,* which is the source for this abbreviated description (HMC, 2019a).

NRC Site Cleanup Levels for the Middle Chinle aquifer have been established for the mixing zone and the non-mixing zone. Figure 3-41 displays the extent of the Middle Chinle Mixing Zone. In the area west of the West Fault, it is believed the Middle Chinle subcrops an alluvial aquifer further to the north, based on the geochemistry (calcium concentrations). The Middle Chinle mixing zone is created by alluvial water entering the Middle Chinle north of the area shown on the figure and flowing to the subcrop area to the southwest.

3.2.4.1 COPCs in the Middle Chinle Aquifer

Figures 3-42 and 3-43 presents contours of uranium concentrations in the Middle Chinle aquifer during 2018. Areas in the southern portion of Felice Acres, extending into Section 3, west and northwest of the LTP exhibited concentrations greater than the mixing-zone NRC Site Cleanup Levels. Uranium concentrations in the Middle Chinle aquifer exceeded non-mixing zone NRC Site Cleanup Levels in Broadview Acres and Felice Acres.

Selenium concentrations were measured in 2018 in the Middle Chinle aquifer and are presented on Figures 3-44 and 3-45. An area northwest of the LTP exceeded the mixing zone NRC Site Cleanup Levels in 2018. The higher selenium concentrations in these wells are caused by downward movement of alluvial water into the Middle Chinle aquifer subcrop. An area located in Felice Acres exceeded the non-mixing zone NRC Site Cleanup Levels in two wells.

The 2018 molybdenum concentrations in the Middle Chinle aquifer are presented on Figures 3-46 and 3-47. Molybdenum concentrations greater than the NRC Site Cleanup Levels of 0.10 mg/L can be found west of the West Fault, northwest of the LTP.

Sulfate concentration contours for the Middle Chinle aquifer for 2018 are presented in Figures 3-48 and 3-49. Concentrations ranged from 459 to a high of 2,200 mg/L in 2018. Mixing-zone sulfate concentrations in the Middle Chinle aquifer were above the NRC Site Cleanup Levels of 1,750 mg/L in four wells west of the West Fault. Sulfate concentrations in the non-mixing zone of the Middle Chinle were below the NRC Site Cleanup Levels of 867 mg/L.

Figure 3-50 presents the nitrate concentrations in the Middle Chinle aquifer wells from samples collected in 2018. There is an area west of the West Fault where the mixing zone NRC Site Cleanup Levels was exceeded.

3.2.5 Lower Chinle Aquifer Impacts from the Homestake Facility

Nature and extent of groundwater impacts to the Lower Chinle aquifer from milling operations are presented in this section. A more detailed presentation of the nature extent of groundwater impacts to the Lower Chinle aquifer is presented in *2018 Annual Monitoring Report / Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200,* which is the source for this abbreviated description (HMC, 2019a).

NRC Site Cleanup Levels for the Lower Chinle aquifer have been established for the mixing zone and the non-mixing zone, as shown in Table 3-8. Figure 3-51 displays the location of the Lower Chinle Mixing Zone.

3.2.5.1 COPCs in the Lower Chinle Aquifer

Figures 3-52 and 3-53 present uranium concentrations in the Lower Chinle aquifer collected in 2018. Uranium concentrations observed in 2018 in the Lower Chinle aquifer exceeded the mixing-zone

NRC Site Cleanup Levels southwest of Felice Acres in Section 3. The non-mixing zone adjacent and northeast of the mixing zone also exceeded the NRC Site Cleanup Levels.

Selenium concentrations in the Lower Chinle aquifer for 2018 are presented on Figures 3-54 and 3-55. None of the selenium concentrations obtained in 2018 from the Lower Chinle wells exceeded the NRC Site Cleanup Levels.

The 2018 molybdenum concentrations obtained from the Lower Chinle wells were at levels near the DL. These measurements were consistent with historic measurements of molybdenum in the Lower Chinle aquifer.

Sulfate concentrations in the Lower Chinle aquifer during 2018 are presented in Figures 3-56 and 3-57. None of the Lower Chinle concentrations of sulfate or nitrate exceeded NRC Site Cleanup Levels in the mixing zone. Areas west of the West Fault and north of the LTP have sulfate concentrations greater than NRC Site Cleanup Levels in the non-mixing zone, which are thought to be naturally occurring levels.

Nitrate concentrations measured in 2018 are all significantly below the site standard.

3.2.6 San Andres-Glorietta Aquifer

As described in Section 2.6.5, the San Mateo alluvial and SAG aquifers are separated by the Chinle formation, preventing the direct communication between the aquifers. A subcrop of the SAG to the San Jose alluvial aquifer occurs about 2 miles southwest of the LTP. As can be seen by comparing Figure 2-44 with Figures 3-3 through 3-26, the subcrop occurs in a location that has not been impacted by releases from the Site.

Figures 3-58 and 3-59 provide concentrations versus time plots for uranium from SAG wells that are routinely monitored by HMC. The location of these wells is shown on Figure 2-44. Highest uranium concentrations in the SAG wells monitored during 2018 were 0.088 and 0.03 mg/l in wells 943 and 951R respectively. The 2017 uranium value of 0.11 mg/l from well 806R appears to be an outlier. Uranium concentrations in well 943 are much greater than those in well 943M because leakage into well 943 from an overlying aquifer had affected the concentration in well 943 prior to its abandonment.

Selenium concentrations in the San Andres aquifer vary from <0.005 to 0.011 mg/l except for the effected concentration in well 943 of 0.047 mg/l. All measured molybdenum concentrations are less than 0.03 mg/l.

Uranium milling operations at the Bluewater Mill Site, which is located approximately 4 miles west north-west (directly upgradient) of the LTP released uranium to the SAG aquifer. Refer to Figure 3-60 for an isoconcentration contour map for uranium in the SAG aquifer. Based on this information, the increase in uranium concentration experienced in Well 951R is probably the result of uranium releases from the Bluewater Mill Site.

3.2.7 Nature and Extent of Soil Contamination from the Homestake Facility

As described in Section 1.4.2.2 of this report, areas around the tailings piles, shown on Figure 1-5, were remediated to the soil cleanup levels prescribed by NRC in 10 CFR 40 Appendix A (NRC 1999). Characterization and verification methods used, and the data collected were documented in

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill (ERG 1995). For reference, this report is provided in Appendix C.

Described in this section are results of recent Homestake Facility soils investigations to characterize the nature and extent of soil contamination.

3.2.7.1 Chemicals and Radionuclides of Potential Concern and PRGs

In 2011, EPA completed a background study for surface soils (EPA 2014a). Samples for the background study were collected approximately 2 miles southwest of the Site (refer to Figure 3-61). Electronic data for the soil data set is provided in Appendix D. A statistical summary of select radionuclides and metals is presented in Table 3-13. Based on the results of the background study, as well as Site history and results from the extensive environmental studies and activities completed at the Site, the following soil ROPCs were retained:

- Uranium-234/238
- Th-230
- Ra-226 and Ra-228

40 CFR 192 establishes soil cleanup values of 5 pCi/g above background in surface soils (>15 centimeters) and 15 pCi/g above background in subsurface soils for Ra-226, Ra-228, and Th-230 at UMTRA Title I sites. The surface value is a health-based standard based on gamma radiation exposure. Since the Homestake Facility will remain under federal control following completion of remediation, these standards are relevant and appropriate. Other PRGs for soil are developed for the HHRA (see Section 5) using EPA's PRG Calculator (EPA 2019b).

Table 3-13 Background Descriptive Statistics for Metals and Radionuclides in Soil

Chemical	n	Mean	Median	Minimum	Maximum	Standard Deviation
Metals (mg/kg)						
Arsenic	12	4.80	4.68	4.25	5.52	0.40
Lead	12	11.13	10.55	9.46	14.20	1.56
Molybdenum	12	0.41	0.39	0.34	0.62	0.08
Selenium	12	0.55	0.40	0.35	2.03	0.47
Vanadium	12	27.55	28.05	20.40	36.50	4.47
Radionuclides (pCi/g)						
Ra-226	12	1.70	1.74	1.29	2.00	0.21
Ra-228	12	1.08	1.11	0.91	1.26	0.11
Th-230	5	1.10	1.05	0.70	1.56	0.31
U-234	5	0.91	0.88	0.60	1.22	0.24
U-235	12	0.10	0.10	0.06	0.12	0.02
U-235	5	0.06	0.06	0.00	0.12	0.05
U-238	5	0.95	0.89	0.73	1.21	0.21

Source: EPA 2014a
mg/kg = milligram per kilogram
pCi/g = picocurie per gram

3.2.7.2 EPA Soil Sampling for 2013 Human Health Risk Assessment

EPA completed an investigation of soils within and near the Homestake Facility boundaries for developing a baseline risk assessment for off-Site residential receptors. Surface soil samples were collected from banks of evaporation ponds, near the fence line at the southwest boundary of the Homestake Facility, and areas between the fence line and the evaporation ponds. Refer to Figure 3-61 for the sample locations. Figure 3-62 displays the Ra-226 results from the soil samples collected within Homestake Facility boundaries.

Table 3-14 and 3-15 provide the descriptive statistics for samples collected within the Homestake Facility and at the fence line, respectively.

As shown on Figure 3-61, two samples were collected from near the banks of EP-1. According to information from EPA, these samples were collected from “white residue” at the banks of EP-1. It is believed that the white residue is salts that evaporate from the ponds. Since the salts do not represent soil, data from these samples is evaluated qualitatively.

Table 3-14 Descriptive Statistics for Metals and Radionuclides in Surface Soil (0-6 inches bgs) Collected Between the Evaporation Ponds and Fenceline

Chemical	n	Mean	Median	Minimum	Maximum	Standard Deviation
Metals (mg/kg)						
Arsenic	26	5.89	6.32	2.68	9.58	1.68
Lead	26	14.28	16.15	3.88	19.70	4.79
Molybdenum	26	6.93	1.81	0.62	126.00	24.33
Selenium	26	1.37	0.75	0.37	11.10	2.09
Vanadium	26	36.29	40.05	11.70	60.70	12.46
Radionuclides (pCi/g)						
Ra-226	26	3.50	3.06	1.48	8.90	1.78
Ra-228	25	1.32	1.47	0.48	1.71	0.37
Th-230	24	2.13	1.83	0.51	5.85	1.40
U-234	24	3.39	2.47	0.58	18.30	3.48
U-235	26	0.25	0.22	0.07	0.70	0.14
U-235	24	0.19	0.14	0.03	0.99	0.19
U-238	24	3.43	2.68	0.83	19.00	3.61

Source: EPA 2014a
mg/kg = milligram per kilogram
pCi/g = picocurie per gram

Table 3-15 Descriptive Statistics for Metals and Radionuclides in Soil Collected Near the Fenceline

Chemical	n	Mean	Median	Minimum	Maximum	Standard Deviation
Metals (mg/kg)						
Arsenic	4	3.72	3.76	2.67	4.71	0.95
Lead	4	9.31	8.74	6.45	13.30	3.33
Molybdenum	4	0.94	1.01	0.35	1.41	0.50
Selenium	4	0.48	0.50	0.23	0.68	0.22
Vanadium	4	20.58	19.85	15.10	27.50	6.38
Radionuclides (pCi/g)						
Ra-226	4	2.41	2.39	1.20	3.64	1.00
Ra-228	4	0.87	0.89	0.61	1.09	0.23
Th-230	4	1.56	1.50	0.66	2.58	0.80
U-234	4	1.17	1.13	0.49	1.95	0.62
U-235	4	0.15	0.15	0.08	0.22	0.06
U-235	4	0.12	0.12	0.08	0.17	0.05
U-238	4	1.14	1.07	0.52	1.90	0.57

Source: EPA 2014a
mg/kg = milligram per kilogram
pCi/g = picocurie per gram

3.2.7.3 Soil Sampling Near Evaporation Ponds

In 2009, HMC collected soil samples around the evaporation ponds (EP-1, EP-2, and EP-3). The objective of the soil sampling was to characterize pre-construction soil conditions near EP-3 and provide general indicators of soil quality near EP-1 and EP-2. The location of the soil samples collected is displayed on Figure 3-63. Soil samples were collected from the surface (0 inch to 6 inches) around EP-1 and EP-2 (17 locations) and EP-3 (10 locations). Subsurface samples (depths greater than 6 inches) were collected at 11 of the 17 EP-1 and EP-2 locations and at all EP-3 locations.

The samples obtained in the vicinity of EP-1, EP-2, and EP-3 were analyzed for radionuclides (Ra-226, Th-230, and uranium), molybdenum, selenium and a number of soil quality parameters that are not relevant to the RI Report and are therefore not included in this report. Analytical methods used for the analysis are provided in Table 3-16.

Table 3-16 Analytical Methods for Soil Analysis

Parameter	Method Number	Method
Soil digestion	EPA Method 3052[1]	Microwave digestion
Radium-226	EPA Method 903.1[2]	Radon emanation
Thorium-230	ESM 4506/4108[3]	Alpha spectroscopy
Total Uranium	EPA 6020[1]	EPA 6020[1]
Total Molybdenum	EPA 6020[1]	EPA 6020[1]
Total Selenium		

Source: HMC 2014
1. EPA 2007a
2. EPA 2008
3. Instrument manufacturer procedure: Alpha Spectrometer Counting Procedure (4108), Determination of Thorium in Soil and Water

Results from the analysis of samples collected near EP-1 and EP-2 for molybdenum and selenium are provided in Table 3-17.

Table 3-17 Analytical Results: Molybdenum and Selenium Concentrations Near EP-1 and EP-2.

Sample ID	Molybdenum mg/kg	Selenium mg/kg	Sample ID	Molybdenum mg/kg	Selenium mg/kg
EP-1 0-6"	13[1]	1[2]	EP-9 12-18"	6[2]	1[2]
EP-1 6-12"	11[1]	1[2]	EP-10 0-6"	8[1]	1[2]
EP-2 0-6"	6[2]	1[2]	EP-10 6-12"	6[2]	1[2]
EP-3 0-6"	26[1]	1[2]	EP-11 0-6"	7[2]	1[2]
EP-3 6-12"	9[1]	1[2]	EP-12 0-6"	7[2]	1[2]
EP-3 12-18"	6[2]	1[2]	EP-13 0-6"	20[1]	3[1]
EP-4 0-6"	6[2]	1[2]	EP-13 6-12"	18[1]	4[1]
EP-4 6-12"	6[2]	1[2]	EP-13 12-18"	6[2]	1[2]
EP-5 0-6"	6[2]	1[2]	EP-14 0-6"	12[1]	2[1]
EP-6 0-6"	6[2]	1[2]	EP-14 6-12"	7[1]	2[1]
EP-6 6-12"	6[2]	1[2]	EP-15 0-6"	7[2]	1[2]
EP-6 12-18"	6[2]	1[2]	EP-16 0-6"	20[1]	3[1]
EP-7 0-6"	6[2]	1[2]	EP-16 6-12"	12[1]	3[1]
EP-7 6-12"	6[2]	1[2]	EP-16 12-18"	6[2]	3[1]
EP-8 0-6"	6[2]	1[2]	EP-17 0-6"	6[2]	1[2]
EP-9 0-6"	11[1]	1[2]	EP-17 6-12"	6[2]	1[2]
EP-9 6-12"	6[2]	1[2]			

Source: HMC 2014
1. Sample result qualified as B; i.e., analyte concentration detected at a value between method and practical quantitation limits. The associated value is an estimated quantity.
2. Sample result qualified as U; i.e., the material was analyzed for, but was not detected above the level of the associated value. The associated value is the sample quantitation or detection limit.
mg/kg = milligram per kilogram

Table 3-18 lists the concentrations of Ra-226, Th-230, and uranium from samples collected near EP-1 and EP-2. Concentrations of molybdenum and selenium from samples collected near EP-3 are listed in Table 3-19 and Table 3-20 lists radionuclide concentrations from samples collected near EP-3. Figure 3-62 displays the Ra-226 results from the soil samples collected.

Table 3-18 Analytical Results: Radionuclide Concentrations Near EP-1 and EP-2.

Sample ID	Radium-226 Concentration pCi/g	Radium-226 MDC pCi/g	Thorium-230 Concentration pCi/g	Thorium-230 MDC pCi/g	Uranium Concentration mg/kg	Uranium Concentration pCi/g
EP-1 0-6"	0.7	1.1	-0.1	1.6	13	9
EP-1 6-12"	9.9	1.6	1.4	1.5	5	3
EP-2 0-6"	1.1	1.5	0.53	1.4	6	4
EP-3 0-6"	3.6	0.78	2.7	1.5	29	20
EP-3 6-12"	1.5	0.92	0.43	1.6	6	4
EP-3 12-18"	0.84	0.82	-0.24	1.6	4[1]	3[1]
EP-4 0-6"	9	1.1	1.7	1.8	8	5
EP-4 6-12"	1.3	0.99	0.14	1.6	2[1]	1[1]
EP-5 0-6"	0.92	1.2	0.57	1.6	5[1]	3[1]
EP-6 0-6"	1.1	1.2	0.66	2	6[1]	4[1]
EP-6 6-12"	0.91	0.99	-0.07	1.7	2[1]	1[1]
EP-6 12-18"	6.2	1.3	0.28	1.7	1[1]	1[1]
EP-7 0-6"	0.65	0.44	0.44	1.5	4[1]	3[1]
EP-7 6-12"	0.79	1.1	0.02	1.5	2[1]	1[1]
EP-8 0-6"	1.2	1.1	3	1.5	2[1]	1[1]
EP-9 0-6"	1.3	0.91	0.88	1.8	9	6
EP-9 6-12"	1	1.1	0.39	1.5	3[1]	2[1]
EP-9 12-18"	0.05	0.95	0.47	1.6	2[1]	1[1]
EP-10 0-6"	4.1	1.2	1.5	1.6	15	10
EP-10 6-12"	3.6	1.1	1.5	1.6	11	7
EP-11 0-6"	3	1.3	2	1.6	8	5
EP-12 0-6"	2.6	1.2	1.4	1.5	6[1]	4[1]
EP-13 0-6"	2.3	1.1	1.3	1.6	24	16
EP-13 6-12"	3.1	1.3	1.9	1.6	13	9
EP-13 12-18"	1.5	1.2	0.68	1.6	4[1]	3[1]
EP-14 0-6"	2	0.88	2.8	1.5	11	7
EP-14 6-12"	1.7	0.97	0.61	1.6	6	4
EP-15 0-6"	6.1	0.82	2.5	1.7	7[1]	5[1]
EP-16 0-6"	4	1.1	2.3	1.6	16	11
EP-16 6-12"	4.6	1.1	1.9	1.7	9	6
EP-16 12-18"	1.8	0.81	1	1.7	5[1]	3[1]
EP-17 0-6"	2.1	0.74	1.6	1.5	5[1]	3[1]
EP-17 6-12"	2.2	0.81	2.9	1.5	30	20

Source: HMC 2014

1. Sample result qualified as B; i.e., analyte concentration detected at a value between method and practical quantitation limits. The associated value is an estimated quantity.

pCi/g = picocurie per gram

mg/kg = milligram per kilogram

Table 3-19 Analytical Results: Molybdenum and Selenium Near EP-3.

Sample ID	Molybdenum mg/kg	Selenium mg/kg	Sample ID	Molybdenum mg/kg	Selenium mg/kg
EP3-1 0-6"	6[2]	2[1]	EP3-5 0-6"	6[2]	1[2]
EP3-1 6-18"	6[2]	1[2]	EP3-5 6-18"	6[2]	1[2]
EP3-2 0-6"	49	2[1]	EP3-6 0-6"	6[2]	1[2]
EP3-2 6-18"	28[2]	1	EP3-6 6-18"	6[2]	1[2]
EP3-3 0-6"	6[2]	3[1]	EP3-7 0-6"	6[2]	1[2]
EP3-3 6-18"	6[2]	1[2]	EP3-7 6-18"	6[2]	1[2]
EP3-4 0-6"	6[2]	1[2]	EP3-8 0-6"	6[2]	1[2]
EP3-4 6-18"	6[2]	1[2]	EP3-8 6-18"	6[2]	1[2]

Source: HMC 2014
1. Sample result qualified as B; i.e., analyte concentration detected at a value between method and practical quantitation limits. The associated value is an estimated quantity.
2. Sample result qualified as U; i.e., the material was analyzed for, but was not detected above the level of the associated value. The associated value is the sample quantitation or detection limit.
mg/kg = milligram per kilogram

Table 3-20 Analytical Results: Radionuclide Concentrations Near EP-3.

	Radium-226		Thorium-230		Uranium, total	
	Concentration	MDC	Concentration	MDC	Concentration	
Sample ID	pCi/g	pCi/g	pCi/g	pCi/g	mg/kg	pCi/g
EP3-1 0-6"	14	1	2.9	1.4	6	4
EP3-1 6-18"	3.8	1.1	1.9	1.5	3[1]	2[1]
EP3-2 0-6"	2.8	0.77	1.3	1.5	44	30
EP3-2 6-18"	2.6	1	1.3	1.5	24	16
EP3-3 0-6"	8.3	1	7.4	1.5	6[1]	4[1]
EP3-3 6-18"	2.9	1.1	1.6	1.5	8	5
EP3-4 0-6"	5.9	0.86	2	1.7	3[1]	2[1]
EP3-4 6-18"	1.5	0.95	0.77	1.4	3[1]	2[1]
EP3-5 0-6"	2.8	0.75	2.4	1.4	3[1]	2[1]
EP3-5 6-18"	1.9	0.95	1.8	1.5	3[1]	2[1]
EP3-6 0-6"	5.5	1.2	3	1.4	6[1]	3[1]
EP3-6 6-18"	1.3	0.8	0.85	1.7	3[1]	2[1]
EP3-7 0-6"	5.6	0.73	7.1	1.6	5[1]	3[1]
EP3-7 6-18"	3	0.8	2.3	1.3	3[1]	2[1]
EP3-8 0-6"	3.3	1	2.3	1.5	4[1]	3[1]
EP3-8 6-18"	1.4	1.1	0.91	1.4	2[1]	1[1]
EP3-9 0-6"	1.7	0.83	2.2	1.9	3[1]	2[1]
EP3-9 6-18"	1.1	0.83	0.98	1.6	2[1]	1[1]
EP3-10 0-6"	1	0.82	1.1	1.4	3[1]	2[1]
EP3-10 6-18"	0.04	1.1	0.12	1.7	2[1]	1[1]

Source: HMC 2014
Sample result qualified as B; i.e., analyte concentration detected at a value between method and practical quantitation limits. The associated value is an estimated quantity.
pCi/g = picocurie per gram
mg/kg = milligram per kilogram

3.2.7.4 Windblown Contamination Remediation Outside the Homestake Facility

As described in Section 1.4.2.2, soil remediation was conducted as part of the facility decommissioning to remediate soil impacted by dust generated during mill operations. The remediation occurred both within and outside the license boundary, as shown in Figure 1.5.

Remediation of the windblown areas outside license boundaries were remediated as required by NRC License Condition 29C and in accordance with 10 CFR 40 Appendix A Criterion 6 (6). Specifically, the soil cleanup criteria was:

- 10.5 piC/g in the upper 15 cm of soil
- 20.5 piC/g below 15 cm the ground surface

See Section 1.4.2.2 for further discussion of the soil cleanup criteria.

Confirmation sampling of the areas outside the license boundary consisted of both field gamma readings and confirmation sampling and analysis. In addition, the density of confirmation sampling varied for the “inner zone” and the “outer zone”. Refer to Figure 1-5 for the extent of the zones. Areas outside the license boundary were within the outer zone. The confirmation sampling for the outer zone was performed as follows:

- Grid blocks measuring 500 feet by 500 feet were established.
- The grid blocks were futher divided into 100 square meter blocks (roughly 33 feet by 33 feet). Areas were remediated until the average gamma reading for any area of 100 square meter size was 21,000 counts per minute (cpm) or less.
- For the first 52 500 foot by 500 foot grid blocks, the 100 square meters with the highest average gamma reading within each grid block was sampled and analyzed for Ra-226.
- Statictics were calculated for the 52 samples and compared to the cleanup criteria of 10.5 piC/g for Ra-226. The mean concentration was 2.51 pCi/g and the 95% confidence level using the student t test was 2.6 piC/g, which is much less that the cleanup criteria (ERG 1995).
- Based on passing the statistical test, the remaining outer zone was divided into 1,000 foot by 1,000 foot grid blocks. One sample from the 100 square meter block within each 1,000 foot by 1,000 fot grid block with the highest average gamma reading was sampled and analyzed for Ra-226. A total of 78 samples was collected using the larger grid blocks.
- Statistics for the set of 78 samples indicated that the mean concentration was 2.95 pCi/g (ERG 1995) and the 95% confidence level using the student t test was 3.5 piC/g, which is much less that the cleanup criteria (ERG 1995).

Confirmation samples collected were analyzed using an on-site lab and approximately ten percent of the samples were analyzed at an off-site laboratory for quality control.

Gamma scans and confirmation scanning extended beyond the extent of soil remediation to verify that the extent of windblown contaminants had been remediated. In the report documenting the

remediation, the area beyond what was remediated was referred to as the “off-set” area. Generally, the offset area extended 100 - 200 feet beyond the remediation limits.

As described in Section 1.4.2.2, the objective of the windblown cleanup was to remediate the top 15 cm of soil to less than 10.5 pCi/g. This cleanup objective was met. Details of the remediation results, including the plates showing the gamma scan results, are available in Appendix C. Documentation of NRC approval of the remediation is also available in Appendix C.

The mean concentrations of Ra-226 were based on a sampling methodology that was biased high. For each 500 foot by 500 foot grid blocks, there were 225 100 square meters blocks that were scanned. On average there were between 8 and 9 gamma readings recorded within each 100 square meters block. The block with the highest average gamma reading was sampled. For the 1,000 foot by 1,000 foot grid blocks, there were 900 100 square meters blocks and the one with the highest average gamma reading was sampled. As a result, the mean Ra-226 concentrations do not represent the average Ra-226 concentration in the surface soil after remediation, but a concentration that is higher.

Two relatively recent activities provide relevant information that can be compared to the confirmation data from the windblown remediation:

- In 2013, the EPA completed a Time Critical Removal Action which included soil remediation in the nearby subdivisions. For the Removal Action, an action level of 3.5 pCi/g was used, which is higher than the confirmation sample averages (EPA 2013).
- In 2019, Homestake conducted a gamma survey of a portion of the San Mateo alluvial flood plain upgradient of the Homestake Facility. See Figure 3-64 for the location and a graphic display of the gamma survey results. The average of the upgradient gamma data was calculated to be 14,337 cpm (ERG 2019). The 52 500 foot by 500 foot grid blocks recorded an average gamma reading of 16,629 cpm. Although the average gamma confirmation data is higher, the confirmation sampling methodology was biased high.

Preliminary analyses indicate that potential health risks within the windblown remediation area outside facility license boundaries are within EPA’s risk management range. The analysis included using the RadPRG calculator to compute a PRG range for Ra-226 for a trespasser scenario. The PRG range for $1x10^{-4}$ to $1x10^{-6}$ cancer risk was 0.98 – 98 pCi/g. Confirmation sampling completed within the outer zone found the average concentration of Ra-226 in the 100 square meters blocks with the highest gamma reading to be 2.51 pCi/g and 2.95 pCi/g. Compared to the trespasser risk range computed with the RadPRG calculator, these concentrations would represent a cancer risk within $1x10^{-5}$ to $1x10^{-6}$.

3.2.8 Nature and Extent of Air Contamination from the Homestake Facility

HMC operates an air-monitoring program for the Homestake Facility. Monitoring data is used to assess the impact on nearby residences and the environment using monitors placed along the perimeter of the Homestake Facility. Potential exposures from the Homestake Facility include:

- Air particulates
- Radon 222

- Direct gamma radiation

Monitors for the above parameters at the Homestake Facility are summarized in Table 3-21. Figure 3-5 shows the locations of these monitors.

Table 3-21 Summary of Air Monitoring Locations

Station	Sampling Unit	Location Notes
HMC-1	Hi-Volume Particulate (Air) Track Etch Cup (Radon) OSL Badge (Gamma)	Located to have the highest concentrations of radioactive airborne particulates
HMC-1A	Hi-Volume Particulate (Air) Track Etch Cup (Radon) OSL Badge (Gamma)	In sectors to have the highest concentrations of radioactive airborne particulates Added in 1st Quarter 2010
HMC-2	Hi-Volume Particulate (Air) Track Etch Cup (Radon) OSL Badge (Gamma)	Located to have the highest concentrations of radioactive airborne particulates
HMC-3	Hi-Volume Particulate (Air) Track Etch Cup (Radon) OSL Badge (Gamma)	Located to have the highest concentrations of radioactive airborne particulates
HMC-4	Hi-Volume Particulate (Air) Track Etch Cup (Radon) OSL Badge (Gamma)	At facility boundary nearest occupied residences
HMC-5	Hi-Volume Particulate (Air) Track Etch Cup (Radon) OSL Badge (Gamma)	At facility boundary nearest occupied residences
HMC-6	Hi-Volume Particulate (Air) Track Etch Cup (Radon) OSL Badge (Gamma)	Background for airborne particulate
HMC-7	Particulate Blank Track Etch Cup (Radon)	At facility boundary, south of the LTP, along Highway 605
HMC-16	Track Etch Cup (Radon) OSL Badge (Gamma)	Background for Radon and Direct Gamma Radiation

Source: HMC 2013a
OSL = optically stimulated luminescence detector

HMC-16 is the NRC approved air monitoring location for radon background at the Homestake Facility and HMC-6 is the NRC approved location for airborne particulates at the Homestake Facility.

These background locations were selected when the Homestake Facility was licensed in 1958 and a basis for the selection of these locations is not documented in the record.

For particulates, the most appropriate location for a background station would be upwind. As stated in Section 2.3.2, the most dominant (strongest) winds are from the west and southwest. HMC-6's location to the west would seem appropriate, but a study into the most appropriate location has not been conducted.

In 2013, HMC conducted an evaluation of radon background to evaluate whether HMC-16 is appropriate and if not, to select a more appropriate location. A key consideration in selecting the appropriate background is the conceptual model for radon transport from the Homestake Facility and other sources. Based on evaluation of collected data and air modeling completed by HMC, the highest radon concentrations in air occur during calm or near-calm conditions. During calm

conditions radon transport is driven predominantly by topography, moving principally downgradient (HMC 2013b). Thus, an appropriate location for background is topographically upgradient from the Homestake Facility and situated in a similar topographic position. Other key considerations for selecting an appropriate location include:

- Within an area that has similar geologic formations; and
- Within an area that is far enough from the Homestake Facility to not be significantly affected by Homestake Facility off-gassing of radon.

HMC-16 is topographically higher than nearby drainages and isolated from San Mateo Creek. For these reasons, HMC has concluded that it is likely underestimating background radon concentrations (HMC 2013b).

3.2.8.1 Radionuclides of Potential Concern

ROPCs at the Homestake Facility are monitored by HMC and include:

- Uranium, Th-230, Ra-226
- Radon-222
- Gamma radiation

3.2.8.2 Uranium, Radium-226, and Thorium-230

Particulate samplers are analyzed for natural uranium, Ra-226, and Th-230. Monitoring station HMC-6 is considered background for airborne particulates.

Semiannual reports submitted to NRC summarize radionuclide concentrations. Table 3-22 summarizes the average quarterly results of radionuclide concentrations in micro Curies per milliliter (µCi/ml) for the high volume samplers for calendar years 2015 and 2018.

Table 3-22 Radionuclide Concentrations (µCi/ml) 2015 through 2018

Monitor Location	Radionuclide	Average	Max	Min
HMC-1	Uranium	2.79E-16	4.73E-16	1.25E-16
	Th-230	1.58E-17	2.50E-17	6.75E-18
	Ra-226	2.53E-17	3.00E-17	1.60E-17
HMC-1A[2]	Uranium	1.72E-16	2.85E-16	9.25E-17
	Th-230	1.86E-17	2.60E-17	1.08E-17
	Ra-226	2.68E-17	3.50E-17	1.25E-17
HMC-2	Uranium	2.59E-16	4.58E-16	1.45E-16
	Th-230	1.99E-17	3.50E-17	1.10E-17
	Ra-226	3.03E-17	3.75E-17	1.85E-17
HMC-3	Uranium	6.33E-16	1.12E-15	4.23E-16
	Th-230	2.00E-17	3.00E-17	1.38E-17
	Ra-226	3.32E-17	4.00E-17	2.03E-17
HMC-4	Uranium	8.56E-16	1.50E-15	4.63E-16
	Th-230	4.01E-17	6.50E-17	2.13E-17
	Ra-226	5.63E-17	9.25E-17	2.78E-17
HMC-5	Uranium	1.82E-15	2.58E-15	1.04E-15
	Th-230	2.34E-17	4.25E-17	1.25E-17
	Ra-226	3.58E-17	4.25E-17	2.58E-17
HMC-6 (Background)	Uranium	3.24E-16	4.63E-16	1.93E-16
	Th-230	2.14E-17	3.75E-17	1.20E-17
	Ra-226	3.56E-17	4.25E-17	2.23E-17

Source: HMC 2013a; HMC 2019c

3.2.8.3 Radon-222/220

Semiannual reports submitted to NRC summarize radon gas concentrations. Table 3-23 summarizes the average semiannual results of radon concentrations (µCi/ml) for the track etch samplers for calendar years 2015 through 2018. HMC-16 is considered background for radon and direct gamma radiation.

Table 3-23 Summary of Annual Radon Gas Monitoring Results 2015 through 2018 (pCi/L)

Monitor Location	2015	2016	2017	2018
HMC-1	1.13	0.91	0.73	0.80
HMC-1A	1.18	0.94	0.62	0.73
HMC-2	1.21	0.97	0.72	0.93
HMC-3	0.92	0.72	0.57	0.71
HMC-4	1.37	1.10	0.71	0.89
HMC-5	1.37	0.91	0.68	0.84
HMC-6	0.98	0.92	0.69	0.69
HMC-7	0.84	0.85	0.69	0.81
HMC-16 (Background)	0.65	0.49	0.32	0.35

Source: HMC 2013a; HMC 2019c
NA = Not available, data set incomplete
μCi/mL = microCurie per milliliter

A NRC License amendment in 2002 requires HMC to collect radon flux measurements annually. Radon flux is measured with radon canisters placed on the LTP and STP. Radon flux from the mill tailings pile is limited to 20 pCi/m^{2}s in accordance with National Emission Standards for Hazardous Air Pollutants Subpart W: Standards for Radon Emissions from Operating Uranium Mill Tailings.

Through 2016, 100 canisters distributed over the interim covers on the LTP and STP were used to measure the radon flux. Starting in 2017, 200 canisters, 100 on the LTP and 100 on the STP, were used. Figure 3-66 shows the locations of these canisters.

Prior to 2017, the average radon flux from the LTP was calculated using the area-weighted average of the flux measured annually from the top of the LTP and the flux measured on the side slopes and aprons in 1994 and 1995. The area of the aprons and side slopes constitutes 65 percent of the total area with the top of the pile being 35 percent. In 2017, NRC determined average flux of the LTP could no longer include the side slope. At the STP, because the evaporation pond (EP-1) that sits atop the STP is an operational facility, flux calculations using an area-weighted average is appropriate.

Table 3-24 summarizes the radon flux measurements for the LTP and the STP since 2003. As can be seen, the regulatory limit of 20 pCi/m^{2}s was exceeded in 2016-2018. In 2017, Homestake requested a variance from the flux standard for the top of the LTP as existing groundwater treatment and monitoring wells prevent placement of final radon barrier. Discussions with NRC on the path forward are ongoing and resolution is expected in 2020. In addition, dose assessment based on site measurements indicates the limit exceedance doesnot result in exceedances of public dose limits (HMC 2019c).

Table 3-24 Radon Flux Measurements for Large and Small Tailings Pile

Year	Total Number of Canisters	Total Number of Readings	Number of Measurements Location		Average Measured Flux[1] (Average) pCi/m²s	
			LTP	STP	LTP	STP
2003	89	97	52	46	14.1	5.58
2004	89	99	66	33	20.3	7.7
2005	97	101	61	36	15.3	8.21
2006	97	102	61	36	20.6	6.9
2007	97	97	61	36	14.1	12.05
2008	97	103	64	36	9.73	4.67
2009	96	102	64	35	16.8	5.6
2010	97	103	65	35	17.5	6.59
2011	100	100	65	36	18.8	9.14
2012	100	99	63	36	15.67	4.12
2013	100	100	64	36	18.93	8.28
2014	100	100	64	36	19.7	6.84
2015	100	100	64	36	19.64	7.22
2016	204	200	100	100	21.73	7.88
2017	200	200	100	100	46.6	3.5
2018	200	200	100	100	51.3	12.7

Source: HMC 2013a, HMC 2019c
1 Individual canister measurements are presented in annual monitoring reports
pCi/m²s = picocurie per square meter per second
LTP = Large Tailings Pile
STP = Small Tailings Pile

Measured average flux values for the LTP slightly exceeded the 20 pCi/m²s standard in 2004, 2006, 2010, 2011, and 2015 - 2018. In 2004, additional interim cover was placed on the top of the LTP and new measurements were collected at canister locations that were affected by the new cover. A new average was calculated for the LTP, which brought the pile into compliance. For the year 2006, the measurements could not be made until September. Because of inclement weather, interim cover could not be added until early 2007 where the new measurements indicated an average flux of 18.1 pCi/m2 (Cox 2007). Values reported in Table 3-24 are final measurements.

In 2011, EPA collected radon data from locations on HMC property. Monitoring stations were established at 12 locations along the fenceline between the Homestake Facility and the subdivisions (Murray Acres and Broadview Acres) and at 9 locations either upgradient or downgradient of the former mill facilities. Figures 3-67 and 3-68 show the monitoring station locations. At each of the locations, detectors were in place for approximately 3 months. Monitoring continued for 1 year. Two detectors were placed each quarter at fenceline monitoring stations: one approximately 5 feet above the ground surface and one approximately 6 inches above the ground surface. At the nine stations upgradient or downgradient of the former mill facilities, three detectors were placed 5 feet above the ground surface. At 10 percent of the detectors, an additional, co-located detector was installed for data quality assurance.

During the third and fourth quarters of radon data collection, two passive track-etch detectors were placed side by side at some of the radon monitoring stations, with one of the detectors having a thoron proof filter and the second that detects both radon 222 and thoron (radon-220). Thoron gas is then calculated based on equations and procedures provided by Department of Energy (Pearson, et al. 1991). It is important to note that the correction factors and the calculation of radon (222 and 220) were based on the direct relationship between measured values of the two detectors, one with thoron filter and the other without thoron filter. Table 3-25 summarizes EPA's corrected results.

Table 3-25 Annual HMC Radon Results adjusted for Thoron (Radon-220) in pCi/L

Location	Annual HMC Radon Results adjusted for Thoron	Sub-Location
HMC01	0.91	Upgradient North of Facility
HMC02	1.37	Upgradient North of Facility
HMC03	1	Upgradient North of Facility
HMC04	1.12	Upgradient North of Facility
HMC05	2.1	Downgradient South of Facility
HMC06	2.36	Downgradient South of Facility
HMC07	2.36	Downgradient South of Facility
HMC08	1.2	West of the Facility
HMC09	0.54	North West of the Facility

Source: EPA 2014a
pCi/L = picocurie per Liter

3.2.8.4 Gamma Radiation

Semiannual reports submitted to NRC summarize direct gamma radiation results. Table 3-26 summarizes the average semiannual results of direct gamma radiation results (millirems per year [mrem/yr]) for the optically stimulated luminescence samplers for calendar years 2009 through 2012.

Table 3-26 Net Annual Gamma-Ray Exposure Rate at Nearest Neighbor Locations[1] (mrem/yr)

Year	HMC-1	HMC-2	HMC-3	HMC-4[2]	HMC-5[2]
2012	3	12	6	15	17
2011	3.5	17	0	15	15.5
2010	0	14	8	17	22
2009	1	13	36	11	9

Source: HMC 2013a
1. Values assume 10 percent occupancy.
2. Location used to demonstrate compliance with public dose limits.

3.3 Impacts to Environmental Media at the Land Treatment Areas

The LTAs were irrigated with groundwater that contained uranium, selenium, and other chemicals. This section will describe soil and groundwater impacts to LTAs from irrigation activities. Comparison of pre-irrigation and post-irrigation sampling and analysis of groundwater and soil will be used as the basis for the impacts.

3.3.1 Nature and Extent of Groundwater Contamination at Land Treatment Areas

Impacts to the underlying aquifers resulting from irrigation using Site groundwater are presented for the 120-acre flood irrigation field (located in Section 34), the 150-acre center pivot irrigation field (located in Section 33), the 24-acre flood irrigation field (located in Section 33), and the 100-acre center pivot irrigation field (located in Section 28). Information regarding the geology and hydrogeology as well as concentrations of chemicals monitored is provided the LTAs.

3.3.1.1 Chemicals of Potential Concern at Land Treatment Areas

Based on the chemistry of the groundwater applied to the LTAs, uranium, selenium, and molybdenum are the COPCs for groundwater below the LTAs. Other parameters including sulfate, TDS, chloride, and nitrate are also monitored to evaluate impacts to water quality.

3.3.1.2 Groundwater Impacts at the 120-Acre Flood Irrigation Field

Figure 3-69 provides a plan view of the 120-acre flood irrigation field and Figure 3-70 provides a geologic cross-section of the area. As shown on the cross-section, the San Mateo alluvial aquifer exists throughout the extent of the 120-acre flood irrigation field (HMC 2014). Table 3-27 provides data from monitoring wells used to collect groundwater samples. As shown on Figure 3-69, wells 555, 556, and 557 are located on the western edge of the 120-acre flood irrigation field and wells 844 and 845 are located on the north and south boundaries of the 120-acre flood irrigation field, respectively. Well 846 is located approximately 0.25 mile west of the 120-acre flood irrigation field.

Table 3-27 Well Data for 120-Acre Flood Irrigation Field

Well	Well Depth (ft-bgs)	Casing Diameter (inch)	Water Level			
			Date	Depth (ft-bgs)	Elevation (ft-msl)	
555	80	5	2/6/2018	47.52	6509.62	
556	80	5	2/6/2018	54	6502.02	
557	70	5	2/10/2016	41.55	6512.22	
844	75	4	2/6/2018	41.56	6514.57	
845	65	4	2/6/2018	39.62	6517.43	
846	75	4	12/3/2018	43.82	6505.1	
Well	**Pipe stickup Above Ground Surface (ft)**	**Well Elevation Top of Pipe (ft-msl)**	**Base of Alluvium (ft-bgs)**	**Base of Alluvium (ft-msl)**	**Well Screen Interval (ft bgs)**	**Alluvium Saturated Thickness (ft)**
555	2	6557	80	6477	60-80	32.62
556	2	6556	78	6478	60-80	24.02
557	2	6556	70	6486	50-70	26.22
844	1.2	6556.13	70	6484.9	35-75	29.67
845	1.7	6557.05	55	6500.4	45-65	17.03
846	0.8	6548.92	65	6483.1	40-65	22.00

Source: HMC 2014, HMC 2019c
bgs = below ground surface
ft = feet
msl = mean sea level

Figures 3-71 through 3-77 present COPC concentrations over time for wells 555, 556, 557, 844, 845, and 846. These wells are used to monitor the 120-acre flood irrigation field. There has not been a discernable change trend in uranium concentration with the exception of well 844, which appears to be trending slightly upward from 2005 to 2012. Subsequently, the well has been trending downward with uranium concentrations below the established and approved alluvial background concentration of 0.16 mg/L. Well 555 has been monitored since 2011 and the uranium concentration may be trending up slightly. The relatively short monitoring period for this well makes trend analysis less certain than the other wells with all uranium concentrations continuing to be well below the established and approved alluvial background concentration.

Selenium concentrations in well 846 appear to be trending upward since 1995. Since this trend begins prior to the start of the irrigation, the rise is not likely associated with the land treatment program. Wells 844 and 845 both experienced a rise in selenium concentrations, occurring in 2002 in the former and between 2003 and 2005 in the latter. Since those events, selenium concentrations in both wells appear to have stabilized at a concentration well below the established and approved alluvial background of 0.32 mg/L. Well 557, which has been monitored since 2010, appears to be trending upward but remains well below the alluvial background concentration. A trend is not noted in wells 555 and 556.

Molybdenum concentrations in all wells appear stable since 1997.

Sulfate concentrations in wells 844 and 845 have exhibited a general increase during the period of irrigation, but their concentrations are slightly less than concentrations that were observed prior to the mid-1990s. Sulfate concentrations in monitoring well 846 have shown an increasing trend since the early 1990s. Wells 555, 556, and 557, which have been monitored since 2010, show varied trends: well 555 appears to be trending upward: well 556 appears stable: and well 557 appears to be trending downward. It is unclear from the data whether any of the wells are reacting in response to land irrigation. The TDS and chloride trends over time have shown similar patterns to those of sulfate.

In wells 844 and 845, nitrate concentrations have dropped from 2004 to 2012, then rose in 2013, while well 846 rose steadily from 1996 through 2012, and then dropped in 2013. Wells 555 and 557 appear to be trending upward since 2011 and well 556 is trending slightly downward.

3.3.1.3 Groundwater Impacts at the 150-Acre Center Pivot and 24-Acre Flood Irrigation Land Treatment Areas

Figure 3-78 provides a plan view of the 150-acre center pivot irrigation field and 24-acre flood irrigation fields. The 150-acre center pivot irrigation field is underlain by the Rio San Jose alluvium (HMC 2014) as shown on the geologic cross-section displayed on Figure 3-79. A geologic cross-section of the 24-acre flood irrigation field is shown on Figure 3-70. Alluvium also underlies the 24-acre flood irrigation field; however, bedrock elevation is greater than the groundwater surface elevation below much of this field, thus, the alluvial aquifer is not present. Table 3-28 presents the monitoring well data.

Table 3-28 Well Data for 150-Acre Center Pivot Irrigation and 24-Acre Flood Irrigation Land Treatment Areas

Well	Well Depth (ft-bgs)	Casing Diameter (inch)	Water Level			
			Date	Depth (ft-bgs)	Elevation (ft-msl)	
551	130	5	12/26/2018	99	6448.3	
553	120	5	12/26/2018	104.1	6443.38	
554	140	5	12/26/2018	106.7	6440.47	
647	140	4.5	12/26/2018	104.9	6447.01	
649	124	4.5	12/26/2018	102.9	6440.39	
650	109	4.5	12/26/2018	81.73	6465.38	
658	130	6	12/26/2018	107.5	6442.68	
Well	**Pipe Stickup Above Ground Surface (ft)**	**Well Elevation Top of Pipe (ft-msl)**	**Base of Alluvium (ft-bgs)**	**Base of Alluvium (ft-msl)**	**Well Screen Interval (ft bgs)**	**Alluvium Saturated Thickness (ft)**
551	2	6547.3	120	6433	90-130	15.30
553	2	6547.48	110	6433	80-120	10.38
554	2	6547.17	130	6411	100-140	29.47
647	1.4	6551.91	132	6418.5	80-140	28.51
649	0.3	6543.29	115	6428	84-124	12.39
650	2.2	6547.11	103	6441.9	89-109	23.48
658	0.4	6550.18	129	6420.8	89-130	21.88

Source: HMC 2014, HMC 2019c
bgs = below ground surface
ft = feet
msl = mean sea level

Figures 3-80 through 3-86 present COPC concentrations over time for wells 551, 553, 554, 647, 649, 650, and 658. Each of these wells (with the exception of well 650) is used to monitor the 150-acre center pivot irrigation field, which was irrigated from 2000 through 2009. There has not been a discernable change in uranium or selenium concentrations over the monitoring period (1997 to 2014). Uranium and selenium concentrations remain well below the approved alluvial background standard. Very few data points exhibit concentrations above the DL for molybdenum.

Sulfate concentrations in the wells appear to be trending up slightly since 2009, with the exception of well 658, which appears to be trending flat to slightly lower, and well 649, which has been trending slightly upward since 2007. The trend may have flattened for several wells since 2012, including wells 551, 553, and 647. All wells, however, remain well below the approved alluvial background standard for sulfate of 1,500 mg/L. Much like the other irrigation fields, TDS trends are similar to sulfate and they also are below the approved alluvial background for TDS of 2,734 mg/L. Concentrations of TDS recorded in wells 551, 553, and 554 have a slight upward trend since monitoring began in these wells in 2009. TDS in wells 647 and 650 has been stable since 2010. Chloride concentrations in wells 553 and 554 have a slight upward trend since monitoring began in

these wells in 2009, while well 551 has been generally stable since 2010. In wells 647 and 650, concentrations trended upward from 2009 to 2011 and have been stable since. Wells 649 and 658 appear to trend up slightly since 2012 with all these well below the approved background standard within the alluvial aquifer for chloride of 250 mg/L. Nitrate concentrations have fluctuated in many of the wells since monitoring began in 1995, but no significant trends are apparent with all wells below the approved nitrate standard for the alluvial aquifer of 12 mg/L.

Well 650 is used to monitor the 24-acre flood irrigation field, which was irrigated in 2004, 2005, 2008, and 2009. Figures 3-80 through 3-86 present COPC concentrations over time for this well. There has not been a discernable change in uranium, selenium, or molybdenum concentrations over the monitoring period (1997 to 2014). Sulfate, TDS, and chloride concentrations appear to be trending up since 2010. Nitrate concentrations over time do not indicate a trend. All COPC concentrations continue to be well below the approved NRC Site Cleanup Levels for the alluvium.

3.3.1.4 Groundwater Impacts at the 100-Acre Center Pivot Irrigation Field

Figure 3-87 provides a plan view of the 100-acre center pivot irrigation field and Figure 3-88 provides a geologic cross-section of the area. This area has consisted of 60 acres of center pivot irrigation from 2002 through 2004, and, after expansion of the center pivot area, 100 irrigated acres from 2005 through 2009 and in 2011 and 2012. The 100-acre center pivot irrigation field exists over the San Mateo alluvial aquifer that extends to the western portion of Section 28 (HMC 2014).

Table 3-29 provides data from monitoring wells 634, 881, 886, and 888, which are used to collect groundwater samples. As shown on Figure 3-87, wells 881, 886, and 893 are located within the 100-acre center pivot irrigation field and wells 634, 888, and 890 are located west of the 100-acre center pivot irrigation field.

Table 3-29 Well Data for 100-Acre Center Pivot Irrigation Field

Well	Well Depth (ft-bgs)	Casing Diameter (inch)	Water Level			
			Date	Depth (ft-bgs)	Elevation (ft-msl)	
634	103	4.5	12/26/2018	71.14	6488.93	
881	96	4.5	12/26/2018	69.17	6495.87	
886	90	5	12/26/2018	65.78	6498.77	
888	105	5	12/26/2018	77.57	6479.76	
890	101	5	8/28/2018	74.33	6484.1	
893	98	4.5	12/26/2018	66.11	6497.86	
Well	**Well Elevation Top of Pipe (ft-msl)**	**Pipe Stickup Above Ground Surface (ft)**	**Base of Alluvium (ft-bgs)**	**Base of Alluvium (ft-msl)**	**Well Screen Interval (ft bgs)**	**Alluvium Saturated Thickness (ft)**
634	6560.07	2.8	95	6462.3	80-100	28.77
881	6565.04	2	103	6460.0	Jun-96	34.41
886	6564.55	1.5	87	6476.1	60-90	23.97
888	6557.33	1.1	90	6466.2	75-105	16.7
890	6558.43	1.7	93	6463.7	81-101	18.3
893	6563.97	2.1	93	6468.9	78-98	25.5

Source: HMC 2014, HMC 2019c
bgs = below ground surface
ft = feet
msl = mean sea level

Figures 3-89 through 3-95 present the COPC concentrations over time for wells 634, 881, 886, 888, 890, and 893. Uranium concentrations in well 881 trended downward from 2002 to late 2005, but have been variable with trending upward through 2010 and downward since that time. In well 886, the trend from 2001 to 2013 was variable but generally downward until the last reading that was up sharply. Well 893 was stable from 2002 through 2008, and has been variable since 2009. In the downgradient wells (634, 888, and 890) there is no discernable trend. Selenium concentrations have been generally stable with no discernable trends. Molybdenum concentrations in the wells are mostly below DLs, though concentrations slightly higher than the DLs have been observed in wells 881 (since 2008) and 886 (since 2010).

Sulfate concentrations are variable, but there appears to be a slight upward trend for all wells between 2007 and 2012 with downward trends since that time. The TDS and chloride trends have shown similar patterns to those of sulfate. There do not appear to be any meaningful trends in the nitrate concentrations.

3.3.2 Nature and Extent of Soil Contamination at Land Treatment Areas

Soil samples have been collected from within and near the irrigation fields from 1999 through 2013. Composite samples were prepared from locations within each irrigation area. In 2000, samples

were collected from 0- to 6-inch, 6- to 18-inch, and 18- to 36-inch depth intervals. Sampling depths during 2001 through 2013 were 0 to 1 foot, 1 to 2 feet, and 2 to 3 feet, respectively. For simplicity, this variation is not noted further in the data presentation or evaluation. Depths greater than 3 feet were first sampled in 2009.

ACZ Laboratories, Inc., of Steamboat Springs, Colorado, performed the analyses on the soil samples from 1998 through 2012. Energy Laboratories, Inc., of Billings, Montana, performed the analyses on the soil samples in 2013. Samples were analyzed for uranium, selenium, molybdenum, calcium, magnesium, sodium, chloride, and sulfate and occurred following completion of irrigation. Results from uranium and selenium are presented.

In 1998, HMC characterized uranium and selenium concentrations in soils, prior to selecting fields for land treatment of groundwater. Refer to Figure 3-96 for the location of the samples collected in 1998. HMC also collected and analyzed soil samples outside the irrigated fields from 1999 through 2010. These results, along with the 1998 data, are used to calculate background concentrations for uranium and selenium in soil. Background data is presented and discussed for each of the irrigation fields. Tables summarizing analytical results for uranium and selenium from each sample used to calculate background are provided in Appendix E.

3.3.2.1 Soil Chemicals of Potential Concern at Land Treatment Areas

Based on the chemistry of the groundwater applied to the LTAs, uranium and selenium are the COPCs for soil within the LTAs. Other parameters including molybdenum, calcium, magnesium, sodium, chloride, and sulfate are also monitored to evaluate impacts on water quality.

3.3.2.2 Soil Impacts at the Flood Irrigation Fields

Figures 3-97 through 3-110 display the locations of the soil samples collected each year from the flood irrigations fields and surrounding (background) locations. The following information summarizes the number of samples collected within the irrigation fields by year:

- 1999 and 2000: Nine locations within the 120-acre flood irrigation field
- 2001: 30 samples from 3 depths at 10 locations within the 120-acre flood irrigation field
- 2002: 36 samples from 3 depths at 12 locations within the 120-acre flood irrigation field
- 2003: 33 samples from 3 depths at 11 locations within the 120-acre flood irrigation field
- 2004, 2005, 2006, 2007, and 2008: 36 samples from 3 depths at 12 locations within the 120-acre flood irrigation field and 3 locations within the 24-acre flood irrigation field
- 2009: Samples were collected from three lysimeters and five soil sampling locations within the 120-acre flood irrigation field and one lysimeter and one soil sampling location within the 24-acre flood irrigation field
- 2010: Seven sample locations within the 120-acre flood irrigation field and one location within the 24-acre flood irrigation field
- 2011: Five sample locations within the 120-acre flood irrigation field and one location within the 24-acre flood irrigation field
- 2012 and 2013: Five samples within the 120-acre flood irrigation field

Background concentrations for uranium and selenium are summarized in Table 3-30. Values contained in the table are the average calculated from sample locations outside the irrigated area (refer to Figures 3-976 through 3-108) and from samples collected in 1998 (refer to Figure 3-96).

Table 3-30 Statistics for Uranium and Selenium Background Concentrations for Flood Irrigation Fields

Metal	Interval (feet)	n	Mean	Median	Minimum	Maximum
Uranium (mg/kg)	0-1[1]	29	2.14	2.31	0.45	3.60
	1-2	17	1.81	1.60	0.53	3.93
	2-3	18	1.19	1.15	0.40	2.29
	3-4	2	0.75	0.75	0.56	0.94
	4-5	2	0.55	0.55	0.52	0.58
	5-6	4	0.44	0.47	0.31	0.52
	6-8	4	0.61	0.58	0.33	0.93
	8-10	4	0.68	0.68	0.27	1.11
	10-12	4	1.12	1.25	0.65	1.33
	12-14	1	0.96	0.96	0.96	0.96
	14-16	1	0.97	0.97	0.97	0.97
Selenium (mg/kg)	0-1[2]	28	0.43	0.40	0.10	0.80
	1-2	16	0.45	0.37	0.20	0.87
	2-3	17	0.31	0.34	0.10	0.54
	3-4	2	0.17	0.17	0.16	0.17
	4-5[3]	2	0.07	0.07	0.03	0.11
	5-6	4	0.05	0.05	0.03	0.09
	6-8	4	0.07	0.06	0.03	0.12
	8-10	4	0.09	0.09	0.03	0.17
	10-12	4	0.42	0.14	0.07	1.31
	12-14	1	0.53	0.53	0.53	0.53
	14-16	1	0.27	0.27	0.27	0.27

Source: HMC 2014
mg/kg = milligram per kilogram
Notes:
1. 17 samples collected from 0-12", 11 from 0-6", and one from 0-14"
2. 16 samples collected from 0-12", 11 from 0-6", and one from 0-14"

Figure 3-111 presents a plot of the uranium concentrations over time from the Section 33 and 34 flood areas and compares them to average background. Uranium concentrations have gradually increased in the 0- to 1-foot interval (referred to as Upper in Figure 3-111) for the previous 8 years and were steady in 2013, when irrigation did not occur. The concentrations have had steady levels in the 1- to 2-foot interval for the last 6 years. From 2001 to 2011, uranium concentrations in the 120-acre flood irrigation field increased in the 0- to 1-foot layer from 2.72 mg/kg to a maximum of 5.15 mg/kg in 2011, and were at 4.67 mg/kg and 4.70 mg/kg in 2012 and 2013, respectively.

Overall, the average uranium concentration in the upper 3 feet of soil increased from 1.91 mg/kg to 3.07 mg/kg, or by a factor of 1.61.

Figure 3-112 presents the uranium concentrations with depth for the treated and background concentrations. The distance between these two lines is the increase in uranium concentration. The green shaded area shows where uranium concentrations increased in the 120-acre flood irrigation field to a depth of 4 feet. The increase is primarily in the upper 2 feet with a lesser increase in the 2- to 4-foot interval. The black pattern on this figure shows an increase in 2012 within the 9- to 13-foot interval; however, the increase is small and is likely attributable to variation in the laboratory analyses.

The 2013 selenium level in the upper interval was similar to the 2012 concentration, but slightly higher (refer to Figure 3-113). A comparison of sample results from 2001 through 2013 indicates that selenium concentrations have increased in the treated areas of Section 34. Figure 3-114 shows that this increase has mainly been in the upper interval of the soil.

3.3.2.3 Soil Impacts at the 100-Acre Center Pivot Irrigation Field

Irrigation at the 100-acre center pivot irrigation field in Section 28 began in 2002. Figures 3-115 through 3-125 display the locations of the soil samples collected each year from the 100-acre center pivot irrigation field and surrounding (background) locations. The following summarizes the number of samples collected within the irrigation fields by year:

- 2002 through 2008: Twelve locations, each sampled at three depths (0 to 1 foot, 1 to 2 feet, and 2 to 3 feet)
- 2009: Samples were collected from three lysimeter and five soil sampling locations
- 2010: Samples were collected from one lysimeter and five soil sampling locations
- 2011, 2012, and 2013: Samples were collected from one lysimeter and four soil sampling locations

Background concentrations for uranium and selenium are summarized in Table 3-31. These values are the average calculated from sample locations outside of the irrigated area (refer to Figures 3-115 through 3-126) and from samples collected in 1998 (refer to Figure 3-96).

Table 3-31 Statistics for Uranium and Selenium Background Concentrations in the 100-Acre Center Pivot Irrigation Field

Metal	Interval (feet)	n	Mean	Median	Minimum	Maximum
Uranium (mg/kg)	0-1[1]	14	0.80	0.64	0.19	2.99
	1-2[2]	11	0.64	0.51	0.34	1.62
	2-3	9	0.70	0.56	0.45	1.45
	3-4	2	0.46	0.46	0.39	0.52
	4-5	2	0.41	0.41	0.36	0.45
	5-6	2	0.53	0.53	0.43	0.62
	6-8	2	0.62	0.62	0.44	0.79
	8-10	2	0.50	0.50	0.48	0.52
	10-12	2	0.81	0.81	0.65	0.97
	12-14	2	0.64	0.64	0.60	0.68
	14-16	2	0.69	0.69	0.54	0.84
Selenium (mg/kg)	0-1[3]	13	0.13	0.15	0.03	0.23
	1-2[4]	10	0.11	0.10	0.03	0.24
	2-3	8	0.14	0.13	0.06	0.25
	3-4	2	0.08	0.08	0.07	0.09
	4-5	2	0.06	0.06	0.06	0.07
	5-6	2	0.08	0.08	0.08	0.08
	6-8	2	0.09	0.09	0.08	0.09
	8-10	2	0.09	0.09	0.09	0.09
	10-12	2	0.12	0.12	0.12	0.12
	12-14	2	0.11	0.11	0.08	0.13
	14-16	2	0.10	0.10	0.09	0.10

Source: HMC 2014

Notes:

1. Ten samples collected from 0-12", two from 0-6", and two from 0-8"
2. Nine samples collected from 12"-24", one from 8"-28", and one from 8"-24"
3. Nine samples collected from 0-12", two from 0-6", and two from 0-8"
4. Eight samples collected from 12"-24", one from 8"-28", and one from 8"-24"

Figure 3-127 presents a plot of the uranium concentrations over time from the 100-acre center pivot irrigation field. For comparison, the concentrations are compared on the graph to the average concentrations of samples collected to represent background. Upper, middle and lower are soil results for the 0-1, 1-2 and 2-3 foot intervals respectively. The concentrations are from a composite sample from the several sample locations in each irrigation area. Uranium concentrations in composite samples collected from the treated and background areas in 2002 were, with one exception, at concentrations above pre-operational levels.

Uranium concentrations in the treated area in the 2- to 3-foot interval increased in 2012 and 2013 from the levels observed in 2011. The uranium concentrations in the 0- to 1-foot and 1- to 2-foot intervals were less than the DL in 2013. Figure 3-128 presents the uranium concentrations with

depth for the treated and background concentrations. The most recent (that is, 2013) concentrations of uranium observed in the treated area produced uranium gains of less than 0.40 mg/kg (at 0 to 1 foot), less than 0.48 mg/kg (at 1 to 2 feet), and 0.79 mg/kg (at 2 to 3 feet).

Figure 3-129 presents a plot of the selenium concentrations over time from the 100-acre center pivot irrigation field. For comparison, the concentrations are compared on the graph to the average concentrations of samples collected to represent background. Upper, middle and lower are soil results for the 0-1, 1-2 and 2-3 foot intervals respectively. The concentrations are from a composite sample from the several sample locations in each irrigation area. A comparison of the results obtained from 2001 through 2013 indicates that selenium concentrations increased in the 100-acre center pivot irrigation field. Figure 3-130 indicates that this increase has mainly been in the upper 1 foot of the soil.

3.3.2.4 Soil Impacts at the 150-Acre Center Pivot Irrigation Field

Irrigation at the 150-acre center pivot irrigation field in Section 33 began in 2000. Figures 3-97 through 3-108 display the locations of the soil samples collected each year from the 150-acre center pivot irrigation field and surrounding (background) locations. The following summarizes the number of samples collected within the irrigation fields by year:

- 1999 and 2000: Three locations
- 2001-2008: Twelve locations, each sampled at three depths (0 to 1 foot, 1 to 2 feet, and 2 to 3 feet)
- 2009: Samples were collected from five lysimeter and five soil sampling locations
- 2010: Samples were collected from one lysimeter and five soil sampling locations
- 2011, 2012, and 2013: Samples were collected from five soil sampling locations

Background concentrations for uranium and selenium are summarized in Table 3-32. These values are the average calculated from sample locations outside the irrigated area (refer to Figures 3-97 through 3-109) and from samples collected in 1998 (refer to Figure 3-96).

Table 3-32 Statistics for Uranium and Selenium Background Concentrations for 150-Acre Center Pivot Irrigation Field

Metal	Interval (feet)	n	Mean	Median	Minimum	Maximum
Uranium (mg/kg)	0-1[1]	17	0.83	0.85	0.36	1.14
	1-2	10	0.72	0.74	0.52	0.89
	2-3	10	0.81	0.82	0.66	1.09
	3-4	2	1.02	1.02	1.01	1.03
	4-5	2	0.92	0.92	0.90	0.94
	5-6	2	0.60	0.60	0.52	0.68
	6-8	2	0.90	0.90	0.80	0.99
	8-10	2	0.86	0.86	0.72	0.99
	10-12	2	0.66	0.66	0.56	0.76
	12-14	2	0.55	0.55	0.42	0.68
	14-16	2	0.72	0.72	0.45	0.99
Selenium (mg/kg)	0-1[2]	16	0.16	0.18	0.03	0.39
	1-2	9	0.20	0.16	0.12	0.44
	2-3	9	0.20	0.19	0.12	0.30
	3-4	2	0.17	0.17	0.15	0.18
	4-5	2	0.15	0.15	0.12	0.17
	5-6	2	0.10	0.10	0.08	0.11
	6-8	2	0.12	0.12	0.09	0.14
	8-10	2	0.08	0.08	0.05	0.11
	10-12	2	0.04	0.04	0.03	0.06
	12-14	2	0.08	0.08	0.06	0.10
	14-16	2	0.12	0.12	0.09	0.14

Source: HMC 2014
Notes:
mg/kg = milligram per kilogram
1. 11 samples collected from 0-12", 6 from 0-6"
Analytical results below detection limits were set at 1/2 the detection limit

Figure 3-131 presents a plot of the uranium concentrations over time from the 150-acre center pivot irrigation field and compares the concentrations to calculated background. The most recent (that is, 2013) concentrations observed in the treated area were 2.20 mg/kg (at 0 to 1 foot), 1.60 mg/kg (at 1 to 2 feet), and 1.20 mg/kg (at 2 to 3 feet). This compares to the corresponding mean background values of 0.80 mg/kg (at 0 to 1 foot), 0.69 mg/kg (at 1 to 2 feet), and 0.73 mg/kg (2 to 3 feet). Uranium concentrations increased in the upper two feet of soil at a relatively constant rate until 2004, when concentrations reached a steady state, then increased in 2009 and 2010 and declined in 2011. The 2012 and 2013 data returned to values similar to those found in 2009 and 2010. Figure 3-132 shows the 2012 and 2013 increase in uranium concentrations in Section 33. The increase in the upper 5 feet in 2012 is supported by the 2013 data.

Figure 3-133 presents a plot of the selenium concentrations over time from the 150-acre center pivot irrigation field and compares the concentrations to calculated background. In all three intervals, a variable, but a slightly upward trend is observed. Selenium concentrations in 2012 for the top three feet of treated soil exceeded the mean background by factors of 2.67 (at 0 to 1 foot), 2.27 (at 1 to 2 feet), and 1.85 (at 2 to 3 feet). The 150-acre center pivot irrigation field selenium concentration profile is presented in Figure 3-134 using 2012 data concentrations (2013 selenium analytical results were unusable due to high DLs). The majority of the increase is in the upper 7 feet with some increase observed in two of the four lower intervals.

3.3.2.5 EPA Soil Data from Irrigation Fields

In 2009 and 2010, EPA collected soil samples (0-6") within the four irrigation fields. Table 3-33 displays descriptive statistics of analytical results for uranium and selenium.

Table 3-33 Statistics for Uranium and Selenium in Irrigation Fields (mg/kg)[1]

Location	Chemical	n	Mean	Median	Minimum	Maximum
Center Pivot Fields	Selenium	13	0.48	0.46	0.29	0.71
	Total Uranium [2, 4]	12	2.04	2.07	1.57	2.68
Irrigation Fields	Selenium	6	0.85	0.75	0.50	1.31
	Total Uranium [3, 4]	6	5.30	4.90	3.05	8.01

Source: EPA 2014a
1. Uranium data converted from pCi/g to mg/kg using conversion factor of 1.48.
2. Two sets of U-235 data were included for the center pivot irrigation fields. The data set that reported the same number of data points was used for this table.
3. Two sets of U-235 data were included for the center pivot irrigation fields. The data set that reported the higher value was used for this table.
4. Total Uranium is the sum of U-234, U-235, U-238.

3.3.2.6 HMC Soil Data Collected from Irrigation Fields 2017-2018

Comprehensive soil sampling and analysis at each of the four irrigation fields was completed in 2017 and 2018. The objective of the sampling and analysis program was to evaluate whether concentration of constituents of potential concern met the proposed criteria for unrestricted release from NRC Radioactive Materials License SUA-1471 (ERG 2018).

Soil surveys at each land application area included comprehensive gamma radiation surveys, and statistically-based soil sampling. Gamma survey data was used to evaluate areas of elevated terrestrial gamma radiation and select biased soil sampling locations. The sampling interval was from the ground surface to a depth of 15 cm. Analysis of the samples included selenium, uranium, and Ra-226. Descriptive statistics of the analytical results from the soil sampling, including duplicates, is provided in Table 3-34. The following is a brief summary of the activities completed at each of the irrigation fields (ERG 2018).

- 100-Acre Center Pivot Irrigation Field: Twenty samples plus two biased samples were collected. Refer to Figure 1-135 for sampling locations. In one of the bias sample locations, Ra-226 concentration was 80.8 pCi/g, which is above the NRC-approved 10.5 pCi/g cleanup criterion. Based on this result, excavation was conducted until gamma scan readings approached local background levels. A composite soil sample, centered on the location where the Ra-226 concentration was found to be 80.8 pCi/g, was collected after removal of

contaminated soil. The results reported in Table 3-34 exclude the results from the sample which triggered the excavation activities. Excavated soils were disposed at the solid waste trench disposal area on the southern portion of the STP (ERG 2018).

- 150-Acre Center Pivot Irrigation Field: Twenty samples plus four biased samples were collected. Refer to Figure 1-136 for sampling locations.
- 24-Acre Flood Irrigation Field: Twenty samples plus two biased samples were collected. Refer to Figure 1-137 for sampling locations.
- 120-Acre Flood Irrigation Field: Twenty samples plus seven biased samples were collected. Refer to Figure 1-138 for sampling locations.

Table 3-34 Statistics for 2017-2018 Soil Data from Irrigation Fields

Location	Chemical	n	Mean	Median	Minimum	Maximum
100 Acre CP Section 28	Selenium (mg/kg)	23	0.4	0.4	0.3	0.5
	Uranium Nat (mg/kg)	23	0.8	0.7	0.5	2.8
	Ra-226 (pCi/g)	23	0.9	0.9	0.5	1.8
150 Acre CP Section 33	Selenium (mg/kg)	25	0.6	0.6	0.3	1.2
	Uranium Nat (mg/kg)	25	1.4	1.3	0.6	3.3
	Ra-226 (pCi/g)	25	1.2	1.3	0.7	2.1
24 Acre Irrigation Section 33	Selenium (mg/kg)	24	0.5	0.5	0.4	0.7
	Uranium Nat (mg/kg)	24	1.6	1.6	1.3	2.0
	Ra-226 (pCi/g)	24	1.8	1.7	1.2	3.9
120 Acre Irrigation Section 34	Selenium (mg/kg)	29	1.3	1.3	0.7	2.6
	Uranium Nat (mg/kg)	29	4.1	4.1	1.8	7.2
	Ra-226 (pCi/g)	29	2.0	2.0	1.5	2.9

Source: ERG 2018

3.3.2.7 Oak Ridge Soil Data Collected from Irrigation Fields 2018

At the request of NRC, the Oak Ridge Institute for Science and Education (ORISE) performed confirmatory survey activities at the four irrigation fields. Activities included gamma radiation surface soil scans, surface and subsurface soil sampling, and limited alpha-plus-beta scans and surface activity measurements on irrigation equipment (ORISE 2019).

Gamma radiation scans were performed over a randomly selected population of confirmatory investigation areas that consisted of 400 square meter blocks. The scan objective was to determine if anomalous areas of elevated direct radiation indicative of residual contamination were present. None were identified (ORISE 2019).

Alpha-plus-beta scans of the irrigation equipment identified uniform, elevated count rates commonly encountered on metal surfaces and indicative of natural radon long-lived progeny build-up. Although elevated, the total surface activity levels measured were less than NRC guidance limits (ORISE 2019).

Soil samples were collected from the center of each of the 400 square meter blocks. At each location, a sample was collected from 0 to 30 cm below the ground surface. At some of the locations, a second sample was collected from 30 cm to 60 cm below the ground surface. The number of subsurface locations sampled was dependent upon physical boundary limitations—specifically, the composition and density of the soil. In total, 103 soil samples were collected from 41 locations at the following depths:

- 41 samples from 0–15 cm
- 39 samples from 15–30 cm
- 23 samples from 30–60 cm

The sample locations are shown on Figure 3-139 through 3-142. Each was analyzed for Ra-226, Th-230, and uranium. Table 3-35 provides a summary of the data.

Table 3-35 Statistics for ORISE Soil Data from Irrigation Fields

Radionuclide	Minimum	Maximum	Mean	Standard Deviation
Ra-226 (pCi/g)	0.22	1.49	0.68	0.32
Th-230 (pCi/g)	-7.7	3.4	0.18	1.93
U-total (mg/kg)	1.42	7.47	3.33	1.59

Source: ORISE 2019

4 Contaminant Fate and Transport

Migration and persistence of COPCs and ROPCs in the environment will be discussed in this section. Understanding contaminant fate and transport at a site provides an important basis for assessing human health and ecological risks from exposure. The COPCs and ROPCs for the Site are limited to inorganic chemicals and radionuclides.

4.1 Routes of Migration

4.1.1 Groundwater Transport Pathway

As described in Section 1.4, the LTP and STP were deposited above grade, the majority in the form of slurry. Downward migration of pore water from the tailings piles is a primary source of groundwater contamination at the Site. Introduction of water from wells as part of the current remediation system is intended to accelerate the drawdown of pore water and COPCs/ROPCs from the tailings. Percolation of precipitation through the vadose zone may also drive COPCs/ROPCs to groundwater, though this pathway is limited due to the arid climate. Once COPCs/ROPCs reach the groundwater, movement is governed by groundwater flow within the alluvial and Chinle Formation aquifers and geochemical conditions.

HMC has developed a Groundwater Flow and Transport model that includes the Site and also the SMC Basin. The framework for the model is the Hydrogeologic Site Conceptual Model (HSCM). A HSCM is a summary of available knowledge related to groundwater flow and water quality of the principal hydrostratigraphic units at a certain location and scale. Key HSCM elements specific to the Site include:

- Aquifers of Quaternary, Triassic, and Permian age are present at the Site.
- Principal aquifers with groundwater flow at the Site include the alluvium; Upper, Middle, and Lower transmissive units of the Chinle Formation; and SAG aquifer.
- Local groundwater flow in the alluvium generally flows parallel to downgradient surface flows in SMC, the Rio Lobo, and the Rio San Jose, but bifurcates around a bedrock high located south of the LTP.
- Groundwater flow in the Chinle Formation aquifer units is generally to the north-northeast, except where influenced by faulting, subcrop locations, or ongoing restoration operations.
- Groundwater flow in the underlying SAG aquifer is to the east and southeast.
- Site remedial activities have included groundwater extraction and injection in both the alluvium and Chinle sandstones, affecting local groundwater flow conditions.
- The presence of fault zones has restricted and redirected local groundwater flow in the Chinle aquifers under the Site.
- Local groundwater flow conditions have been well characterized through data collected from hundreds of monitoring wells on the Site.

As an initial step toward creating a groundwater flow and transport model, a 3-D geologic model was developed that captures stratigraphy and faulting at both the site scale around the Site and regionally within the SMC Basin. The geologic model was then used to create appropriate hydrostratigraphic layer structure. The geologic model was developed using Leapfrog^{TM}, a geologic modeling software that provides for enhanced interpretation and visualization of regional stratigraphy and geology. Development of the regional Leapfrog 3-D geologic included the incorporation of an existing site-scale geologic model's interpretations of surface outcrops, stratigraphic layer thicknesses, fault structures, dip directions, and dip angles to produce "layer cake" representation of the primary stratigraphic units in the SMC Basin in the vicinity of the Site. Information from 1,437 geologic logs from the Site, along with regional well information (well depths and units penetrated) and 14 geologic maps for the region were added and localized changes were made to stratigraphic thicknesses and depths (HMC 2019d).

Table 4-1 summarizes the hydraulic parameters used in the model.

Table 4-1 Hydraulic Properties of Site Stratigraphy

Model Layer Number	Hydrostratigraphy	Horizontal Hydraulic Conductivity (ft/d)	Specific Yield	Specific Storage (1/ft)
1	Alluvium	2.0 - 215	0.1	0.0001
2	Bedrock above the Chinle	0.04	0.01	0.00001
3	Chinle Shale	0.25 – 0.0005	0.005	1E-07
4	Upper Chinle Aquifer	1.0 - 10	0.01	0.00001
5	Chinle Shale	0.25 – 0.0002	0.005	1E-07
6	Middle Chinle Aquifer	1.0 - 10	0.01	0.00001
7	Chinle Shale	0.0009	0.005	1E-07
8	Lower Chinle Aquifer	0.5 - 10	0.01	0.00001
9	Chinle Shale	0.004	0.01	0.00001
10	SAG	10 - 500	0.2	0.0001

Source: (HMC 2019d)

To understand COC transport through the LTP, STP, and the alluvial aquifer a conceptual geochemical model has been developed – refer to Figure 4-1 (WME 2019). A fundamental description of the model is summarized in the following statements:

- The source of groundwater contamination is contained within the mound of tailings water within the LTP. After flushing of the LTP ceased in 2015, mounding in the LTP has continued to dissipate.
- As a result of the alkaline leaching process, the source is an alkaline (pH ≈ 10) sodium-sulfate type water, with elevated concentrations of TDS, uranium, selenium, molybdenum, and indicator constituents, such as chloride and sulfate. Redox conditions are moderately oxidizing and therefore uranium, selenium, and molybdenum exist in solution as oxyanions (e.g., MoO42-, SeO42-, UO2 (CO3)34).
- As LTP seepage migrates into the alluvial aquifer, it becomes partially diluted as it mixes with moderately-oxidizing water from upgradient in the San Mateo alluvial aquifer.

- As the impacted groundwater moves downgradient, the concentrations of predominantly indicator constituents (chloride, sulfate) are primarily controlled by dilution and dispersion. The oxyanionic forms of uranium (UO2 (CO3)34-), molybdenum (MoO42-), and selenium (SeO42- and/or SeO32-) are partially adsorbed to hydrous ferric hydroxide, but the majority remain mobile and are transported downgradient.
- Some areas of the groundwater are slightly reducing, such that selenium exists as selenium (IV) (SeO32-), with the potential for precipitation as amorphous elemental selenium.
- Within the LTP, solid forms of uranium, selenium, and molybdenum remain in the tailing, which could be released upon long-term leaching or weathering. Historical information suggests that uranium, selenium, and molybdenum may exist as oxide and/or sulfide minerals, associated with clays, or adsorbed to iron oxides.

Data collection and evaluation to advance the conceptual geochemical model is ongoing.

Movement of contaminants into and within groundwater has been modeled by HMC using MODFLOW-NWT and MT3D-USGS (collectively referred to as the SMC Basin model). MODFLOW-NWT is a publically available model created and maintained by U.S. Geological Survey, includes the Newton-Raphson solution formulation that enables improved unconfined groundwater flow simulations, and incorporates code changes that better simulate drying and rewetting, which may occur within the GRP and SMC Basin if sufficient water table declines and increases are predicted (Niswonger et al., 2011). MT3D-USGS simulates contaminant transport ((Bedekar et al. 2016).

A separate seepage model (the reformulated mixing model [RMM]) was previously developed to assess long-term changes in both seepage flow rates and constituent mass loading. Assessments of past LTP seepage rates, along with predictions of future seepage rates, were developed based on vadose modeling using the VADOSE/W code (HMC 2012). The RMM was recently replaced by a Drain Down Model (DDM) that incorporates the Brooks and Corey method to estimate seepage and toe drain rates (Brooks and Corey 1964). The revised seepage estimates developed from the DDM model were incorporated into this SMC Basin model update to simulate seepage from the LTP into the underlying local groundwater system (HMC 2019d).

In the land treatment fields, irrigating with water containing inorganics is a pathway for contaminants to potentially impact groundwater quality. Recharge from rainfall, can also drive contaminants through the vadose zone into groundwater, though recharge rates are low due to the arid climate.

The release of contaminants from the LTP has impacted residential wells in the nearby subdivisions. As described in Section 1, through agreements with EPA in 1983 and NMED in 2009, HMC has extended the Village of Milan’s municipal water supply to the residences of the subdivisions and provided connection.

4.1.2 Air Transport Pathways

Under current Site conditions, releases of COPCs/ROPCs to air from dust and generation of radon-222 through radioactive decay of Ra-226 is inhibited by the cap that was placed on the tailings piles in the mid-1990s. During historical mill operations, dust generation and transport by wind was likely because operations involved intensive milling, earth-moving, and ore-hauling activities. Significant deposition of dust primarily downwind of the tailings piles was remediated in the mid-1990s (refer to Figure 1-5) after milling operations ceased. Mine tailings and the mill operation areas were capped

with imported materials. Quarterly radon monitoring suggests that migration of radon from the Homestake Facility does not exceed background levels.

EPA completed a RI that studied the transport of radon from the Homestake Facility in 1989. The evaluation included 59 residential houses and 28 outdoor monitoring stations and was conducted over a fifteen-month period. At the houses, the average annual indoor radon concentration was 2.7 pCi/1 and the average annual outdoor concentration was 1.9 pCi/1. Based on the results of the RI, EPA determined that the uranium mill and tailing embankments at the Homestake Facility, though a potential source of radon, were not contributing significantly to subdivision radon concentrations. This determination resulted in a “no action” decision that was formalized in a ROD (EPA 2014a).

In 2010, EPA undertook a second investigation of the radon near the Site. The study included:

- Selection of a “background” community
- Collection and analysis of 885 indoor radon samples from 79 houses in the five subdivisions and 28 houses in the background community.
- Collection and analysis of 751 outdoor long term annual (4 quarters) radon samples were collected from several areas around the Homestake Facility, the Five Subdivisions and the background community.

The study concluded the following:

- For indoor air, statistical tests did not show significant difference between the subdivisions and the background community.
- Outdoor radon levels in the subdivisions were statistically higher than outdoor radon levels at the background community.
- Radon levels collected from monitors placed 6 inches above the ground surface were statistically higher than levels from corresponding monitors 5 feet above the ground surface along the fence line separating the Homestake Facility and the subdivisions.
- The upgradient air monitors did not show a trend in the level of radon flowing from the north towards the Homestake Facility.
- Air monitors downgradient from the Homestake Facility showed higher radon levels than upgradient radon levels.
- The impact of radon/thoron gas that was seen at the HMC downgradient monitors and near the Homestake Facility was not seen at the fence line air monitors or at the community at large.

Using information from the study, EPA conducted a HHRA that concluded outdoor radon in the area of the Five Subdivisions presents excess cancer risk greater than EPA’s acceptable risk range. The HHRA calculates the source of the excess cancer risk as 13 X 10^{-4} from background sources and 5 X 10^{-4} (EPA 2014a).

Based on the results of the indoor radon study, EPA took removal action at ten properties in the subdivision. EPA installed radon mitigation systems in homes where indoor radon exceeded the EPA mitigation action level of 4 pCi/L. The source of the indoor radon was not determined (EPA 2015).

4.1.3 Runoff, Overland Flow Pathways

Surface water and runoff can be a means of transporting inorganic contaminants. As described in Section 2.7, the Site is generally flat and natural surface drainages no longer exist at the Homestake Facility. Artificially made surface channels have been constructed to transport flood water (refer to Figure 1-7). Due to the capping that has occurred at the Homestake Facility and the climate conditions, surface water and runoff pathways are not significant factors of contaminant transport at the Site, though possible in an extreme weather event.

The top perimeter of the Large Tailings Pile is graded and a berm erected to prevent stormwater from flowing from the top and down the sides, which could result in erosion of the side slope radon barrier. The stormwater collected on the top of the pile is transported down the side slopes of the tailing pile through 12-inch diameter pipe downdrains.

In 2010, because of high rainfall events, runoff from the top of the pile was preferentially directed to three areas on the top of the south side of the large tailings pile. The pooled water spilled over berms that direct runoff to the downdrains. Three areas of the radon barrier were eroded; however, uranium mill tailings were not exposed. The erosion areas were repaired and drainage improvements completed to prevent similar occurrences (DBE 2010).

4.2 Contaminant Persistence

Persistence is one of the key factors considered in assessing the risk associated with a chemical in the environment. Metals, which are elemental, are infinitely persistent, though can change oxidation state or combine with other elements to form compounds. Radionuclides undergo natural radioactive decay that, for some compounds, may significantly reduce potential risks over relatively short time periods. However, for other radionuclides, half-lives are very long, meaning that risks posed by the presence of these compounds will persist for a very long time. Table 4-2 summarizes the half-lives of radionuclides commonly found at the Site.

Table 4-2 Half-Life of Common Site Radionuclides

Nuclide	Half-life	Decay Mode	Daughter
Uranium-238	$4.47*10^8$ years	alpha	Thorium-234
Uranium-235	$7.04*10^8$ years	alpha	Thorium-231
Uranium-234	$2.46*10^5$ years	alpha	Thorium-230
Thorium-230	$7.54*10^4$ years	alpha	Radium-226
Thorium-234	24 days	beta	Protactinium-234
Radon-222	3.82 days	alpha	Polonium -218

Source: Vanderbilt 2013

5 Risk Analyses

5.1 Data Evaluation

Data collected by EPA for use in its human health risk assessment (HHRA) for the Site (EPA 2014a) and data collected by HMC for yearly monitoring reports completed for the Site since 2014 are the primary inputs for the risk assessments performed for this RI Report. Other reports completed by HMC for the Site were reviewed and applicable data collected for use in the risk assessments.

Selection of data for the risk assessments was based on several factors:

1. The newest data, where available at the time of this report, were considered preferable to older data to reflect current Site conditions. Older data were included only if a data gap was identified with use of the new data only.

2. Radon data collected by HMC and EPA were included for specific stations (Figure 3-64). Background radon concentrations were evaluated at HMC-16. HMC-6 was used as the background location for particulate analytes in air.

3. Current indoor air radon data were evaluated; however, personnel monitoring data and lysimetry data were not included.

4. No data qualified as rejected or unusable were used.

The analytical results along with the screening for contaminants are presented as summary statistics (minimum and maximum detected results, arithmetic mean, number of samples, number of detected results, and frequency of detection) in Appendix F. The data presented include:

1. HMC and EPA soil data from 2017 and earlier for the Homestake Facility, and soil data from 2017 to 2018 for the LTAs

2. EPA surface soil data to represent background

3. Evaporation pond sediment and water quality data from 2015 to 2018

4. Radon data (indoor and outdoor) (HMC quarterly data from 2014 to 2018)

Table 5-1 provides a summary of reports and data sources evaluated for use in the HHRA.

There were three soil samples (EP-2, EP-5, and EP3-9) that were not included in the final soil data set since they were located outside the Homestake Facility and not within a LTA. In addition, the Ra-226 results from one sample were rejected based on the data usability review and statistical analysis.

Refer to Appendix G for the data usability report.

Table 5-1 Data Sets Evaluated

Item	Data Set Description	Data Owner	Location	Medium	Year	Laboratory	Reference	Information Provided
1	Background	EPA-Region 6 (R6)	South of Homestake Mill	Soil	2011	NAREL	EPA 2014a	
2	Evaporation Pond Sediment	HMC	Homestake Facility	Sediment	2015	Energy	ERG 2017	Report
3	Evaporation Pond Water	HMC	Homestake Facility	Water	2015-2018	Energy	ERG 2017	Report
4	EP-1 & EP-2	HMC	Homestake Facility	Soil	2009	ACZ	ERG 2014	Sample Results
5	EP- 3	HMC	Homestake Facility	Soil	2009	ACZ	ERG 2014	Sample Results
6	EP-1 & EP-2	HMC	Homestake Facility	Soil	2009	ACZ	ERG 2014	Sample Results
7	Radon and Air Particulate Data	HMC	HMC-1, HMC-16 (BKG), HMC-1A, HMC-2, HMC-3, HMC-4, HMC-5, HMC-6, HMC-6 (BKG), HMC-7, Office, RO Plant (See Figure 3-64)	Indoor and Outdoor Air	2014-2018 (Radon) 2015-2018 (Particulate)	Energy	HMC 2019c	Sample Results
8	Soil Data for LTAs - ORISE	HMC	LTAs	Soil	August 27-20, 2018	Radiological and Environmental Analytical Laboratory in Oak Ridge, Tennessee	ORISE 2019	Sample Results
9	Soil Data for LTAs – Final Status Survey	HMC	LTAs	Soil	2017-2018	Energy	ERG 2018	Sample Results

Notes:
BKG = Background
EDD = electronic data deliverable
EPA = U.S. Environmental Protection Agency
ERG = Environmental Restoration Group, Inc.
HMC = Homestake Mining Company
LTA = Land Treatment Area
NAREL = EPA National Air and Radiation Environmental Laboratory in Montgomery, Alabama
ACZ = ACZ Laboratories, Inc. of Steamboat Springs, Colorado
Energy = Energy Laboratories, Inc. of Billings, Montana and Casper, Wyoming
R6 = Region 6
ORISE = Oak Ridge Institute for Science and Education

5.2 Human Health Risk Assessment

The HHRA consists of a conceptual site model, a screening level analysis, and the baseline or forward risk analysis. The baseline or forward risk analysis includes an exposure assessment, toxicity assessment, and risk characterization. Uncertainty is addressed, and a comparison made to background, in the risk characterization.

Risk Assessment Guidance for Superfund (RAGS) Part D Planning Tables are provided in Appendix H.

5.2.1 Conceptual Site Model

The conceptual site model (CSM) is a description of the Site and its environment based on existing knowledge of Site conditions. It describes contamination sources and possible receptors, and the interactions that link them. The CSM typically addresses both current and future land use scenarios, and is developed and used as a planning tool to integrate information from a variety of resources and to evaluate the information with respect to project objectives and data needs. The HHRA CSM describes the ways that COPCs and ROPCs can be released to or transported within the environment, and the exposure routes that could lead to human receptors. Exposure pathways are shown on the CSM. Complete exposure pathways consist of five components: 1) source, 2) exposure medium, 3) release mechanism, 4) exposure route, and 5) receptor.

HHRA CSMs have been prepared for the Homestake Facility and the LTAs and are included as Tables 5-2 and 5-3. EPA also developed its own CSM for human access and exposure to COPCs and ROPCs representing the potential chemical and radiological hazards for nearby residential receptors (EPA 2014a). EPA's CSM served as a basis for developing the HHRA CSMs for this RI Report.

The sources of COPCs and ROPCs at the Site above background concentrations result from historical uranium milling and mining activities in the region. Residual chemical and radionuclide contamination potentially remains in the Homestake Facility and LTAs following cessation of mill activities, demolition of the mill, and subsequent remedial actions discussed in Section 1.4.

5.2.1.1 Current and Future Land Use

The current primary land uses for the Homestake Facility area are groundwater remediation and associated maintenance activities and general property maintenance such as cap monitoring, fence repair, equipment and road repairs, facility administration, and weed control. The Homestake Facility area totals 1,085 acres. There are four LTAs in Sections 28, 33, and 34: two flood irrigated fields (24 acres and 120 acres), and two center pivot irrigated fields (100 acres and 150 acres). Spray and flood irrigation that occurred in the LTAs ceased in 2012 (refer to Figure 1-2). Currently, the LTAs are not used for Site-related activities.

Upon completion of Homestake Facility decommissioning, the Homestake Facility will be turned over to the Department of Energy (DOE) for legacy management. There are no planned changes in the existing land uses known at this time for the Homestake Facility. It will continue under an industrial use scenario.

Trespassing could occur in this area. It is not expected that trespassers would access the area frequently because there is other open space in the area. The property is also fenced.

Currently, a Declaration of Restrictive Covenants is being developed by HMC that, upon recording, will prohibit residential and agricultural use of the LTAs and use of groundwater beneath the LTAs for drinking water purposes.

5.2.1.2 Contaminant Sources

The primary sources of ROPCs and COPCs for both the Homestake Facility and the LTAs are the two tailings piles (refer to Figure 1-2) remaining from the historical uranium milling operations. Secondary sources are materials contaminated by release and transport from primary sources.

In the Homestake Facility, surface and subsurface soils, groundwater, fugitive dusts, two collection and three evaporation ponds, and the RO equipment could act as potential secondary sources.

Secondary sources at the LTAs include soils and fugitive dust. Wind could have carried contaminants from the Homestake Facility, and irrigation water could have introduced contamination to soils.

Groundwater is approximately 40 feet below grade at the Site. HMC provided communities south of the Homestake Facility with a potable water system as an extension of the Village of Milan water supply in the 1980s to address a concern over the quality of groundwater used for domestic purposes. HMC, through a Memorandum of Agreement with NMED, provided residents of these communities connection to the Village of Milan water at HMC's expense (NMED 2009b). The community continues to be served by this alternate water supply. In addition, remedial efforts are underway to treat groundwater that has migrated from the Homestake Facility. Within the Homestake Facility, HMC uses bottled water for drinking and water from a SAG well for other domestic and sanitary uses. For these reasons, groundwater is not considered to be a current complete pathway in this HHRA. Potential groundwater risks were evaluated only for future receptors exposed to post-remedy groundwater concentrations.

5.2.1.3 Release and Transport Mechanisms

Tailings produced during the mill's operation were placed in the tailings piles within the Homestake Facility. From there, the potential primary release and transport mechanisms included:

- Air dispersion/volatilization (for example, windblown fugitive dust or radon gas generation)
- Percolation of water, vertical migration
- Runoff, overland flow

5.2.1.4 Potential Routes of Migration

Potential routes of migration are described in Section 4.1. Routes of migration as they pertain to the risk assessment CSM are summarized in this section.

COPCs and ROPCs released from the tailings could be transported by surface water runoff to other areas down gradient from the source. Surface soil concentrations collected downgradient from the tailing piles also reflect contamination transported by surface water in addition to contamination transported by air. Erosion occurring on the tailings piles is not considered a reasonably expected event as the in-place erosion protection is designed to protect the impoundment for a Probable Maximum Precipitation event and to last a minimum of at least 1,000 years.

Windblown dust, especially in arid regions, represents a potential migration pathway for contaminants in surface soils due to generation of fugitive dust. In addition, radon gas migrates through air. Contaminants deposited onto surface soils can migrate through vertical and horizontal migration or mechanical disturbance.

Groundwater is another potential route of migration for COPCs and ROPCs from the tailings pile. Leaching to groundwater followed by groundwater flow can carry contaminants in the plume away from the primary source. Groundwater is currently undergoing remediation, and is being addressed and monitored under a separate EPA-led initiative.

Contaminants can also potentially migrate through uptake via the food chain. EPA measured concentrations of COPCs and ROPCs in produce (EPA 2014a) and evaluated residential exposure south of the Homestake Facility. Because of a deed restriction proposed in 2019, residential and agricultural uses will be prohibited within the LTAs, if the deed restriction is selected as part of a remedial alternative by EPA. Specifically, the deed restriction will prohibit residential, agricultural (animal grazing or using the land to grow food for animal or human consumption) uses within the LTAs. These land uses are also not envisioned for the Homestake Facility since it will be returned to DOE for legacy purposes. Therefore, food chain contamination due to contaminated irrigation water or alluvial groundwater will not be further addressed in this HHRA.

The draft deed restriction also prohibits use of groundwater except in compliance with a permit or applicable law (this would address groundwater-related pathways). In addition, groundwater remedies approved and monitored by EPA will reduce contamination from groundwater at the LTAs. The remedies will be designed to remove contamination to Site specific background levels; however, these background levels could be higher than the MCL value of some chemicals and/or radionuclides.

Potential Human Receptors

Human receptors potentially exposed to COPCs and ROPCs for this RI Report differ by exposure area. Current workers within the Homestake Facility operate under approved health and safety programs and are not considered receptors in this HHRA. Although other human receptors could possibly be in the vicinity of the Site and come in contact with environmental media, these categories identified below are intended to address those humans most likely exposed at the highest (that is, reasonable maximum exposure (RME)) rates. Access to the Homestake Facility is controlled and the area is fenced; however, trespassing remains a possibility and is considered in this analysis.

In the Homestake Facility, potential current and hypothetical future receptors evaluated for the HHRA include the following (refer to Table 5-2):

- Future Commercial/Industrial Indoor/Outdoor Worker (adult). This is also referred to as "composite worker".
- Future Construction Worker (adult)
- Current and Future Trespasser (adult)

The LTA receptors are:

- Future Composite Worker (adult)
- Future Construction Worker (adult)

- Current and future trespassers (adult)

Note that a hypothetical future residential receptor is not modeled in the risk assessment. EPA has modeled risks to local residents near the LTAs and so current and future potential risks are identified and understood. Any risks to a resident would be higher than those for a worker due to longer exposure durations and higher exposure frequency. Because of the proposed deed restriction, residential use is not an expected land use for this area.

5.2.1.5 Exposure Media and Exposure Routes

The following exposure media and exposure routes are addressed in this risk assessment.

- Soil (surface and subsurface) - Exposure routes include incidental ingestion (for COPCs), dermal or direct contact (for COPCs), outdoor only fugitive dust inhalation of COPCs and ROPCs, inhalation of volatile ROPCs, and external radiation (submersion or immersion in a radiation field) from ROPCs (beta and gamma emitters).
    - All exposure routes in the Homestake Facility or LTAs for surface soil contact are considered potentially complete for all receptors.
    - Contact with subsurface soils is considered possible for the future construction worker engaged in excavation, and the future composite worker in the Homestake Facility in the event that excavated subsurface soils are left at the surface.
- Evaporation Pond Water – The evaporation ponds contain water or brine and may be a source of intermittent exposure due to accidental contact resulting in incidental ingestion of COPCs or ROPCs, dermal contact for COPCs, and immersion for ROPCs. Contact with pond water or brine is considered potentially complete for a hypothetical current trespasser. Accidental exposure is considered a rare event and was conservatively modeled at 6 days per year (d/y) for 10 years. Closure of the ponds will eliminate evaporation pond pathways for future trespassers.
- Evaporation Pond Sediments – Pond sediments are the solids at the bottom of the Evaporation Ponds and not the white residue or evaporites surrounding the ponds. Sediment samples have been collected and the sediment data is provided in the risk assessment.
- Evaporites or Brine Lining the Evaporation Ponds - An accidental immersion into the brine or sludge surrounding the ponds was considered a possibility. However, review of EPA data indicated many constituents were lower in evaporites or white residue than in surface soils, likely because the ponds contain relatively clean water that has been treated in the RO unit (EPA 2014a). If included in an exposure model, part of the typical total allotted soil ingestion rate would have to be reallocated to this brine/sludge material, which would then reduce predicted soil exposure. Given that the areal extent of the brine/sludge is very small relative to the soil areal extent and that humans would rarely contact it; it was not included in the quantitative evaluation.
- Groundwater –Groundwater is not a current exposure medium in the HHRA. For future land use; however, ground water is evaluated as a complete exposure pathway for the future indoor worker with the NRC Site Cleanup Levels used to quantify potential exposures. Groundwater is encountered at a depth of roughly 40 ft bgs and is undergoing remediation.

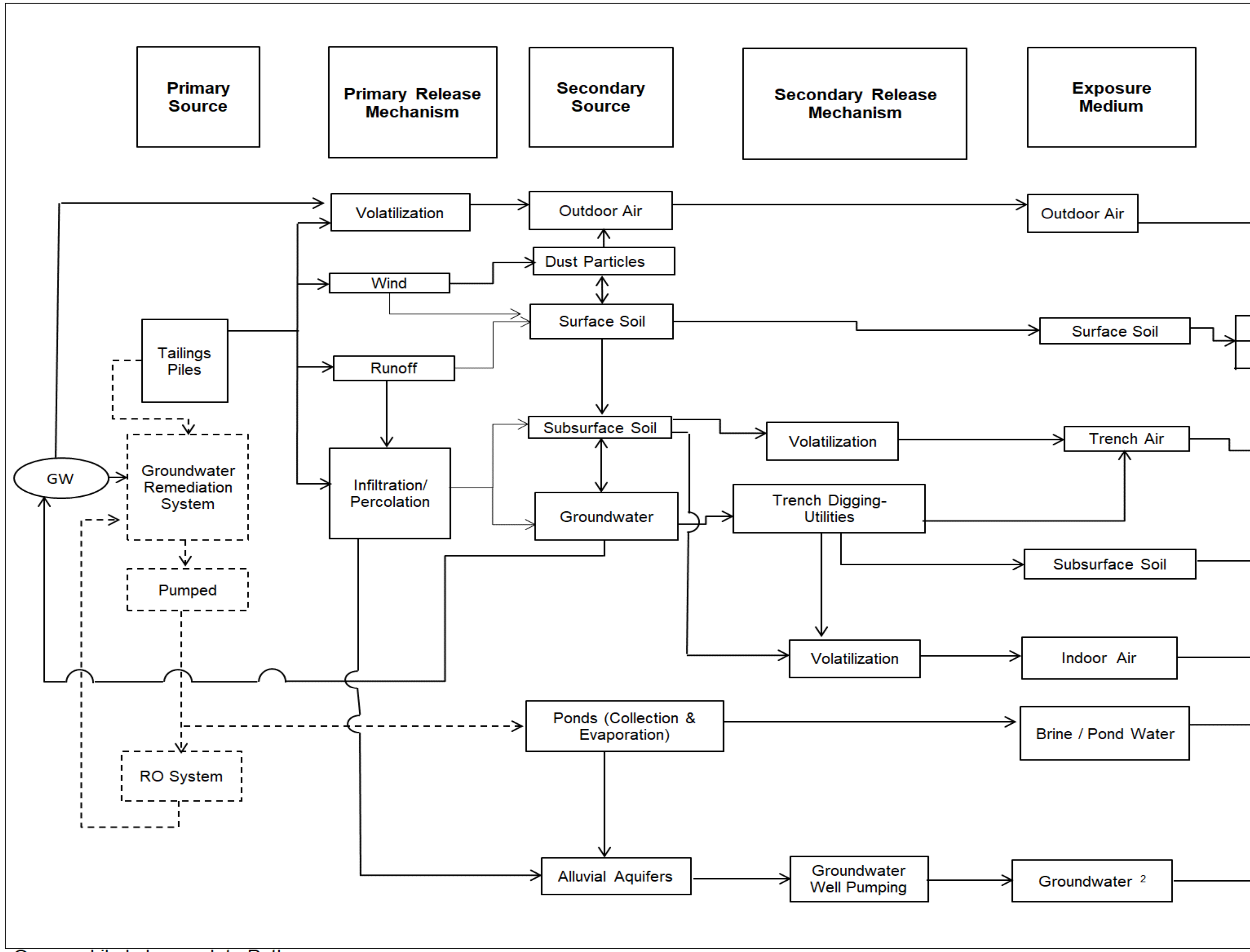
Groundwater that passes through the reverse osmosis system may enter the evaporation ponds, at which point any exposure is addressed as pond water. Section 5.2.5.2.7 discusses post-remediation groundwater exposure.

- Irrigation Water – Irrigation is not occurring in the Homestake Facility or LTAs. Irrigation in the LTAs was terminated in 2012.
- Air – Air can be an exposure medium. Measured indoor and outdoor air data for radon gas and outdoor air data for particulates were included in the HHRA. The results of modeling particulate exposure from soil dust emissions and measured particulate data are compared. This is discussed in the uncertainty analysis.
- Trench Air – Air in deep trenches is a potential exposure medium for construction workers. However, only radon gas is a ROPC for this medium as it is the only volatile in the Homestake Facility or LTA. There is no radon gas data for surface or subsurface soils, and therefore trench air was not modeled quantitatively for those media. Exposure to trench air is quantified with measured indoor and outdoor air data, and addressed in the uncertainty analysis.

Access to the Homestake Facility is restricted by fencing and HMC personnel. There are no natural and permanent surface water features on the Site. Surface water that may be associated with evaporation ponds has been included in this CSM for current trespassers. Natural sediment is not evaluated.

Indoor air exposure to volatile compounds was evaluated based on the future composite worker, although it is expected that future buildings would have mitigation for radon as part of best construction practices. Inhalation of fugitive dust was assessed for the future composite worker, and inhalation of trench air for the future construction worker.

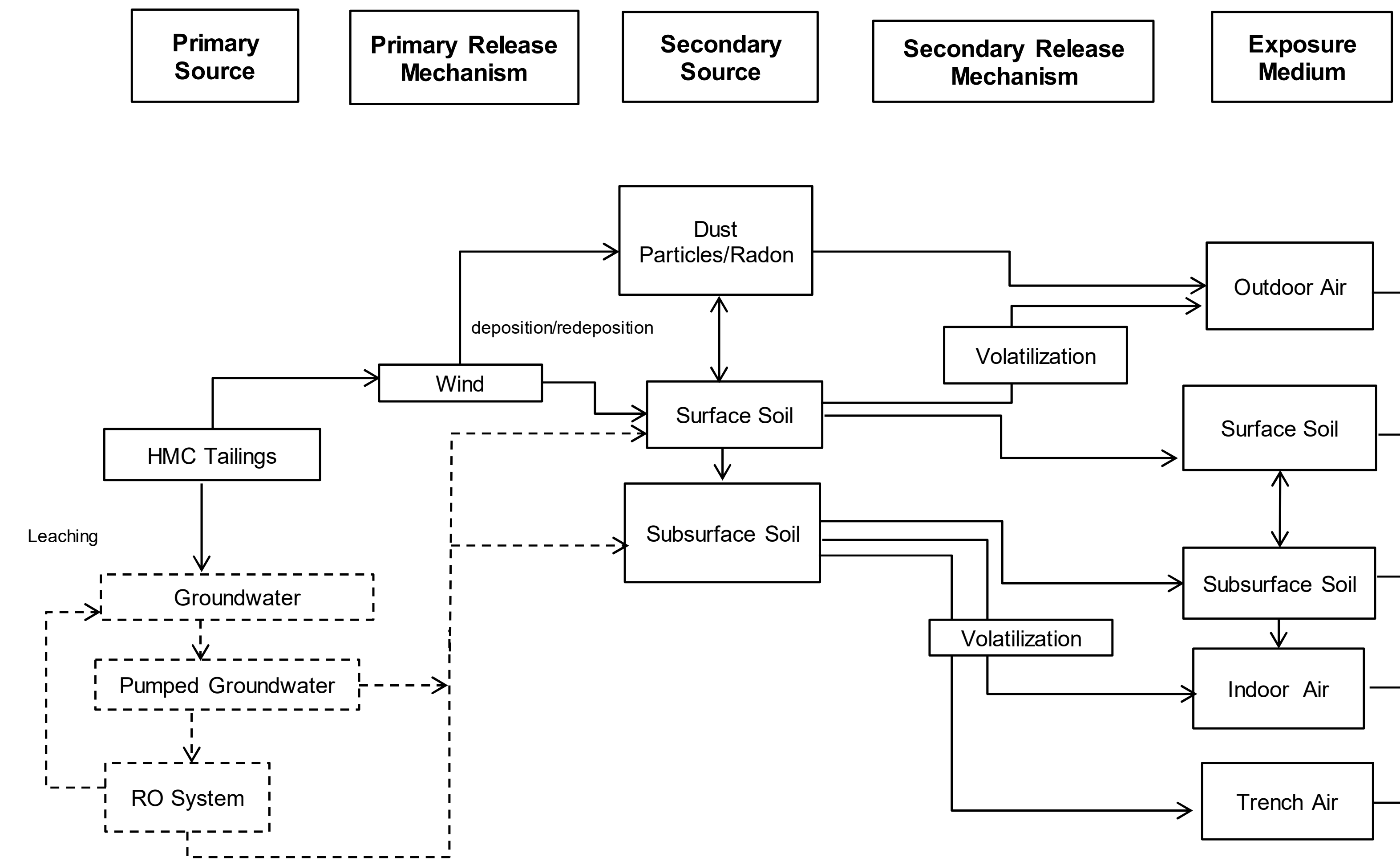
Table 5-2 Conceptual Site Model for Human Receptors within Homestake Facility



Exposure Medium	Exposure Route	Future Commercial/ Industrial Indoor/ Outdoor Worker	Future Construction Worker	Current Trespasser (Adult)	Future Trespasser (Adult)
Outdoor Air	Inhalation	◉	◉	◉	◉
	Submersion[3]	◉	◉	◉	◉
Surface Soil	Ingestion	◉	◉	◉	◉
	Dermal Contact[1]	◉	◉	◉	◉
	External Radiation	◉	◉	◉	◉
Trench Air	Inhalation	○	◉	○	○
	Submersion[3]	○	◉	○	○
Subsurface Soil	Ingestion	◉	◉	○	○
	Dermal Contact[1]	◉	◉	○	○
	External Radiation	◉	◉	○	○
Indoor Air	Inhalation (Radon)	◉	○	○	○
	Submersion (Radon)	◉	○	○	○
Brine / Pond Water	Incidental Ingestion	○	○	◉	○
	Inhalation	○	○	◉	○
	Dermal Contact[1]	○	○	◉	○
	External Radiation	○	○	◉	○
Groundwater[2]	Ingestion	◉	○	○	○
	Inhalation	◉	○	○	○
	Dermal Contact[1]	◉	○	○	○
	External Radiation	◉	○	○	○

○ Likely Incomplete Pathway
◉ Potentially Complete Pathway
Shading denotes potential exposure is de minimus; not quantitatively evaluated
RO = reverse osmosis
- - - - -> Represents above ground GW treatment system (OU-1)
Current facility operators and site workers are covered under the Occupation Safety and Health Administration standards.
[1] Dermal contact for non-radionuclides only
[2] Groundwater (OU-1) is under remediation; evaluated for future indoor worker in the HHRA.
[3] - Applies to ROPCs only

Table 5-3 Conceptual Site Model for Human Receptors within Land Treatment Areas



Exposure Medium	Exposure Route	Potential Future Receptors: Commercial/Industrial Indoor/Outdoor Worker	Potential Future Receptors: Construction Worker	Potential Current & Future Receptor: Trespasser
Outdoor Air	Inhalation	⊙	⊙	⊙
	Submersion[2]	⊙	⊙	⊙
Surface Soil	Ingestion	⊙	⊙	⊙
	Dermal Contact [1]	⊙	⊙	⊙
	External Radiation	⊙	⊙	⊙
Subsurface Soil	Ingestion	○	⊙	○
	Dermal Contact [1]	○	⊙	○
	External Radiation	○	⊙	○
Indoor Air	Inhalation	⊙	○	○
	Submersion[2]	⊙	○	○
Trench Air	Inhalation	○	⊙	○
	Submersion[2]	○	⊙	○

⊙ Potentially Complete Pathway

○ Incomplete Pathway

- - -> represents above ground GW treatment system (OU-1)

Land Treatment Area irrigation ceased in 2012

[1] Dermal contact for non-radionuclides only

[2] Applies to ROPCs only

GW = groundwater

RO = reverse osmosis

5.2.2 HHRA Screening for Chemicals of Potential Concern and Radionuclides of Potential Concern

The source documents referenced in Table 5-1 were reviewed to compile a primary list of analytes for the quantitative HHRA. HMC and EPA soil data were segregated into Homestake Facility, LTAs, or background.

EPA provides default regional screening level (RSLs) tables for workers and residents, and a calculator that estimates remediation goals or risks for chemicals in soil, air, and water for receptors potentially associated with the Site including recreational visitors or trespassers, indoor and outdoor workers, construction workers, and composite workers which are inclusive of both indoor and outdoor exposure pathways (EPA, 2019a). For initial soil COPC screening, workers as a group were addressed using the default RSLs for industrial soil (EPA 2019a) which are based on the composite worker exposure scenario.

In addition, the EPA and the Oak Ridge National Laboratory (ORNL) provide screening values for radionuclides or radiological preliminary remediation goals (RadPRGs) in various environmental media. RadPRGs are provided as defaults or can be calculated as Site-specific values whereby the user may input different exposure parameters and Site conditions. The human receptors addressed by the RadPRGs include composite workers, construction workers, and recreational visitors or trespassers. For the HMC HHRA, the default RadPRGs for the composite worker in all available environmental media were selected as most applicable for the initial ROPC screening based on the CSMs in Section 5.2.1.

The metals and radionuclides in the Homestake Facility and LTA data sets were compared record by record to these conservative, default screening levels based on EPA's "composite worker" and if the ratio for the maximum concentration or activity exceeded a screening level the analyte was considered to carry forward into the Baseline HHRA. Therefore, if the COPC and ROPC concentrations exceeded the screening values, those COPCs and ROPCs were retained for further evaluation in the HHRA Screening values for the composite worker are provided in Tables 5-4 through 5-7. This receptor has long-term, high rates of exposure to multiple pathways and is typically considered protective of other industrial receptors.

5.2.2.1 Inorganics

Inorganic chemicals evaluated in the screening level risk assessment were arsenic, lead, molybdenum, selenium, vanadium, and uranium as a metal. The screening methods and results are described in the following sections. All screening levels are conservative default values and have not been adjusted to reflect Site-specific conditions. The results and raw data are presented by location (i.e. LTAs or Homestake Facility) in Appendix F.

5.2.2.1.1 Soil

EPA RSLs for the composite worker exposed to industrial soil were used as the screening levels for metals for identifying COPCs (EPA 2019a). Site surface and subsurface soil concentrations were combined and compared to the 2019 EPA industrial soil RSLs for the composite worker (EPA 2019a) (refer to Table 5-4). Metals that exceeded the industrial soil RSLs are carried forward for further evaluation. The results are presented in Section 5.2.2.4. Appendix F also contains a summary of soil screening levels used in the HHRA.

Table 5-4 Summary of Soil Screening Values for All Analytes Evaluated in the HHRA

Analyte Name	Chemical Symbol	CASRN	Effect Basis	Composite Worker RSL (TCR=1E-06 THQ=0.1) (mg/kg)	Composite Worker RadPRG - Composite Worker (pCi/g)
Inorganics (mg/kg)					
Arsenic	As	7440-38-2	c*R	3.0	NA
Lead	Pb	7439-92-1	nc	800	NA
Molybdenum	Mo	7439-98-7	nc	580	NA
Selenium	Se	7782-49-2	nc	580	NA
Uranium (soluble salts)	U	--	nc	23	NA
Vanadium	V	7440-62-2	nc	580	NA
Radionuclides					
Gross Alpha	Gross Alpha	12587-46-1	c	NA	NA
Barium-140	Ba-140	14798-08-4	c	NA	0.0143
Gross Beta	Gross Beta	12587-47-2	c	NA	NA
Bismuth-212	Bi-212	--	c	NA	0.0258
Bismuth-214	Bi-214	--	c	NA	0.0231
Cobalt-60	Co-60	10198-40-0	c	NA	0.0142
Cesium-137	Cs-137	--	c	NA	0.069
Iodine-131	I-131	10043-66-0	c	NA	0.109
Potassium-40	K-40	13966-00-2	c	NA	0.219
Protactinium-234 Metastable	Pa-234m	15100-28-4	c	NA	0.02
Lead-212	Pb-212	15092-94-1	c	NA	0.024
Lead-214	Pb-214	15067-28-4	c	NA	0.0204
Radium-223	Ra-223	15623-45-7	c	NA	0.146
Radium-226	Ra-226	--	c	NA	0.0203
Radium-228	Ra-228	--	c	NA	0.0153

Table 5-4 Summary of Soil Screening Values for All Analytes Evaluated in the HHRA (Con't)

Analyte Name	Chemical Symbol	CASRN	Effect Basis	Composite Worker RSL (TCR=1E-06 THQ=0.1) (mg/kg)	Composite Worker RadPRG -Composite Worker (pCi/g)
Radon-219	Rn-219		c	NA	0.239
Radon-222	Rn-222	--	c	NA	0.0204
Thorium-227	Th-227	15623-47-9	c	NA	0.106
Thorium-228	Th-228	14274-82-9	c	NA	0.0238
Thorium-230	Th-230	14269-63-7	c	NA	0.0203
Thorium-232	Th-232	--	c	NA	0.0153
Thorium-234	Th-234	--	c	NA	0.02
Thallium-208	Tl-208	14913-50-9	c	NA	0.01
Uranium-234	U-234	13966-29-5	c	NA	0.0203
Uranium-235	U-235	--	c	NA	0.0731
Uranium-238	U-238	--	c	NA	0.02
U-natural	U-nat	--	c	23	0.02015

Sources: EPA 2019a.

Notes:

COPC = chemical of potential concern;
ROPC = radionuclide of potential concern

c = cancer
c*R = RBA applied (See User Guide for Arsenic notice) (EPA 2019a)
CASRN = Chemical Abstracts Service Registry Number
EPA = U.S. Environmental Protection Agency
HMC = Homestake Mining Company
mg/kg = milligram per kilogram

NA = not applicable
nc = non-cancer
ORNL = Oak Ridge National Laboratory
pCi/g = picoCurie per gram
RadPRG = radionuclide preliminary remediation goal assuming secular equilibrium
RBA = relative bioavailability factor
RSL = regional screening level
TCR = total cancer risk
THQ = total hazard quotient

5.2.2.1.2 Water

EPA RSLs (EPA 2019a) for residential use of tapwater were used to conservatively assess potential water exposures because there are no tapwater RSLs for industrial use, but the residential RSLs represent long-term exposure to a higher contact rate than would be expected under an industrial use scenario, and are therefore considered conservative for the screening evaluation. Tapwater RSLs for metals were used to screen the evaporation and collection ponds water data for dissolved and total metals (refer to Table 5-5). Where both dissolved and total data were available, the total concentrations were used as the basis of the exposure point concentrations (EPCs). Metals that exceeded the residential tapwater RSLs are carried forward for further evaluation. The results are presented in Section 5.2.2.4. All residential tapwater RSLs are also provided in Appendix F.

5.2.2.2 Radionuclides

RadPRGs were obtained from the EPA-Oak Ridge National Laboratory (ORNL). Screening values assume secular equilibrium with daughter products (progeny) throughout the chain, including the assumption of no decay. EPA provides RadPRGs for various media for composite workers and other receptors using both default and Site-specific exposure parameters. For consistency and in accordance with the CSMs in Section 5.2.1, default RadPRGs for the composite worker were selected for ROPC screening. All screening levels and raw data are provided in Appendix F.

5.2.2.2.1 Soil

Soil screening levels for radionuclides were the default RadPRGs for the composite worker (refer to Table 5-4). This is expected to be protective of other industrial exposure scenarios (e.g., construction workers) because this is a long-term worker with moderately high contact rates, and is the basis of default screening values used by EPA. The Site surface and subsurface soil data for radionuclides were combined and compared to the RadPRGs. If concentrations exceeded the RadPRG for the composite worker, the radionuclide was carried forward for further evaluation. The results are presented in Section 5.2.2.4. All RadPRGs are also provided in Appendix F.

5.2.2.2.2 Water

Residential tapwater RadPRGs were used to screen the evaporation and collection pond water data (refer to Table 5-6) because industrial SLs are not available for tapwater. This is conservative because receptors would not be expected to use any of the evaporation or collection ponds as a primary drinking water source. Evaporation pond data for radionuclides were compared to the RadPRGs for residential use. If concentrations exceeded the RadPRG for residential use of tapwater, the radionuclide was carried forward for further evaluation. The results are presented in Section 5.2.2.4. All RadPRGs are also provided in Appendix F.

5.2.2.2.3 Sediment

There are sediment data from two samples. One sample was collected from the West Collection Pond and was analyzed for uranium natural (U-nat) and Th-230. The other sample was collected at EP1 and analyzed for Ra-226. Soil RadPRGs (Table 5-4) were used to initially screen sediments. The sediment samples evaluated in the risk assessment were collected on September 24, 2015 (ERG 2017).

There are no residential or industrial screening levels for sediment. Therefore, sediment data were compared to industrial soil screening levels (Table 5-4).

There is a salt crust around the edges of the evaporation ponds. The primary constituents found in this grey or white crust were calcium carbonate, magnesium, sodium and silicon. Silicon indicates the presence of soil or rock. The crust does not represent true sediments; however, as it is formed by evaporation. Receptors are not expected to contact the evaporite for any length of time due to the limited areal extent, and data from the salt crust are not used to develop the sediment EPCs.

Table 5-5 Tapwater Regional Screening Levels (RSLs) for Chemicals in Evaporation & Collection Pond Water

Analyte Name	CAS Number	Residential Tapwater RSL (µg/L)
Manganese	7439-96-5	43 nc
Molybdenum	7439-98-7	10 nc
Nitrate	14797-55-8	3200 nc
Selenium	7782-49-2	10 nc
Uranium (Soluble Salts)	NA	0.4 nc
Vanadium and Compounds	7440-62-2	8.6 nc

Notes:
Tap water regional screening levels (RSLs) obtained from EPA 2019a: HQ=0.1
nc = non-cancer
µg/L = microgram per liter

Table 5-6 Tapwater RadPRGs for Radionuclides in Evaporation and Collection Pond Water

Isotope	Residential Tapwater RadPRG (pCi/L)
Ra-226	0.000397
Ra-228	0.000966
Th-230	0.000396

Notes:
Residential tapwater RadPRGs obtained from EPA 2019b
RadPRG = radiological preliminary remediation goal
pCi/L = picoCurie per liter

5.2.2.2.4 Air

For outdoor air, radon gas and particulate data for U-nat, Ra-226, and Th-230 data were available for ROPC screening (refer to Table 5-7). The data are based on radon track etch and high volume particulate samples (HMC 2019c). Ambient air RadPRGs for the composite worker were obtained from EPA ORNL (EPA 2019b). Homestake Facility air data were used for screening. The air data for radionuclides were compared to the RadPRGs. If concentrations exceeded the RadPRG for air for composite workers, the radionuclide is carried forward for further evaluation. The results are presented in Section 5.2.2.4. All RadPRGs are also provided in Appendix F.

For indoor air, the data from the office and RO plant were utilized to predict air concentrations of Rn-222 in an indoor environment. Only data from the second quarter of 2015 through 2018 were

utilized for indoor air because the ventilation system was improved. Thus, previously measured air concentrations of radon are not reflective of current conditions.

Table 5-7 Composite Worker RadPRGs for Ambient Air

Isotope	Composite Worker Air PRG (no decay) (pCi/m^3)
Ra-226	0.000135
Rn-222	0.000258
Th-230	0.000086
U-234	0.0000661
U-235	0.000025
U-238	0.0000553

Notes:
Composite Worker Air RadPRGs obtained from ORNL/EPA, July 2019 including inhalation and external exposure risk components
pCi/m^3 = picoCurie per cubic meter
RadPRG = radionuclide preliminary remediation goal

5.2.2.3 Evaluation of Detection Limits Relative to Contaminant Screening Levels

Detection limits represented by method detection limits (MDLs), minimum detectable concentration (MDC), or reporting limits (RLs) were available. The vast majority of the data were detected results thus minimizing any uncertainty introduced by missing detection limits. For non-detected analytes, if the maximum detection limit exceeded a screening value, it was retained in that medium for further evaluation.

5.2.2.4 Screening Results

The MDCs were compared to the RSLs and the RadPRGs for each data set and by environmental sampling medium for the Homestake Facility and LTA s. If the MDC exceeded the screening value, the chemical was retained for further evaluation in Section 5.2.3.

<u>Soil</u>

Surface and subsurface soil were combined for this analysis. Contaminants that carried forward for further quantitative analysis in the baseline or forward risk analysis component of the HHRA are summarized in Table 5-8. The comparison of the HHRA data to the screening levels and identification of ROPCs and COPCs is presented in detail in Appendix F.

Table 5-9 identifies the EPCs for use in the baseline HHRA. Where there were a minimum required number of samples, upper 95th percentile confidence limits (UCL95s) on the arithmetic mean were estimated with ProUCL version 5.1 (EPA 2016). ProUCL supporting information is provided in Appendix F. If there were no detections, a UCL was not calculated. If there were fewer than five detections, a mean was used as a robust estimate of the UCL. Otherwise, the highest UCL recommended by ProUCL (EPA 2016) was selected as the EPC.

Background soil data are used in the uncertainty analysis portion of the HHRA and are not used to remove analytes from evaluation as COPCs or ROPCs. The background raw data reported in Appendix F were used in hypothesis tests with ProUCL (EPA 2016) to determine if the site significantly exceeded background or not.

Table 5-8 Screening Level Results for Soil by Location

Analyte	Units	n	Maximum RL[1]	Minimum Detected Result	Maximum Detected Result	Number of Detected Values	RSL or PRG	Industrial Ratio
Homestake Facility								
As	mg/kg	26	NA	1.91	9.58	26	3	3E+00
Ba-140	pCi/g	27	11.8	NA	NA	0	0.0143	8E+02
Bi-212	pCi/g	27	NA	0.39	2.04	27	0.0258	8E+01
Bi-214	pCi/g	27	NA	0.504	5.79	27	0.0231	3E+02
Co-60	pCi/g	27	0.0345	NA	NA	0	0.0142	2E+00
Cs-137	pCi/g	27	0.027	0.0105	0.151	20	0.069	2E+00
I-131	pCi/g	27	27.2	NA	NA	0	0.109	2E+02
K-40	pCi/g	27	NA	12.9	21.2	27	0.219	1E+02
Mo	mg/kg	61	7	0.619	126	38	580	2E-01
Pa-234m	pCi/g	26	NA	1.2	18.9	26	0.02	9E+02
Pb	mg/kg	26	NA	3.88	19.7	26	800	2E-02
Pb-212	pCi/g	27	NA	0.425	1.67	27	0.024	7E+01
Pb-214	pCi/g	27	NA	0.54	6.13	27	0.0204	3E+02
Ra-223	pCi/g	20	NA	0.097	0.67	20	0.146	5E+00
Ra-226	pCi/g	75	NA	0.04	9.9	75	0.0203	5E+02
Ra-228	pCi/g	27	NA	0.483	1.71	27	0.0153	1E+02
Rn-219	pCi/g	3	NA	0.124	0.29	3	0.239	1E+00
Se	mg/kg	61	1	0.283	11.1	34	580	2E-02
Th-227	pCi/g	8	NA	0.047	0.227	8	0.106	2E+00
Th-228	pCi/g	27	NA	0.47	2.34	27	0.0238	1E+02
Th-230	pCi/g	76	-0.1	0.02	7.4	73	0.0203	4E+02
Th-232	pCi/g	27	NA	0.39	1.81	27	0.0153	1E+02
Th-234	pCi/g	20	NA	0.28	11.2	20	0.02	6E+02
Tl-208	pCi/g	27	NA	0.138	0.527	27	0.01	5E+01
U natural	pCi/g	49	NA	1	30	49	0.02015	1E+03
U total	mg/kg	49	NA	1	44	49	23	2E+00
U-234	pCi/g	27	NA	0.58	18.3	27	0.0203	9E+02
U-235	pCi/g	27	NA	0.071	0.697	27	0.0731	1E+01
U-238	pCi/g	27	NA	0.79	19	27	0.02	1E+03
U-nat	mg/kg	NA	NA	NA	NA	NA	NA	NA
V	mg/kg	26	NA	11.7	60.7	26	580	1E-01

Table 5-8 Screening-Level Results For Soil by Location (Con't)

Analyte	Units	n	Maximum RL[1]	Minimum Detected Result	Maximum Detected Result	Number of Detected Values	RSL or PRG	Industrial Ratio
Homestake Facility								
Land Treatment Areas								
As	mg/kg	19	NA	2.04	6.79	19	3	2E+00
Ba-140	pCi/g	21	5.25	NA	NA	0	0.0143	4E+02
Bi-212	pCi/g	21	NA	0.45	1.71	21	0.0258	7E+01
Bi-214	pCi/g	21	NA	0.43	1.44	21	0.0231	6E+01
Co-60	pCi/g	21	0.0293	NA	NA	0	0.0142	2E+00
Cs-137	pCi/g	21	NA	0.016	0.114	21	0.069	2E+00
I-131	pCi/g	21	17.3	NA	NA	0	0.109	2E+02
K-40	pCi/g	21	NA	11.5	20.3	21	0.219	9E+01
Mo	mg/kg	134	1	0.283	4	51	580	7E-03
Pa-234m	pCi/g	13	NA	0.66	3.3	13	0.02	2E+02
Pb	mg/kg	19	NA	3.47	18	19	800	2E-02
Pb-212	pCi/g	21	NA	0.419	1.52	21	0.024	6E+01
Pb-214	pCi/g	21	NA	0.485	1.55	21	0.0204	8E+01
Ra-223	pCi/g	17	NA	0.093	0.364	17	0.146	2E+00
Ra-226	pCi/g	309	NA	0.218	3.9	309	0.0203	2E+02
Ra-228	pCi/g	21	NA	0.453	1.66	21	0.0153	1E+02
Rn-219	pCi/g	NA	NA	NA	NA	NA	NA	NA
Se	mg/kg	319	0.5	0.06	2.6	244	580	4E-03
Th-227	pCi/g	1	NA	0.087	0.087	1	0.106	8E-01
Th-228	pCi/g	6	NA	1.02	1.84	6	0.0238	8E+01
Th-230	pCi/g	109	-0.1	0.1	3.4	65	0.0203	2E+02
Th-232	pCi/g	6	NA	1.04	1.92	6	0.0153	1E+02
Th-234	pCi/g	15	NA	0.27	2.09	15	0.02	1E+02
Tl-208	pCi/g	21	NA	0.134	0.5	21	0.01	5E+01
U natural (pCi/g)	pCi/g	NA	NA	NA	NA	NA	NA	NA
U total	mg/kg	218	1	0.19	7.47	192	23	3E-01
U-234	pCi/g	6	NA	0.88	2.73	6	0.0203	1E+02
U-235	pCi/g	15	NA	0.059	0.193	15	0.0731	3E+00
U-238	pCi/g	6	NA	1.06	2.49	6	0.02	1E+02
U-nat	mg/kg	185	NA	0.5	7.2	185	23	3E-01
V	mg/kg	19	NA	9.16	39.6	19	580	7E-02

Table 5-8 Screening-Level Results For Soil by Location (Con't)

Analyte	Units	n	Maximum RL[1]	Minimum Detected Result	Maximum Detected Result	Number of Detected Values	RSL or PRG	Industrial Ratio
Background								
As	mg/kg	12	5.52	4.25	5.52	12	3	2E+00
Ba-140	pCi/g	13	3.69	NA	NA	0	0.0143	3E+02
Bi-212	pCi/g	13	1.34	0.87	1.34	13	0.0258	5E+01
Bi-214	pCi/g	13	1.05	0.806	1.05	13	0.0231	5E+01
Co-60	pCi/g	13	0.0294	NA	NA	0	0.0142	2E+00
Cs-137	pCi/g	13	0.093	0.053	0.093	13	0.069	1E+00
I-131	pCi/g	13	9.7	NA	NA	0	0.109	9E+01
K-40	pCi/g	13	19.9	16.6	19.9	13	0.219	9E+01
Mo	mg/kg	12	0.623	0.343	0.623	12	580	1E-03
Pa-234m	pCi/g	4	1.6	0.9	1.6	4	0.02	8E+01
Pb	mg/kg	12	14.2	9.46	14.2	12	800	2E-02
Pb-212	pCi/g	13	1.22	0.89	1.22	13	0.024	5E+01
Pb-214	pCi/g	13	1.1	0.84	1.1	13	0.0204	5E+01
Ra-223	pCi/g	10	0.344	0.224	0.344	10	0.146	2E+00
Ra-226	pCi/g	13	2	1.29	2	13	0.0203	1E+02
Ra-228	pCi/g	13	1.26	0.91	1.26	13	0.0153	8E+01
Rn-219	pCi/g	NA	NA	NA	NA	NA	NA	NA
Se	mg/kg	12	2.03	0.349	2.03	12	580	4E-03
Th-227	pCi/g	5	0.14	0.061	0.14	5	0.106	1E+00
Th-228	pCi/g	5	1.44	0.98	1.44	5	0.0238	6E+01
Th-230	pCi/g	5	1.56	0.7	1.56	5	0.0203	8E+01
Th-232	pCi/g	5	1.12	0.87	1.12	5	0.0153	7E+01
Th-234	pCi/g	10	0.88	0.32	0.88	10	0.02	4E+01
Tl-208	pCi/g	13	0.394	0.285	0.394	13	0.01	4E+01
U natural (pCi/g)	pCi/g	NA	NA	NA	NA	NA	NA	NA
U total	mg/kg	NA	NA	NA	NA	NA	NA	NA
U-234	pCi/g	5	1.22	0.6	1.22	5	0.0203	6E+01
U-235	pCi/g	18	0.123	0.03	0.123	17	0.0731	2E+00
U-238	pCi/g	5	1.21	0.73	1.21	5	0.02	6E+01
U-nat	mg/kg	NA	NA	NA	NA	NA	NA	NA
V	mg/kg	12	36.5	20.4	36.5	12	580	6E-02

Notes:
[1] - the maximum RL is the highest reporting limit for nondetected samples
Shaded cells indicate the analyte is an ROPC or COPC and carries forward to the Baseline HHRA
Abbreviations:
NA – Not applicable, RL – Reporting limit
RSL – Regional screening level for non-radioactive inorganics
PRG – Preliminary remedial goal for radionuclides

Table 5-9 Soil Exposure Point Concentrations for Baseline Risk Assessment

Homestake Facility Exposure Point Concentrations				
Parameter	**Units**	**Distribution**	**Statistic**	**Value**
As	mg/kg	Approx. Normal	95% Student's-t UCL	6.328
Bi-212	pCi/g	No Dist	95% Student's-t UCL	1.498
Bi-214	pCi/g	Approx. Gamma	95% Adjusted Gamma UCL	2.333
Cs-137	pCi/g	Normal	95% KM (t) UCL	0.0672
K-40	pCi/g	Approx. Normal	95% Student's-t UCL	18.1
Mo	mg/kg	No Dist	99% KM (Chebyshev) UCL	36.53
Pa-234m	pCi/g	Approx. Gamma	95% Adjusted Gamma UCL	4.603
Pb-212	pCi/g	No Dist	95% Student's-t UCL	1.348
Pb-214	pCi/g	Approx. Gamma	95% Adjusted Gamma UCL	2.468
Ra-223	pCi/g	Normal	95% Student's-t UCL	0.414
Ra-226	pCi/g	Gamma	95% Adjusted Gamma UCL	4.027
Ra-228	pCi/g	No Dist	95% Student's-t UCL	1.422
Se	mg/kg	No Dist	99% KM (Chebyshev) UCL	3.797
Th-227	pCi/g	Normal	95% Student's-t UCL	0.174
Th-228	pCi/g	Approx. Normal	95% Student's-t UCL	1.604
Th-230	pCi/g	Gamma	95% KM Approximate Gamma UCL	2.596
Th-232	pCi/g	No Dist	95% Student's-t UCL	1.372
Th-234	pCi/g	Gamma	95% Adjusted Gamma UCL	3.26
Tl-208	pCi/g	No Dist	95% Student's-t UCL	0.434
U total	mg/kg	Lognormal	95% H-UCL	14.2
U-234	pCi/g	Approx. Gamma	95% Adjusted Gamma UCL	4.287
U-235	pCi/g	Gamma	95% Adjusted Gamma UCL	0.307
U-238	pCi/g	Lognormal	95% H-UCL	4.323

Table 5-9 Soil Exposure Point Concentrations for Baseline Risk Assessment (Con't)

Homestake Facility Exposure Point Concentrations				
Parameter	**Units**	**Distribution**	**Statistic**	**Value**
Land Treatment Area Exposure Point Concentrations				
As	mg/kg	Approx. Gamma	95% Adjusted Gamma UCL	4.693
Bi-212	pCi/g	No Dist	95% Student's-t UCL	1.015
Bi-214	pCi/g	No Dist	95% Modified-t UCL	0.87
Cs-137	pCi/g	Normal	95% Student's-t UCL	0.0711
K-40	pCi/g	Normal	95% Student's-t UCL	15.92
Mo	mg/kg	No Dist	95% Student's-t UCL	0.623
Pa-234m	pCi/g	Gamma	95% Adjusted Gamma UCL	1.844
Pb-212	pCi/g	No Dist	95% Modified-t UCL	0.938
Pb-214	pCi/g	No Dist	95% Modified-t UCL	0.942
Ra-223	pCi/g	Approx. Lognormal	95% H-UCL	0.253
Ra-226	pCi/g	Gamma	95% Approximate Gamma UCL	1.41
Ra-228	pCi/g	No Dist	95% Modified-t UCL	0.982
Se	mg/kg	No Dist	99% KM (Chebyshev) UCL	1.12
Th-228	pCi/g	Normal	95% Student's-t UCL	1.763
Th-230	pCi/g	Normal	95% KM (t) UCL	1.164
Th-232	pCi/g	Normal	95% Student's-t UCL	1.74
Th-234	pCi/g	Gamma	95% Adjusted Gamma UCL	0.892
Tl-208	pCi/g	No Dist.	95% Modified-t UCL	0.295
U total	mg/kg	No Dist.	95% Modified-t UCL	3.987
U-234	pCi/g	Normal	95% Student's-t UCL	2.23
U-235	pCi/g	No Dist	95% Student's-t UCL	0.131
U-238	pCi/g	Normal	95% Student's-t UCL	2.21

Table 5-9 Soil Exposure Point Concentrations for Baseline Risk Assessment (Con't)

Homestake Facility Exposure Point Concentrations				
Parameter	**Units**	**Distribution**	**Statistic**	**Value**
Background				
As	mg/kg	Normal	95% Student's-t UCL	5.01
Bi-212	pCi/g	Normal	95% Student's-t UCL	1.195
Bi-214	pCi/g	Normal	95% Student's-t UCL	0.948
Cs-137	pCi/g	Normal	95% Student's-t UCL	0.0731
K-40	pCi/g	Normal	95% Student's-t UCL	18.35
Mo	mg/kg	Approx. Normal	95% Student's-t UCL	0.447
Pa-234m	pCi/g	Normal	95% Student's-t UCL	1.515
Pb	mg/kg	Normal	95% Student's-t UCL	11.94
Pb-212	pCi/g	Normal	95% Student's-t UCL	1.104
Pb-214	pCi/g	Normal	95% Student's-t UCL	1.017
Ra-223	pCi/g	Normal	95% Student's-t UCL	0.296
Ra-226	pCi/g	Normal	95% Student's-t UCL	1.81
Ra-228	pCi/g	Normal	95% Student's-t UCL	1.14
Se	mg/kg	No Discernable Distribution	95% Student's-t UCL	0.799
Th-227	pCi/g	Normal	95% Student's-t UCL	0.13
Th-228	pCi/g	Normal	95% Student's-t UCL	1.412
Th-230	pCi/g	Normal	95% Student's-t UCL	1.393
Th-232	pCi/g	Normal	95% Student's-t UCL	1.135
Th-234	pCi/g	Normal	95% Student's-t UCL	0.703
Tl-208	pCi/g	Normal	95% Student's-t UCL	0.357
U total	mg/kg	Mean of U-234 and U-238	Multiply by 1.48 to get concentration	1.69
U-234	pCi/g	Normal	95% Student's-t UCL	1.141
U-235	pCi/g	Normal	95% Student's-t UCL	0.112
U-238	pCi/g	Normal	95% Student's-t UCL	1.147
V	mg/kg	Normal	95% Student's-t UCL	29.87

Notes: U-natural or U-total activities are not used as EPCs in the EPA/ORNL calculator and so are not shown in this table. The calculator predicts radiation risk on individual isotope measurements and estimated activity throughout the decay chain.
KM – Kaplan-Meier
mg/kg – milligram per kilogram, pCi/g – picocuries per gram
No Dist – Data do not follow a known distribution
UCL – Upper confidence limit on the mean

The screening level analysis of the Homestake Facility data reduced the analytes to two COPCs (arsenic and U-total) and 25 ROPCs in soil. Molybdenum and selenium were retained at the request of EPA although maximum concentrations were below screening levels. Only Ba-140, Co-60, I-131, lead, Rn-219, and vanadium were screened out.

The screening level analysis of the LTA data reduced the analytes to one COPC (arsenic) and 18 ROPCs in the combined surface and subsurface soil. Molybdenum and selenium were retained at the request of EPA although maximum concentrations were orders of magnitude below screening levels. Only Ba-140, Co-60, I-131, lead, Th-227, U-total (as a metal), U-nat (as a metal), and vanadium were removed from soil for the LTAs. U-total was carried forward as a metal since the uranium isotopes carried forward although it was well below screening levels.

Surface Water

Surface water data from the monitoring program were available for 2015 to 2018. Maximum concentrations of each analyte were compared to the residential tapwater RSL or a radionuclide PRG if available. Tapwater SLs are not available for the industrial scenario. These screening levels assume a lifetime ingestion rate of 2.5 L/d as an adult and 0.78 L/d as a child up through age 6. This is overly conservative for the evaporation ponds, where only infrequent, incidental ingestion of a few milliliters (ml) at most is expected to occur. Every analyte exceeded its screening level (Table 5-10).

Sediment

There are two sludge samples evaluated in the risk assessment (Table 5-10). All analytes in sediment/sludge carry forward because they exceeded industrial screening levels for soils.

Outdoor Air

No particulates were retained in air as all maximum concentrations were well below screening levels (Table 5-11). These measured results were compared to the results of the soil inhalation pathway for which the PEF is used to model inhalation exposure to predict risk of exposure to fugitive dusts. The inhalation risk was less than 1×10^{-6} for all radionuclides based on maximum concentrations, similar to the results of the measured particulate data. Radon-222 in outdoor air was retained for further evaluation for the Homestake Facility and LTAs based on a combined of outdoor air samples. Radon-222 was retained for trench air based on a proxy data set of the indoor air measurements from the office and RO plant. The outdoor air and trench air data were used to estimate representative concentrations across the Site. Radon-222 was retained in indoor air from the Homestake Facility based on data from the RO building.

Screening Level Uncertainty Analysis

One identified uncertainty in the screening analysis is associated with data for molybdenum and selenium analyzed by HMC contract laboratories where the RLs were elevated compared to RLs from EPA's laboratories. However, the number of detected values associated with the EPA 2011 data suggests that selenium and molybdenum concentrations are not elevated across the Site, and both metals were below screening levels (Table 5-8). Because they are COPC, selenium and molybdenum are retained for further evaluation.

Another identified uncertainty is the evaluation of the uranium isotopes. PRGs are available only for individual isotopes and not uranium mixtures. U-nat is predominantly U-238 (i.e., approximately 99%) with lesser amounts of other isotopes. The NRC states U-nat contains the relative

concentrations of isotopes found in nature of 0.7 percent uranium-235, 99.3 percent uranium-238, and a trace amount of uranium-234 by mass. In terms of radioactivity, however, the radiation emitted by natural uranium comes approximately 2.2 percent from uranium-235, 48.6 percent from uranium-238, and 49.2 percent from uranium-234 (NRC 2019). To represent the toxicity of U-nat, the mean of the screening level activity of U-238 and U-234 was used. This uncertainty is not likely to bias results of the evaluation.

Table 5-10 Summary of Screening Results and EPCs for Air, Pond Sludge/Sediment, and Pond Water

Analyte Name	Units	Sample Size (n)	Minimum Result	Maximum Result	Number of Detected Results	Industrial SL	Industrial SL Ratio	UCL95	Basis
Sludge									
Ra226	pCi/g	1	32.5	32.5	1	0.0203	2E+03	NA	n<8-10, Use Maximum
Th230	pCi/g	1	0.5	0.5	1	0.0203	2E+01	NA	n<8-10, Use Maximum
U-nat	pCi/g	1	2566	2566	1	0.02015	1E+05	NA	n<8-10, Use Maximum
Water									
Manganese (total)	mg/L	43	0.001	1.4	42	0.043	3E+01	0.302	No Dist @ 5% - Use 95% KM (Chebyshev) UCL
Molybdenum (total)	mg/L	80	3.82	4760	80	0.01	5E+05	864.4	Lognormal - Use 95% H-UCL
Nitrate	mg/L	25	0.1	9	15	3.2	3E+00	2.135	Approx. Normal - Use 95% KM (t) UCL
Ra-226	pCi/L	24	0.06	130	24	0.000397	3E+05	45.75	Gamma - 95% Adjusted Gamma UCL
Ra228	pCi/L	24	-0.5	140	21	0.000966	1E+05	71.01	No Dist @ 5% - Use 99% KM (Chebyshev) UCL
Selenium (total)	mg/L	64	0.11	5.98	63	0.01	6E+02	0.733	Approx. Lognormal - Use KM H-UCL
Th230	pCi/L	24	0.006	2210	24	0.000396	6E+06	1200	Lognormal - Use 99% Chebyshev (Mean, Sd) UCL
U-natural (total)	mg/L	80	2	2940	80	0.0004	7E+06	548.8	Lognormal - Use 95% H-UCL
Vanadium	mg/L	24	0.01	0.32	16	0.0086	4E+01	0.107	Gamma - 95% KM Adjusted Gamma UCL

Table 5-10 Summary of Screening Results and EPCs for Air, Pond Sludge/Sediment, and Pond Water (Con't)

Analyte Name	Units	Sample Size (n)	Minimum Result	Maximum Result	Number of Detected Results	Industrial SL	Industrial SL Ratio	UCL95	Basis
Outdoor Air									
Ra-226	pCi/L	120	2E-12	2E-10	120	1.35E-07	1E-03	NA	Not a ROPC
Rn-222	pCi/L	160	0.37	1.77	160	2.58E-07	7E+07	0.949	Approx. Gamma – Use 95% Approx. Gamma UCL
Th-230	pCi/L	120	3E-12	3E-10	120	8.58E-08	3E-03	NA	Not a ROPC
U-Nat	pCi/L	120	1.9E-13	6.7E-09	120	6.07E-08	3E-01	NA	Not a ROPC
Indoor Air									
Rn-222	pCi/L	29	0.75	2.9	29	2.58E-07	1E+07	1.837	Approx. Normal – Use 95% Student's-t UCL

Notes:

Approx. - approximate
n = number of samples
Dist - distribution
pCi/m^3 = picoCurie per cubic meter
KM = Kaplan-Meier
mg/L = milligram per liter
pCi/g = picoCurie per gram
pCi/L = picoCurie per liter
ROPC = radionuclide of potential concern
UCL = upper confidence limit
* UCL95 = 95% upper confidence limit; UCL95s calculated by ProUCL V5.1 (EPA 2016)

Table 5-11. Comparison of Modeled Fugitive Dust and Measured Particulate Inhalation Risks

Radionuclide	Soil Activity (pCi/g)	Fugitive Dust Inhalation Risk (unitless)	Particulate Activity (pCi/L)	Particulate Activity (pCi/m^3)	Particulate Inhalation Risk (unitless)
Ra-226	9.9	1E-08	2.0E-10	2.00E-07	1E-09
Th-230	7.4	1E-08	3.0E-10	3.00E-07	4E-09
U-234	18.3	4E-08	3.35E-09	3.35E-06	5E-08
U-238	19	5E-08	3.35E-09	3.35E-06	6E-08
U-natural	NA	NA	6.70E-09	6.70E-06	

Notes: Half the U-natural activity maximum was assigned equally to U-234 and U-238 to compare risks to modeled fugitve dust

5.2.3 Baseline Human Health Exposure Assessment

This Exposure Assessment uses available information to provide numeric estimates of exposure for each of the identified receptors in Tables 5-2 and 5-3 for each of the COPCs and ROPCs identified in Tables 5-8 and 5-10. Only COPCs or ROPCs that exceeded screening levels (Appendix F) are further addressed in the Baseline HHRA.

5.2.3.1 Media of Potential Concern

5.2.3.1.1 Soil

The following COPCs exceeded one or more screening level in surface or subsurface soil media in the Homestake Facility and are further evaluated:

- Arsenic – exceeded surface soil only. There are no subsurface data for arsenic.
- U-total (as a metal)
- Selenium and Molybdenum were retained at the request of EPA although they were below screening levels.

Nearly all radioisotopes were identified as ROPCs that exceeded screening levels for soil at the Homestake Facility (see Table 5-8). These are addressed in the baseline HHRA.

Arsenic was the only COPC that exceeded screening levels in LTA surface soil, and nearly all ROPCs exceeded screening levels in surface soils in the LTAs (Table 5-8).

It is known that U-nat is 99% U-238, and in terms of radioactivity it is approximately half U-234 and half U-238. Therefore, retaining all uranium analytes in the baseline risk assessment, which culminates with summation of cancer risks across all ROPCs and COPCs, would lead to overestimating the EPC and thus double counting the risks due to exposure to uranium isotope activity. The EPA RadPRG calculator only predicts exposure to individual uranium isotopes, and therefore the U-nat or U-total activity data were not utilized.

5.2.3.1.2 Surface Water

All of the analytes exceeded tapwater screening levels (Table 5-10). The following analytes in the evaporation pond water are further addressed for the Homestake Facility:

- Manganese
- Molybdenum
- Nitrate
- Selenium
- Uranium-natural (reported in units of mg/L)
- Vanadium
- Ra-226

- Ra-228
- Th-230

5.2.3.1.3 Air

Radon is the only ROPC identified for indoor or outdoor air. Levels in indoor air were higher than in outdoor air.

5.2.3.1.4 Sediments

There were three radionuclides evaluated in sediments and all carried forward into the baseline HHRA:

- Ra-226
- Th-230
- U-nat

5.2.3.2 Current and Future Potential Receptors

Current and future receptors were identified and described in Section 5.2.1.5 and are shown in Tables 5-2 and 5-3. Included are receptors that could potentially occur currently, or may be expected to occur in the future. Current receptors are modeled as exposed to conditions at the current time. The same data were used to represent future conditions, although once the Homestake Facility is closed, certain pathways will become incomplete (for example, contact with the evaporation ponds would be incomplete because the ponds would be removed). Therefore, the future scenario analyses may be overestimating risks for that time frame. Furthermore, future workers will not be onsite 8 hours per day, 250 days per year, but would spend at most two weeks per year conducting sampling under the legacy program. Workers currently engaged in remediation activities may enter the area, but they are not considered under this HHRA because they have received appropriate training and are covered under the Occupational Safety and Health Administration 1910.120 standards which requires air monitoring, employing use of personal protective equipment or other engineering controls, etc.

The receptors that are quantitatively addressed in this HHRA are:

- Future composite workers
- Future construction workers
- Current and future trespassers

5.2.3.3 Potentially Complete Exposure Pathways

A complete exposure pathway is one where chemical contaminants or radionuclides can be traced from a source to a target organ within a receptor where an adverse health effect can occur. Potential pathways were considered complete unless there was sound justification for designating them as incomplete. The potentially complete exposure pathways vary by receptor. Exposure pathways may be potentially complete, incomplete due to a missing pathway component, or potentially complete but likely insignificant.

Dermal exposure is not evaluated for ROPCs, for which external or submersion exposure in a radiation field is evaluated (EPA 2019b). For COPCs, external or submersion exposure is not evaluated, but dermal exposure is.

Some pathways may be complete but exposure cannot be quantified due to lack of data, at least for some constituents. This adds to the uncertainty, but does not infer that these pathways are either incomplete or insignificant. This can occur when critical exposure parameters are lacking for exposure modeling or risk evaluation, such as dermal permeability coefficients (Kp) or dermal absorption factors (ABSd), or toxicity values.

5.2.3.4 Receptor-Specific Exposure Parameters

The exposure parameters for the receptors identified above are summarized in Table 5-12. Receptor-specific parameters vary with the exposure assumptions for each receptor. The parameters that are applied to each receptor are discussed below.

5.2.3.4.1 Future Composite Worker

Site knowledge indicates that it is unlikely that any worker would be at the Homestake Facility full time in the future, and therefore, this is a hypothetical future scenario. This worker is conservatively modeled as present within the Homestake Facility for a full day (exposure time [ET] of 8 hours), for an exposure frequency (EF) of 250 days per year. It is more realistic to expect that workers at the facility in the future will be there on an infrequent, intermittent basis, but this receptor is protective of other future workers.

The default composite worker represents a long-term exposure duration (ED) of 25 years doing security, fence or building repairs, office or commercial work, or landscape maintenance work. This worker could breathe radon gas or particulates in air, and contact surface soils. The particulate emission factor (PEF) for both COPCs and ROPCs was based on the EPA (2019a; 2019b) calculators for Albuquerque, New Mexico (NM). The risk assessment evaluates the default worker, but actual risks to workers will be much lower. A Site-specific composite worker is one that is on-Site for 10 years full time until the property is relinquished to DOE, and another who is on-Site at most 2 weeks per year indefinitely under the DOE legacy program. The default worker spends 50,000 hours over a 25 year period, whereas the 10 year worker would be exposed 20,000 hours, and the legacy worker 2,800 hours over the working life.

The soil ingestion rate (IRS) of 100 mg/d (EPA 2019a; 2019b) applied to this receptor is a standard value for workers that may be outdoors. A skin surface area (SA) of 3,527 centimeters squared (cm^2) for workers for evaluating COPC dermal exposure to hands, forearms, and head (EPA 2019a) was applied. This is a weighted average of mean values for head, hands, and forearms for males and females of 21 or more years of age. The dermal adherence factor (AF) of 0.12 milligrams per centimeter squared (mg/cm^2 - event) applied to evaluate dermal exposure for the COPCs is the currently recommended value for commercial/industrial outdoor workers (EPA 2019a). Table 5-12 presents the exposure parameters for the future composite worker, and Table 5-13 presents chemical-specific parameters.

Table 5-12 Receptor – Specific Exposure Factors Used in the HMC Remedial Investigation HHRA

Parameter Name and Abbreviation	Units	Future Composite Worker		Future Construction Worker		Current Trespasser		Future Trespasser	
Absorption Factor, Dermal (ABSd)	unitless	CS	a	CS	a	CS	a	CS	a
Adherence Factor (AF)	mg/cm^2-d	0.12	a	0.3	a	0.12	a	0.12	a
Averaging Time, non-cancer (ATnc)	d	9125	a	365	a	3650	c	3650	c
Averaging Time, cancer (ATc)	d	25550	a	25550	a	25550	a	25550	a
Body Weight (BW)	kg	80	a,b	80	a,b	80	a,b	80	a,b
Correction Factor, mass (CF_m)	kg/mg	1×10^{-6}	a	1×10^{-6}	a	1×10^{-6}	a	1×10^{-6}	a
Correction Factor, time (CF_{time})	1 d/24 hr	0.042		0.042		0.042		0.042	
Event (EV)	event/day	1	a	1	a	1	a	1	a
Exposure Duration (ED)	y	25	a,b	1	a,b	10	c	10	c
Exposure Frequency, soil (EFs)	d/y	250	a,b	250	a,b	48	c	48	c
Exposure Frequency, water (EFw)	d/y	NA		NA		6	c	NA	
Exposure Time(ET)	h/d	4 indoor 4 outdoor	c	8	a,b	2	c	2	c
Exposure Time, water (event)	h/event	NA				0.2	c	NA	
Gamma Shielding Factor GSF	unitless	1	b	1	b	1	b	1	b
Inhalation Rate, IRA	m^3/d	60	b	60	b	20	b	20	b
Particulate Emission Factor (PEF), Albuquerque, NM	m^3/kg	6.61E+09	a	7.31E+07	a,d	6.61E+0 9	a	6.61E+09	a
Soil Ingestion Rate (IRSow)	mg/d	100	a,b	330	a,b	100	c	100	c
Surface Area (SA)	cm^2	3527	a,d	3527	a	3527	a	3527	a
Time of exposure (tw)	y	25	a,b	1	a,b	10	c	10	c
Water Ingestion Rate (IRW)	L/d	NA		NA		0.005	c	NA	
Water-Air Transfer Factor (Kp)	L/m^3	NA		NA		CS	a	NA	

a - EPA 2019a
b - EPA 2019b
c - Professional judgment
d –PEF from calculator for other construction activity
e - Weighted average of mean values for head, hands, and forearms (male and female, 21+years)(EPA 2019a)
CS - Chemical-specific; refer to Table 5-13
ATnc - Calculated as ED * 365 d/y
ETw - Based on assumed 12 minutes incidental contact time

Table 5-13 Chemical Specific Parameters Used in the Exposure Assessment for COPCs

Analyte	Kp	GI_{ABS}	ABSd
Arsenic, Inorganic	0.001	1	0.03
Lead Compounds	0.0001	NV	NV
Molybdenum	0.001	1	NV
Selenium	0.001	1	NV
Uranium (Soluble Salts)	0.001	1	NV
Vanadium and Compounds	0.001	0.026	NV

Source: EPA 2019a; 2004

5.2.3.4.2 Future Construction Worker

This receptor represents a short-term worker (1-year exposure duration) engaged in excavation such as pipeline or utility work. This receptor could reroute piping, put up buildings, and move equipment. This receptor is potentially exposed to surface and subsurface soil, fugitive dust from soils, and radon gas in trench or outdoor air. This receptor was modeled as short-term (1 year), 250 days per year, for 8 hours per day (refer to Table 5-12). Exposure to surface or subsurface soil is possible, and the potential for high soil contact is reflected in the value of 330 mg/d as the soil ingestion rate (EPA 2019a; 2019b).

The PEF for construction workers includes exposure to dust generated by Site construction activities including wind erosion (Other Than Standard Vehicle Traffic equations in the EPA [2019b] calculator). For this analysis, it was assumed 30 acres total, with 10 acres of tilling, 10 acres of grading, 10 acres of bulldozing, fraction of vegetative cover of 0.25, bulldozer or grading blade length of 2 m, bulldozing and grading of Site one time, to 1 m depth, and 10 m^2 for area of excavation at any given time would generate dust. A Site-specific PEF of 7.31 $x10^7$ cubic meters per kilogram (m^3/kg) was derived using these inputs for the future construction worker.

The dermal surface area contacting bulk solids of 3,527 cm^2 is a standard value for a construction worker and is based on the weighted average mean values for head, hands, and forearms (male and female), 21 years and older (EPA 2019a). This surface area assumes that a short-sleeved shirt, long pants, and shoes are worn. The dermal adherence factor that predicts soil remaining on skin for the construction worker for COPC dermal contact was obtained from EPA RSL calculator and Soil Screening Guidance (EPA 2019a; EPA 2002). Body weight is estimated to be 80 kg (EPA 2019a; 2019b). Table 5-12 presents the exposure parameters for the future construction worker.

5.2.3.4.3 Current and Future Trespasser

This receptor is assumed an older adolescent or young adult and represents an adult or older juvenile who walks or otherwise uses the Homestake Facility or LTAs for infrequent recreational purposes. This receptor was not expected to trespass in the Homestake Facility for the entire duration of local residence, only for an exposure duration of 10 years during young adulthood. The trespasser may contact surface soils or breathe fugitive dust from surface soils or radon gas in air. The PEF of $6.61x10^9$ for both COPCs and ROPCs was based on the EPA (2019a; 2019b) calculators for Albuquerque, NM.

It is unlikely that this receptor would contact subsurface soils. This receptor was modeled as currently contacting water incidentally from the evaporation ponds (i.e., an incidental ingestion rate of 5 milliliters each incidence, or 5 milliliters per day [ml/d]) although not using it as a drinking water source. This could occur if the receptor splashed in the pond(s). In the future, the evaporation ponds will be closed, and so a future trespasser would not have access to surface water in the Homestake Facility. It is assumed that this receptor, currently or in the future, would be on-Site infrequently (1 time per week, 4 weeks per month, for twelve months per year for a total exposure frequency of 48 days per year), but only contact the ponds six times per year for a period of 10 years. It is assumed that the ponds will be decommissioned after this period. There is no reason to suspect frequent contact as there are no fish in the ponds and therefore they would not present a source of interest. The soil ingestion rate of 100 mg/d for outdoor workers and residential adult (EPA 2019a; 2019b) was assumed applicable to this receptor based on presumed activity patterns. The standard skin surface area of 3,527 cm^2 for adult workers from EPA (2014c) was applied, assuming head, hands, and forearms are exposed. The dermal adherence factor for the outdoor worker for COPC exposure (EPA 2019a) was applied to the trespasser as well. Table 5-12 presents the exposure parameters for the current and future trespasser.

5.2.3.5 Site-Specific Exposure Parameters

Site-specific exposure parameters are ones that are dependent on-Site conditions or assumptions. The following Site-specific exposure parameters were incorporated into the HHRA:

- PEF (m^3/kg) – The value for Albuquerque, NM from the EPA RSL calculator of 6.61×10^9 m^3/kg was applied to the future composite worker and the current and future trespassers for COPCs and ROPCs. A value of 7.31×10^7 m^3/kg was applied to the future construction worker, which was developed with the EPA (2019a) calculator as described above.
- Gamma Shielding Factor (GSF) (unitless) – Set to the default value of 1.
- The radionuclide-specific Area Correction Factor (ACF) for the external radiation equations was conservatively based on a 0 cm soil cover and a 1,000 m^2 (infinite) slab. This is considered to represent baseline conditions.

5.2.3.6 Exposure Point Concentrations

The EPC is the concentration to which a receptor is presumed exposed for the purposes of the risk assessment. EPCs (Tables 5-9 and 5-10) are different for each medium and between exposure areas, or area where receptors are potentially exposed. Two general exposure areas were identified at the Site based on potential current and future land use and contaminant levels:

- Homestake Facility – this area includes the evaporation ponds, RO unit, and tailings piles.
- LTAs – this area includes the center pivot and flood irrigation LTAs.

Protective clothing and respiratory protection was assumed to be absent for all current and future receptors evaluated in the HHRA. For evaluating potential exposure, surface and subsurface soil data were combined for the construction worker. Evaporation pond water, radon gas in air, and sediment samples were used. The UCL95 value was used as a conservative representation of the RME EPC (EPA 1989) for each COPC in each exposure area if there were eight or more samples with six or more detected values. ProUCL Version 5.00.00 (EPA 2016) was used to calculate the UCL95. ProUCL estimates a reliable and stable UCL95 of the population mean using both the

detected and non-detected data. The UCL95 provides an RME estimate for the unknown population mean where there is 95 percent confidence that the true mean is below the UCL95. ProUCL may recommend more than one value that can be used as the UCL95 for a given data set, in which case, the maximum recommended UCL95 value that was lower than the maximum detected value was used in the risk assessment. The UCL95 recommended by ProUCL V5.0 was the primary value unless greater than the maximum detected concentration.

Small sample size or low numbers of detected values in a dataset can preclude calculation of the UCL95 statistic. If a UCL95 could not be calculated, a proxy value was applied per EPA guidance (EPA 2016) and consistent with the USEPA human health risk assessment for this site (EPA 2014a). UCL95s were used for all analytes except Pa-234m, for which there were only 4 samples. A mean was used as the EPC for this radionuclide.

The soil EPCs were presented in Table 5-9 for analytes that exceeded screening levels and so were identified as COPCs or ROPCs. Each of the COPCs and ROPCs is addressed in further detail in this risk assessment.

Air concentrations due to generation of fugitive dust were modeled from soil data by use of particulate emission factors (PEFs) and also from measured particulate data (Table 5-11). This information was used to predict risk due to inhalation exposure. No COPCs were measured in air, so this represents the only inhalation pathway for inorganics. ROPCs were measured in outdoor air, although particulate radionuclides and fugitive dusts were all below screening levels.

Rn-222 was measured in outdoor air samples from the Homestake Facility and at the fenceline, and these data were used as the basis of the EPC for the LTAs and Homestake Facility. The EPC for outdoor air was 949 pCi/m^3 based on an approximate gamma UCL95. This was considered to represent a Site-wide outdoor air radon concentration based on evaluation of the wind rose for the Site (Figures 2-1 and 2-2). Rn-222 was measured from indoor air from buildings on the Homestake Facility. Trench air data were not available. The indoor air value was a 95% Student's-t UCL of 1837 pCi/m^3 and was also considered representative of trench air, and the combined indoor and outdoor air concentrations resulted in an EPC of 1074 pCi/m^3. The combined indoor and outdoor air EPC was used to represent exposure by all commercial/industrial receptors (i.e., composite worker and construction worker).

The data sets used to develop the EPCs were presented in Table 5-1 and the EPCs are shown in Tables 5-9 and 5-10.

5.2.3.7 Fate and Transport Modeling

Fate and transport modeling was performed to provide estimates of COPC or ROPC concentrations in potential exposure media that were not sampled as part of the RI activities. These media include fugitive dust associated with surface soil emissions. Air particulate data were available which likely represent dust emissions from surface soil, but data for all of the surface soil COPCs or ROPCs were not available. Therefore, the standard PEF model in the EPA calculator was set to Albuquerque, NM, and used to predict fugitive dust from soil exposure for all surface soil ROPCs. The PEF is not chemical-specific, but is based on Site-specific conditions and assumptions such as wind speed and vegetative cover, and can be receptor specific. The construction worker generates dust by construction activities and this is reflected in the PEF for this receptor. This PEF for each receptor is reported in Table 5-12.

Volatile chemicals such as radon (Rn-222) that behave according to Henry's Law can emanate from water or soil into air, and can then be inhaled. Radon emitted from the ponds would be captured in the air samples collected from around the site.

5.2.3.8 Exposure Intake Equations

Exposure intakes are receptor-specific estimates of daily exposure made by applying the exposure parameters defined in Table 5-12 to equations for each receptor. The exposure intake is a measure of exposure expressed as the mass of a substance per unit body weight per unit time (for example, milligrams per kilogram body weight per day [mg/kg-d]) (EPA 1989). For COPCs, these equations were derived by rearranging the equations used by EPA (2019) to estimate screening levels for each medium to solve for target cancer risk or non-cancer hazard. The COPC intake equations are shown in Table 5-14 and the ROPC equations (EPA 2019b) are presented in Table 5-15. These equations demonstrate the relationship between abiotic media concentrations and predictions of exposure.

The RadPRG calculator was used to provide risk estimates by substituting receptor and Site-specific exposure parameters from Table 5-12 into the calculator.

Table 5-14 Exposure Equations for Cancer and Non-Cancer Endpoints by Receptor - COPCs

FUTURE COMPOSITE WORKER – CANCER
Surface Soil Pathways (Incidental Ingestion, Dermal Contact, Fugitive Dust)
CDIs-ing = (Cs * IRS * CFm * EF * ED) / (BW * ATc)
CDIs-derm = (Cs * SA * ABSd * AF * CFm *EV* EF * ED) / (BW * ATc)
ECs-fg[1] = (Cs * EF * ED * ET * 1 d/24 h*1000 ug/mg * 1/PEF) / (ATc)
Air Pathways (Inhalation, Submersion)
(ROPCs Only)
FUTURE COMPOSITE WORKER - NON-CANCER
Surface Soil Pathways (Incidental Ingestion, Dermal Contact, Fugitive Dust)
CDIsi-ing = (Csi * IRS * CFm * EF * ED) / (BW * ATnc)
CDIsi-derm = (Csi * SA * ABSd * AF * CFm * EV* EF * ED) / (BW * ATnc)
ECs-fg[2] = (Cs * EF * ED * ET * 1 d/24 h * 1/PEF) / (ATnc)
Air Pathways (Inhalation, Submersion)
(ROPCs Only)
FUTURE CONSTRUCTION WORKER – CANCER
Surface and Subsurface Soil Pathways (Incidental Ingestion, Dermal Contact, Fugitive Dust)
CDIs-ing = (Cs * IRS * CFm * EF * ED) / (BW * ATc)
CDIs-derm = (Cs * SA * ABSd * AF * CFm * EF * ED) / (BW * ATc)
ECs-fg[1,3] = (Cs * EF * ED * ET * 1 d/24 h*1000 ug/mg * 1/PEF) / (ATc)
Air Pathways (Inhalation, Submersion)
(ROPCs Only)
FUTURE CONSTRUCTION WORKER - NON-CANCER
Surface and Subsurface Soil Pathways (Incidental Ingestion, Dermal Contact, Fugitive Dust)
CDIs-ing = (Cs * IRS * CFm * EF * ED) / (BW * ATnc)
CDIs-derm = (Cs * SA * ABSd * AF * CFm * EF * ED) / (BW * ATnc)
ECs-fg[2,3] = (Cs * EF * ED * ET * 1 d/24 h * 1/PEF)/ (ATnc)
Air Pathways (Inhalation, Submersion)
(ROPCs Only)
CURRENT AND FUTURE TRESSPASSER – CANCER[4]
Surface Soil Pathways (Incidental Ingestion, Dermal Contact, Fugitive Dust)
CDIs-ing = (Cs * IRS * CFm * EF * ED) / (BW * ATc)
CDIs-derm = (Cs * SA * ABSd * AF * CFm * EV * EF * ED) / (BW * ATc)
ECs-fg = (Cs * EF * ED * ET * 1 d/24 h*1000 ug/mg * 1/PEF)/ (ATc)
Air Pathways (Inhalation, Submersion)
(ROPCs Only)

Table 5-14 Exposure Equations for Cancer and Non-Cancer Endpoints by Receptor – COPCs (Con't)

CURRENT AND FUTURE TRESSPASSER - NON-CANCER
Surface Soil Pathways (Incidental Ingestion, Dermal Contact, Fugitive Dust)
CDIs-ing = (Cs * IRS * CFm * EF * ED) / (BW * ATnc)
CDIs-derm = (Cs * SA * ABSd * AF * CF* EV * EF * ED) / (BW * ATnc)
ECs-fg = (Cs * EF * ED * ET * 1 d/24 h * 1/PEF)/ (ATnc)
Air Inhalation Pathway
(ROPCs Only)
CURRENT TRESSPASSER ONLY – CANCER[4]
Evaporation Pond Water Pathways (Incidental Ingestion, Dermal Contact, Inhalation of Volatiles)
CDIw-ing = (Cw * IRW * EF * ED) / (BW * ATc)
DAD = (Cw* Kp * ETw * EV * EF*ED *SA * 1L/1000 cm^3) / (BW*ATc)
ECw-inh= ROPCs Only
CURRENT TRESPASSER ONLY – NON-CANCER
Evaporation Pond Water Pathways (Incidental Ingestion, Dermal Contact, Inhalation of Volatiles)
CDIw-ing = (Cw * IRW * EF * ED) / (BW * ATnc)
DAD = Cw* Kp * ETw * EV * EF*ED *SA * 1L/1000 cm^3) / (BW*ATnc)
ECsw-inh= ROPCs Only

Notes:
1. EC in units of ug/m3 to be consistent with cancer inhalation unit risk (IUR) factor
2. EC in units of mg/m3 to be consistent with non-cancer reference concentration (RfC)
3. PEF is based on other than standard vehicular traffic, Refer to Section 5.2.3.4.2
4. Pond water exposure only pertains to current trespassers
5. Pond water exposure only pertains to current receptors

Variable Definitions and Units:
CDI*i*–chronic daily intake (mg/kg-d) for contact with medium *i*
EC–exposure concentration (cancer = $\mu g/m^3$, non-cancer = mg/m^3)
DAD–Contaminant dermally absorbed dose (mg/kg-d) (EPA 2004)
C*i* – Concentration in medium *i*

Media Abbreviations–Surface or subsurface soil
ing–Ingestion; derm–Dermal; fg–Air particulates or fugitive dust; w- Evaporation pond water

Parameter Definitions:
ABSd – Absorption factor, chemical-specific (Table 5-13)
AF –Adherence factor, receptor-specific (Table 5-12)
ATc –Averaging time, cancer, receptor-specific (Table 5-12)
ATnc –Averaging time, noncancer, receptor-specific (Table 5-12)
BW – Body weight, receptor-specific (Table 5-12)
CFm –Conversion factor for mass (Table 5-12)
GI_{ABS} – Gastrointestinal absorption, chemical-specific (Table 5-13)
ED – Exposure duration, receptor-specific (Table 5-12)
EF – Exposure frequency, receptor-specific (Table 5-12)
ET –Exposure time, receptor-specific (Table 5-12)
EV – Number of events per day, receptor-specific (Table 5-12)
IRS –Soil ingestion rate, receptor-specific (Table 5-12)
IRW – Water ingestion rate, receptor-specific (Table 5-12)
Kp – Partition coefficient, chemical-specific (Table 5-13)
PEF – Particulate emission factor, Site-specific (Table 5-12)
SA – Surface area, receptor-specific (Table 5-12)

Table 5-15 Exposure Equations for Cancer and Non-Cancer Endpoints by Receptor - ROPCs

FUTURE COMPOSITE WORKER – CANCER
Surface Soil Pathways (Incidental Ingestion, External Radiation, Inhalation of Fugitive Dust or Particulates from Soil)[1]
CEs-ing = (Cs* (1-e$^{-\lambda tw}$) * IRS * EF * ED * g/1000 mg)/ (tw * λ)
CEs-ext = (Cs* (1-e$^{-\lambda tw}$) * ACF * EF *1 yr/365 d* ED * ET *1 d/24 h *GSF)/ (tw * λ)
CEs-fg = (Cs* (1-e$^{-\lambda tw}$) * IRA * EF * ED * 1/PEF *ET *1 d/24h *1000g/kg)/ (tw * λ)
Air Inhalation Pathway (No Decay)
CEair-inh = Cair * ET * 1 d/24 h * EF * ED * IRA
CEair-ext/sub = Cair * ET * 1 d/24 h * EF * ED * 1 y/365 d * GSF
FUTURE CONSTRUCTION WORKER – CANCER[2]
Surface Soil Pathways (Incidental Ingestion, External Radiation, Inhalation of Fugitive Dust or Particulates from Soil)
CEs-ing = (Cs* (1-e$^{-\lambda tw}$) * IRS * EF * ED * g/1000 mg)/ (tw * λ)
CEs-ext = (Cs* (1-e$^{-\lambda tw}$) * ACF * EF *1 yr/365 d* ED * ET *1 d/24 h *GSF)/ (tw * λ)
CEs-fg = (Cs* (1-e$^{-\lambda tw}$) * IRA * EF * ED * 1/PEF *ET *1 d/24h *1000g/kg)/ (tw * λ)
Air Inhalation Pathway (No Decay)
CEair-inh = Cair * ET * 1 d/24 h * EF * ED * IRA
CEair-ext/sub = Cair * ET * 1 d/24 h * EF * ED * 1 y/365 d * GSF
CURRENT AND FUTURE TRESPASSER - CANCER
Surface Soil Pathways (Incidental Ingestion, External Radiation, Inhalation of Fugitive Dust)
CEs-ing = (Cs* (1-e$^{-\lambda tw}$) * IRS * EF * ED * g/1000 mg)/ (tw * λ)
CEs-ext = (Cs* (1-e$^{-\lambda tw}$) * ACF * EF *1 yr/365 d* ED * ET *1 d/24 h *GSF)/ (tw * λ)
CEs-fg = (Cs* (1-e$^{-\lambda tw}$) * IRA * EF * ED * 1/PEF *ET *1 d/24h *1000g/kg)/ (tw * λ)
Air Inhalation Pathway (No Decay)
CEair-inh = Cair * ET * 1 d/24 h * EF * ED * IRA
CEair-ext/sub = Cair * ET * 1 d/24 h * EF * ED * 1 y/365 d
CURRENT TRESPASSER ONLY- CANCER
Evaporation Pond Water[3]
CEw-ing = Cw* EF * ED * IRW
CEw-ext = Cw *1 yr/8760 h* EF * ED * EV * tevent

Table 5-15 Exposure Equations for Cancer and Non-Cancer Endpoints by Receptor - ROPCs (con't)

Notes:
1. The risk for each pathway was calculated with RadPRG Calculator using default exposure parameters to obtain screening levels (.e, RadPRGs) for the screening level analysis). The calculator results were used with Site-specific exposure parameters in the Baseline HHRA. Cancer risks were then summed to obtain total cancer risk across all pathways.
2. The RSL calculator was used with nonradioactive inorganic data and results used for each receptor. Default exposure parameters were used for SLs, and Site-specific parameters for the baseline HHRA.

Variable Definitions and Units:
CE–chronic exposure (pCi)
DAD–Contaminant dermally absorbed dose (mg/kg-d) (EPA 2004)
Ci – Concentration in medium i

Media Abbreviations:
air–Air
s–Surface or subsurface soil
ing–Ingestion
derm–Dermal
fg–Air particulates or fugitive dust
w- Evaporation pond water
ext/sub–External exposure or submersion to air
ext–External exposure to soil

Parameter Definitions:
λ–Decay constant; 0.693/half-life (EPA 2019b)
ACF – Area correction factor, isotope-specific (Table 5-16)
ED – Exposure duration, receptor-specific (Table 5-12)
EF – Exposure frequency, receptor-specific (Table 5-12)
ET –Exposure time, receptor-specific (Table 5-12)
EV – Number of events per day, receptor-specific (Table 5-12)
GSF- Gamma shielding factor (Table 5-12)
IRA –Inhalation rate, receptor-specific (Table 5-12)
IRS –Soil ingestion rate, receptor-specific (Table 5-12)
IRW – Water ingestion rate, receptor-specific (Table 5-12)
PEF – Particulate emission factor, Site-specific (Table 5-12)
tw – Time for exposure, receptor-specific (Table 5-12)
tevent –Exposure time for water, receptor-specific (Table 5-12)

5.2.4 Toxicity Assessment

The toxicity assessment presents the toxicity values for individual COPCs and ROPCs. These are used to determine if predicted exposure to COPCs and ROPCs exceeds levels associated with no adverse effects on human health. Just as cancer and non-cancer intakes are tracked separately, there are separate toxicity values for cancer and non-cancer health effects.

Inhalation and fugitive dust exposure is addressed with concentration-based toxicity values as opposed to the dose-based values applied to evaluation of bulk solid media ingestion or dermal exposure. The most current EPA toxicity values, as summarized by EPA (EPA 2019a) and the Integrated Risk Information System (IRIS) (EPA 2014b), were applied in this HHRA (refer to Table 5-13).

Uranium was evaluated as a COPC with mass concentration data, and also evaluated as a ROPC using specific activity levels as described in Section 5.2.4.3. The non-cancer effects of uranium as a COPC are addressed in Section 5.2.4.2.

The EPA/ORNL calculator evaluates risks for individual isotopes, and predicts exposure for all progeny as well along the decay chain to the last stable isotope. For Rn-222, the progeny are solids that bind to aerosols or dusts, and historically the calculator only performed decay chain calculations for Po-218 – Pb-214 – Bi-214 –Po-214, and any progeny after Po-214 were assumed to be on the ground. Pb-210 has a long half-life, and the assumption was that Pb-210, Bi-210, Po-210, Hg-206, and Tl-206 would settle to the ground. The revised calculator assesses radon daughters down the decay chain to the stable isotope Pb-206 in air, although this is not realistic. Particulate measurements were made in air at the Site, and there are no elevated risks due to particulates including all progeny modeled from parent radionuclide assuming secular equilibrium. Therefore, it was deemed reasonable to stop the evaluation of radon in air at nuclides lower than Po-214.

5.2.4.1 Carcinogenic Toxicity Values

The toxicity value used to predict the potential for carcinogenic risk for dermal and ingestion exposure to water or soils is the oral cancer slope factor (CSF). The CSF converts estimated daily intakes averaged over a lifetime of exposure to incremental risk of an individual developing cancer. The CSF is expressed in units of the inverse of milligrams chemical per kilogram body weight per day, or 1/mg/kg-d, also written as $(mg/kg\text{-}d)^{-1}$.

The inhalation unit risk (IUR) factor is used to predict carcinogenic risk for inhalation exposure for fugitive dust or vapor emissions from bulk solid media, as well as risk due to inhalation of outdoor air. The units for the IUR are the inverse of micrograms chemical per cubic meter of air, or $1/ug/m^3$, also written as $(ug/m^3)^{-1}$. The toxicity values for evaluating cancer risk for COPCs are summarized in Table 5-16.

Table 5-16 Toxicity Values for COPCs

Analyte	CSF (mg/kg-day)$^{-1}$		IUR (ug/m^3)$^{-1}$		RfD (mg/kg-day)		RfC (mg/m^3)		GI_{ABS}	ABS	RBA
Arsenic, Inorganic	1.5E+00	I,R	4.3E-03	I	3.0E-04	I	1.5E-05	C	1	0.03	0.6
Lead Compounds	NV		NV		NV		NV		1	--	--
Molybdenum	NV		NV		5.0E-03	I	NV		1	--	--
Selenium	NV		NV		5.0E-03	I	2.0E-02	C	1	--	--
Uranium (Soluble Salts)	NV		NV		2.0E-04	A	4.0E-05	A	1	--	--
Vanadium and Compounds	NV		NV		5.0E-03	G	1.0E-04	A	1	0.03	0.6

A – Agency for Toxic Substances and Disease Registry (ATSDR)
C – California EPA
G – EPA (2019a) User's Guide, Section 5, stating RfD derived from IRIS oral RfD for vanadium pentoxide by factoring out molecular weight of oxide ion.
NV - No value
I – EPA Integrated Risk Information System (IRIS)
R- Relative bioavailability factor of 0.6 is applied to arsenic solid media ingestion
ABS – Dermal absorption factor
GIABS – Gastrointestinal absorption factor
RBA – Relative bioavailability factor

5.2.4.2 Noncarcinogenic Toxicity Values

The toxicity value used to predict the potential for noncarcinogenic hazard for dermal and ingestion exposure is the oral reference dose (RfD) (refer to Table 5-16). The RfD is an estimate, with uncertainty of approximately an order of magnitude (inclusive of sensitive subgroups), that is based on the assumption that there is a threshold for noncarcinogenic responses, below which there is little risk of adverse effect(s) during the course of a lifetime (EPA 2019c). The RfD can be derived from various types of toxicity endpoints (i.e., a no observed adverse effect level (NOAEL), a lowest observed adverse effect level (LOAEL), or a benchmark concentration, to which uncertainty factors are applied to reflect limitations of the data used. The units for the RfD are milligrams chemical per kilogram body weight per day (mg/kg-d).

The reference concentration (RfC) is used to predict non-cancer hazard for inhalation exposure; the units are milligrams chemical per cubic meter of air (mg/m^3). It can be derived from a NOAEL, LOAEL, or benchmark concentration, to which uncertainty factors are applied to reflect limitations of the data used. The RfC (refer to Table 5-16) is applied to evaluate the non-cancer hazard due to inhalation exposure to suspended particulates or vapors in air.

5.2.4.3 Radionuclide Toxicity Values

Radionuclide toxicity values are based on a cancer endpoint and are referred to as slope factors (SF) to distinguish them from cancer slope factors for COPCs. ROPC slope factors differ by medium and receptor as well as by constituent. The EPA-ORNL calculator was used to obtain the radionuclide toxicity values for each receptor and medium combination. Only SFs for adults were

utilized in the risk assessment. SFs were only calculated for adult receptors because all current and future receptors at this Site are considered older adolescents or adults.

Tables 5-17, 5-18, and 5-19 provide the radionuclide SFs for each receptor and exposure route. Soil SFs are presented for inhalation, ingestion, and external contact for each receptor that is modeled as having soil contact. The exposure parameters used to assess potential risk to these receptors were reported in Table 5-12.

Table 5-17 Slope Factors for the ROPCs for Soil and Air Exposure Pathways

Composite and Construction Worker							
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1000 m^2 Soil Volume Area Correction Factor
**Secular Equilibrium Risk for Bi-212*							
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	6.02E+03	1.15E-04	8.05E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	1.19E+05	5.81E-06	8.71E-01
**Secular Equilibrium Risk for Bi-214*							
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
**Secular Equilibrium Risk for Cs-137*							
Ba-137m	-	0.00E+00	2.69E-06	0.00E+00	1.43E+05	4.86E-06	7.63E-01
Cs-137	S	1.12E-10	5.52E-10	3.18E-11	2.30E-02	3.02E+01	7.22E-01
**Secular Equilibrium Risk for K-40*							
K-40	S	2.22E-10	7.99E-07	1.51E-11	5.54E-10	1.25E+09	8.32E-01
**Secular Equilibrium Risk for Pa-234m*							
At-218	-	0.00E+00	2.74E-11	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	9.06E+02	7.65E-04	8.02E-01
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	3.11E+05	2.23E-06	8.23E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	6.24E+08	1.11E-09	7.57E-01

Table 5-17 Slope Factors for the ROPCs for Soil and Air Exposure Pathways (Con't)

Composite and Construction Worker							
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1000 m^2 Soil Volume Area Correction Factor
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	2.82E-06	2.46E+05	1.00E+00
**Secular Equilibrium Risk for Pb-212*							
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	5.71E+02	1.21E-03	6.98E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	1.19E+05	5.81E-06	8.71E-01
**Secular Equilibrium Risk for Pb-214*							
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
**Secular Equilibrium Risk for Ra-223*							
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	2.21E+01	3.13E-02	7.31E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	7.64E+04	9.08E-06	8.21E-01
**Secular Equilibrium Risk for Ra-226*							
At-218	-	0.00E+00	2.74E-11	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	6.62E+01	1.05E-02	7.84E-01

Table 5-17 Slope Factors for the ROPCs for Soil and Air Exposure Pathways (Con't)

Composite and Construction Worker							
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1000 m^2 Soil Volume Area Correction Factor
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
**Secular Equilibrium Risk for Ra-228*							
Ac-228	S	4.92E-11	4.04E-06	8.58E-13	9.87E+02	7.02E-04	8.18E-01
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	5.71E+02	1.21E-03	6.98E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Po-216	-	0.00E+00	7.10E-11	0.00E+00	1.51E+08	4.60E-09	8.03E-01
Ra-224	S	1.13E-08	3.91E-08	8.47E-11	6.91E+01	1.00E-02	6.86E-01
Ra-228	S	4.37E-08	3.43E-11	6.70E-10	1.21E-01	5.75E+00	1.00E+00
Rn-220	-	1.15E-12	2.77E-09	0.00E+00	3.93E+05	1.76E-06	7.72E-01
Th-228	S	1.32E-07	5.64E-09	6.40E-11	3.63E-01	1.91E+00	7.95E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	1.19E+05	5.81E-06	8.71E-01
**Secular Equilibrium Risk for Rn-219*							
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	7.64E+04	9.08E-06	8.21E-01
**Secular Equilibrium Risk for Rn-222*							
At-218	-	0.00E+00	2.74E-11	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	6.62E+01	1.05E-02	7.84E-01
**Secular Equilibrium Risk for Th-227*							
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	2.21E+01	3.13E-02	7.31E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Th-227	S	3.50E-08	4.45E-07	2.06E-11	1.35E+01	5.12E-02	7.25E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	7.64E+04	9.08E-06	8.21E-01
**Secular Equilibrium Risk for Th-228*							
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	5.71E+02	1.21E-03	6.98E-01

Table 5-17 Slope Factors for the ROPCs for Soil and Air Exposure Pathways (Con't)

Composite and Construction Worker							
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1000 m^2 Soil Volume Area Correction Factor
Po-212	-	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Po-216	-	0.00E+00	7.10E-11	0.00E+00	1.51E+08	4.60E-09	8.03E-01
Ra-224	S	1.13E-08	3.91E-08	8.47E-11	6.91E+01	1.00E-02	6.86E-01
Rn-220	-	1.15E-12	2.77E-09	0.00E+00	3.93E+05	1.76E-06	7.72E-01
Th-228	S	1.32E-07	5.64E-09	6.40E-11	3.63E-01	1.91E+00	7.95E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	1.19E+05	5.81E-06	8.71E-01
**Secular Equilibrium Risk for Th-230*							
At-218	-	0.00E+00	2.74E-11	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	9.19E-06	7.54E+04	9.34E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
**Secular Equilibrium Risk for Th-232*							
Ac-228	S	4.92E-11	4.04E-06	8.58E-13	9.87E+02	7.02E-04	8.18E-01
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	5.71E+02	1.21E-03	6.98E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Po-216	-	0.00E+00	7.10E-11	0.00E+00	1.51E+08	4.60E-09	8.03E-01
Ra-224	S	1.13E-08	3.91E-08	8.47E-11	6.91E+01	1.00E-02	6.86E-01
Ra-228	S	4.37E-08	3.43E-11	6.70E-10	1.21E-01	5.75E+00	1.00E+00
Rn-220	-	1.15E-12	2.77E-09	0.00E+00	3.93E+05	1.76E-06	7.72E-01
Th-228	S	1.32E-07	5.64E-09	6.40E-11	3.63E-01	1.91E+00	7.95E-01
Th-232	S	4.33E-08	3.58E-10	8.47E-11	4.93E-11	1.41E+10	9.79E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	1.19E+05	5.81E-06	8.71E-01
**Secular Equilibrium Risk for Th-234*							
At-218	-	0.00E+00	2.74E-11	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	9.06E+02	7.65E-04	8.02E-01

Table 5-17 Slope Factors for the ROPCs for Soil and Air Exposure Pathways (Con't)

Composite and Construction Worker							
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1000 m^2 Soil Volume Area Correction Factor
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	3.11E+05	2.23E-06	8.23E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	9.19E-06	7.54E+04	9.34E-01
Th-234	S	3.08E-11	1.77E-08	9.51E-12	1.05E+01	6.60E-02	7.64E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	2.82E-06	2.46E+05	1.00E+00
**Secular Equilibrium Risk for Tl-208*							
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	1.19E+05	5.81E-06	8.71E-01
**Secular Equilibrium Risk for U-234*							
At-218	-	0.00E+00	2.74E-11	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	9.19E-06	7.54E+04	9.34E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	2.82E-06	2.46E+05	1.00E+00
**Secular Equilibrium Risk for U-235*							
Ac-227	S	1.49E-07	1.98E-10	2.01E-10	3.18E-02	2.18E+01	9.60E-01
At-219	-	0.00E+00	0.00E+00	0.00E+00	3.90E+05	1.78E-06	9.00E-01
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Bi-215	-	0.00E+00	1.08E-06	0.00E+00	4.79E+04	1.45E-05	7.74E-01
Fr-223	S	4.07E-11	1.35E-07	4.88E-12	1.66E+04	4.19E-05	7.64E-01
Pa-231	F	7.62E-08	1.27E-07	1.54E-10	2.12E-05	3.28E+04	7.85E-01

Table 5-17 Slope Factors for the ROPCs for Soil and Air Exposure Pathways (Con't)

Composite and Construction Worker							
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1000 m^2 Soil Volume Area Correction Factor
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	2.21E+01	3.13E-02	7.31E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Th-227	S	3.50E-08	4.45E-07	2.06E-11	1.35E+01	5.12E-02	7.25E-01
Th-231	S	1.50E-12	2.49E-08	9.07E-13	2.38E+02	2.91E-03	8.49E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	7.64E+04	9.08E-06	8.21E-01
U-235	S	2.50E-08	5.51E-07	4.92E-11	9.84E-10	7.04E+08	6.88E-01
**Secular Equilibrium Risk for U-238*							
At-218	-	0.00E+00	2.74E-11	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	9.06E+02	7.65E-04	8.02E-01
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	3.11E+05	2.23E-06	8.23E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	9.19E-06	7.54E+04	9.34E-01
Th-234	S	3.08E-11	1.77E-08	9.51E-12	1.05E+01	6.60E-02	7.64E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	2.82E-06	2.46E+05	1.00E+00
U-238	S	2.36E-08	1.24E-10	4.66E-11	1.55E-10	4.47E+09	1.00E+00

Notes:
ICRP - International Commission on Radiological Protection
pCi - pico Curies
yr - year
g - gram
m2 – meters squared

Table 5-18 Air Slope Factors (SFs) for Composite Worker, Construction Worker, and Trespasser for ROPCs in Radon Decay Chain

Isotope	Inhalation Slope Factor (risk/pCi)	Submersion External Exposure Slope Factor (risk/yr per pCi/m^3)
At-218	0.00E+00	3.08E-14
Bi-210	4.55E-10	5.29E-12
Bi-214	6.18E-11	6.69E-09
Pb-214	7.77E-11	1.02E-09
Po-214	0.00E+00	3.57E-13
Po-218	1.39E-11	3.95E-17
Rn-218	0.00E+00	3.19E-12
Rn-222	2.28E-12	1.62E-12

Source: EPA 2019b. Composite_rprg_table_run_pCi_25NOV14.xlsx

Table 5-19 Water Slope Factors (SFs) for the Trespasser for ROPCs

Isotope	Water Ingestion Slope Factor (risk/pCi)	Immersion Slope Factor (risk/yr per pCi/L)
**Secular Equilibrium Risk for Ra-226*	-	-
At-218	0.00E+00	5.13E-17
Bi-210	8.92E-12	7.82E-15
Bi-214	1.92E-13	1.45E-11
Hg-206	0.00E+00	1.08E-12
Pb-210	8.84E-10	9.08E-15
Pb-214	3.44E-13	2.23E-12
Po-210	1.78E-09	9.07E-17
Po-214	0.00E+00	7.74E-16
Po-218	0.00E+00	5.06E-20
Ra-226	3.85E-10	6.27E-14
Rn-218	0.00E+00	6.92E-15
Rn-222	0.00E+00	3.51E-15
Tl-206	0.00E+00	1.47E-14
Tl-210	0.00E+00	2.69E-11
**Secular Equilibrium Risk for Ra-228*	-	-
Ac-228	1.88E-12	8.15E-12
Bi-212	7.18E-13	9.91E-13
Pb-212	2.52E-11	1.23E-12
Po-212	0.00E+00	0.00E+00
Po-216	0.00E+00	1.42E-16
Ra-224	1.67E-10	9.12E-14
Ra-228	1.04E-09	5.02E-16
Rn-220	0.00E+00	5.71E-15
Th-228	1.08E-10	1.66E-14
Tl-208	0.00E+00	3.46E-11
**Secular Equilibrium Risk for Th-230*	-	-
At-218	0.00E+00	5.13E-17
Bi-210	8.92E-12	7.82E-15
Bi-214	1.92E-13	1.45E-11
Hg-206	0.00E+00	1.08E-12
Pb-210	8.84E-10	9.08E-15
Pb-214	3.44E-13	2.23E-12
Po-210	1.78E-09	9.07E-17
Po-214	0.00E+00	7.74E-16
Po-218	0.00E+00	5.06E-20
Ra-226	3.85E-10	6.27E-14
Rn-218	0.00E+00	6.92E-15
Rn-222	0.00E+00	3.51E-15
Th-230	9.14E-11	3.01E-15
Tl-206	0.00E+00	1.47E-14
Tl-210	0.00E+00	2.69E-11

Source: EPA 2019b. EPA 2019b. Output generated 22AUG2019:19:30:14

Slope factors for water exposures (refer to Table 5-19) were obtained from the recreational receptor for exposure to tap water in the EPA-ORNL calculator (EPA 2019b). The Site-specific exposure parameters in Table 5-12 were used in the calculator in lieu of standard residential values to

represent the Site-specific current and future trespasser receptor and generate trespasser-specific radionuclide SFs and risk model outputs.

5.2.4.4 Derivation of Toxicity Values for the Dermal Exposure Pathway

Oral toxicity factors are applied to evaluate risk for the ingestion pathways, and dermal toxicity factors derived from the oral values are applied to estimate risk due to the dermal exposure pathways. Oral toxicity factors represent an administered or external dose, whereas dermal toxicity is typically due to the fraction of the dose that is absorbed (that is, molecules of contaminant crossing the skin to circulate in the bloodstream). The dermal exposure intake equations convert the concentration applied to the skin (that is, the concentration of chemical in soil in mg/kg) into an absorbed or internal dose, or the concentration of chemical at the target organ normalized to body weight (mg/kg-d). The toxicity values require a similar conversion from applied or administered to an absorbed basis. When gastrointestinal absorption of a compound in the critical study from which the toxicity value (that is, RfD or CSF) was derived is high (that is, 100 percent), the absorbed dose is equivalent to the administered dose, that is, the dose at the target organ that triggers the response is the same as that provided to the receptor. Therefore, no adjustment of the toxicity values is necessary.

For chemicals for which gastrointestinal absorption is low (that is, less than 50 percent), the absorbed dose is much smaller than the administered dose, and the chemical is more toxic in effect than what it would appear from the administered dose. For example, the absorption of a chemical is 10 percent, toxic effects are not due to an administered dose of 10 mg/kd-d but to this absorbed fraction of 1 mg/kg-d. An adjustment is made with the gastrointestinal absorption factor (GI_{ABS}) to the toxicity values to account for the difference in the absorbed dose relative to the administered dose (EPA 2004). Vanadium is the only COPC that is adjusted for dermal exposure, but while it is a COPC in water it is not a COPC in soils and therefore the gastrointestinal absorption factor dermal adjustment is not applied.

A higher CSF is indicative of higher carcinogenic potential, and the GI_{ABS} adjusts the slope factor accordingly. The GI_{ABS} value converts the oral slope factors to dermal slope factors by factoring out the proportion that is not absorbed into blood. These adjustments only apply to the dermal exposure pathways. For the derivation of the cancer slope factor for an absorbed dose (CSF_{ABS}) from the oral administered dose (CSF), the following equation was used:

$$CSF_{ABS} = \frac{CSF}{GI_{ABS}}$$

Where:

CSF_{ABS} -Absorbed cancer slope factor; chemical-specific, inverse of milligram per kilogram per body weight per day $(mg/kg\text{-}d)^{-1}$

CSF - Oral cancer slope factor; chemical-specific $(mg/kg\text{-}d)^{-1}$

GI_{ABS} - Gastrointestinal absorption factor; the fraction of contaminant absorbed in the gastrointestinal tract in the critical toxicity study (dimensionless); chemical-specific

A lower RfD is indicative of greater toxicity, and GI_{ABS} adjusts the oral RfD accordingly. For the derivation of the absorbed reference dose (RfD_{ABS}) from the orally administered RfD, the following equation was used:

$$RfD_{ABS} = RfD \times GI_{ABS}$$

Where:

RfD_{ABS} - Oral reference dose absorbed; chemical-specific (mg/kg-d)

RfD - Oral reference dose; chemical-specific (mg/kg-d)

GI_{ABS} - Fraction of contaminant absorbed in the gastrointestinal tract in the critical toxicity study (dimensionless); chemical-specific

If a value is lacking, EPA recommends assuming that absorption is 100 percent (that is, a value of 1 is used for GI_{ABS}) (EPA 2004). The adjustment factors for the COPCs are shown in Table 5-16.

5.2.5 Risk Characterization

Risk characterization is the step in the risk assessment process where the toxicity data are combined with the exposure intakes in order to produce estimates of potential cancer and non-cancer health effects (EPA 1989). Toxicity values (Section 5.2.4) are compared to the estimated intakes ECs, or CEs (Section 5.2.3.7) for each receptor in the baseline risk assessment. Uncertainty is described, and background conditions are addressed in the risk estimates. Cumulative cancer risks and non-cancer hazard indices (HIs) are also estimated. The risk characterization process is explained in detail below.

5.2.5.1 Risk Estimation

Risk estimation is the process of developing quantitative or numeric cancer and non-cancer risk estimates. A cancer risk was estimated for each receptor and media combination to reflect the contribution made by each complete exposure pathway. The cancer risk management range is considered to be 1 x 10^{-6} to 1 x 10^{-4}, or 1 in 1,000,000 to 1 in 10,000 excess cancers per exposed people (EPA 1989). COPCs or ROPCs that produce cancer risks that fall within or below this range may be acceptable under EPA guidelines, with no further evaluation or risk management typically required. COPCs or ROPCs that produce excess cancer risks above the upper bound of 1 x 10^{-4} are considered a COC for further evaluation or risk management, and require further evaluation or other action.

A non-cancer hazard is also estimated for each receptor and media combination to reflect the contribution made by each complete exposure pathway, but the target value is always 1 or less. If the HQ for a COPC is greater than 1, the COPC becomes a COC and must undergo further evaluation or risk management.

5.2.5.1.1 ROPC Cancer Risk Estimation

Cancer risks are related to intakes and toxicity values as follows for each ROPC, by receptor, for each exposure area:

Cancer Risk (CR) = Chronic Radiation Exposure (CDI) x SFi

Where:

Cancer risk (CR) – the probability of contracting cancer due to exposure to ROPCs over the course of a 70-year lifetime (unitless)

Radiation Exposure– the daily dose or exposure *i* (CDI) based on the assumptions used in the exposure model averaged over 70 years (pCi),

SFi– the radionuclide slope factor for radionuclide *i* (risk/pCi)

5.2.5.1.2 COPC Cancer Risk Estimation

Cancer risks due to chemical exposure are related to intakes and toxicity values as follows for each COPC, by receptor, for each exposure area:

Cancer Risk (CR) = Chronic Daily Cancer Intake (CDI) x CSFi

Where:

Cancer risk (CR) – the probability of contracting cancer over the course of a 70-year lifetime (unitless)

Cancer Intake– the daily dose or exposure intake (CDI) based on the assumptions used in the exposure model (mg/kg-d), averaged over 70 years

CSFi– the oral or dermal cancer slope factor for chemical *i* $(mg/kg\text{-}d)^{-1}$

For inhalation exposures, cancer risk was estimated as follows:

Cancer Risk (CR) = Chronic Cancer Air Concentration (ECair) x IURi

Where:

Cancer risk (CR) – the probability of contracting cancer over the course of a 70-year lifetime (unitless)

ECair– the air EPC (mg/m^3) weighted by receptor-specific exposure parameters (Table 5-11)

IURi– the inhalation unit risk factor for chemical *i* $(mg/m^3)^{-1}$

The cancer risks for each COPC in each pathway were summed to obtain a total pathway risk. Cumulative cancer risks for each receptor were then estimated by summing risks across multiple chemicals and pathways to derive the total cancer risks for receptors of interest. Care must be taken to avoid double counting exposure when combining exposure pathway risk estimates.

- A receptor with both surface soil and subsurface soil exposure would have doubled exposure if risks were directly summed for each media separately. Therefore, both soil media were combined and analyzed as one medium. For most constituents there was not a great difference in concentration between surface and subsurface media. The UCL95 was based on the combined dataset and therefore there is not expected to be an underestimate of risk.
- The composite worker was modeled with both indoor and outdoor air exposures and would have double exposure if both were counted at 8 hours per day, resulting in a 16-hour daily exposure. The EPA/ORNL calculator addresses this type of exposure without designating indoor or outdoor. Therefore, the indoor and outdoor air data were combined for one EPC for radon.
- The construction worker can be exposed to both outdoor and trench air. This receptor would have double exposure if both media were counted at 8 hours per day, resulting in a 16-hour

daily exposure. Indoor air was considered appropriate to predict exposure in a trench. Therefore, the indoor and outdoor air data were combined for one EPC for radon.

Given the uncertainty in the risk estimates, cancer risks are considered accurate to only one significant figure (EPA 1989). This means that a cancer risk value between 0.5 $x10^{-6}$ and 1.49 $x10^{-6}$ cannot be mathematically distinguished from $1x10^{-6}$, and any values between 1.5 $x10^{-6}$ to 2.49 $x10^{-6}$ are not distinguishable from the number 2 $x10^{-6}$.

5.2.5.1.3 COPC Non-Cancer Hazard

Non-cancer hazards for COPCs are not probabilities and the magnitude of the hazard quotient (HQ) cannot be used to state the likelihood of occurrence of adverse effects or be used to predict the severity of effects with any accuracy. The HQ is simply an indicator of whether the estimated daily dose exceeds a dose predicted to be reasonably safe or not. Generally, the higher the HQ, the greater is the level of concern (EPA 1989). The HQ is estimated as follows:

$$HQ = \frac{Noncancer\ Intake}{RfD}$$

Where:

HQ– The ratio of a single substance exposure intake over a specified time period (e.g., chronic or subchronic) to a reference dose for that substance derived from a similar exposure period (unitless)

Non-cancer Intake – The daily non-cancer exposure intake based on the assumptions used in the exposure model (mg/kg-d)

RfD– The oral or dermal reference dose (mg/kg-d)

For inhalation exposures, noncancer hazard was estimated as follows:

Noncancer Hazard Quotient (HQ) = Chronic Noncancer Air Concentration (ECair) / RfC

Where:

HQ – indicator that exposure exceeds the expected acceptable level. HQs greater than one require further evaluation or risk management (unitless)

ECair– the air EPC (mg/m3) weighted by receptor-specific exposure parameters (Table 5-10)

RfC – the inhalation reference concentration for chemical i (mg/m3)

The non-cancer HQs for each pathway was summed to obtain a Total HQ for each COPC. Total non-cancer hazards across multiple chemicals are estimated for noncarcinogens by summing the Total HQs to obtain a Hazard Index (EPA 1989).

Where HQs for any individual COPC exceed 1, the Site should proceed forward into further evaluation or risk management. If the HQs are less than 1, the COPC may be dropped from further evaluation. Where the HI is above 1 but the HQs are not, the mechanisms of toxic action may be evaluated to determine if the toxic effects would be less than additive. This could occur if the mechanism of toxic action for each analyte occurred on different target organs.

Given the uncertainty in the risk estimates, HQs are considered accurate to only one significant figure (EPA 1989). This means that a HQ between 0.5 and 1.49 cannot be mathematically

distinguished from 1, and any values between 1.5 and 2.49 are not mathematically distinguishable from the number 2.

5.2.5.1.4 Comparison to Background

Soil

The soil data for the site were compared to surface soil background data for COPCs and ROPCs. The Wilcoxon-Mann-Whitney Test in ProUCL (EPA 2016) was used to test the hypothesis that the site was less than background. Gehan's test was used when there were multiple detection limits to verify the results. Table 5-20 presents this comparison for the Homestake Facility, and Table 5-21 presents the comparison for the LTAs.

The ROPCs Cs-137, K-40, Pb-212, Th-227, Th-228, Th-232, and U-235 soil concentrations were statistically similar to or less than background soil for the Homestake Facility; the remaining ROPCs were statistically higher than background (Table 5-20).

The ROPCs at the LTAs were statistically equal to or below background with the exception of Th-232, U-234, and U-238 (Table 5-21). Maximum acitivities of Th-232, U-234, and U-238 exceeded screening levels as well.

The maximum concentrations of the COPCs molybdenum, selenium, and vanadium were below screening levels at the Homestake Facility. Only arsenic both exceeded screening levels and exceeded background. Molybdenum is statistically significantly elevated at a 5% significance level at both the Homestake Facility and the LTAs. There was one outlier of 126 mg/kg in the Homestake Facility dataset; this outlier was nearly 5 times higher than the next highest value of 26 mg/kg.

The COPCs arsenic, molybdenum, lead, and vanadium were statistically less than background at the LTAs. Only selenium exceeded background, and this analyte was below screening levels.

Air

EPA prefers the use of HMC-16 as a background location for radon in air. HMC has disagreed with this because HMC-16 is elevated out of the valley and would not be expected to have concentrations as high as those found in an area of topographic similarity as the Site. EPA considers that HMC-1OFF is located too close to the LTP to provide an accurate estimate of background.

Radon concentrations from air data collected at HMC-16 were used to calculate a BTV similar to the statistic used for the EPCs for addressing exposure. HMC-16 is the NRC approved air monitoring location for background at the Homestake Facility.

Using data collected from HMC-16, a UCL95 for outdoor air was estimated as 551 pCi/m^3 for Rn-222 based on data collected from 2014 to 2019 (Table 5-22). The background UCL is lower than the UCL95 radon concentrations calculated from data collected for the Homestake Facility which is 949 pCi/m^3 for outdoor air.

Table 5-20 Background and Homestake Facility Soil Comparisons

Analyte	Homestake Facility Soil Detection Frequency	Homestake Facility UCL95	Homestake Facility UCL95 Basis	Background Surface Soil Detection Frequency	Background UCL95	Wilcoxon -Mann-Whitney Test	Conclusion	Retain COPC or ROPC?
Inorganics, mg/kg								
Arsenic	26/26	6.328	95% Student's-t	12/12	5.01	$p < 0.05$	>BKG	Y, RR>1
Molybdenum	33/43	36.53	99% KM (Chebyshev) UCL	12/12	0.447	$p < 0.05$	>BKG	N, RR<1*
Lead	26/26	15.53	95% Student's-t UCL	12/12	11.94	$p < 0.05$	>BKG	N,RR<1
Selenium	30/43	3.869	99% KM (Chebyshev) UCL	12/12	0.799	$p \geq 0.05$	<=BKG	N, RR<1,<BKG*
Uranium (total)	24/24	15.53	95% Adjusted Gamma UCL	No Data	1.69 (mean of U-234 and U-238)	$p < 0.05$	>BKG	Y, RR>1
Vanadium	26/26	39.47	95% Student's-t UCL	12/12	29.87	$p < 0.05$	>BKG	N,RR<1
Radionuclides, pCi/g								
Ba-140	0/27	--	NA - All ND	0/13	NA	NA	NA	N, All ND
Bi-212	26/26	1.498	95% Student's-t UCL	12/12	1.195	$p < 0.05$	>BKG	Y, RR>1
Bi-214	26/26	2.333	95% Adjusted Gamma UCL	12/12	0.948	$p < 0.05$	>BKG	Y, RR>1
Co-60	0/27	--	NA - All ND	0/12	NA	NA	NA	N, All ND
Cs-137	19/27	0.0672	95% KM (t) UCL	12/12	0.0731	$p \geq 0.05$	<=BKG	Y, RR>1
I-131	0/27	--	NA- All ND	0/12	NA	NA	NA	N, All ND
K-40	26/26	18.1	95% Student's-t UCL	12/12	18.35	$p \geq 0.05$	<=BKG	Y, RR>1
Pa-234m	25/25	4.603	95% Adjusted Gamma UCL	4/4	1.515 (mean)	$p < 0.05$	>BKG	Y, RR>1
Pb-212	26/26	1.348	95% Student's-t UCL	12/12	1.104	$p < 0.05$	>BKG	Y, RR>1

Table 5-20 Surface Soil Background and Homestake Facility Soil Comparisons (Con't)

Analyte	Homestake Facility Soil Detection Frequency	Homestake Facility UCL95	Homestake Facility UCL95 Basis	Background Surface Soil Detection Frequency	Background UCL95	Wilcoxon -Mann-Whitney Test	Conclusion	Retain COPC or ROPC?
Pb-214	26/26	2.468	95% Adjusted Gamma UCL	12/12	1.017	p < 0.05	>BKG	Y, RR>1
Ra-223	20/20	0.414	95% Student's-t UCL	9/9	0.296	p < 0.05	>BKG	Y, RR>1
Ra-226	50/50	4.348	95% Adjusted Gamma UCL	12/12	1.81	p < 0.05	>BKG	Y, RR>1
Ra-228	26/26	1.422	95% Student's-t UCL	12/12	1.14	p < 0.05	>BKG	Y, RR>1
Rn-219	NA – Not an ROPC							N, HQ<u><</u>1
Th-227	8/8	0.174	95% Student's-t UCL	5/5	0.13	p <u>></u> 0.05	<=BKG	Y, RR>1
Th-228	26/26	1.604	95% Student's-t UCL	5/5	1.412	p <u>></u> 0.05	<=BKG	Y, RR>1
Th-230	50/50	2.607	95% KM Approximate Gamma UCL	5/5	1.393	p < 0.05	>BKG	Y, RR>1
Th-232	26/26	1.372	95% Student's-t UCL	5/5	1.135	p <u>></u> 0.05	<=BKG	Y, RR>1
Th-234	20/20	3.26	95% Adjusted Gamma UCL	9/90	0.703	p < 0.05	>BKG	Y, RR>1
Tl-208	26/26	0.434	95% Student's-t UCL	12/12	0.357	p < 0.05	>BKG	Y, RR>1
U natural (pCi/g)	24/24	11.29	95% H-UCL	No Data; use mean of U-234 and U-238	1.14	p < 0.05	>BKG	Y, RR>1
U-234	26/26	4.287	95% Adjusted Gamma UCL	5/5	1.141	p < 0.05	>BKG	Y, RR>1

Table 5-20 Surface Soil Background and Homestake Facility Soil Comparisons (Con't)

Analyte	Homestake Facility Soil Detection Frequency	Homestake Facility UCL95	Homestake Facility UCL95 Basis	Background Surface Soil Detection Frequency	Background UCL95	Wilcoxon -Mann-Whitney Test	Conclusion	Retain COPC or ROPC?
U-235	26/26	0.307	95% Adjusted Gamma UCL	11/12	0.112	$p \geq 0.05$	<=BKG	Y, RR>1
U-238	26/26	4.323	95% H-UCL	5/5	1.147	$p < 0.05$	>BKG	Y, RR>1

Notes:
BKG – Background
HHRA = human health risk assessment
KM = Kaplan Meier
mg/kg = milligram per kilogram
n = number of samples
N = no
NA = not available or not applicable
pCi/g = picoCurie per gram
RR = maximum divided by screening level is termed the risk ratio
Sd = standard deviation
UCL95 = 95th percentile upper confidence limit on the arithmetic mean
Y = yes
U-total background estimated from the mean of U-234 and U-238 multiplied by 1.48 (USDOE 2011) to convert activity to concentration
Background Data Source EPA 2014a

Table 5-21 Surface Soil Background and Land Treatment Areas Soil Comparisons for the RI HHRA

Analyte	LTAs Soil Detection Frequency	LTAs UCL95	LTAs UCL95 Basis	Background Surface Soil Detection Frequency	Background UCL95	Wilcoxon -Mann-Whitney Test	Conclusion	Retain as COPC or ROPC?
Inorganics, mg/kg								
Arsenic	18/18	4.693	95% Adjusted Gamma UCL	12/12	5.01	$p > 0.05$	LTAs<=BKG	Y, RR>1
Molybdenum	39/49	2.452	99% KM (Chebyshev) UCL	12/12	0.447	$p \geq 0.05$	LTAs<=BKG	N, RR<1, <BKG*
Lead	18/18	13.4	95% Chebyshev (Mean, Sd) UCL	12/12	11.94	$p \geq 0.05$	LTAs<=BKG	N,RR<1, <BKG
Selenium	134/150	0.975	99% KM (Chebyshev) UCL	12/12	0.799	$p < 0.05$	LTAs > BKG	N,RR<1*
Uranium (total)	133/134	4.329	99% KM (Chebyshev) UCL	No Data	No Data	$p \geq 0.05$	LTAs<=BKG	N, RR<1, <BKG
Vanadium	18/18	25.15	95% H-UCL	12/12	29.87	$p \geq 0.05$	LTAs<=BKG	N,RR<1, <BKG
Radionuclides, pCi/g								
Ba-140	0/20	--	NA- All ND	0/13	NA – all ND	NA	NA	N, All ND
Bi-212	20/20	1.015	95% Student's-t UCL	13/13	1.195	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Bi-214	20/20	0.87	95% Modified-t UCL	13/13	0.948	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Co-60	0/20	--	NA-All ND	0/13	NA	NA	NA	N, All ND
Cs-137	20/20	0.0711	95% Student's-t UCL	13/13	0.0731	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
I-131	0/20	--	NA-All ND	0/13	NA	NA	NA	N, All ND
K-40	20/20	15.92	95% Student's-t UCL	13/13	18.35	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Pa-234m	13/13	1.844	95% Adjusted Gamma UCL	4/4	1.515	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Pb-212	20/20	0.935	95% Student's-t UCL	13/13	1.104	$p \geq 0.05$	LTAs<=BKG	Y, RR>1

Table 5-21 Surface Soil Background and Land Treatment Areas Soil Comparisons for the RI HHRA (Con't)

Analyte	LTAs Soil Detection Frequency	LTAs UCL95	LTAs UCL95 Basis	Background Surface Soil Detection Frequency	Background UCL95	Wilcoxon-Mann-Whitney Test	Conclusion	Retain as COPC or ROPC?
Pb-214	20/20	0.938	95% Student's-t UCL	13/13	1.017	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Ra-223	16/16	0.244	95% Modified-t UCL	10/10	0.296	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Ra-226	224/224	1.325	95% Chebyshev (Mean, Sd) UCL	13/13	1.81	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Ra-228	20/20	0.978	95% Student's-t UCL	13/13	1.14	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Rn-219	No Data	NA						
Th-227	1/1	0.087	Maximum	5/5	0.13	NA	NA	N, RR<1
Th-228	6/6	1.763	95% Student's-t UCL	5/5	1.412	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Th-230	65/109	1.032	95% KM (t) UCL	5/5	1.393	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Th-232	6/6	1.74	95% Student's-t UCL	5/5	1.135	$p < 0.05$	LTAs > BKG	Y, RR>1
Th-234	14/14	0.892	95% Adjusted Gamma UCL	10/10	0.703	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
Tl-208	20/20	0.294	95% Student's-t UCL	13/13	0.357	$p \geq 0.05$	LTAs<=BKG	Y, RR>1
U natural (pCi/g)	No Data	2.22	Mean of U-234 and U-238 UCLs	No Data – Mean of U-234 and U-238	1.1	$p < 0.05$	LTAs > BKG	Y, RR>1
U-234	6/6	2.23	95% Student's-t UCL	5/5	1.141	$p < 0.05$	LTAs>BKG	Y, RR>1
U-235	15/15	0.131	95% Student's-t UCL	17/18	0.112	$p \geq 0.05$	LTAs <= BKG	Y, RR>1
U-238	6/6	2.21	95% Student's-t UCL	5/5	1.147	$p < 0.05$	LTAs > BKG	Y, RR>1

Table 5-21 Surface Soil Background and Land Treatment Areas Soil Comparisons for the RI HHRA (Con't)

Notes:
*Indicates the COPC retained at request of EPA
Detection frequency is shown as the number of detections divided by the number of samples for the analyte
BKG - Background
RR – Risk ratio of maximum to screening level
KM = Kaplan Meier
LTA = land treatment area
mg/kg = milligram per kilogram
n = number of samples
N = no
pCi/g = picocurie per gram
Sd = standard deviation
UCL95 = 95th percentile upper confidence limit on the arithmetic mean
UPL = upper prediction limit
Y = yes
Background Data Source: EPA 2014a

Table 5-22. UCL95 Values for Radon in Air Background Compared to Site Activity

Data Set	Indoor Air (pCi/m^3)	UCL Basis	Outdoor Air (pCi/m^3)	UCL Basis	Combined Indoor and Outdoor Air (pCi/m^3)	UCL Basis
Site Data	1837	95% Student's-t UCL	949	95% Approximate Gamma UCL	1074	95% Approximate Gamma UCL
HMC-16 BKG	--	--	551	95% Student's-t UCL	--	
Bluewater	2000	USEPA (2014)				
Indoor BKG[1]	2000	NA	--	--	--	

Notes:
All data in pCi/m^3
-- = No value
1 – Indoor background for Cibola County, NM ranges from 2000 to 4000 pCi/m^3 (EPA 2019d)

5.2.5.2 Risk Description

This section discusses the numeric risk estimates for each receptor. It also identifies how exposure pathways were combined to determine aggregate risk. Tables 5-23 through 5-30 present the numerical risk estimates, including estimated inherent background risks, for the COPCs and ROPCs that were identified as exceeding background for the Homestake Facility, and Tables 5-31 through 5-36 present the numerical risk estimates for the LTAs.

The inherent risks due to background exposure, and the amount of risk potentially attributable to the Site once background is accounted for by subtracting the background UCL95 from the site UCL95, are shown by receptor and location in Tables 5-23 through 5-36. The inherent background risk presented in these tables is based on the background surface soil concentrations and soil exposure pathways of ingestion, inhalation as estimated from PEF, and dermal exposure for COPCs or external exposure for ROPCs.

The column labeled “Excess Risk Attributable to Site” is the difference between the sum of the soil pathways and the “Inherent Background Soil Risk” column. This applies to COPCs and ROPCs.

5.2.5.2.1 Future Composite Worker - Homestake Facility

Tables 5-23 and 5-24 present the ROPC and COPC cancer risks and non-cancer HQs for each analyte evaluated for each exposure pathway for this receptor. The initial results suggest that cancer risks for arsenic, and soil radionuclides are elevated for surface soils. However, arsenic cancer risks are not elevated above background cancer risk for soils (Table 5-23) and there is no excess risk at the Site due to arsenic once background is accounted for. There are no non-cancer HQs above 1 (Table 5-24).

The major contributor to risk is due to radon inhalation. Rn-222 risks are elevated for exposure to the EPC based on combined outdoor and indoor air data. The total cumulative cancer risk based on the combined indoor and outdoor air EPC of 1074 pCi/m^3 is 2 x 10^{-2}, which is above the upper bound of the risk management range.

Note that radon is, however, not greatly elevated above background for outdoor air, being elevated at the Site by less than a factor of 2. The Site outdoor air EPC is 949 pCi/m^3 which is 1.7 times above the background outdoor air UCL95 of 551 pCi/m^3. Risks due to radon are 2 x 10^{-2}, and, once background is accounted for, are 1 x 10^{-2}, which is above the risk management range. The Site indoor air concentration of 1837 pCi/m^3 is less than the reported background for both Bluewater and Cibola County identified by EPA’s radon map of 2-4 pCi/L (2000 to 4000 pCi/m^3). The radon indoor air concentration for Bluewater developed by EPA (2014) is 2 pCi/L (2000 pCi/m3), which is at the low end of the Cibola County Range.

Consultation with EPA indicated that risk cannot exceed 1, and the RadPRG calculator defaults to a different model above 1 x10^{-2}. There may be a discrepancy in risk estimates due to use of different models simply because background risks for radon, even after daughter progeny below Po-214 are removed, are so high.

Major contributors for soil exposure risk are Pa-234m, Ra-226, U-234, and U-238, all of which had cancer risk estimates above 1 x 10^{-4}. However, a significant part of the cancer risk is related to Site background levels for soils (refer to Table 5-23). EPCs for Pa-234m, U-234, and U-238 are approximately 3 to 4 times higher in the Site soils than background, but other risk driving radionuclides in soil are only 1 to 2 times higher than background. The Site cumulative cancer risk

for soils is 8 x 10^{-4}, and excess risk attributable to the Site soils after accounting for background is $9x10^{-4}$. This is above the upper bound of the cancer risk management range.

5.2.5.2.2 Future Construction Worker - Homestake Facility

Table 5-25 presents the cancer risks for COPCs and ROPCs. Table 5-26 presents the non-cancer hazards.

There are no excess cancer risks for chemicals (Table 5-25). There are no non-cancer hazard quotients (refer to Table 5-26) above 1 for COPCs.

The results indicate that while over half the isotopes in soils have cancer risks above $1x10^{-6}$, that there are no elevated cancer risks above $1x10^{-4}$ for soils. Total cancer risk for the construction worker exposed to surface and subsurface soils is 7 $x10^{-5}$. This includes consideration of soil ingestion, particulate inhalation during construction activities, and external exposure. When inherent risks due to background exposure are factored out, the excess risk attributable to the Site is 4 $x10^{-5}$.

Rn-222 risks are elevated for exposure to air. The air EPC of 1074 pCi/m^3 was based on indoor air samples from second quarter of 2015 through 2018 from the HMC office and RO plant, and outdoor air based on all data combined from 2014 through 2018 from the Homestake Facility. The indoor/outdoor air EPC of 1074 pCi/m^3 was used to represent both the Homestake Facility and LTAs. The indoor/outdoor air EPC was used to represent potential trench air radon levels. The total cumulative cancer risk at the Homestake Facility for air is 8 x 10^{-4}, which is above the upper bound of the risk management range. When inherent background is subtracted out of the total risk, the cancer risk attributable to the Site is 4 x 10^{-4}, which also exceeds the upper bound of the risk management range.

External exposure is the only exposure pathway with elevated risks for soil contact pathways for this receptor. The ingestion and inhalation of fugitive dust pathways have lower radiation risks. The major risk driver is radon in air for risks estimated for the inhalation pathways from measured air concentrations; all other estimated cancer risks fall below the upper bound of the risk management range.

A significant part of the cancer risk is related to Site background radon levels (refer to Table 5-25). Radon activity in outdoor air (949 pCi/m3) at the Homestake Facility is higher by a factor of 1.7 than outdoor background concentrations of 551 pCi/m^3 based on a UCL95 from the data from HMC-16. Radon risks are higher than soil exposure pathway risks.

5.2.5.2.3 Current and Future Trespasser -Homestake Facility

Table 5-27 presents the cancer risks for COPCs and ROPCs for exposure to soil and air in the Homestake Facility for the current trespasser, and Table 5-28 presents the cancer risks for exposure to surface water and sediments. Table 5-29 presents the non-cancer hazards for exposure to soils, surface water, sediment, and air for the Homestake Facility for the current trespasser. Remediation efforts will remove the evaporation ponds, and thereby remove pond water and sediments as a potential exposure medium for future receptors. The future trespasser in the Homestake Facility therefore has only soil and air exposure pathways compared to the current trespasser who is potentially exposed infrequently to sediments and surface water as well as to soil and air. Cancer risks for the future trespasser are shown in Table 5-30 and non-cancer hazards are shown in Table 5-31.

There are no excess cancer risks for chemicals for soil and air (Table 5-27 and 5-30) for the current or future trespasser. There are no non-cancer hazard quotients (refer to Table 5-29) above 1 for COPCs in soil and air. There is an HQ of 2 for uranium for exposure to surface water for the current trespasser; the HI for exposure to surface water in the evaporation ponds is 3 (Table 5-29). The HI for exposure to sediment is less than 1 (Table 5-29).

The results indicate that while over half the isotopes have cancer risks above $1x10^{-6}$, that there are no elevated cancer risks above $1x10^{-4}$ for soils. Total cancer risk for the current trespasser exposed to soils is $4x10^{-5}$. This includes consideration of soil ingestion, particulate inhalation, and external exposure. When inherent risks due to background exposure are factored out, the excess risk attributable to the Site is $2x10^{-5}$.

The major risk driver for current trespassers is radon activity in air for risks estimated for the inhalation pathway from measured air concentrations. Cancer risk is $1x10^{-4}$ for total Site risk for air. After subtracting background activity the excess risk attributable to the Site is $6x10^{-5}$, which falls within the risk management range.For future trespassers within the Homestake Facility, the exposure pathways are the same as for current trespassers for soil and air. Risks and hazards are the same as for the current trespasser for soil and air.

Table 5-28 shows cancer risks for incidental exposure to surface water or sediment. Background data were not available for surface water or sediment and Site risks cannot be adjusted to reflect amounts expected to be naturally occurring. Cancer risks for radionuclides are $7x10^{-5}$ for surface water, in sediment potential risk estimates are $6x10^{-5}$ for U-234 and U-238, and total cancer risk is $1x10^{-4}$. Pond water and sediment pathways are removed for future trespassers (refer to Tables 5-30 and 5-31).

Table 5-28 suggests potential risk to trespassers at the ponds for contact with sediment. Exposure parameters used to predict sediment exposure (0.2 hours/day, 6 days/year for 10 years) are considered conservative because it is unlikely someone would fall into the ponds on a regular basis. Albuquerque was used as a location for the PEF to model if sediments dried and became wind-blown. A sediment ingestion rate of 100 mg/day was used to predict sediment exposure which is also considered conservative as humans would not spend as much time in contact with sediments as they do with soils. Neither soil, air, surface water or sediment exposure estimates result in cancer risks above $1x10^{-4}$.

5.2.5.2.4 Future Composite Worker - Land Treatment Areas

Tables 5-32 and 5-33 present the ROPC and COPC cancer risks and non-cancer HQs for each analyte evaluated for each exposure pathway for this receptor. There is no cancer risk above $2x10^{-6}$ for chemicals for exposure within the LTAs (Table 5-32). There are no non-cancer hazards above 1. Total cancer risk for exposure to radionuclides in soil is $8x10^{-4}$. After accounting for background, the cancer risk due to radionuclides is $1x10^{-4}$. The major contributor to risk is due to radon inhalation in air. Rn-222 risks are elevated for exposure to an EPC based on outdoor and indoor air data (Table 5-32).

There are no indoor or outdoor air measurements for the LTAs. Data from monitoring stations around the LTP were used as the basis of the LTA air EPC, which is conservative. Data from these monitors are collected quarterly. Indoor air monitoring data used is from the second quarter of 2015, after a modification to the air circulation system, through 2018. The predicted indoor/outdoor air concentration for the LTAs of 1074 pCi/m^3 is lower than the indoor air background of 2000 pCi/m^3 at

Bluewater, and below the lower end of the average indoor air concentrations predicted for Cibola County (EPA 2019d) of 2000 - 4000 pCi/m^3.

A significant part of the cancer risk is related to Site background levels for soils as well as air (refer to Table 5-32), and many isotopes are not elevated at the LTAs. However, U-234 and U-238 risks for soil exposure pathways are nearly 2 times higher at the LTAs than background. Radon risks for air are two orders of magnitude higher than soil risks and exceed the upper bound of the cancer risk management range (Table 5-32).

5.2.5.2.5 Future Construction Worker - Land Treatment Areas

Table 5-34 presents the cancer risks for COPCs and ROPCs. Table 5-35 presents the non-cancer hazards. There are no cancer risks above 1x10^{-6} for COPCs (refer to Table 5-34) and no non-cancer hazard quotients (refer to Table 5-35) above 1 for COPCs.

The total cumulative cancer risk for the soil exposure pathways for radionuclides is 1x10^{-5}. This is estimated as the sum of the surface and subsurface soil pathways at exposure times of 8 hours per day and soil ingestion rates of 330 mg/d plus the sum of the fugitive dust air pathway and external exposure. External exposure is the only exposure pathway with elevated risks for the soil contact pathways for this receptor. Excess risk (Table 5-34) attributable to the LTAs based on the soil pathways is 4x10^{-5}. Once background is factored out, the overall inherent site risk is 1x10^{-5}.

The major risk driver is radon for risks estimated for the inhalation pathway from measured air concentrations; all other estimated cancer risks fall below the upper bound of the risk management range. Rn-222 risks are elevated for exposure to the Site-wide outdoor and indoor air concentration of 1,074 pCi/m^3. This concentration was used to represent exposure to outdoor and trench air concentration. Total risk is 8x10-4, but once background is factored out, excess risk (Table 5-34) attributable to the LTAs based on the air pathways is 4x10^{-4}. The Site-wide radon concentration in combined indoor and outdoor air of 1,074 pCi/m^3 is higher than the outdoor background UCL95 of 551 pCi/m^3 based upon data from HMC-16, and below average indoor air concentrations predicted by background for Bluewater (EPA 2014a) of 2000 pCi/m^3, or for Cibola County of 2000 – 4000 pCi/m^3 (EPA 2019d).

5.2.5.2.6 Current and Future Trespasser - Land Treatment Areas

Cancer risk and non-cancer hazard for the LTA trespasser is similar under current or future scenarios and the exposure pathways are also similar (Tables 5-36 and 5-37). There is no cancer risk above 1x10^{-6} for chemicals for exposure within the LTAs. There are no non-cancer hazard quotients above 1 for COPCs (refer to Table 5-37).

The cumulative cancer risk for soil exposure pathways for Site radionuclides and background are 2x10^{-5} and 1x10^{-5}, respectively. Excess cancer risk attributable to the Site is 1x10^{-5}, which is within the risk management range.

Radon risks were evaluated for exposure to outdoor air. The cumulative cancer risk for the current and future LTA trespasser is 1x10^{-4} for the Site and 7x10^{-5} for the UCL95 of 551 pCi/m^3 based on HMC-16 data. The excess cancer risk is 3x10^{-5}, or within the cancer risk management range.

The excess risk for both current and future trespassers attributable to the LTAs' surface soils and air is within the cancer risk management range. Outdoor radon concentrations in air are modeled as higher than background, but since the data were all collected on the Homestake Facility, outdoor air

risks may be biased high. A large component of risk for radon exposure is due to ambient conditions.

Table 5-23 Cancer Risk for Future Composite Workers in the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	Dermal Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site from Soil	Excess Site Risk >1E-06?	Excess Site Risk >1E-04?
Arsenic	6.328	2E-06	3E-10	4E-07	2E-06	2E-06	0E+00	No	No
Molybdenum	36.53	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	3.87	NA	NA	NA	NA	NA	NA	NA	NA
Uranium (total)	15.53	NA	NA	NA	NA	NA	NA	NA	NA
Cumulative Cancer Risk		2E-06	3E-10	4E-07	2E-06	2E-06	0E+00	No	No

Isotope	Homestake Facility Soil EPC (pCi/g)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	External Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site from Soil	Site Air EPC (pCi/m3)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)	Inherent Background Air Risk	Excess Risk Attributable to Site[1]	Excess Site Risk > 1E-06?	Excess Site Risk >1E-04?
*Secular Equilibrium Risk for Bi-212	1.498	4E-10	3E-12	5E-05	5E-05	4E-05	1E-05	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Bi-214	2.333	3E-06	1E-09	8E-05	8E-05	3E-05	5E-05	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Cs-137	0.0672	1E-09	1E-13	7E-07	7E-07	8E-07	0E+00								
*Secular Equilibrium Risk for K-40	18.1	2E-07	8E-11	7E-05	7E-05	7E-05	0E+00								
*Secular Equilibrium Risk for Pa-234m	4.603	7E-06	1E-08	2E-04	2E-04	5E-05	1E-04	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Pb-212	1.35	1E-08	2E-11	5E-05	5E-05	4E-05	9E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Pb-214	2.468	3E-06	1E-09	1E-04	1E-04	4E-05	6E-05	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Ra-223	0.414	3E-08	2E-10	2E-06	2E-06	2E-06	6E-07	--	--	--	--	--	--	No	No
**Secular Equilibrium Risk for Ra-226*	4.00	6E-06	4E-09	2E-04	2E-04	7E-05	1E-04	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Ra-228	1.422	7E-07	5E-09	8E-05	8E-05	6E-05	2E-05	--	--	--	--	--	--	Yes	No
Secular Equilibrium Risk for Rn-222	--	--	--	--	--	--	--	1074	2E-02	5E-05	2E-02	1E-02	1E-02	Yes	Yes*
*Secular Equilibrium Risk for Th-227	0.174	2E-08	2E-10	1E-06	1E-06	9E-07	3E-07								
*Secular Equilibrium Risk for Th-228	1.604	2E-07	4E-09	6E-05	6E-05	5E-05	7E-06								
**Secular Equilibrium Risk for Th-230*	2.593	4E-06	5E-09	1E-04	1E-04	6E-05	5E-05	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Th-232	1.372	8E-07	6E-09	7E-05	8E-05	6E-05	1E-05								
*Secular Equilibrium Risk for Th-234	3.26	5E-06	7E-09	1E-04	1E-04	3E-05	1E-04	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Tl-208	0.434	0E+00	0E+00	4E-05	4E-05	3E-05	7E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for U-234	4.287	7E-06	1E-08	2E-04	2E-04	5E-05	1E-04	--	--	--	--	--	--	Yes	Yes
*Secular Equilibrium Risk for U-235	0.307	1E-07	2E-09	3E-06	3E-06	1E-06	2E-06								
*Secular Equilibrium Risk for U-238	4.323	7E-06	1E-08	2E-04	2E-04	5E-05	1E-04	--	--	--	--	--	--	Yes	Yes
Total Risk	--	4E-05	5E-08	2E-03	2E-03	7E-04	8E-04	--	2E-02	5E-05	2E-02	1E-02	1E-02	Yes--	Yes

Note: EPA RSL and RadPRG calculators used to determine risk estimates. If risk does exceed $1x10^{-2}$, the calculator defaults to a different model. This represents modeling uncertainty.
* Rn-222 air risk calculated with progeny down decay chain to Po-214 only, at which point radon daughters are not expected to be airborne.
1 – Excess risk is the Total Risk (Site) – Inherent Background Air Risk estimated with the UCL95 of 551 pCi/m3 derived from data from HMC-16 as the EPC
EPCs - 95th percentile upper confidence limit on the mean (UCL95); bold values are maxima
Highlighted cells indicate the cancer risk > 1E-6, red shading for Site, blue shading for background; red text indicates result is above $1x10^{-4}$
NA = not applicable
-- = No value
pCi/g = picocurie per gram
Arsenic risks were corrected for the RBA of 0.6
NA = Not applicable, no cancer slope factor
EPC = Exposure point concentration
ROPC = Radionuclide of potential concern
There are no metals in air data shown because particulates in air screened out. Particulates generated from soils are predicted with PEF and presented as fugitive dust inhalation risk.

Table 5-24 Non-Cancer Risk for Future Composite Workers in the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion HQ	Fugitive Dust Inhalation HQ	Dermal Exposure HQ	Total Homestake Facility Soil HQ	Inherent Soil Background HQ	Excess Hazard Attributable to Site	Excess Site HQ>1?
Arsenic	6.328	1E-02	1E-05	2E-03	1E-02	1E-02	0E+00	No
Molybdenum	36.53	6E-03	No RfC	No ABS	6E-03	8E-05	6E-03	No
Selenium	3.869	7E-04	7E-09	No ABS	7E-04	1E-04	6E-04	No
Uranium	15.53	6E-02	1E-05	No ABS	6E-02	7E-03	5E-02	No
Hazard Index (HI)		8E-02	2E-05	2E-03	8E-02	2E-02	6E-02	No

Notes:
EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
ABS = Dermal absorption factor
COPC = Contaminant of potential concern
EPC = Exposure point concentration
HQ = Hazard quotient
mg/kg = milligram per kilogram
RfC = Reference concentration
-- = No value
Arsenic risks were corrected for the RBA of 0.6
Background values for uranium were estimated by averaging the activity for U-234 and U-238, then multiplying by 1.48 ug/pCi to convert to mass units per DOE (2011)
HQ>1 represent elevated hazard; indicated with red text
EPCs = 95th percentile upper confidence limit on the mean (UCL95)
Excess hazard is calculated as the sum of the Site surface soil pathway hazards or Total HQ minus the background hazard for that constituent

Table 5-25 Cancer Risk for Future Construction Workers Within the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	Dermal Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Excess Site Risk >1E-06?	Excess Site Risk >1E-04?
Arsenic	6.328	2E-07	1E-09	4E-08	3E-07	2E-07	1E-07	No	No
Molybdenum	36.53	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	3.869	NA	NA	NA	NA	NA	NA	NA	NA
Uranium (total)	15.53	NA	NA	NA	NA	NA	NA	NA	NA
Cumulative Cancer Risk		2E-07	1E-09	4E-08	3E-07	2E-07	1E-07	No	No

Isotope	Homestake Facility Soil EPC (pCi/g)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	External Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site from Soil	Site Air EPC (pCi/m³)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Site Risk (no decay)	Inherent Background Air Risk	Excess Risk Attributable to Site[1]	Excess Site Risk>1E-06?	Excess Site Risk >1E-04?
*Secular Equilibrium Risk for Bi-212	1.498	5E-11	1E-11	2E-06	2E-06	2E-06	0E+00	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Bi-214	2.333	4E-07	5E-09	3E-06	4E-06	1E-06	3E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Cs-137	0.0672	2E-10	5E-13	3E-08	3E-08	3E-08	0E+00								
*Secular Equilibrium Risk for K-40	18.1	2E-08	3E-10	3E-06	3E-06	3E-06	0E+00								
*Secular Equilibrium Risk for Pa-234m	4.603	9E-07	4E-08	7E-06	8E-06	2E-06	6E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Pb-212	1.35	2E-09	7E-11	2E-06	2E-06	2E-06	0E+00	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Pb-214	2.468	4E-07	5E-09	4E-06	4E-06	2E-06	2E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Ra-223	0.414	4E-09	8E-10	9E-08	9E-08	7E-08	2E-08	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Ra-226	4.348	8E-07	2E-08	7E-06	8E-06	3E-06	5E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Ra-228	1.422	1E-07	2E-08	3E-06	3E-06	3E-06	0E+00	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Rn-222	--	-	-	-	-	-	--	1074	8E-04	2E-06	8E-04	4E-04	4E-04	Yes	Yes*
*Secular Equilibrium Risk for Th-227	0.174	2E-09	8E-10	5E-08	5E-08	4E-08	1E-08								
*Secular Equilibrium Risk for Th-228	1.604	2E-08	2E-08	2E-06	2E-06	2E-06	0E+00								
*Secular Equilibrium Risk for Th-230	2.607	5E-07	2E-08	4E-06	5E-06	2E-06	3E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Th-232	1.372	1E-07	2E-08	3E-06	3E-06	3E-06	0E+00								
*Secular Equilibrium Risk for Th-234	3.26	7E-07	3E-08	5E-06	6E-06	1E-06	5E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Tl-208	0.434	0E+00	0E+00	2E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for U-234	4.287	9E-07	4E-08	7E-06	8E-06	2E-06	6E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for U-235	0.307	1E-08	7E-09	1E-07	1E-07	5E-08	5E-08								
*Secular Equilibrium Risk for U-238	4.323	9E-07	4E-08	7E-06	8E-06	2E-06	6E-06	--	--	--	--	--	--	Yes	No
Total Risk	--	6E-06	2E-07	5E-05	6E-05	3E-05	4E-05	--	8E-04	2E-06	8E-04	4E-04	4E-04	Yes	No

Notes: EPA RSL and RadPRG calculators used to determine risk estimates. If risk does exceed $1x10^{-2}$, the calculator defaults to a different model. This represents modeling uncertainty.
* Rn-222 air risk calculated with progeny down decay chain to Po-214 only, at which point radon daughters are not expected to be airborne.
1 – Excess risk is the Total Risk (Site) – Inherent Background Air Risk estimated with the UCL95 of 551 pCi/m³ derived from data from HMC-16 as the EPC
Arsenic risks were corrected for the RBA of 0.6
EPCs - 95th percentile upper confidence limit on the mean (UCL95); bold values are maxima
Highlighted cells indicate the cancer risk >$1x10^{-6}$, red shading for Site, blue shading for background; red text indicates result is above $1x10^{-4}$
NA = not applicable
-- = No value
pCi/g = picocurie per gram
NA = Not applicable, no cancer slope factor
EPC = Exposure point concentration
ROPC = Radionuclide of potential concern
-- = No value
pCi/g = picoCurie per gram
-- = No value
pCi/g = picoCurie per gram

Table 5-26 Non-Cancer Risk for Future Construction Workers Within the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion HQ	Fugitive Dust Inhalation HQ	Dermal Exposure HQ	Total Homestake Facility Soil HQ	Inherent Soil Background HQ	Excess Hazard Attributable to Site	Excess Site HQ>1?
Arsenic	6.328	4E-02	1E-03	6E-03	4E-02	4E-02	0E+00	No
Molybdenum	36.53	2E-02	No RfC	No ABS	2E-02	3E-04	2E-02	No
Selenium	3.87	2E-03	6E-07	No ABS	2E-03	5E-04	2E-03	No
Uranium (total)	15.53	2E-01	5E-04	No ABS	2E-01	3E-02	2E-01	No
Hazard Index (HI)		3E-01	2E-03	6E-03	3E-01	6E-02	2E-01	No

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
ABS = Dermal absorption factor
COPC = Contaminant of potential concern
EPC = Exposure point concentration
HQ = Hazard quotient
mg/kg = milligram per kilogram
RfC = Reference concentration
-- = No value

Arsenic risks were corrected for the RBA of 0.6
Background values for U-total were estimated by averaging the activity for U-234 and U-238, then multiplying by 1.49 ug/pCi
Particulates in air screened out and fugitive dusts are modeled from soil concentrations
HQs > 1 represent elevated risk, indicated with red text
EPCs = 95th percentile upper confidence limit on the mean (UCL95)
Uranium (total) in Background (1.69 mg/kg) is the mean of U-234 and U238 activity multiplied by 1.48 to convert to a mass (DOE 2011)
Excess hazard is calculated as the sum of the Site surface soil pathway hazards or Total HQ minus the background hazard for that constituent

Table 5-27 Cancer Risks for Current Trespassers within the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	Dermal Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Excess Site Risk >1E-06?	Excess Site Risk >1E-04?
Arsenic	6.328	3E-07	1E-11	6E-08	3E-07	1E-07	2E-07	No	No
Molybdenum	36.53	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	3.87	NA	NA	NA	NA	NA	NA	NA	NA
Uranium (total)	15.53	NA	NA	NA	NA	NA	NA	NA	NA
Cumulative Cancer Risk	--	3E-07	1E-11	6E-08	3E-07	1E-07	2E-07	No	No

Isotope	Homestake Facility Soil EPC (pCi/g)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	External Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Site Outdoor Air EPC (pCi/m^3)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Site Risk (no decay)	Inherent Background Air Risk	Excess Risk Attributable to Site[1]	Excess Site Risk > 1E-06?	Excess Site Risk > 1E-04?
*Secular Equilibrium Risk for Bi-212	1.498	1E-10	2E-14	1E-06	1E-06	8E-07	2E-07	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Bi-214	2.333	6E-07	9E-12	2E-06	2E-06	9E-07	1E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Cs-137	0.0672	1E-10	9E-16	1E-08	1E-08	2E-08	0E+00								
*Secular Equilibrium Risk for K-40	18.1	5E-08	5E-13	1E-06	1E-06	1E-06	0E+00								
*Secular Equilibrium Risk for Pa-234m	4.603	1E-06	7E-11	4E-06	5E-06	1E-06	4E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Pb-212	1.35	4E-09	1E-13	9E-07	9E-07	8E-07	1E-07	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Pb-214	2.468	6E-07	9E-12	2E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Ra-223	0.414	1E-08	1E-12	4E-08	5E-08	4E-08	1E-08	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Ra-226	4.00	1E-06	3E-11	3E-06	4E-06	2E-06	2E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Ra-228	1.422	2E-07	3E-11	1E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Rn-222	--	--	--	--	--	--	--	949	1E-04	8E-07	1E-04	7E-05	3E-05	Yes	No
*Secular Equilibrium Risk for Th-227	0.174	6E-09	1E-12	2E-08	3E-08	2E-08	1E-08								
*Secular Equilibrium Risk for Th-228	1.604	6E-08	3E-11	1E-06	1E-06	1E-06	0E+00								
*Secular Equilibrium Risk for Th-230	2. 593	7E-07	3E-11	2E-06	3E-06	1E-06	2E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Th-232	1.372	2E-07	4E-11	1E-06	2E-06	1E-06	1E-06								
*Secular Equilibrium Risk for Th-234	3.26	1E-06	5E-11	2E-06	3E-06	7E-07	2E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Tl-208	0.434	0E+00	0E+00	7E-07	7E-07	6E-07	1E-07	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for U-234	4.287	1E-06	6E-11	3E-06	4E-06	1E-06	3E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for U-235	0.307	2E-08	1E-11	6E-08	8E-08	3E-08	5E-08								
*Secular Equilibrium Risk for U-238	4.323	1E-06	8E-11	3E-06	5E-06	1E-06	4E-06	--	--	--	--	--	--	Yes	No
Total Risk	--	8E-06	4E-10	3E-05	4E-05	2E-05	2E-05	--	1E-04	8E-07	1E-04	7E-05	3E-05	Yes	No

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
* Rn-222 air risk calculated with progeny down decay chain to Po-214 only, at which point radon daughters are not expected to be airborne.
1 – Excess risk is the Total Risk (Site) – Inherent Background Air Risk estimated with the UCL95 of 551 pCi/m^3 derived from data from HMC-16 as the EPC
NA = Not applicable, no cancer slope factor
EPC = Exposure point concentration
ROPC = Radionuclide of potential concern
-- = No value
pCi/g = picoCurie per gram
Arsenic risks were corrected for the RBA of 0.6
Background data were not available for surface water or sediment
There are no metals in air data shown because particulates in air screened out. Particulates generated from soils are predicted with PEF and presented.
EPCs - 95th percentile upper confidence limit on the mean (UCL95); bold values are maxima
Highlighted cells indicate the cancer risk > 1x10^{-6}, red shading for Site, blue shading for background, red text indicates risk>1x10^{-4}

Table 5-28 Cancer Risks for Current Trespassers Exposed to Sediment and Surface Water in the Evaporation Ponds within the Homestake Facility

Surface Water And Sediment Cancer Risk											
Isotope	Homestake Facility Pond Surface Water EPC (pCi/L)	Ingestion Risk	Immersion Risk	Total Surface Water Risk	Homestake Facility Pond Sediment EPC (pCi/g)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Sediment Risk	Excess Site Risk >1E-06?	Excess Site Risk >1E-04?
*Secular Equilibrium Risk for Ra-226	45.75	8E-09	1E-12	8E-09	**32.5**	1E-06	3E-12	3E-07	1E-06	No	No
*Secular Equilibrium Risk for Ra-228	71.01	6E-09	2E-12	6E-09	**--**	--	--	--	--	No	No
*Secular Equilibrium Risk for Th-230	1200	2E-07	3E-11	2E-07	**0.5**	2E-08	7E-14	5E-09	2E-08	No	No
*Secular Equilibrium Risk for U-234	185357.2	4E-05	4E-09	4E-05	**1283**	5E-05	2E-10	1E-05	6E-05	Yes	No
*Secular Equilibrium Risk for U-238	185357.2	4E-05	4E-09	4E-05	**1283**	5E-05	3E-10	1E-05	6E-05	Yes	No
*Total Risk		7E-05	9E-09	7E-05	**--**	1E-04	5E-10	2E-05	1E-04	Yes	No

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
U-234 and U-238 actiivity estimated from Utotal mass concentration. Calculated from UCL95 for Utotal (548.8 mg/L) *1000 (ug/mg)* 0.67 pCi/ug = 367696 pCi/L divided by 2 = 185357.2 pCi/L for U-234 and 185357.2 for U-238

EPC = Exposure point concentration
pCi/g = picoCurie per gram
pCi/L = picoCurie per liter
-- = No value
Background data were not available for surface water or sediment in the evaporation ponds
EPCs - 95th percentile upper confidence limit on the mean (UCL95); bold values are maxima
Highlighted cells indicate the cancer risk > $1X10^{-6}$, red shading for Site, red text for cancer risk>$1x10^{-4}$
Measured activity of U-natural in sediment was used to estimate EPCs for U-234 and U-238 EPCs in the absence of isotopic-specific data by assigning half the U-natural activity to each isotope.
Exposure parameters used to predict sediment exposure were those for surface water exposure (0.2 hours/day, 6 days/year for 10 years), with Albuquerque as a location for PEF in the event dried sediments were wind-blown, and a sediment ingestion rate of 100 mg/day as per soils

Table 5-29 Non-Cancer Hazard for Current Trespassers Within the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion HQ	Fugitive Dust Inhalation HQ	Dermal Exposure HQ	Total Homestake Facility Soil HQ	Inherent Soil Background Hazard	Excess Hazard Attributable to Site	Excess Site HQ>1?
Arsenic	6.328	2E-03	7E-07	4E-04	3E-03	2E-03	1E-03	No
Molybdenum	36.5	1E-03	No RfC	No ABS	1E-03	1E-05	1E-03	No
Selenium	3.8	1E-04	3E-10	No ABS	1E-04	3E-05	7E-05	No
Uranium (total)	14.3	1E-02	6E-07	No ABS	1E-02	1E-03	9E-03	No
Hazard Index (HI)		2E-02	1E-06	4E-04	1E-02	3E-03	1E-02	No

Surface Water and Sediment Non-Cancer Hazard										
COPC	Homestake Facility Surface Water EPC (mg/L)	Surface Water Ingestion HQ	Dermal Exposure HQ	Total Homestake Facility Surface Water HQ	Pond Sediment EPC (mg/kg)	Ingestion HQ	Inhalation HQ	Dermal HQ	Total Sediment HQ	Excess Site HQ>1?
Manganese	0.302	3E-06	3E-04	3E-04	--	--	--	--	--	No
Molybdenum (total)	864.4	4E-02	1E-01	2E-01	--	--	--	--	--	No
Nitrate	2.135	3E-07	1E-06	1E-06	--	--	--	--	--	No
Selenium (total)	0.572	3E-05	1E-04	1E-04	--	--	--	--	--	No
Uranium (total)	548.8	6E-01	2E+00	3E+00	**2566**	3E-01	1E-06	No ABS	3E-01	No
Vanadium	0.107	4E-06	7E-04	7E-04	--	--	--	--	--	No
Hazard Index (HI)		6E-04	6E-01	2E+00	3E+00	--	3E-01	1E-06	-	3E-01

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
ABS = Dermal absorption factor
COPC = Contaminant of potential concern
EPCs = 95th percentile upper confidence limit on the mean (UCL95)
HQ = Hazard quotient
mg/kg = milligram per kilogram
mg/L = milligram per liter
-- = No value
Arsenic risks were corrected for the RBA of 0.6
Background data were not available for surface water or sediment in the evaporation ponds
EPCs - 95th percentile upper confidence limit on the mean (UCL95); bold values are maxima
Uranium (total) in Background soil (1.69 mg/kg) is the mean of U-234 and U238 activity multiplied by 1.48 ug/pCi to convert to a mass (DOE 2011)
Excess hazard is calculated as the sum of the Site surface soil pathway hazards or Total HQ minus the background hazard for that constituent
Exposure parameters used to predict surface water exposure (0.2 hours/day, 6 days/year for 10 years), Albuquerque as a location for PEF, and a sediment ingestion rate of 100 mg/day were used to predict sediment exposure
Molybdenum and selenium were below SLs but retained at request of EPA
HQs > 1 represent elevated non-cancer hazard as indicated with red text

Table 5-30 Cancer Risk for Future Trespassers within the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	Dermal Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Excess Site Risk >1E-06?	Excess Site Risk >1E-04?
Arsenic	6.328	3E-07	1E-11	6E-08	3E-07	1E-07	2E-07	No	No
Molybdenum	36.53	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	3.87	NA	NA	NA	NA	NA	NA	NA	NA
Uranium (total)	15.53	NA	NA	NA	NA	NA	NA	NA	NA
Cumulative Cancer Risk	--	3E-07	1E-11	6E-08	3E-07	1E-07	2E-07	No	No

Isotope	Homestake Facility Soil EPC (pCi/g)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	External Exposure Risk	Total Homestake Facility Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Site Outdoor Air EPC (pCi/m3)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Site Risk (no decay)	Inherent Background Air Risk	Excess Risk Attributable to Site[1]	Excess Site Risk >1E-06?	Excess Site Risk >1E-04?
*Secular Equilibrium Risk for Bi-212	1.498	1E-10	2E-14	1E-06	1E-06	8E-07	2E-07	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Bi-214	2.333	6E-07	9E-12	2E-06	2E-06	9E-07	1E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Cs-137	0.0672	1E-10	9E-16	1E-08	1E-08	2E-08	0E+00								
*Secular Equilibrium Risk for K-40	18.1	5E-08	5E-13	1E-06	1E-06	1E-06	0E+00								
*Secular Equilibrium Risk for Pa-234m	4.603	1E-06	7E-11	4E-06	5E-06	1E-06	4E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Pb-212	1.35	4E-09	1E-13	9E-07	9E-07	8E-07	1E-07								
*Secular Equilibrium Risk for Pb-214	2.468	6E-07	9E-12	2E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Ra-223	0.414	1E-08	1E-12	4E-08	5E-08	4E-08	1E-08	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Ra-226	4.00	1E-06	3E-11	3E-06	4E-06	2E-06	2E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Ra-228	1.422	2E-07	3E-11	1E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for Rn-222	--	--	--	--	--	--	--	949	1E-04	8E-07	1E-04	7E-05	3E-05	Yes	Yes*
*Secular Equilibrium Risk for Th-227	0.174	6E-09	1E-12	2E-08	3E-08	2E-08	1E-08								
*Secular Equilibrium Risk for Th-228	1.604	6E-08	3E-11	1E-06	1E-06	1E-06	0E+00								
*Secular Equilibrium Risk for Th-230	2. 593	7E-07	3E-11	2E-06	3E-06	1E-06	2E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Th-232	1.372	2E-07	4E-11	1E-06	2E-06	1E-06	1E-06								
*Secular Equilibrium Risk for Th-234	3.26	1E-06	5E-11	2E-06	3E-06	7E-07	2E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Tl-208	0.434	0E+00	0E+00	7E-07	7E-07	6E-07	1E-07	--	--	--	--	--	--	No	No
*Secular Equilibrium Risk for U-234	4.287	1E-06	6E-11	3E-06	4E-06	1E-06	3E-06	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for U-235	0.307	2E-08	1E-11	6E-08	8E-08	3E-08	5E-08								
*Secular Equilibrium Risk for U-238	4.323	1E-06	8E-11	3E-06	5E-06	1E-06	4E-06	--	--	--	--	--	--	Yes	No
Total Risk	--	8E-06	4E-10	3E-05	4E-05	1E-05	2E-05	--	1E-04	8E-07	1E-04	7E-05	3E-05	Yes	Yes

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
* Rn-222 air risk calculated with progeny down decay chain to Po-214 only, at which point radon daughters are not expected to be airborne.
1 – Excess risk is the Total Risk (Site) – Inherent Background Air Risk estimated with the UCL95 of 551 pCi/m^3 derived from data from HMC-16 as the EPC
COPC = Contaminant of potential concern
EPC = Exposure point concentration
NA = not applicable, no cancer slope factor
pCi/g = picoCurie per gram
pCi/m^3 = picoCurie per cubic meter
ROPC = Radionuclide of potential concern
-- = No value
Arsenic risks were corrected for the RBA of 0.6
EPCs - 95th percentile upper confidence limit on the mean (UCL95); bold values are maxima
Highlighted cells indicate the cancer risk > $1x10^{-6}$, red shading for Site, blue shading for background, and red text indicates risk > $1x10^{-4}$

Table 5-31 Non-Cancer Hazard for Future Trespassers Within the Homestake Facility

COPC	Homestake Facility Soil EPC (mg/kg)	Soil Ingestion HQ	Fugitive Dust Inhalation HQ	Dermal Exposure HQ	Total Homestake Facility Soil HQ	Inherent Soil Background HQ	Excess Hazard Attributable to Site	Excess Site HQ>1?
Arsenic	6.328	2E-03	7E-07	4E-04	3E-03	2E-03	1E-03	No
Molybdenum	36.53	1E-03	No RfC	No ABS	1E-03	1E-05	1E-03	No
Selenium	3.87	1E-04	3E-10	No ABS	1E-04	3E-05	7E-05	No
Uranium (total)	15.53	1E-02	6E-07	No ABS	1E-02	1E-03	9E-03	No
Hazard Index (HI)		2E-02	1E-06	4E-04	1E-02	3E-03	1E-02	No

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
ABS = Dermal absorption factor
COPC = Contaminant of potential concern
EPC = Exposure point concentration
HQ = Hazard quotient
mg/kg = milligram per kilogram
RfC = Reference concentration
-- = No value
Arsenic risks were corrected for the RBA of 0.6
Background data were not available for surface water or sediment in the evaporation ponds
HQs >1 represent elevated hazard and are indicated by red text
Uranium (total) in Background is the mean of U-234 and U238 activity multiplied by 1.48 ug/pCi to convert to a mass (DOE 2011)
EPCs = 95th percentile upper confidence limit on the mean (UCL95)
Molybdenum and selenium were below SLs but retained at request of EPA; uranium also retained as conservative assumption since related to Site
Excess hazard is calculated as the sum of the Site surface soil pathway hazards or Total HQ minus the background hazard for that constituent

Table 5-32 Cancer Risks for Future Composite Worker in the Land Treatment Areas

COPC	LTAs Soil EPC (mg/kg)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	Dermal Exposure Risk	Total LTAs Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Excess Site Risk >1E-04?
Arsenic	4.69	1.3E-06	2E-10	3E-07	2E-06	2E-06	None	No
Molybdenum	0.628	NA	NA	NA	NA	NA	NA	NA
Selenium	1.12	NA	NA	NA	NA	NA	NA	NA
Uranium (total)	3.99	NA	NA	NA	NA	NA	NA	NA
Cumulative Cancer Risk		1.3E-06	2E-10	3E-07	2E-06	2E-06	None	No

Isotope	LTAs Soil EPC (pCi/g)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	External Exposure Risk	Total LTAs Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Site Air EPC (pCi/m^3)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)	Inherent Background Air Risk	Excess Risk Attributable to Site[1]	Excess Site Risk > 1E-06?	Excess Site Risk > 1E-04?
*Secular Equilibrium Risk for Bi-212	1.015	3E-10	2E-12	3E-05	3E-05	4E-05	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Bi-214	0.87	1E-06	5E-10	3E-05	3E-05	3E-05	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Cs-137	0.0711	1E-09	2E-13	8E-07	8E-07	8E-07	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for K-40	15.92	2E-07	7E-11	6E-05	6E-05	7E-05	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pa-234m	1.45	3E-06	4E-09	7E-05	8E-05	5E-05	3E-05	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pb-212	0.935	8E-09	1E-11	3E-05	3E-05	4E-05	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pb-214	0.942	1E-06	5E-10	4E-05	4E-05	4E-05	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-223	0.253	2E-08	1E-10	1E-06	1E-06	2E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-226	1.41	2E-06	2E-09	6E-05	6E-05	7E-05	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-228	0.978	5E-07	3E-09	5E-05	5E-05	6E-05	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Rn-222	-	-	-	-	-	--	-	1074	2E-02	5E-05	2E-02	1E-02	1E-02	Yes	Yes*
*Secular Equilibrium Risk for Th-228	1.763	2E-07	5E-09	6E-05	6E-05	5E-05	1E-05								
*Secular Equilibrium Risk for Th-230	1.164	2E-06	2E-09	5E-05	5E-05	6E-05	0E+00								
*Secular Equilibrium Risk for Th-232	1.74	1E-06	8E-09	1E-04	1E-04	6E-05	3E-05	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for Th-234	0.892	1E-06	2E-09	4E-05	4E-05	3E-05	8E-06								
*Secular Equilibrium Risk for Tl-208	0.294	0E+00	0E+00	3E-05	3E-05	3E-05	0E+00								
*Secular Equilibrium Risk for U-234	2.23	3E-06	5E-09	9E-05	9E-05	5E-05	4E-05	--	--	--	--	--	--	Yes	No
*Secular Equilibrium Risk for U-235	0.131	5E-08	8E-10	1E-06	1E-06	1E-06	0E+00								
*Secular Equilibrium Risk for U-238	2.21	3E-06	6E-09	9E-05	9E-05	5E-05	4E-05	--	--	--	--	--	--	Yes	No
Total Risk		7E-06	2E-08	8E-04	8E-04	7E-04	1E-04	--	2E-02	5E-05	2E-02	1E-02	1E-02	Yes	Yes

Notes: * EPA RSL and RadPRG calculators used to determine risk estimates. If risk does exceed 1×10^{-2}, the calculator defaults to a different model. This represents modeling uncertainty.
* Rn-222 air risk calculated with progeny down decay chain to Po-214 only, at which point radon daughters are not expected to be airborne.
1 – Excess risk is the Total Risk (Site) – Inherent Background Air Risk estimated with the UCL95 of 551 pCi/m^3 derived from data from HMC-16 as the EPC
COPC – Contaminant of potential concern
EPC = Exposure point concentration
LTA = Land Treatment Area
NA = not applicable, no cancer slope factor
-- = No value
pCi/g = picoCurie per gram
pCi/m^3 = picoCurie per cubic meter
The Site soil risks are for surface soil; for background only surface soil data were available. The Site radon air EPC is for indoor and outdoor air combined; for background only outdoor air data were used.
EPCs - 95th percentile upper confidence limit on the mean (UCL95)
Excess risk for soils calculated as the sum of the Site surface soil pathway hazards minus the background risk or hazard for that constituent
Highlighted cells show cancer risk > 1×10^{-6}, red shading for Site, blue shading for background; red text indicates result is >1×10^{-4}
Risks based on default exposure parameters for the composite worker
Uranium (total) in Background is the mean of U-234 and U238 activity multiplied by 1.48 ug/pCi to convert to a mass (DOE 2011)

Table 5-33 Non-Cancer Hazard Quotients for Future Composite Workers in the Land Treatment Areas

COPC	LTAs Soil EPC (mg/kg)	Soil Ingestion HQ	Fugitive Dust Inhalation HQ	Dermal Exposure HQ	Total LTAs Soil HQ	Inherent Soil Background HQ	Excess Hazard Attributable to Site	Excess Site HQ >1?
Arsenic	4.69	8E-03	1E-05	2E-03	1E-02	1E-02	None	No
Molybdenum	0.628	1E-04	No RfC	No ABS	1E-04	8E-05	2E-05	No
Selenium	1.12	2E-04	2E-09	No ABS	2E-04	1E-04	1E-04	No
Uranium (total)	3.99	2E-02	3E-06	No ABS	2E-02	7E-03	1E-02	No
Hazard Index (HI)	--	3E-02	1E-05	2E-03	3E-02	2E-02	1E-02	No

Notes:
ABS = Dermal absorption factor
COPC – Contaminant of potential concern EPC = Exposure point concentration
HQ = Hazard quotient
LTA = Land Treatment Area
mg/kg = milligram per kilogram
RfC = Inhalation reference concentration
-- = No value

The Site soil risks are for surface and subsurface soil combined; for background only surface soil data were available
The Site radon air EPC is for indoor and outdoor air combined; for background only outdoor air data were used.
EPCs - 95th percentile upper confidence limit on the mean (UCL95)
Excess risk calculated as the sum of the Site surface soil pathway hazards minus the background risk or hazard for that constituent
Highlighted cells show HQs >1, red shading for Site, blue shading for background; red text indicates result is >1
Risks based on default exposure parameters for the composite worker
Uranium (total) in Background is the mean of U-234 and U238 activity multiplied by 1.49 ug/pCi to convert to a mass
Background risk is for background soil ingestion, dermal contact, and inhalation pathways based on background soil EPC.
Molybdenum and selenium were below SLs but retained at request of EPA; uranium also retained as conservative assumption since related to Site
Excess hazard is calculated as the sum of the Site surface soil pathway hazards or Total HQ minus the background hazard for that constituent

Table 5-34 Cancer Risk for Future Construction Workers in the Land Treatment Areas

COPC	LTAs Soil EPC (mg/kg)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	Dermal Exposure Risk	Total LTAs Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Excess Site Risk >1E-04?
Arsenic	4.69	2E-07	3E-08	9E-10	2E-07	2E-07	None	No
Molybdenum	2.452	NA	NA	NA	NA	NA	NA	NA
Selenium	0.975	NA	NA	NA	NA	NA	NA	NA
Uranium (total)	4.329	NA	NA	NA	NA	NA	NA	NA
Cumulative Cancer Risk		--	--	--	--	--	--	--

Isotope	LTAs Soil EPC (pCi/g)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	External Exposure Risk	Total LTAs Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Site Air EPC (pCi/m³)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)	Inherent Background Air Risk	Excess Risk Attributable to Site[1]	Excess Site Risk >1E-06?	Excess Site Risk >1E-04?
*Secular Equilibrium Risk for Bi-212	1.015	4E-11	8E-12	1E-06	1E-06	2E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Bi-214	0.87	1E-07	2E-09	1E-06	1E-06	1E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Cs-137	0.0711	2E-10	5E-13	3E-08	3E-08	3E-08	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for K-40	15.92	2E-08	2E-10	2E-06	2E-06	3E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pa-234m	1.45	4E-07	2E-08	3E-06	3E-06	2E-06	1E-06	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pb-212	0.935	1E-09	5E-11	1E-06	1E-06	2E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pb-214	0.942	2E-07	2E-09	1E-06	2E-06	2E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-223	0.253	2E-09	5E-10	5E-08	5E-08	7E-08	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-226	1.41	3E-07	5E-09	2E-06	2E-06	3E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-228	0.978	7E-08	1E-08	2E-06	2E-06	3E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Rn-222	-	-	-	-	-	--	--	1074	8E-04	2E-06	8E-04	4E-04	4E-04	Yes	Yes*
*Secular Equilibrium Risk for Th-228	1.763	2E-08	2E-08	3E-06	3E-06	2E-06	5E-07	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Th-230	1.164	2E-07	7E-09	2E-06	2E-06	2E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Th-232	1.74	1E-07	3E-08	4E-06	4E-06	3E-06	1E-06	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Th-234	0.892	2E-07	7E-09	1E-06	2E-06	1E-06	3E-07	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Tl-208	0.294	0E+00	0E+00	1E-06	1E-06	1E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for U-234	2.23	5E-07	2E-08	3E-06	4E-06	2E-06	2E-06	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for U-235	0.131	6E-09	3E-09	5E-08	6E-08	5E-08	9E-09	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for U-238	2.21	5E-07	2E-08	4E-06	4E-06	2E-06	2E-06	--	--	--	--	--	--	Yes	No
Total Risk		2E-06	1E-07	3E-05	4E-05	3E-05	4E-06	--	8E-04	2E-06	8E-04	4E-04	4E-04	Yes	Yes- Air

Notes: * EPA RSL and RadPRG calculators used to determine risk estimates. If risk does exceed $1x10^{-2}$, the calculator defaults to a different model. This represents modeling uncertainty.
* Rn-222 air risk calculated with progeny down decay chain to Po-214 only, at which point radon daughters are not expected to be airborne.
1 – Excess risk is the Total Risk (Site) – Inherent Background Air Risk estimated with the UCL95 of 551 pCi/m³ derived from data from HMC-16 as the EPC
COPC – Contaminant of potential concern
EPC = Exposure point concentration
LTA = Land Treatment Area
NA = not applicable, no cancer slope factor
-- = No value; pCi/g = picoCurie per gram; pCi/m³ = picoCurie per cubic meter
The Site soil risks are for surface and subsurface soil combined; for background only surface soil data were available
The Site radon air EPC is for indoor and outdoor air combined; for background only outdoor air data were used.
EPCs - 95th percentile upper confidence limit on the mean (UCL95)
Excess risk for soils calculated as the sum of the Site surface soil pathway hazards minus the background risk or hazard for that constituent
Highlighted cells show cancer risk > $1x10^{-6}$, red shading for Site, blue shading for background; red text indicates result is >$1x10^{-4}$
Risks based on default exposure parameters for the composite worker
Uranium (total) in Background is the mean of U-234 and U238 activity multiplied by 1.48 ug/pCi to convert to a mass (DOE 2011)
Background risk is for background soil ingestion, dermal contact, and inhalation pathways based on background soil EPC.

Table 5-35 Non-Cancer Hazard Quotients for Future Construction Worker in the Land Treatment Areas

COPC	LTAs Soil EPC (mg/kg)	Soil Ingestion HQ	Fugitive Dust Inhalation HQ	Dermal Exposure HQ	Total LTAs Soil HQ	Inherent Soil Background Hazard	Excess Hazard Attributable to Site	Excess HQ>1?
Arsenic	4.69	3E-02	1E-03	4E-03	3E-02	4E-02	None	No
Molybdenum	1.971	1E-03	No RfC	No ABS	1E-03	3E-04	7E-04	No
Selenium	0.829	5E-04	1E-07	No ABS	5E-04	5E-04	None	No
Uranium	4.329	6E-02	1E-04	No ABS	6E-02	3E-02	3E-02	No
Hazard Index (HI)		9E-02	1E-03	4E-03	1E-01	6E-02	4E-02	No

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
ABS = Dermal absorption factor
COPC = Contaminant of potential concern
EPC = Exposure point concentration
HQ = Hazard quotient
LTA – Land Treatment Area
mg/kg = milligram per kilogram
RfC = Reference concentration
-- = No value
Background values for uranium were estimated by averaging the activity for U-234 and U-238, then multiplying by 1.49 ug/pCi to convert to mass units
HQs >1 represent elevated hazard, indicated with red text
Molybdenum and selenium were below SLs but retained at request of EPA; uranium also retained as conservative assumption since related to Site
EPCs = 95th percentile upper confidence limit on the mean (UCL95)
Excess hazard is calculated as the sum of the Site surface and subsurface soil pathway hazards or Total HQ minus the background hazard for that constituent

Table 5-36 Cancer Risk for Current and Future Trespasser in the Land Treatment Areas

COPC	LTAs Soil EPC (mg/kg)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	Dermal Exposure Risk	Total LTAs Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Excess Site Risk >1E-04?
Arsenic	4.69	1E-07	1E-08	5E-12	1E-07	1E-07	0E+00	No
Molybdenum	0.628	-	-	-	-	-	-	-
Selenium	1.12	-	-	-	-	-	-	-
Uranium (total)	3.99	-	-	-	-	-	-	-
Cumulative Cancer Risk	-	1E-07	1E-08	5E-12	1E-07	1E-07	0E+00	No

Isotope	LTAs Soil EPC (pCi/g)	Soil Ingestion Risk	Fugitive Dust Inhalation Risk	External Exposure Risk	Total LTAs Soil Risk	Inherent Soil Background Risk	Excess Risk Attributable to Site	Site Outdoor Air EPC (pCi/m^3)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Site Risk (no decay)	Inherent Background Air Risk	Excess Risk Attributable to Site[1]	Excess Site Risk > 1E-06?	Excess Site Risk > 1E-04?
*Secular Equilibrium Risk for Bi-212	1.015	8E-11	1E-14	7E-07	7E-07	8E-07	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Bi-214	0.87	2E-07	3E-12	6E-07	8E-07	9E-07	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Cs-137	0.0711	1E-10	1E-15	2E-08	2E-08	2E-08	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for K-40	15.92	4E-08	4E-13	1E-06	1E-06	1E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pa-234m	1.45	5E-07	3E-11	1E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pb-212	0.935	3E-09	8E-14	6E-07	6E-07	8E-07	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Pb-214	0.942	2E-07	4E-12	7E-07	9E-07	1E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-223	0.253	7E-09	9E-13	2E-08	3E-08	4E-08	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-226	1.41	4E-07	9E-12	1E-06	1E-06	2E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Ra-228	0.978	1E-07	2E-11	1E-06	1E-06	1E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Rn-222	-	-	-	-	-	-	-	949	1E-04	8E-07	1E-04	7E-05	3E-05	Yes	No*
*Secular Equilibrium Risk for Th-228	1.763	6E-08	3E-11	1E-06	1E-06	1E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Th-230	1.164	3E-07	1E-11	8E-07	1E-06	1E-06	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Th-232	1.74	2E-07	5E-11	2E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Th-234	0.892	3E-07	1E-11	7E-07	9E-07	7E-07	2E-07	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for Tl-208	0.294	0E+00	0E+00	5E-07	5E-07	6E-07	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for U-234	2.23	6E-07	3E-11	2E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for U-235	0.131	9E-09	5E-12	2E-08	3E-08	3E-08	0E+00	--	--	--	--	--	--	--	--
*Secular Equilibrium Risk for U-238	2.21	7E-07	4E-11	2E-06	2E-06	1E-06	1E-06	--	--	--	--	--	--	--	--
Total Risk	--	4E-06	2E-10	2E-05	2E-05	2E-05	4E-06	--	1E-04	8E-07	1E-04	7E-05	3E-05	Yes	No

Notes: EPA RSL and RadPRG calculators used to determine risk estimates. If risk does exceed $1x10^{-2}$, the calculator defaults to a different model. This represents modeling uncertainty.
* Rn-222 air risk calculated with progeny down decay chain to Po-214 only, at which point radon daughters are not expected to be airborne.
1 – Excess risk is the Total Risk (Site) – Inherent Background Air Risk estimated with the UCL95 of 551 pCi/m^3 derived from data from HMC-16 as the EPC
COPC = Contaminant of potential concern
EPC = Exposure point concentration
LTA = Land Treatment Area
NA = not applicable, no cancer slope factor
pCi/g = picoCurie per gram
pCi/m^3 = picoCurie per cubic meter
ROPC = Radionuclide of potential concern
-- = No value
The Site soil risks are for surface soil; for background only surface soil data were available
Arsenic risks were corrected for the RBA of 0.6
EPCs - 95th percentile upper confidence limit on the mean (UCL95); bold values are maxima
Highlighted cells indicate the cancer risk > $1x10^{-6}$, red shading for Site, blue shading for background, and red text indicates risk > $1x10^{-4}$

Table 5-37 Non-Cancer Hazard Quotients for Current and Future Trespasser in the Land Treatment Areas

COPC	LTAs Soil EPC (mg/kg)	Soil Ingestion HQ	Fugitive Dust Inhalation HQ	Dermal Exposure HQ	Total LTAs Soil HQ	Inherent Soil Background Hazard	Excess Hazard Attributable to Site	Excess HQ>1?
Arsenic	4.69	2E-03	5E-07	2E-04	2E-03	2E-03	0E+00	No
Molybdenum	0.628	2E-05	No RfC	No ABS	2E-05	1E-05	1E-05	No
Selenium	1.12	4E-05	9E-11	No ABS	4E-05	3E-05	1E-05	No
Uranium	3.99	3E-03	2E-07	No ABS	3E-03	1E-03	2E-03	No
Hazard Index (HI)		4E-03	5E-03	7E-07	5E-03	3E-03	2E-03	No

Notes: EPA RSL (EPA 2019a) and RadPRG (EPA 2019b) calculators used to determine risk estimates.
ABS = Dermal absorption factor
COPC = Contaminant of potential concern
EPC = Exposure point concentration
HQ = Hazard quotient
LTA – Land Treatment Area
mg/kg = milligram per kilogram
RfC = Reference concentration
-- = No value
Background values for uranium were estimated by averaging the activity for U-234 and U-238, then multiplying by 1.48 ug/pCi to convert to mass units (DOE 2011)
HQs >1 represent elevated hazard, indicated with red text
Molybdenum and selenium were below SLs but retained at request of EPA; uranium also retained as conservative assumption since related to Site
EPCs = 95th percentile upper confidence limit on the mean (UCL95)
Excess hazard is calculated as the sum of the Site surface soil pathway hazards or Total HQ minus the background hazard for that constituent

5.2.5.2.7 Potential Risk Estimates for Post-Remedy Groundwater

Groundwater is approximately 40 feet below grade at the Site. It is currently undergoing remedy as OU1, and therefore was not addressed in detail in this HHRA. NRC has designated Site Cleanup Level for groundwater - see Table 3-8.

Risk estimates have been developed to estimate potential risks to future use of remediated groundwater as a potable water supply. Specifically, the estimates evaluate exposure to COPCs or ROPCs with NRC Site Cleanup Levels which are greater than MCL. This scenario is unlikely since potable water is supplied to the area and the State Engineer has prohibited the installation of potables wells in the area. For ingestion of groundwater, potential risks of using the remediated groundwater as a total potable source are as shown in Table 5-38. Noncancer hazard is elevated due to uranium and selenium (Table 5-39).

Table 5-38 Cancer Risk Estimates for Groundwater for NRC Site Cleanup Levels

Isotope	NRC Site Cleanup Levels (pCi/L)	Ingestion Risk	Inhalation Risk	Immersion Risk	Produce Consumption Risk	Total Tapwater Risk
*Secular Equilibrium Risk for U-234	107.2#	7E-03	6E-01	1E-09	2E-02	7E-01

Risk Estimate Exposure Parameters

Default Residential Tapwater Exposure Parameters	Abbreviation	Units	Adult Value	Child Value
Exposure Frequency	EF	d/yr	350	350
Exposure Duration	ED	yr	20	6
Exposure Time (washing)	ETw	hr/event	0.71	0.54
Exposure Time	ET	hr/d	24	24
Number of Events	EV	event/d	1	1
Body Weight	BW	kg	80	15
Water Ingestion Rate	IRW	L/d	2.5	0.78
K (Andelman volatilization factor) L/m³	K	L/m³	0.5	0.5
Surface Area	SA	cm²	19652	6365

Notes:
Shading indicates risk is above target of $1x10^{-6}$, red text indicates risk is above $1x10^{-4}$

Table 5-39 Non-Cancer Hazard Quotients for Groundwater for NRC Action Levels

Chemical	Action Level (ug/L)	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncancer Child Total HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncancer Adult Total H
Nitrate (measured as nitrogen)	12000	4E-01	2E-03	-	4E-01	2E-01	1E-03	-	2E-01
Selenium	320	3E+00	1E-02	-	3E+00	2E+00	1E-02	-	2E+00
Uranium (Soluble Salts)	160	4E+01	2E-01	-	4E+01	2E+01	1E-01	-	2E+01
*Total Risk/HI	-	4E+01	2E-01	-	4E+01	3E+01	2E-01	-	3E+01

Risk Estimate Exposure Parameters

Default Residential Tapwater Exposure Parameters	Abbreviation	Units	Adult Value	Child Value
Exposure Frequency	EF	d/yr	350	350
Exposure Duration	ED	yr	205	6
Exposure Time (washing)	ETw	hr/event	0.715	0.54
Exposure Time	ET	hr/d	248	24
Number of Events	EV	event/d	1	1
Body Weight	BW	kg	80	15
Water Ingestion Rate	IRW	L/d	2.5	0.78
K (Andelman volatilization factor) L/m^3	K	L/m^3	0.5	0.5
Surface Area	SA	cm^2	19652	6365

Shading indicates hazard is above target of 1

5.2.5.3 Uncertainty Analysis

The baseline HHRA uncertainty analysis describes the known and suspected uncertainties and their impacts on the baseline HHRA results. It is not the goal of the uncertainty analysis to eliminate all uncertainty or variability, merely to understand how uncertainty or variability in underlying assumptions or data may affect the risk assessment HHRA results.

5.2.5.3.1 Uncertainty in the Toxicity Values

The toxicity values represent currently accepted regulatory values proposed for this purpose. However, some of the EPA RSL toxicity values are not based on IRIS information. These are considered more uncertain than those that have an IRIS value because they may not have undergone the same level of peer-review.

There is conservatism built into the toxicity estimates. This is because each slope factor is the upper 95th percentile estimate of cancer potency (EPA 1989). According to EPA, upper 95th percentiles of probability distributions are not strictly additive, and the cumulative or total cancer risk estimate can become artificially more conservative as the cancer risks from multiple carcinogens are summed (EPA 1989).

The toxicity for the ROPCs was addressed with values incorporating exposure to progeny. For every parent ROPC measurement, the complete decay chain was evaluated under the assumption of no decay and secular equilibrium. However, due to air movement its uncertain if secular equilibrium would occur in the environment. This may bias the risk assessment results high.

In addition, for radon all progeny are solids and not gases. The daughters are expected to adhere to particulates or aerosols and settle out of the atmosphere, particularly from Pb-210 (which has a 22 year half-life) down the decay chain. This complicates the assumption of secular equilibrium, since the aerosols don’t remain suspended and Po-210 cannot reach equilibrium with Pb-210, and data indicate Po-210 air concentrations are lower by a factor of 10 to 20 (Marley et al. 2000). The Agency for Toxic Substances and Disease Registry states that Pb-210, Bi-210, and Po-210 are not considered to contribute to respiratory tract toxicity (ATSDR 2012). Previous versions of the EPA/ORNL RadPRG calculator did not evaluate radon toxicity below Po-214. This approach is also used by the NAS (1991), which states decay chain calculations can be truncated at Pb-210. Thus, risks for Bi-210, Hg-206, Pb-210, Po-210, and Tl-2016 could be realistically removed from the total radon chain risk estimate, and current radon risk estimates are biased high. The remaining radon risk would be approximately 2% of the modeled amount shown in the risk characterization tables.

5.2.5.3.2 Uncertainty in the Site Data

The Site data may contain uncertainties due to analytical methodology, sample location, seasonal fluctuations in concentrations, or matrix interferences that produce false positives or negatives. Data validation also reduces uncertainty in the analytical results. There is variability inherent in the Site data, which adds to uncertainty in the risk estimates based on the data.

There were more analytes sampled in surface than subsurface soils. Many EPCs were higher in surface soils, suggesting lack of subsurface soil data does not underestimate risk. The locations of samples collected were intended to represent Site conditions.

Detection limits represented by MDLs, MDCs, or RLs were available for some of the data only. It is not likely to bias the risk assessment results low or high.

Background air data were based on outdoor air samples from HMC-16. Background was compared to the EPC based on combined data for indoor and outdoor air for the worker receptors. Indoor air has much higher radon concentrations than outdoor air, where dispersal reduces concentrations. The Site EPCs for workers are higher than background in part for this reason, biasing risk estimates high.

In the LTAs, site specific air data were not available. Data used to derive the EPC were the same as the data used for the Homestake Facility. This is expected to bias the risk estimates for radon inhalation within the LTAs high, since dispersion and other fate processes would act to decrease radon in air between the Homestake Facility and the LTAs. Use of one air concentration to represent exposure at the Homestake Facility and the LTAs was considered conservative and appropriate for risk modeling in the absence of LTA-specific radon data.

The measured site radon outdoor air UCL95 is 1.7 times higher than outdoor air from HMC-16. This conservatively reflects the difference between the Site and background because the HMC-16 is at a location that experiences lower radon concentrations based on its location above the alluvial floodplain and its position on a bedrock outcrop. HMC-16 as a background location is currently under review with NRC. Refer to Section 3.2.8 for discussion of the radon background location.

5.2.5.3.3 Uncertainty in the Exposure Modeling

There are numerous exposure pathways quantified for the receptors. While this allows for identification of potentially significant pathways, summing conservative estimates of risk across multiple pathways creates a total risk estimate that is biased high and potentially leads to double counting. This is the result of propagating the error of biasing risk estimates high over and over again. Each of the exposure parameters was at least 50th percentile measures of central tendency, and some were higher. Multiplying them produces intakes that would be higher than a 50th percentile estimate.

Groundwater was not modeled because it is undergoing remedy. It is assumed that trenching would not be performed by employees not covered by OSHA until the remedy is complete. Air monitoring is recommended if excavation is performed.

Only the current trespasser was modeled as being exposed to pond water or sediments at the evaporation ponds. It is possible that radon could be emitted from the pond water and inhalation of this radon could occur. The radon air measurements are expected to capture all radon sources. However, use of the pond area is expected to be minimal, as well as temporary. Therefore, this uncertainty is not expected to bias or underestimate true risk low.

Risk estimates above 1×10^{-4} for the composite worker within the Homestake Facility were obtained by modeling this receptor with typical default exposure parameters of 8 hours/day, 5 days per week, for 25 years. However, this is overly conservative because the Homestake Facility will be turned over to DOE as a legacy site. During legacy management, there will be workers engaged in semi-annual long-term groundwater monitoring and annual inspections. There would not be workers expected to be exposed to the UCL95 EPC for all ROPCs combined on a daily basis for the entire workday for a period of 25 years. A more realistic, but still conservative, exposure scenario would be a worker exposed for 14 days per year for 25 years. Risk estimates for a DOE legacy worker based on this exposure scenario would be on the order of 4x10-5, which is within the risk management range. For this reason, risk estimates for the composite worker within the Homestake Facility are considered very conservative and biased high.

5.2.5.3.4 Cross Media Transport Modeling

Fugitive dusts generated from outdoor soils were quantified by modeling cross-media transport with the PEF. The PEF was adjusted by using climatic information from Albuquerque, NM. This is not expected to bias risk estimates. The future construction worker PEF accounts for Site activity including excavation and grading. If the area undergoing activity is larger than that modeled, dust exposure could be underestimated. If it is smaller, dust exposure would be overestimated. The measured air data provide a higher estimate of risk than estimates modeled from surface soil data. This could be because air data sample locations were targeted around the tailings pile. The measured air data included radon gas and high volume particulate samples. Particulates screened out based on measured data, and are not expected to add significant exposure levels to the assessment.

5.2.5.3.5 Uncertainty in Receptor Selection

Receptors were selected that reflect the current and realistic future uses at the Site. All these receptors were older adolescents or adults. Residents, including children and infants, are not anticipated to be present because of land use restrictions. This may bias risk estimates low since exposure and therefore risk estimates are higher for residential scenarios. There are no current residents within the LTAs or Homestake Facility, and the remedy at the Site is already underway. Current remediation efforts include a remediation system intended to drive contaminated groundwater back to the Homestake Facility boundary. The Homestake Facility is designated to be returned to DOE, and no residential use is envisioned in that area either. Therefore, the lack of evaluation of a residential use scenario does not bias the risk assessment results low under realistic exposure scenarios.

5.2.6 Conclusions

Risks to human receptors within the LTAs are within the cancer risk management range for soils. The air data indicate radon inhalation risks may exceed the upper bound of the risk management range; however, the air data used to generate the EPC were collected from closer to the LTP than the LTAs are, making the risk estimates for the LTAs for inhalation exposure more conservative. Radon is similar to background levels, suggesting risks in the LTAs are acceptable for the receptors and exposure conditions evaluated. Risks due to radon in air are above the upper bound of the cancer risk management range for workers, but the majority of this is due to ambient conditions. That the LTAs do not present an elevated risk to human health under the assumptions in this report is further supported by the soil EPCs being less than or similar to background.

Risk to long-term composite workers within the Homestake Facility is above the cancer risk management range for soil. For the composite workers, this is primarily due to concentrations of Pa-234m, Ra-226, U-234, and U-238 in soils when evaluated for external exposure. Note that while statistically significantly different from background, EPCs for Ra-226 within the Homestake Facility are only 2 times higher than background, and the other three risk drivers are 3 times higher than background.

For construction workers, risk is due primarily to measured concentrations of radon in potential trench air concentrations. However, radon within the Site is similar to background concentrations, suggesting that the bulk of exposure is due to naturally occurring radon gas in air. Cancer risks to all other receptors for the Homestake Facility are within the risk management range.

Note that radon is, however, not greatly elevated above background for outdoor air, being elevated at the Site by less than a factor of 2. The Site outdoor air EPC is 949 pCi/m3 (0.949 pCi/L) which is 1.7 times above the background outdoor air UCL95 of 551 pCi/m3 (0.551 pCi/L). Risks due to radon are 2 x 10^{-2}, and, once background is accounted for, are 1 x 10^{-2}, which is above the risk management range. The Site indoor air concentration of 1837 pCi/m3 (1.837 pCi/L) is less than the reported background for both Bluewater and Cibola County identified by EPA's radon map of 2-4 pCi/L (2000 to 4000 pCi/m^3. The radon indoor air concentration for Bluewater developed by EPA (2014) is 2 pCi/L (2000 pCi/m^3), which is at the low end of the Cibola County Range. The site is still undergoing groundwater remediation. Radon flux and emission from the LTP is expected to go down when final radon barrier is placed on top of the LTP, thus potentially reducing the radon level within HMC facility.

There are no non-cancer hazard quotients above 1 associated with exposure to media at the LTA or Homestake Facility under the assumptions made in this HHRA.

5.3 Baseline Ecological Risk Assessment

This section presents the Screening Level Ecological Risk Assessment (SLERA) and Baseline Ecological Risk Assessment (BERA) completed for the areas of concern, which are defined as the Homestake Facility and the LTAs (refer to Figure 1-1).

EPA procedures (1997, 1998) for conducting an ecological risk assessment recommend a tiered approach for risk evaluation. The SLERA is considered the first tier of the process and is designed to serve as Steps 1 and 2 of EPA's eight-step process (EPA 1997). Step 1 consists of evaluating relevant information, formulating problems and evaluating toxicity. Step 2 consists of developing exposure estimates and risk calculations.

At the end of Step 2, a scientific/management decision point (SMDP) is reached where it may be concluded that:

- There is adequate information to conclude that ecological risks are negligible and therefore there is no need for remediation on the basis of ecological risk;
- The information is not adequate to make a decision at this point, and the ecological risk assessment process will continue to Step 3a; or
- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

If the decision is made that further evaluation is warranted for any specific receptors/pathways, a BERA is conducted (EPA 2001). The BERA serves to refine the conservative risk analysis conducted in the SLERA by considering additional Site specific factors.

Data quality objectives for the BERA are summarized as follows:

Problem Statement: Potential ecological impacts due to operations at the HMC uranium mill have not previously been evaluated and quantified. The BERA will be conducted with historical data collected by HMC and EPA using EPA procedures (EPA 1997; 1998).

BERA Goal: The goal of the BERA is to determine if metals, radionuclides, and ionizing radiation associated with HMC activities pose an unacceptable risk to the environment.

BERA Information Inputs: Data used in the evaluation include historical soil and evaporation pond sampling data from the areas of concern in conjunction with ecological screening levels developed primarily by EPA and the New Mexico Environment Department.

Study Boundaries: The spatial boundaries of the areas of concern are shown in Figure 1-1. There are no temporal boundaries for soils data. For the evaporation ponds, the most recent sampling data available were used. An additional temporal boundary is that the evaporation ponds will be removed when the remedy effort is complete.

Information Synthesis Strategy: The following decision rules were applied to the data used in the BERA:

- Historical sampling data were evaluated and validity for use in the BERA was confirmed.
- All rejected data were assumed to have been removed from the datasets prior to providing them for use in the BERA. If there are unknown but rejected data in the dataset, then there is additional uncertainty in the BERA results.
- If the maximum concentration for a constituent exceeded its respective ecological screening level, the constituent was further evaluated in the BERA.
- If historical data were collected from areas that have not undergone remediation, and could be predicted to be reflective of current Site conditions, they were used in the BERA. All available post-remedy data were used in the BERA.

Plan for Obtaining Data: Historical Site documents and reports were reviewed. HMC and EPA were contacted to provide electronic versions of data from past sampling events. The data were organized in Microsoft Excel for evaluation and quantification of risk.

5.3.1 Screening-Level Risk Assessment

5.3.1.1 Screening-Level Problem Formulation

The screening-level problem formulation serves to define the reasons for the SLERA and BERA, and to define the methods for analyzing/characterizing risks. The specific goal of this effort is a conservative evaluation of the likelihood for adverse effects, and the ecological significance of any such predicted effects, to receptors that may be exposed to Site related constituents.

Problem formulation produces three outputs: (1) assessment endpoints that adequately reflect management goals and the ecosystem the goals are meant to protect, (2) a Site Conceptual Exposure Model (SCEM) that describes the relationships between stressors and the assessment endpoints, and (3) a plan for analyzing the potential risks to the assessment endpoints.

5.3.1.1.1 Environmental Setting

Site characteristics, including Site features, soils, geology, hydrogeology, current and future land use, and ecology, are described in Section 2.0. Information for Site conditions and characterization of ecological habitats and resources is based on a review of observations and findings from the following surveys and reports:

- **Salter, 1990.** Baseline ecology data were collected in 1990 for a proposed tailings disposal area at the Site. A wildlife biologist walked regular north-south transects at 300-foot intervals

throughout the tailings basin, recorded wildlife observations, and mapped habitat types. No sensitive ecological resources (e.g., threatened and endangered species or their habitats) were observed in this baseline study.

- **Byszewski, B., 2006.** A cultural resources inventory of 350 acres was conducted within the vicinity of the areas of concern and included observations of the environmental setting and ecological species.
- **Bridges and Meyer 2007, NRC 2008.** A biologist collected baseline data at the Site in 2006 for an environmental assessment of the construction of EP-3. No sensitive ecological resources (e.g., threatened and endangered species or their habitats) were observed in this study.
- **USFWS and NMED**. The websites of the U.S. Fish and Wildlife Service (USFWS), New Mexico Ecological Services Field Office and Natural Heritage New Mexico (NHNM) were queried for lists of threatened and endangered species and species of concern known to occur in Cibola County (HMC, 2013a). The species identified from these queries are summarized in Table 2-5.

No species currently listed as endangered by the Federal government or the State of New Mexico are expected in the areas of concern included in this BERA due to a lack of suitable habitat. A survey by biologist Louis Bridges, who has extensive experience with western threatened and endangered species evaluations, confirmed the lack of suitable habitat for listed plant and animal species (Bridges and Meyer 2007). Species of concern that may occasionally pass through the Site when migrating are American peregrine falcons, arctic peregrine falcons, and bald eagles.

Homestake Facility. Much of the Homestake Facility was remediated in 1995 and re-seeded with shrubs, forbs, and grasses. No aquatic species are present on or near the Site and there are no native aquatic habitats, riparian areas, or wetlands. The only features containing open water within the Homestake Facility are the manmade collection ponds and evaporation ponds, which will be reclaimed as part of final closure of the Homestake Facility.

Wildlife is generally limited to small mammals and bird species that are common in desert landscapes and relatively tolerant of human disturbance. During a cultural resource inventory survey in June 2006, cottontail rabbits and black tailed jackrabbits, ravens, rattlesnakes, horned lizards, blackbirds, and prairie dogs were observed (Byszewski, 2006). Table 2-4 lists species potentially expected to occur at the Site based on past observations.

Land Treatment Areas. Plant and wildlife communities in the LTAs are expected to be similar to those at the Homestake Facility.

Evaporation Ponds. There are three lined evaporation ponds and two collection ponds in use at the Homestake Facility (Figure 1-2). The evaporation system receives water from the extraction wells in the alluvial and Upper Chinle aquifers and brine from the RO plant. The evaporation ponds are engineered structures designed to concentrate Site contaminants and do not provide true aquatic habitat. There is no vegetation in or along the banks of the ponds and there are no fish present. Various species of shorebirds and waterfowl have been observed using the evaporation ponds during spring and fall migration (HMC 1982; Bridges and Meyer 2007). The evaporation ponds are within the fenced area of the Homestake Facility.

5.3.1.1.2 Contaminants at the Site

As discussed in Section 3.1, sources of inorganic and radionuclide constituents within the areas of concern (Homestake Facility and LTAs) are the HMC tailings piles and groundwater pumped from the remediation system into on-Site evaporation ponds. Historically, there was pumping to off-Site irrigation fields/LTAs, but this ceased in 2012.

5.3.1.1.3 Site Conceptual Exposure Model

Table 5-40 presents the SCEM. Exposure pathways for several groups of ecological receptors were identified as potentially relevant. Each exposure pathway includes a potential source of chemicals of potential concern (COPCs) and radionuclides of potential concern (ROPCs), an environmental medium, and a potential exposure route. Surface soil and evaporation/collection pond surface water are the primary media of potential ecological concern due to the presence of inorganic and radionuclide constituents from past milling activities.

5.3.1.1.4 Contaminant Fate and Transport

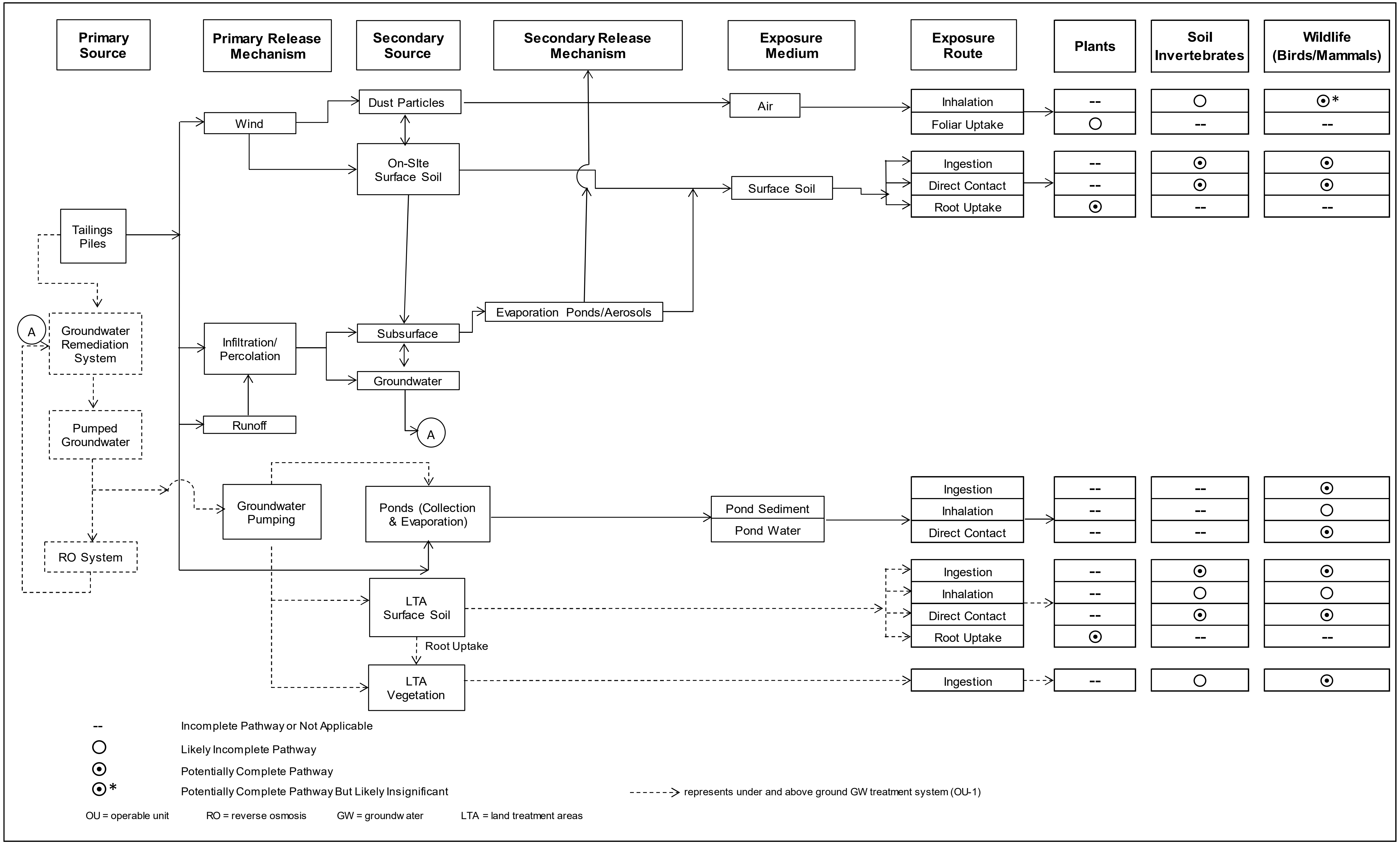
The potential for constituents to be released and transported from the sources to points of contact with ecological receptors depends on their physicochemical properties, concentrations, and their spatial distribution. As shown on the SCEM in Table 5-40, potential fate and transport process of constituents from the tailings piles include:

- Suspension and windblown transport of particulates in ambient air
- Groundwater pumping to Site collection and evaporation ponds
- Historical application of pumped groundwater to LTAs

5.3.1.1.5 Ecotoxicity

The potential ecotoxicity for constituents related to the Site vary depending on a wide range of factors, such as constituent concentrations, the receptor species exposed, the exposure route (e.g., ingestion or direct contact), and physical factors (e.g., soil pH, temperature, moisture content). Some of the effects that could be observed in wildlife are mortality, reduced reproductive ability, decreased fertility, decreased offspring survival, alteration of immune and behavioral function, and retarded growth.

Table 5-40 Ecological Risk Assessment Site Conceptual Exposure Model



The following paragraphs describe the potential ecotoxicity for the types of constituents detected in the areas of concern (Homestake Facility and LTAs). These descriptions of constituent mechanisms of toxicity are presented without consideration of constituent concentrations, as the descriptions are intended to convey an understanding of possible effects, rather than to describe the concentrations at which these effects might occur.

Metals. Toxicity and effects of trace metals may be greatly influenced by biotic and abiotic factors, including pH, organic carbon content, and the presence of sulfides in the matrix in which they occur. These factors affect the nature of the inorganic and organic complexes formed by the metal and its bioavailability. Imbalances in the essential trace metals may cause a decrease in photosynthetic ability, teratogenesis, susceptibility to predation and disease, reduced growth, mortality, histopathological changes, organ dysfunction of the liver or kidneys, neurological defects, changes in respiration and osmoregulation, and anemia. However, some of the metals (e.g., molybdenum) at the Site are known to be nutrients required by birds and mammals. If in large excess, nutrients can also have adverse effects.

Radionuclides. In general, organisms that are more primitive are the most radioresistant taxonomic groups, and more advanced complex organisms, such as mammals, are the most radiosensitive. The early effects of exposure to ionizing radiation result primarily from cell death; cells that frequently undergo mitosis are the most radiosensitive, and cells that do not divide are the least. Thus, embryos and fetuses are particularly susceptible to ionizing radiation and very young animals are consistently more radiosensitive than adults.

5.3.1.1.6 Potential Receptors

Ecological receptors located in the Homestake Facility and LTAs were selected to represent communities and species in the major consumer trophic levels. The categories of receptors are intentionally generic at the SLERA stage of the assessment process. Ecological receptors potentially at risk consist of terrestrial plants, soil invertebrates, and wildlife (birds and mammals).[1] These receptors were selected based on the habitat provided in the Homestake Facility and LTAs and their likelihood for exposure to potential contaminants. Consideration of these species provides a measure of protection to species of concern that may occasionally pass through the Site when migrating.

1 Although potential exposure pathways may exist for reptiles, there is a lack of herpetofauna-specific toxicological data for most environmental contaminants. Reptiles are indirectly assessed via the bird and mammals evaluations since they are not likely to be more sensitive than the receptors evaluated (Hall and Henry, 1992).

5.3.1.1.7 Exposure Pathways

A complete exposure pathway is one in which the constituent can be traced or expected to travel from the source to a receptor that can be affected by the chemicals. Therefore, a constituent, its migration from the source, a receptor, and the mechanisms of toxicity of that constituent must be demonstrated before a complete exposure pathway can be identified.

The ecological SCEM for the Site is shown in Table 5-40 and integrates the potential sources of concern, the media in which they are present, the exposure routes by which they interact with ecological receptors, and the various types of potentially exposed ecological receptors.

The relevant potential exposure pathways identified in the ecological SCEM include:

- Potential exposure of vegetation and soil invertebrates from direct contact with constituents in surface soils Homestake Facility and in the LTAs;
- Potential exposure of terrestrial avian and mammalian receptors from ingestion of constituents in surface soil at the Homestake Facility and in the LTAs and through uptake in the food chain from terrestrial prey resources; and
- Potential exposure of avian and mammalian receptors from contact with constituents in the on-Site evaporation ponds.

The soil and water ingestion pathways are the primary routes of potential exposure for wildlife. In addition, sediment ingestion may be a route of exposure for ecological receptors. Dietary exposure pathways are also a major route of potential exposure and bioaccumulation is incorporated into the screening levels for exposure to soils.

Although inhalation is listed as a possible exposure route, under most exposure conditions inhalation pathways do not represent a significant contribution to ecological receptor risk (EPA 2005). In addition, while dermal exposure is listed as a possible exposure route, under most exposure conditions dermal pathways do not represent a significant contribution to ecological receptor risk. Feathers of birds, fur on mammals, and scales on reptiles are thought to reduce potential dermal exposure by limiting the contact of the skin surface with the contaminated media (EPA 2005). The dermal and inhalation pathways are usually minor exposure pathways (Sample et al. 1997) and are not evaluated in this SLERA.

5.3.1.1.8 Assessment and Measurement Endpoints

Based on the identification of potentially complete exposure pathways, assessment endpoints and measures of effect were identified. Assessment endpoints contain an entity (e.g., avian population) and an attribute of that entity (e.g., survival rate). Because assessment endpoints often cannot be measured directly, a set of surrogate endpoints (measures of effect) are generally selected for ecological risk assessment that relate to the assessment endpoints and have measurable attributes (e.g., comparison of media concentrations to screening benchmarks, results of food web models) (EPA 1997; 1998). These measures of effect provide a quantitative metric for evaluating potential effects of constituents on the ecosystem components potentially at risk.

The following assessment endpoints and measures of effect were selected for the SLERA:

Soil Assessment Endpoint 1 – Survival, growth, and reproduction of terrestrial plant and soil invertebrate communities in Homestake Facility and LTA upland habitat areas.

Soil Measure of Effect 1 – Comparison of maximum concentrations of constituents in soil to soil screening values derived for the protection of plants and soil invertebrates.

Soil Assessment Endpoint 2 –Survival, growth, and reproduction of terrestrial wildlife receptors within the Homestake Facility and LTA upland habitat areas.

Soil Measure of Effect 2 – Comparison of maximum concentrations of constituents in soil to soil screening values derived for the protection of avian and mammalian receptors exposed to soil or to bioaccumulating analytes in prey species.

Evaporation Pond Assessment Endpoint 1 –Survival, growth, and reproduction of wildlife receptors that may occasionally ingest water from the evaporation ponds.

Evaporation Pond Measure of Effect 1 – Comparison of maximum concentrations of constituents in evaporation pond surface water and sediment to screening values derived for protection of aquatic life.

5.3.1.2 Screening-Level Ecological Effects Evaluation

In the screening-level ecological effects evaluation, data were evaluated to characterize potential ecological exposures and corresponding effects. Risk estimates developed in this evaluation were intended to serve as a means to identify COPCs/ROPCs to be carried forward into Step 3a (BERA). The outcome of Step 2 is an initial identification of COPCs/ROPCs based on conservative screening level risk estimates. Following Step 2 screening, refining COPCs/ROPCs in Step 3a of the process enables identification of screening level risk estimates with more appropriate Site-specific significance.

5.3.1.2.1 Exposure Point Concentrations

Data from past sampling at the Site were used for this SLERA and were considered adequate for identifying COPCs and ROPCs from historical milling operations. A significant amount of soil cleanup was completed in 1995. Only post-remediation data were considered in this evaluation.

A full summary of the data used in the SLERA (including the number of samples collected in each media, number of detections, and minimum and maximum detections) is provided in Appendix F. Soil sample locations are shown on Figures 3-39 and 3-40. Sample analyses included radionuclides and inorganics although not all media and locations were analyzed for all of these constituents in each sampling event.

EPCs were selected based on maximum detected concentrations for each COPC from the areas of concern for each media.

- **Soil - Homestake Facility and Soil - LTAs.** Refer to Appendix F. Data were obtained from EPA (EPA 2014a), ORISE (ORISE 2019), and ERG (ERG 2014; 2018) and include Homestake Facility samples and LTA samples. Older as well as newer soil data were included to adequately represent current conditions at the Site and avoid introducing data gaps. It was assumed that soil concentrations were not likely to change as much seasonally or over time as air and pond water concentrations would, and so using older data would not introduce excessive uncertainty.
- **Evaporation Pond Surface Water.** Refer to Appendix F. Data were obtained from HMC Semi-Annual Monitoring Reports (HMC 2019c) and included samples from EP-1, EP-2, EP-

3-A, EP-3-B, the East Collection Pond, and the West Collection Pond. Only the most recent surface water data were used to adequately reflect current conditions at the Site.

- **Evaporation Pond Sediments.** Data were obtained for a limited subset of analytes for pond sediments or sludge from the West Collection Pond and EP1 (ERG 2017). This is not the white crust, which is a saline evaporite lining the banks, but sediments in the pond.

5.3.1.2.2 ESV/RESL Selection

Ecological screening values (ESVs) and radioecological screening levels (RESLs) used in the screening-level ecological effects characterization are summarized in Tables 5-41 and 5-42, respectively for all chemical constituents for which soil, surface water or sediment data are available and relevant radionuclides (See Section 5.3.2.3). ESVs (also called ecotoxicity values or benchmark values) represent conservative thresholds for adverse ecological effects. RESLs correspond to the No Observed Radiological Effect Level (NOREL) for virtually any nonhuman organism or any ecosystem.

In selecting ESVs and RESLs for soil, preference was given to sources from EPA, other federal governmental agencies, and the NMED. For evaluating wildlife that may occasionally ingest water from the evaporation ponds, acute ESVs are not available for bird and mammals. ESVs based on acute National Ambient Water Quality Criteria (NAWQC) for aquatic life were selected as a surrogate. This approach is overly conservative for this evaluation and will overestimate the potential for risk as aquatic life are typically much more sensitive to water-borne constituents than terrestrial life since gill membranes allow for rapid and efficient transport of water-soluble constituents directly into the blood stream.

The soil RESLs were considered representative of sediments since the intent is not to protect a benthic invertebrate community but to protect terrestrial animals that may incidentally and infrequently contact sediments in the evaporation ponds. The soil RESLs should be adequately conservative since terrestrial animals are not expected to remain in constant contact with sediments due to lack of prey or cover in the evaporation pond area.

5.3.1.2.3 COPCs/ROPCs with no ESVs/RESLs

Table 5-43 summarizes constituents that were included in historical data but for which ecological screening values do not exist. None of the constituents listed in Table 5-43 are identified as a concern in any of the historical evaluations reviewed for this SLERA. Most have short half-lives and are daughter products of parent compounds that are included in this SLERA. As such, these constituents were not evaluated quantitatively in this SLERA (see Section 5.3.9):

- Pb-214 (half-life 27 minutes) and Bi-214 (half-life 20 minutes) are daughters of Ra-226.
- Pb-212 (half-life 11 hours), Bi-212 (half-life 61 minutes), and Tl-208 (half-life 3 minutes) are daughters of Th-228.
- Th-234 (half-life 24 days) and Pa-234m (half-life 1 minute) are daughters of U-238.
- Th-227 (half-life 19 days) and Ra-223 (half-life 11 days) are daughters of U-235.
- Tl-208 (half-life 3 minutes) is a daughter of Ra-228

Table 5-41 Ecological Screening Values for Site Media

Chemical	Soil ESVs					Evaporation Pond ESVs
	Plants (mg/kg)	Invertebrates (mg/kg)	Avian (mg/kg)	Mammals (mg/kg)	ESV (mg/kg)	Surface Water (mg/L)
Arsenic	18 [a]	60 [b]	43 [a]	46 [a]	18 [c]	0.34 [d]
Lead	120 [a]	1,700 [a]	11 [a]	56 [a]	11 [c]	0.065 [d]
Manganese	NA	NA	NA	NA	NA	0.120[d]
Molybdenum	2 [b]	Not Established	15	Not Established	2 [c]	160 [e]
Nitrate	NA	NA	NA	NA	NA	3[g]
Selenium	0.52 [a]	4.1 [a]	1.2 [a]	0.63 [a]	0.52 [c]	0.0015 [f]
Uranium	5 [b]	Not Established	1,100 [h]	480 [h]	5 [c]	0.046 [e]
Vanadium	2 [b]	Not Established	7.8 [a]	280 [a]	2 [c]	0.28 [e]

[a] EPA EcoSSL, ECOTOX Database (www.epa.gov/ecotox) (EPA, 2010).
[b] No EPA EcoSSL available; value from Oak Ridge National Laboratory (ORNL) (Sample et al. 1997).
[c] Selected ESV for initial screening in this SLERA. Lowest plant, soil invertebrate, avian, and mammalian ESV selected.
[d] EPA National Recommended Water Quality Criteria, Aquatic Life, Freshwater Acute (assumed hardness of 100 mg/L in the absence of Site-specific data).
[e] Suter and Tsao, 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota (Freshwater, Tier II Acute)
[f] Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater. EPA 822-P-15-001. July 2015).
[g] Water Quality Guidelines for Nitrogen (Nitrate, Nitrite, and Ammonia). Water Stewardship Division Ministry of Environment, Province of British Columbia (Nordin and Pommen, 2009)
[h] LANL 2019. QrESLss. 03/13/19.
NA – Not applicable

Table 5-42 Radioecological Screening Levels for Site Media

Radionuclide	Soil or Sediment RESLs					Evaporation Pond RESLs
	Plants (pCi/g)	Burrowing Animals (pCi/g)	Deer (pCi/g)	Mountain Lion (pCi/g)	ESV (pCi/g)	Surface Water (pCi/L)
Cesium-137	2,460 [a]	3,180 [a]	254 [a]	1,000 [a]	254 [b]	6,190 [c]
Radium-226	21.2 [a]	985 [a]	61.5 [a]	575 [a]	21.2 [b]	160 [c]
Radium-228	1430 [a]	1,700 [a]	57.3 [a]	584 [a]	57.3 [b]	0.9[e]
Thorium-228	16.1 [a]	1,190 [a]	180 [a]	1,030 [a]	16.1 [b]	60 [d]
Thorium-230	112 [a]	39,600 [a]	280 [a]	2,120 [a]	112 [b]	413 [d]
Thorium-232	131 [a]	8,070 [a]	56.2 [a]	425 [a]	56.2 [b]	477 [d]
Uranium-234	110 [a]	63,200 [a]	442 [a]	4,070 [a]	110 [b]	400,000 [c]
Uranium-235	117 [a]	9,520 [a]	464 [a]	3,960 [a]	117 [b]	416,000 [c]
Uranium-238	118 [a]	36,700 [a]	466 [a]	4,230 [a]	118 [b]	455,000 [c]
U-natural	114[f]	49950[f]	454[f]	4150[f]	114[f]	--

[a] Radioecological Screen Level (RESL) (NMED 2000). Radiological screening involves sum of fractions when multiple radionuclides present.
[b] Selected ESV for initial screening in this SLERA. Lowest plant, borrowing animal, deer, and mountain lion RESL selected.
[c] NMED RESLs and DOE Benchmarks for surface water (NMED 2000, Tables 3-6 and 3-10).
[d] No NMED RESL available, value from Oak Ridge National Laboratory Radiological Benchmarks (Bechtel Jacobs Company, 1998).
[e] Ecorisk Database, Version 4.1. March 13, 2019. Minimum LANL ESL for algae (LANL 2019)
[f] U-natural is only evaluated for sediments because individual isotopic data are not available. Value is the average of U-234 and U-238 RESLs.

Table 5-43 Constituents Not Evaluated Quantitatively for Ecological Risk (No RESL)

Constituent	Minimum Detection (pCi/L)	Maximum Detection (pCi/L)	Constituent	Minimum Detection (pCi/L)	Maximum Detection (pCi/L)
Bi-212			**Pb-212**		
LTA Soil	0.45	1.71	LTA Soil	0.419	1.52
Homestake Facility Soil	0.39	2.04	Homestake Facility Soil	0.425	1.67
Bi-214			**Pb-214**		
LTA Soil	0.43	1.44	LTA Soil	0.485	1.55
Homestake Facility Soil	0.504	5.79	Homestake Facility Soil	0.54	6.13
Co-60			**Ra-223**		
LTA Soil	ND	ND	LTA Soil	0.093	0.364
Homestake Facility Soil	ND	ND	Homestake Facility Soil	0.097	0.67
I-131			**Th-227**		
LTA Soil	ND	ND	LTA Soil	0.087	0.087
Homestake Facility Soil	ND	ND	Homestake Facility Soil	0.047	0.227
K-40			**Th-234**		
LTA Soil	11.5	20.3	LTA Soil	0.27	2.09
Homestake Facility Soil	12.9	21.2	Homestake Facility Soil	0.28	11.2
Pa-234m			**Tl-208**		
LTA Soil	0.66	3.3	LTA Soil	0.134	0.5
Homestake Facility Soil	1.2	18.9	Homestake Facility Soil	0.138	0.527

5.3.1.3 Screening-Level Exposure Estimates and Risk Calculations

This step of the SLERA is comprised of the estimation of ecological intakes, risk estimation, risk characterization, and the evaluation of uncertainties. These form the foundation of evidence to support the scientific management decision point.

5.3.1.3.1 Risk Calculation Method for Inorganics

To estimate risk in the SLERA, HQs were used to calculate the screening level risk estimate for each COPC in each medium. An HQ is the unitless ratio of a constituent concentration in media to the ESV for that constituent in that medium considered protective of ecological receptors.

$$\text{Hazard Quotient} = \frac{\text{Exposure Point Concentration}}{\text{Ecological Screening Value}} \qquad \text{(Equation 1)}$$

An HQ less than or equal to 1 in the SLERA indicates that the constituent alone is unlikely to cause adverse ecological effects. However, an HQ > 1 does not in itself represent an unacceptable risk; but instead indicates that additional evaluation is needed to better determine the risk potential.

Maximum detected soil concentrations were used as the EPCs for soil (Homestake Facility and LTAs) and maximum detected surface water and sediment concentrations were used as the EPCs for the evaporation ponds. The lowest available soil ESVs for plants, soil invertebrates, and avian and mammalian wildlife were used in the calculations.

5.3.1.3.2 Risk Calculation Method for Radionuclides

Default RESLs were used to evaluate radioactive materials in soils, sediment, and surface water. The default RESLs are based on a set of mathematical models and modeling assumptions and use input parameters representative of the most sensitive species. As such, they provide a large margin of safety and a high level of assurance that concentrations below these values have a very low likelihood of having adverse radioecological effects. When multiple radionuclides are present, a Site will pass the radioecological screening process if the following equation is satisfied (referred to as the sum of fractions rule):

$$\left[SUF = \sum {}^{Ci}/_{RESLi}\right] < 1.0$$

where:
SUF = sum of fractions (Equation 2)

Ci = concentration or radionuclide i in soil (pCi/g)

RESLi = limiting RESL for radionuclide i in soil

5.3.1.4 Initial Screening Level Results

The following subsections summarize results of the initial screening (refer to Table 5-44 through 5-50). Note that there were no inorganic analytes in the sediment samples, thus a table for inorganics is not presented. For each constituent screened with an HQ exceeding 1, an initial SMDP was reached that information was not adequate to make a decision regarding adverse ecological effects and the constituent was carried forward for evaluation in Step 3a.

Table 5-44 Soil Screening – Inorganics Homestake Facility

Chemical	Max Conc. (mg/kg)	Sample Location	ESV (mg/kg)	HQ	COPC Selection
Arsenic	9.58	6F	18	0.5	No
Lead	19.7	10E	11	2	Yes – HQ > 1
Molybdenum	126	3A	2	63	Yes – HQ > 1
Selenium	11.1	6F	0.52	21	Yes – HQ > 1
Uranium (total)	44	EP3-2	5	9	Yes – HQ > 1
Vanadium	60.7	6F	2	30	Yes – HQ > 1

Shading indicates COPC retained for further evaluation.

Table 5-45 Soil Screening – Radionuclides Homestake Facility

Radionuclide	Max Conc. (pCi/g)	Sample Location	RESL (pCi/g)	HQ	COPC Selection
Cesium-137	0.15	10C	254	0.0	No
Radium-226	9	EP3-1	21.2	0.4	No
Radium-228	1.71	6F	57.3	0.0	No
Thorium-228	2.34	6B	16.1	0.1	No
Thorium-230	7.4	EP3-3	112	0.1	No
Thorium-232	1.81	6C	56.2	0.0	No
Uranium-234	18.3	3A	110	0.2	No
Uranium-235	0.697	3A	117	0.0	No
Uranium-238	19	3A	118	0.2	No
Sum of Fractions (SUF)				**1**	

Shading indicates COPC retained for further evaluation.

Table 5-46 Soil Screening – Inorganics Land Treatment Areas

Chemical	Max Conc. (mg/kg)	Sample Location	ESV (mg/kg)	HQ	COPC Selection
Arsenic	6.79	FIA2-1	18	0.4	No
Lead	18.0	FIA2-1	11	2	Yes – HQ > 1
Molybdenum	4	FIA2-1	2	2	Yes – HQ > 1
Selenium	2.6	34F-B1	0.52	5	Yes – HQ > 1
Uranium (total)	7.47	5328S0033A	5	1	No
Vanadium	39.6	FIA2-1	2	20	Yes – HQ > 1

Shading indicates COPC retained for further evaluation.

[a] Maximum uranium concentration estimated by converting maximum U-238 concentration to mg/kg.

Table 5-47 Soil Screening – Radionuclides Land Treatment Areas

Radionuclide	Max Conc. (pCi/g)	Sample Location	RESL (pCi/g)	HQ	COPC Selection
Cesium-137	0.114	P2-1	254	0.0004	No
Radium-226	3.9	33F-S-11-0015-121238	21.2	0.2	No
Radium-228	1.66	FIA2-1	57.3	0.03	No
Thorium-228	1.84	FIA3-2	16.1	0.1	No
Thorium-230	3.4	5328S0013A	112	0.03	No
Thorium-232	1.92	FIA3-2	56.2	0.03	No
Uranium-234	2.73	FIA2-1	110	0.02	No
Uranium-235	0.193	FIA2-1	117	0.002	No
Uranium-238	2.49	FIA2-1	118	0.02	No
Sum of Fractions				**0.4**	

Table 5-48 Evaporation Pond Surface Water Screening – Inorganics

Chemical	Max Conc. (mg/L)	ESV (mg/L)	HQ	COPC Selection
Manganese	1.4	0.120	12	Yes – HQ>1
Molybdenum	760	160	30	Yes – HQ > 1
Nitrate	9	3	3	Yes – HQ >1
Selenium	5.98	0.0015	3,987	Yes – HQ > 1
Uranium –natural (total)	2,940	0.046	63,913	Yes – HQ > 1
Vanadium	0.32	0.28	1	No

Shading indicates COPC retained for further evaluation.

Table 5-49 Evaporation Pond Surface Water Screening – Radionuclides

Radionuclide	Max Conc. (pCi/L)	RESL (pCi/L)	HQ	COPC Selection
Radium-226	130	160	0.8	No
Radium-228	140	0.9	156	Yes – HQ >1
Thorium-230	2,210	413	5	Yes – HQ > 1
Sum of Fractions			**162**	

All ROPCs retained for further evaluation; shading indicates the HQ>1

Table 5-50 Evaporation Pond Sediment Screening – Radionuclides

Radionuclide	Max Conc. (pCi/L)	RESL (pCi/g)	HQ	COPC Selection
Radium-226	32.5	21.2	2	Yes – HQ >1
Thorium-230	0.5	112	0.004	No
Uranium-natural	2566	114[a]	23	Yes – HQ >1
Sum of Fractions			**25**	

[a] Use average of ESVs of major components of U-natural, which are U-234 and U238.
All ROPCs retained for further evaluation; shading indicates the HQ>

5.3.1.4.1 Soil (Homestake Facility) Initial Screening Level Results

Soil assessment endpoint 1 (protection of plants and soil invertebrates) and soil assessment endpoint 2 (protection of terrestrial wildlife) were evaluated by calculating HQs from maximum detected soil concentrations divided by the lowest available soil ESV/RESL for plants, soil invertebrates, and avian and mammalian wildlife.

As shown in Table 5-44, an HQ of 1 was exceeded for the following inorganics: lead, molybdenum, selenium, uranium, and vanadium. As shown in Table 5-45, no individual radionuclides exceeded an HQ of 1 and the sum of fractions for all detected radionuclides does not exceed 1.

5.3.1.4.2 Soil (Land Treatment Areas) Initial Screening Results

Soil assessment endpoint 1 (protection of plants and soil invertebrates) and soil assessment endpoint 2 (protection of terrestrial wildlife) were evaluated by calculating HQs from maximum detected soil concentrations divided by the lowest available soil ESV/RESL for plants, soil invertebrates, and avian and mammalian wildlife.

As shown in Table 5-46, an HQ of 1 was exceeded for the following inorganics: lead, selenium, and vanadium. As shown in Table 5-47, no individual radionuclides exceeded an HQ of 1 and the sum of fractions for all detected radionuclides was below 1.

5.3.1.4.3 Evaporation Pond Surface Water and Sediment Initial Screening Results

Evaporation pond assessment endpoint 1 (protection of wildlife that may occasionally drink water from the evaporation ponds) was evaluated by calculating HQs from maximum detected surface water concentrations divided by the lowest calculated Site specific ESV for avian and mammalian wildlife and RESLs for aquatic environments.

As shown in Table 5-48, an HQ of 1 was exceeded for the following inorganics in evaporation pond surface water: manganese, molybdenum, nitrate, selenium, vanadium, and uranium. As shown in Table 5-49, individual radionuclides exceeded an HQ of 1 for Ra-228, and thorium-230. Individual HQs for radium -226 do not exceed 1 but contribute to the sum of fractions exceeding 1.

Sediment HQs are reported in Table 5-50. Radium-226 and uranium exceeded RESLs.

5.3.1.5 Step 3a - COPC/ROPC Refinement for BERA

The assumptions made in Steps 1 and 2 of the screening level risk analysis were designed to provide a conservative evaluation of potential risk based on the maximum detected constituent concentrations and maximized exposure scenarios. COPCs and ROPCs identified for further evaluation following the initial screening are summarized in Table 5-51.

Table 5-51 COPC/ROPC Identification Following Initial Screening

Chemical	Soil Homestake Facility	Soil Land Treatment Areas	Surface Water	Sediment
Arsenic	--	--	--	NV
Lead	HQ = 2	HQ = 2	--	NV
Manganese	NV	NV	HQ=12	NV
Molybdenum	HQ = 63	HQ = 2	HQ = 30	NV
Nitrate	NV	NV	HQ=3	NV
Selenium	HQ = 21	HQ = 5	HQ = 3987	NV
Uranium	HQ = 9	--	HQ = 63913	NV
Vanadium	HQ = 30	HQ = 20	--	NV
Radionuclide	**Soil Homestake Facility**	**Soil Land Treatment Areas**	**Surface Water**	**Sediment**
Radium-226	--	--	--	HQ = 2
Radium-228	--	--	HQ = 156	NV
Thorium-230	--	--	HQ = 5	--
Uranium-natural	--	--	--	HQ = 23

NV – No value because data unavailable
-- Not identified as a COPC/ROPC in the initial screening.

The presence of constituents in environmental media at concentrations above ESVs/RESLs does not necessarily constitute ecological risk or indicate that ecological risk is present under actual Site specific conditions. The maximum detected concentration is an over-estimate of the potential

average exposure level and constituents may not be absorbed into an organism's system following ingestion, or may not be absorbed through direct contact due to the chemical form of the constituent.

The objective of a Step 3a evaluation is to refine the list of COPCs/ROPCs identified Steps 1 and 2 of the BERA and determine if there are COPCs/ROPCs that warrant evaluation in additional steps of the ecological risk assessment process. The refinement of COPCs/ROPCs allows for the identification and characterization of potential ecological risks using more Site specific assumptions than were considered in the screening level evaluation.

COPCs that could not be eliminated based on maximum EPC and maximum exposure-based assumptions were further evaluated based on the following factors:

- Consideration of more realistic EPCs.
- Consideration of receptor-specific exposure.

In the refined COPC/ROPC selection, an EPC based on the 95 percent upper confidence limit (UCL95) of the mean for each chemical or radionuclide carried forward was calculated. The UCL95 is based on surface soil data only, and is generally regarded as an appropriately conservative estimator of the upper-bound, central tendency EPC that receptors foraging randomly throughout an exposure area would be expected to encounter.

With the exception of burrowing animals, ecological receptors only contact surface soils. In the Homestake Facility, maximum concentrations were higher in surface than subsurface soils for molybdenum, selenium, and uranium. In the LTAs, maximum concentrations of selenium and uranium were higher in surface than subsurface samples, and molybdenum does not carry forward as a COPC. Therefore, use of only surface soil data was considered a conservative assumption.

EPA's ProUCL Version 5.00.00 software (EPA 2016) was used to calculate the UCL95. The ProUCL recommended UCL95 was selected as the reasonable maximum EPC unless the recommended UCL was higher than the maximum detected concentration. In these instances, the lower of the selected UCL and the maximum detected concentration was used as the reasonable maximum EPC. Appendix F provides the output from ProUCL.

The resultant UCL95 EPC values were compared to the same ESVs used in the initial screening (see tables 5-52 through 5-56).

Table 5-52 Refined Soil Screening – Inorganics Homestake Facility

Chemical	UCL95 (mg/kg)	ESV (mg/kg)	HQ (UCL95)	COPC Refinement
Lead	15.53	11	1	No
Molybdenum	36.53	2	18	Yes – HQ > 1
Selenium	3.87	0.52	7	Yes – HQ > 1
Uranium	15.53	5	3	Yes – HQ > 1
Vanadium	39.47	2	20	Yes – HQ > 1

Shading indicates COPC retained for further evaluation.

Table 5-53 Refined Soil Screening – Inorganics Land Treatment Areas

Chemical	UCL95 (mg/kg)	ESV (mg/kg)	HQ (UCL95)	COPC Refinement
Lead	13.4	11	1	No
Molybdenum	2.45	2	1	No
Selenium	0.975	0.52	2	Yes – HQ > 1
Vanadium	25.15	2	13	Yes – HQ > 1

Shading indicates COPC retained for further evaluation.

Table 5-54 Refined Evaporation Pond Surface Water Screening – Inorganics

Chemical	UCL95 (mg/L)	ESV (mg/L)	HQ	COPC Refinement
Manganese	0.302	0.12	3	Yes – HQ > 1
Molybdenum	864.4	160	5	Yes – HQ > 1
Nitrate	2.135	3	0.7	No
Selenium	0.733	0.0015	488	Yes – HQ > 1
Uranium	548.8	0.046	11,930	Yes – HQ > 1
Vanadium	--	--	--	--

Concentrations are for total inorganics when both dissolved and total concentrations provided by laboratory.
Shading indicates COPC retained for further evaluation.

Table 5-55 Refined Evaporation Pond Surface Water Screening – Radionuclides

Radionuclide	UCL95 (pCi/L)	RESL (pCi/L)	HQ	ROPC Refinement
Radium-226	45.75	21.2	2	Yes –HQ > 1
Radium-228	71.01	0.9	79	Yes – HQ > 1
Thorium-230	1,200	413	3	Yes – HQ > 1
Sum of Fractions			**84**	

Shading indicates ROPC retained for further evaluation.

Table 5-56 Refined Evaporation Pond Sediment Screening – Radionuclides

Radionuclide	UCL95 (pCi/g)	RESL (pCi/g)	HQ	ROPC Refinement
Radium-226	32.5	21.2	2	Yes – HQ > 1
U-natural	2566	114	23	Yes – HQ > 1
Sum of Fractions			**25**	

Shading indicates ROPC retained for further evaluation.
The average of the RESLs for U-234 and U-238 was used to represent the RESL for U-natural

5.3.1.5.1 Soil (Homestake Facility) Refined Screening Results

As shown in Table 5-52 for Homestake Facility soil, UCL95 concentrations result in an HQ of greater than one for molybdenum, selenium, uranium, and vanadium.

5.3.1.5.2 Soil (Land Treatment Areas) Refined Screening Results

As shown in Table 5-53 for LTA soil, the UCL95 concentration results in an HQ greater than one for selenium and vanadium.

5.3.1.5.3 Evaporation Pond Surface Water and Sediment Refined Screening Results

As shown in Table 5-54 for evaporation pond surface water, UCL95 concentrations exceed an HQ of 1 for manganese, molybdenum, selenium, and uranium. As shown in Table 5-55 for evaporation pond surface water, Ra-226, Ra-228, and Th-230 UCL95 concentrations exceed an HQ of 1.

Table 5-56 shows the screening results for sediment based on maximum measured concentrations. These results cannot be refined with a UCL95 due to the small sample size.

5.3.1.6 SLERA Uncertainty Analysis

The SLERA by definition is a highly conservative analysis. The evaluation is intended to separate those media or constituents that are not a potential threat to the environment from those that are. In order to make this distinction, the following assumptions are used:

- The maximum measured concentration is utilized in the evaluation for each analyte. This is expected to bias risk results high.
- The minimum screening levels for any receptor is used. In combination with the maximum EPC, the maximum HQ is obtained. In selecting ESVs and RESLs for soil, preference was given to sources from EPA, other federal governmental agencies, and the NMED. This is not expected to bias risk results high or low.
- ESVs were not available for some constituents. A reasonable surrogate was used were applicable (i.e., the average of ESVs for U-234 and U-238 to represent U-natural).
- Radionuclides with very short half-lives without ESVs were not evaluated because they would not provide chronic exposure. This is not expected to bias risk results low.
- For evaluating wildlife that may occasionally ingest water from the evaporation ponds, ESVs based on acute NAWQC for aquatic life were selected as a surrogate. This approach is overly conservative for this evaluation and will overestimate the potential for risk as aquatic life are typically much more sensitive to water-borne constituents than terrestrial life since gill membranes allow for rapid and efficient transport of water-soluble constituents directly into the blood stream. There are no aquatic life in the ponds as they are artificial impoundments receiving water from the RO plant. Aquatic life are typically more sensitive because they are continually immersed in water than are birds and mammals that briefly contact water for drinking. The ESVs and RESLs are expected to bias risk results high.
- There are also uncertainties with respect to the analytical data. If there are unknown but rejected data in the dataset, then there is additional uncertainty in the risk results. There is also a mixture of older and newer data, because it was assumed that soil concentrations were not likely to change as much seasonally or over time as air and pond water concentrations would, and so using older data would not introduce excessive uncertainty. This is not expected to bias risk results high or low.

5.3.2 Baseline Ecological Risk Assessment (BERA)

The following sections describe the BERA. Exposure assumptions are further refined to reflect Site-specific conditions. Risk estimates are therefore also more representative of Site-specific

conditions. Table 5-57 indicates the locations and analytes evaluated in each medium in the BERA:

Table 5-57 COPC/ROPC Identification Following Refined Screening

Chemical	Soil Homestake Facility	Soil Land Treatment Areas	Surface Water	Sediment
Manganese	--	--	HQ = 3	--
Molybdenum	HQ = 10	--	HQ = 5	--
Selenium	HQ = 3	HQ = 2	HQ = .833	--
Uranium	HQ = 3	--	HQ = 11,930	--
Vanadium	HQ = 20	HQ = 13	--	--
Radionuclide	**Soil Homestake Facility**	**Soil Land Treatment Areas**	**Surface Water**	**Sediment**
Radium-226	--	--	HQ = .2	2
Radium-228	--	--	HQ = 792	--
Thorium-230	--	--	HQ = 3	--
Uranium-natural	--	--	--	22

-- Not identified as a COPC/ROPC in the refined screening.

5.3.2.1 Exposure Assessment

COPCs and ROPCs identified following the refined screening with UCL95 EPCs are summarized in Table 5-57.

Birds and mammals were further evaluated in the BERA. Because plants and invertebrates are immobile, application of exposure assessment refinements does not alter HQs predicted for these taxa. To further evaluate the assessment endpoints identified in Section 5.3.1.8 for avian and mammalian receptors, a food web model was used and receptor-specific exposures were estimated. Food chain modeling was applied to the non-radionuclide COPCs, whereas surface water and sediment ROPC concentrations were compared against the Los Alamos National Laboratory Ecorisk Database (LANL) RESLs because food chain modeling is already incorporated into the LANL values.

- **Soil Assessment Endpoint 2 –** Protection and maintenance of terrestrial wildlife receptors within the Homestake Facility and LTA upland habitat areas.
- **Evaporation Pond Assessment Endpoint 1 –** Protection and maintenance of wildlife receptors that may occasionally ingest water from the evaporation ponds.

The calculation of chemical constituent doses provides the means, when compared to toxicity, reference values for drawing inferences regarding the protection of avian and mammalian receptors. Exposure was modeled using the methods described in the EPA's *Wildlife Exposure Factors Handbook* (EPA 1993). The approach and the parameters are described in detail in the following sections.

$$HQ_j = \frac{\left(\left(Soil_j * P_s * DIR\right) + \left(SW_j * WIR\right) + \left(\sum_{i=1}^{N} B_i * P_i * DIR\right)\right) * AUF}{TRV_j}$$ (Equation 3)

where:
HQ_j = Hazard quotient for contaminant (j) (unitless)

$Soil_j$ = Concentration of contaminant (j) in soil (mg/kg dry weight)

P_s = Soil ingestion as proportion of diet

DIR = Dietary ingestion rate (kg food [dry weight (dw)]/kg body weight/day)

SW_j = Concentration of contaminant (j) in surface water (mg/L)

WIR = Water ingestion rate (L/day)

B_i = Concentration of contaminant in biota type (i) (mg/kg dw)

P_i = Proportion of biota type (i) in diet

TRV_j = Toxicity reference value for contaminant (j) (mg/kg-d)

AUF = Area use factor (set equal to 1 for screening)

5.3.2.1.1 Representative Receptors

It is not feasible to evaluate exposures and risks for each avian and mammalian species potentially present at the Site. For this reason, several species were selected to serve as representative species (surrogates) of several different feeding guilds. Risk to protected species that may occasionally pass through the Site can be indirectly determined or implied within the selections of the species models and input parameters for assessment endpoints appropriate to the protected species. In the case of protected species (i.e., migratory birds, bald eagles), adverse effects to individual organisms could have population-level consequences.

Representative wildlife receptors selected for the Site are summarized in Table 5-58. Selection was based on receptors representing key feeding guilds and ecological communities known and/or expected to be present in the Site vicinity (see Table 2-4) for which adequate life history data are available.

Table 5-58 Representative Receptors

Feeding Guild	Representative Receptor	Ecological Attributes
Avian herbivore	Scaled Quail (*Callipepla squamata*)	Herbivorous birds are an important prey item for many higher trophic level predators. They are important in seed dispersal for many plants in both terrestrial and aquatic ecosystems.
Avian invertivore	American Robin (*Turdus migratorius*)	Invertivorous birds are an important prey item for higher trophic level predators. Also, they consume insects and other soil invertebrates, which may have taken up Site-related constituents in their tissues.
Avian carnivore	American Kestrel (*Falco sparverious*)	Carnivorous birds provide an important functional role to the environment by regulating lower trophic-level prey populations. The kestrel is also selected as a surrogate for the bald eagle (*Haliaeetus leucocephalus*).[2] American kestrel is the most common falcon species in open and semi-open areas throughout North America. Compared to other birds of prey, the smaller body weight of the American kestrel yields a higher body weight-normalized ingestion rate and, therefore, a more conservative exposure assessment.
Mammalian herbivore	Ord's Kangaroo Rat (*Dipodomys ordi*)	Herbivorous mammals are an important prey item for many higher trophic level predators. They provide an important link for energy transfer between primary and higher trophic-level consumers. In addition, these organisms generally comprise the majority of the terrestrial tissue biomass, and are important in seed dispersal and pollination for many plant species. They are the direct link in the terrestrial food chain between plants and higher trophic-level organisms.
Mammalian omnivore	Deer Mouse (*Peromyscus maniculatus*)	Omnivorous mammals are an important prey item for higher trophic level predators, and influence lower trophic level populations through predation. They are the direct link in the terrestrial food chain between plants and higher trophic-level organisms.
Mammalian carnivore	Kit Fox (*Vulpes macrotis*	Carnivorous mammals provide an important functional role to the environment by regulating lower trophic-level prey populations.

5.3.2.1.2 Estimates of Exposure

Exposure to wildlife receptors was estimated for ingestion of soil and food chain exposure for soil in the Homestake Facility and in the LTAs and for ingestion of surface water from the evaporation ponds. There were no COPCs in sediment and therefore food chain modeling was not performed for this medium. Exposure assumptions (e.g., body weights, ingestion rates, etc.) are provided in Table

[2] The bald eagle has been reported to potentially pass through the Site on occasion during migration. The American kestrel was selected to serve as a surrogate for this and other larger birds of prey potentially passing through the area.

5-59. Data were generally obtained from the EPA's Wildlife Exposure Factors Handbook (EPA 1993). Alternate sources were only used when the handbook did not provide sufficient information. Allometric equations (as cited in EPA 1993) were used to estimate the 90^{th} percentile ingestion rate. The potential food chain exposure was conservatively modeled assuming receptors eat only prey items from the Site.

Simplified and conservative assumptions were used in the food chain modeling since it is difficult to mimic a complete diet. With the exception of the deer mouse, all other receptors were assumed to consume a single food type at the UCL95 concentration 100% of the time. Contaminant concentrations in biota types (the term for "B_i" in Equation 3 above) composing the wildlife diets were estimated by assuming that the concentration of the contaminant in the food type could be predicted from the concentration of the contaminant in the soil (Soilj) by using a bioaccumulation factor (see Table 5-60).

Table 5-59 Receptor-Specific Exposure Parameters

Parameter	Scaled Quail	Western Kingbird	American Kestrel	Ord's Kangaroo Rat	Deer Mouse	Kit Fox
Scientific Name	*Callipepla squamata*	*(Tyrannus verticalis)*	*Falco sparverious*	*Dipodomys ordi*	*Peromyscus maniculatus*	*Vulpes macrotis*
Habitat	Upland	Upland	Upland	Upland	Upland	Upland
Feeding Guild	Avian Herbivore	Avian Invertivore	Avian Carnivore	Mammalian Herbivore	Mammalian Omnivore	Mammalian Carnivore
Dietary Ingestion Rate (DIR) (kg/kg/d)						
DIR (min BW)	0.1831	0.2316	0.1011	0.1109	0.1918	0.0647
DIR (max BW)	0.1810	0.2241	0.0844	0.0849	0.1604	0.0565
Allometric Equation	=0.398*BW^0.850/BW	=0.398*BW^0.850/BW	=0.301*BW^0.751/BW	=0.621BW^0.564/BW	=0.621BW^0.564/BW	=0.235BW^0.822/ BW
Equation for	passerine	passerine	nonpasserine	rodent	rodent	all mammals
Soil Fraction in Diet (P)	0.1	0.1	0.028	0.02	0.02	0.028
Source	Beyer et al, 1994 woodcock	Beyer et al, 1994 woodcock	Beyer et al, 1994 red fox	Beyer et al, 1994 white footed mouse	Beyer et al, 1994 white footed mouse	Beyer et al, 1994 red fox
Diet (Pi)	100% plants	100% terrestrial Invertebrates	100% small mammals	100% plants	50% plants; 50% terrestrial invertebrates	100% small mammals
Water Ingestion Rate (WIR) (L/kg/d)						
WIR (min BW)	0.104	0.175	0.136	0.133	0.151	0.096
WIR (max BW)	0.102	0.163	0.107	0.125	0.145	0.089
Allometric Equation	=0.059BW^0.67 /BW	=0.059BW^0.67 /BW	=0.059BW^0.67 /BW	=0.099BW^0.9/BW	=0.099BW^0.9/BW	=0.099BW^0.9/BW
Body Weight (BW) (g for birds; kg for mammals)						
BW Minimum	177	37	80	0.052	0.0148	1.4
BW Maximum	191	46	165	0.096	0.0223	3
Source	Schemnitz, 1994	EPA, 1993	EPA, 1993	Smithsonian, 2009	EPA, 1993	Meyer, 2009

Notes: All data from EPA, 1993 unless otherwise stated.
Shaded cells indicate parameter estimated with algometric equations from EPA, 1993

Table 5-60 Equations to Estimate Contaminant Concentration in Different Biota Types

COPC	Herbivore Uptake Equation for Plants (mg/kg dw)	Invertivore Uptake Equation for Earthworms (mg/kg dw)	Carnivore Uptake Equation for Small Mammals (mg/kg dw)
Arsenic	$B_i = 0.03752*(Soilj)$	$B_i = e^{0.76*ln(Soilj) -1.421}$	$B_i = e^{0.8188*ln(Soilj) -4.8471}$
Lead	$B_i = e^{0.561*ln(Soilj) -1.328}$	$B_i = e^{0.807*ln(Soilj) -0.218}$	$B_i = e^{0.4422*ln(Soilj) + 0.0761}$
Molybdenum	$B_i = 0.085*(Soilj)$	$B_i = 0.209*(Soilj)$	$B_i = 0.01*(Soilj)$
Selenium	$B_i = e^{1.104*ln(Soilj) -0.677}$	$B_i = e^{0.733*ln(Soilj) -0.075}$	$B_i = e^{0.3764*ln(Soilj) -0.4158}$
Uranium	$B_i = 0.002*(Soilj)$	$B_i = 0.063*(Soilj)$	Not Available
Vanadium	$B_i = 0.00485*(Soilj)$	$B_i = 0.042*(Soilj)$	$B_i = 0.0123*(Soilj)$

Sources:
Values for arsenic, lead, selenium, and vanadium from EPA Ecological Soil Screening Level (Eco-SSL) Table 4a, EcoSSL Attachment 4-1 (EPA 2007b)
Values for molybdenum and uranium from Sample et al., 1996b and Efroymson, 1997.

5.3.2.2 Toxicity Assessment

Once exposure is estimated with the food chain model described above, the estimated exposure is compared to a toxicity reference value (TRV). TRVs for terrestrial wildlife that could ingest soil, sediments, and evaporation pond surface water are provided in Table 5-61. Chronic NOAELs and chronic LOAELs were used as measures of effect. In addition, acute TRV values were considered for surface water COPCs exceeding an LOAEL HQ of 1.

Due to human disturbance and a lack of quality habitat and cover, evaporation pond exposure is limited in duration compared to the basis of chronic NOAEL/LOAEL TRVs. The evaporation ponds have no naturally occurring aquatic or benthic life and have no discharge point other than evaporation. They will be removed following completion of the groundwater restoration program (thereby eliminating potential exposure pathways for ecological receptors). They are fenced and access is limited. As such, the acute TRVs are considered appropriate for evaluating measures of effect.

TRVs were not available for the ROPCs, some of which carried forward in surface water and sediment. New Mexico Environment Department presents normalized dose rates that can be multiplied by the measured activity and then divided by a no effect activity for birds or mammals of 0.1 rem/d (NMED 2000). Alternatively, LANL has RESLs for various avian and mammalian species that have already accounted for the normalized internal and external dose rates due to soil, water and food ingestion (LANL 2019). The LANL No Effect ESL values (Table 5-62) were applied in this step of the risk assessment. Values for soils were applied to sediments as well, even though sediments might be less frequently contacted.

Table 5-61 Wildlife TRVs

COPC	Avian TRVs (mg/kg-day)			Mammalian TRVs (mg/kg-day)		
	NOAEL	LOAEL	Acute	NOAEL	LOAEL	Acute
Manganese	179[f]	348[f]	435 [f]--	51.5[f]	65[f]	136[f]
Molybdenum	3.50 [b]	35.3 [b]	[c]	0.26 [b]	2.60 [b]	40 [d]
Selenium	0.29 [a]	0.606 [a]	--	0.143 [a]	0.437 [a]	--
Uranium	16.00 [b]	160 [b]	1,600 [b]	3.07 [b]	6.13 [b]	118 [e]
Vanadium	0.344 [a]	1.19 [a]	--	4.16 [a]	5.92 [a]	--

-- TRV not needed as calculated LOAEL and/or NOAEL HQs were below 1 for all receptors in all media.
[a] EPA Ecological Soil Screening Level (Eco-SSL) documents (EPA 2007b).
[b] Toxicological Benchmarks for Wildlife (Sample et al., 1996a).
[c] TRV not found in literature.
[d] Acute NOAEL dose for developmental toxicity to Spraque Dawley rats, Reproductive Toxicology 49 (2014) 202-208 (Murray, et al., 2014).
[e] Acute NOAEL dose for hepatic or renal toxicity to Spraque Dawley rats, Toxicological Profile for Uranium (ATSDR, 2013).
[f] EcoSSL for Manganese (EPA 2007b) – TRV for EcoSSL and lowest bounded LOAEL for the categories growth, reproduction, and mortality. Acute avian dose is a 14 day NOAEL for chicken, number 34, Appendix 5.1. Acute mammalian dose is a 1 day NOAEL for hamster, study number 96, Appendix 6.1.

Table 5-62 Receptor-Specific RESLs for Surface Water and Sediment

Receptor	Feeding Guild	Surface Water (pCi/L)			
		Ra-228 NE ESL	Ra-228 LE ESL	Th-230 NE ESL	Th-230 LE ESL
American Kestrel	Avian insectivore/carnivore	1.0E06	1.00E07	4.2E07	4.20E08
American Robin	Avian herbivore/omnivore/ insectivore	9.9E05	9.90E06	4.2E07	4.20E08
Deer Mouse	Mammalian omnivore	1.1E07	1.10E08	7.8E08	7.80E09
Gray Fox	Mammalian carnivore	6.4E04	6.40E05	3.2E06	3.20E07
Receptor	Feeding Guild	Soil/Sediment (pCi/g)			
		Ra-226 NE ESL	Ra-226 LE ESL	U-natural NE ESL	U-natural LE ESL
American Kestrel	Avian insectivore/carnivore	6.1E01	6.1E02	1.4E04	1.4E05
American Robin	Avian herbivore/omnivore/ insectivore	8.2E00	8.2E01	1.1E03	1.1E04
Deer Mouse	Mammalian omnivore	3.8E02	3.8E03	7.4E02	1.8E03
Gray Fox	Mammalian carnivore	3.7E02	3.7E03	4.8E03	1.2E04

NE ESL – no effect ESL
LE ESL – lowest effect ESL
Source: LANL (2019). Lowest ESL value used as the NE ESL and LE ESL if animals were assigned to multiple feeding categories.

5.3.2.3 Risk Characterization

COPCs exceeding the refined screening in any media were carried forward into the BERA for receptor-specific evaluation (see Tables 5-63 through 5-69). ROPCs that exceeded the refined screening in any media are further evaluated in Tables 5-70.

A 90th percentile of the dietary ingestion rate (DIR) (Table 5-53) as estimated from the minimum and maximum DIR based on body weight was used to represent dietary intake and calculate soil and food dose. A 90th percentile water ingestion rate (WIR) (Table 5-53) estimated from the minimum and maximum body weight range was used to determine surface water exposure.

Table 5-63 Scaled Quail Risk Calculations – Soil Homestake Facility and Land Treatment Areas

COPC	Soil Homestake Facility					Soil Land Treatment Areas				
	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ
Molybdenum	0.67	0.16	1.24	0.4	--	--	--	--	--	--
Selenium	0.069	1.43	0.48	2	0.8	0.02	0.09	0.11	0.4	--
Uranium	0.26	0.0004	0.29	0.02	--	--	--	--	--	--
Vanadium	0.72	0.10	0.76	2	0.6	0.46	0.02	0.48	1	--

[a] Soil Dose = (Soil Concentration)*(90th percentile Dietary Ingestion Rate)*(Soil Fraction in Diet) (see Table 5-58)
[b] Food Dose calculated using herbivore uptake equation for plants presented in Table 5-59.
Shading indicates HQ exceeding 1.
-- Not calculated as NOAEL HQ does not exceed 1.

Table 5-64 Western Kingbird Risk Calculations – Soil Homestake Facility and Land Treatment Areas

COPC	Soil Homestake Facility					Soil Land Treatment Areas				
	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ
Molybdenum	0.84	1.76	2.6	0.7	--	--	--	--	--	--
Selenium	0.088	0.58	0.67	2	1	0.02	0.21	0.23	0.8	--
Uranium	0.33	0.23	0.58	0.04	--	--	--	--	--	--
Vanadium	0.91	0.38	1.3	4	1	0.58	0.24	0.82	2	0.7

[a] Soil Dose = (Soil Concentration)*(90th percentile Dietary Ingestion Rate)*(Soil Fraction in Diet) (see Table 5-58)
[b] Food Dose calculated using insectivore uptake equation for earthworms presented in Table 5-59.
Shading indicates HQ exceeding 1.
-- Not calculated as NOAEL HQ does not exceed 1.

Table 5-65 American Kestrel Risk Calculations – Soil Homestake Facility and Land Treatment Areas

COPC	Soil Homestake Facility					Soil Land Treatment Areas				
	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ
Molybdenum	0.10	0.04	0.14	0.04	--	--	--	--	--	--
Selenium	0.01	0.11	0.12	0.4	--	0.003	0.065	0.068	0.2	--
Uranium	0.04	No UF	0.04	0.003	--	--	--	--	--	--
Vanadium	0.11	0.05	0.16	0.5	--	0.070	0.031	0.101	0.3	--

[a] Soil Dose = (Soil Concentration)*(90[th] percentile Dietary Ingestion Rate)*(Soil Fraction in Diet) (see Table 5-58)

[b] Food Dose calculated using carnivore uptake equation for small mammals presented in Table 5-59. “No UF” indicates an uptake factor for prey is not available and dose cannot be calculated.

Shading indicates HQ exceeding 1.

-- Not calculated as NOAEL HQ does not exceed 1.

Table 5-66 Ord’s Kangaroo Rat Risk Calculations – Soil Homestake Facility and Land Treatment Areas

COPC	Soil Homestake Facility					Soil Land Treatment Areas				
	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ
Molybdenum	0.13	0.34	0.47	2	0.2	--	--	--	--	--
Selenium	0.01	0.25	0.26	2	0.6	0.004	0.05	0.06	0.4	--
Uranium	0.06	0.003	0.06	0.02	--	--	--	--	--	--
Vanadium	0.14	0.02	0.17	0.04	--	0.092	0.01	0.11	0.03	--

[a] Soil Dose = (Soil Concentration)*(90[th] percentile Dietary Ingestion Rate)*(Soil Fraction in Diet) (see Table 5-58)

[b] Food Dose calculated using herbivore uptake equation for plants presented in Table 5-59.

Shading indicates HQ exceeding 1.

-- Not calculated as NOAEL HQ does not exceed 1.

Table 5-67 Deer Mouse Risk Calculations – Soil Homestake Facility and Land Treatment Areas

COPC	Soil Homestake Facility					Soil Land Treatment Areas				
	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ
Molybdenum	0.17	1.01	1.18	5	0.5	--	--	--	--	--
Selenium	0.018	0.45	0.47	3	1	0.005	0.133	0.137	1	0.7
Uranium	0.072	0.095	0.17	0.1	--	--	--	--	--	--
Vanadium	0.182	0.17	0.36	0.1	--	0.116	0.111	0.227	0.1	--

[a] Soil Dose = (Soil Concentration)*(90th percentile Dietary Ingestion Rate)*(Soil Fraction in Diet) (see Table 5-58)
[b] Food Dose calculated using herbivore uptake equation for plants (50%) and insectivore uptake equation for earthworms (50%) presented in Table 5-59.
Shading indicates HQ exceeding 1.
-- Not calculated as NOAEL HQ does not exceed 1.

Table 5-68 Kit Fox Risk Calculations – Soil Homestake Facility and Land Treatment Areas

COPC	Soil Homestake Facility					Soil Land Treatment Areas				
	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ	Soil Dose[a] (mg/kg-d)	Food Dose[b] (mg/kg-d)	Total Dose (mg/kg-d)	NOAEL HQ	LOAEL HQ
Molybdenum	0.102	0.023	0.125	0.5	--	--	--	--	--	--
Selenium	0.011	0.070	0.081	0.6	--	0.003	0.042	0.044	0.3	--
Uranium	0.043	No UF	0.043	0.01	--	--	--	--	--	--
Vanadium	0.11	0.031	0.141	0.03	--	0.070	0.020	0.090	0.02	--

[a] Soil Dose = (Soil Concentration)*(90th percentile Dietary Ingestion Rate)*(Soil Fraction in Diet) (see Table 5-58)
[b] Food Dose calculated using carnivore uptake equation for small mammals presented in Table 5-59. “No UF” indicates an uptake factor for prey is not available and dose cannot be calculated.
Shading indicates HQ exceeding 1.
-- Not calculated as NOAEL HQ does not exceed 1.

Table 5-69 Receptor-Specific Risk Calculations – Evaporation Pond Surface Water

COPC	TRVs		EPC	HQs					
	Birds (mg/kg-d)	Mammals (mg/kg-d)	Surface Water UCL95 (mg/L)	Scaled Quail	American Robin	American Kestrel	Ord's Kangaroo Rat	Deer Mouse	Kit Fox
	NOAEL TRVs			NOAEL HQs					
Manganese	179	51.5	0.302	0.0002	0.0003	0.0002	0.0008	0.0009	0.0006
Molybdenum	3.53	0.26	864.4	26	43	33	440	500	316
Selenium	0.29	0.143	0.733	0.3	0.4	0.3	1	1	0.5
Uranium-natural	16	3.07	548.8	4	6	5	24	27	17
	LOAEL TRVs			LOAEL HQs					
Manganese	179	51.5	0.302	--	--	--	--	--	--
Molybdenum	35.3	2.6	864.4	3	4	3	44	50	32
Selenium	0.606	0.437	0.733	--	--	--	--	--	--
Uranium-natural	160	6.13	548.8	0.4	0.6	0.5	12	13	9
	Acute TRVs			Acute HQs					
Manganese	435	136	0.302						
Molybdenum	[b]	40	864.4	[b]	[b]	[b]	2	2	1
Uranium-natural	1600	118	548.8	0.04	0.1	0.05	0.6	0.7	0.4

Shading indicates HQ exceeding 1.

[a] No LOAEL TRV found in literature.

[b] No acute TRV found in literature.

Concentrations shown are on a total basis.

Table 5-70 Evaporation Pond Surface Water and Sediment Receptor-Specific Evaluation

ROPC	Surface Water UCL95 (pCi/L)	Receptor-Specific No Effect RESLs (pCi/g) American Kestrel	American Robin	Deer Mouse	Gray Fox	No Effect HQs American Kestrel	American Robin	Deer Mouse	Gray Fox
Ra-228	71.01	1000000	990000	11000000	64000	0.00007	0.0001	0.00001	0.001
Th-230	1200	42000000	42000000	780000000	3200000	0.00003	0.00003	0.000002	0.0004
ROPC	**Sediment Maximum (pCi/g)**	**Receptor-Specific No Effect RESLs (pCi/g) American Kestrel**	**American Robin**	**Deer Mouse**	**Gray Fox**	**No Effect HQs American Kestrel**	**American Robin**	**Deer Mouse**	**Gray Fox**
Ra-226	32.5	61	8.2	380	370	0.5	4	0.08	0.08
U-nat	2566	14,000	1,100	740	4800	0.2	2	3	0.5
Sum of Fractions (SUF)						0.7	6	3	0.6
ROPC	**Sediment Maximum (pCi/g)**	**Low Effect RESLs (pCi/g) American Kestrel**	**American Robin**	**Deer Mouse**	**Gray Fox**	**Low Effect HQs American Kestrel**	**American Robin**	**Deer Mouse**	**Gray Fox**
Ra-226	32.5	--	82	--	--	--	0.4	--	--
U-nat	2566	--	11,000	1,800	--	--	0.2	1	--
Sum of Fractions (SUF)							0.6	1	

ROPC RESLS from LANL 2019

Shading indicates HQ exceeding 1

5.3.2.3.1 Soil- Homestake Facility

5.3.2.3.1.1 COPCs

COPCs were evaluated for receptor-specific exposure in a food web model. As shown in Tables 5-63 through 5-69, NOAEL HQs exceed 1 for the following receptors:

- Scaled quail – selenium and vanadium
- Western kingbird – selenium and vanadium
- Kangaroo rat - molybdenum and selenium
- Deer mouse - molybdenum and selenium

As shown in Tables 5-63 through 5-69, no LOAEL HQs exceed 1. The American kestrel was selected as a surrogate for protected species (migratory birds, bald eagles) potentially passing through the area. As shown in Table 5-65, NOAEL HQs do not exceed 1 for any COPCs for the American kestrel. Based on these findings, exposure to soil at the Homestake Facility is not expected to result in unacceptable risks to terrestrial receptors.

5.3.2.3.1.2 ROPCs

No ROPCs were identified in soil following the initial screening (see Table 5-52).

5.3.2.3.2 Soil - Land Treatment Areas

5.3.2.3.2.1 COPCs

COPCs were evaluated for receptor-specific exposure in a food web model. As shown in Tables 5-63 through 5-69, NOAEL HQs exceed 1 for the following receptors:

- Western kingbird – vanadium
- Kangaroo rat - selenium
- Deer mouse - selenium

As shown in Tables 5-62 through 5-67, no LOAEL HQs exceed 1. The American kestrel was selected as a surrogate for protected species (migratory birds, bald eagles) potentially passing through the area. As shown in Table 5-65, NOAEL HQs do not exceed 1 for any COPCs for the American kestrel. Based on these findings, exposure to soil in the LTAs is not expected to result in unacceptable risks to terrestrial receptors.

5.3.2.3.2.2 ROPCs

No ROPCs were identified in soil following the initial screening (see Table 5-52).

5.3.2.3.3 Evaporation Ponds

5.3.2.3.3.1 COPCs

COPCs were evaluated for receptor-specific exposure. As shown in Table 5-69, manganese and selenium in evaporation pond surface water had HQs below 1 for all species and are not expected to result in unacceptable risks to terrestrial receptors.

As shown in Table 5-69, NOAEL HQs exceed 1 for all receptors for molybdenum and uranium. As shown in Table 5-69, LOAEL HQs exceed 1 for the following receptors.

- Scaled quail – molybdenum
- American robin –molybdenum
- American kestrel – molybdenum
- Ord's-Kangaroo rat - molybdenum, uranium
- Deer mouse – molybdenum, uranium
- Kit fox - molybdenum, uranium

As shown in Table 5-69, acute HQs exceed 1 for the following receptors.

- Ord's-Kangaroo rat - molybdenum
- Deer mouse – molybdenum

Because the acute HQ is below 1, uranium in evaporation pond surface water is not expected to result in unacceptable risks to terrestrial receptors. Additional evaluation of the uncertainties and assumptions is needed prior to making a conclusion regarding ecological effects from evaporation pond exposure to molybdenum.

5.3.2.3.3.2 ROPCs

As shown in Table 5-69, the UCL95 EPCs for Ra-226, Ra-228, and Th-230 in evaporation pond surface water are below receptor-specific no effect RESLs, and the sum of fractions is less than 1.

Table 5-69 also reports HQs for comparison to maximum sediment concentrations as EPCs, because a UCL95 could not be calculated due to low sample size. HQs are greater than 1 for the American robin (representing herbivorous, omnivorous, and insectivorous birds) for Ra-226 and uranium as represented by U-natural activity. HQs for uranium for the deer mouse also exceed 1. LANL has low effect RESLs, and all HQs based on dividing maximum concentrations by low effect RESLs were 1 or less (LANL 2019).

5.3.3 Evaluation of Uncertainties

This BERA has many sources of uncertainty that are associated with the conservative assumptions characteristic of any screening assessment.

Use of Generic ESVs/RESLs. The ESVs used in the screening evaluation are generic values developed using a variety of test species and experimental conditions that may not be representative of the receptors and Site specific environmental conditions. Therefore, application of these generic values adds uncertainty to the risk assessment because these values may not be directly relevant to environmental conditions at the Site (e.g., acclimation of ecological receptors over time to Site specific factors, differences in bioavailability of COPCs, heterogeneous soil matrices, etc.). In general, these values are developed using highly conservative assumptions and tend to incorporate significant margins of error. As such, the likelihood of adverse ecological effects could be overestimated for COPCs exceeding the ESV benchmarks.

The RESLs used to calculate HQs for ROPCs in the evaporation ponds are based on protection of aquatic life. The ERA used EPA's NAWQC to assess risk to birds and mammals even though the AWQC are not designed to protect these two receptor groups from toxicity due to ingestion of contaminated surface water. However, wildlife receptors are not expected to receive the same level of exposure via surface water ingestion compared to aquatic community-level receptor groups (e.g., algae, invertebrates, fish, larval amphibians) which are in constant direct and continuous contact with dissolved constituents. Use of the NAWQC as a screening tool was overly protective of avian and mammalian receptors that may ingest water from the ponds as a drinking water source. This conservative approach carried more analytes from the SLERA into the BERA than would have been the case if wildlife surface water ingestion criteria had been used in the analysis.

Analysis of Only Constituents with Established ESVs. Data gaps that exist in this BERA include a lack of available toxicity benchmarks for some COPCs/ROPCs. Toxicity benchmarks have been developed for the contaminants that are relatively toxic to wildlife, bioaccumulate, and are typically detected in the environment. Therefore, the COPCs/ROPCs that could not be assessed because of a data gap are less likely to pose significant risk than those for which adequate toxicity data exist.

Conservative Assumptions in Risk Calculations. Conservative assumptions regarding body weight, ingestion rates, area of use, etc. were used in the food web model. COPCs were assumed to be 100 percent available to receptors. This is a highly unlikely circumstance based on soil chemistry. Under many circumstances, both inorganic and organic compounds are chemically bound in the soil matrix and are not available for uptake by receptors.

Selection of Receptors for BERA. Receptors were selected that are likely to occur within the Site. Avian and mammalian receptors were evaluated for exposure to all media. The SLERA evaluated plants and invertebrates, but BERA did not evaluate them in any depth because the screening values are the only data for these taxa. The following evaluation helps reduce this uncertainty:

- Arsenic - Plants were the most sensitive taxa for arsenic in soils, and the ESV in the analysis was based on plants. Maximum arsenic concentrations were below the plant ESV.
- Lead - Plants and invertebrates were not the most sensitive taxa to lead by an order of magnitude or more. Lead screened out of the analysis.
- Molybdenum - Plants were the most sensitive taxa for molybdenum, and invertebrate toxicity data were lacking. Molybdenum UCL95 values in the Homestake Facility were 18 times higher than the plant ESV based on data from ORNL, but in the LTAs molybdenum did not carry forward as a COPC.
- Selenium - Plants were the most sensitive taxa for selenium, and invertebrate toxicity data were higher by about an order of magnitude. UCL95 values in the Homestake Facility were seven times higher than the plant EcoSSL used as the ESV, but in the LTAs selenium was only two times higher than the ESV.
- Uranium - Plants were the most sensitive taxa for uranium, and invertebrate toxicity data were not available. UCL95 values in the Homestake Facility were three times higher than the plant ESV from ORNL, but in the LTAs uranium did not carry forward as a COPC.
- Vanadium - Plants were the most sensitive taxa for vanadium, and invertebrate toxicity data were not available. UCL95 values in the Homestake Facility were 20 times higher than the

plant ESV from ORNL, and in the LTAs vanadium was 13 times higher than the ESV based on plants.

- Radionuclides – Plants were often the most sensitive taxa for radionuclide exposure. Radionuclides did not carry forward in soils at the Homestake Facility or LTAs. Therefore, plants have been evaluated for this stressor.

Comparison to Soil Background. With the exception of molybdenum and uranium, the Site does not appear to have elevated soil concentrations:

- Arsenic - Arsenic was at or below background in soils from the Homestake Facility and LTAs, and therefore the Site does not present an excess hazard.
- Lead - Lead was at or below background in soils from the Homestake Facility and LTAs, and therefore the Site does not present an excess hazard.
- Molybdenum – Molybdenum was above background in the Homestake Facility and LTAs.
- Selenium - Selenium was two times background in soils from the Homestake Facility, and below background in the LTAs.
- Uranium – Uranium was eight times higher than background in the Homestake Facility, but only two times higher than background in the LTAs.
- Vanadium - Vanadium was at or below background in soils from the Homestake Facility and LTAs
- Radionuclides – All the radionuclides were similar to or lower than background in the LTAs. Most of the radionuclide activities were only one to two times higher than background in the Homestake Facility, with the exception of U-natural.

Uncertainty in the Site Data. There is variability inherent in the Site data, which adds to uncertainty in the risk estimates based on the data. Soil samples collected from the Homestake Facility include a mix of samples that were collected from within areas that were remediated in 1995 and samples that were collected from areas that were not remediated in 1995. HMC sorted the soil analytical data and statically evaluated these two datasets. The evaluation concluded that datasets representing samples collected from remediated areas and samples collected outside remediated areas are not statistically unique. The Site data may also contain uncertainties due to analytical methodology, sample location, seasonal fluctuations in concentrations, or matrix interferences that produce false positives or negatives. Another uncertainty in the Site data is a lack of data for total uranium.

5.3.3.1 Conclusions

The results of the ecological risk analysis were analyzed and interpreted to determine the potential for adverse ecological effects and to determine whether or not a conclusion of no significant risk can be reached for each assessment endpoint evaluated. The ecological risk characterization summarizes the results of the risk analysis phase of work and provides interpretation of the ecological significance of the findings.

The outcome of the Step 2 screening level evaluation provided an initial identification of COPCs/ROPCs based on conservative screening level risk estimates and Step 3a refined the

COPC/ROPC selection process using more Site specific assumptions for exposure concentrations and ecological effects.

There are three possible decisions at this point in the BERA process:

- There is adequate information to conclude that ecological risks are negligible and therefore no need for remediation on the basis of ecological risk;
- The information is not adequate to make a decision at this point, and the ecological risk assessment process will continue; or
- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

Homestake Facility and Land Treatment Area Soil. As discussed in Section 5.3.8, exposure to soil is not expected to result in unacceptable risks to terrestrial wildlife receptors. Some inorganics are elevated with respect to plants, but most of this is in the Homestake Facility area where more human disturbance occurs. No additional risk evaluation is warranted and remedial decision-making on the basis of ecological risk for these two areas is not recommended.

Evaporation Ponds. Evaporation pond surface water appears to provide limited potential for ecological risk to avian receptors given low chronic LOAEL and acute HQs (see Table 5-68). There is some uncertainty associated with risk from exposure to molybdenum in surface water because acute TRVs could not be determined for avian receptors.

For mammals, NOAEL and LOAEL HQs above one for molybdenum and uranium may indicate the potential for risk when using the evaporation ponds as a source of water. However, as discussed in Section 5.3.9, the HQ calculations used very conservative assumptions (receptors were assumed to eat and drink only from the Site even though the Site provides no quality habitat) that likely overestimate actual risk.

The RESLs used to calculate HQs for ROPCs in surface water are based on protection of aquatic life. Because there is no aquatic life in the ponds, the RESLs are overly conservative for the avian and mammalian receptors at the Site. Continual observations since the start of pond operations do not indicate any adverse effects to avian or mammalian receptors. Site operation crews inspect the ponds daily for wildlife in and around them and no mortality or other indicators have been reported since operation of the first pond began in 1990. Current permit provisions require no measures for mitigation to keep wildlife away from the ponds.

Given that the evaporation ponds will be removed following completion of the groundwater restoration program (thereby eliminating potential exposure pathways for ecological receptors) and there is no indication that pond operations to date have resulted in adverse ecological effects, it is concluded that additional assessment is not warranted.

SMDP: There is adequate information to conclude that, despite some uncertainties, ecological risks are negligible overall for plant and invertebrate and vertebrate wildlife receptors that may come into contact with Site-related constituents in soil and surface water. Therefore, remediation on the basis of ecological risk is not recommended.

6 Summary and Conclusions

6.1 Summary

6.1.1 Nature and Extent of Contamination from the Homestake Facility

6.1.1.1 Groundwater

Nature and extent of impacts on the groundwater aquifers from milling operations are not limited to the Homestake Facility. Groundwater quality standards have been established for the Homestake Facility and are listed in Table 6-1.

Table 6-1 Comparison of NRC License Cleanup Level (Alluvial Aquifer) and Other Potential PRGs

Constituent	Other Potential PRGs	NRC License Cleanup Level	Basis of NRC Cleanup Level
Selenium (mg/L)	0.05[1,2]	0.32	Background
Uranium (mg/L)	0.03[1,2]	0.16	Background
Molybdenum (mg/L)	0.08[3]	0.10	40 CFR Part 192 – Standards for Control of Residual Radioactive Materials from Inactive Uranium Processing Sites
Sulfate (mg/L)	600[2]	1,500	Background
Nitrate (mg/L)	10[1,2]	12	Background
Vanadium (mg/L)	-	0.02	Analytical Detection Limit
Thorium-230 (pCi/L)	15[1]	0.3	Analytical Detection Limit
Radium-226 and Radium-228 (pCi/L)	5[1]	5	40 CFR Part 192 – Standards for Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

1. EPA Primary Maximum Contaminant Level
2. NMAC 20.6.2.3103A
3. EPA risk-based value selected in the Molycorp Inc. ROD (EPA 2010b)

Based on the comparison in Table 6-1, molybdenum is the only COPC/ROPC where other potential PRGs are more stringent than the NRC License Cleanup Levels, excluding those where the NRC License Cleanup Levels was set to background.

6.1.1.1.1 Alluvial Aquifer

Groundwater in the alluvial aquifer has been impacted by historic milling operations. Remediation of the alluvial aquifer was initiated in 1977 with significant progress to date; however, significant contamination still exists. Uranium, selenium, molybdenum, sulfate, TDS, chloride and nitrate concentrations exceed the groundwater quality standards established for the Homestake Facility. The extent of groundwater impacts from these chemicals is beyond the LTP. Thorium and Ra-

226/228 have impacted the alluvial aquifer below the LTP. Figures 3-3 through 3-26 display the extent of groundwater impacts in the alluvial aquifer.

6.1.1.1.2 Upper Chinle Aquifer

Uranium, selenium, molybdenum, vanadium, sulfate, TDS, and chloride concentrations in the Upper Chinle aquifer exceed mixing zone NRC Site Cleanup Levels below and south of the LTP. In addition, non-mixing zone NRC Site Cleanup Levels for uranium, selenium, molybdenum, sulfate, TDS, and chloride were exceeded in the Upper Chinle aquifer. Figures 3-28 through 3-40 display the extent of groundwater impacts in the Upper Chinle aquifer.

6.1.1.1.3 Middle Chinle Aquifer

In the Middle Chinle mixing zone west of the LTP, uranium, selenium, molybdenum, sulfate, TDS, and nitrate exceed NRC Site Cleanup Levels. In addition, uranium, selenium, and TDS exceed the non-mixing zone NRC Site Cleanup Levels south of the license boundaries, with uranium also exceeding mixing zone standards in this area. Figures 3-42 through 3-50 display the extent of groundwater impacts in the Middle Chinle aquifer.

6.1.1.1.4 Lower Chinle Aquifer

Uranium has impacted groundwater in the mixing zone and non-mixing zone of the Lower Chinle aquifer south of the LTP. Refer to Figures 3-52 through 3-57 for the extent of uranium above NRC Site Cleanup Levels in the Lower Chinle aquifer.

6.1.1.1.5 San Andres-Glorietta Aquifer

Uranium milling operations at the Bluewater Mill Site, which is located approximately 4 miles west north-west (directly upgradient) of the LTP released uranium to the SAG aquifer. Refer to Figure 3-60 for an isoconcentration contour map for uranium in the SAG aquifer.

Because the SAG aquifer has been used as a source of fresh water by HMC, ten SAG wells are routinely monitored by HMC. The location of these wells is shown on Figure 2-43. With no areas of direct communication within the area where the alluvial aquifer is impacted by the Homestake tailings seepage, and only very limited hydraulic communication through the Chinle shale, the SAG aquifer is not affected by Site releases (HMC 2019a).

6.1.1.2 Soil

The ROPCs identified for soils at Homestake Facility include Ra-226, Ra-228, Th-232, and U-238. Radionuclides that exceeded screening levels, produced risk in forward risk calculations, and exceeded background for the most sensitive human receptor are considered ROPCs. Table 6-2 summarizes the statistics for each of these ROPCs based on risk estimates for the default composite worker. Note that this receptor is identified as unlikely, and that the long-term worker for the DOE legacy effort would have an exposure level nearly 20 times lower as described in the uncertainty section of the risk assessment (see Section 5.2.5.3.3, page 5-82). However, the extent of the area that will be turmed over to DOE is to be determined, though the extent will likely exceed the existing NRC license boundary, similar to other Uranium Mill Tailings Radiation Control Act Title II sites.

Table 6-2 Summary of Soil ROPCs Homestake Facility (pCi/g)

ROPC	n	Minimum	Maximum	UCL95	Background UCL95
Surface Soil					
Bi-212	27	0.39	2.04	1.498	1.195
Bi-214	27	0.504	5.79	2.333	0.948
Cs-137	27	0.0105	0.151	0.0672	0.0731
K-40	27	12.9	21.2	18.1	18.35
Pa-234m	26	1.2	18.9	4.603	1.515
Pb-212	27	0.425	1.67	1.348	1.104
Pb-214	27	0.54	6.13	2.468	1.017
Ra-223	20	0.097	0.67	0.414	0.296
Ra-226	50	0.65	9.0	4.027	1.81
Ra-228	27	0.483	1.71	1.422	1.14
Th-227	8	0.047	0.227	0.174	0.13
Th-228	27	0.47	2.34	1.604	1.412
Th-230	51	0.44	7.4	2.596	1.393
Th-232	27	0.39	1.81	1.372	1.135
Th-234	20	0.28	11.2	3.260	0.703
Tl-208	27	0.138	0.527	0.434	0.357
U-natural	24	1	30	9.706	1.14
U-234	27	0.58	18.3	4.287	1.141
U-235	27	0.071	0.697	0.307	0.112
U-238	27	0.79	19	4.323	1.147
Surface and Subsurface Soil Combined*					
Ra226	25	0.04	9.9	4.348	1.81
Th230	25	0.02	2.9	2.607	1.393
U-natural	25	1	20	11.29	1.14

Notes:
* = These are the only ROPCs sampled in both surface and subsurface soil.
n = number of observations
UCL = upper confidence limit
ROC – radionuclide of concern

Based on comparison to background, surface soil concentrations of U-234, U-238 and Ra-226 are elevated. Pa-234m, Pb-214, and Ra-226 are also elevated above background. Spatially, there does not appear to be a discernable pattern to the concentrations of these constituents. Soil remediation of much of the Homestake Facility was completed in the early and mid-1990s (refer to Figure 1-5 for the extent of the remediation area). The surface soil action level for the remediation was 10.5 pCi/g of Ra-226, which is above the highest concentration detected at the Site in 2009 (ERG 2014). The current UCL95 is less than half of the action level. Other COPCs were not analyzed during the remediation that took place during the 1990s.

6.1.1.3 Air

Air particulates are continuously monitored at seven locations around the Homestake Facility (refer to Figure 3-64). The location identified as HMC-6 in Figure 3-64 represents background conditions,

and is located due west of the LTP at the westernmost side of the property boundary. Locations HMC-4 and HMC-5 are proximal to the nearest residences and are used to evaluate the equivalent radiation dose received by the public. The evaluation uses quarterly monitoring data for four radionuclides (uranium-238, uranium-234, thorium-230, and radium-226) and is published in Semiannual Environmental Monitoring Reports (HMC 2019c). The equivalent radiation dose at HMC-4 and HMC-5 from Homestake Facility emissions is estimated by subtracting the dose from background concentrations measured at HMC-6. Based on these calculations, the annual radiation dose from particulates ranged from 0.2 to 2.4 mrem over the last 4 years. Compared to the NRC limit for the public of 10 mrem/yr (refer to 10 CFR 20.1101), the equivalent radiation dose attributable to air particulates is relatively small. Particulates in air were below screening levels and are not considered a source of elevated cancer risk.

Radon in air was the major risk driver for the human health risk assessment; however, background concentrations of radon are a major contributor to radon risk estimates. The average radon concentration for 2018 at HMC-4 and HMC-5 was 0.89 and 0.84 pCi/L respectively. The average annual concentration at the background location (HMC-16) was 0.35 pCi/L. Subtracting the background concentration from the measured concentrations at HMC-4 and HMC-5 results in net radon concentrations of 0.54 and 0.49 pCi/L, respectively. Based on these concentrations, the equivalent calculated radiation dose at locations HMC-4 and HMC-5 is 41 and 37 mrem/yr respectively.

An estimate of the radiation dose from direct exposure to radiation sources at the Homestake Facility is obtained from optically stimulated luminescence (OSL) dosimeters placed at each monitoring station. The average annual dose in 2018 was calculated at HMC-4 and HMC-5 to be 130 and 131 mrem/yr, respectively. The average annual dose at the background location (HMC-16) was calculated to be 115 mrem/yr. Using a 75 percent occupancy factor, the net annual dose for HMC-4 and HMC-5 was calculated to be 15 and 16 mrem/yr for HMC-4 and HMC-5 respectively.

Total Effective Dose Equivalent (TEDE) to the nearest resident is calculated by adding net doses from inhalation of airborne particulate, from the exposure to radon, and from direct gamma radiation. The 2018 TEDE at HMC-4 was 52 mrem/yr and at HMC-5 was 50 mrem/yr. These are below the NRC limit of 100 mrem/yr (refer to 10 CFR 20.1301) for public exposure.

6.1.2 Nature and Extent of Contamination Within Land Treatment Areas

6.1.2.1 Groundwater

Impacts to the underlying aquifers resulting from irrigation using Site groundwater were evaluated for each of the LTA fields. Refer to Figure 1-2 for a plan view of the Site showing the location of the LTA fields.

Based on the chemistry of the water applied to the LTAs, uranium, selenium, and molybdenum are the COPCs for groundwater below the LTAs. Other parameters including sulfate, TDS, chloride, and nitrate are also monitored to evaluate impacts on water quality.

6.1.2.1.1 Groundwater Impacts at the 120-Acre Flood Irrigation Field

Figures 3-67 through 3-73 present groundwater COPC concentrations over time using data collected from 6 groundwater monitoring wells located within and around the 120-acre flood irrigation field. A

few concentrations appear to be increasing over time, but the data is either inconsistent, the period of increase does not reasonably coincide with the start of irrigation activities, and/or is not supported by similar increases in nearby wells. For instance, uranium concentrations appear to be increasing in Well 844; however, the increase began in 1994 (6 years prior to the start of irrigation) and there is no evidence of similar increases in other monitoring wells. Based on review of the monitoring well data collected in this field, there do not appear to be data trends that point to groundwater impact from the historical irrigation activities.

6.1.2.1.2 Groundwater Impacts at the 150-Acre Center Pivot and 24 Acre Flood Irrigation Fields

Figures 3-76 through 3-82 present groundwater COPC concentrations over time using data collected from 6 groundwater monitoring wells located within and around the 150-acre center pivot and 24 acre flood irrigation fields. Based on review of the monitoring well data collected in this field, there do not appear to be data trends that point to groundwater impact from the historical irrigation activities.

6.1.2.1.3 Groundwater Impacts at the 100-Acre Center Pivot Irrigation Field

Figures 3-85 through 3-91 present groundwater COPC concentrations over time using data collected from 6 groundwater monitoring wells located within and around the 100-acre center pivot fields. Based on review of the monitoring well data collected in this field, there do not appear to be data trends that point to groundwater impact from the historical irrigation activities.

6.1.2.2 Soil

Impacts to soil resulting from irrigation using Site groundwater were evaluated for each of the LTA fields. Soil samples have been collected from within and near the irrigation fields from 1999 through 2013. In 2017 and 2018, comprehensive soil sampling and analysis at each of the four irrigation fields was completed (Final Status Survey). The objective of the sampling and analysis program was to evaluate whether concentration of constituents of potential concern met the proposed criteria for unrestricted release from NRC Radioactive Materials License SUA-1471. Over one hundred samples were collected and analyzed for selenium, uranium and Ra-226. Based on the results, it was concluded that the criteria for unrestricted release had been met. In 2018, to confirm these results, HMC funded a study by ORISE to independently sample the four LTA fields and confirm or deny the conclusions of the previous study. This study consisted of gamma surveys as well as soil sampling and analysis. Results of the ORIS study were consistent with the Final Status Survey.

6.1.3 Human Health Risk Assessment

6.1.3.1 Human Health Risk Assessment for the Homestake Facility

An evaluation of risks to human health from environmental media Homestake Facility was conducted for the RI. Receptors were selected which conservatively represent current land uses and future land uses which are reasonably expected. Tables 6-3 and 6-4 summarize the cumulative cancer and non-cancer risks, for chemicals and radionuclides.

Table 6-3 Cancer Risks Homestake Facility

Receptor	Media	Total Cancer Risk	Inherent Background Risk[1]	Excess Risk Attributable to Site[2]
Future Composite Worker	Soil	2E-03	7E-04	8E-04
	Air	2E-02	1E-02	1E-02
	Total	**2E-02**	**1E-02**	**1E-02**
Future Construction Worker	Soil	7E-05	3E-05	4E-05
	Air	8E-04	4E-04	4E-04
	Total	**9E-04**	**4E-04**	**4E-04**
Current Trespasser	Soil	4E-05	2E-05	2E-05
	Air	1E-04	7E-05	3E-05
	Total	**1E-04**	**9E-05**	**5E-05**
Future Trespasser	Soil	4E-05	1E-05	2E-05
	Air	1E-04	7E-05	3E-05
	Total	**1E-04**	**8E-05**	**5E-05**

Notes:
1. Background risk is for background soil ingestion, dermal contact, and inhalation pathways based on background soil EPC. Air background risk is for inhalation and immersion to Rn-222. Does not include pond media exposure.
2. Excess risk is the sum of the Site surface soil pathway risks or hazards minus the background risk or hazard for that constituent. If less than zero, the value is set to zero.

Table 6-4 Non-Cancer Risks Homestake Facility

Receptor	Media	Total Non-Cancer Risk	Inherent Background Risk[1]	Excess Risk Attributable to Site[2]
Future Composite Worker	Soil	8E-02	2E-02	6E-02
	Air	NA	NA	NA
	Total	**8E-02**	**2E-02**	**6E-02**
Future Construction Worker	Soil	3E-01	6E-02	2E-01
	Air	NA	NA	NA
	Total	**3E-01**	**6E-02**	**2E-01**
Current Trespasser	Soil	1E-02	3E-03	1E-02
	Air	NA	NA	NA
	Total	**1E-02**	**3E-03**	**1E-02**
Future Trespasser	Soil	1E-02	3E-03	1E-02
	Air	NA	NA	NA
	Total	**1E-02**	**3E-03**	**1E-02**

Notes:
1. Background risk is for background soil ingestion, dermal contact, and inhalation pathways based on background soil EPC.
2. Excess risk is the sum of the Site surface soil pathway risks or hazards minus the background risk or hazard for that constituent.
NA – there are no noncancer risks for air

Risk estimates above $1x10^{-4}$ for the composite worker within the Homestake Facility were calculated for both soil and radon in air. Risks due to soil are likely overstated because the Homestake Facility will be turned over to DOE as a legacy site greatly reducing the worker exposure duration. However, the extent of the area that will be turned over to DOE is to be determined.

Risk to construction workers within the Homestake Facility is above the cancer risk management range. This is primarily due to radon in air.

Cancer risks to current and future trespassers for the Homestake Facility are within the risk management range.

Non-cancer hazard quotients associated with exposure to media from the Homestake Facility under the assumptions made in this HHRA are all below 1.

6.1.3.2 Human Health Risk Assessment Within Land Treatment Areas

An evaluation of risks to human health from environmental media at the LTAs was conducted for the RI. Receptors were selected which represent current land uses and future land uses which are reasonably expected. Tables 6-5 and 6-6 summarize the calculated cancer and non-cancer risks for the selected receptors.

Table 6-5 Cancer Risks Within Land Treatment Areas

Receptor	Media	Total Cancer Risk	Inherent Background Risk[1]	Excess Risk Attributable to Site [2]
Future Composite Worker	Soil	8E-04	7E-04	1E-04
	Air	2E-02	1E-02	1E-02
	Total	**2E-02**	**1E-02**	**1E-02**
Future Construction Worker	Soil	4E-05	3E-05	4E-06
	Air	8E-04	4E-04	4E-04
	Total	**8E-04**	**4E-04**	**4E-04**
Current and Future Trespasser	Soil	2E-05	2E-05	4E-06
	Air	1E-04	7E-05	3E-05
	Total	**1E-04**	**9E-05**	**3E-05**

Notes:

1. Background risk is for background soil ingestion, dermal contact, and inhalation pathways based on background soil EPC. Air background risk is for inhalation and immersion to Rn-222.
2. Excess risk is the sum of the Site surface soil pathway risks or hazards minus the background risk or hazard for that constituent. If less than zero, the value is set to zero.

Table 6-6 Non-Cancer Risks Within Land Treatment Areas

Receptor	Media	Total Non-Cancer Risk	Inherent Background Risk[1]	Excess Risk Attributable to Site[2]
Future Composite Worker	Soil	3E-02	2E-02	1E-02
	Air	NA	NA	NA
	Total	**3E-02**	**2E-02**	**1E-02**
Future Construction Worker	Soil	1E-01	6E-02	4E-02
	Air	NA	NA	NA
	Total	**1E-01**	**6E-02**	**4E-02**
Current and Future Trespasser	Soil	5E-03	3E-03	2E-03
	Air	NA	NA	NA
	Total	**5E-03**	**3E-03**	**2E-03**

Notes:
1. Background risk is for background soil ingestion, dermal contact, and inhalation pathways based on background soil EPC.
2. Excess risk is the sum of the Site surface soil pathway risks or hazards minus the background risk or hazard for that constituent. If less than zero, the value is set to zero.
NA – there are no noncancer risks for air

For construction workers, risk is less than $1x10^{-4}$ in soil, but above this for air. Risk is largely due to measured concentrations of radon in indoor air selected as representative of potential trench air concentrations.

There are no non-cancer hazard quotients above 1 associated with exposure to media at the LTA under the assumptions made in this HHRA.

6.1.4 EPA Human Health Risk Assessment for the Subdivisions

The EPA completed HHRA for receptors living in the subdivisions located southwest of the Homestake Facility (refer to Figure 1-2). Prior to completing the HHRA, EPA performed field investigation. Elements of the field investigation included:

- **Gamma Radiation Scanning**: Performance of a walking, gamma scan (2-3 feet per second; 15 inches above ground surface) at 90 properties in the subdivisions south of the Homestake Facility. Gamma radiation scanning was also conducted around each home up to a maximum of one-acre surface area throughout the yard. In addition, scanning occurred on approximately 250 acres of HMC property, between the evaporation ponds and the fenceline separating HMC property and residential subdivisions. EPA conducted the gamma scan on HMC property to investigate whether:
    - spraying uranium contaminated water high into the air results in contaminants being deposited in the area down gradient from the evaporation ponds, and
    - heavy rains could have resulted in contaminants being carried from the uranium mill tailing piles and evaporation ponds into adjacent residential neighborhoods.

  The conclusion from the gamma scan was "…there was no definitive pattern leading away from the evaporation ponds" (EPA 2014a).

- **Soil Sampling and Analysis**: A total of 640 soil samples were collected from private properties, at various locations on Homestake's property, and from an area south of the residential properties to evaluate background conditions. The location of the soil samples collected on HMC property and background soil sampling locations are shown on Figure 3-58.
- **Ambient and Indoor Air Sampling and Radon Analysis**: The EPA's year-long radon sampling began in September 2010 and was completed it in November 2011. Four quarters of sampling were completed in homes, both indoors and outdoors, in the five subdivisions south of the Homestake Facility, on Homestake's property and north of the large tailings pile, and in Bluewater Village, the location EPA selected to represent background. Approximately 1,500 radon samples were collected and analyzed.

Two land use exposure scenarios were evaluated by EPA:

- residential
- subsistence farming

The subsistence farmer scenario assumed duration is 40 years. Subsistence farming also assumes that 100% of the residences food is produced on the property within the subdivisions for this duration, which is extremely conservative and highly unlikely assumption, for the following reasons:

- Subsistence farming is extremely rare in the United States, especially in the arid west, where soil and climate is not conducive to growing a variety of fruits and vegetables.
- None of the properties appear large enough to support the production of the variety of fruits, vegetables, and grains assumed in the model, as well as provide 100% of the foodstuff for milk cows, beef cattle, chickens for consumption, and chickens for egg production. To support this assertion, HMC researched the size, lot sizes, and property ownership within the subdivision using the Cibola County Assessor's Office – refer to Table 6-7 (Cibola County, 2015). HMC also researched available on the acreage needed to support cows and estimates that at a minimum, 36 acres of grazing pasture would be needed to support one head of cattle (Sprinkle and Bailey 2004). When comparing this information, it is apparent that the subsistence farmer scenario is a highly unlikely and extremely conservative exposure scenario.

Table 6-7 Adjacent Subdivision Lot and Property Sizes

Subdivision Name	Subdivision Size (acres)	Number of Lots	Average Lot Size (acres)	Largest Property Size (acres)
Valley Verde Estates	122	100	1.2	1.6
Pleasant Valley	54	17	3.2	9.2
Murray Acres	132	30	4.4	17.1
Broadview Acres	68	54	1.3	4.6
Felice Acres	68	14	4.9	6.6

Included in both the residential and subsistence farmer exposure scenario is the risk to the use of groundwater for drinking water and other domestic purposes. Significantly, all homes within the subdivisions near the Homestake Facility are currently receiving domestic water from the Milan

municipal water system, with the exception of one Valle Verde residence. Costs to hookup the subdivision residential structures were funded by HMC. Based on the reality of the drinking water source for the residential properties, calculating the risks based on 100% of domestic water being derived from untreated groundwater is extremely conservative.

Table 6-8 presents RME cancer risks from radionuclides for current and future residents.

Table 6-8 RME Cancer Risks from Radionuclides: Current/Future Residents

Medium	Exposure Pathway	Radionuclides Of Primary Concern	Total Cancer Risk	Inherent Background Risk	Risk Attributable to Site
Soil	Ingestion, external, inhalation and produce consumption	Ra-226+D (external exposure)	2.4×10^{-4}	1.8×10^{-4}	6.0×10^{-5}
Air	Inhalation of Ambient Air	Rn-222 +D (inhalation)	1.8×10^{-3}	1.3×10^{-3}	5.0×10^{-4}
Total			2.0×10^{-3}	1.5×10^{-3}	5.6×10^{-4}
Goundwater[1]	Ingestion and inhalation	Rn-222+D & Ra-226 +D (inhalation) Ra-228+D (ingestion)	2.2×10^{-3}	See Note 2	See Note 2

Notes:
1. Risk is from exposure to radionuclides in well water in the event that a well is dug and used for domestic purposes sometime in the future.
2. Radionuclide background concentrations in groundwater were not determined.

Based on EPA's analysis, residential cancer risk from reasonable maximum exposure to radionuclides in soil is above EPA's cancer risk management range; however, when risk attributable to background are factored out, cancer risks from exposure to radionuclides in soils are within the cancer risk management range.

Based on EPA's analysis, residential cancer risk from reasonable maximum exposure to radionuclides in ambient (outdoor) air is above EPA's cancer risk management range. The analysis shows that most of this risk is attributable to background concentrations of radon. After factoring our background risks, the risk from reasonable maximum exposure to radionuclides in outdoor air is above the cancer risk management range.

Based on EPA's analysis, residential cancer risk from reasonable maximum exposure to radionuclides in untreated groundwater used for domestic purposes is above the cancer risk management range.

Table 6-9 presents RME cancer risks from radionuclides for current and future subsidence farmers.

Table 6-9 RME Cancer Risks From Radionuclides: Current/Future Subsistence Farmer

Medium	Exposure Pathway	Radionuclides Of Primary Concern	Total Cancer Risk	Inherent Background Risk	Risk Attributable to Site
Soil	Ingestion, external, inhalation, produce consumption, beef, milk, poultry, and egg consumption	Ra-226+D (external exposure) and Ra- 226+D, U-234 and U238 in milk	1.1×10^{-3}	8.8×10^{-4}	2.2×10^{-4}
Air	Inhalation of Ambient Air	Rn-222 +D (inhalation)	1.8×10^{-3}	1.3×10^{-3}	5.0×10^{-4}
Total			2.9×10^{-3}	2.18×10^{-3}	7.2×10^{-4}
Goundwater[1]	Ingestion and inhalation	Rn-222+D & Ra-226 +D (inhalation) Ra-228+D (ingestion)	2.2×10^{-3}	See Note 2	See Note 2

Notes:
1. Risk is from exposure to radionuclides in well water in the event that a well is dug and used for domestic purposes sometime in the future.
2. Radionuclide background concentrations in groundwater were not determined.

Based on EPA's analysis, residential cancer risk from reasonable maximum exposure to radionuclides in soil is above EPA's cancer risk management range; however, when risk attributable to background are factored out, cancer risks from exposure to radionuclides in soils are within the cancer risk management range.

Based on EPA's analysis, residential cancer risk from reasonable maximum exposure to radionuclides in ambient (outdoor) air is above EPA's cancer risk management range. The analysis shows that most of this risk is attributable to background concentrations of radon. After factoring our background risks, the risk from reasonable maximum exposure to radionuclides in outdoor air is above the cancer risk management range.

Based on EPA's analysis, residential cancer risk from reasonable maximum exposure to radionuclides in untreated groundwater used for domestic purposes is above the cancer risk management range.

6.1.5 Screening Level Ecological Risk Assessment

The results of the ecological risk analysis were analyzed and interpreted to evaluate the potential for adverse ecological effects and conclude whether or not significant risk exists for each assessment endpoint evaluated. Based on the development of an ecological CSM for the Site the following relevant potential exposure pathways were identified:

- Potential exposure of vegetation and soil invertebrates by direct contact to constituents in terrestrial habitat Homestake Facility and in the LTAs;

- Potential exposure of terrestrial avian and mammalian receptors from foraging and through uptake in the food chain to constituents in terrestrial habitat Homestake Facility and in the LTAs; and
- Potential exposure of avian and mammalian receptors by contact to constituents in the on-Site evaporation ponds (Homestake Facility).

Based on the identification of potentially complete exposure pathways, assessment endpoints and measures of effect were identified. Assessment endpoints contain an entity (e.g., avian population) and an attribute of that entity (e.g., survival rate). The following assessment endpoints and measures of effect were selected for the BERA:

Soil Assessment Endpoint 1 – Survival, growth, and reproduction of terrestrial plant and soil invertebrate communities in Homestake Facility and LTA upland habitat areas.

Soil Measure of Effect 1 – Comparison of maximum concentrations of constituents in soil-to-soil screening values derived for the protection of plants and soil invertebrates.

Soil Assessment Endpoint 2 – Survival, growth, and reproduction of terrestrial wildlife receptors within the Homestake Facility and LTA upland habitat areas.

Soil Measure of Effect 2 – Comparison of maximum concentrations of constituents in soil-to-soil screening values derived for the protection of avian and mammalian receptors exposed to soil or to dietary items bioaccumulating analytes from soil.

Evaporation Pond Assessment Endpoint 1 – Survival, growth, and reproduction of wildlife receptors that may occasionally ingest water from the evaporation ponds.

Surface Water Measure of Effect 1 – Comparison of maximum concentrations of constituents in evaporation pond surface water to screening values derived for protection of aquatic receptors.

An initial screening level evaluation (Step 2) identified COPCs/ROPCs based on conservative screening level risk estimates.

For soils Homestake Facility, soil assessment endpoint 1 (survival, growth, and reproduction of plants and soil invertebrates) and soil assessment endpoint 2 (protection of terrestrial wildlife) were evaluated and the following COPCs were identified: lead, molybdenum, selenium, uranium, and vanadium. No ROPCs were identified.

For soils within the LTAs, soil assessment endpoint 1 (survival, growth, and reproduction of plants and soil invertebrates) and soil assessment endpoint 2 (protection of terrestrial wildlife) were evaluated and the following COPCs were identified: lead, selenium, and vanadium. No ROPCs were identified.

Evaporation pond assessment endpoint 1 (survival, growth, and reproduction of wildlife that may occasionally drink water from the evaporation ponds) was evaluated and the following COPCs in surface water were identified: arsenic, molybdenum, selenium, uranium, and vanadium, radium-226, thorium-228, and thorium-230.

For this BERA, further evaluation (Step 3a) refined the COPC/ROPC selection process using more Site-specific assumptions for exposure concentrations and food web modeling.

Homestake Facility and Land Treatment Area Soil. As discussed in Section 5.3.8, exposure to soil is not expected to result in unacceptable risks to terrestrial receptors. No additional risk

evaluation is warranted and remedial decision-making on the basis of ecological risk for these two areas is not recommended.

Evaporation Ponds. Evaporation pond surface water appears to provide limited potential for ecological risk to avian receptors given low chronic LOAEL and acute HQs (see Table 5-58). There is some uncertainty associated with risk from exposure to molybdenum in surface water because acute TRVs could not be determined.

For mammals, NOAEL and LOAEL HQs above one for molybdenum and uranium may indicate the potential for risk when using the evaporation ponds as a source of water. However, as discussed in Section 5.3.9, the HQ calculations used very conservative assumptions (receptors were assumed to eat and drink only from the Site even though the Site provides no quality habitat) that likely overestimate actual risk.

The RESLs used to calculate HQs for ROPCs are based on protection of aquatic life. Because there is no aquatic life in the ponds, the RESLs are overly conservative. Continual observations since the start of pond operations do not indicate any adverse effects to avian or mammalian receptors. HMC operation crews inspect the ponds daily for wildlife in and around them and no mortality or other indicators have been reported since operation of the first pond began in 1990. Current permit provisions require no measures for mitigation to keep wildlife away from the ponds.

Given that the evaporation ponds will be removed following completion of the groundwater restoration program (thereby eliminating potential exposure pathways for ecological receptors), and there is no indication that pond operations to date have resulted in adverse ecological effects, it is concluded that additional assessment is not warranted.

SMDP: There is adequate information to conclude that, despite some uncertainties, ecological risks are negligible overall for plant and invertebrate and vertebrate wildlife receptors that may come into contact with Site-related constituents in soil and surface water. Therefore, remediation on the basis of ecological risk is not recommended.

6.2 Preliminary Remedial Action Objectives

Under the National Contingency Plan, Remedial Action Objectives (RAOs) are established to specify “contaminants and media of concern, potential exposure pathways, and remediation goals” (40 CFR §300.430(e)(2)(i)). RAOs provide a foundational consideration in the process of comparing remedial alternatives and help to focus the development and evaluation of alternatives. Preliminary RAOs are described below. RAOs typically evolve over the course of the RI/FS process and become final only when the ROD is signed. The EPA and New Mexico Environment Department are currently performing an independent reassessment of background for groundwater of the alluvial and Chinle aquifers as part of the CERCLA RI/FS Equivalency process. The outcome of this reassessment will likely result in modification of the preliminary remediation goals identified in the RAOs described below, which are based partly on background and have been established by the NRC in License SUA-1471 and NMED Groundwater Discharge Permit DP-200.

RAO1 – Protect future workers and potential downgradient receptors from ingestion of groundwater from the alluvial, Upper Chinle, Middle Chinle, and Lower Chinle aquifers containing COPCs and ROPCs above NRC Site Cleanup Levels established in NRC License SUA-1471, DP-200, and agreed upon by EPA in correspondence to NRC dated September 27, 2005.

RAO2 – Protect human receptors from inhalation of Rn-222 emissions from the Homestake Facility by limiting average radon flux from the LPT and SPT to 20 pCi/m^2s.

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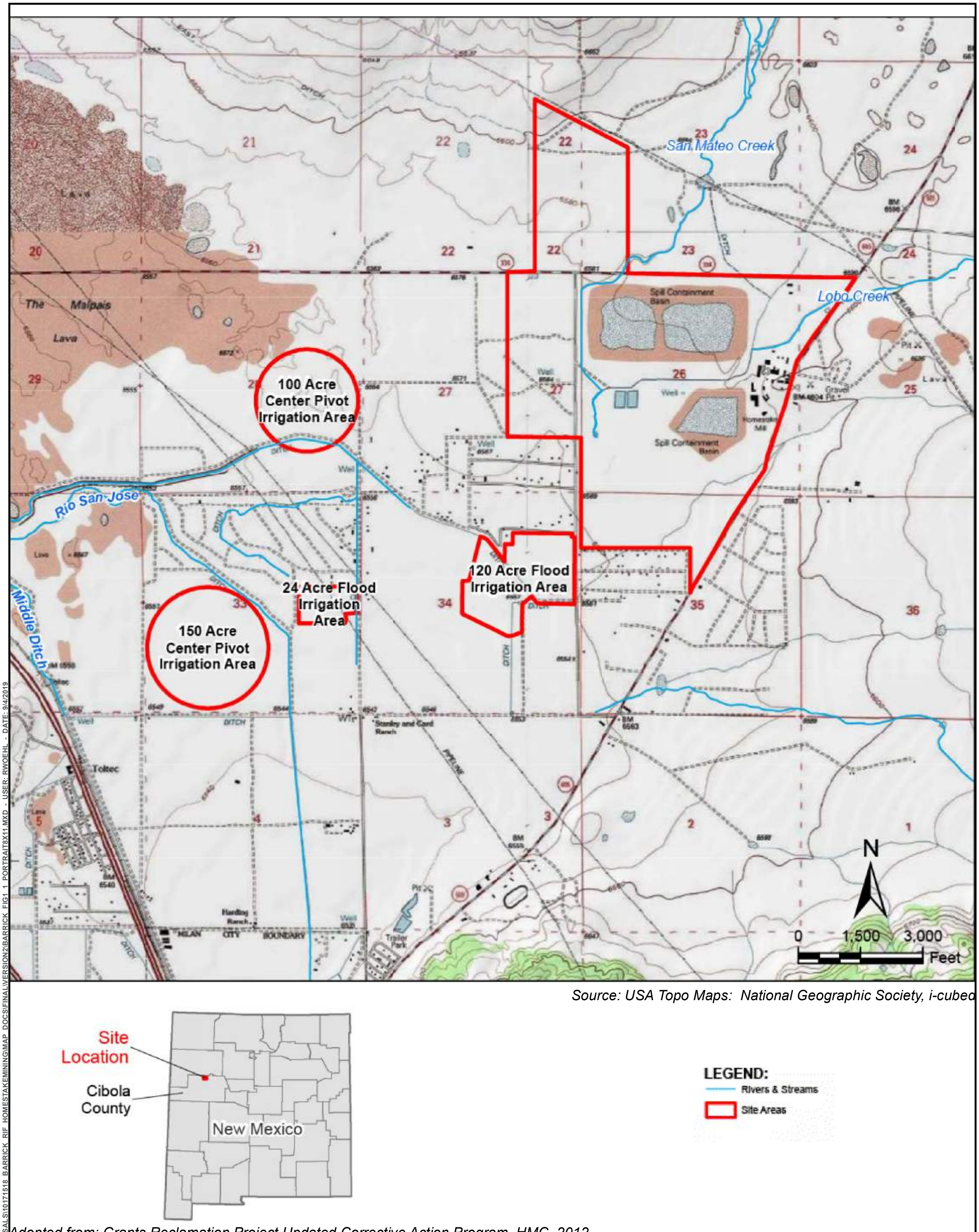
Worthington Miller Environmental, LLC (WME) 2019. Second Interim Draft Geochemical Characterization of Tailings, Alluvial Solids and Groundwater, Grants Reclamation Project. August.

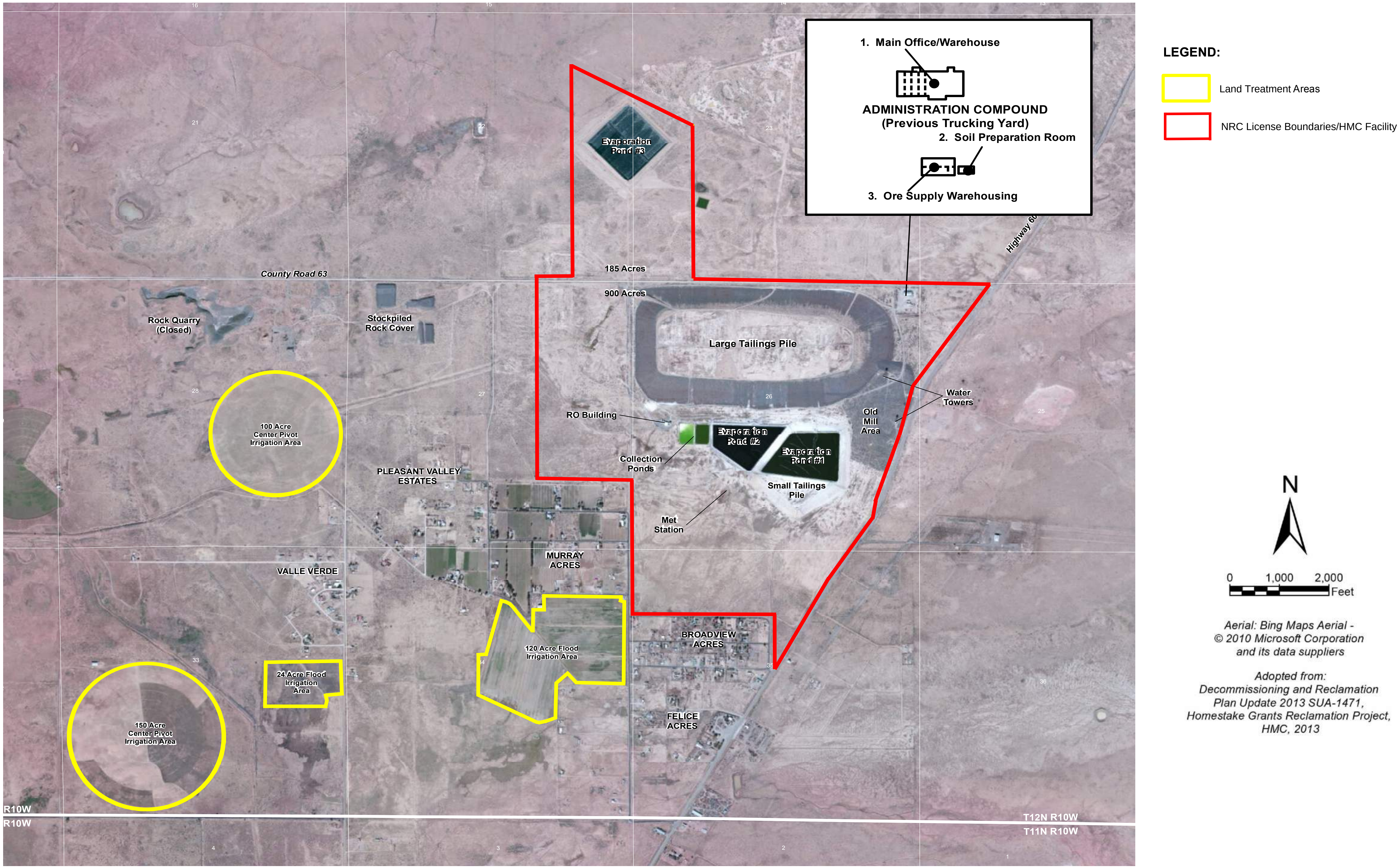


PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG1_1_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/4/2019

HOMESTAKE

SITE LOCATION MAP

FIGURE 1-1



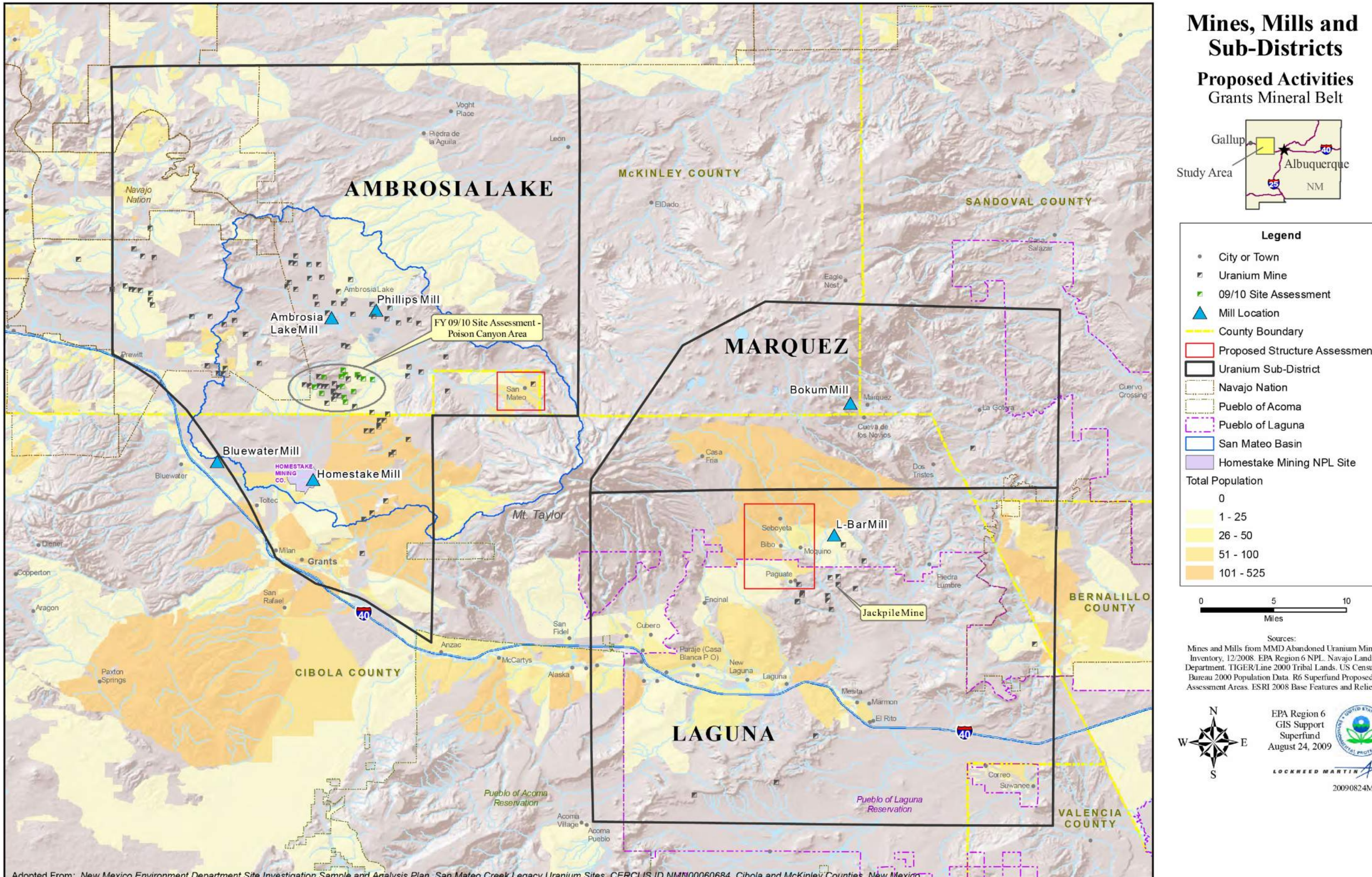
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

EXISTING SITE FEATURES

OVERVIEW MAP

FIGURE 1-2

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG1_2_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/4/2019

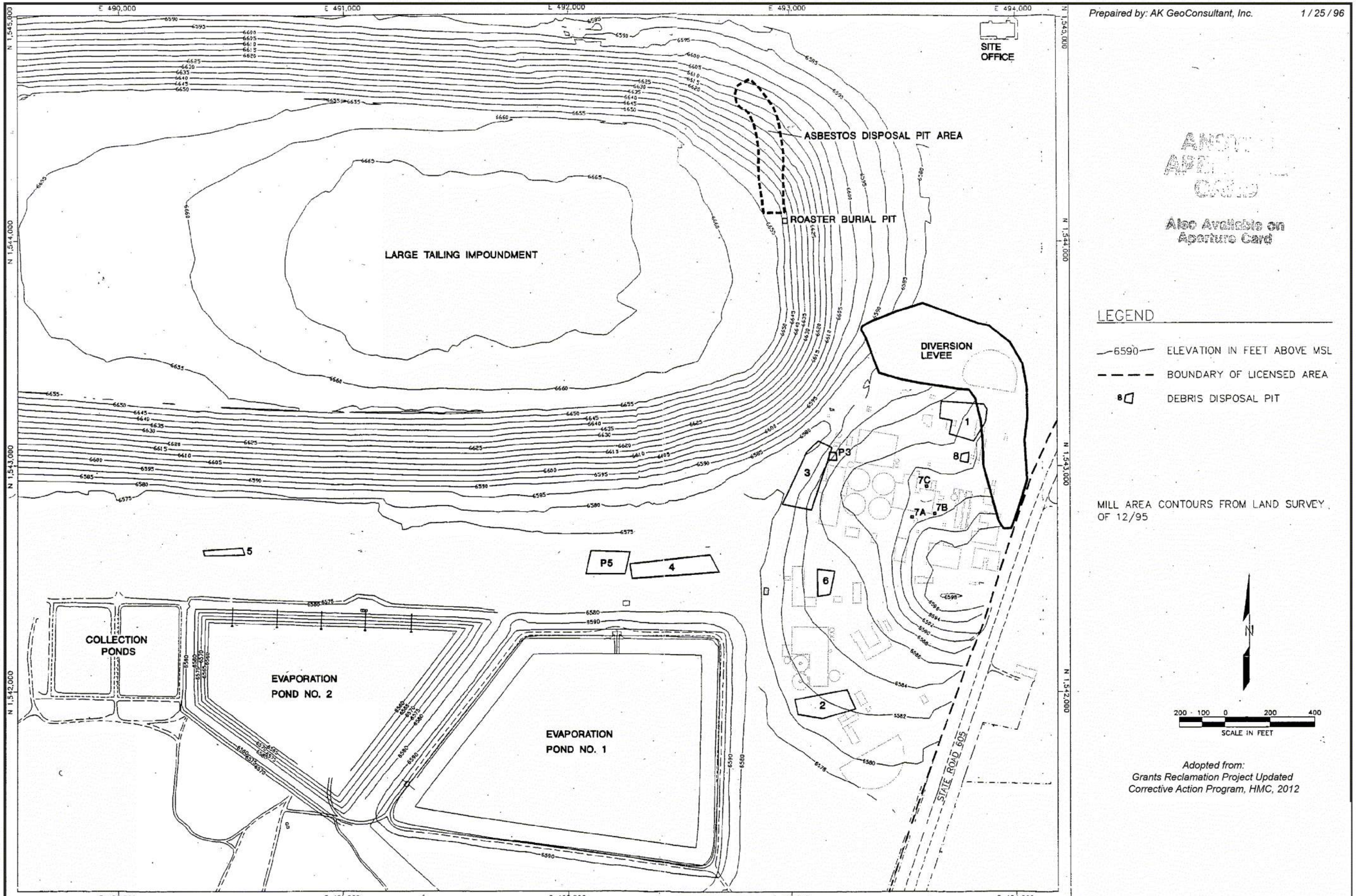


Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

GRANTS MINERAL BELT

OVERVIEW MAP

FIGURE 1-3



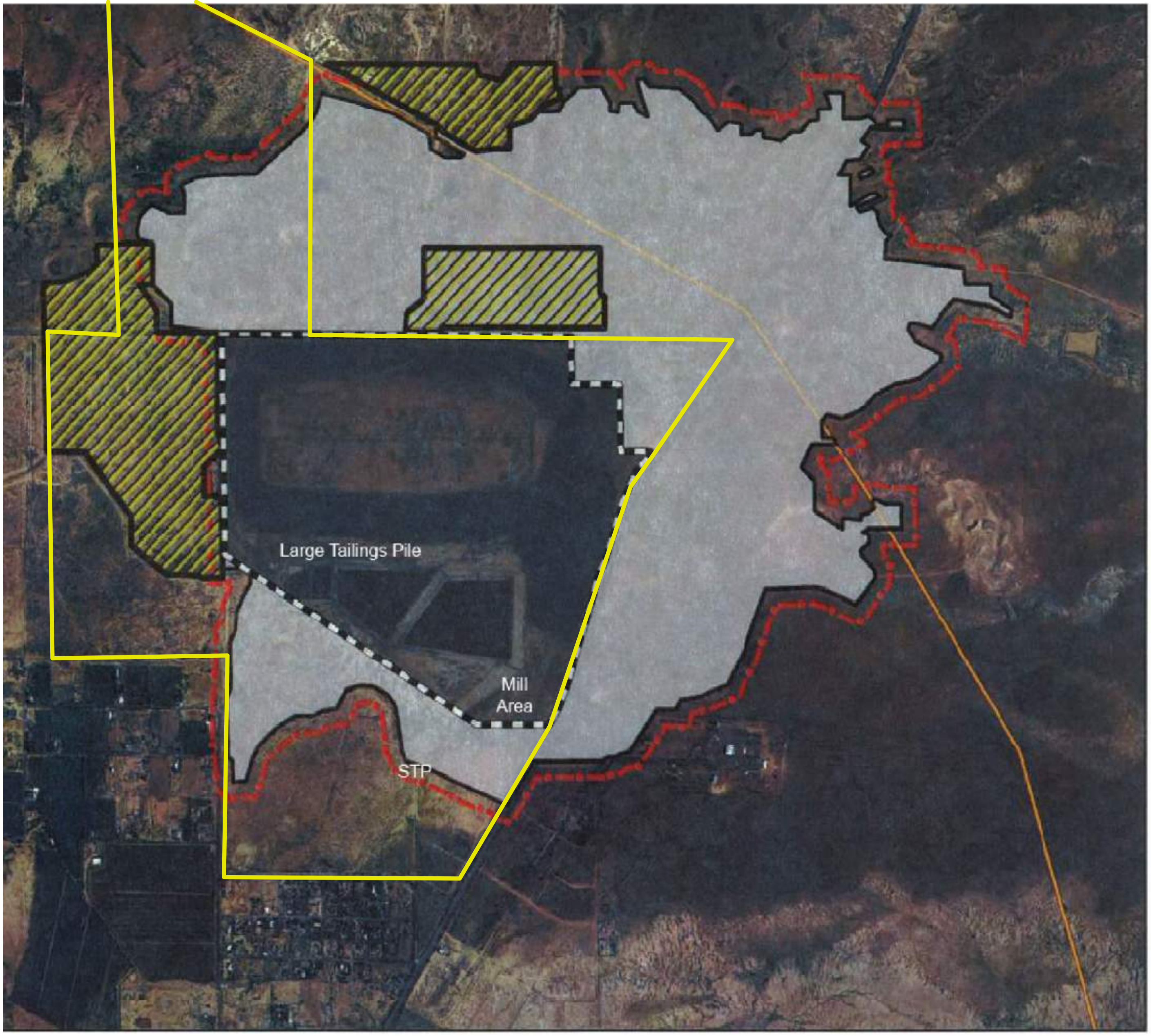
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

1995 DECOMISSIONING AS-BUILT

OVERVIEW MAP

FIGURE 1-4



Soil Excavation and Cleanup Verification Zones

- Inner Zone Remediated Area
- Outer Zone Remediated Area
- Borrow Pit
- Survey Boundary
- Transwestern Pipeline
- STP =Small Tailings Pile
- NRC License Boundary

The Inner and Outer Zones Used for Soil Verification

N

0 1,250 2,500 Feet

Prepared by:
Anderson Engineering Co., Inc.
10/20/1995 FIG 3-2.DWG

Source: ERG 1995

Adopted from:
Decommissioning and Reclamation Plan Update 2013 SUA-1471, Homestake Grants Reclamation Project, HMC, 2013

HOMESTAKE

REMEDIATION OF WINDBLOWN TAILINGS CONTAMINATION AREAS

FIGURE 1-5

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG1_5_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 12/11/2019

HOMESTAKE MINING COMPANY

LEGEND:

- County Road 63 Drainage Crossing
- Diversion Levee
- Scour Trench
- West Drainage Channel
- North Drainage Channel
- Small Tailings Pile Drainage Channel

Aerial: Bing Maps Aerial - © 2010 Microsoft Corporation and its data suppliers

Decommissioning and Reclamation Plan Update 2013 SUA-1471, Homestake Grants Reclamation Project, HMC, 2013

N

0 650 1,300 Feet

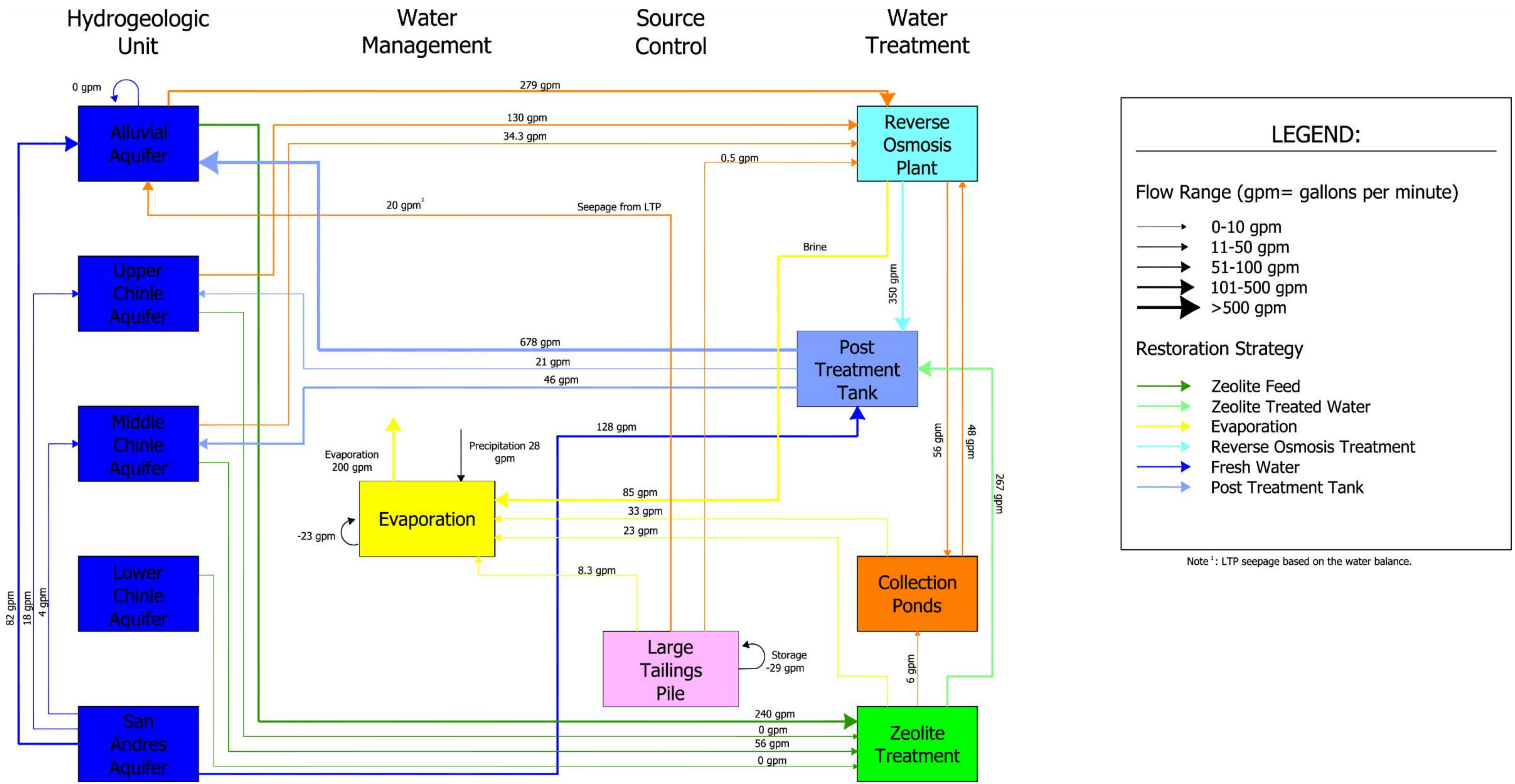
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

CONSTRUCTED SITE DRAINAGES

OVERVIEW MAP

FIGURE 1-6

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG1_6_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/4/2019



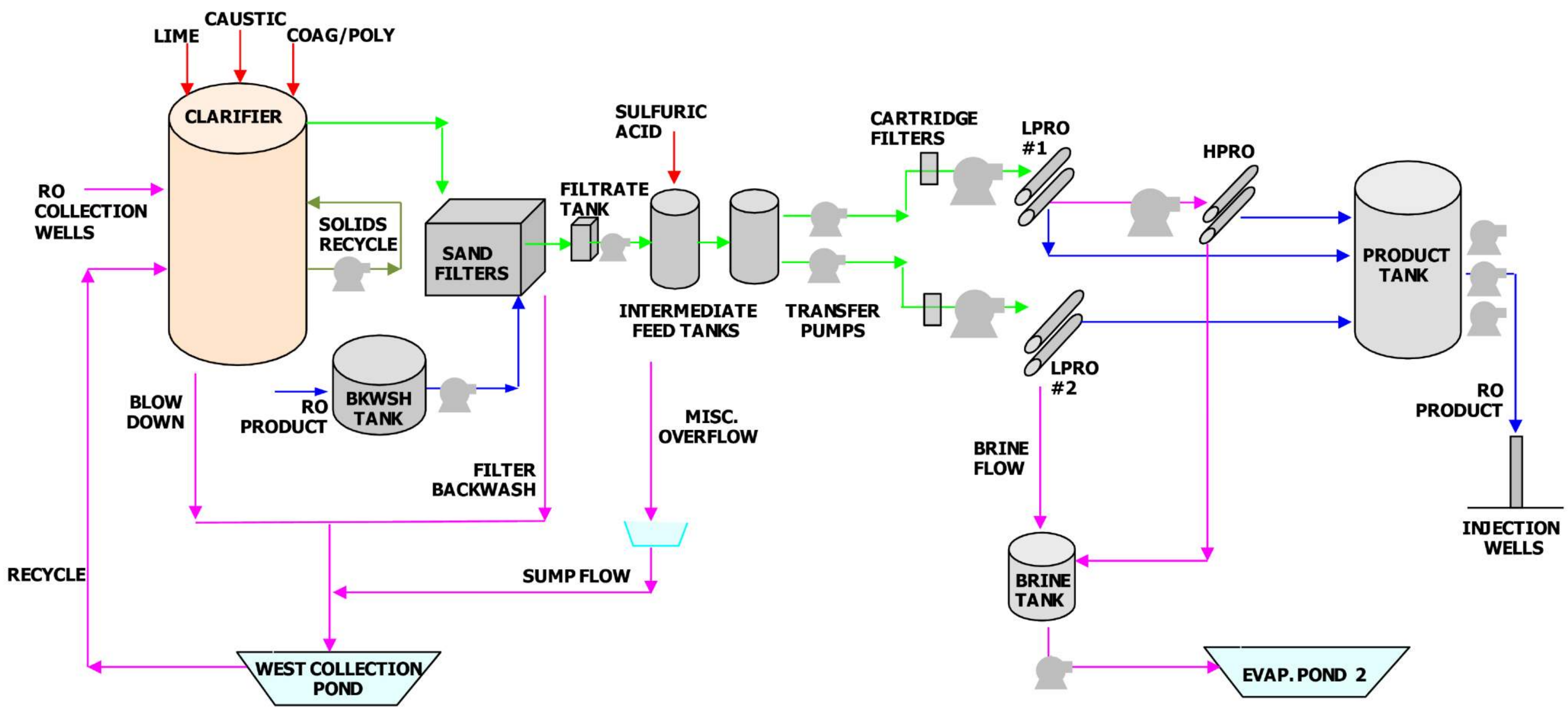
Note [1]: LTP seepage based on the water balance.

HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

2018 MAJOR OPERATIONAL FLOWS
OVERVIEW MAP
FIGURE 1-7

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG1_7_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/4/2019



NOTES:

LPRO = Low Pressure Reverse Osmosis

HPRO = High Pressure Reverse Osmosis

Adopted from:
Grants Reclamation Project Updated
Corrective Action Program, HMC, 2012

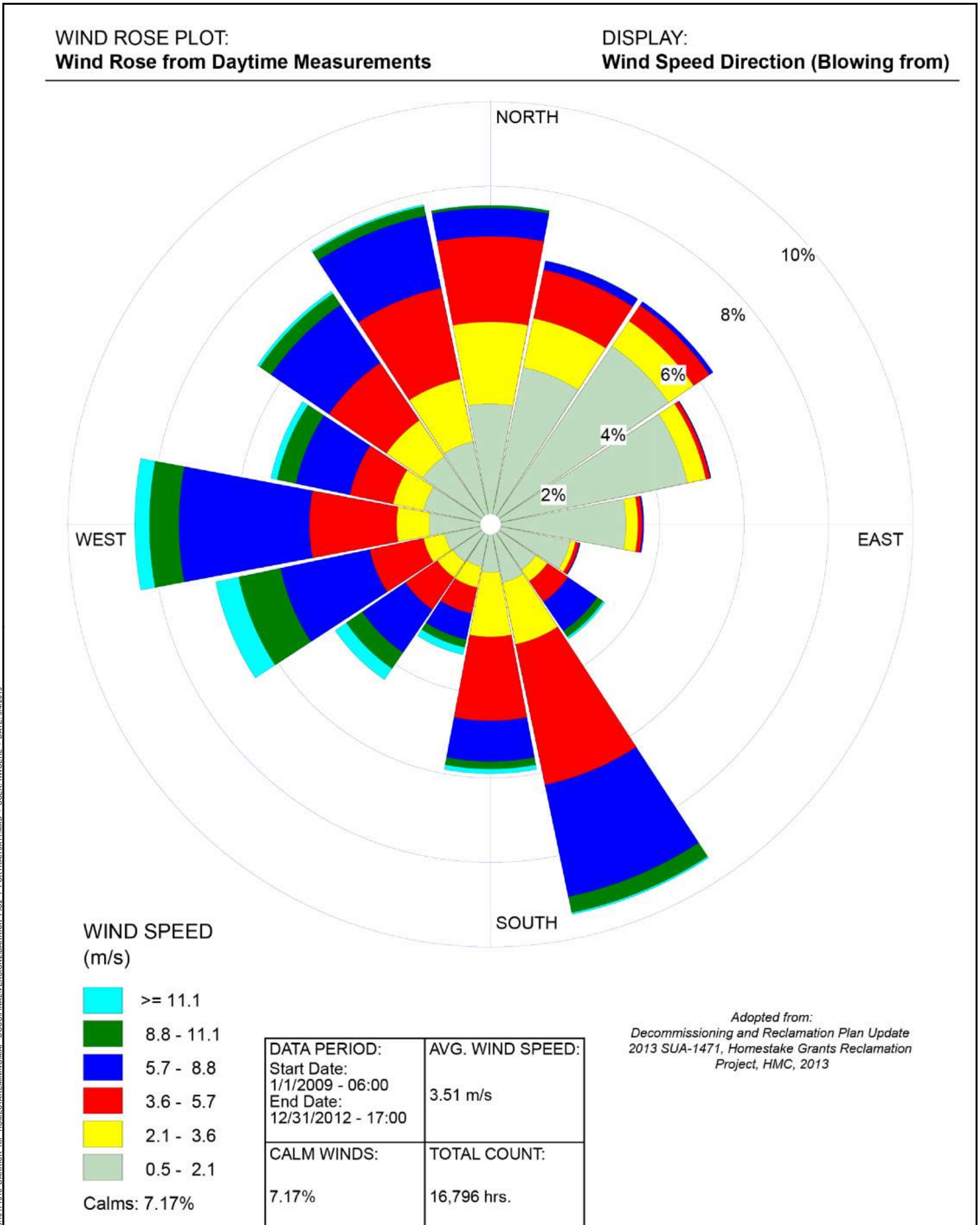
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

RO PLANT PROCESS DIAGRAM

OVERVIEW MAP

FIGURE 1-8



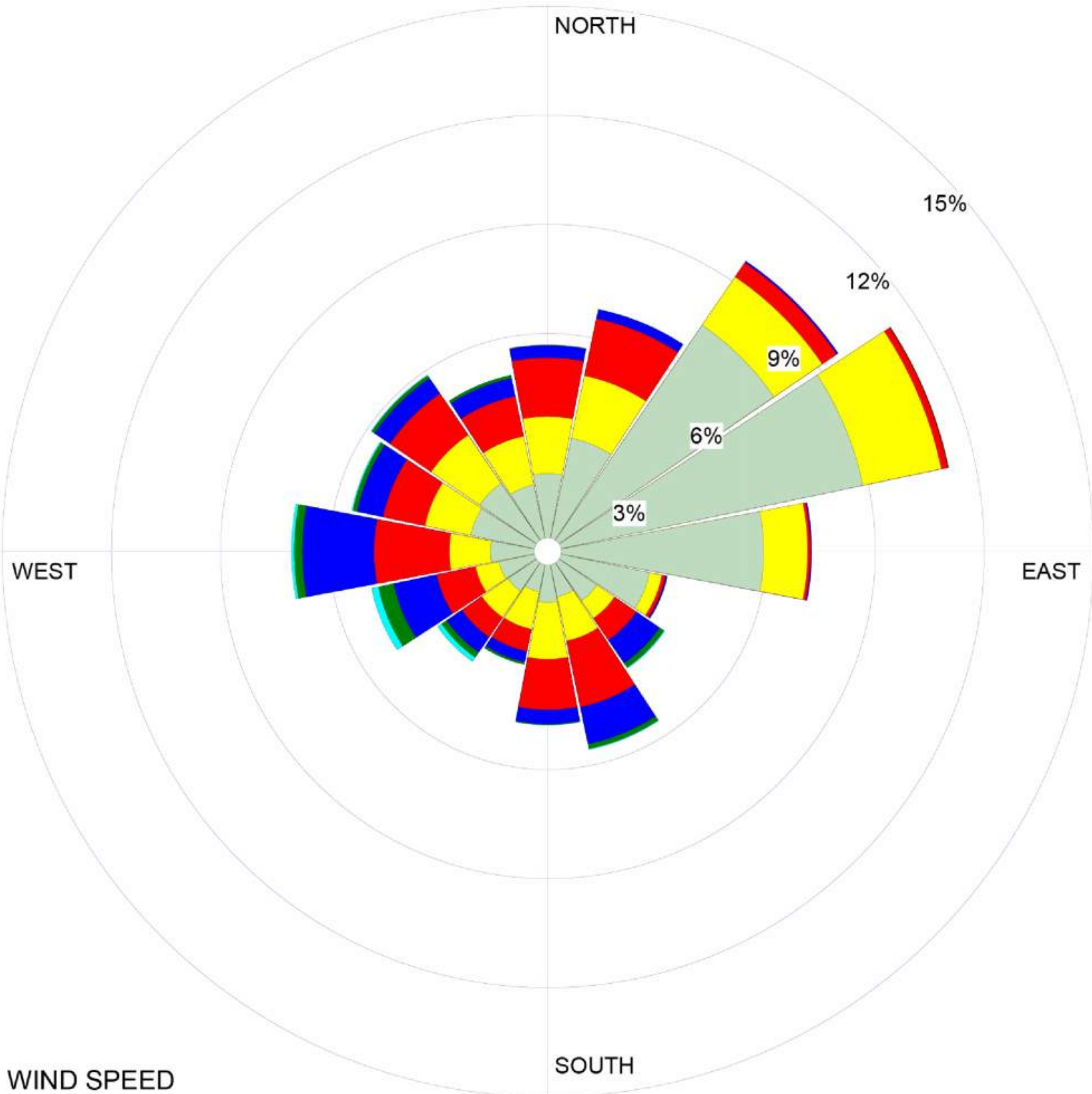
Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

DAYTIME WIND ROSE

FIGURE 2-1

WIND ROSE PLOT:
Wind Rose from Nighttime Measurements

DISPLAY:
Wind Speed Direction (Blowing from)



WIND SPEED (m/s)

- >= 11.1
- 8.8 - 11.1
- 5.7 - 8.8
- 3.6 - 5.7
- 2.1 - 3.6
- 0.5 - 2.1

Calms: 6.34%

DATA PERIOD:	AVG. WIND SPEED:
Start Date: 1/1/2009 - 00:00 End Date: 12/31/2012 - 23:00	2.62 m/s
CALM WINDS:	TOTAL COUNT:
6.34%	19,605 hrs.

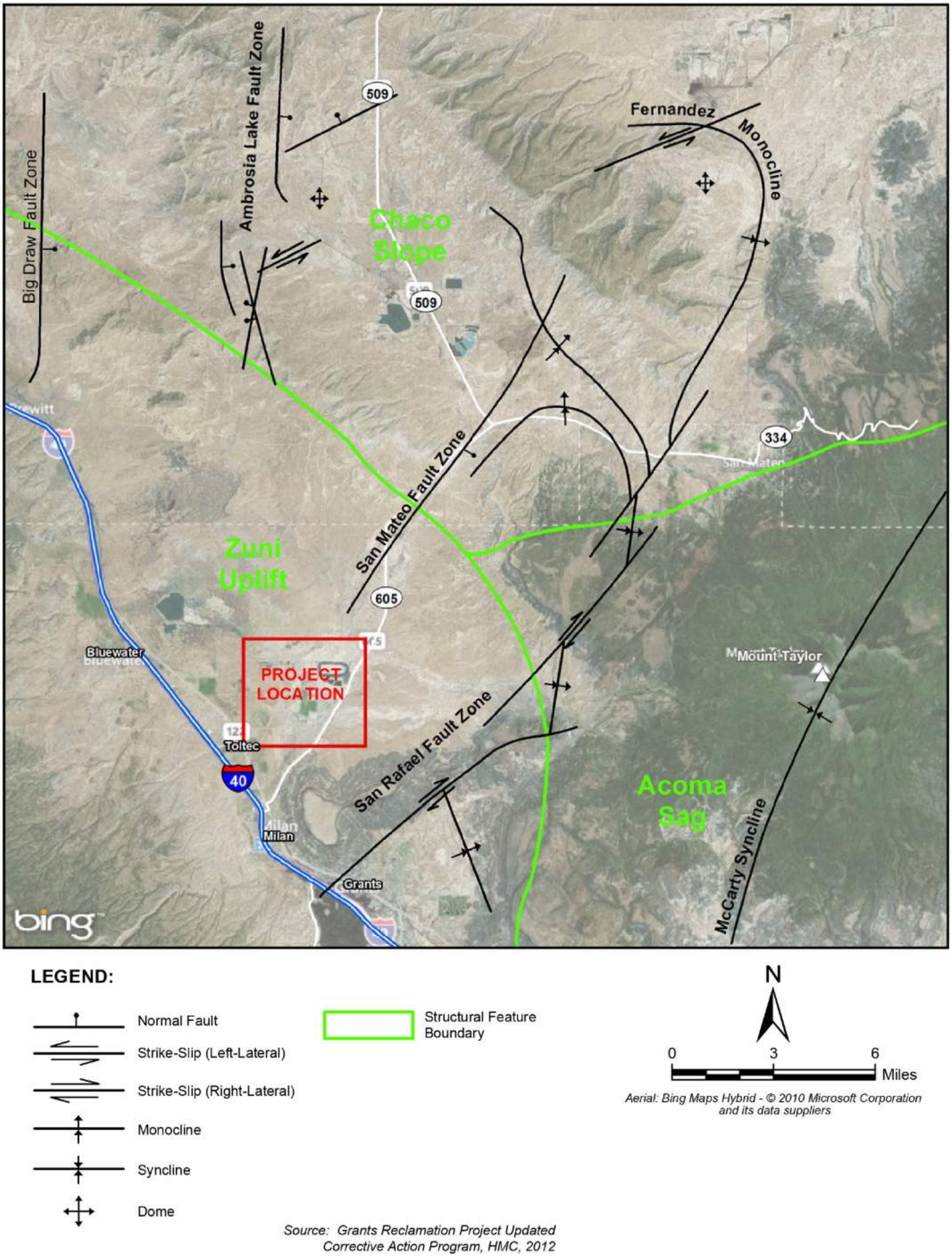
Adopted from: Decommissioning and Reclamation Plan Update 2013 SUA-1471, Homestake Grants Reclamation Project, HMC, 2013

Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

HOMESTAKE

NIGHTTIME WIND ROSE

FIGURE 2-2

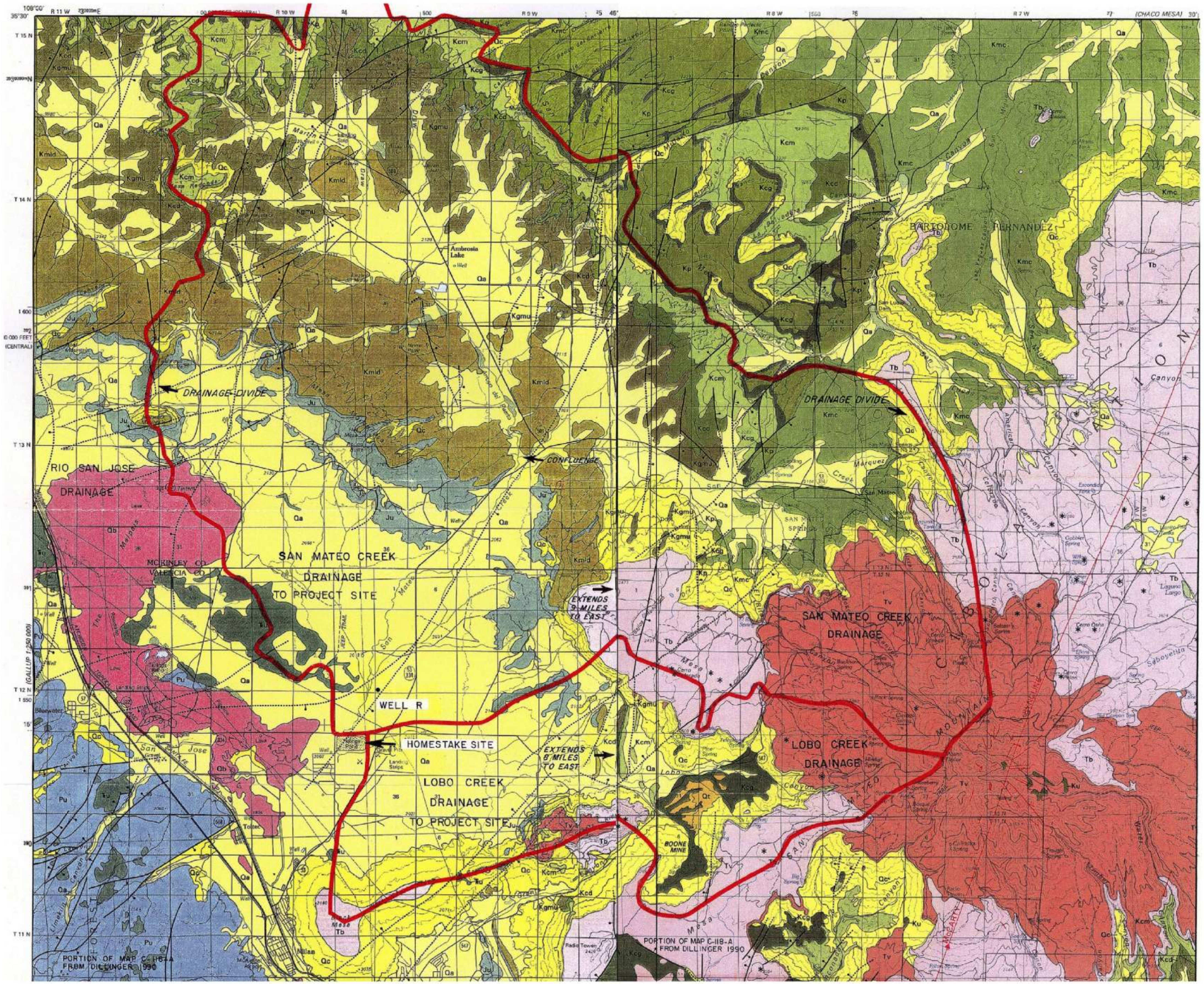


Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

REGIONAL STRUCTURAL FEATURES

FIGURE 2-3

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2_3_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/4/2019



LEGENDS: Correlation of Map Units

Unit	Symbols	Epoch	Period
Alluvium Colluvium and Terrace Gravel	Qa, Qc, Qt	Holocene and Pleistocene	QUATERNARY
Basalt Flows	Qb, QTb		QUATERNARY OR TERTIARY
Basalt Flows	Tb, Tv	Pliocene	TERTIARY
Santa Fe Formation	Ts	Pliocene and Miocene	TERTIARY
UNCONFORMITY			
Cleary Coal Member and Gibson Coal Member	Kmfc, Kmc, Kp, Kcg, Ku	Upper Cretaceous	CRETACEOUS
Dilco Coal Member	Kcm, Kcd	Upper Cretaceous	CRETACEOUS
Gallup Sandstone	Kg, Kgmu	Upper Cretaceous	CRETACEOUS
Mancos Shale	Kmdu, Kmkl	Upper Cretaceous	CRETACEOUS
Dakota Sandstone	Kdm	Upper Cretaceous	CRETACEOUS
UNCONFORMITY			
Morrison Formation, Eolian Sandstone, Wanakah Formation, Entrada Sandstone	Ju		JURASSIC
UNCONFORMITY			
Chinle Formation, Moenkopi Formation	Ћu		TRIASSIC
UNCONFORMITY			
San Andres Limestone, Glorieta Sandstone, Yeso Formation, Abo Formation	Pu	Lower Permian	PERMIAN
UNCONFORMITY			
Precambrian Granite	pCg		PRECAMBRIAN

Source:
Dillinger, J.K., 1990, Geologic map of the Grants 30' x 60' quadrangle, west-central New Mexico: U.S. Geological Survey, Coal Investigation Map C-118-A, scale 1:100,000.

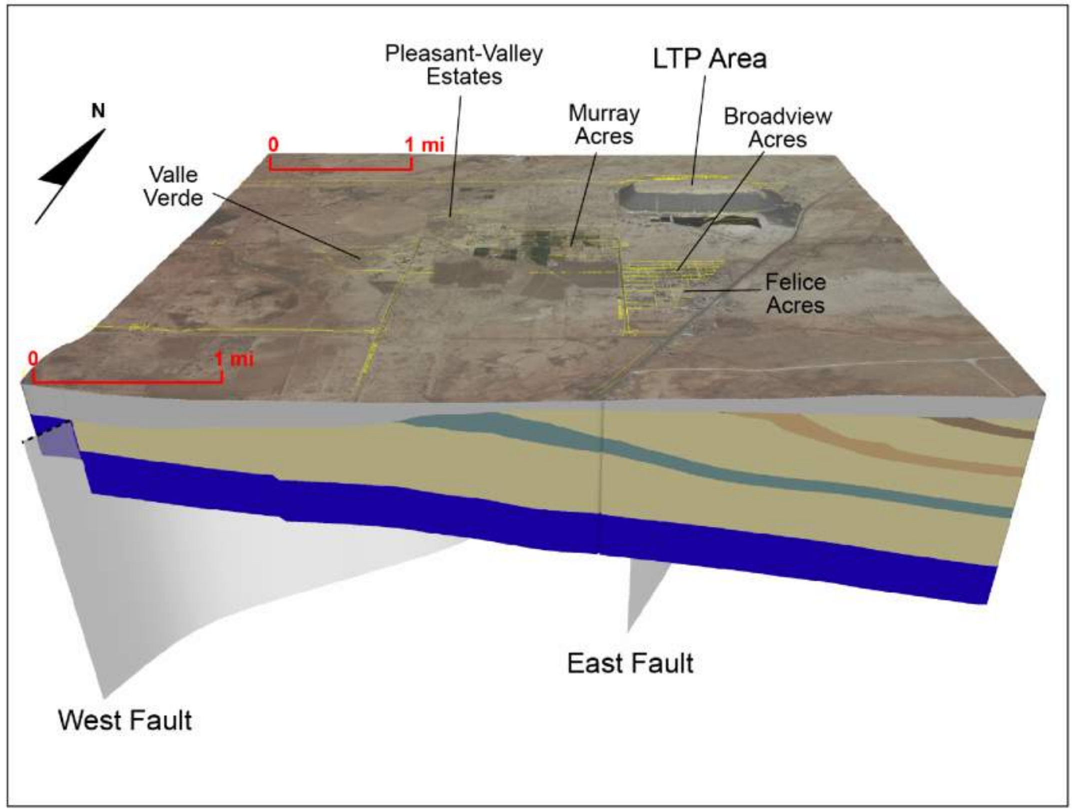
Adopted from:
Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

HOMESTAKE

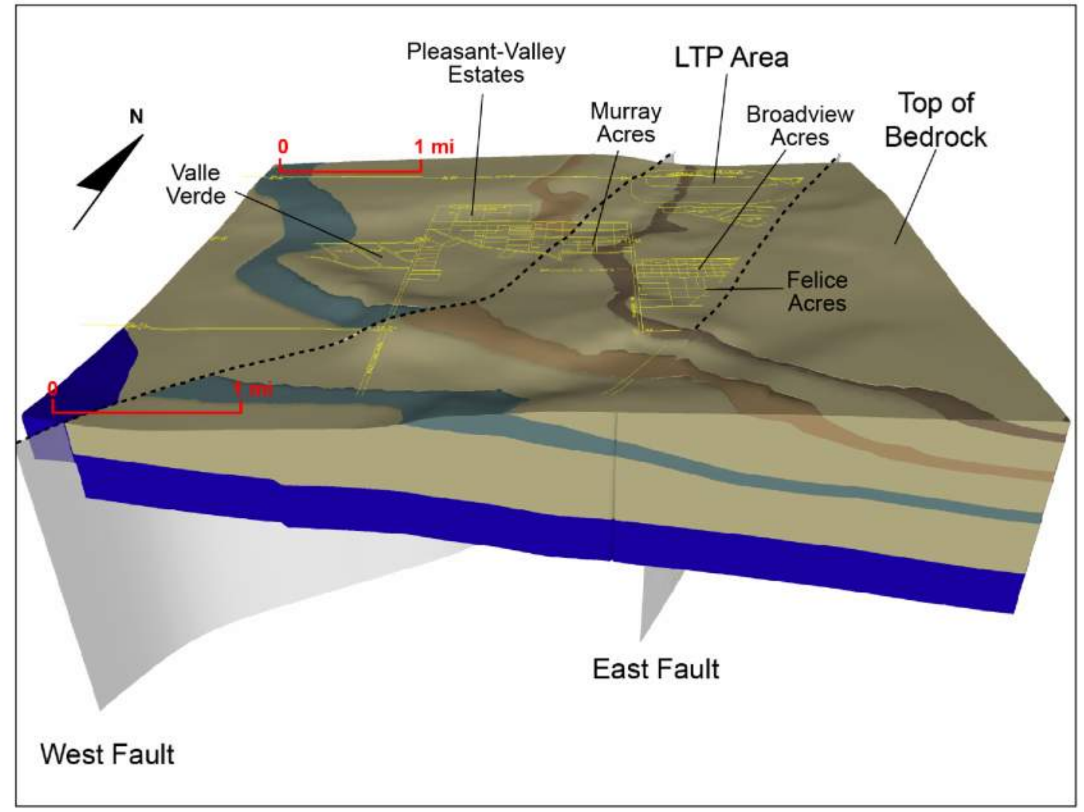
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

BEDROCK GEOLOGY
OVERVIEW MAP
FIGURE 2-4

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2_4_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/4/2019



1. ALLUVIUM AND BEDROCK BLOCK MODEL – FACING NORTH

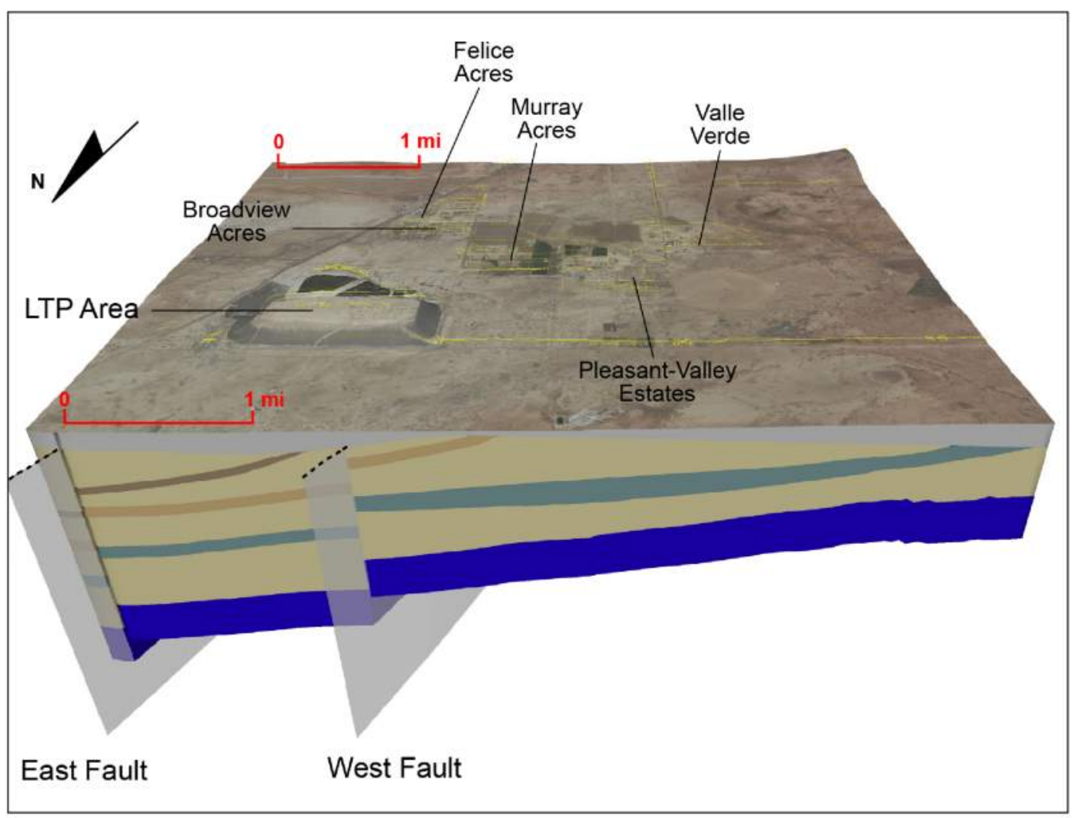


2. BEDROCK BLOCK MODEL DEPICTING CHINLE AND SAN ANDRES-GLORIETTA AQUIFER SUBCROP LOCATIONS – FACING NORTH

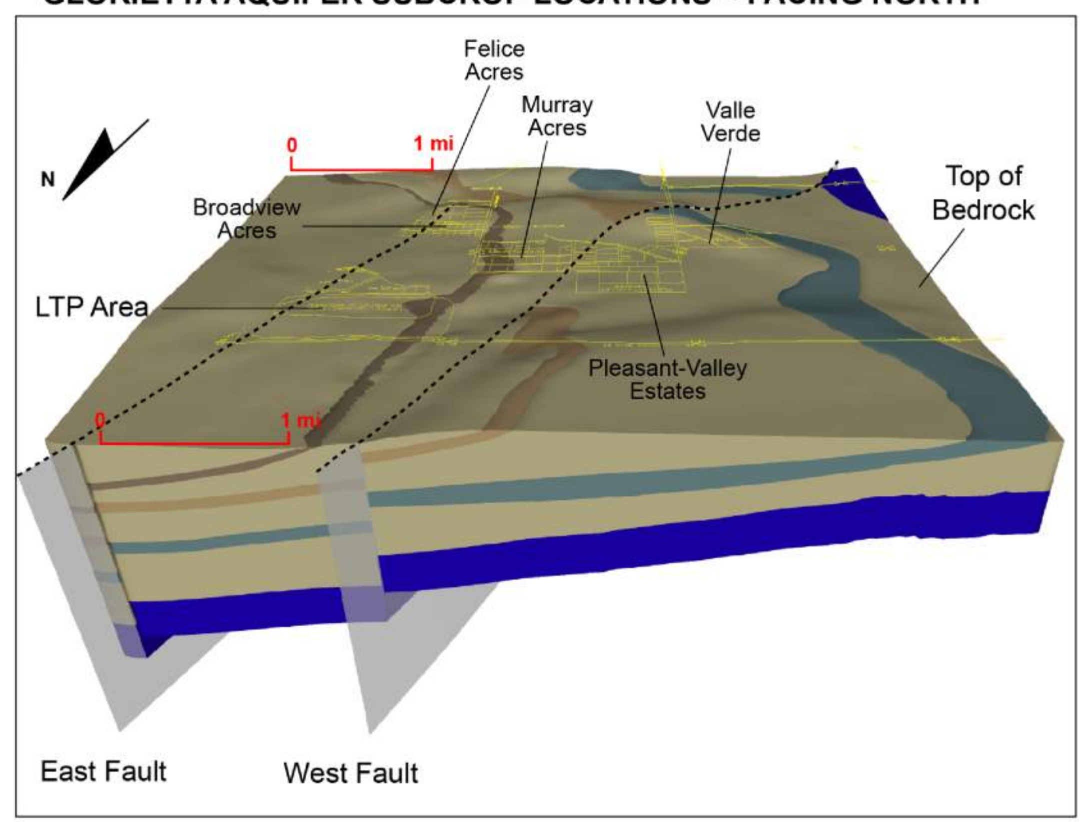
LEGENDS:

BEDROCK HYDROSTRATIGRAPHY

- ALLUVIUM
- CHINLE SHALE
- UPPER CHINLE AQUIFER
- CHINLE SHALE
- MIDDLE CHINLE AQUIFER
- CHINLE SHALE
- LOWER CHINLE AQUIFER
- CHINLE SHALE
- SAN ANDRES-GLORIETTA AQUIFER



3. ALLUVIUM AND BEDROCK BLOCK MODEL – FACING SOUTH



4. BEDROCK BLOCK MODEL DEPICTING CHINLE AND SAN ANDRES-GLORIETTA AQUIFER SUBCROP LOCATIONS – FACING SOUTH

NOTES:

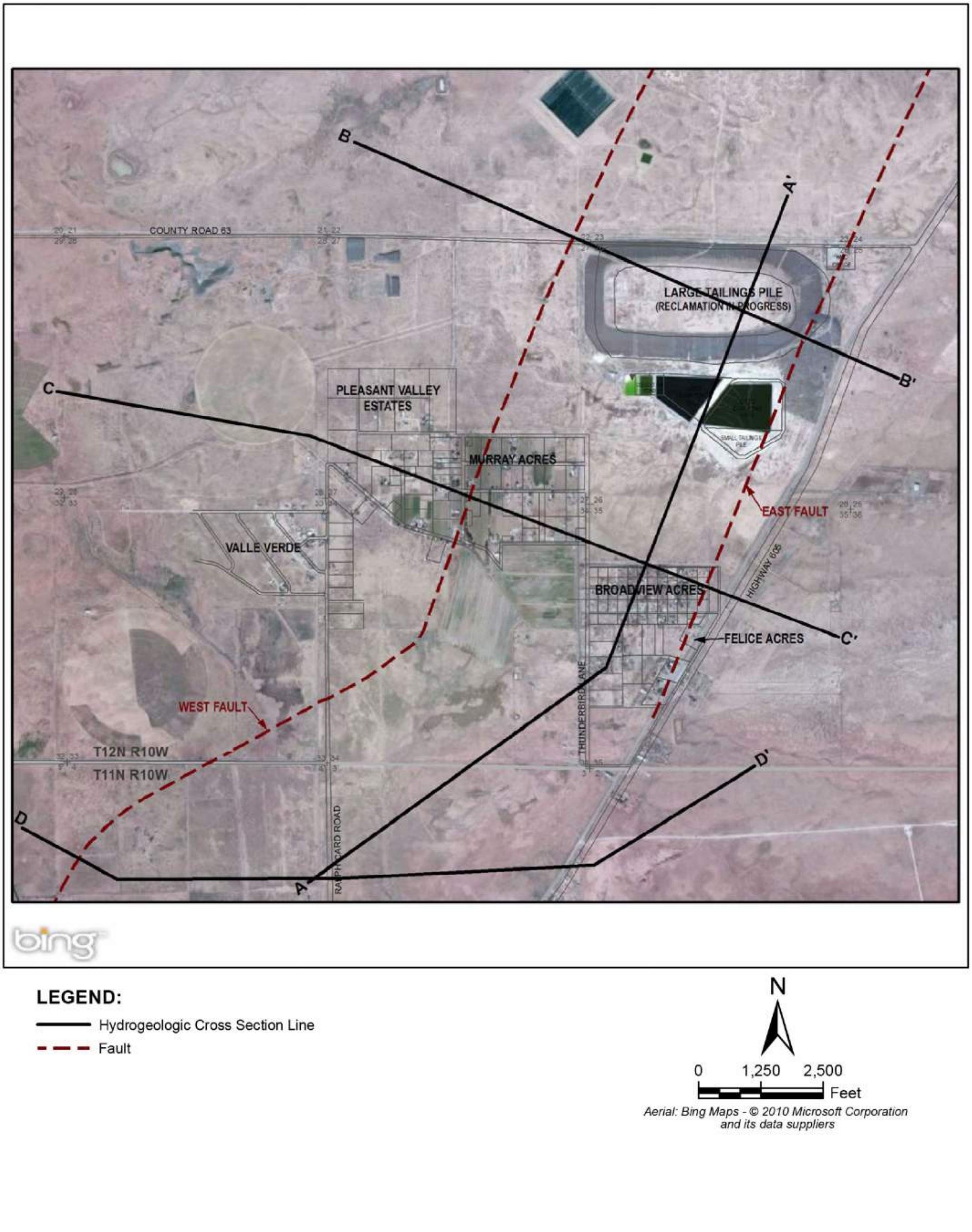
1. 3D model output depicted at 5x vertical exaggeration.

Adopted from:
Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

3D HYDROGEOLOGY
OVERVIEW MAP
FIGURE 2-5



Aerial: Bing Maps - © 2010 Microsoft Corporation and its data suppliers

Source: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

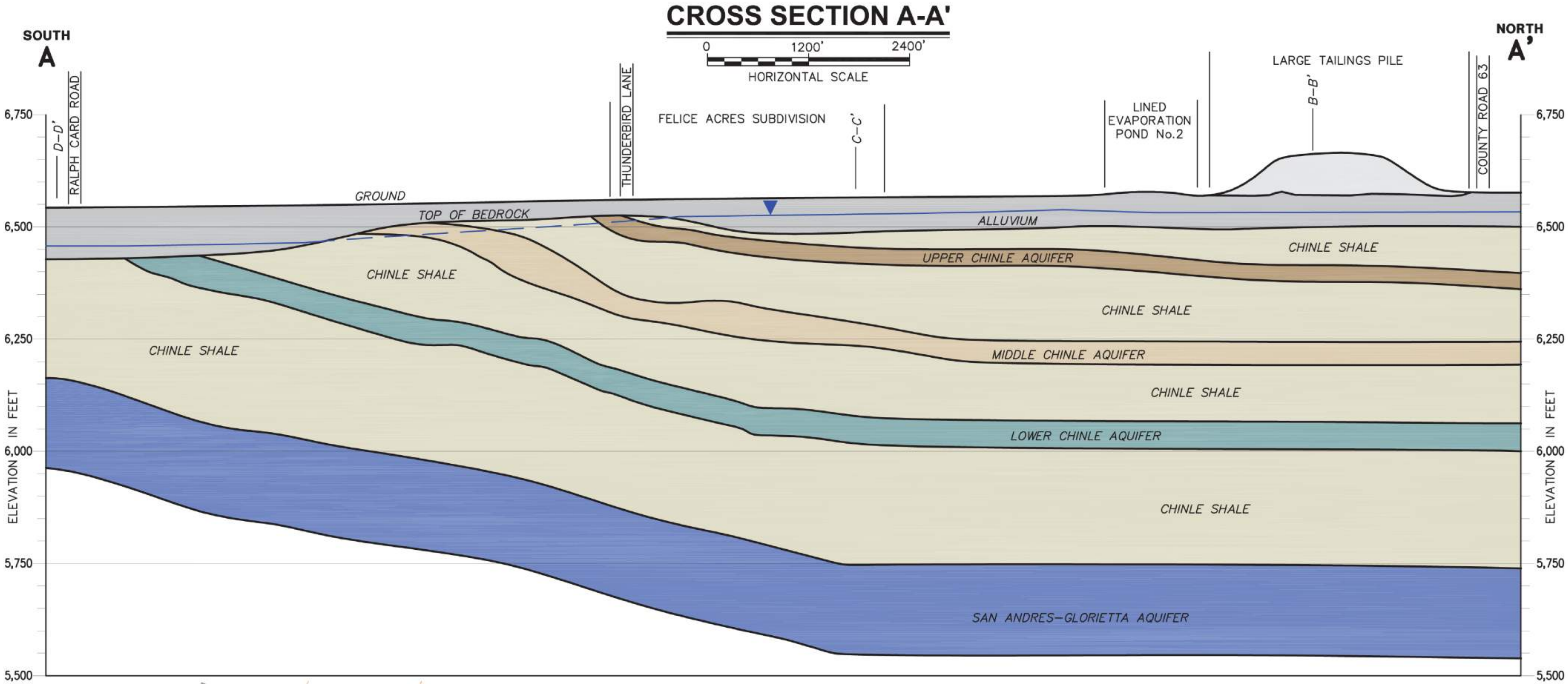
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2_6_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/4/2019

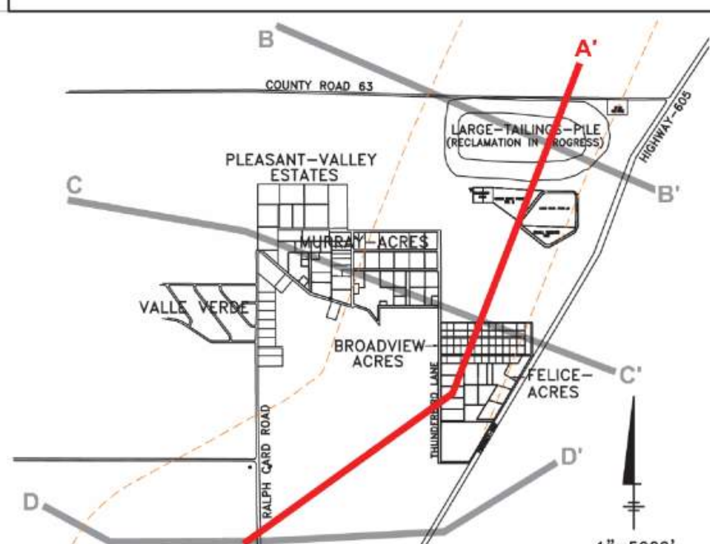
HOMESTAKE

HYDROGEOLOGIC CROSS SECTION

LOCATION MAP

FIGURE 2-6





LOCATION MAP

NOTE:

1. THREE–DIMENSIONAL MODEL OUTPUT DEPICTED AT 5X VERTICAL EXAGGERATION.

LEGEND:

- LARGE TAILINGS PILE
- ALLUVIUM
- CHINLE SHALE
- UPPER CHINLE AQUIFER
- MIDDLE CHINLE AQUIFER
- LOWER CHINLE AQUIFER
- SAN ANDRES–GLORIETTA AQUIFER
- WATER TABLE

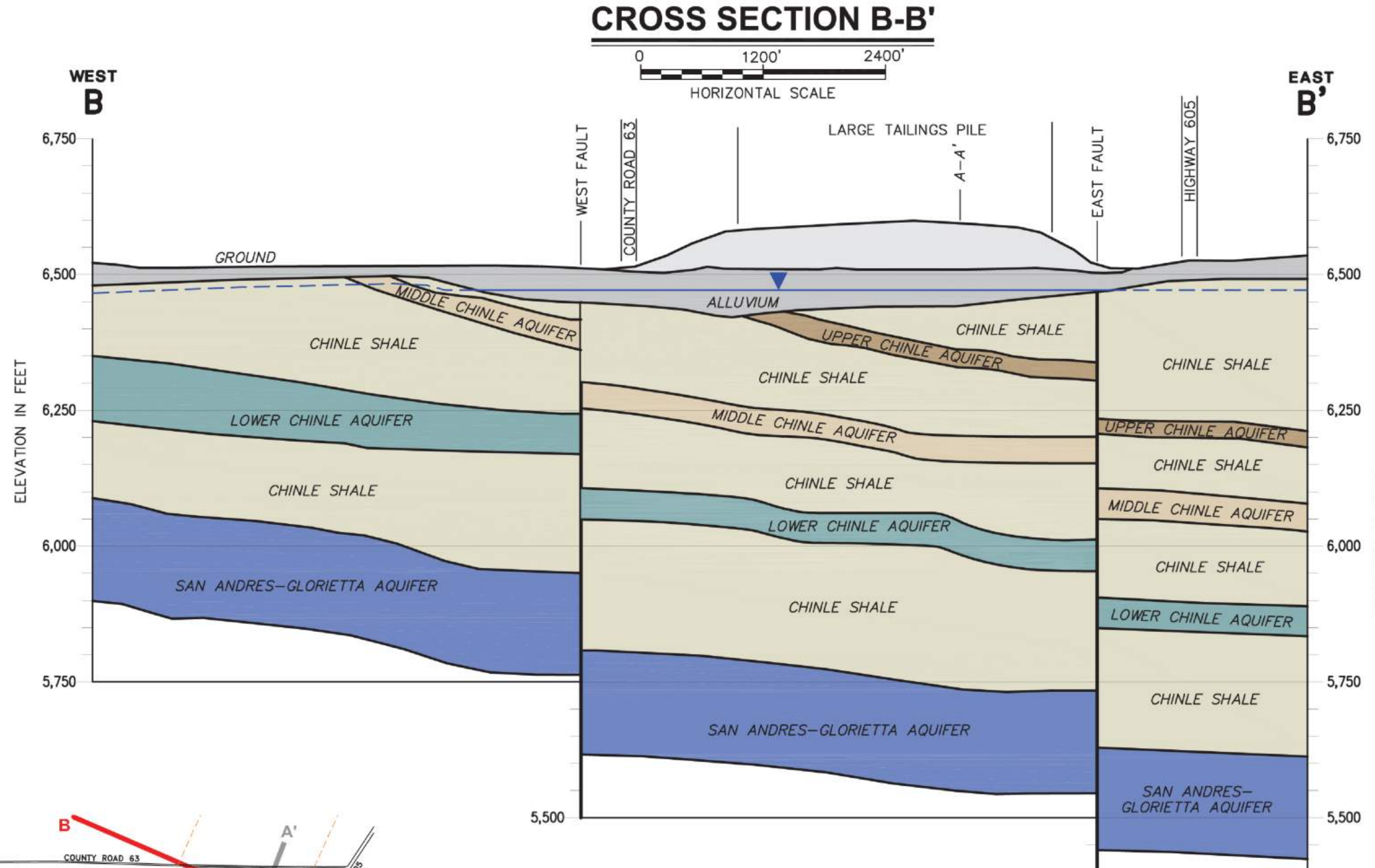
Adopted from:
Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

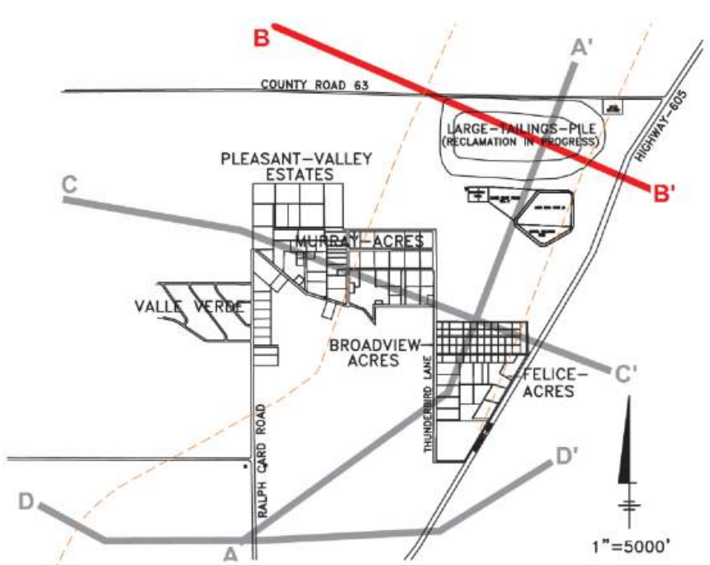
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

HOMESTAKE

HYDROGEOLOGICAL CROSS SECTION A-A'

FIGURE 2-7





LOCATION MAP

NOTE:

1. THREE-DIMENSIONAL MODEL OUTPUT DEPICTED AT 5X VERTICAL EXAGGERATION.

LEGEND:

- LARGE TAILINGS PILE
- ALLUVIUM
- CHINLE SHALE
- UPPER CHINLE AQUIFER
- MIDDLE CHINLE AQUIFER
- LOWER CHINLE AQUIFER
- SAN ANDRES–GLORIETTA AQUIFER
- WATER TABLE

Adopted from:
Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

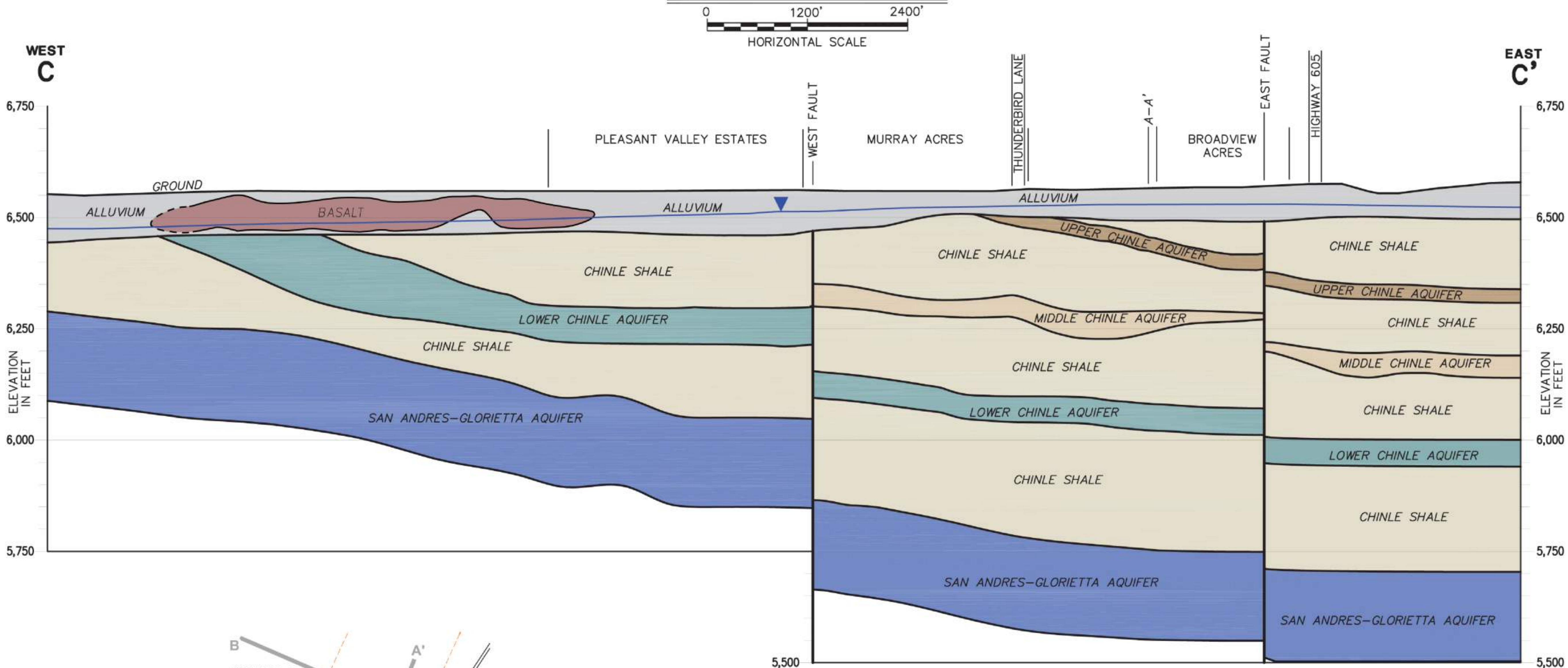
HOMESTAKE

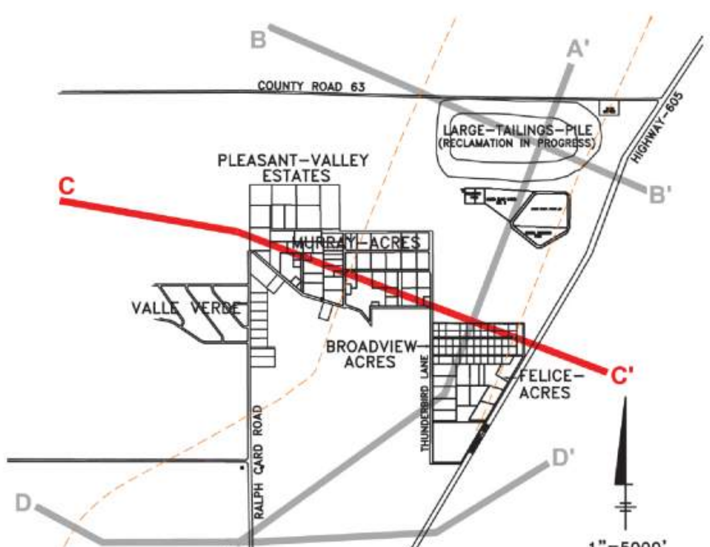
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

HYDROGEOLOGICAL CROSS SECTION B-B'

FIGURE 2-8

CROSS SECTION C-C'





LOCATION MAP

NOTES:

1. THREE-DIMENSIONAL MODEL OUTPUT DEPICTED AT 5X VERITICAL EXAGGERATION.
2. GEOLOGIC CONTACTS DASHED WHERE INFERRED.

LEGEND:

- ALLUVIUM
- BASALT
- CHINLE SHALE
- UPPER CHINLE AQUIFER
- MIDDLE CHINLE AQUIFER
- LOWER CHINLE AQUIFER
- SAN ANDRES-GLORIETTA AQUIFER
- WATER TABLE

Modified: September 4, 2015
Adopted from:
Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

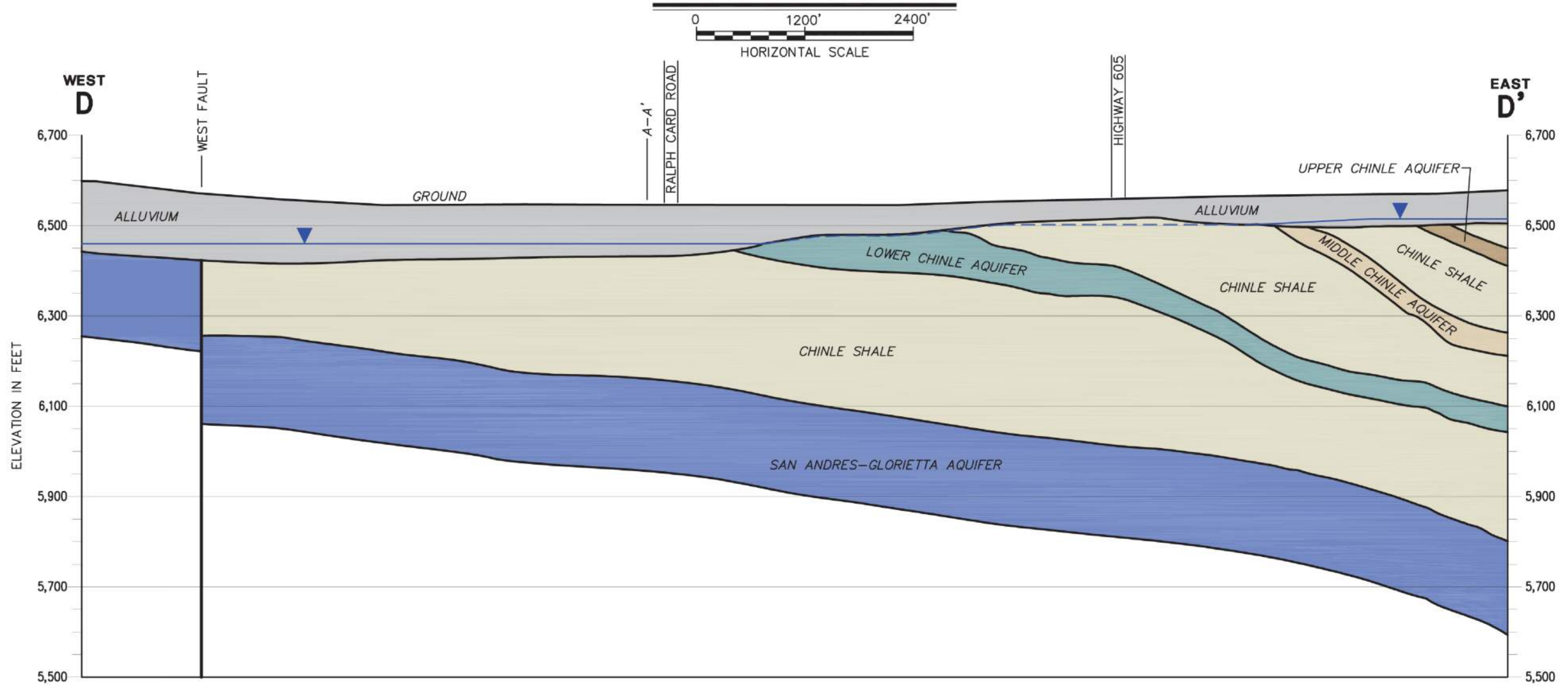
HOMESTAKE

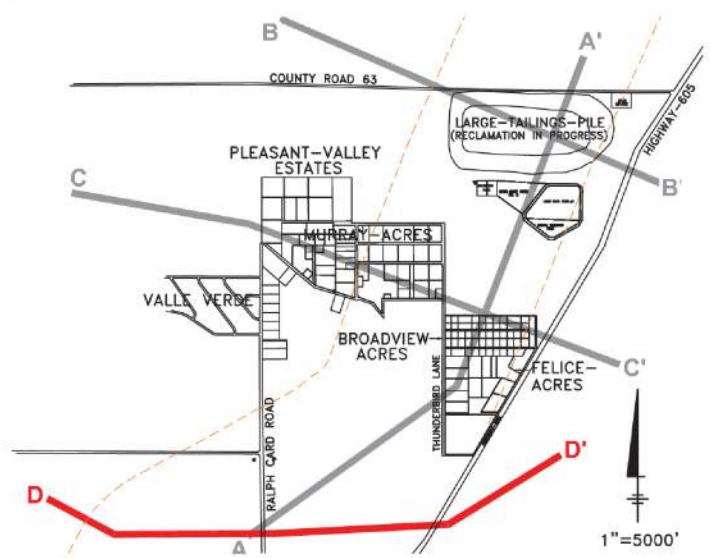
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

HYDROGEOLOGICAL CROSS SECTION C-C'

FIGURE 2-9

CROSS SECTION D-D'





LOCATION MAP

NOTE:

1. THREE-DIMENSIONAL MODEL OUTPUT DEPICTED AT 5X VERTICAL EXAGGERATION.

LEGEND:

- LARGE TAILINGS PILE
- ALLUVIUM
- CHINLE SHALE
- UPPER CHINLE AQUIFER
- MIDDLE CHINLE AQUIFER
- LOWER CHINLE AQUIFER
- SAN ANDRES-GLORIETTA AQUIFER
- WATER TABLE

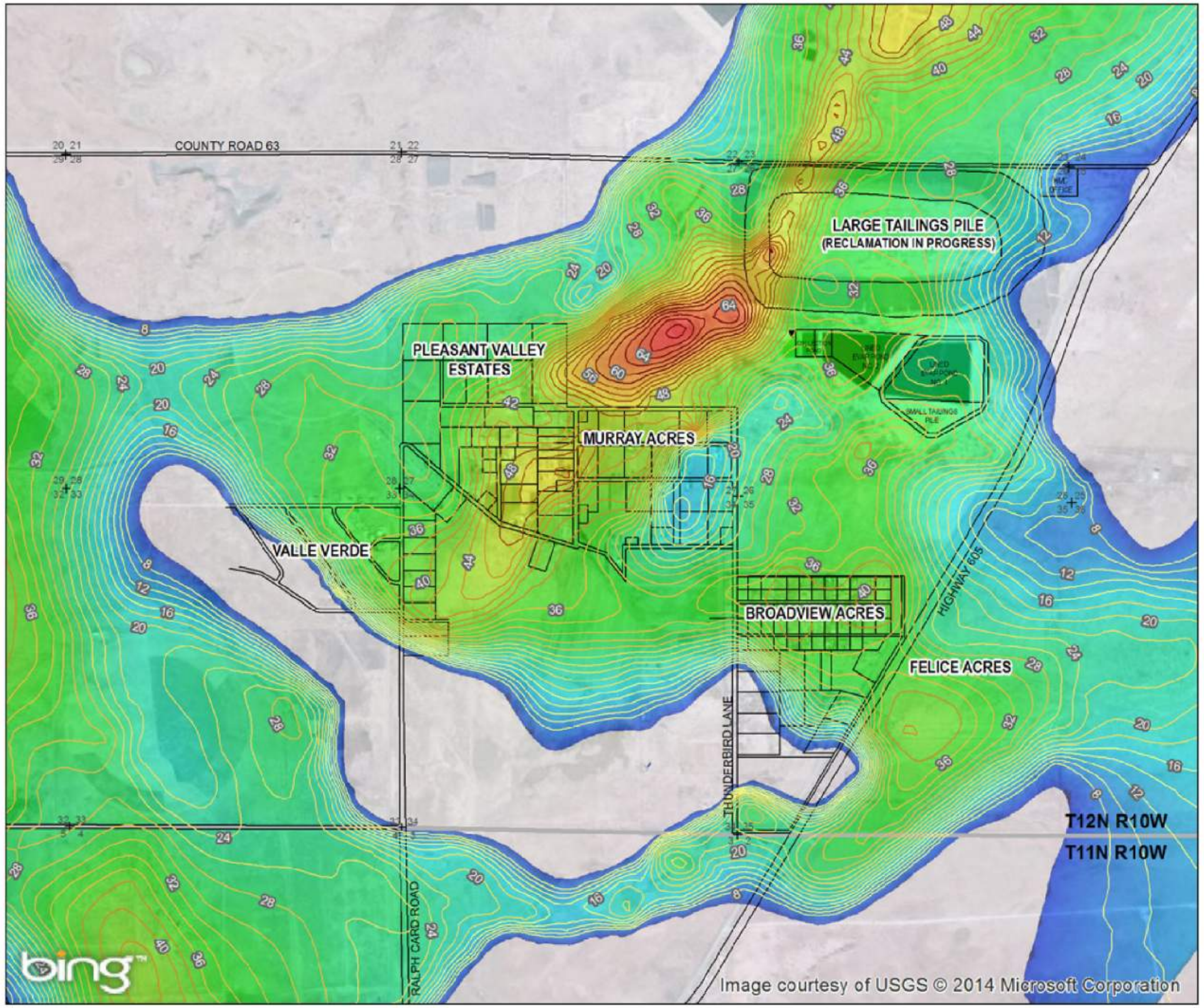
Adopted from:
Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

HOMESTAKE

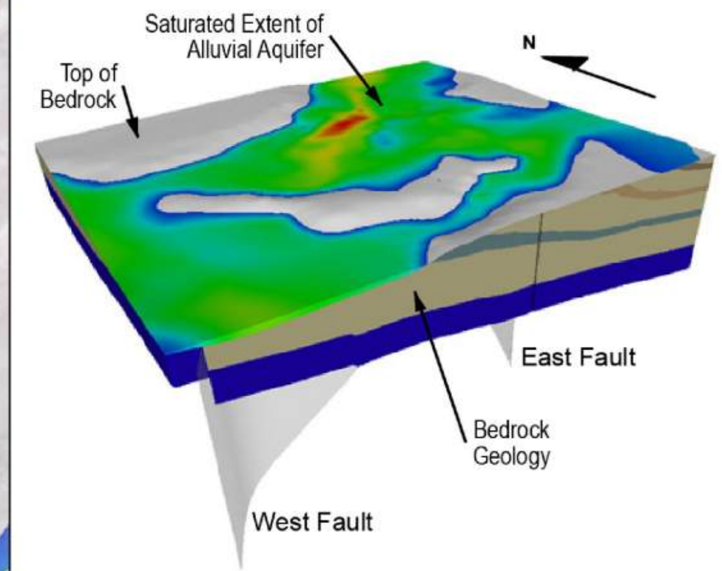
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

HYDROGEOLOGICAL CROSS SECTION D-D'

FIGURE 2-10



3D BEDROCK GEOLOGY AND SATURATED EXTENT OF ALLUVIAL AQUIFER - FACING NORTHEAST



LEGENDS:

Saturated Alluvial Thickness (feet)

69
60
52
43
34
26
17
9
0

Bedrock Hydrostratigraphy

- Chinle Shale
- Upper Chinle Aquifer
- Chinle Shale
- Middle Chinle Aquifer
- Chinle Shale
- Lower Chinle Aquifer
- Chinle Shale
- San Andres-Glorietta Aquifer

Source: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

N

0 1,350 2,700
Feet

Aerial: Bing Maps - © 2010 Microsoft Corporation and its data suppliers

Thickness Contours in Feet

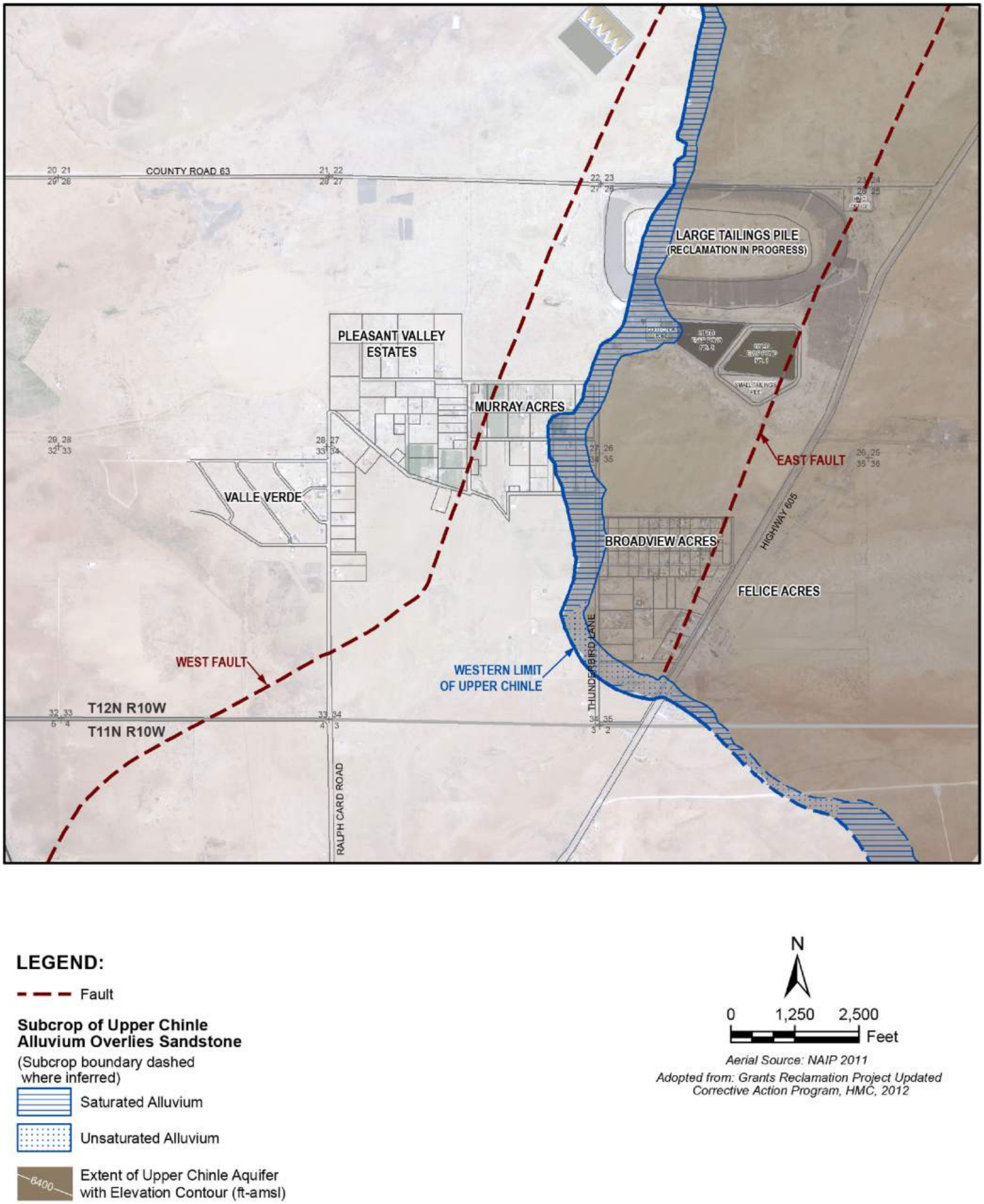
- 8 - 16
- 17 - 26
- 27 - 36
- 37 - 46
- 47 - 56
- 57 - 68

HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

SATURATED EXTENT OF ALLUVIAL AQUIFER

FIGURE 2-11

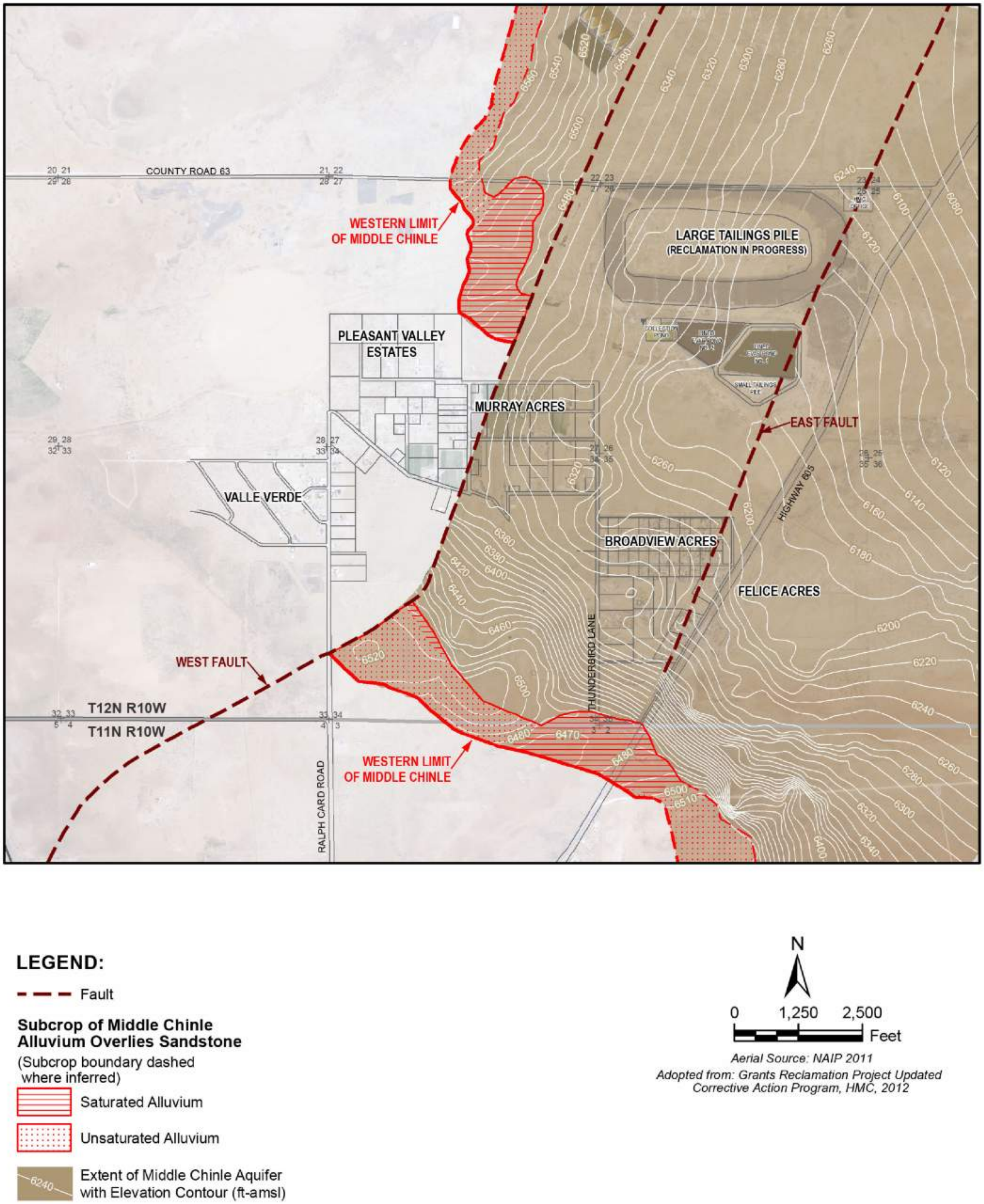


Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

EXTENT OF UPPER CHINLE

LOCATION MAP

FIGURE 2-12

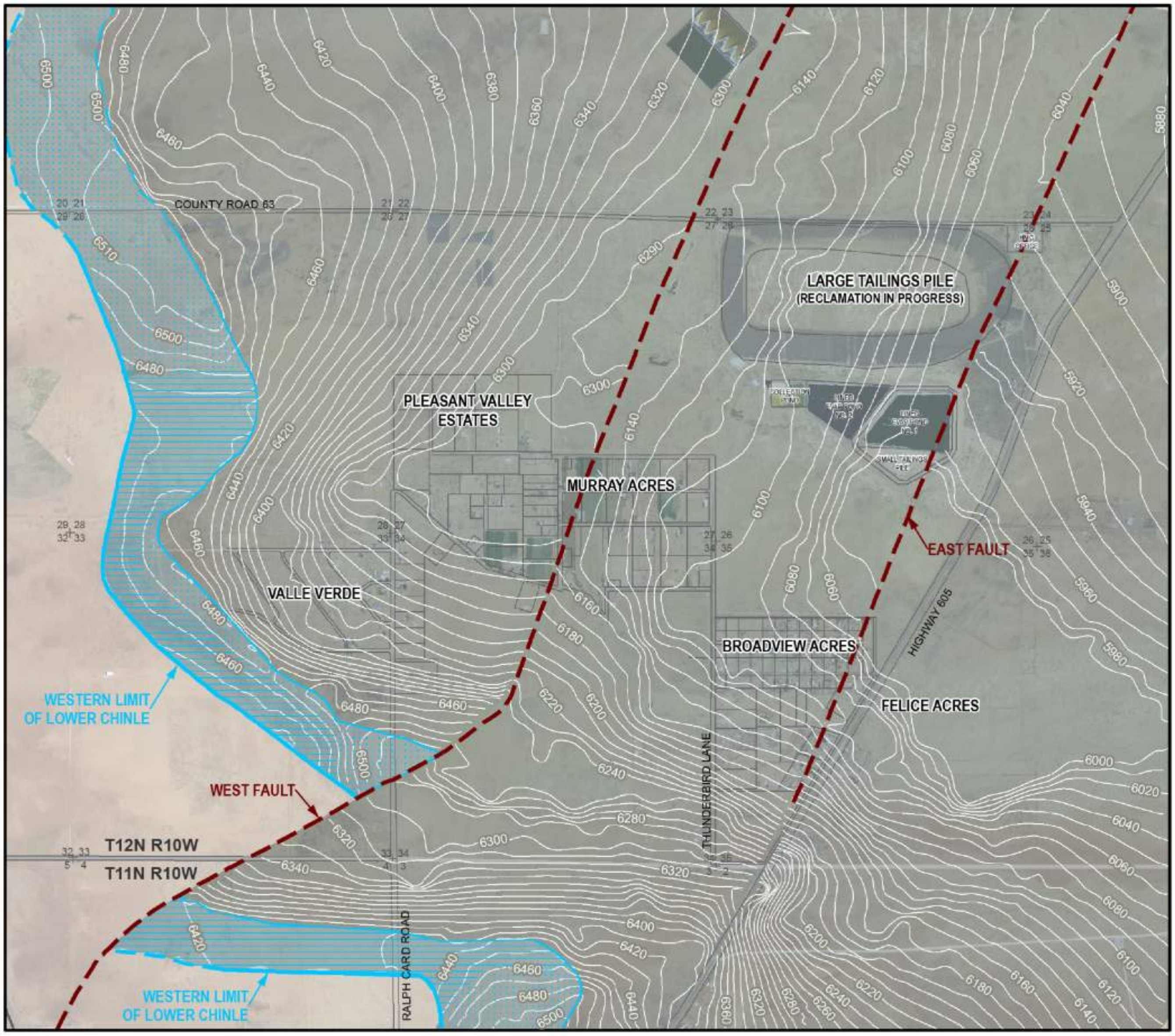


Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

EXTENT OF MIDDLE CHINLE

LOCATION MAP

FIGURE 2-13



LEGEND:

Fault

Subcrop of Lower Chinle
Alluvium Overlies Secondary Porosity
(Subcrop boundary dashed where inferred)

Saturated Alluvium

Unsaturated Alluvium

Extent of Lower Chinle Aquifer with Elevation Contour (ft-amsl)

N

0 1,250 2,500 Feet

Aerial Source: NAIP 2011
Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

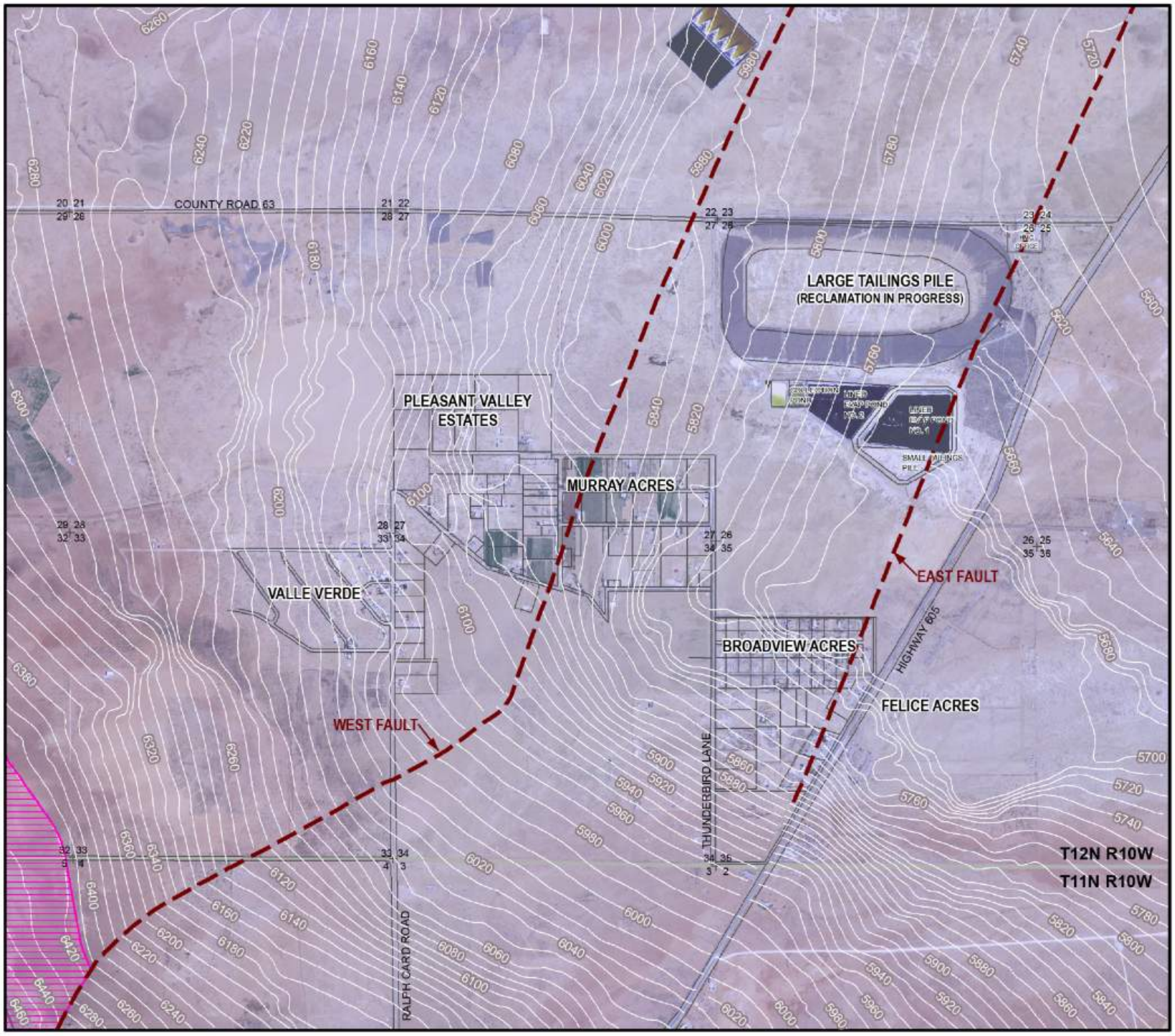
Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

PATH: Z:\PROJECTS\PROPOSALS\10171518 BARRICK RIF HOMESTAKEMINING\MAP DOCS\FINAL\VERSION2\BARRICK FIG2 14 PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/4/2019

EXTENT OF LOWER CHINLE

LOCATION MAP

FIGURE 2-14



LEGEND:

Fault

Subcrop of San Andres-Glorietta
Alluvium Overlies Limestone

Saturated Alluvium

Extent of San Andres-Glorietta Aquifer with Elevation Contour (ft-amsl)

N

0 1,250 2,500 Feet

Aerial Source: NAIP 2011

Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

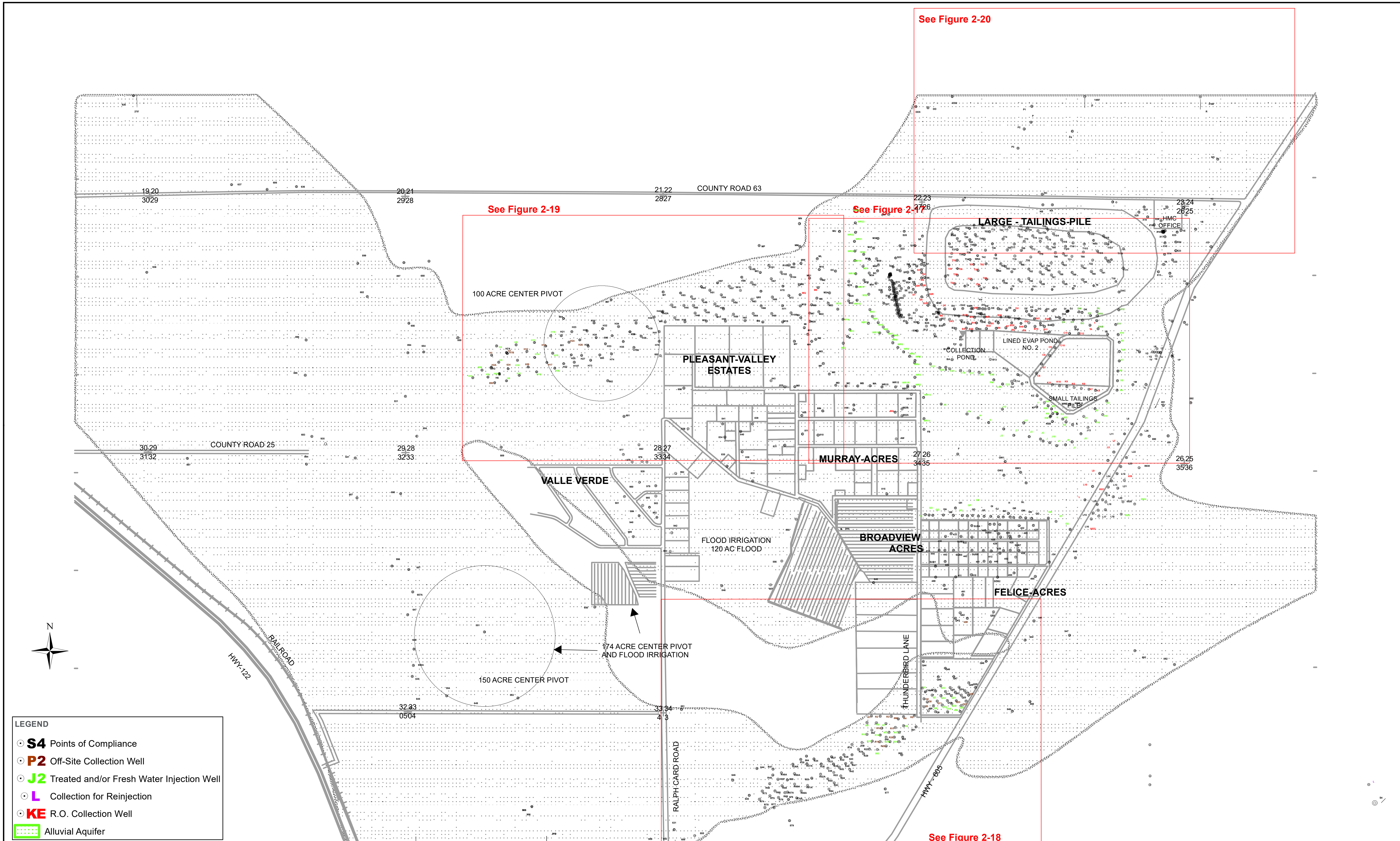
Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

HOMESTAKE

EXTENT OF SAN ANDRES-GLORIETTA

LOCATION MAP

FIGURE 2-15



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

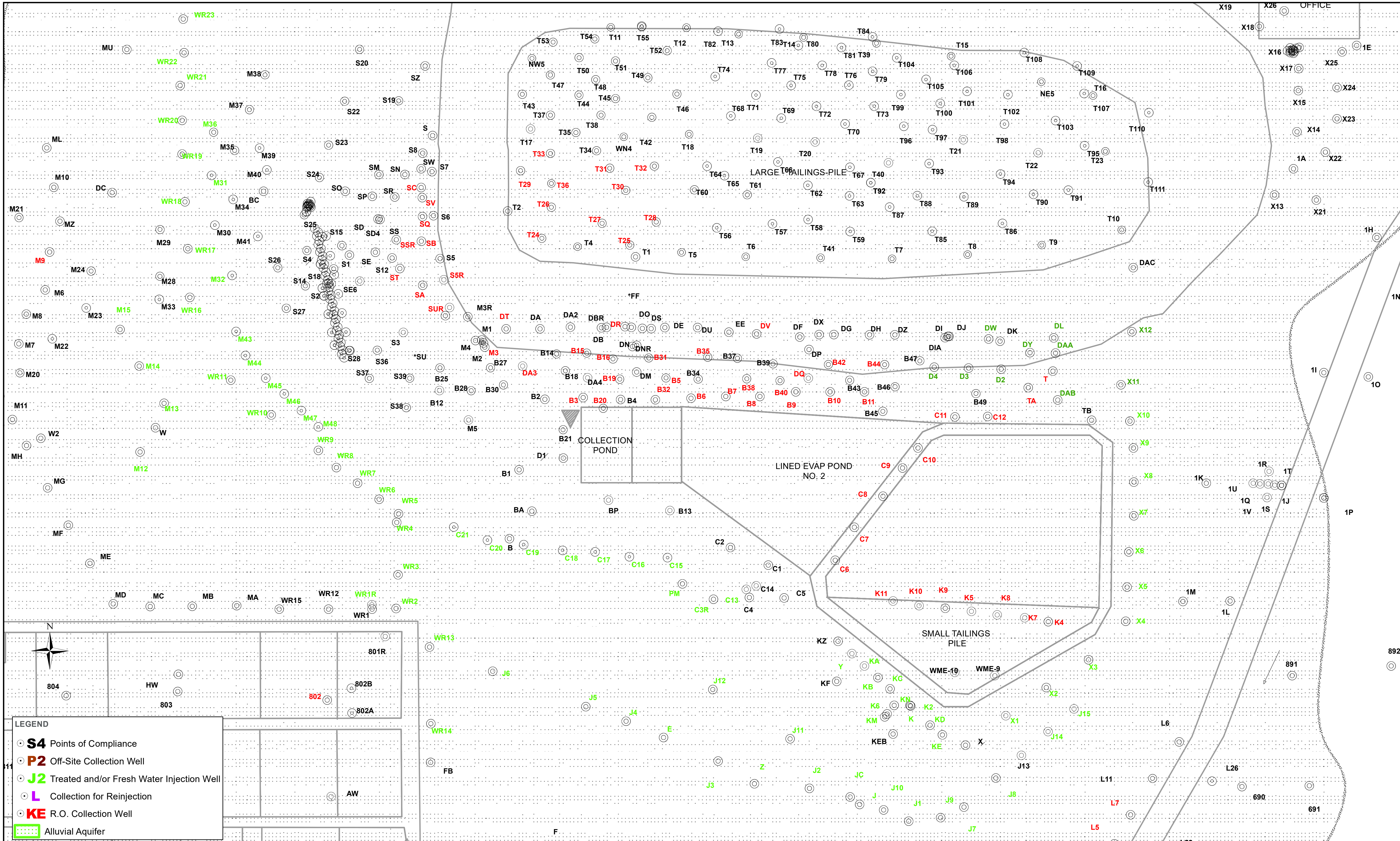
0 1,600 Feet

ALLUVIAL WELL LOCATIONS

OVERVIEW MAP

FIGURE 2-16

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2-16_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/4/2019



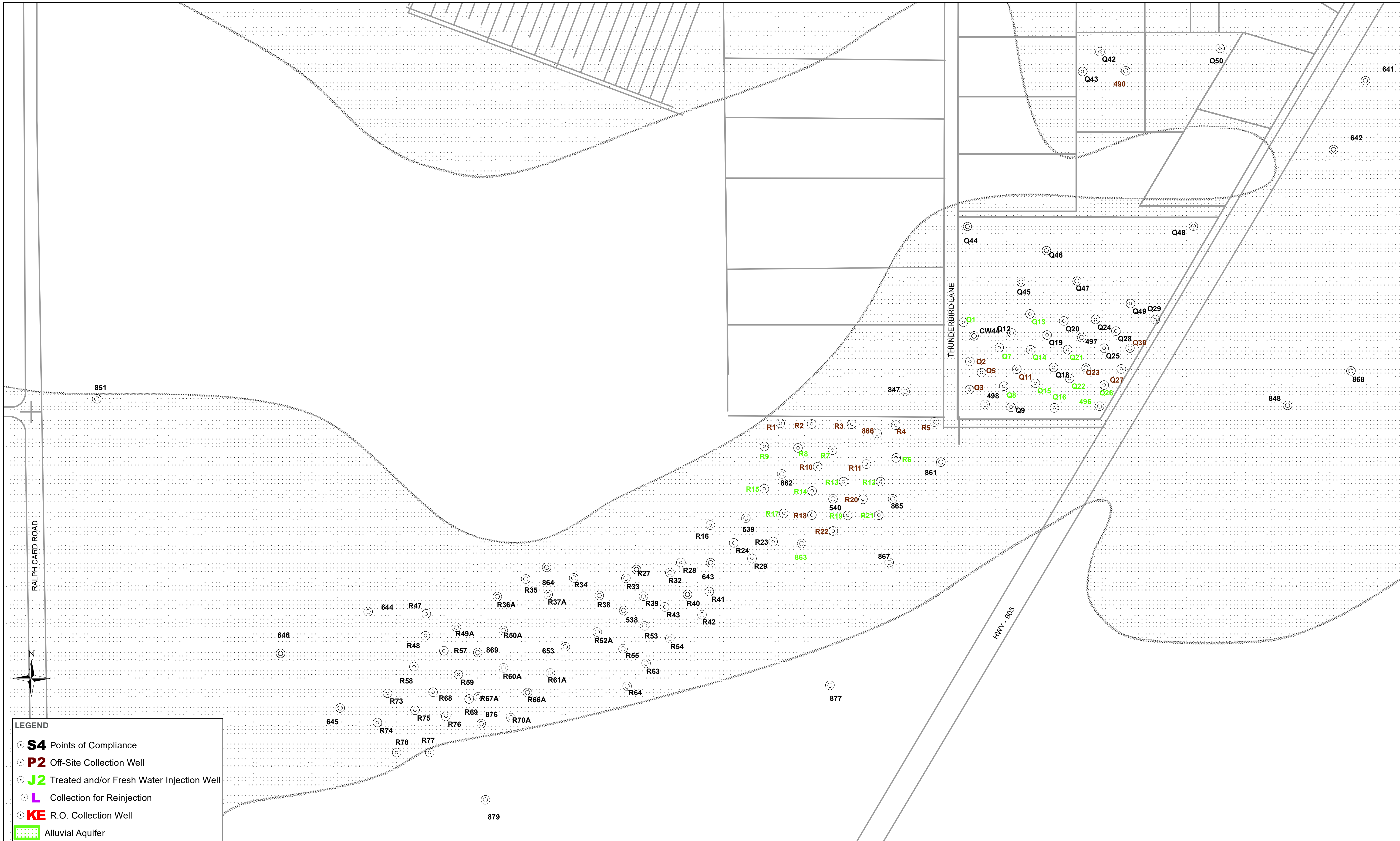
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL WELL LOCATIONS

DETAIL MAP 1

FIGURE 2-17



HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

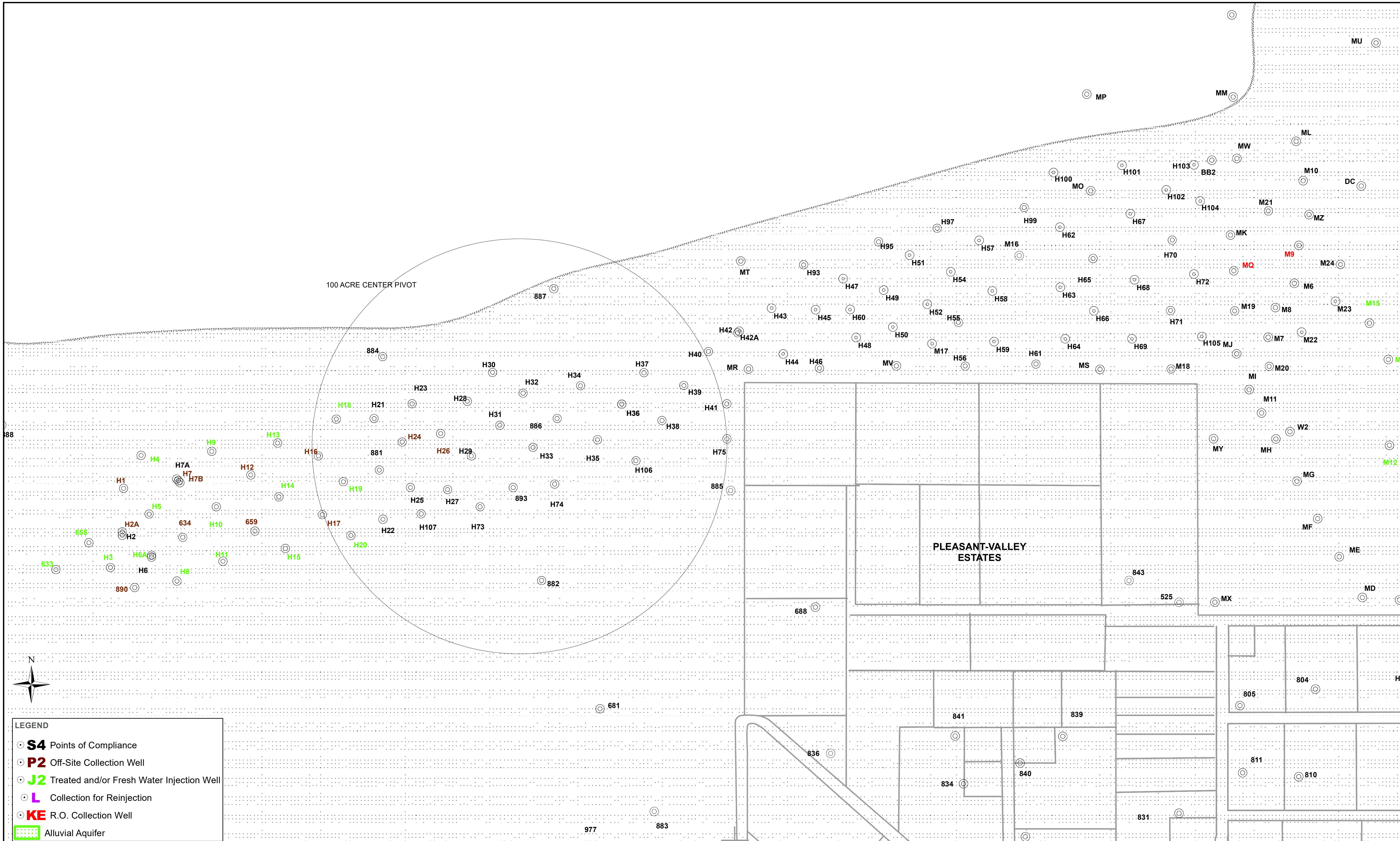
0 500 Feet

ALLUVIAL WELL LOCATIONS

DETAIL MAP 2

FIGURE 2-18

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2-18_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/4/2019



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

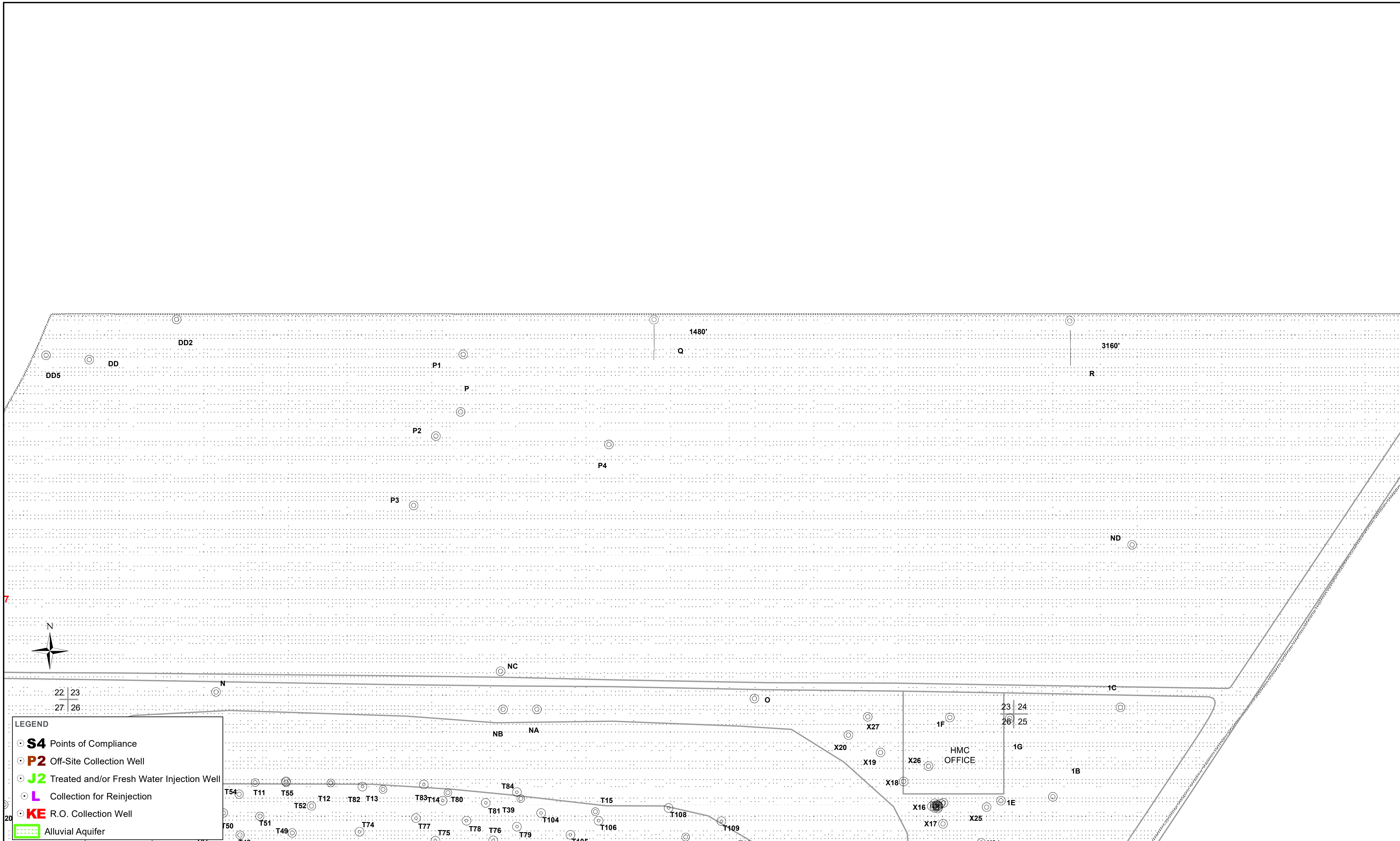
0 500 Feet

HOMESTAKE

ALLUVIAL WELL LOCATIONS

DETAIL MAP 3

FIGURE 2-19



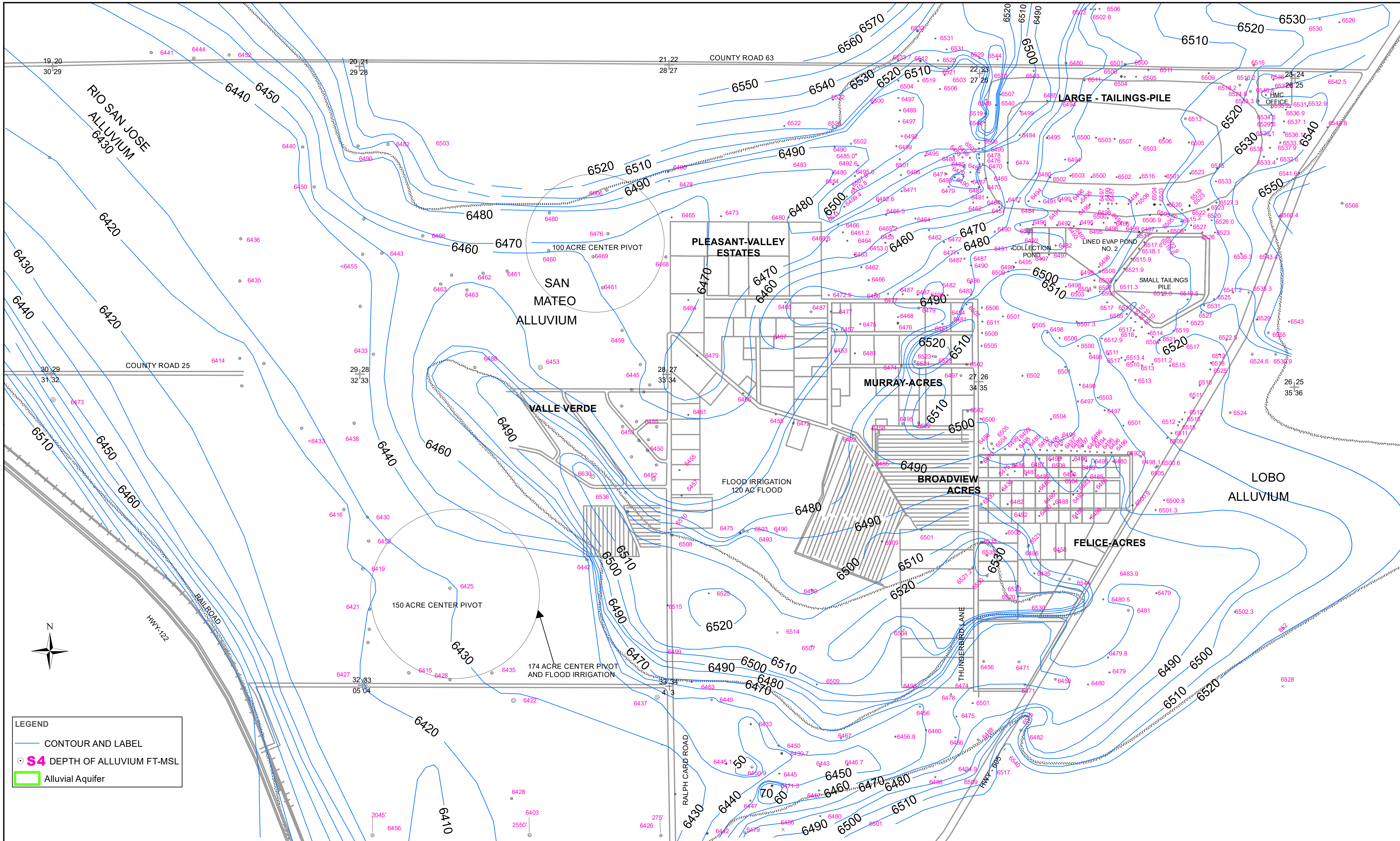
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

ALLUVIAL WELL LOCATIONS

DETAIL MAP 4

FIGURE 2-20



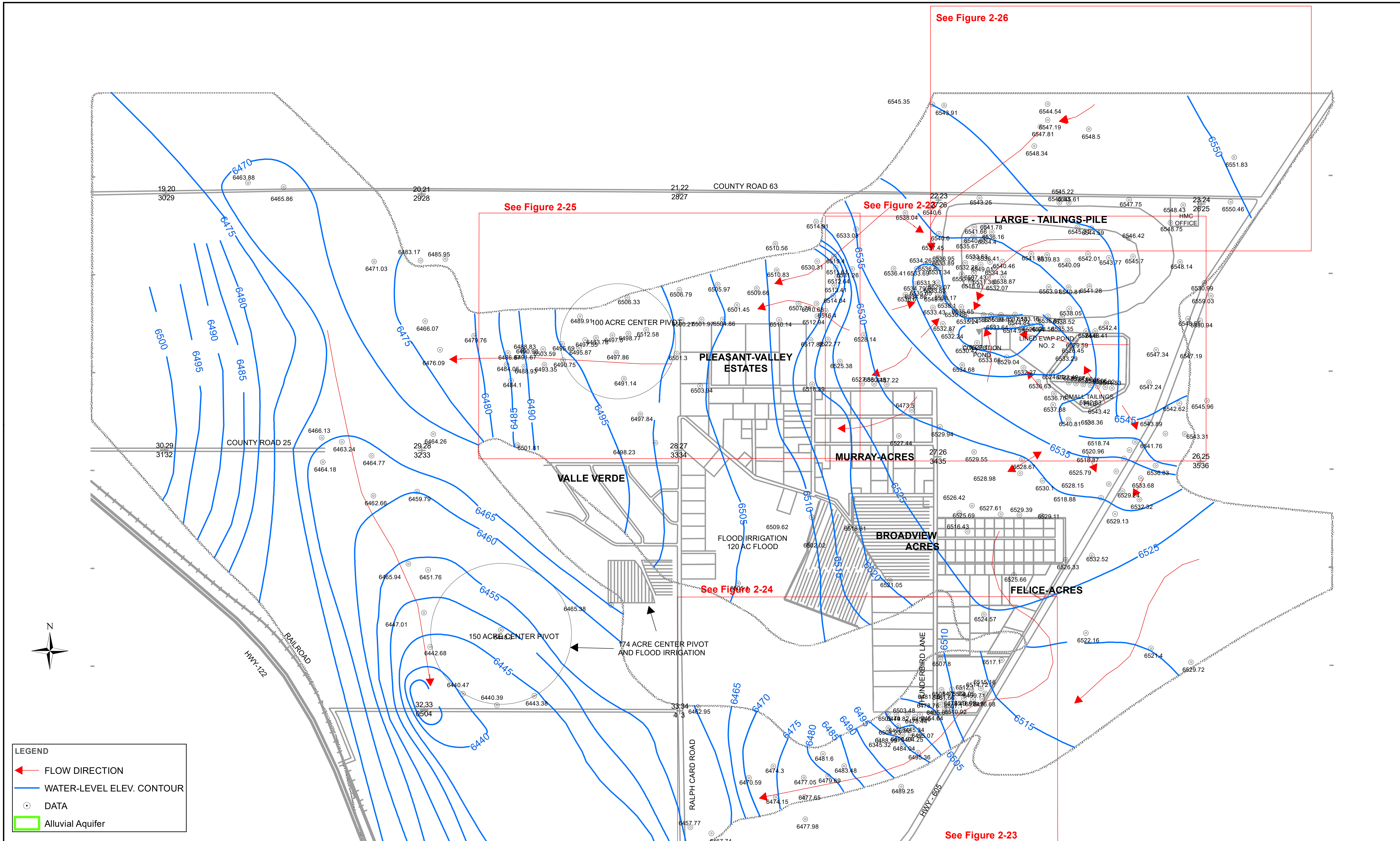
0 1,500 Feet

BASE OF ALLUVIUM CONTOURS

OVERVIEW MAP

FIGURE 2-21

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION4\BARRICK_FIG2-21_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 3/17/2020



HOMESTAKE

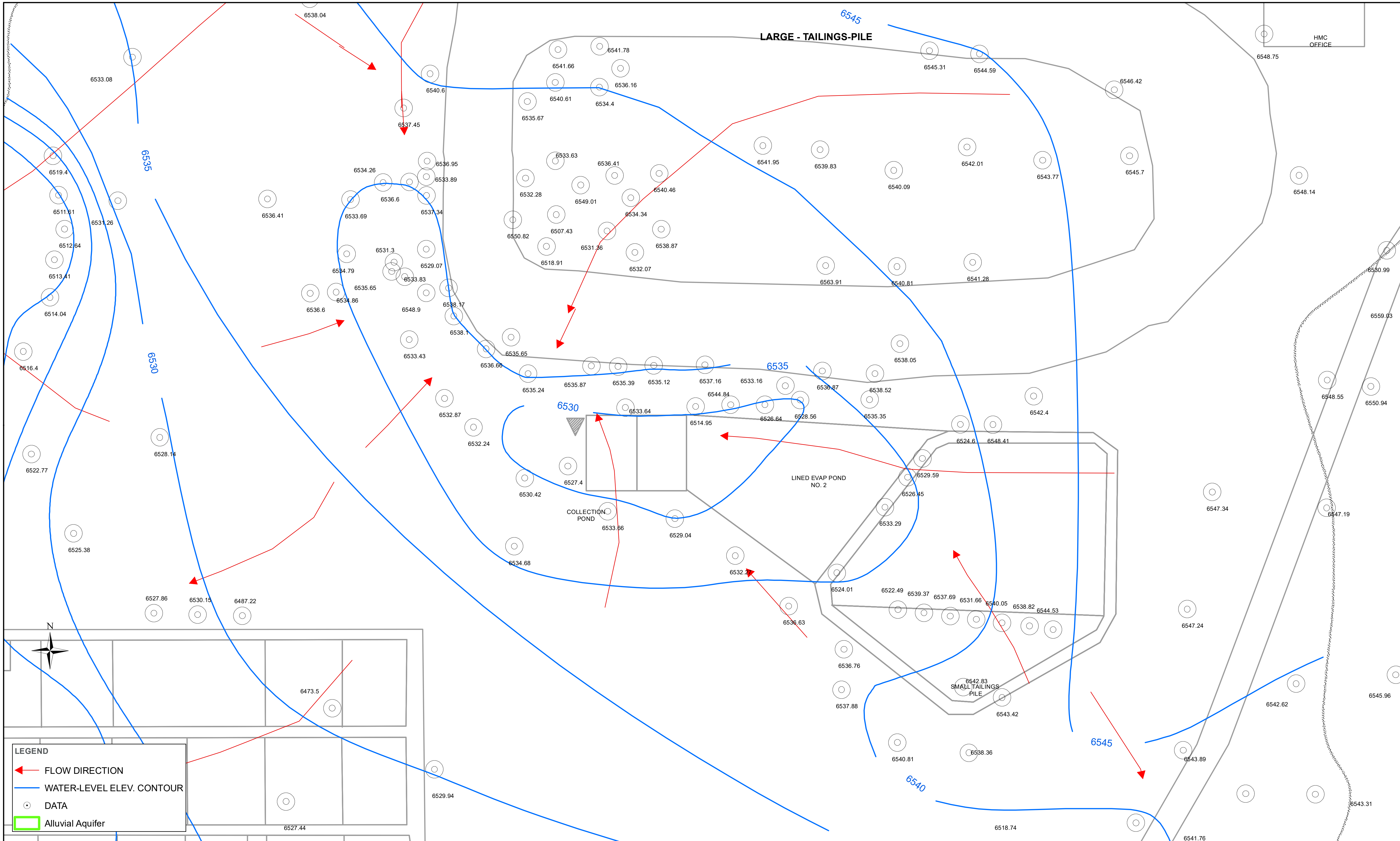
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,800 Feet

ALLUVIAL AQUIFER WATER LEVEL ELEVATIONS

OVERVIEW MAP

FIGURE 2-22



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

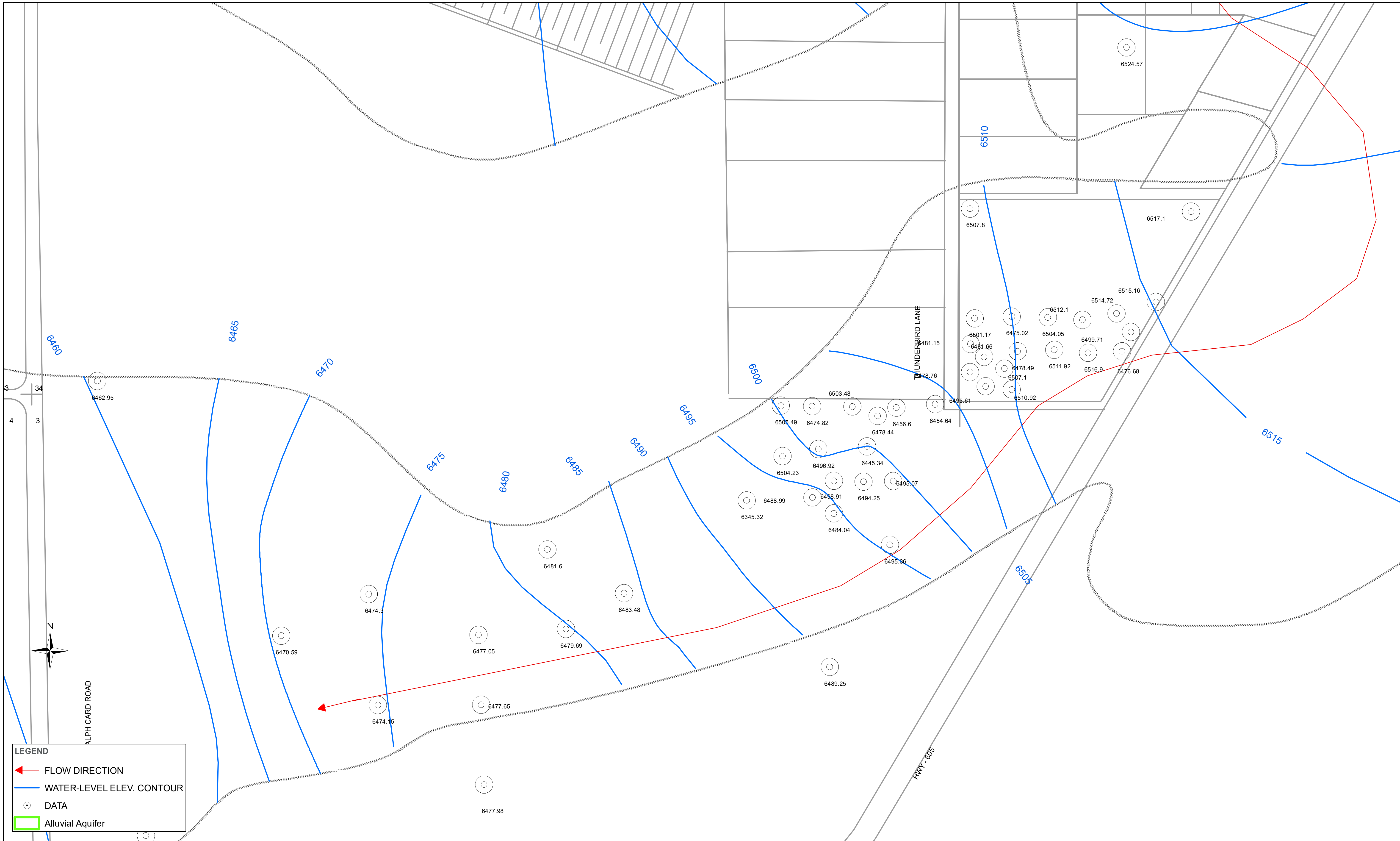
HOMESTAKE

ALLUVIAL AQUIFER WATER LEVEL ELEVATIONS

DETAIL MAP 1

FIGURE 2-23

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2-23_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 1/3/2020



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

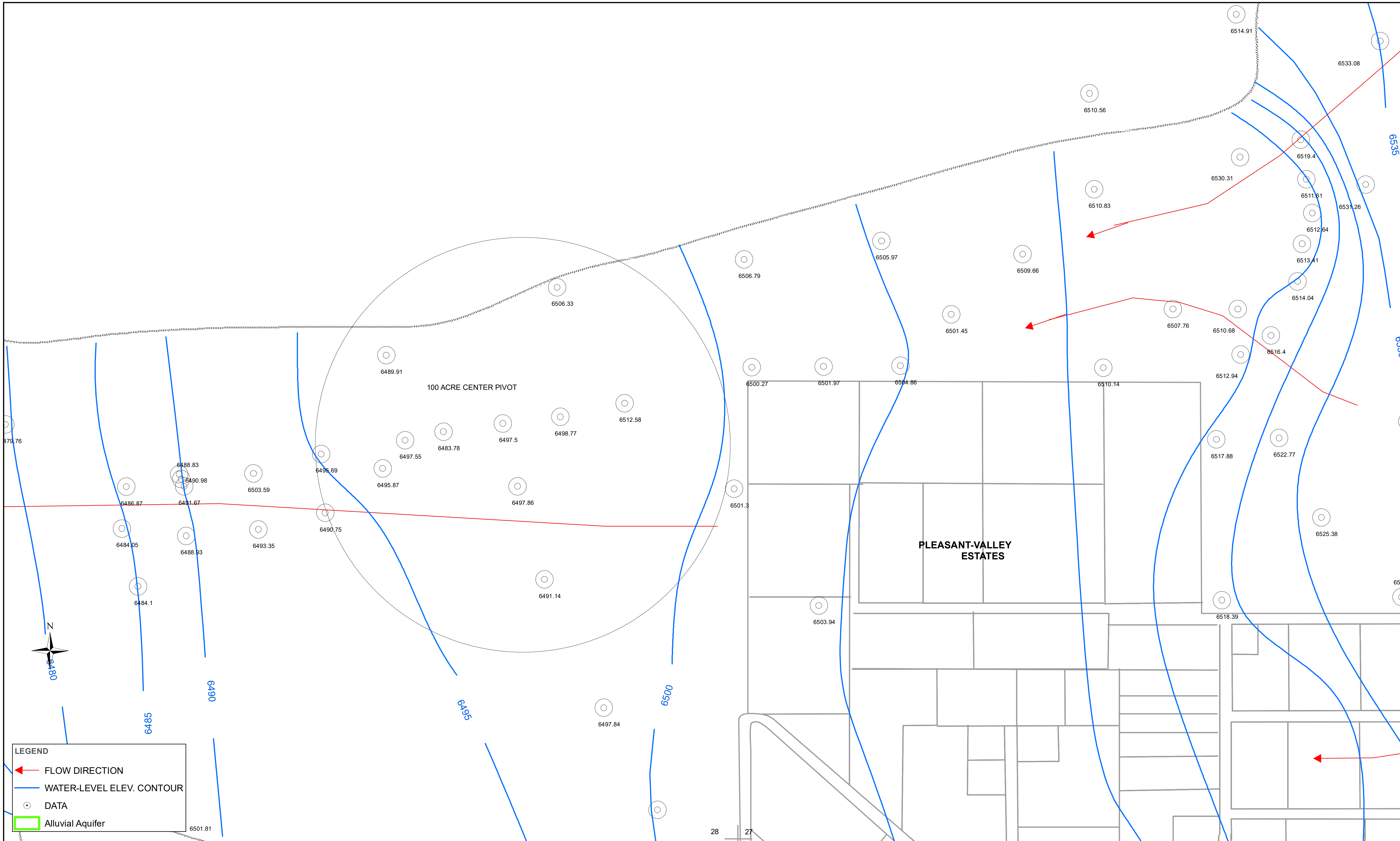
0 500 Feet

ALLUVIAL AQUIFER WATER LEVEL ELEVATIONS

DETAIL MAP 2

FIGURE 2-24

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2-24_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 1/3/2020



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

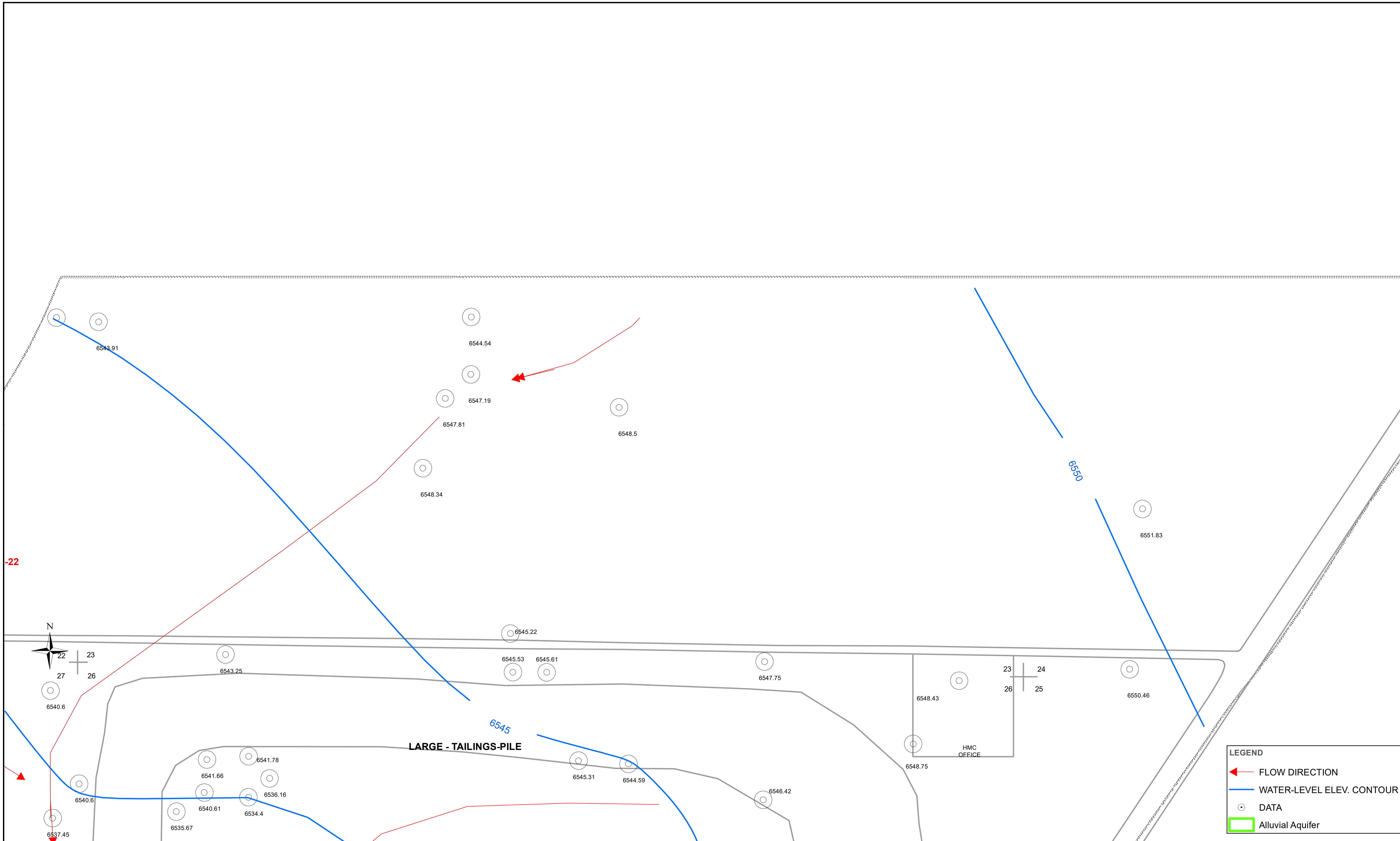
0 500 Feet

ALLUVIAL AQUIFER WATER LEVEL ELEVATIONS

DETAIL MAP 3

FIGURE 2-25

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2-25_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 1/3/2020



HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

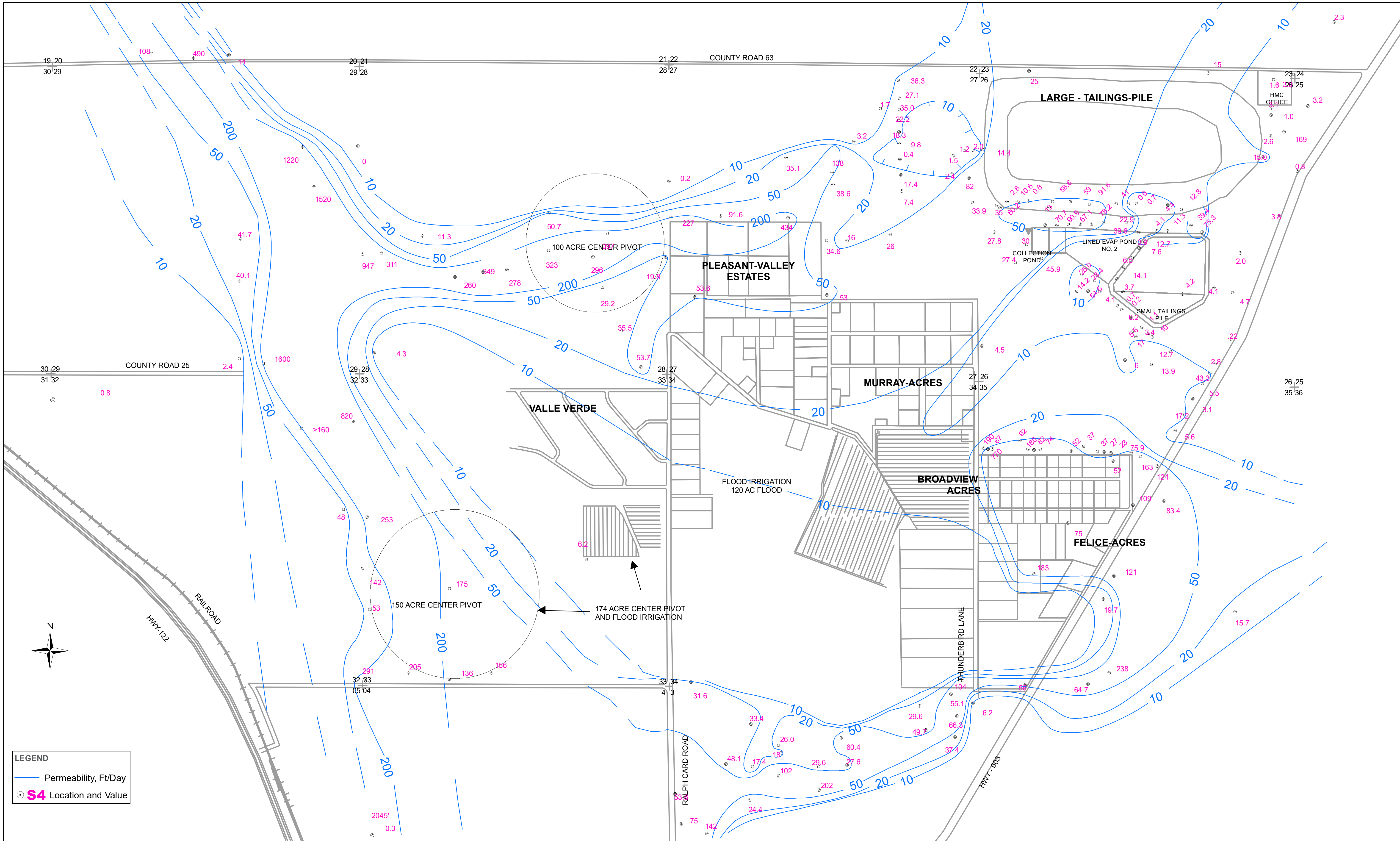
0 500 Feet

ALLUVIAL AQUIFER WATER LEVEL ELEVATIONS

DETAIL MAP 4

FIGURE 2-26

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG2-26_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/4/2019



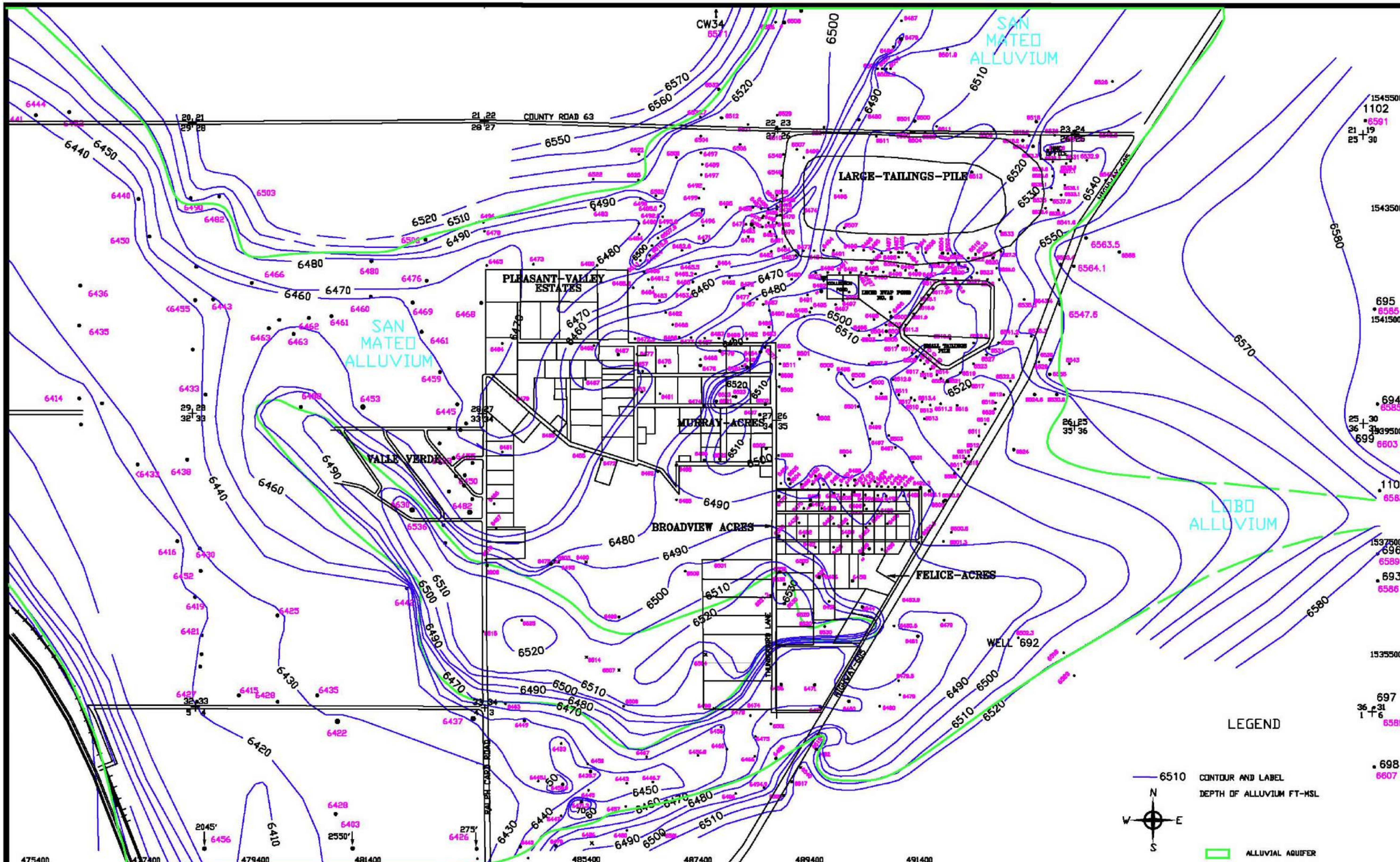
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

HYDRAULIC CONDUCTIVITY FOR THE ALLUVIAL AQUIFER, FT/DAY

FIGURE 2-27

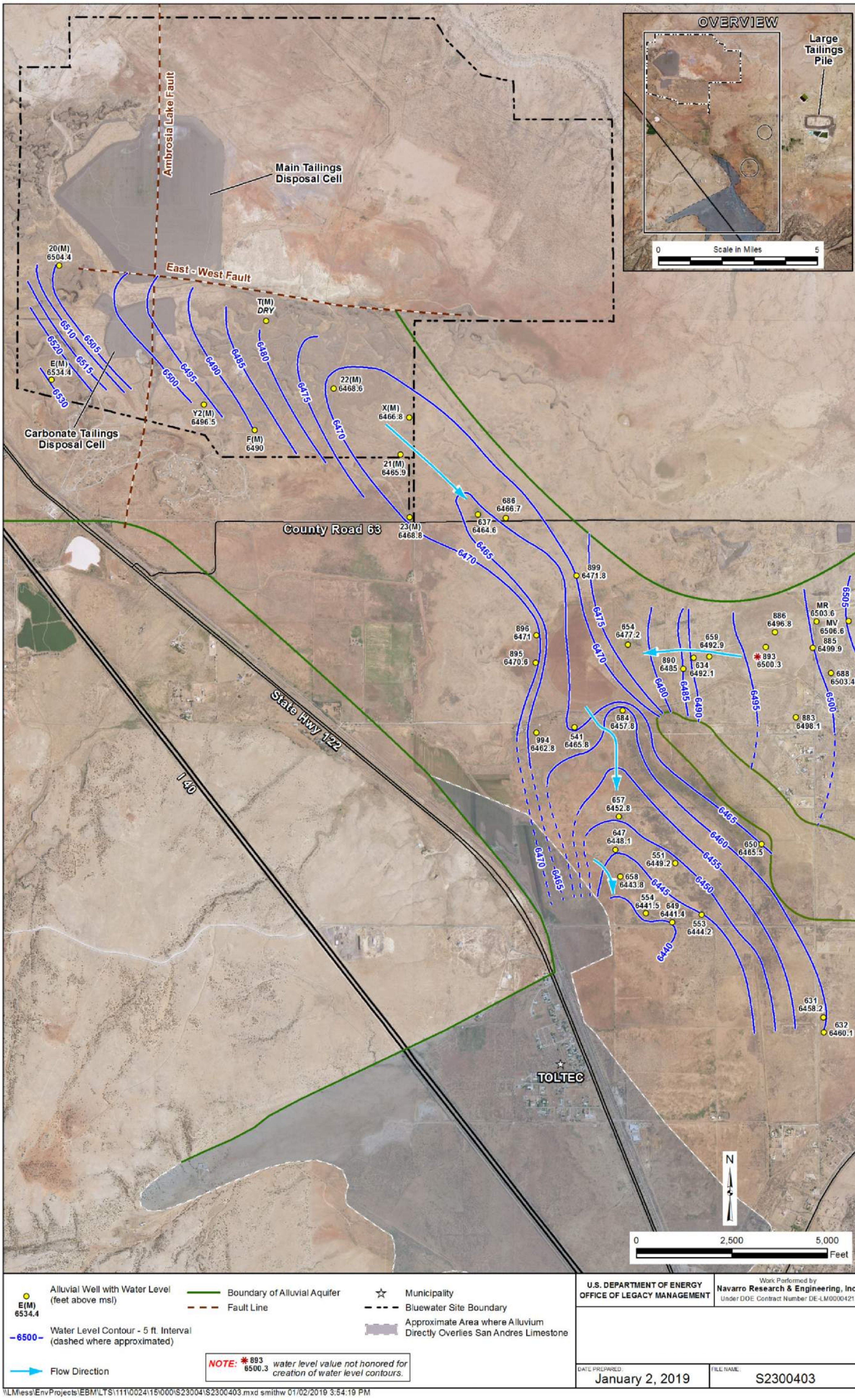


Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

1995 RIO LOBO DRILL HOLES

OVERVIEW MAP

FIGURE 2-28



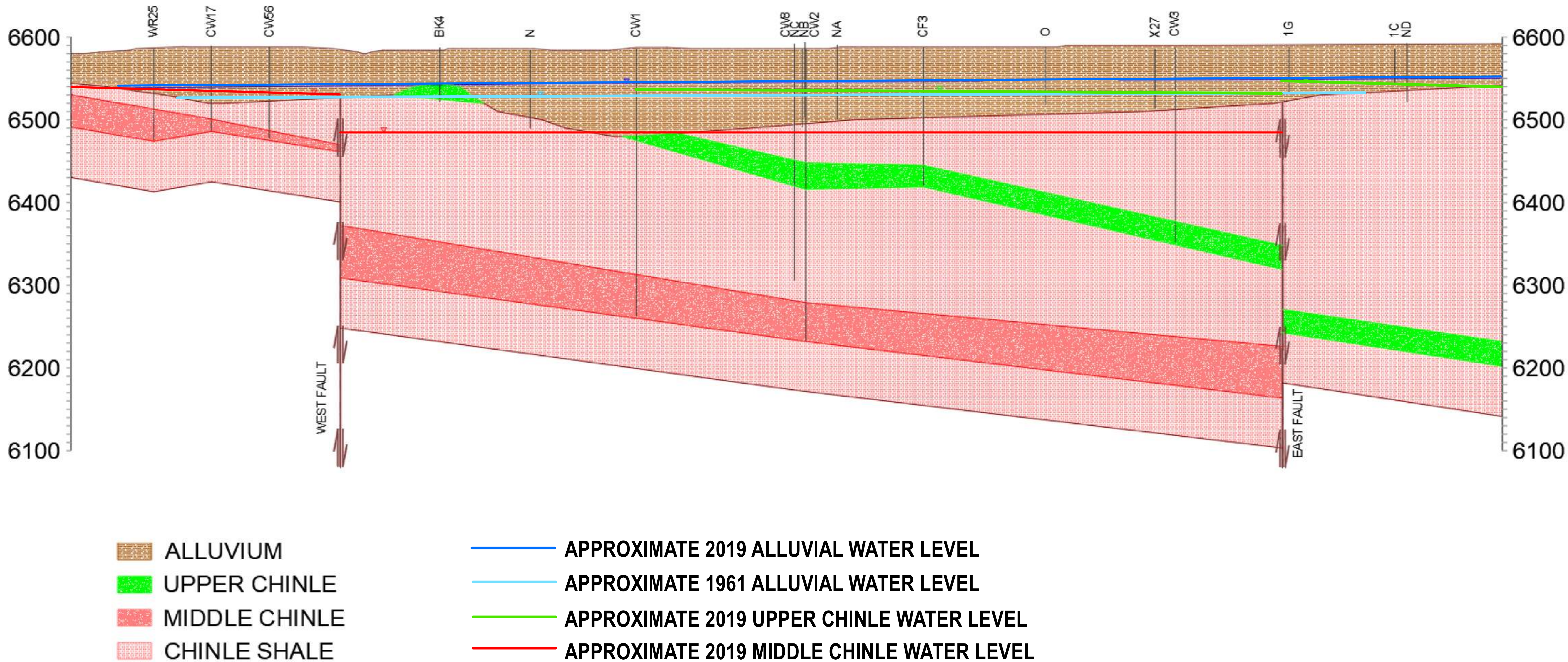
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

SAN JOSE WATER ELEVATION CONTOURS

OVERVIEW

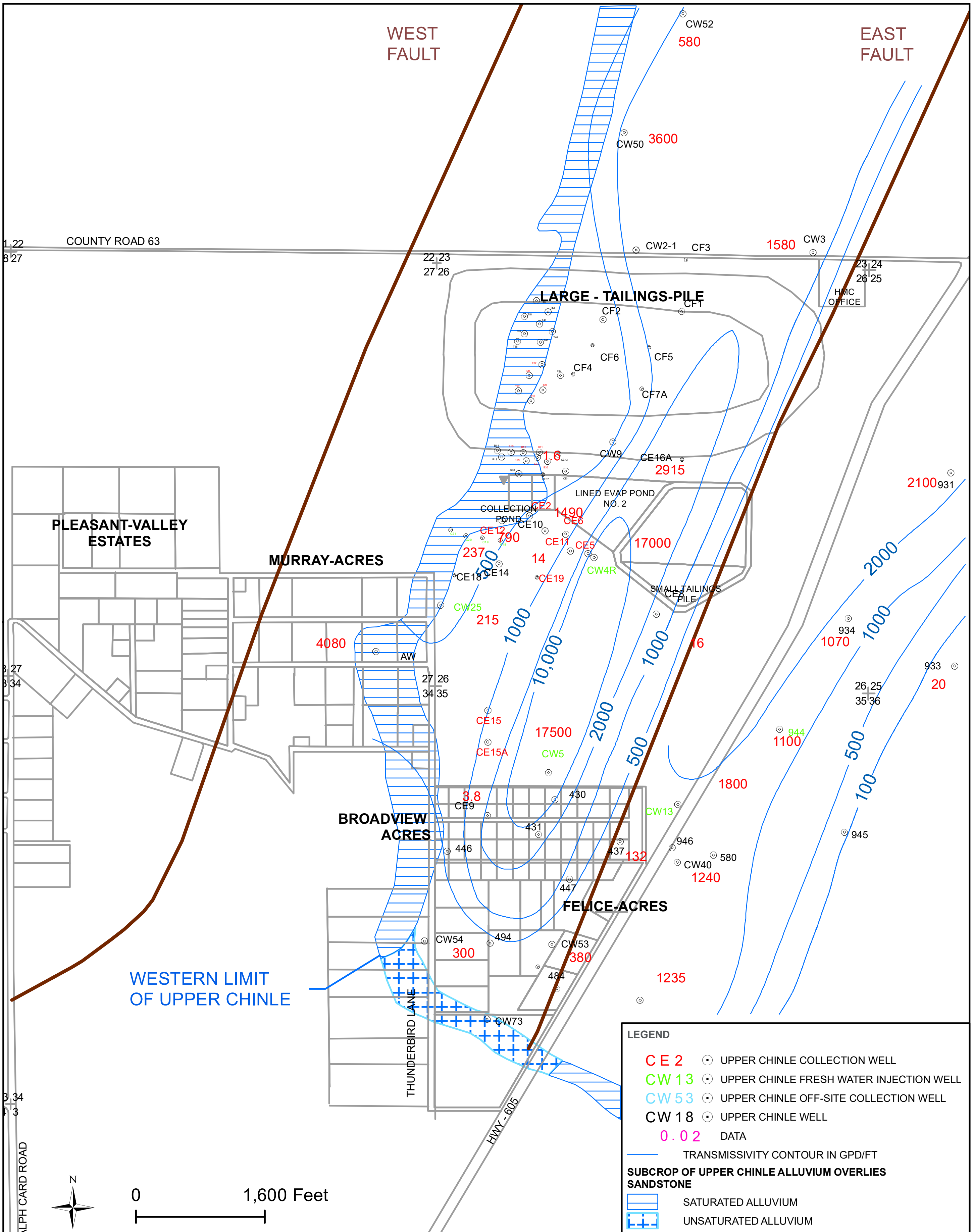
FIGURE 2-29



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

CROSS SECTION NORTH OF LTP

FIGURE 2-30



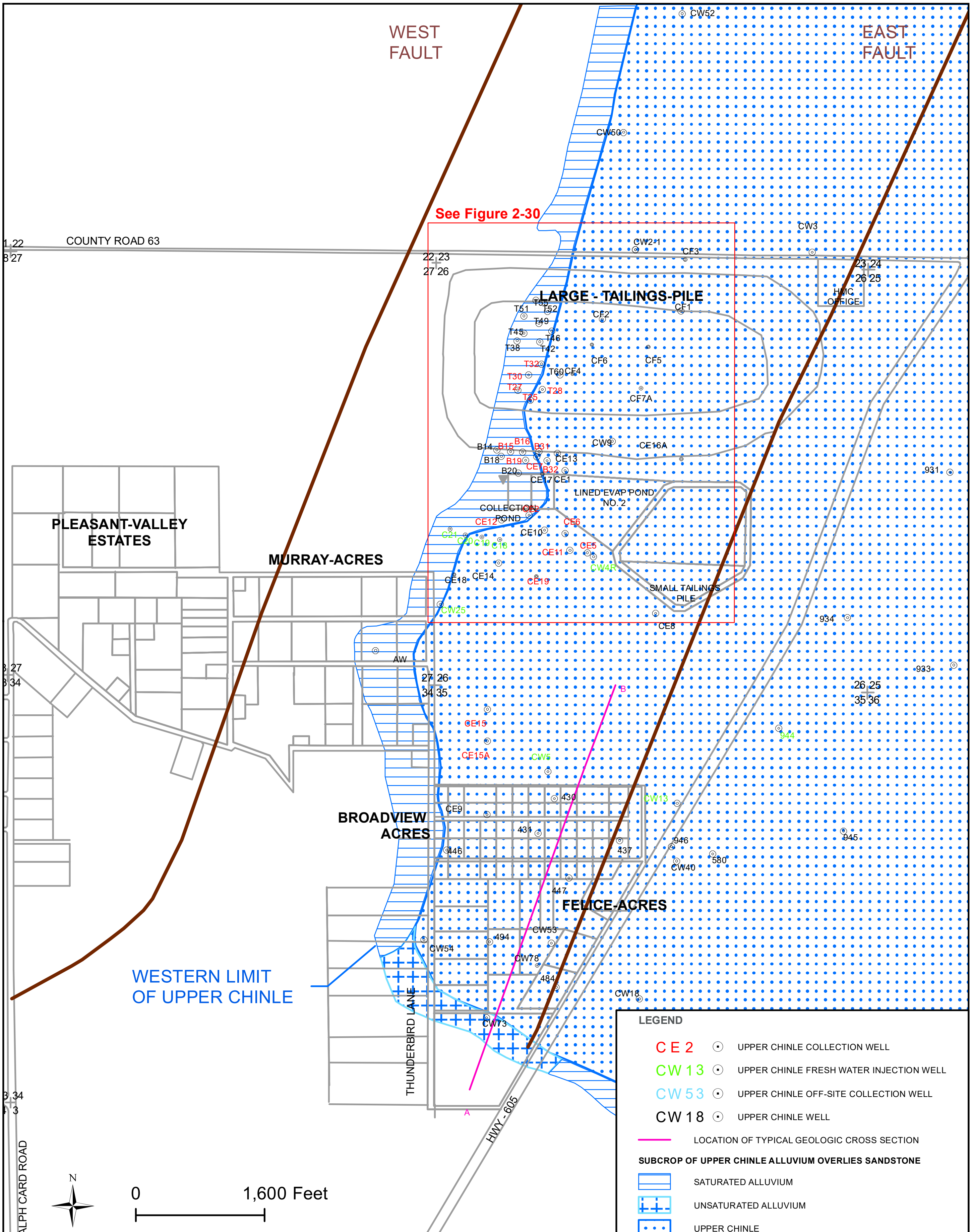
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION4\BARRICK_FIG2-31TRANS_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/9/2020

HOMESTAKE

UPPER CHINLE AQUIFER TRANSMISSIVITY

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 2-31



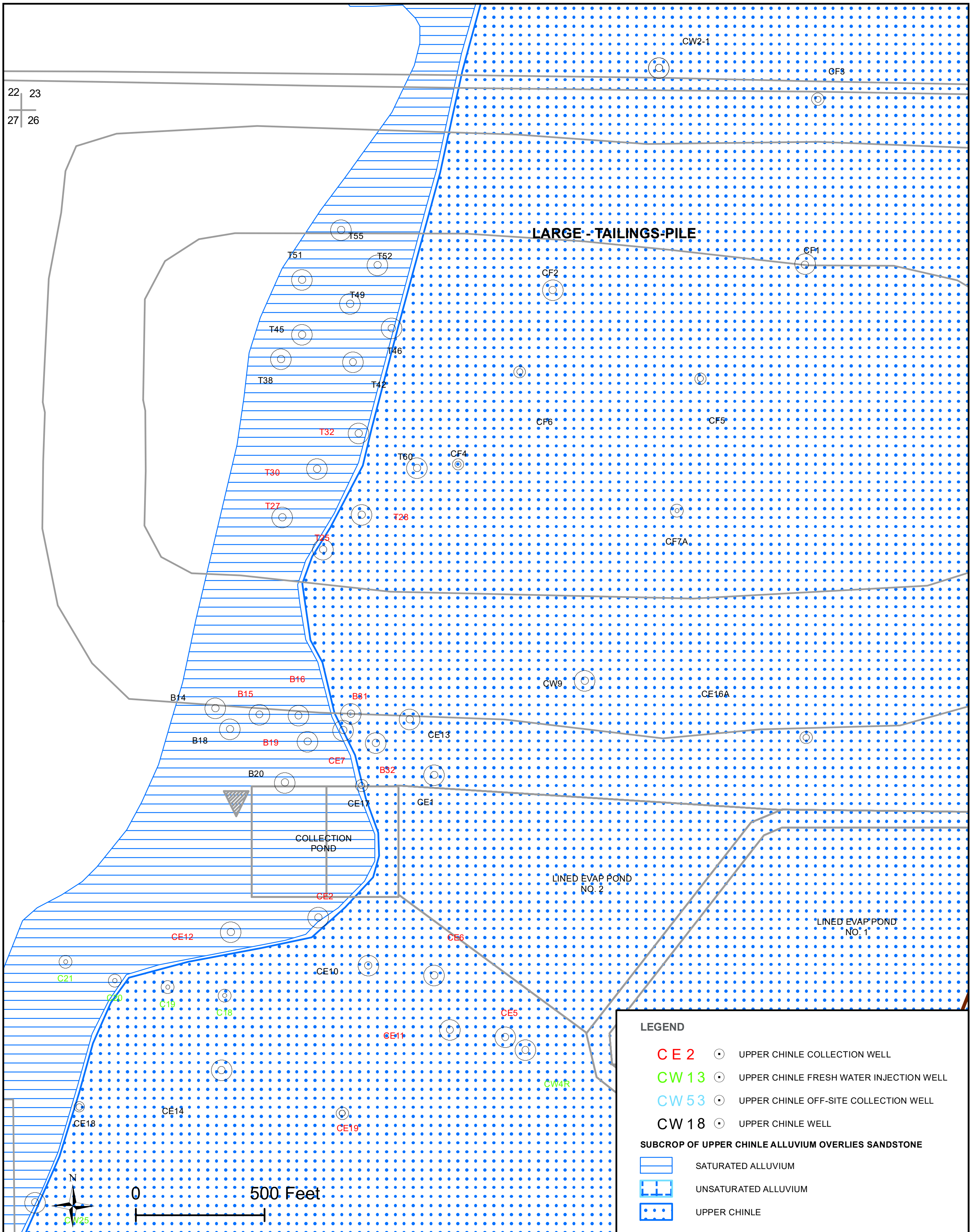
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-31_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

UPPER CHINLE WELL LOCATIONS
OVERVIEW MAP

FIGURE 2-32



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-32_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

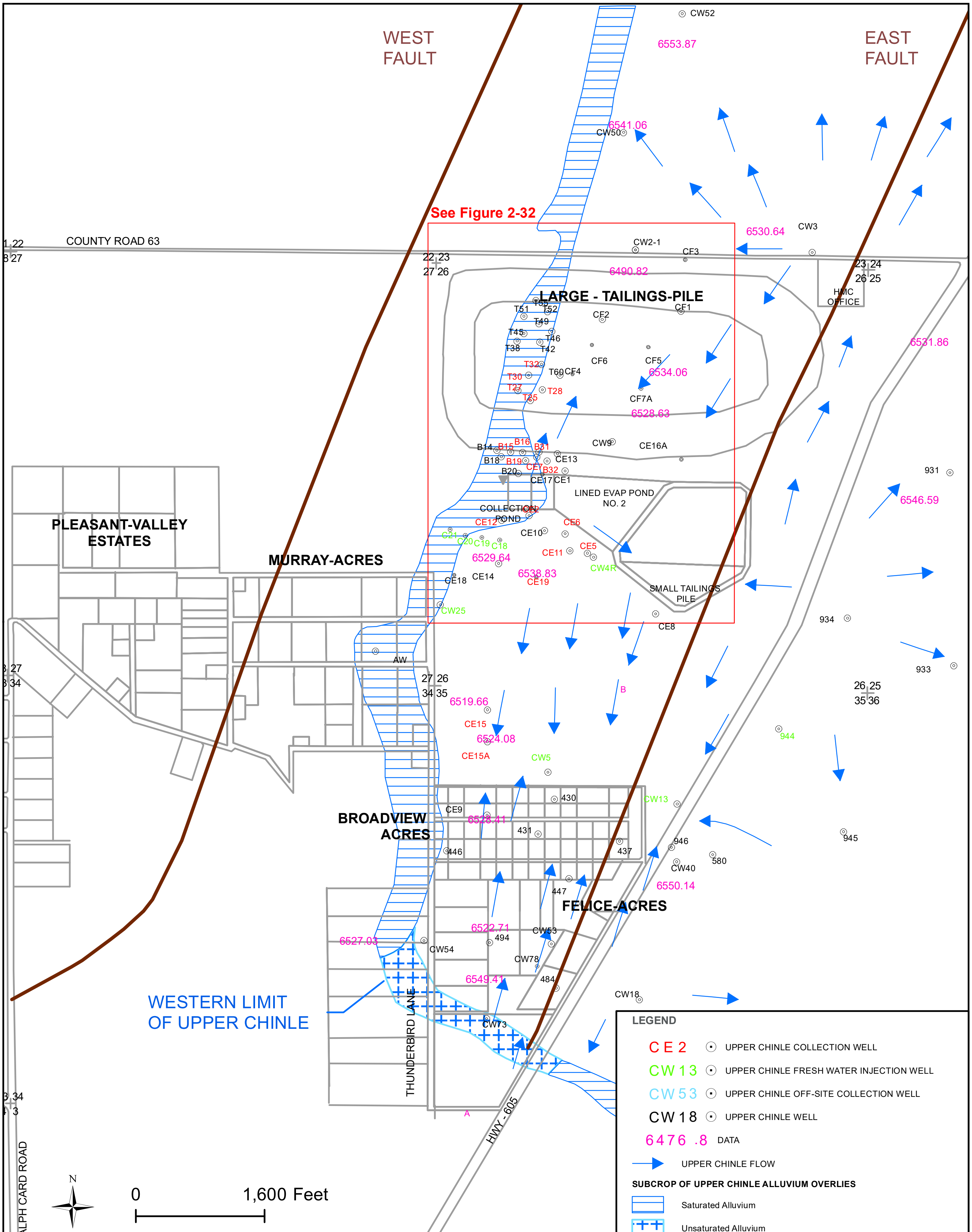
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

UPPER CHINLE WELL LOCATIONS

DETAIL MAP

FIGURE 2-33



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-33_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

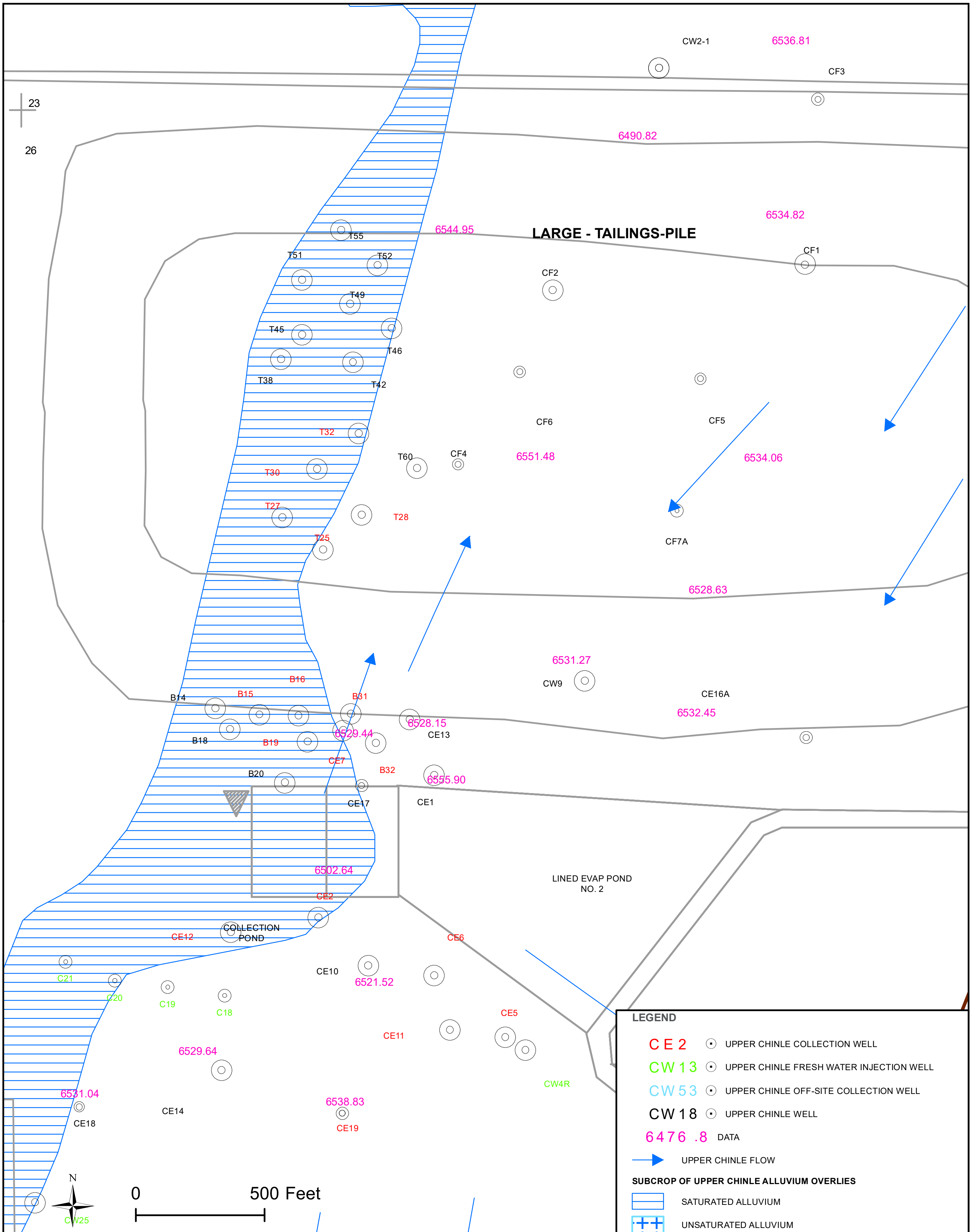
HOMESTAKE

UPPER CHINLE WATER ELEVATION & FLOW DIRECTION

OVERVIEW MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 2-34



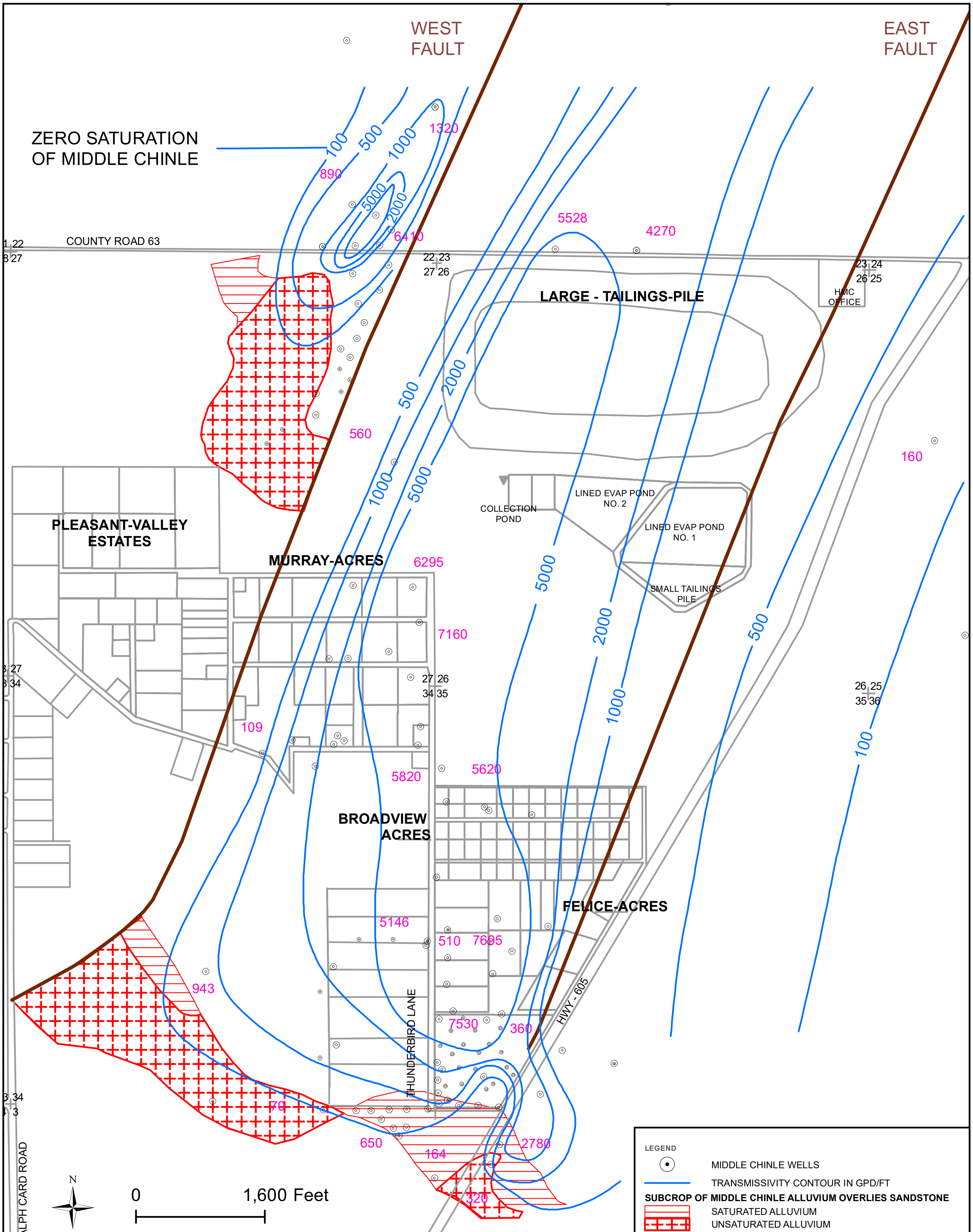
HOMESTAKE

UPPER CHINLE WATER ELEVATION & FLOW DIRECTION

DETAIL MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 2-35



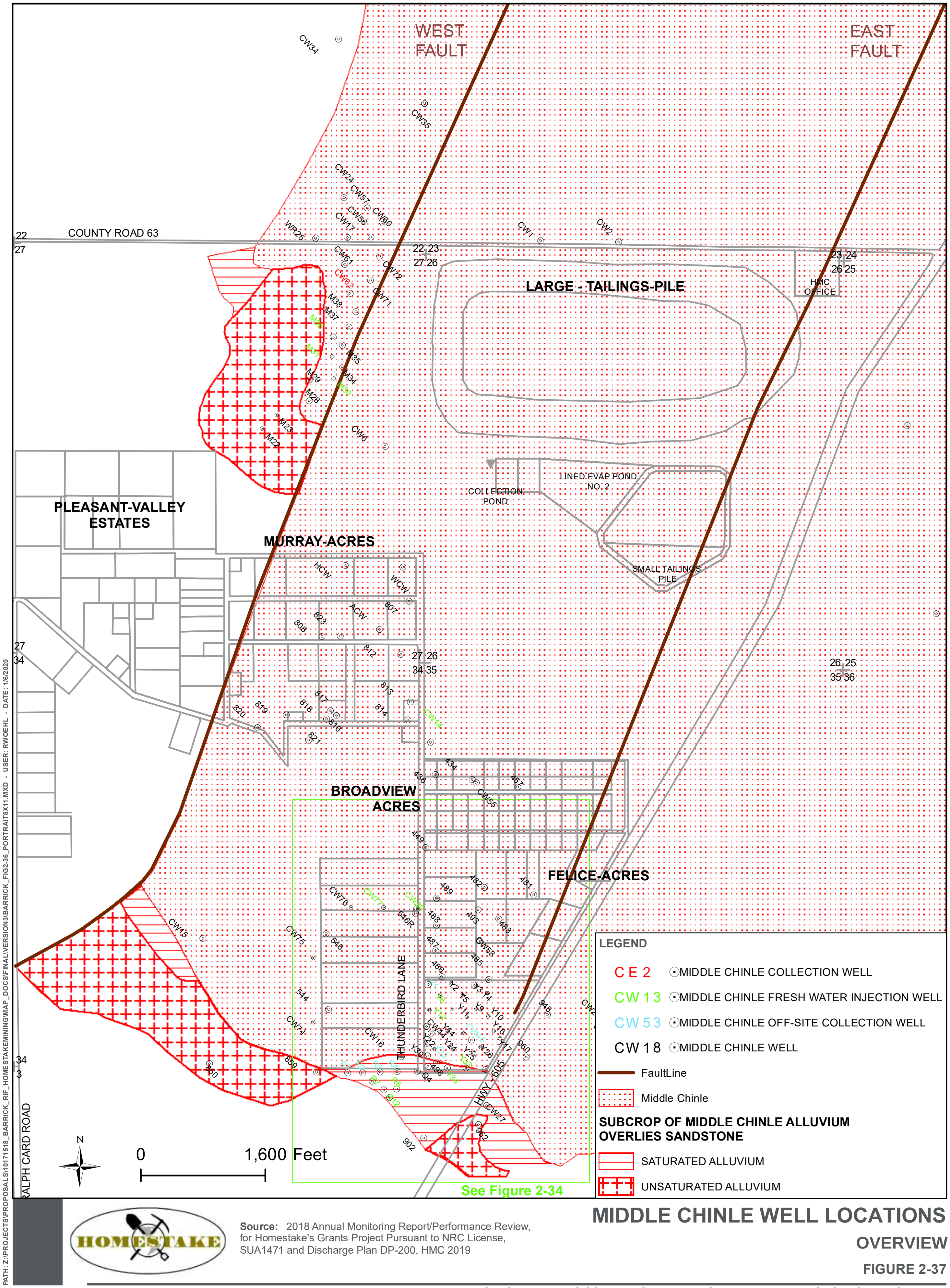
PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-35TRANSMID_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/6/2020

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

MIDDLE CHINLE TRANSMISSIVITY

OVERVIEW MAP

FIGURE 2-36

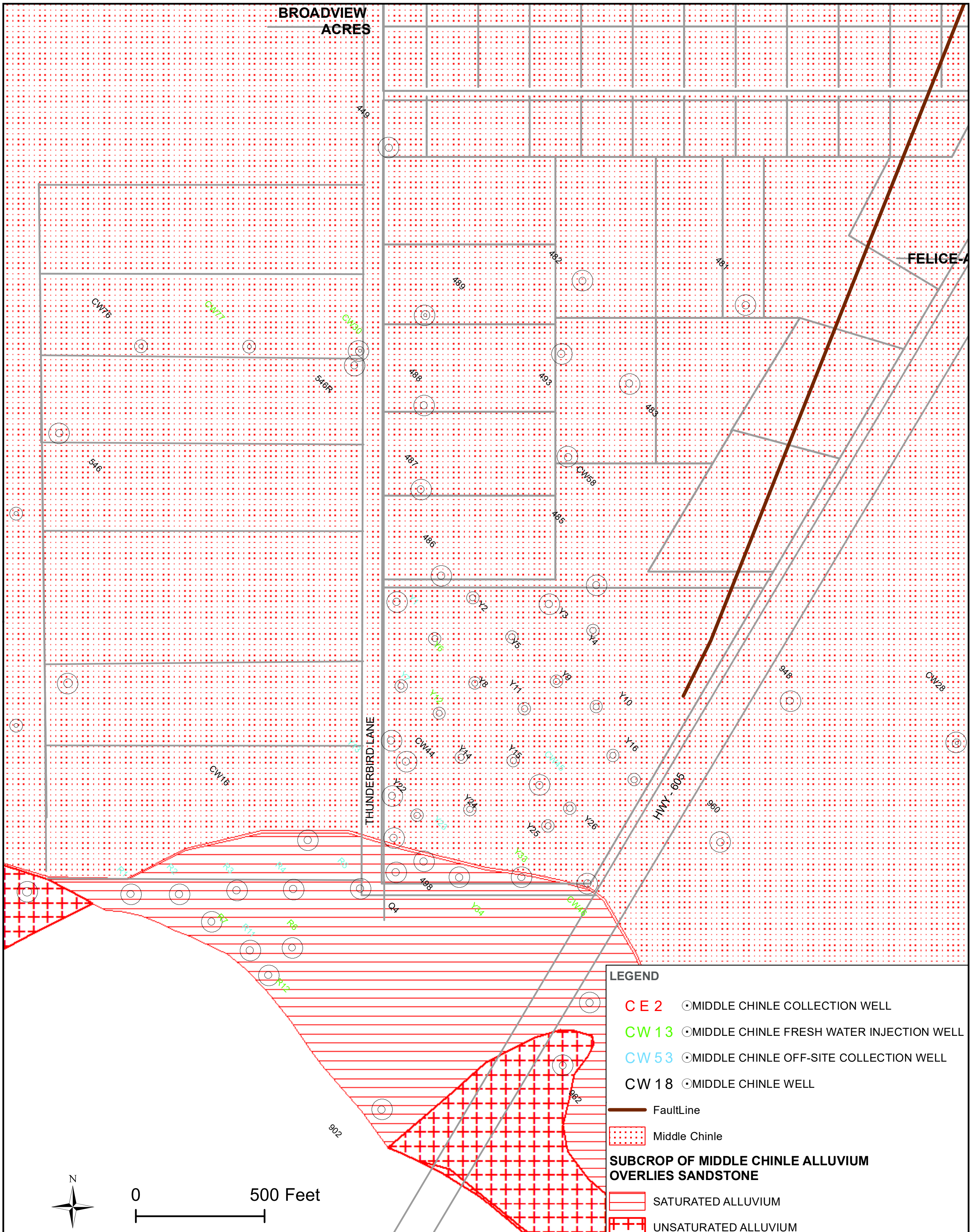


Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

MIDDLE CHINLE WELL LOCATIONS

OVERVIEW

FIGURE 2-37



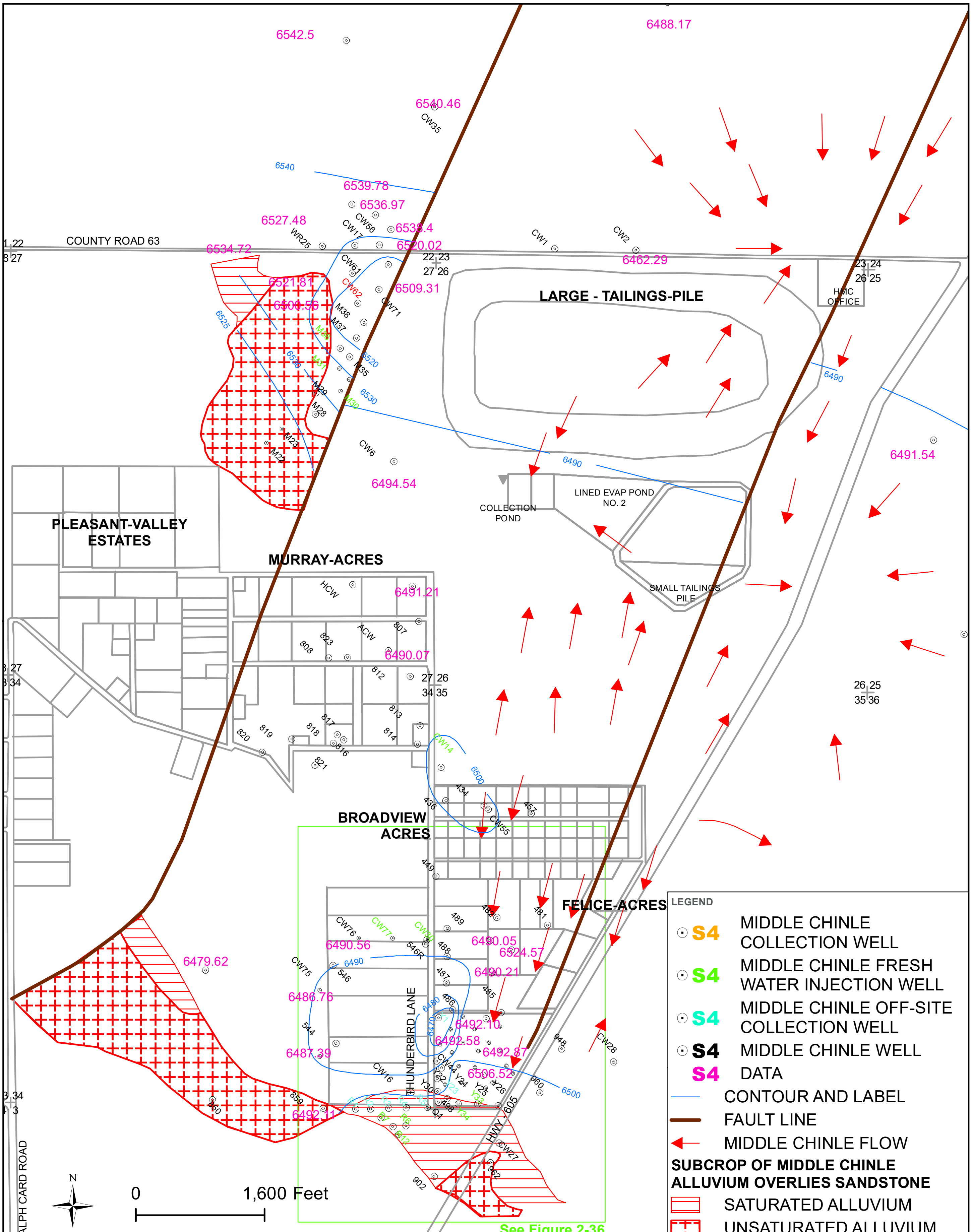
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-37_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/6/2020

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

MIDDLE CHINLE WELL LOCATIONS

DETAIL MAP

FIGURE 2-38



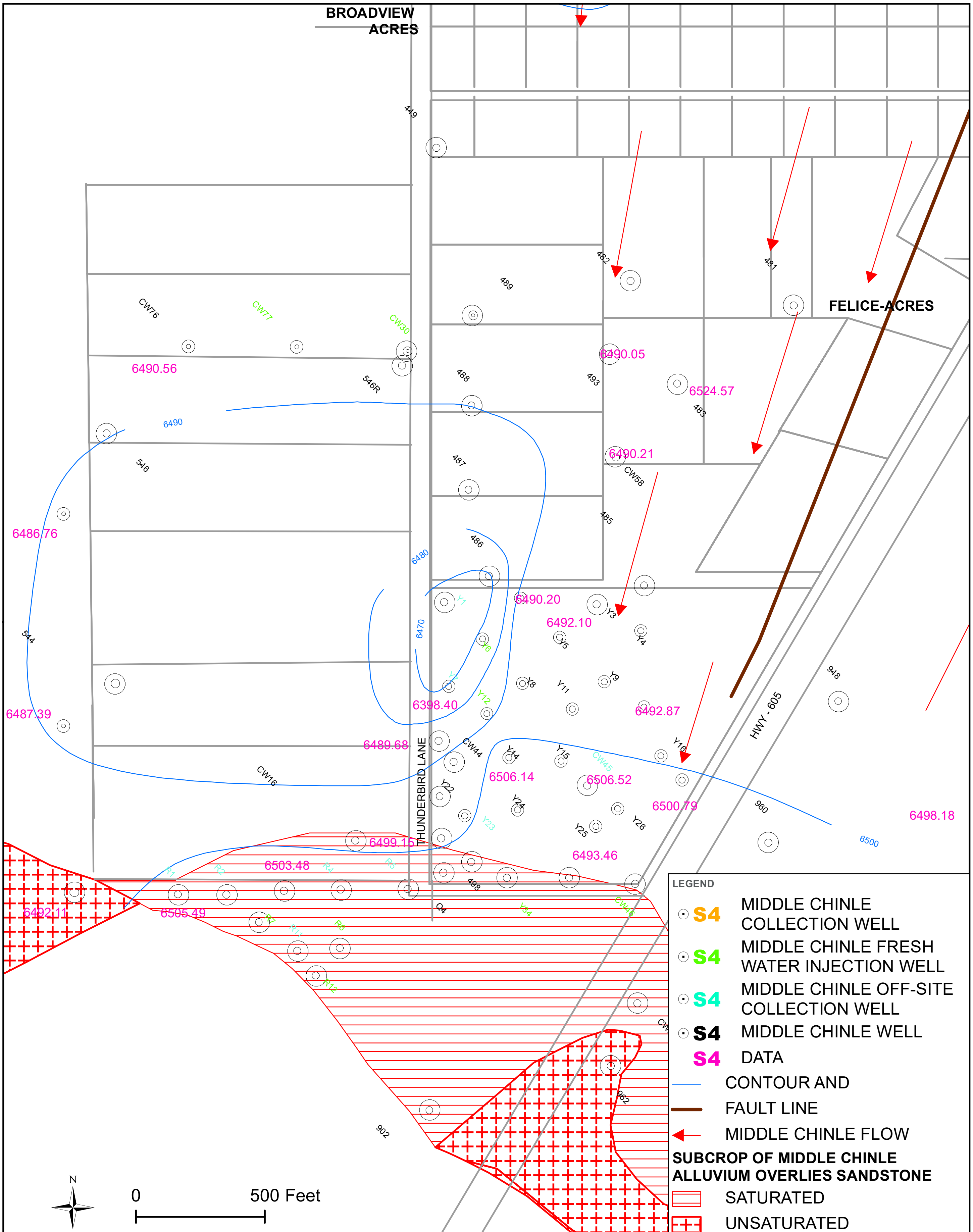
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINALVERSION3\BARRICK_FIG2-38_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

HOMESTAKE

MIDDLE CHINLE WATER ELEVATION AND FLOW DIRECTION MAP OVERVIEW

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 2-39



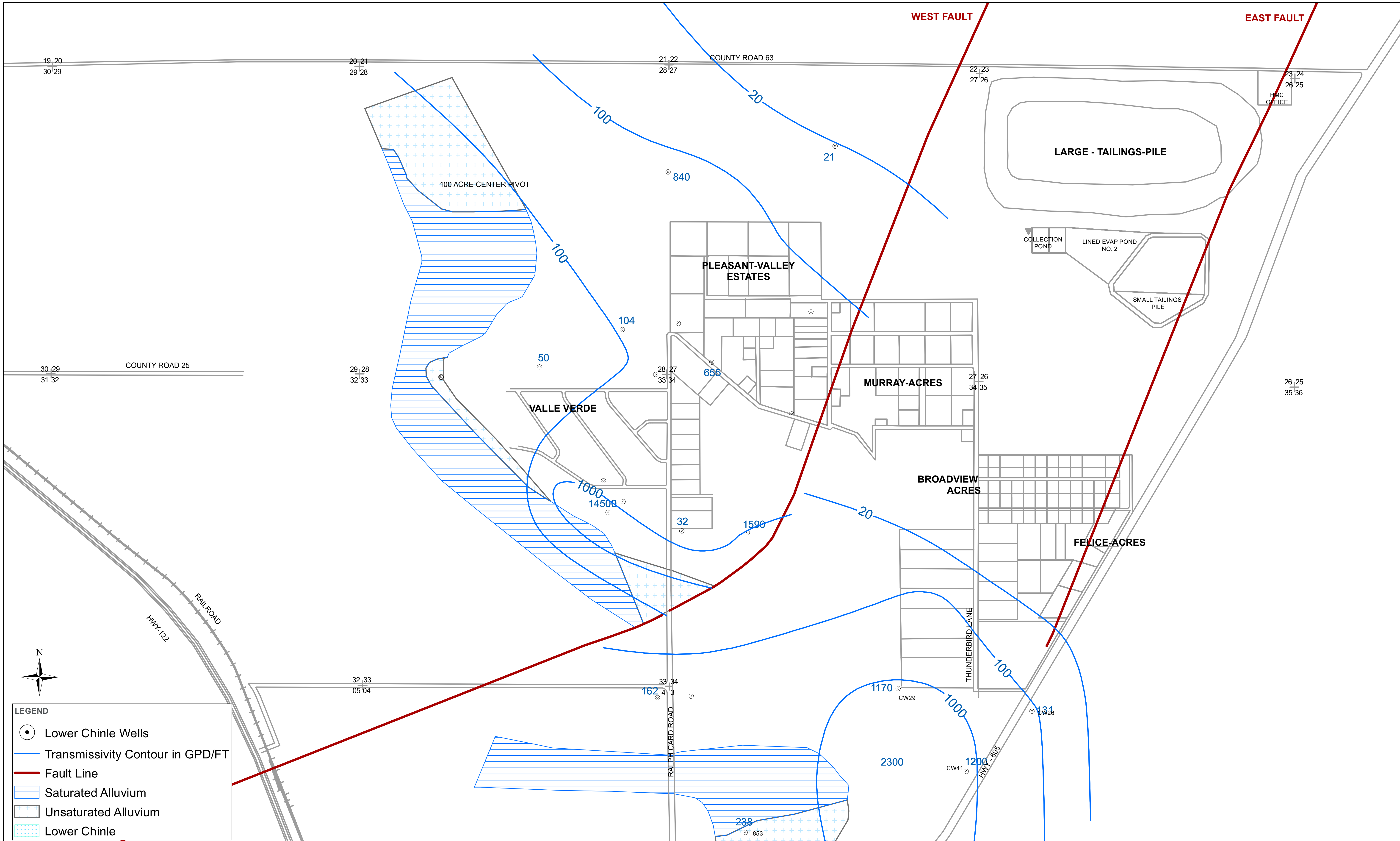
MIDDLE CHINLE WATER ELEVATION AND FLOW DIRECTION MAP

DETAIL MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 2-40

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-39_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/6/2020



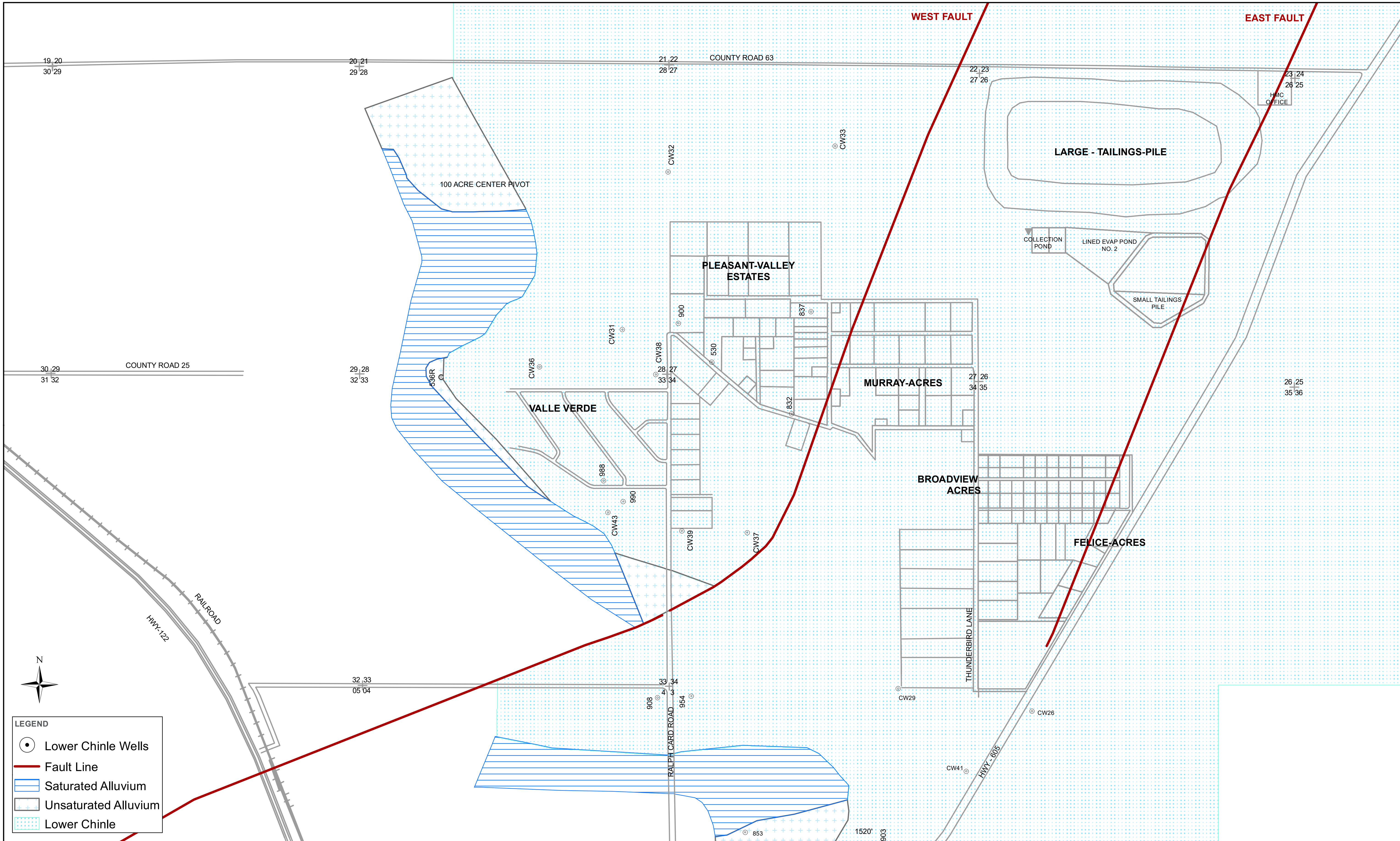
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

LOWER CHINLE TRANSMISIVITY

FIGURE 2-41

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-40TRANS_LOWERLANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 1/6/2020



HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

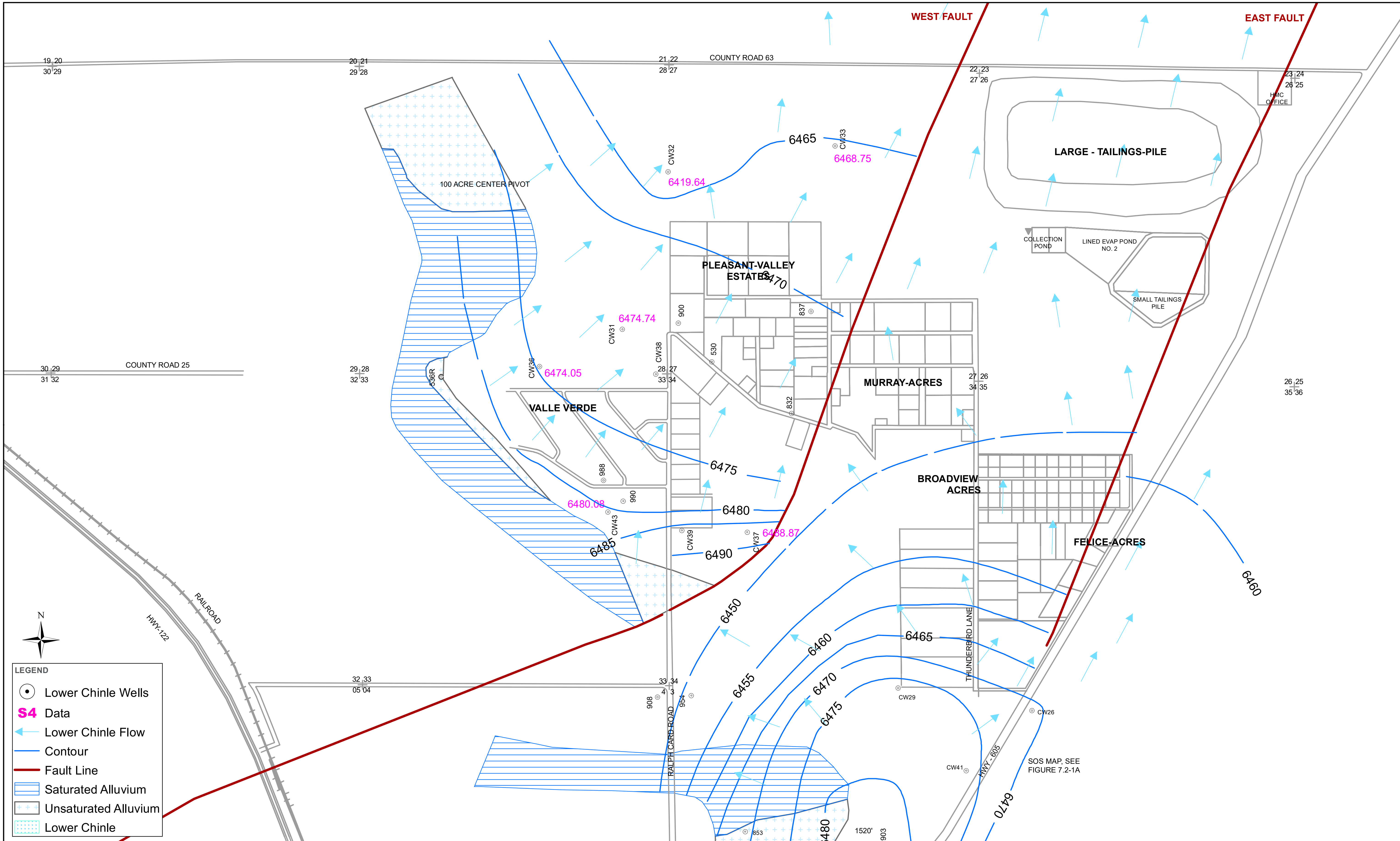
0 1,500 Feet

LOWER CHINLE WELL LOCATIONS

OVERVIEW MAP

FIGURE 2-42

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-41_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 1/3/2020



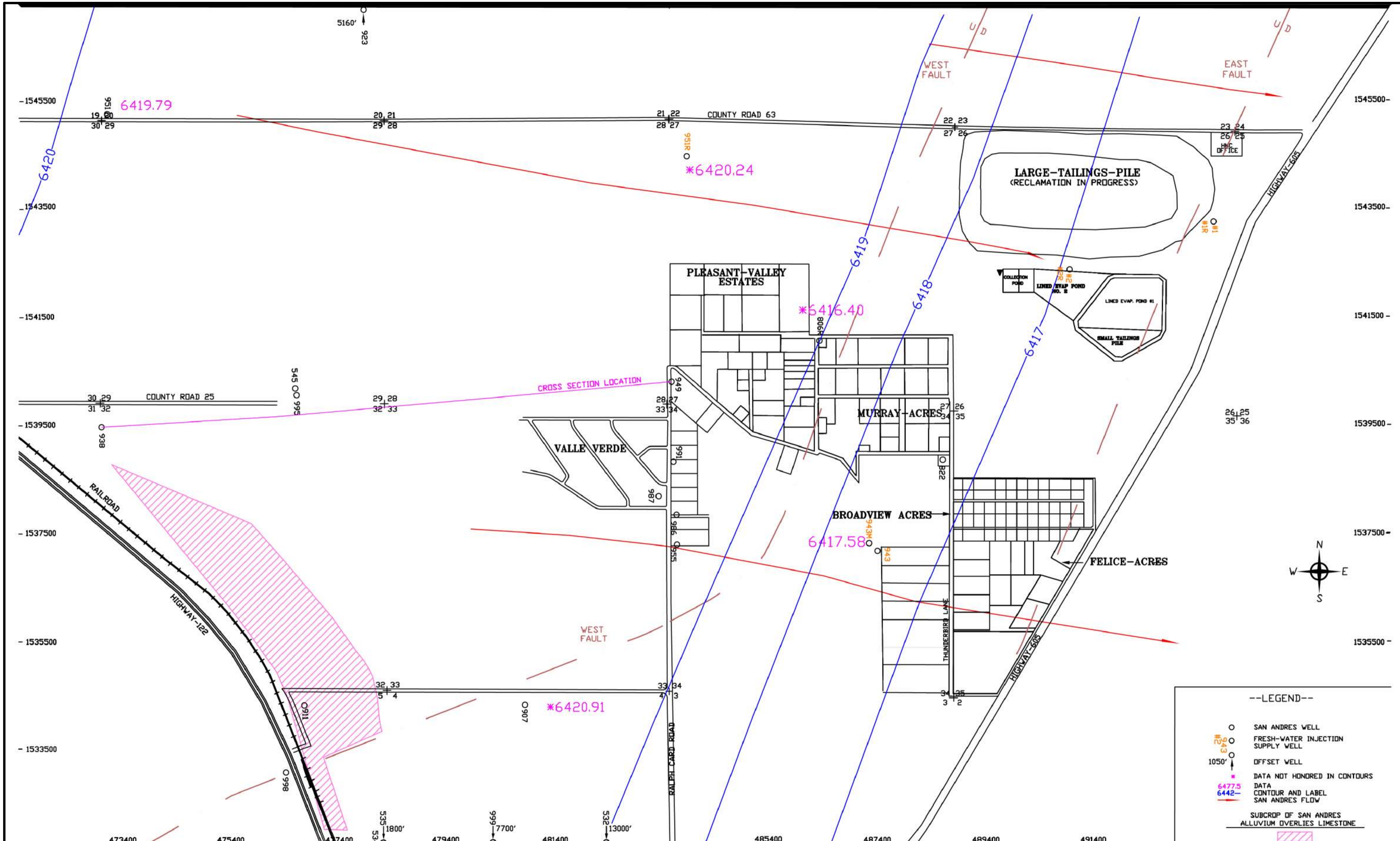
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

LOWER CHINLE WATER ELEVATION AND FLOW DIRECTION OVERVIEW MAP

FIGURE 2-43



HOMESTAKE

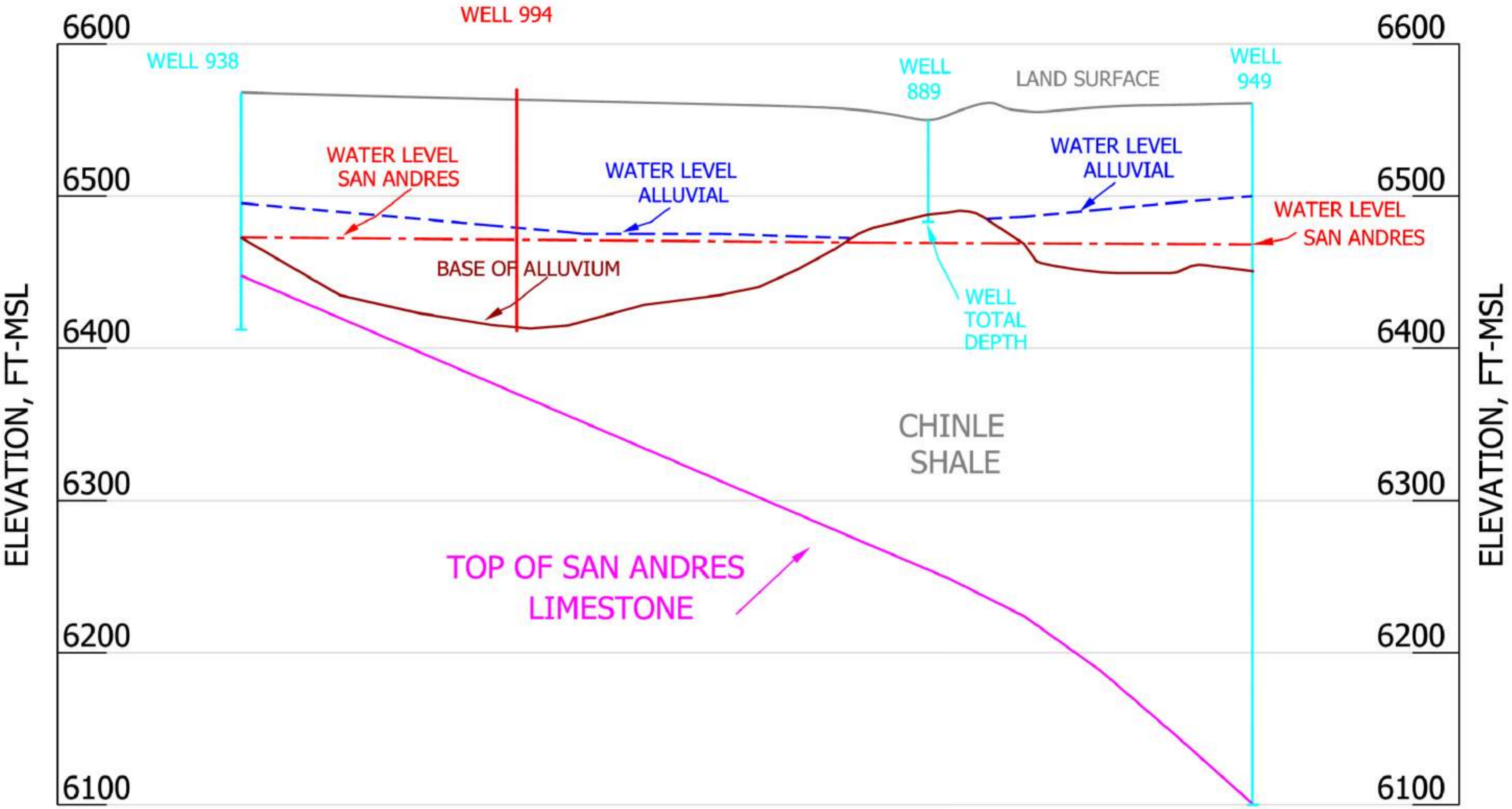
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

SAG WELL LOCATION, WATER ELEVATION, AND FLOW DIRECTION MAP

OVERVIEW MAP

FIGURE 2-44

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG2-43_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 1/3/2020



8.0-4

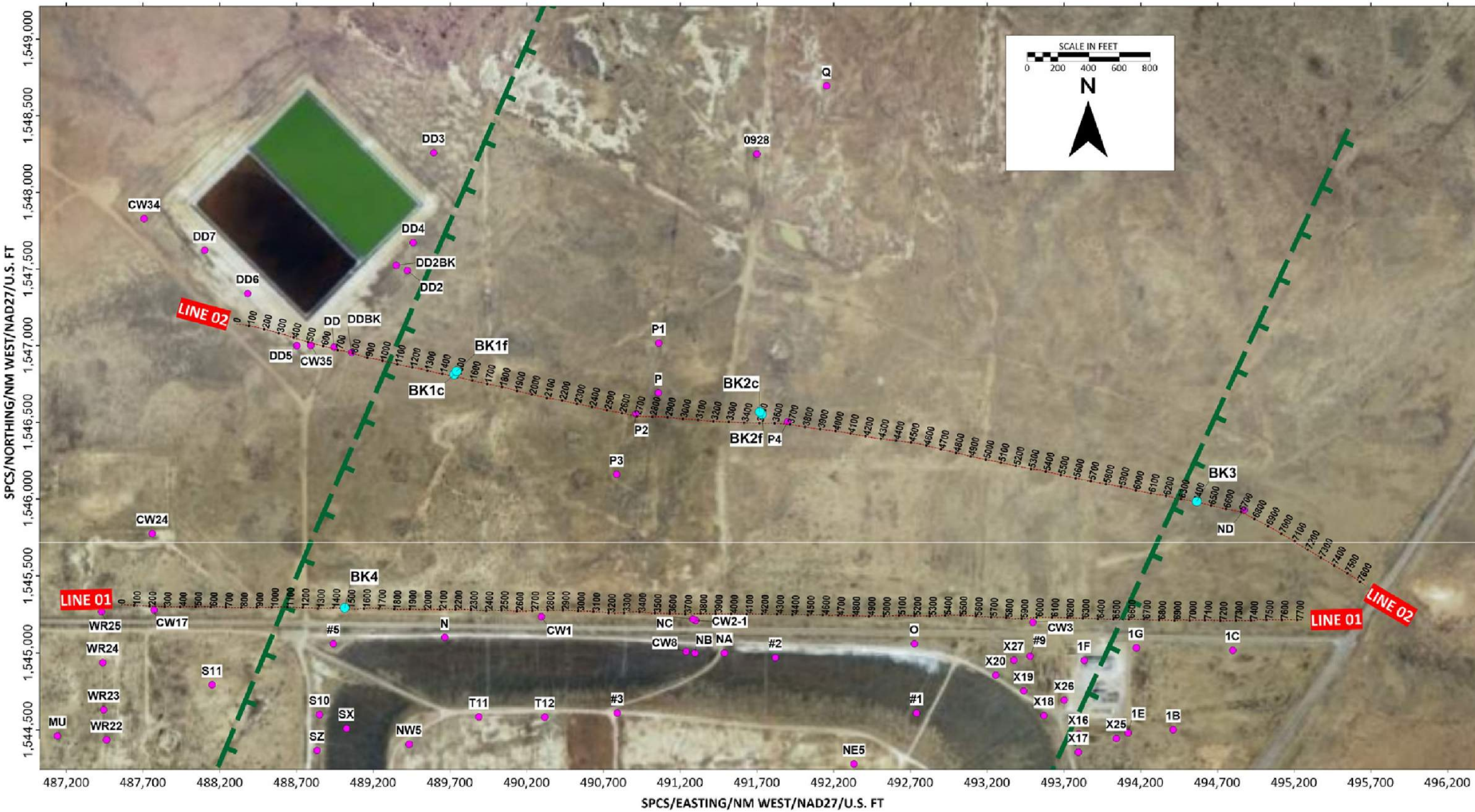
NOTE: X-SECTION BASED ON LOGS FROM WELLS 938, 889, AND 949.

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

SAG CROSS-SECTION

CROSS SECTION

FIGURE 2-45



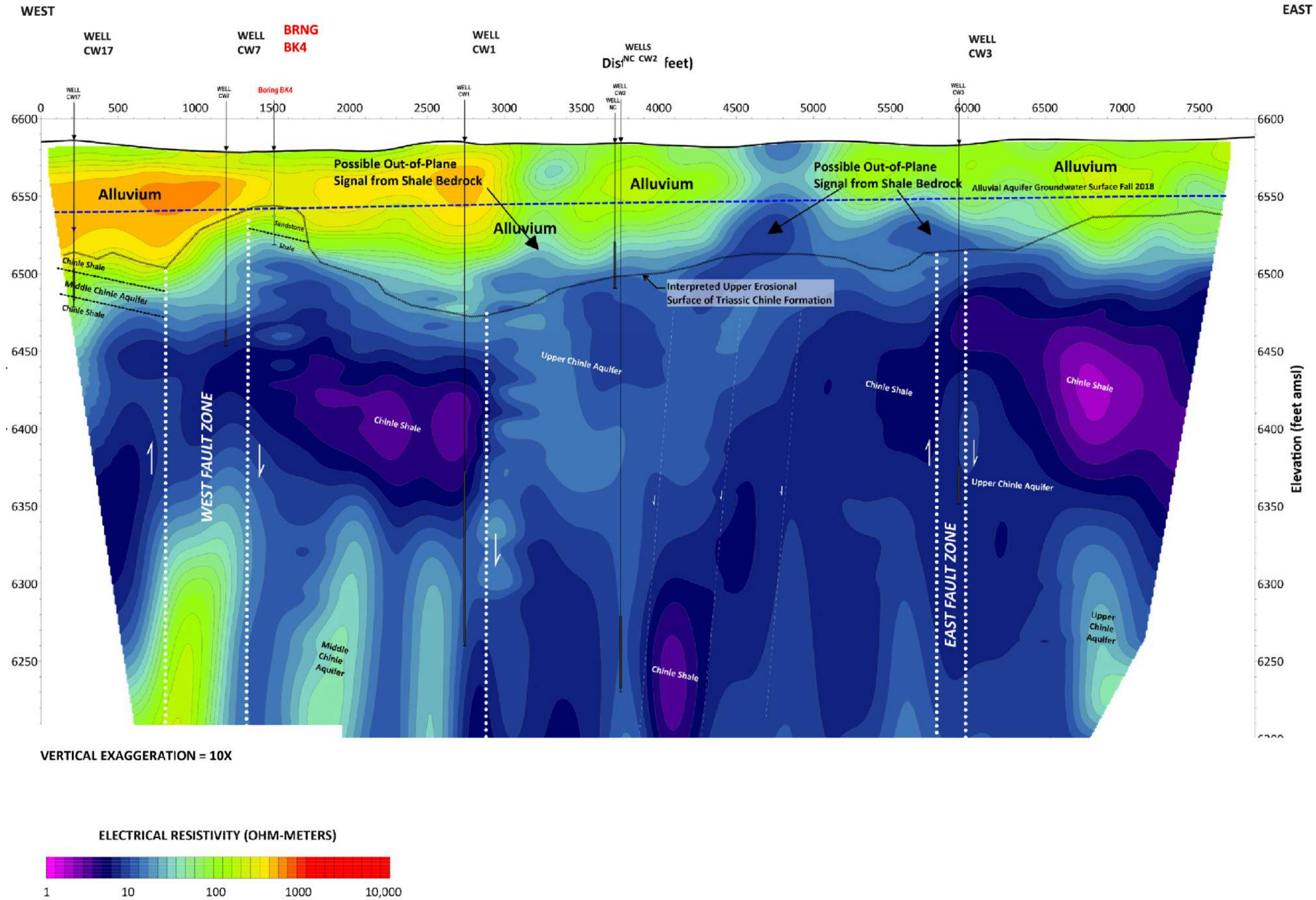
HOMESTAKE

Source: Draft Supplemental Background Soil and Groundwater Investigation Report Grants Reclamation Project, Cibola County, New Mexico. August 2019

SUPPLEMENTAL BACKGROUND INVESTIGATION BORING AND ERT LINE LOCATION PLAN

OVERVIEW MAP

FIGURE 2-46

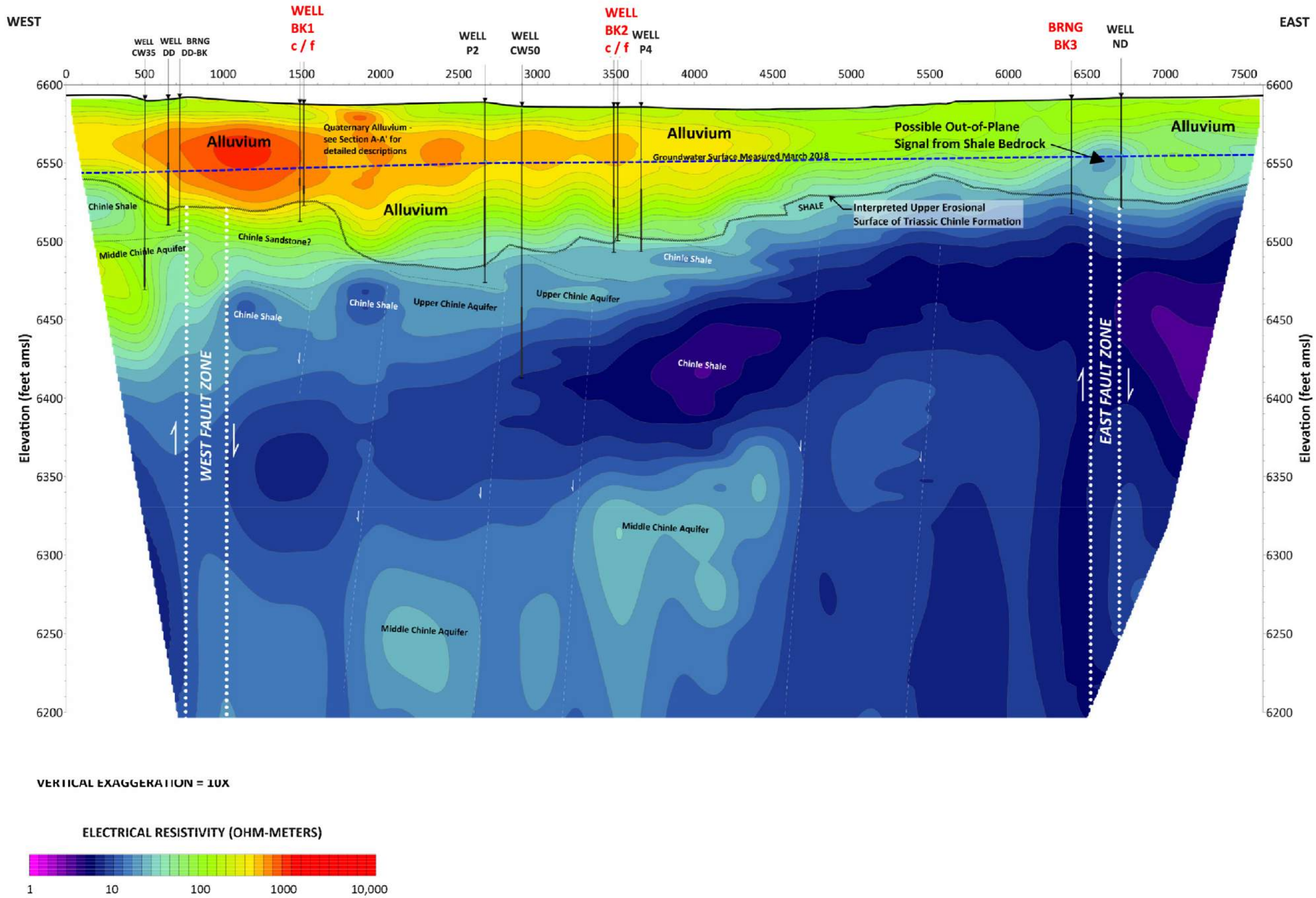


Source: Draft Supplemental Background Soil and Groundwater Investigation Report Grants Reclamation Project, Cibola County, New Mexico. August 2019

SUPPLEMENTAL BACKGROUND INVESTIGATION ERT LINE 1 CROSS-SECTION

2D INVERSION MODEL

FIGURE 2-47



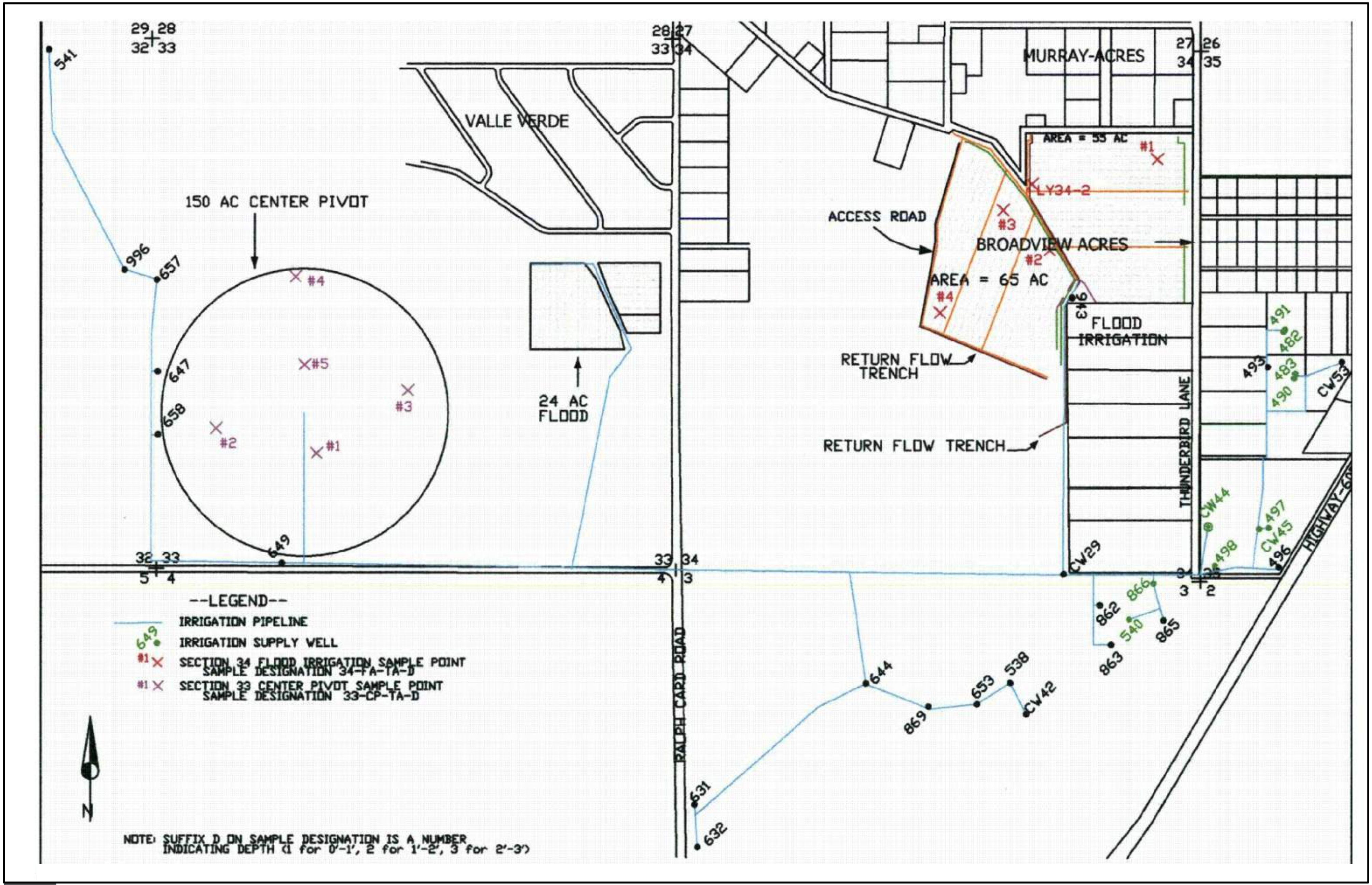
HOMESTAKE

Source: Draft Supplemental Background Soil and Groundwater Investigation Report Grants Reclamation Project, Cibola County, New Mexico. August 2019

SUPPLEMENTAL BACKGROUND INVESTIGATION ERT LINE 2 CROSS-SECTION

2D INVERSION MODEL

FIGURE 2-48

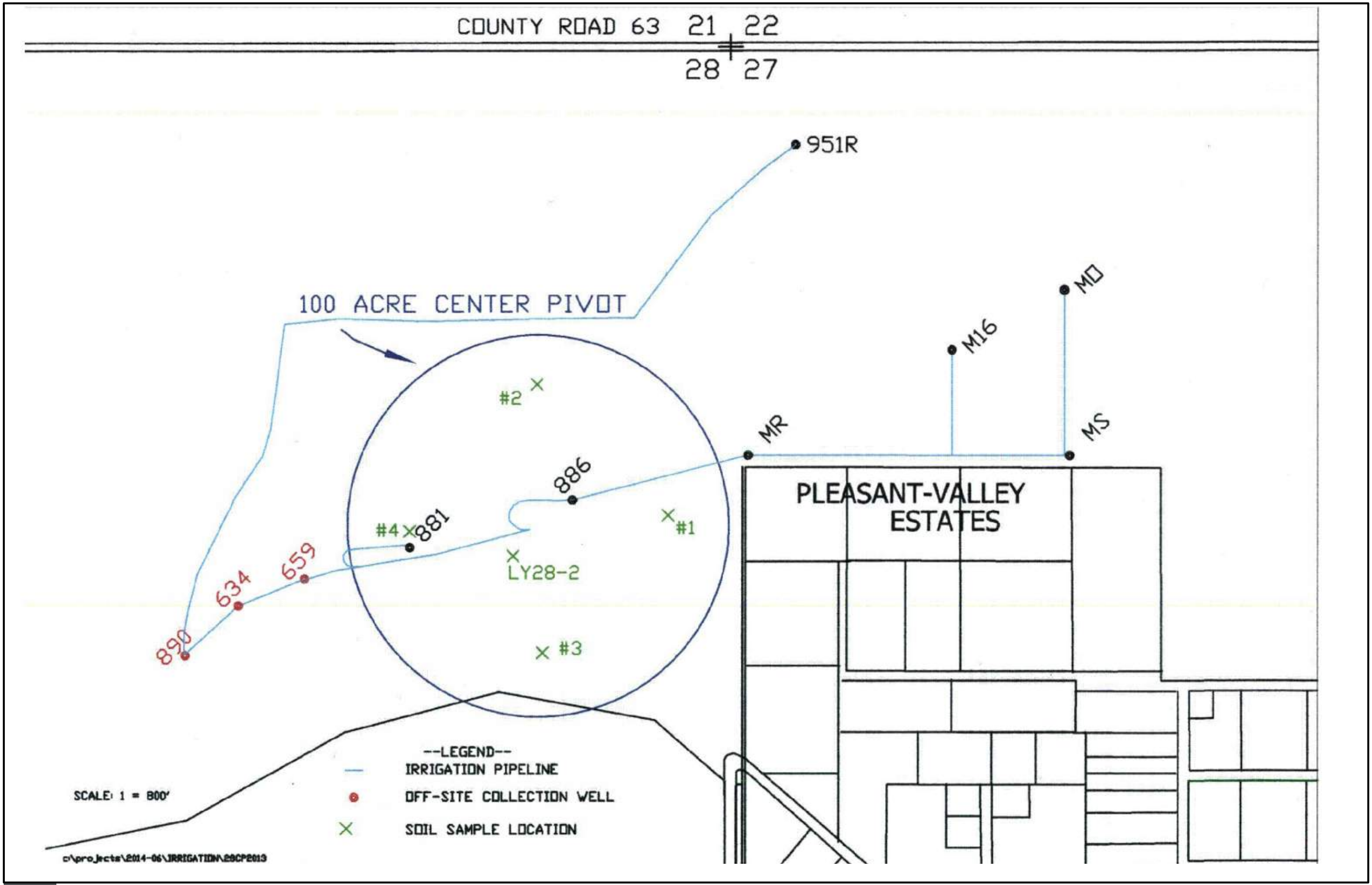


SECTION 33-34 IRRIGATION PIPELINES AND WELLS

HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

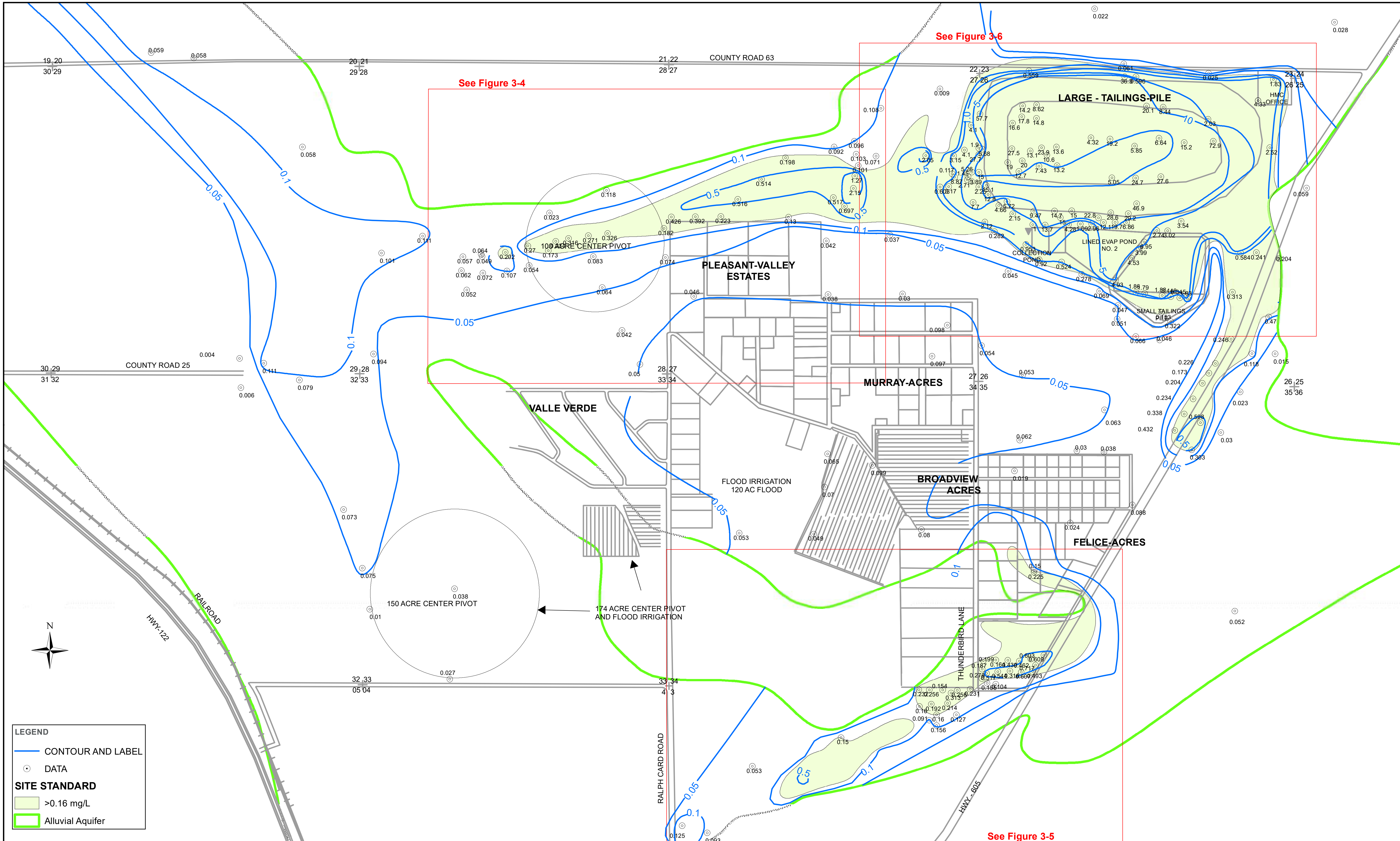
FIGURE 3-1



SECTION 28 IRRIGATION PIPELINES AND WELLS

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FIGURE 3-2



HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

ALLUVIAL AQUIFER URANIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-3

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-3_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/5/2019

HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER URANIUM CONCENTRATIONS

DETAIL MAP 1

FIGURE 3-4

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-4_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/5/2019

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER URANIUM CONCENTRATIONS

DETAIL MAP 2

FIGURE 3-5

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-5_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/5/2019

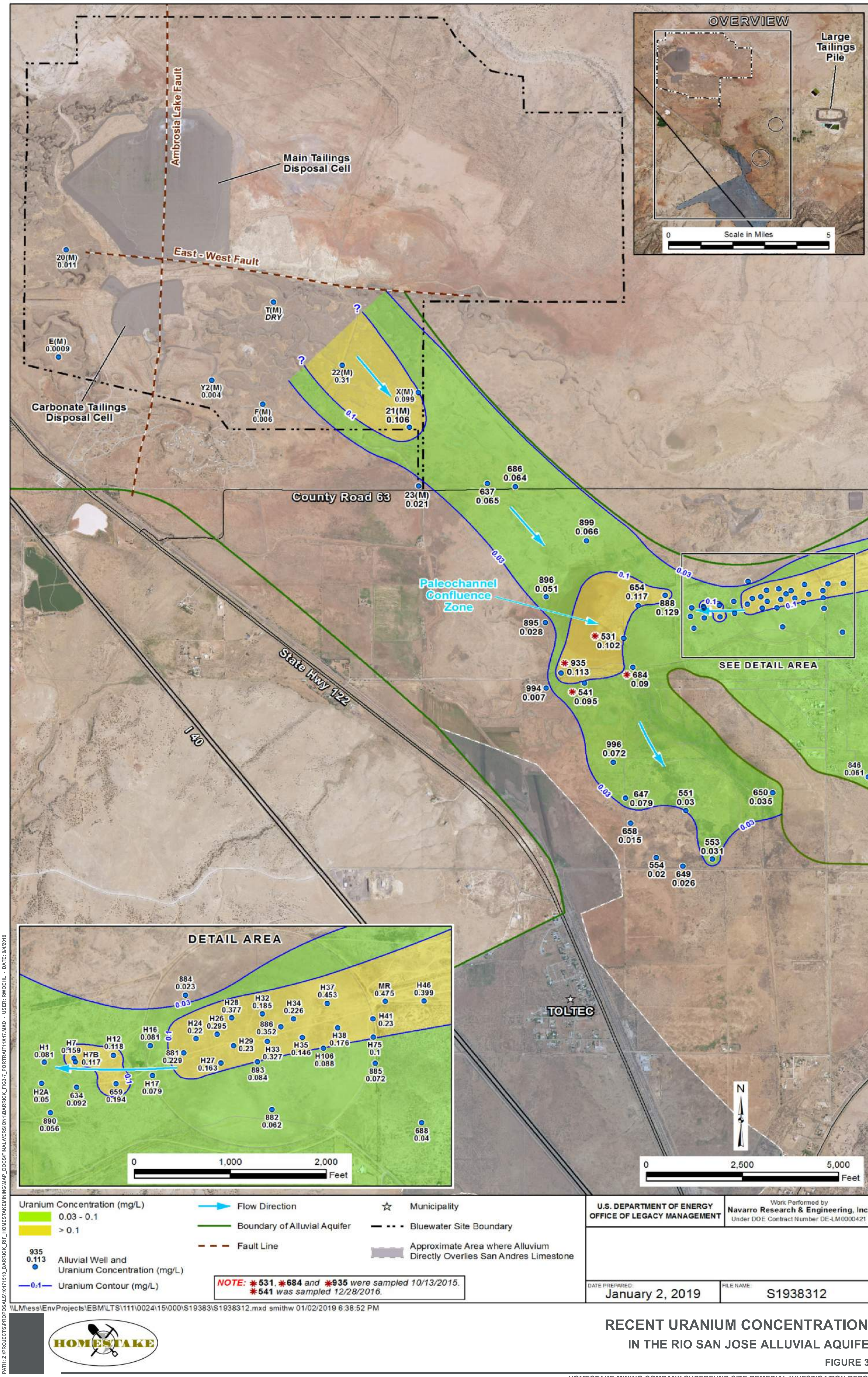
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER URANIUM CONCENTRATIONS

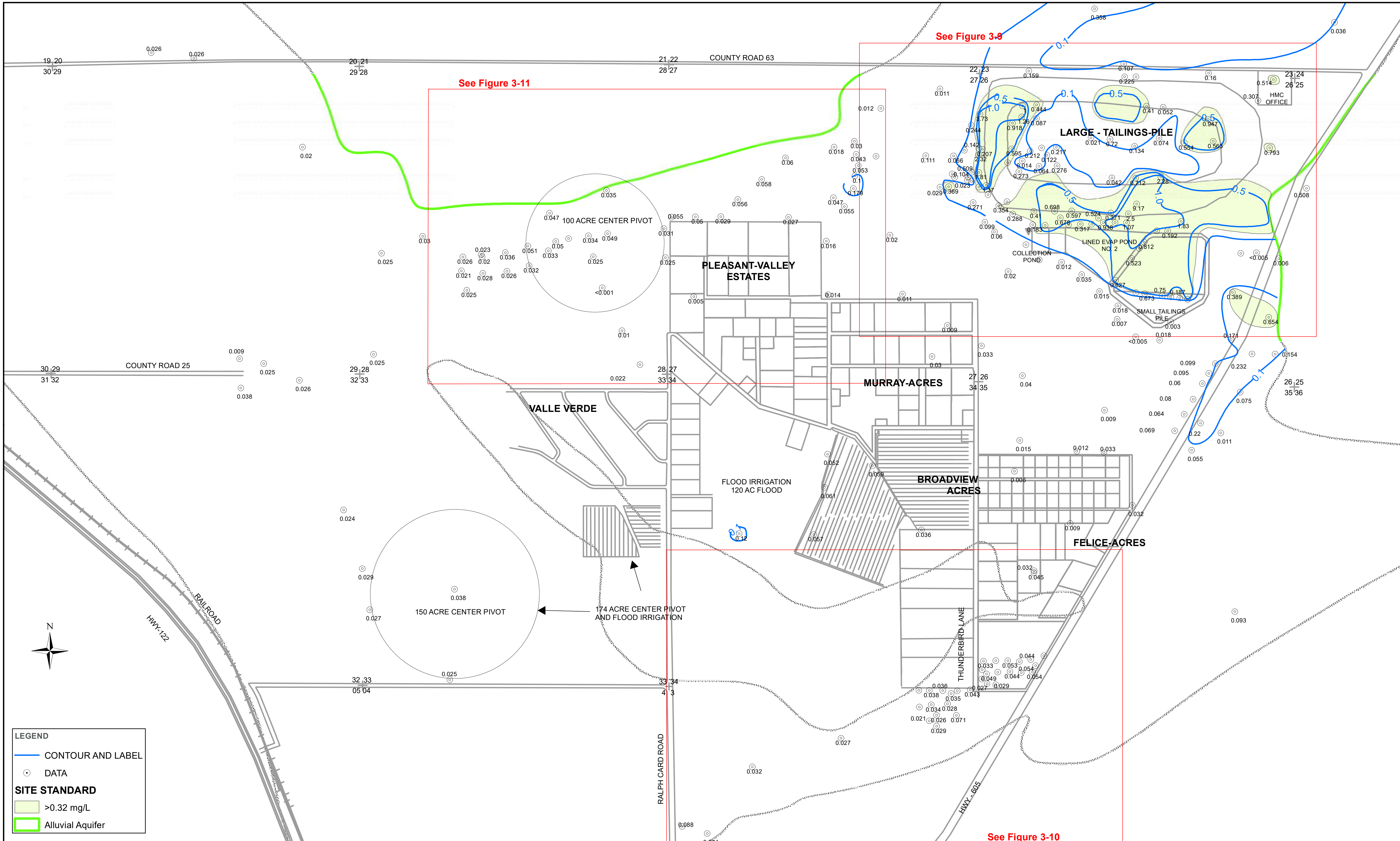
DETAIL MAP 3

FIGURE 3-6



RECENT URANIUM CONCENTRATIONS IN THE RIO SAN JOSE ALLUVIAL AQUIFER

FIGURE 3-7



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

ALLUVIAL AQUIFER SELENIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-8

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-8_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER SELENIUM CONCENTRATIONS

DETAIL MAP 1

FIGURE 3-9

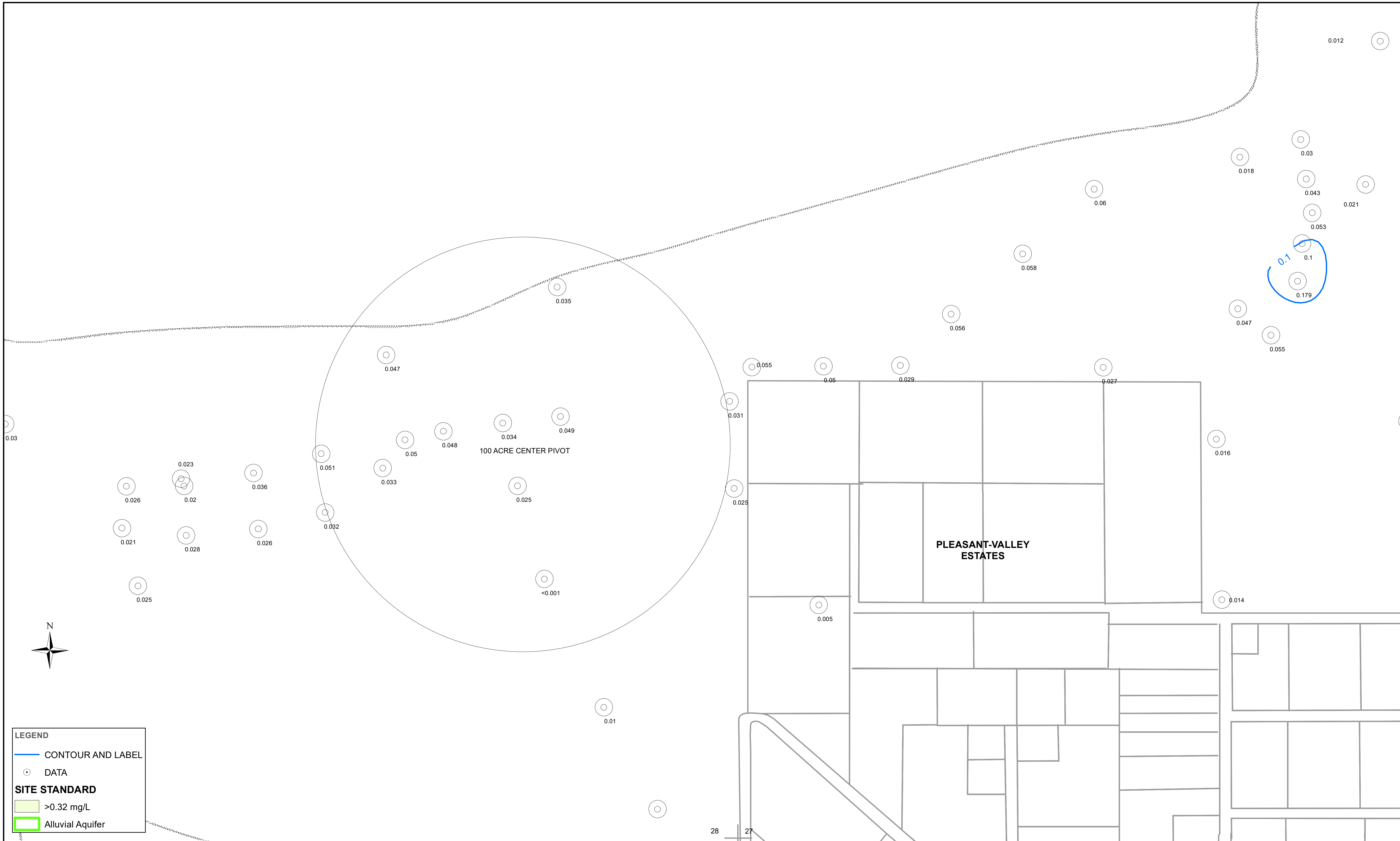
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

ALLUVIAL AQUIFER SELENIUM CONCENTRATIONS

DETAIL MAP 2

FIGURE 3-10

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-10_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



HOMESTAKE

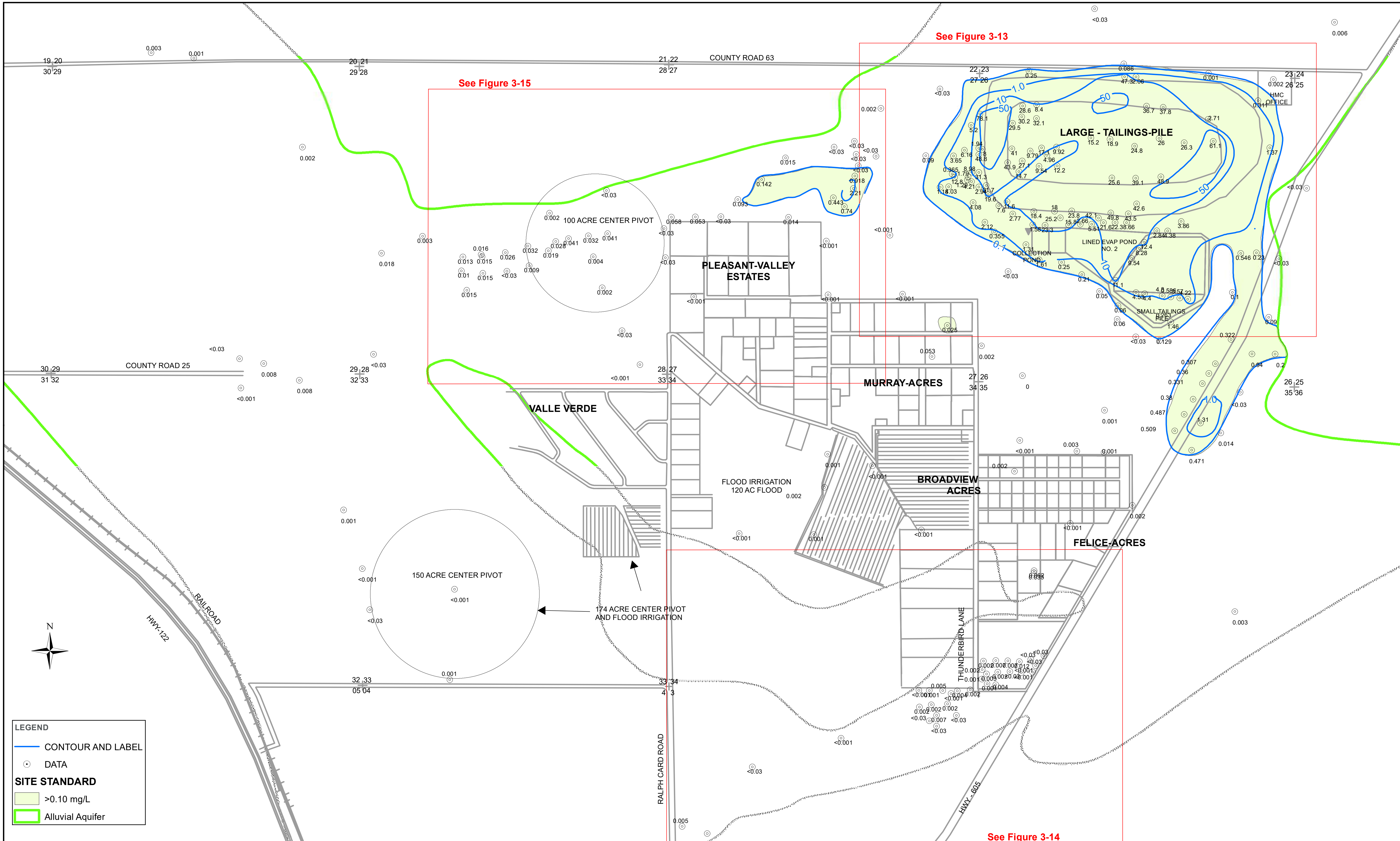
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

ALLUVIAL AQUIFER SELENIUM CONCENTRATIONS

DETAIL MAP 3

FIGURE 3-11

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-11_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

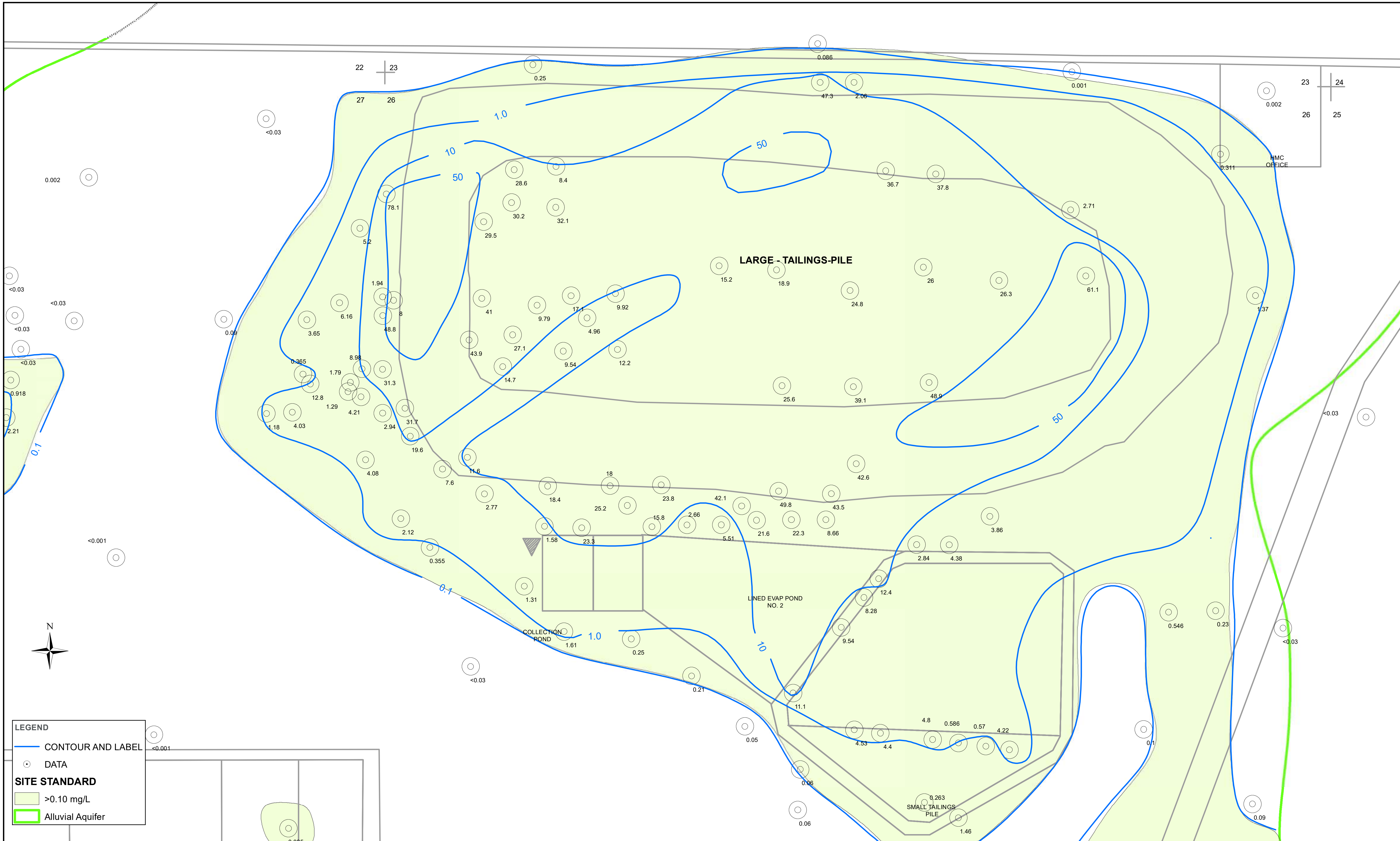
0 1,500 Feet

ALLUVIAL AQUIFER MOLYBDENUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-12

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-12_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

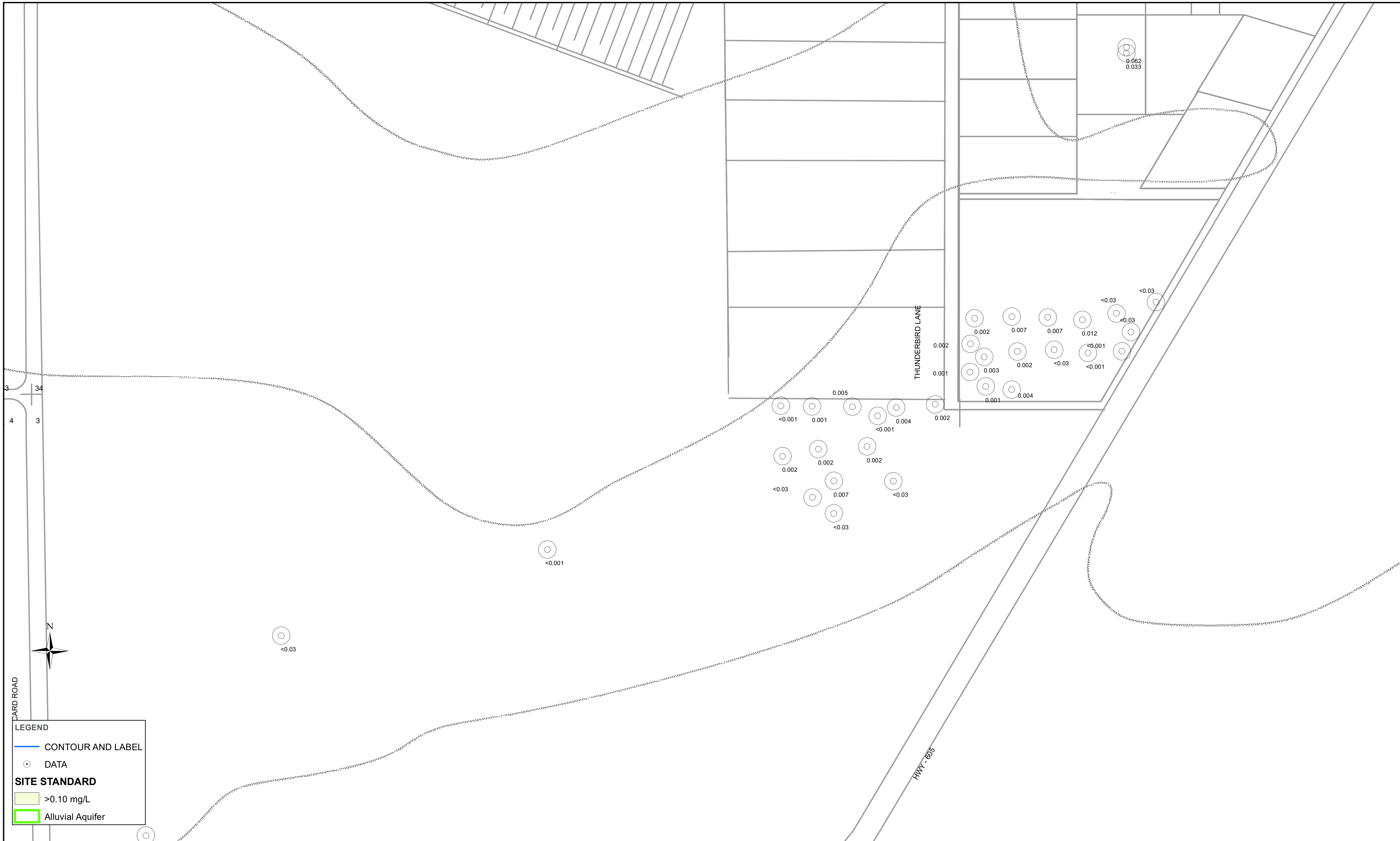
0 500 Feet

ALLUVIAL AQUIFER MOLYBDENUM CONCENTRATIONS

DETAIL MAP1

FIGURE 3-13

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-13_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER MOLYBDENUM CONCENTRATIONS

DETAIL MAP 2

FIGURE 3-14

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-14_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

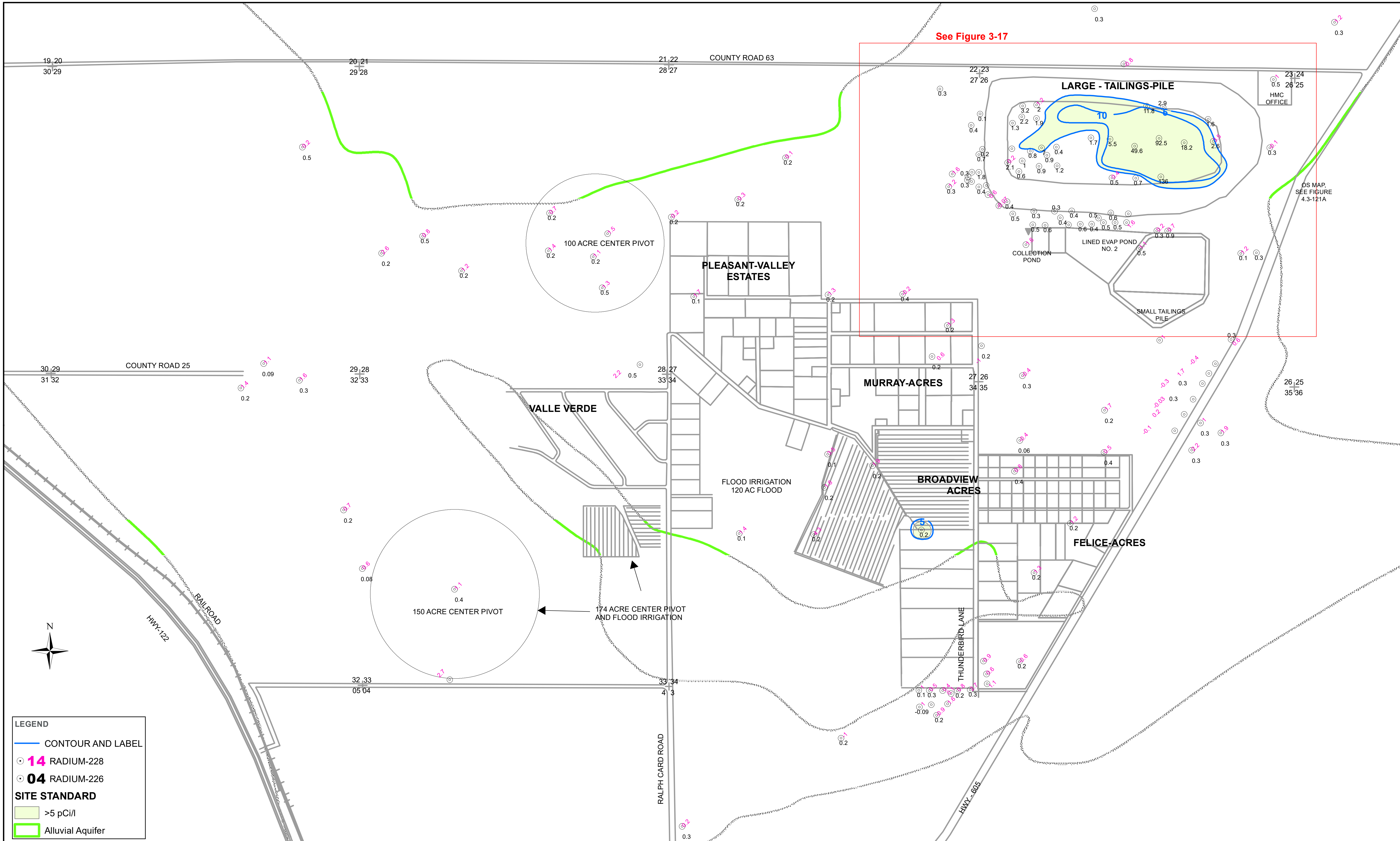
0 500 Feet

ALLUVIAL AQUIFER MOLYBDENUM CONCENTRATIONS

DETAIL MAP 3

FIGURE 3-15

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-15_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

ALLUVIAL AQUIFER RADIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-16

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-16_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019

HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

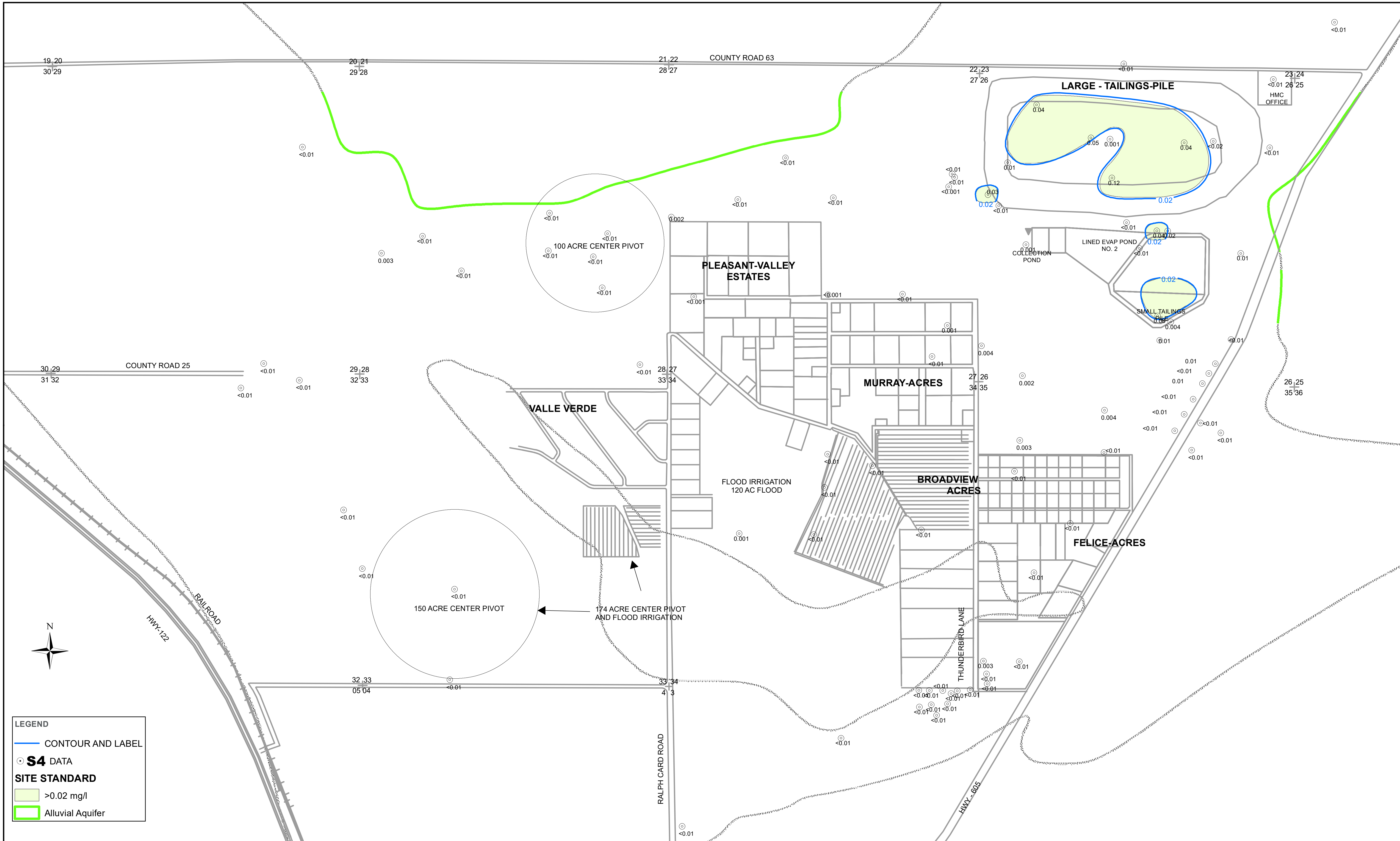
0 500 Feet

ALLUVIAL AQUIFER RADIUM CONCENTRATIONS

DETAIL MAP 1

FIGURE 3-17

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-17_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

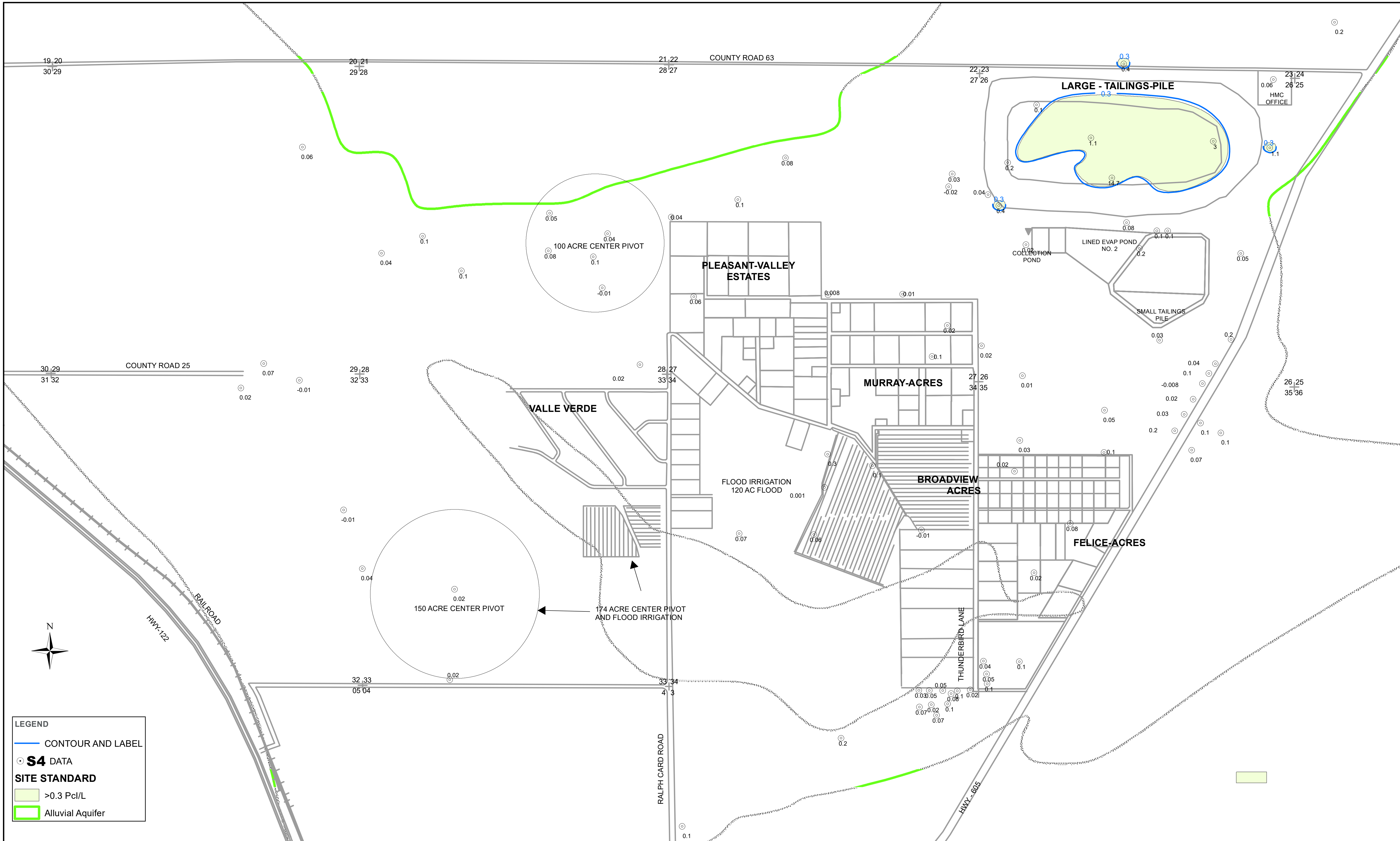
0 1,500 Feet

ALLUVIAL AQUIFER VANADIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-18

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-18_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



HOMESTAKE

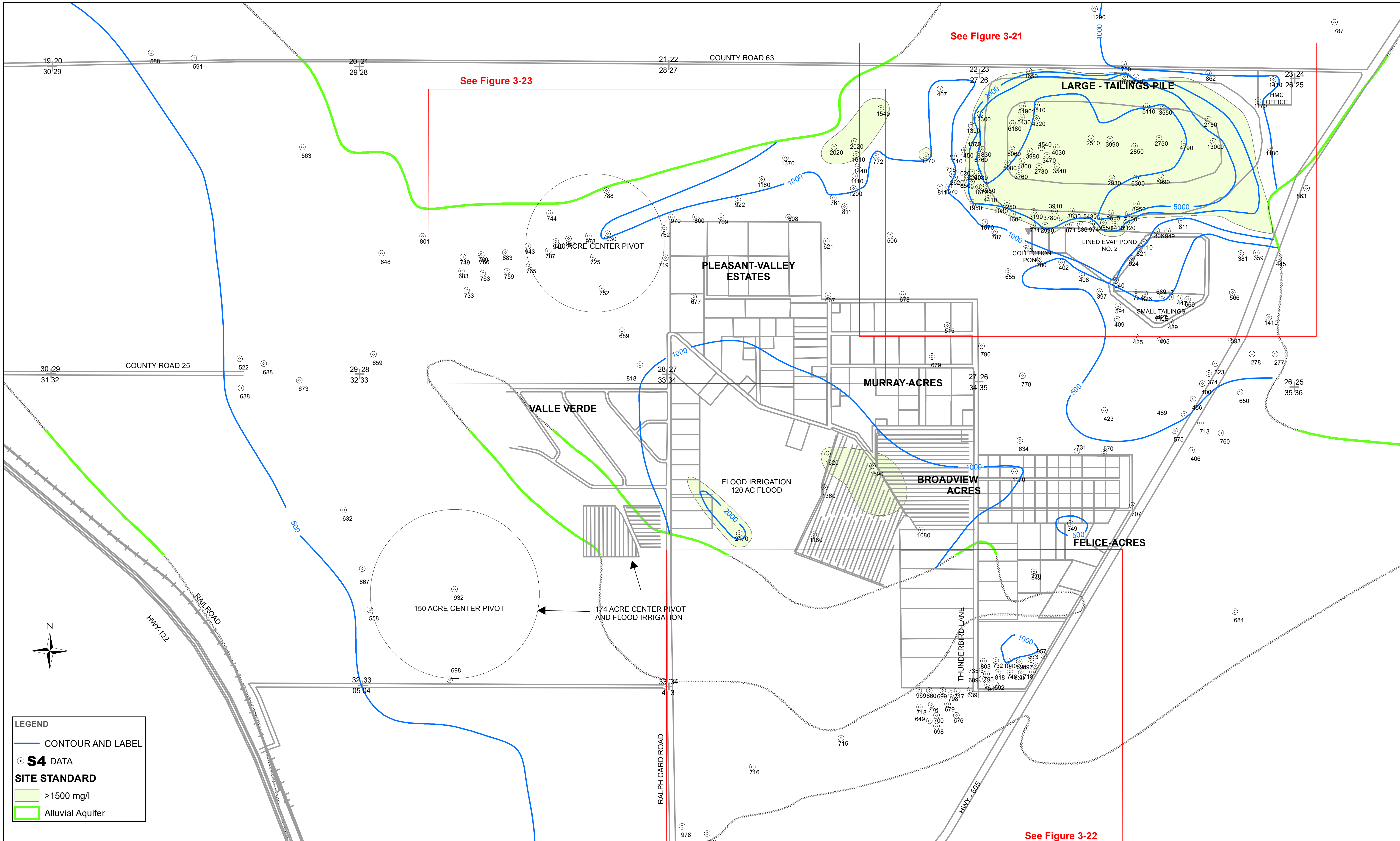
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

ALLUVIAL AQUIFER THORIUM-230 CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-19



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

HOMESTAKE

ALLUVIAL AQUIFER SULFATE CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-20

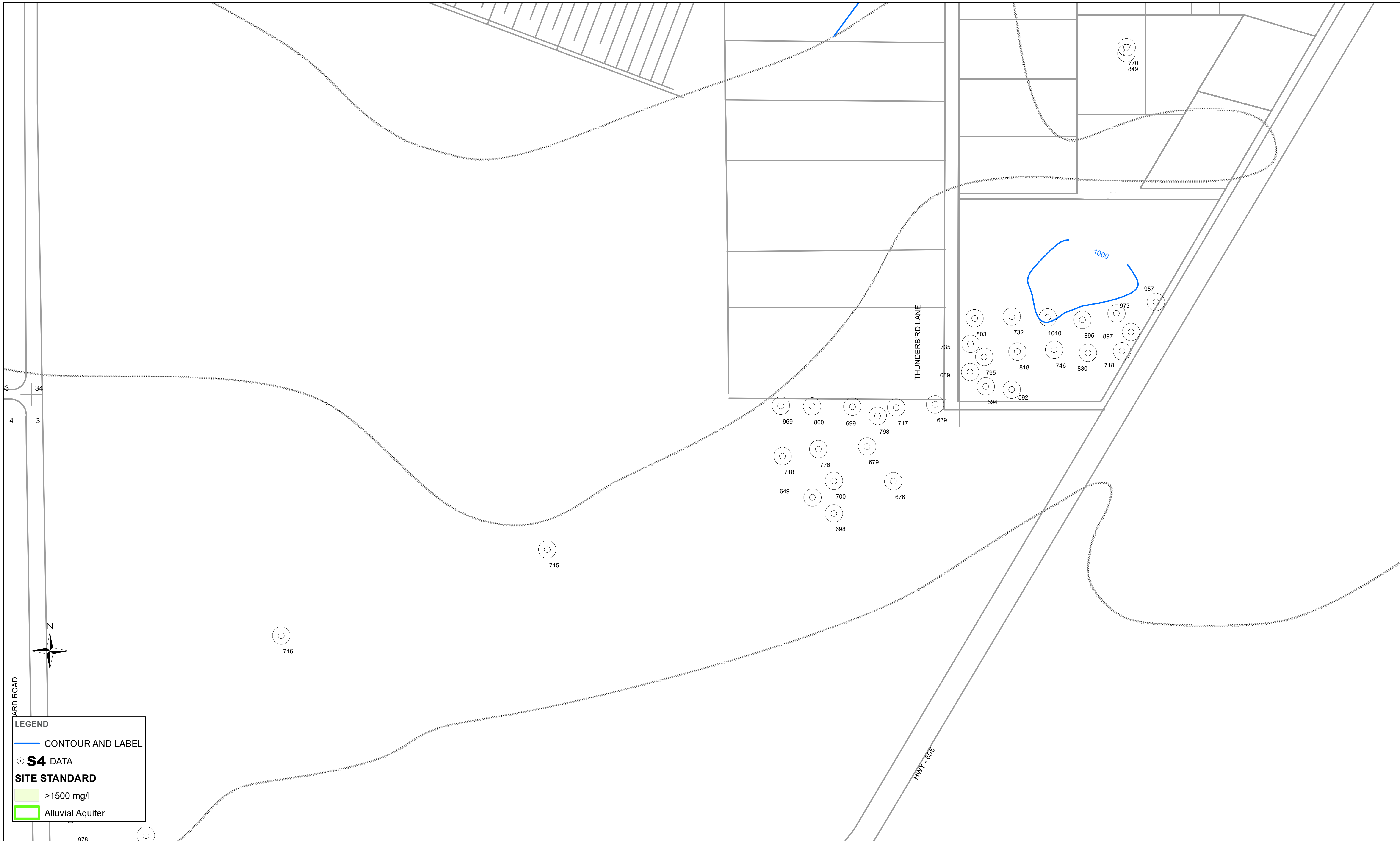
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER SULFATE CONCENTRATIONS

DETAIL MAP 1

FIGURE 3-21



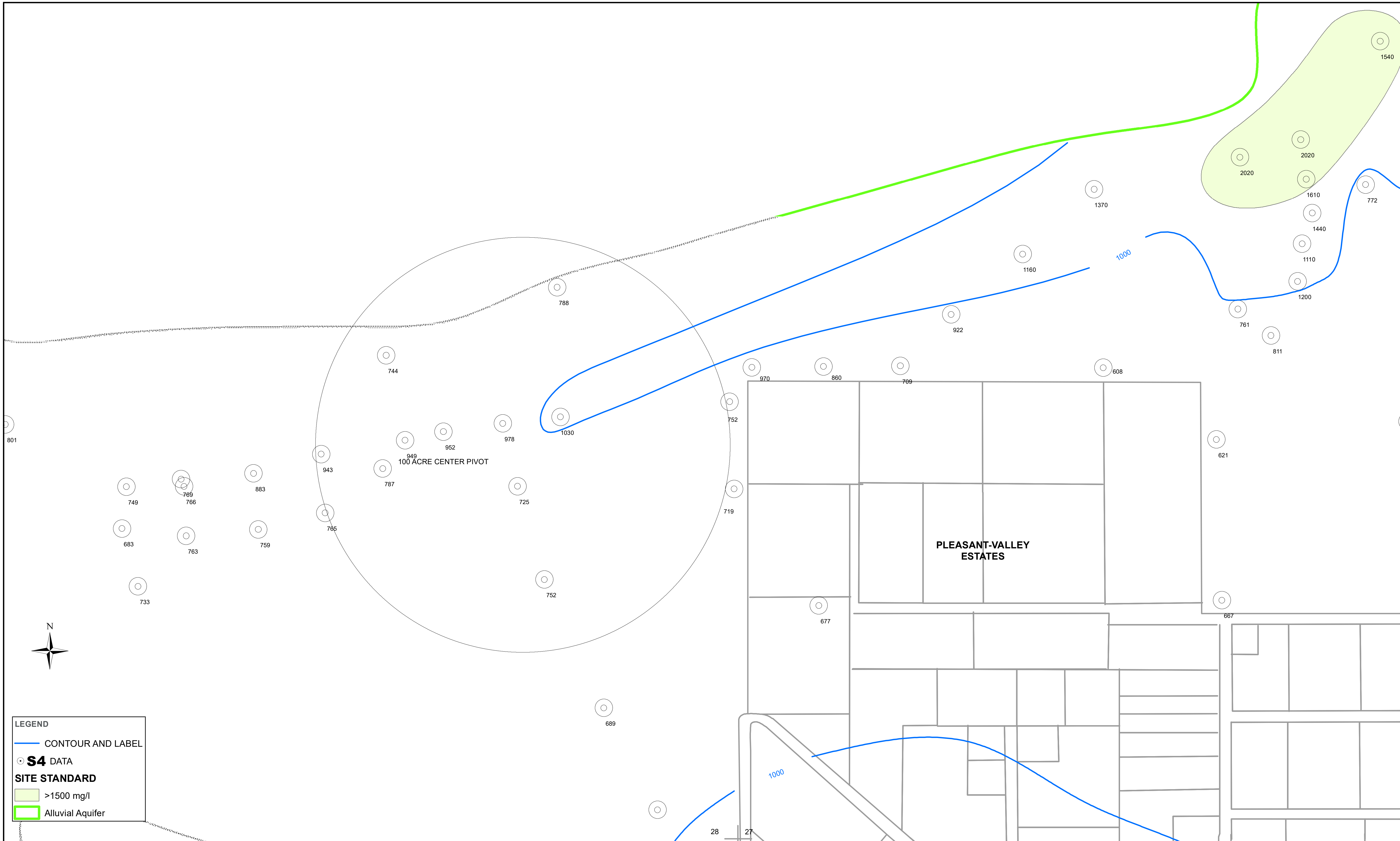
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER SULFATE CONCENTRATIONS

DETAIL MAP 2

FIGURE 3-22



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

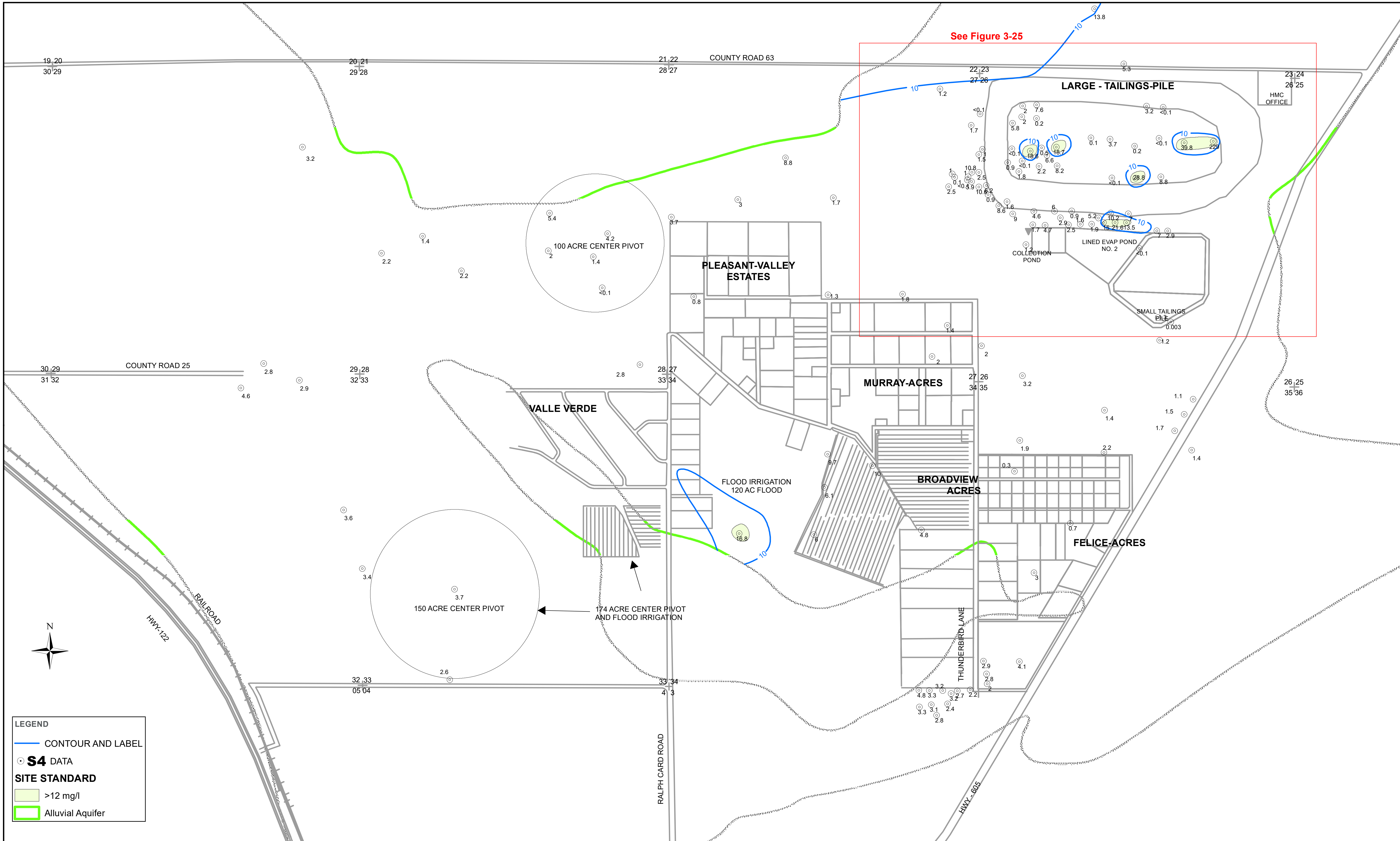
0 500 Feet

HOMESTAKE

ALLUVIAL AQUIFER SULFATE CONCENTRATIONS

DETAIL MAP 3

FIGURE 3-23



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

ALLUVIAL AQUIFER NITRATE CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-24

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-24_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER NITRATE CONCENTRATIONS

DETAIL MAP 1

FIGURE 3-25

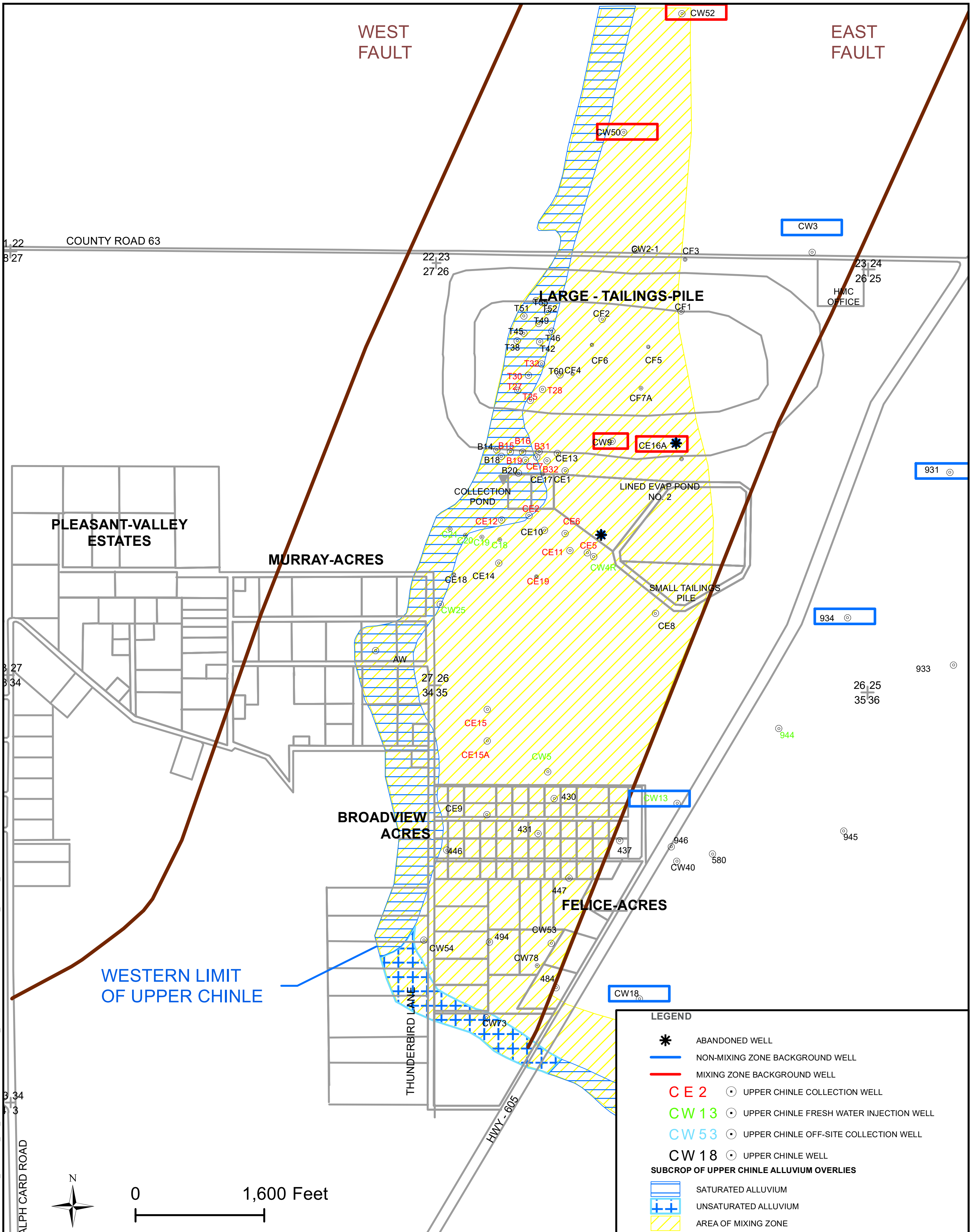
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 500 Feet

ALLUVIAL AQUIFER NITRATE CONCENTRATIONS

DETAIL MAP 2

FIGURE 3-26

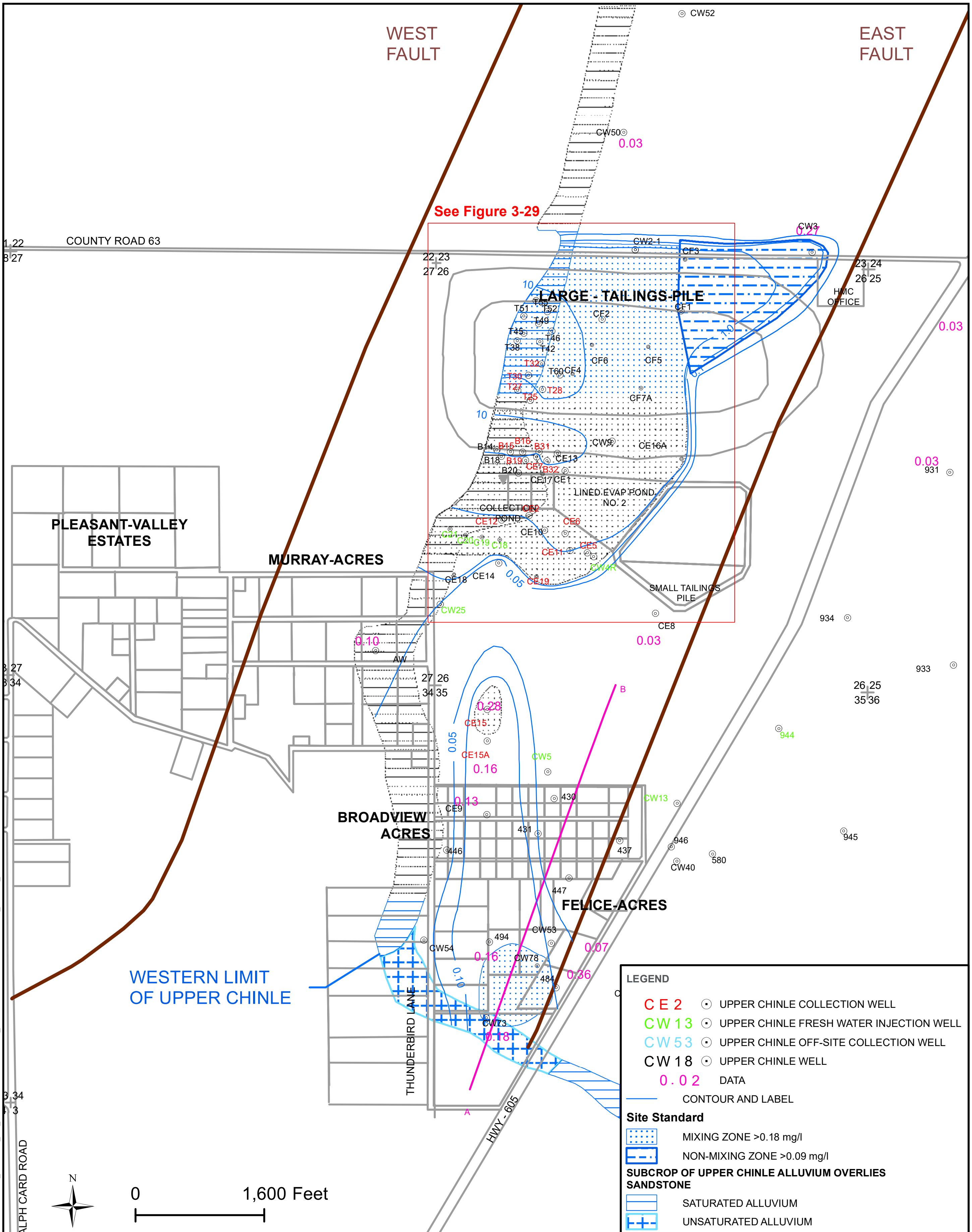


PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-27_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

UPPER CHINLE MIXING ZONE OVERVIEW MAP

FIGURE 3-27



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-28_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

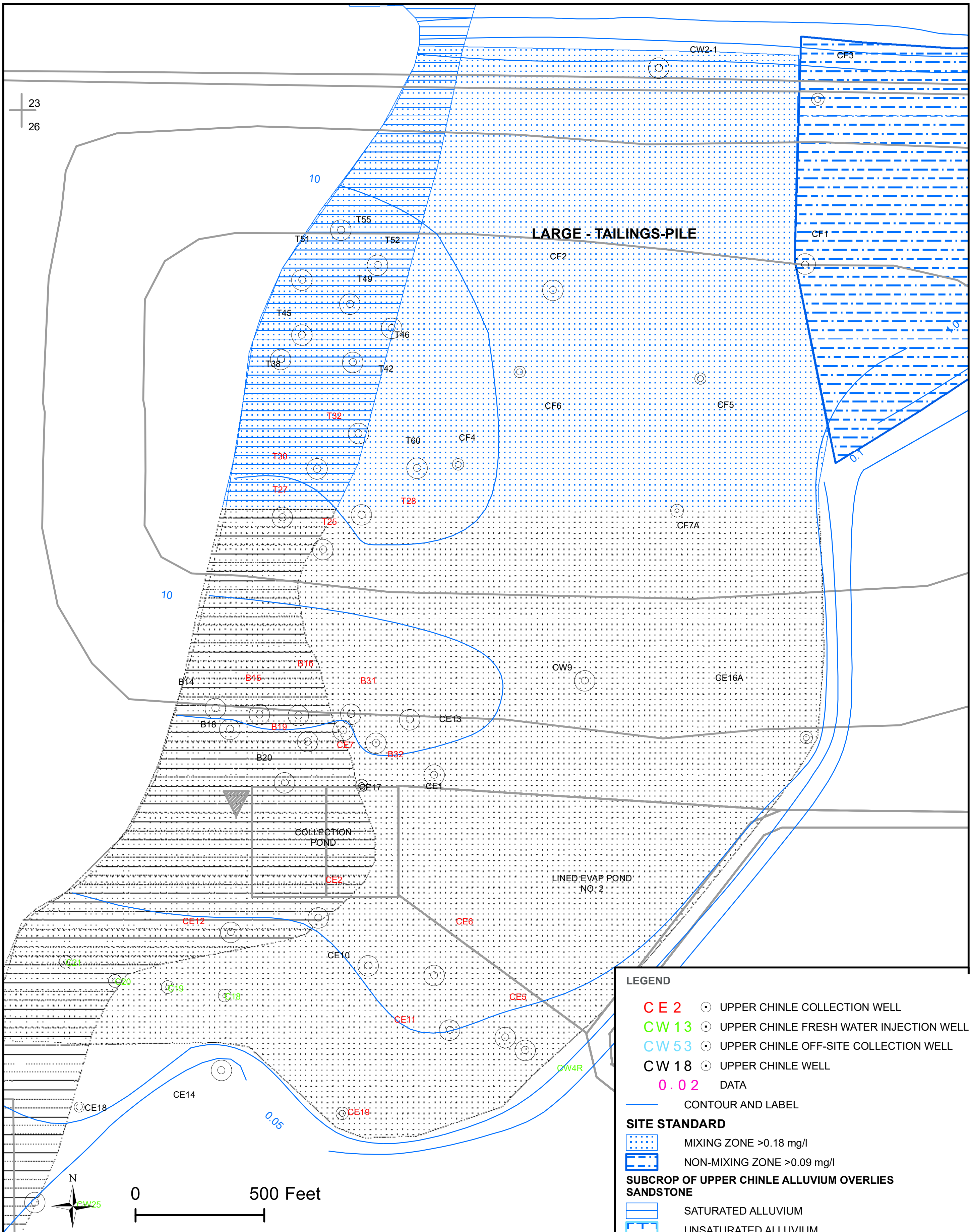
HOMESTAKE

UPPER CHINLE AQUIFER URANIUM CONCENTRATIONS

OVERVIEW MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-28



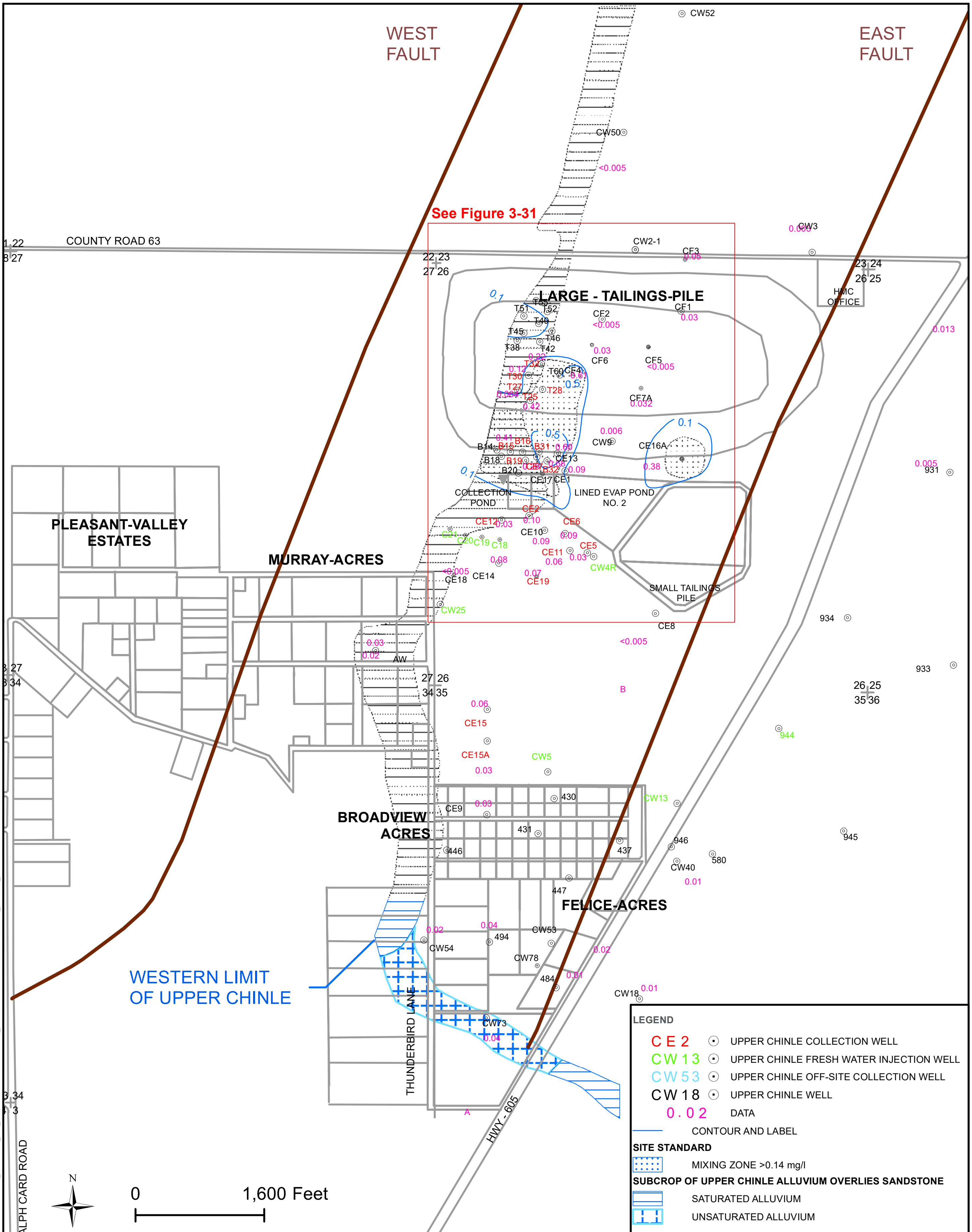
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-29_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

UPPER CHINLE AQUIFER URANIUM CONCENTRATIONS

DETAIL MAP

FIGURE 3-29

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-30_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

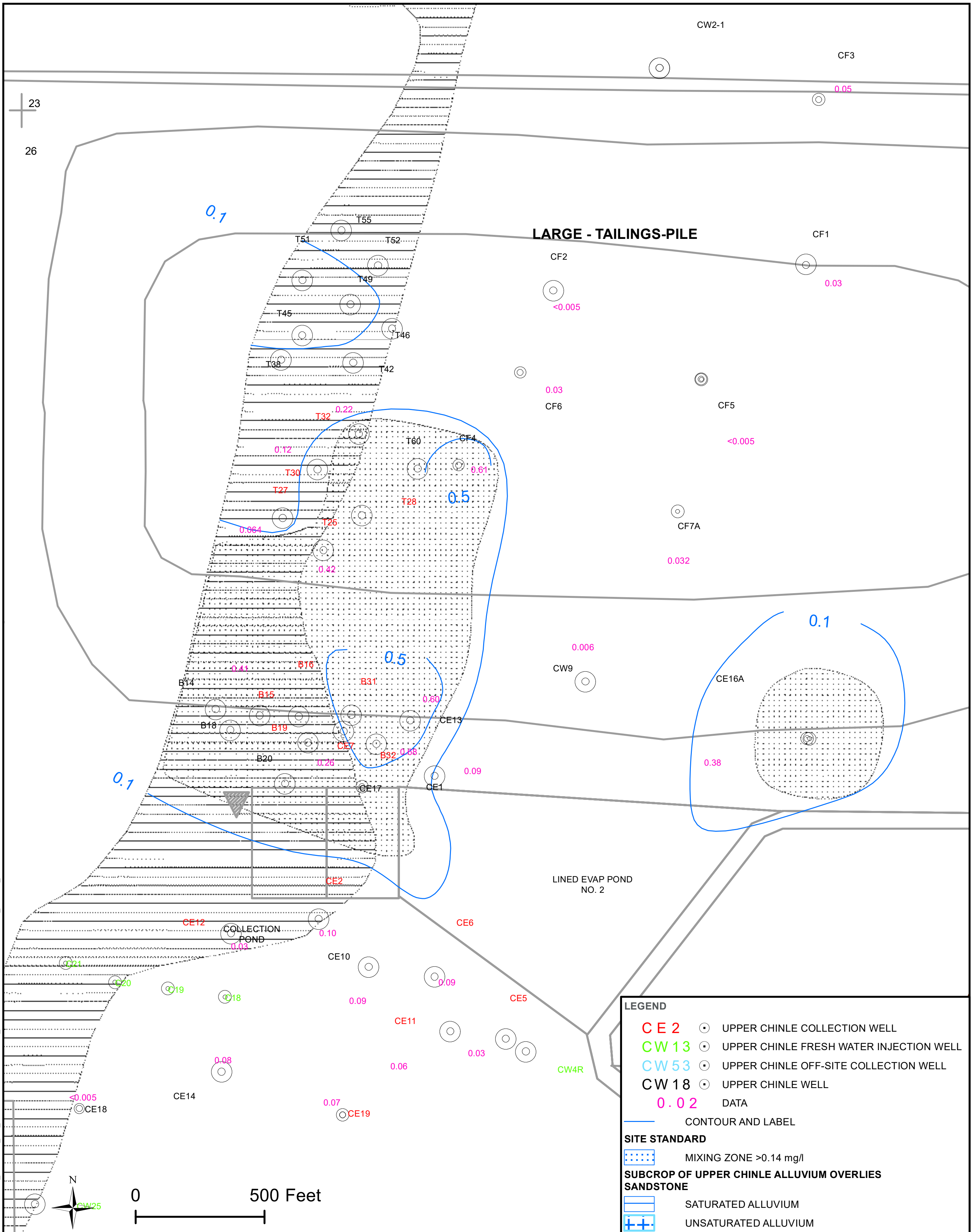
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

UPPER CHINLE AQUIFER SELENIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-30



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-31_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

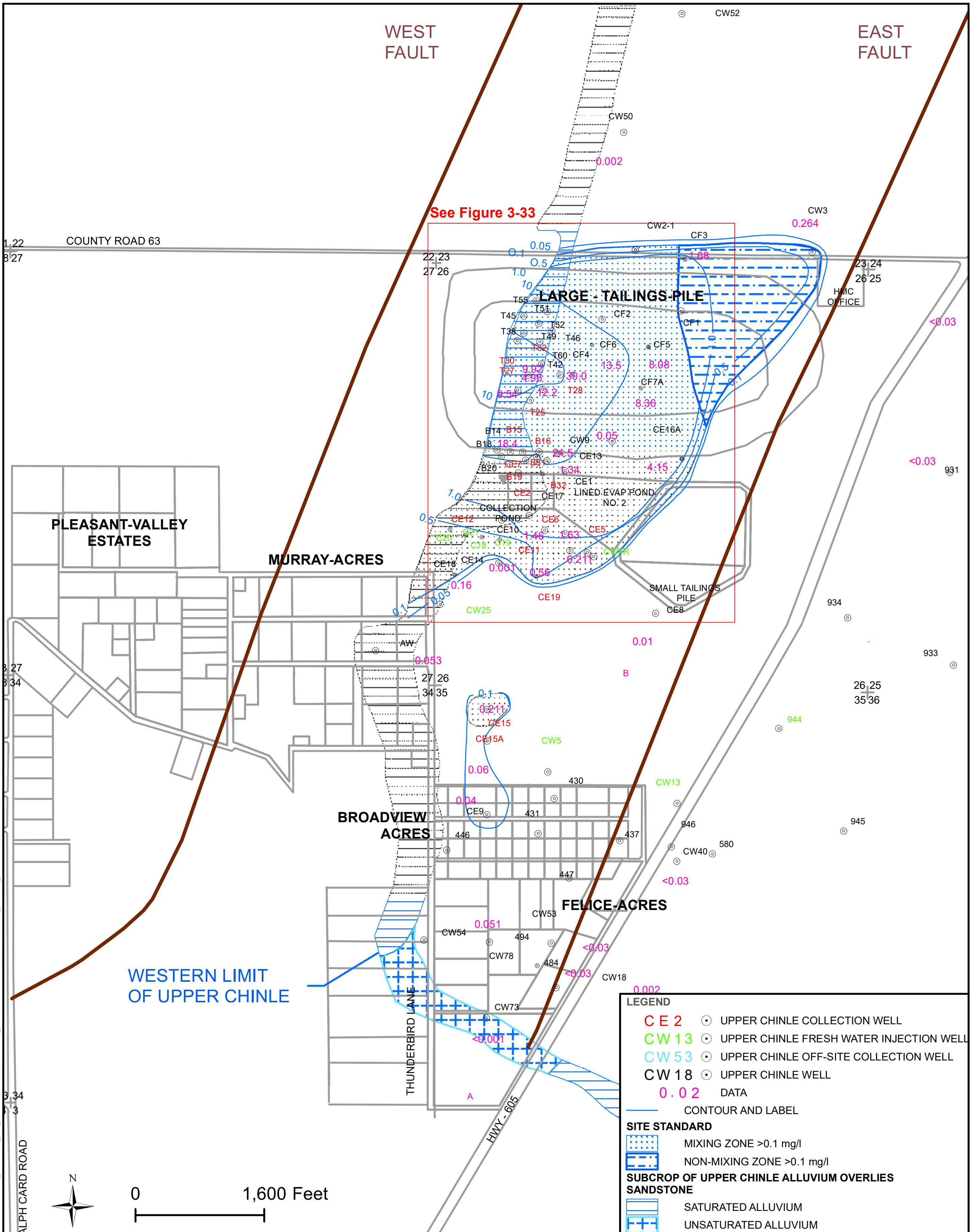
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

UPPER CHINLE AQUIFER SELENIUM CONCENTRATIONS

DETAIL MAP

FIGURE 3-31



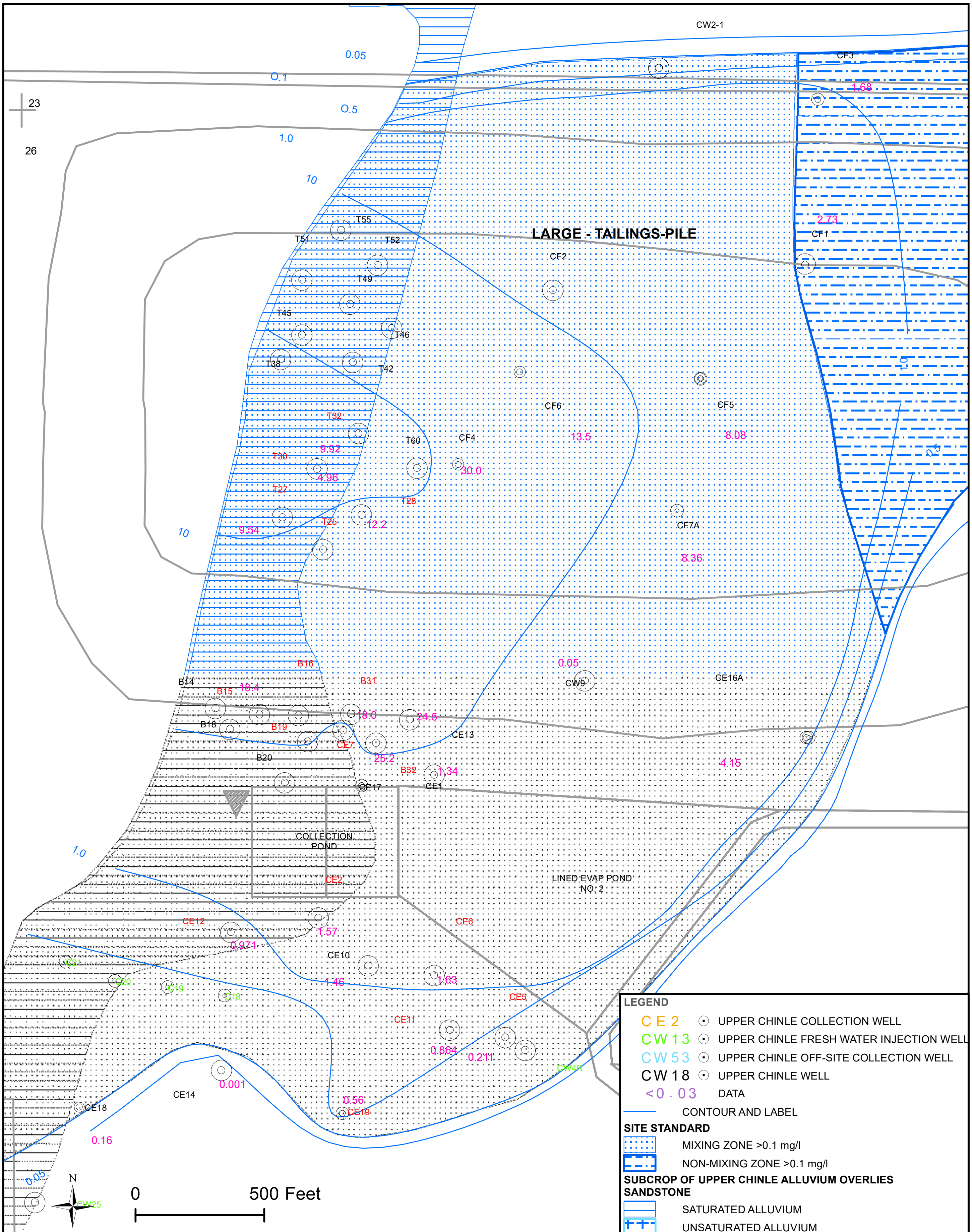
UPPER CHINLE AQUIFER MOLYBDENUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-32

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-32_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-33_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

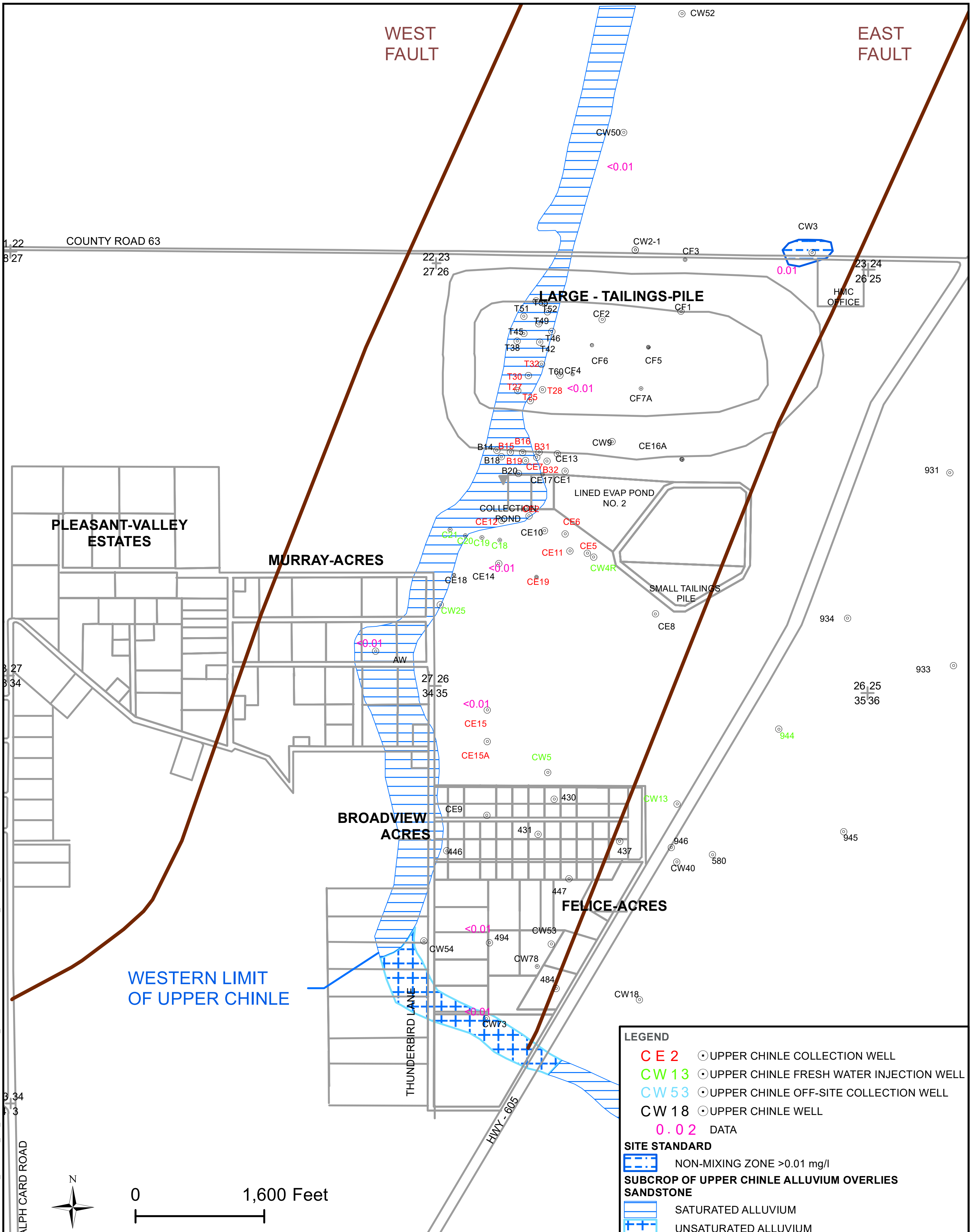
HOMESTAKE

UPPER CHINLE AQUIFER MOLYBDENUM CONCENTRATIONS

DETAIL MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-33



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-34_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

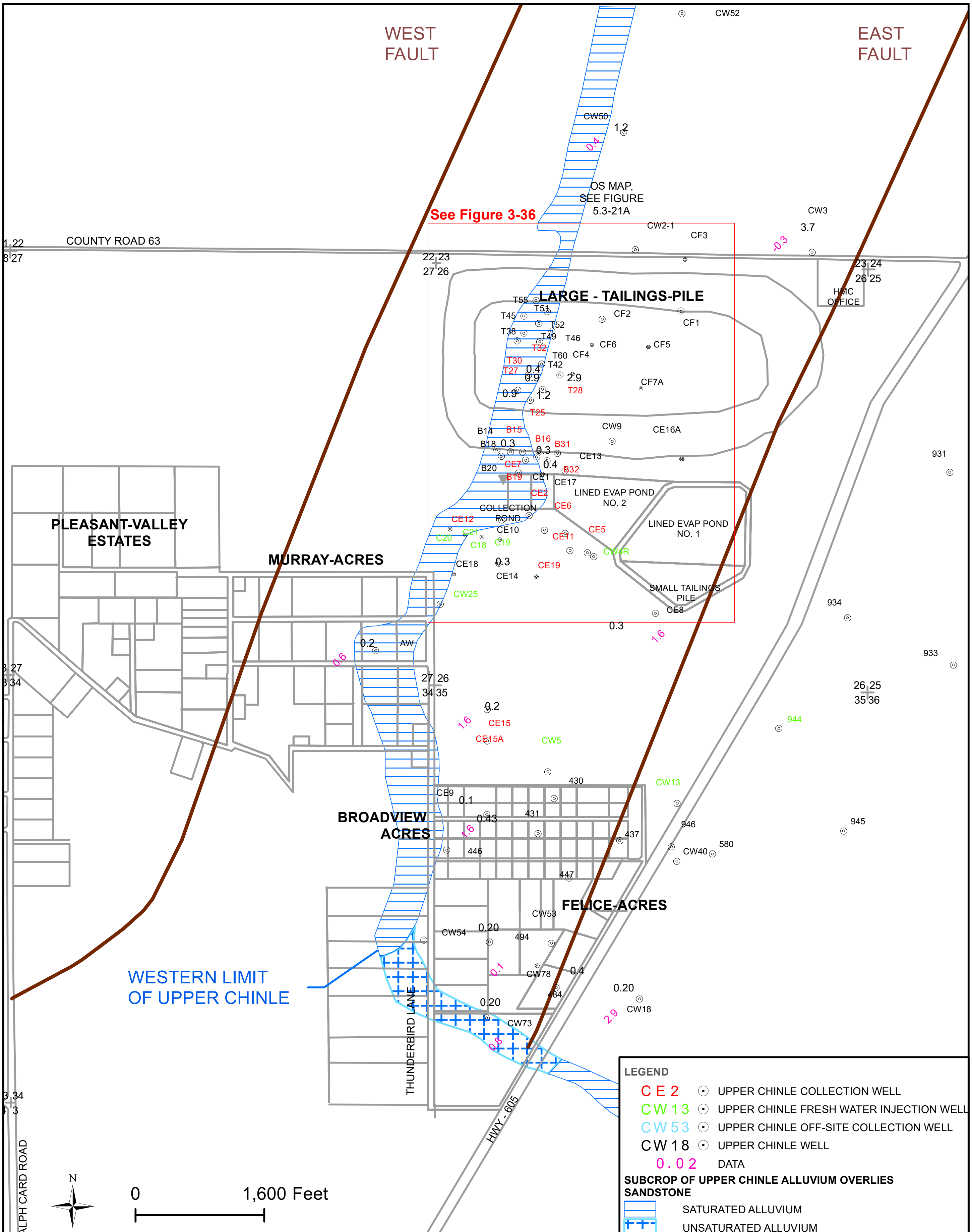
HOMESTAKE

UPPER CHINLE AQUIFER VANADIUM CONCENTRATIONS

OVERVIEW MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-34



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-35_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

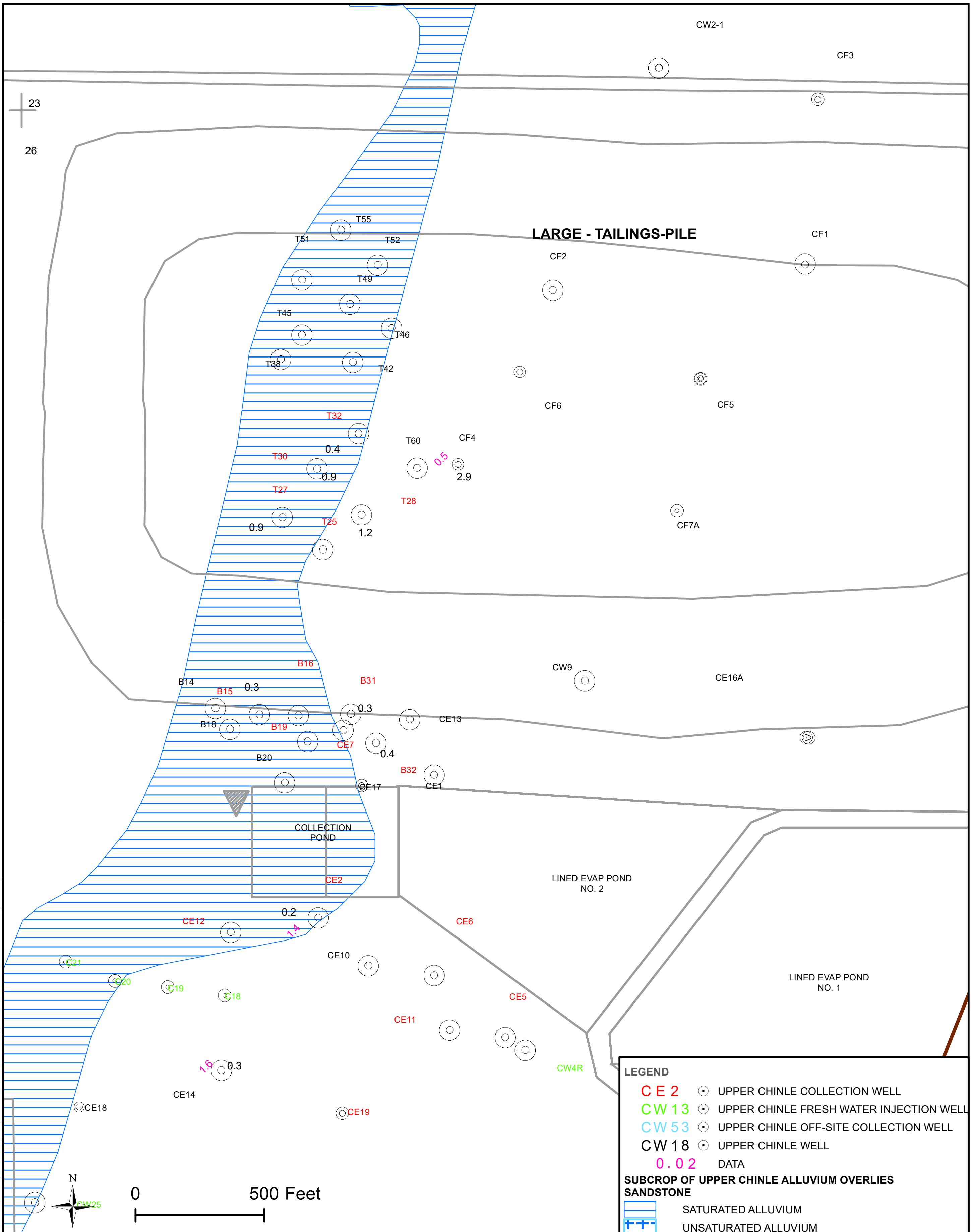
HOMESTAKE

UPPER CHINLE AQUIFER RADIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-35

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-36_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

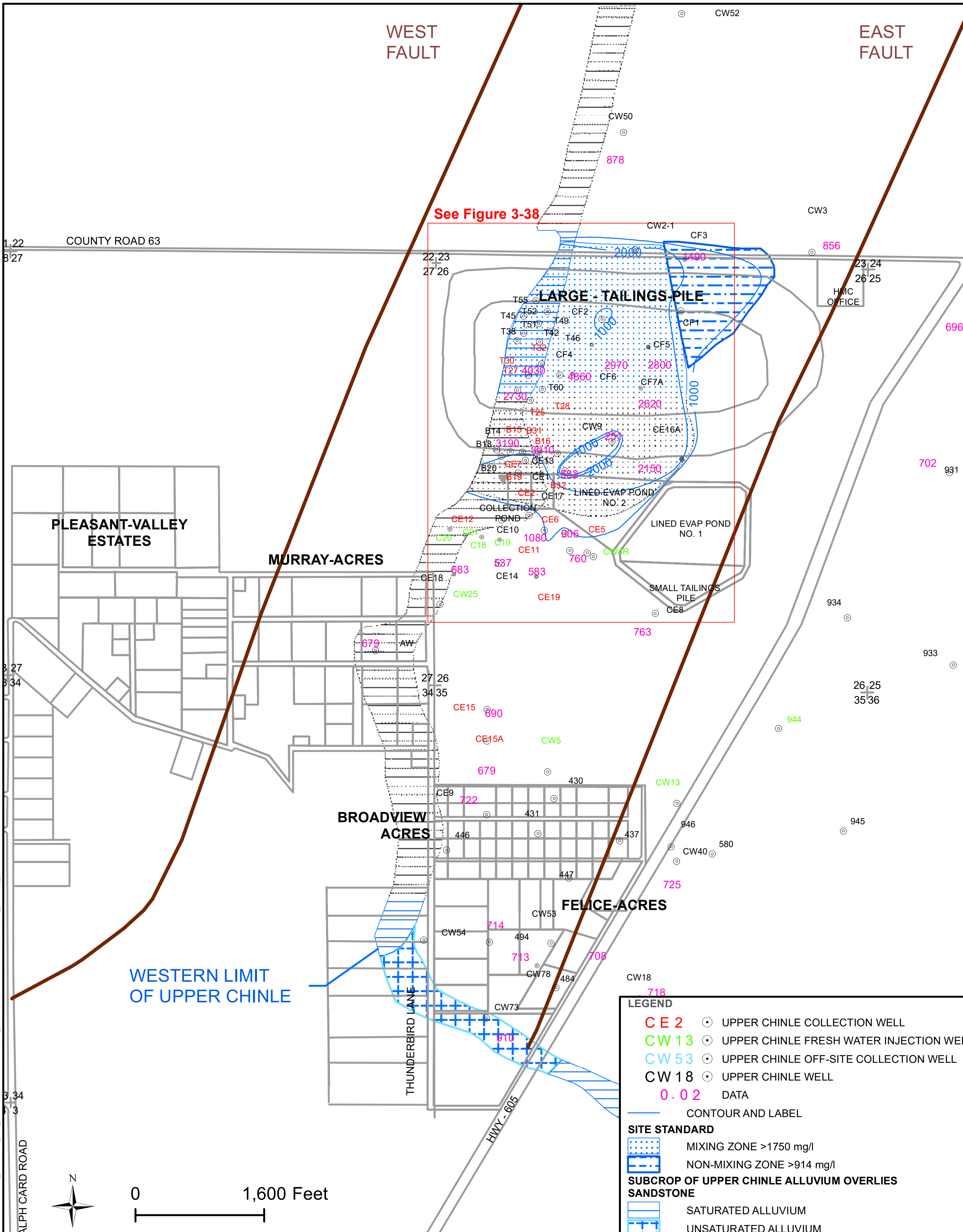
HOMESTAKE

UPPER CHINLE AQUIFER RADIUM CONCENTRATIONS

OVERVIEW MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-36



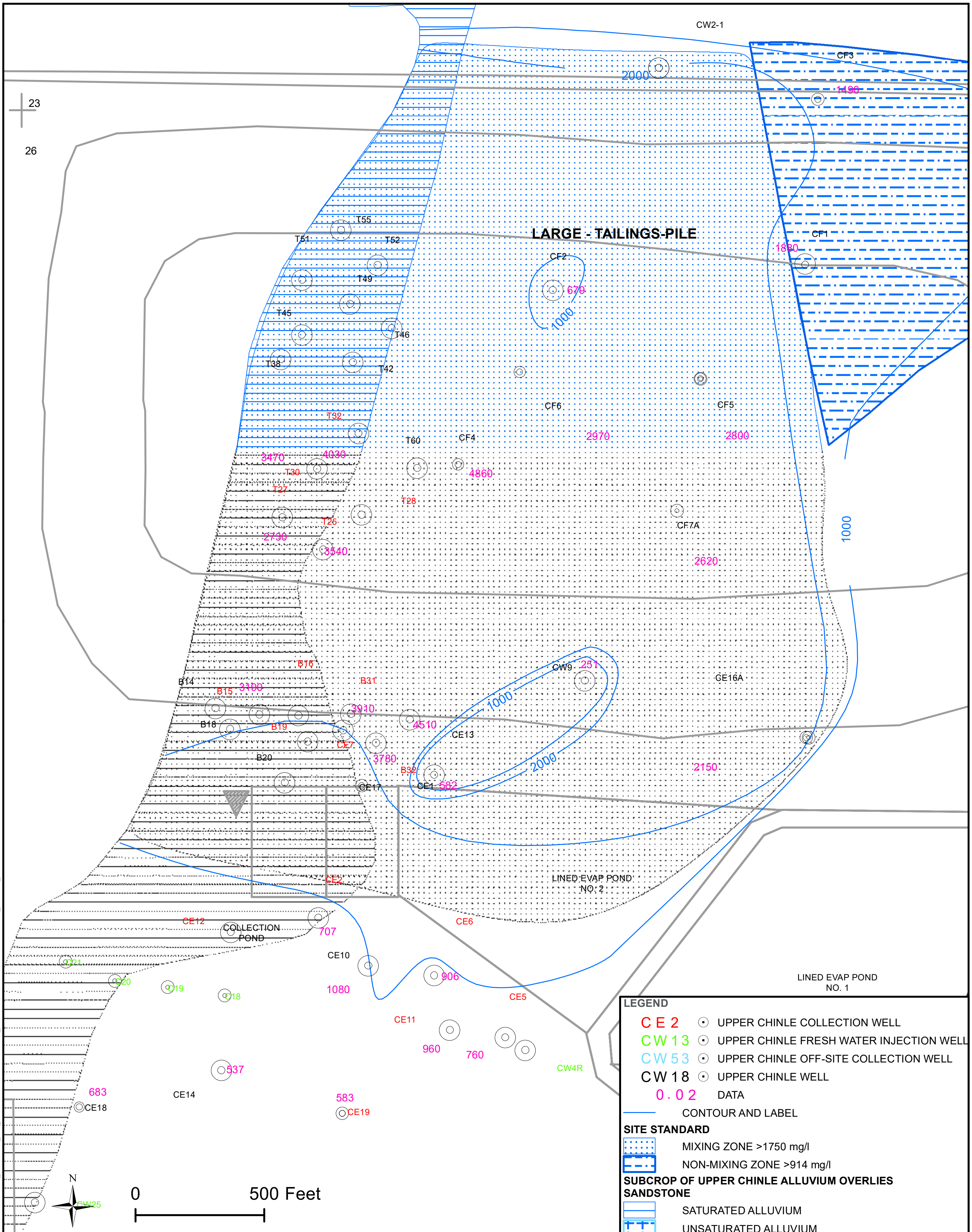
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-37_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

UPPER CHINLE AQUIFER SULFATE CONCENTRATIONS

OVERVIEW MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-37



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-38_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

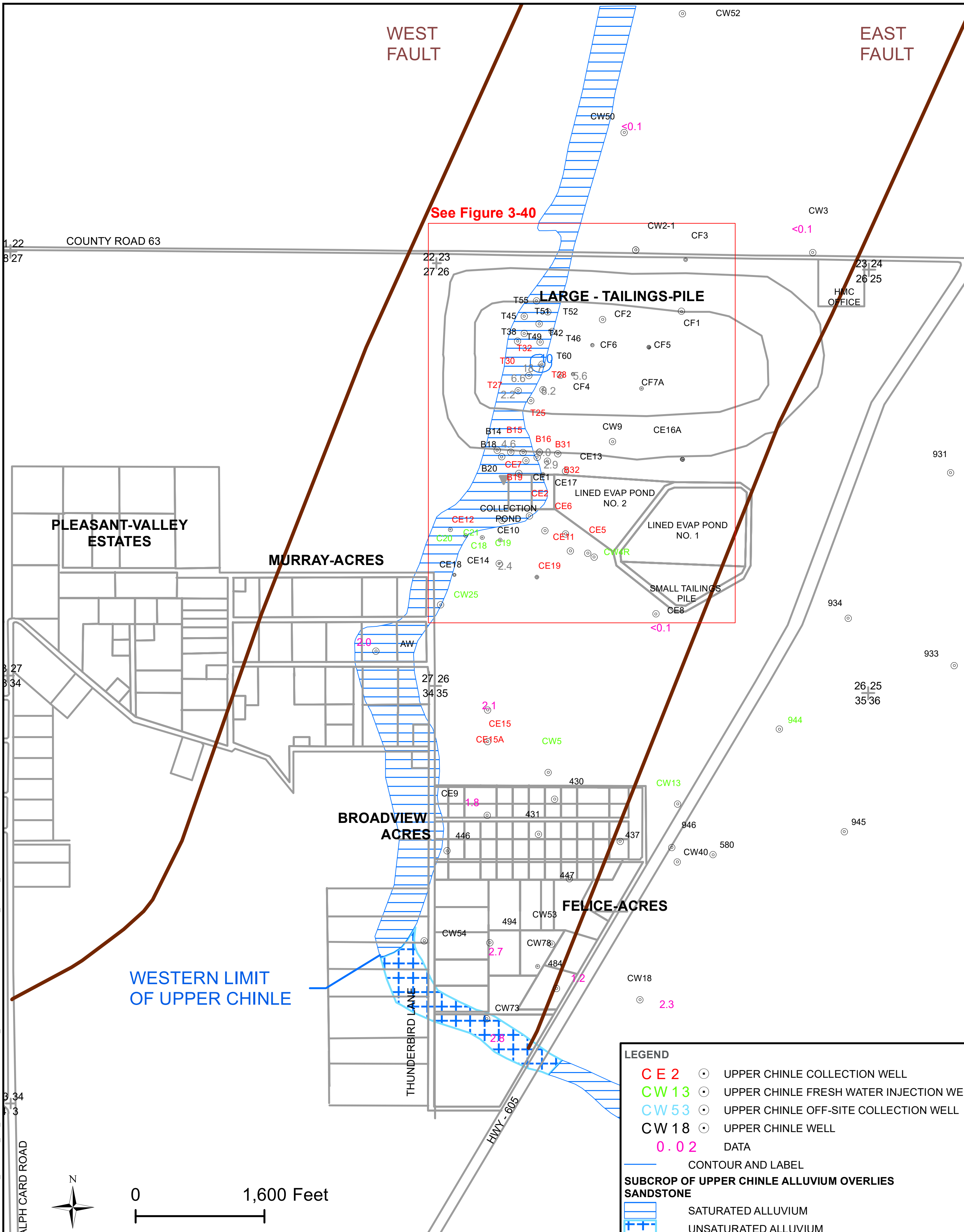
HOMESTAKE

UPPER CHINLE AQUIFER SULFATE CONCENTRATIONS

DETAIL MAP

FIGURE 3-38

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-39_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

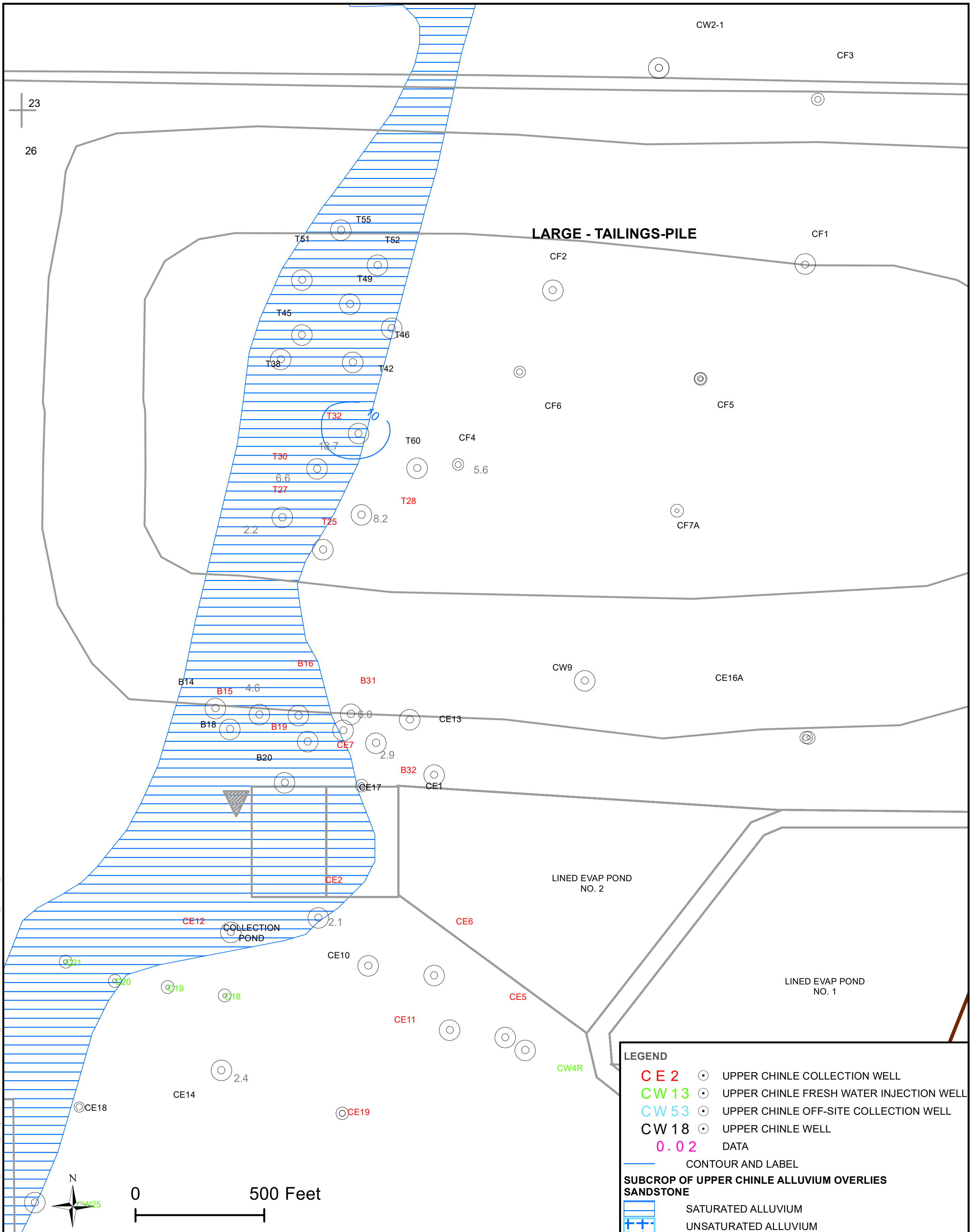
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

UPPER CHINLE AQUIFER NITRATE CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-39



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-40_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

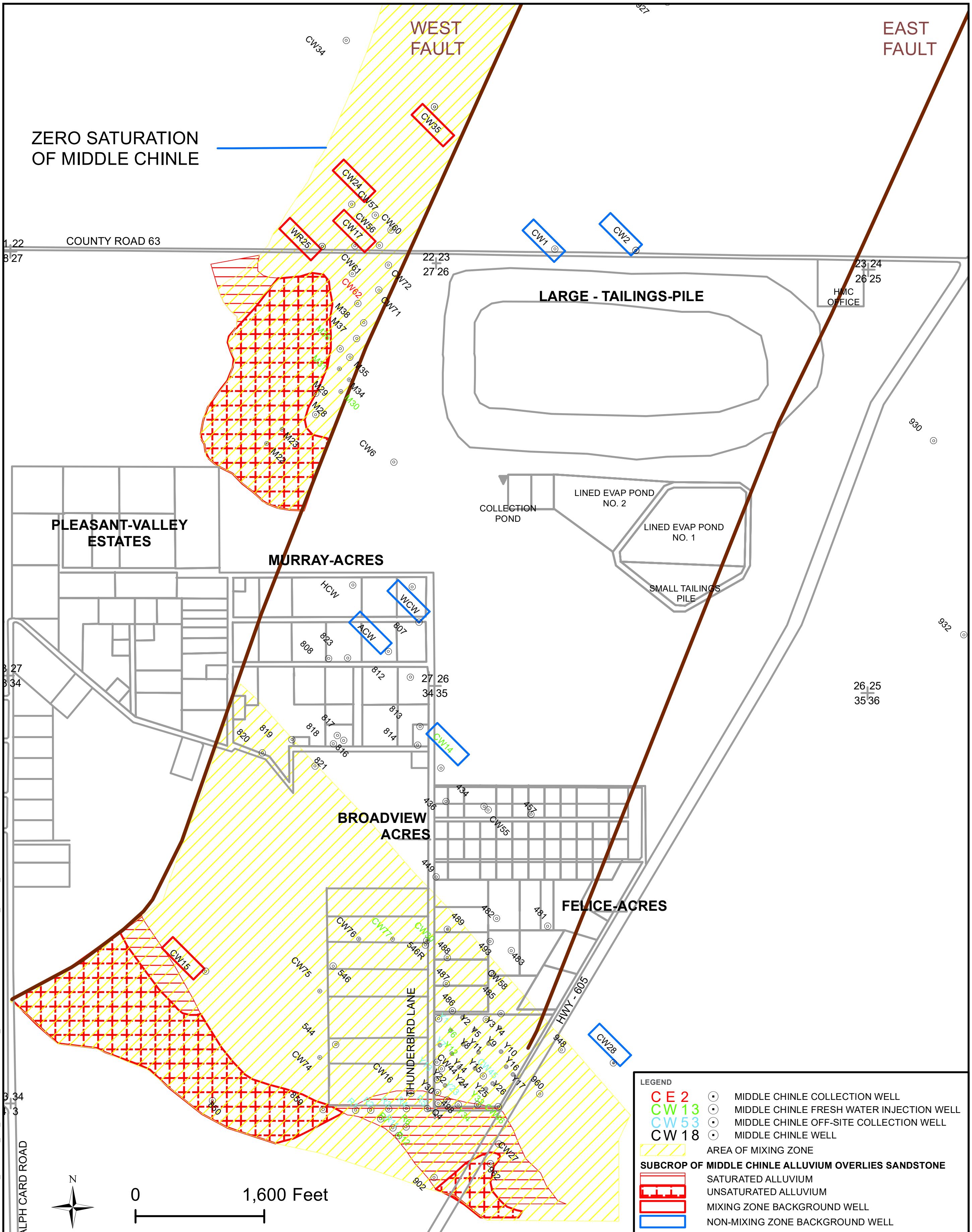
HOMESTAKE

UPPER CHINLE AQUIFER NITRATE CONCENTRATIONS

DETAIL MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-40



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-41_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

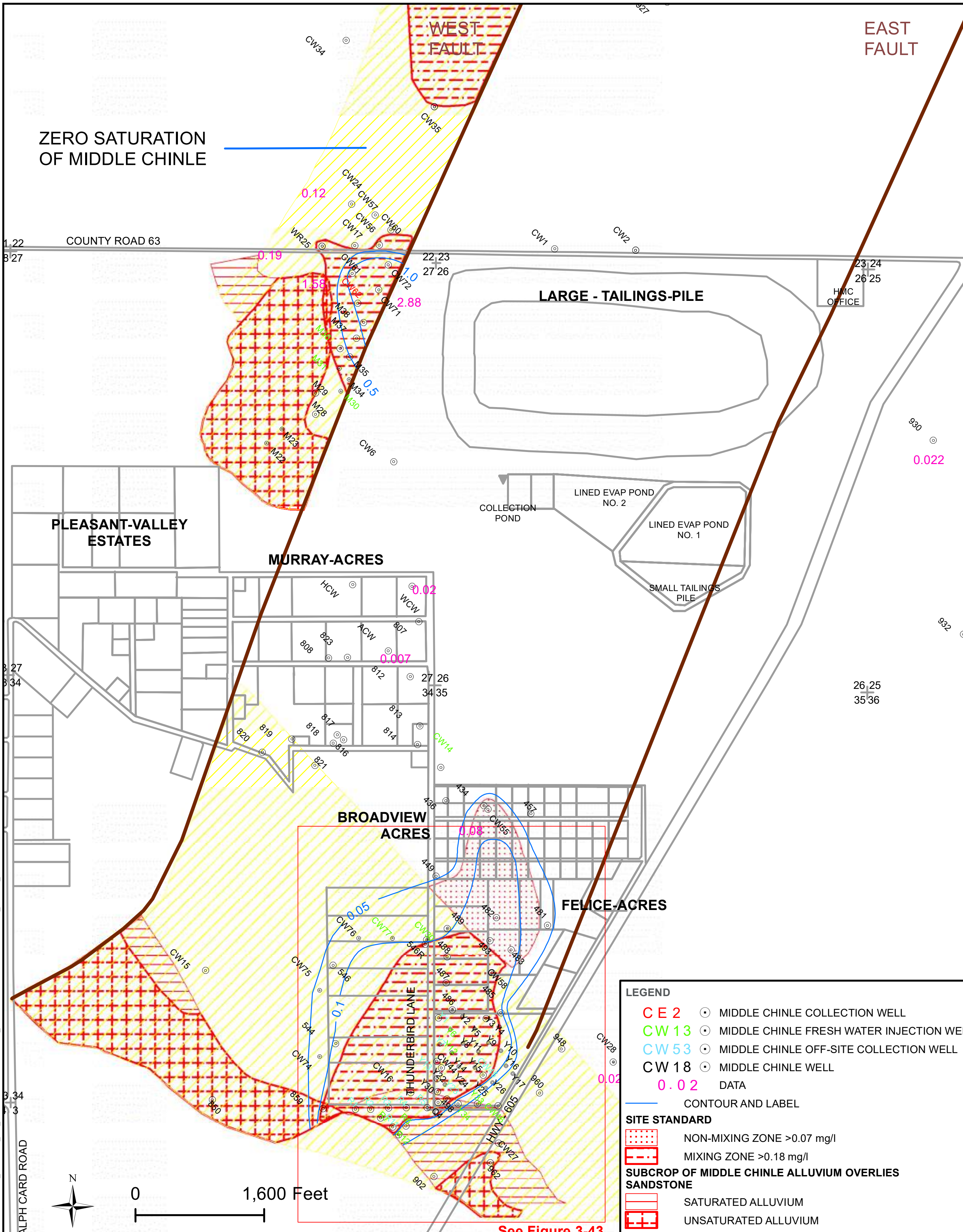
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

MIDDLE CHINLE MIXING ZONE

OVERVIEW MAP

FIGURE 3-41



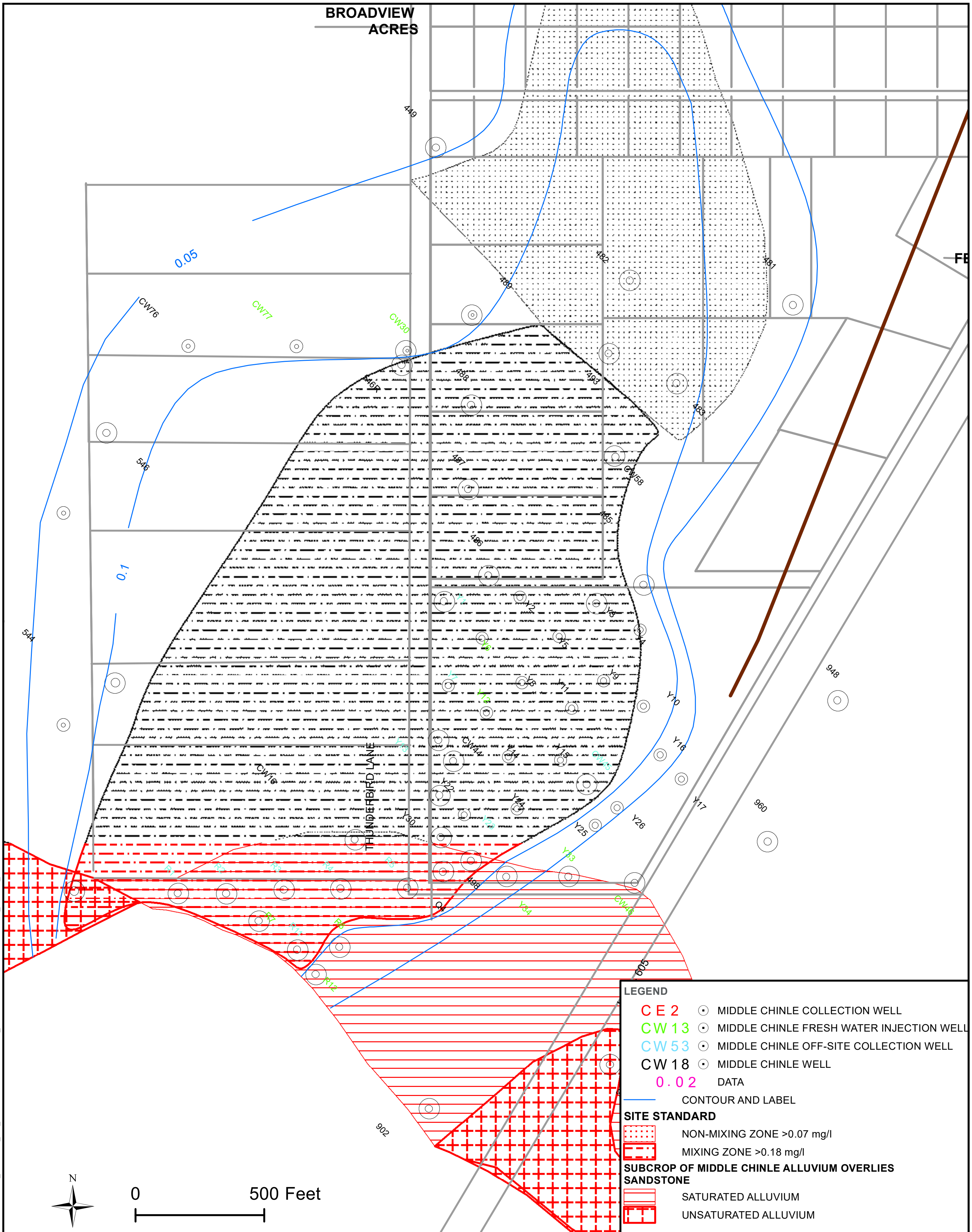
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-42_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

MIDDLE CHINLE AQUIFER URANIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-42

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019



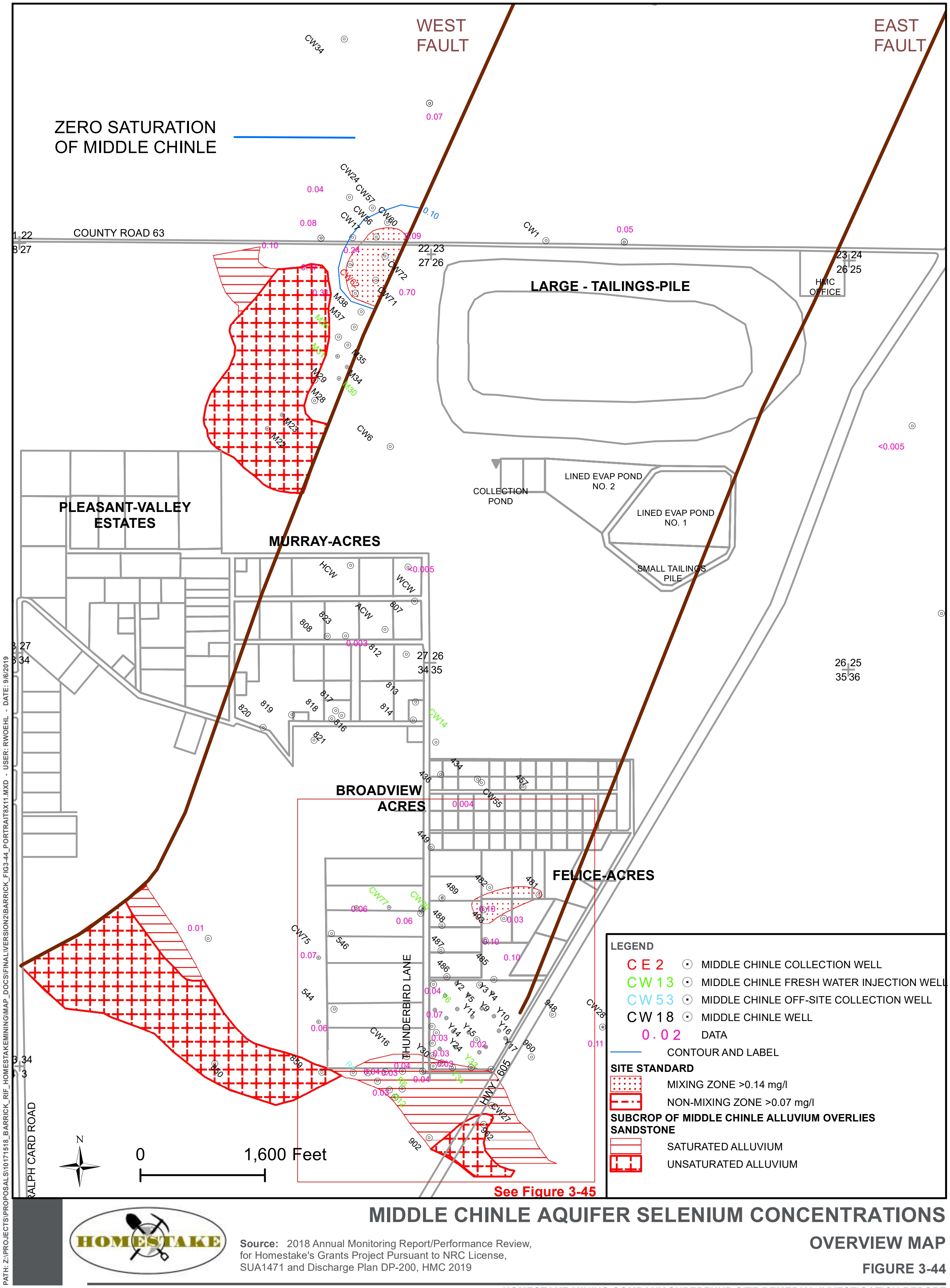
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_RIF_FIG3-43_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

MIDDLE CHINLE AQUIFER URANIUM CONCENTRATIONS

DETAIL MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-43



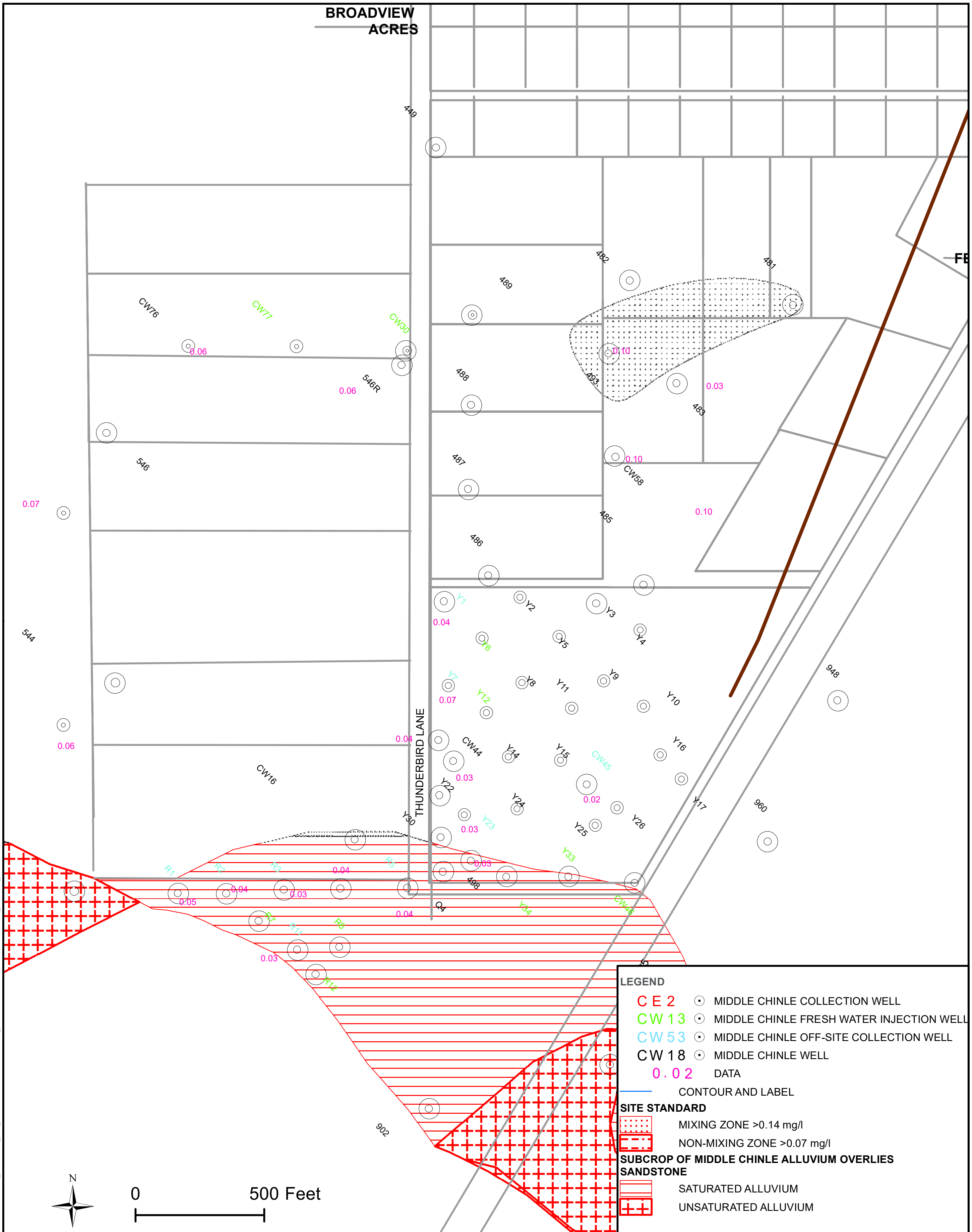
HOMESTAKE

MIDDLE CHINLE AQUIFER SELENIUM CONCENTRATIONS

OVERVIEW MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-44



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-45_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

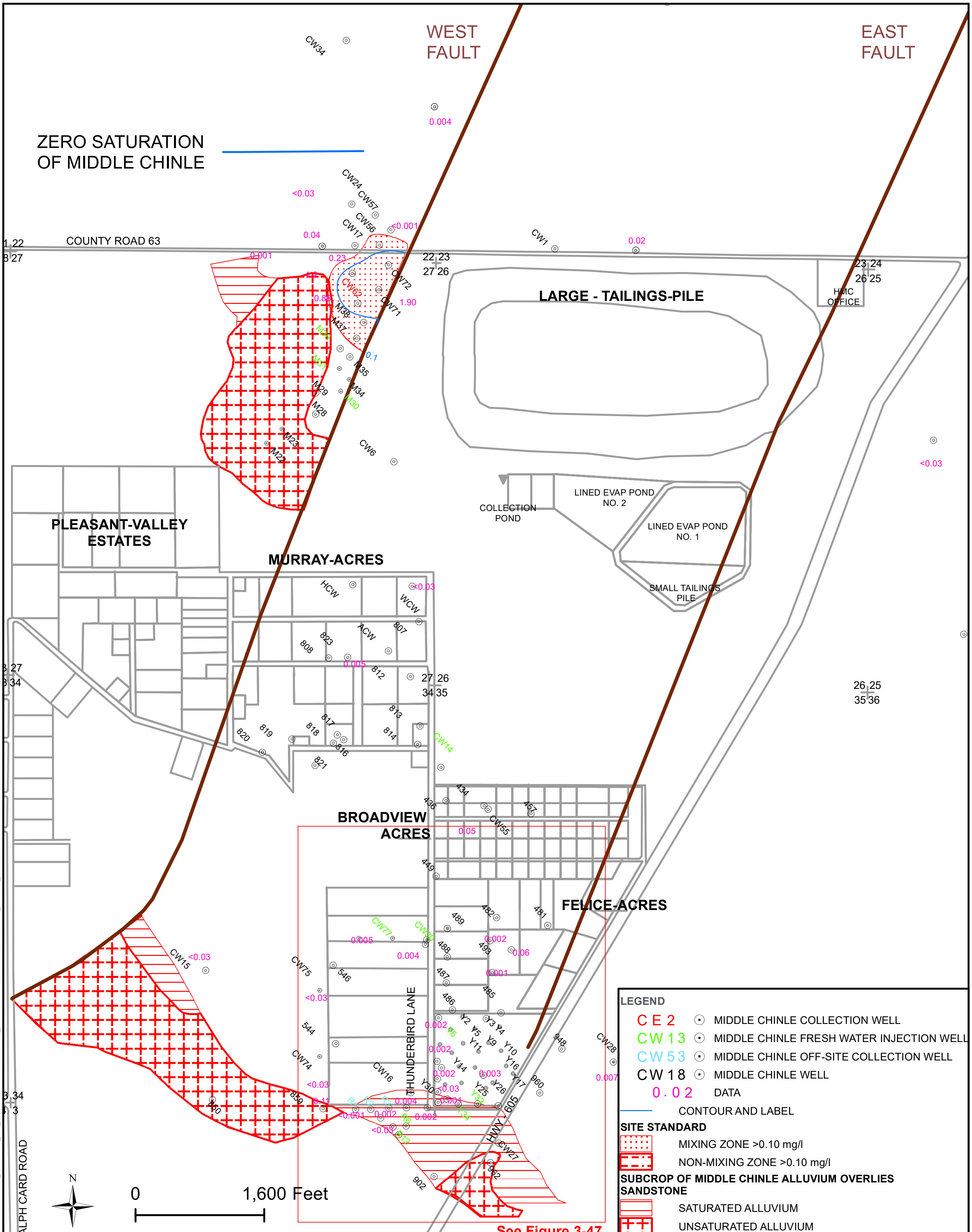
HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

MIDDLE CHINLE AQUIFER SELENIUM CONCENTRATIONS

DETAIL MAP

FIGURE 3-45



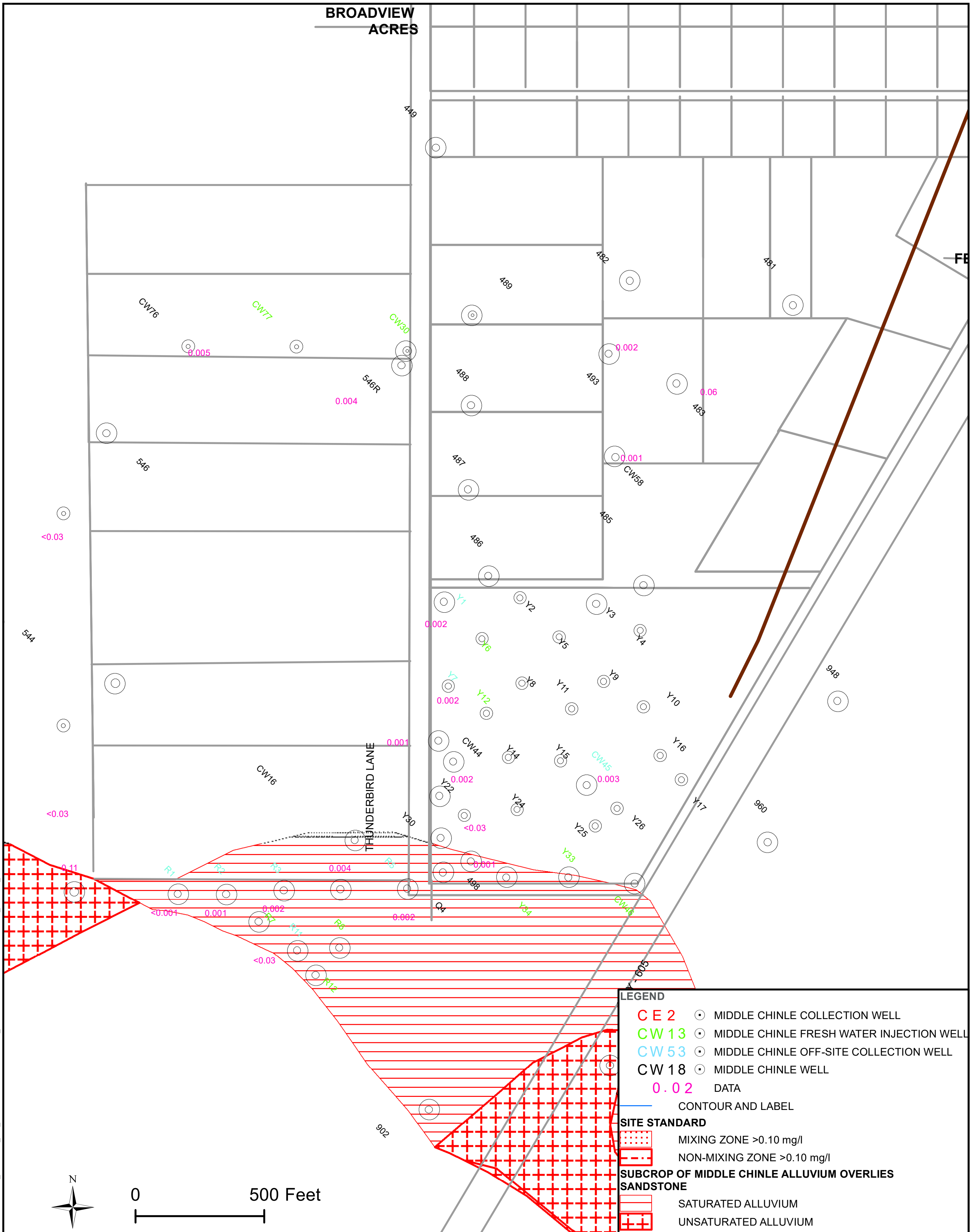
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-46_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

MIDDLE CHINLE AQUIFER MOLYBDENUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-46

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019



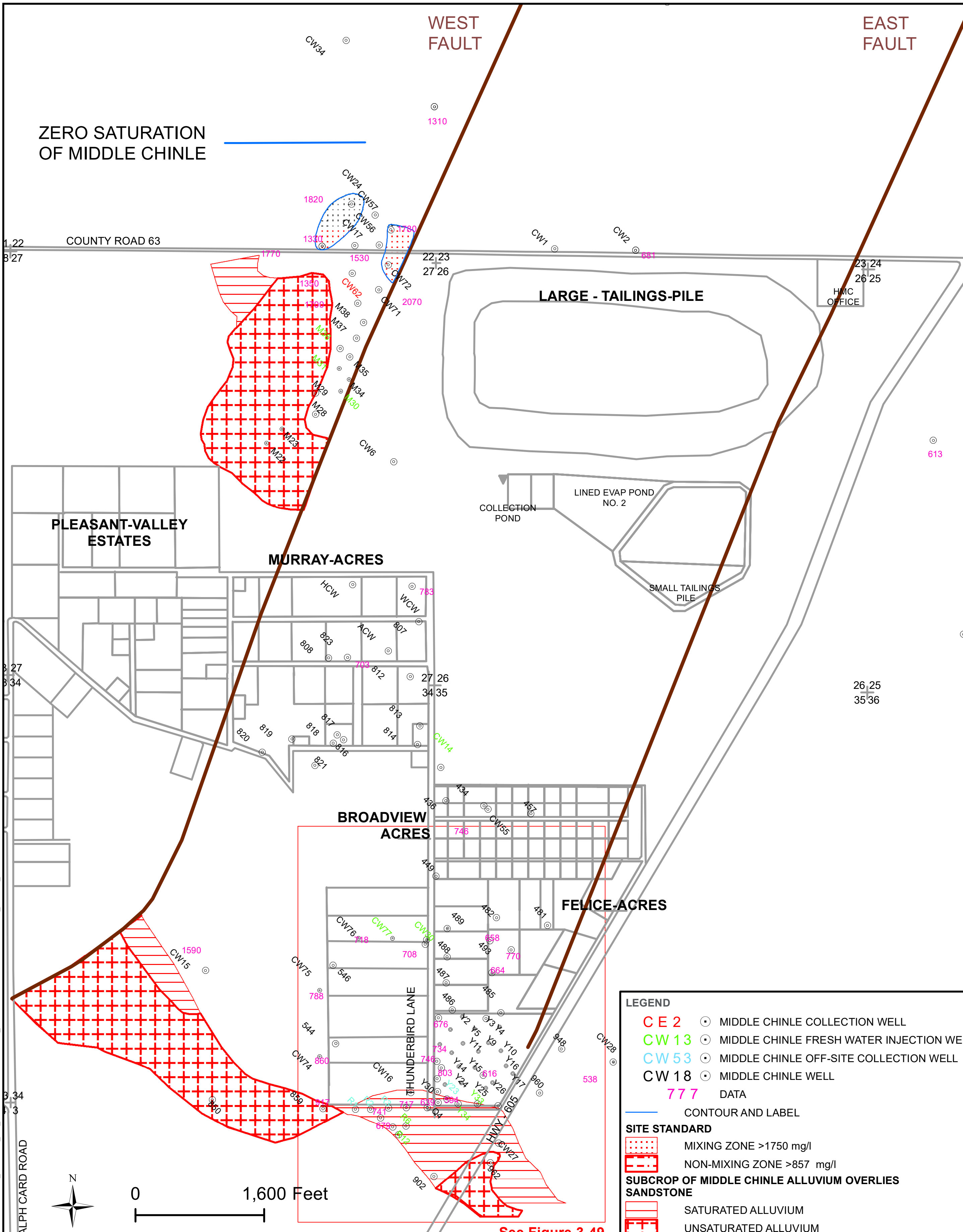
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-47_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

MIDDLE CHINLE AQUIFER MOLYBDENUM CONCENTRATIONS

DETAIL MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-47



See Figure 3-49

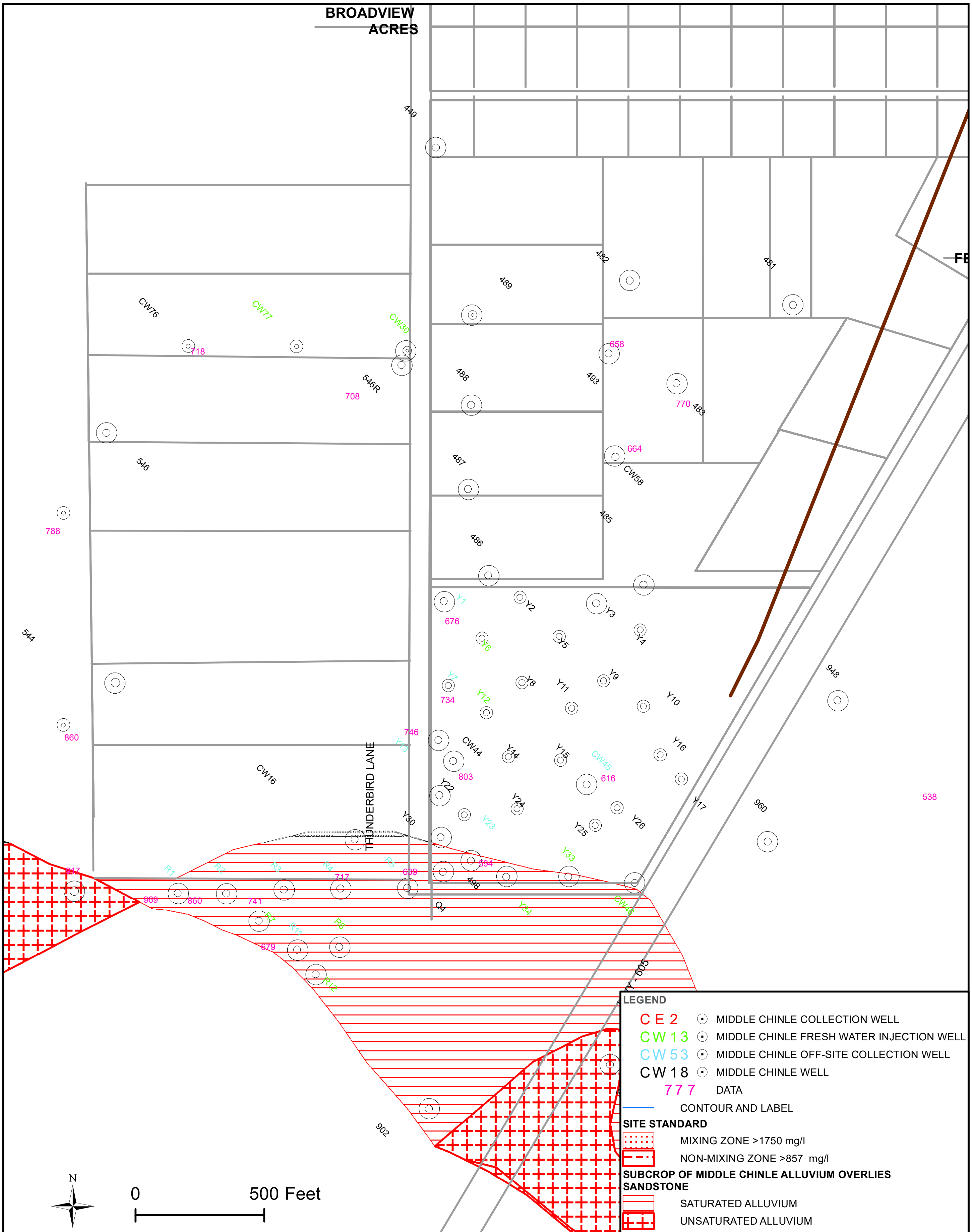
HOMESTAKE

MIDDLE CHINLE AQUIFER SULFATE CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-48

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

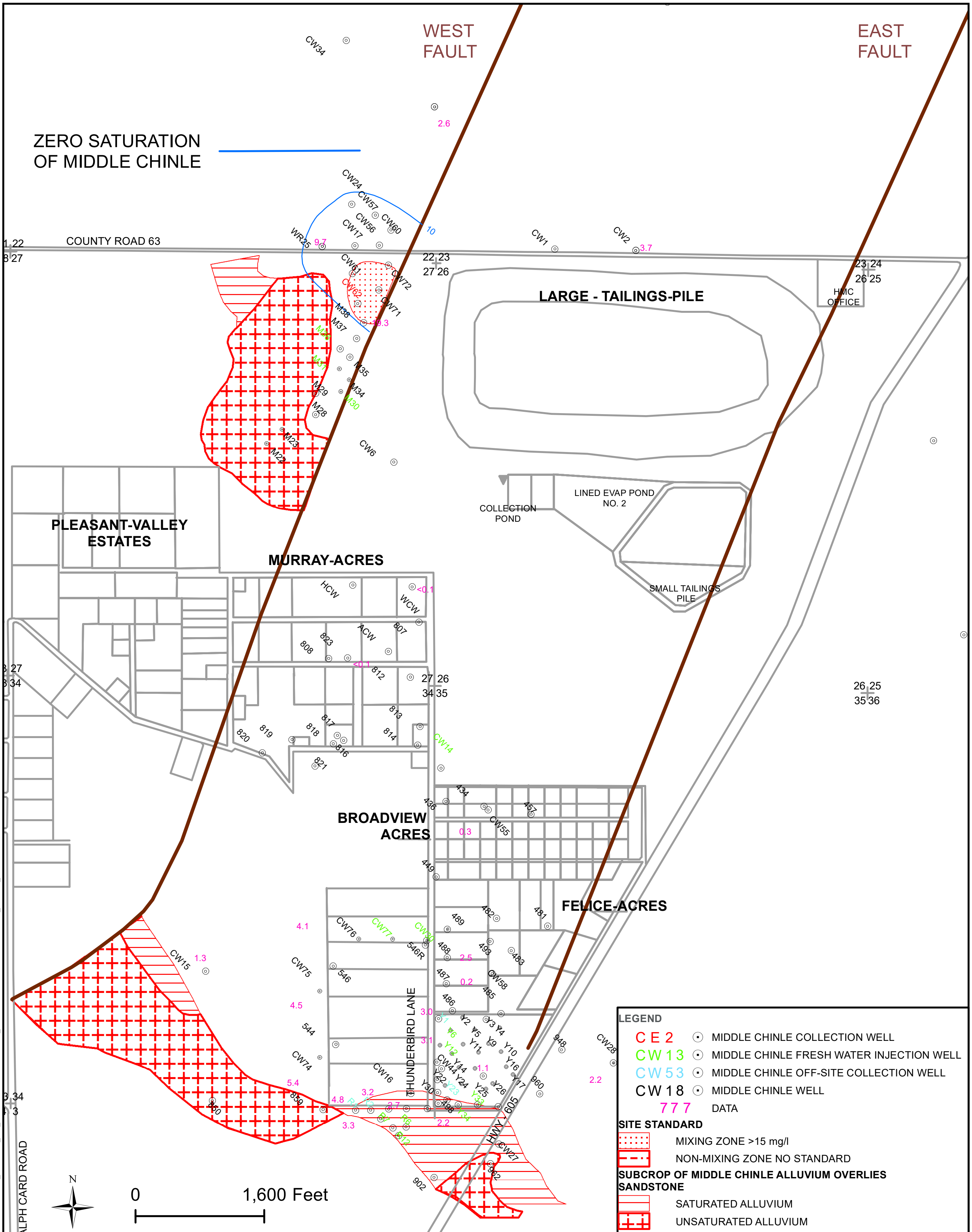


MIDDLE CHINLE AQUIFER SULFATE CONCENTRATIONS

DETAIL MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-49



PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION1\BARRICK_FIG3-50_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

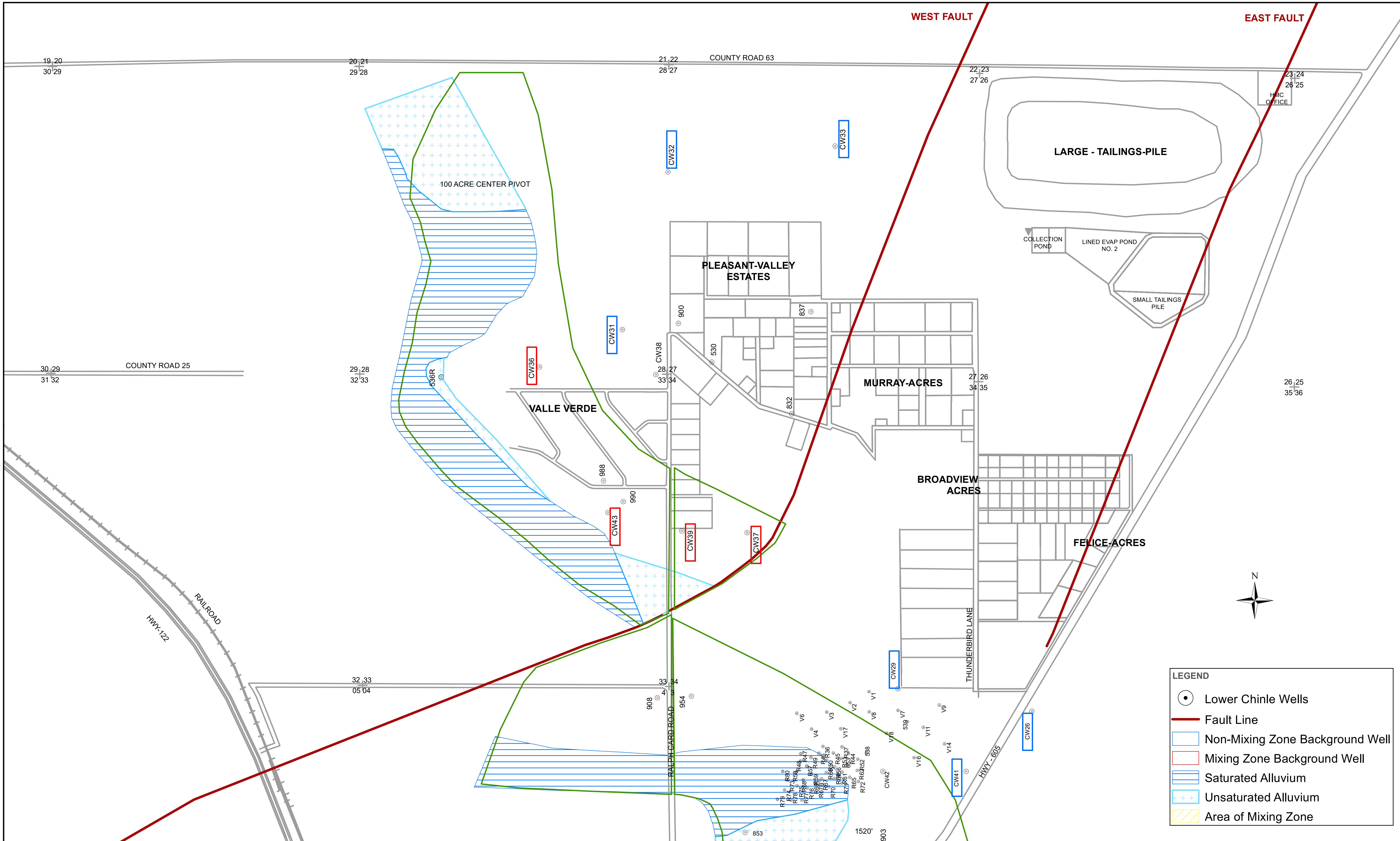
HOMESTAKE

MIDDLE CHINLE AQUIFER NITRATE CONCENTRATIONS

OVERVIEW MAP

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

FIGURE 3-50



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

0 1,500 Feet

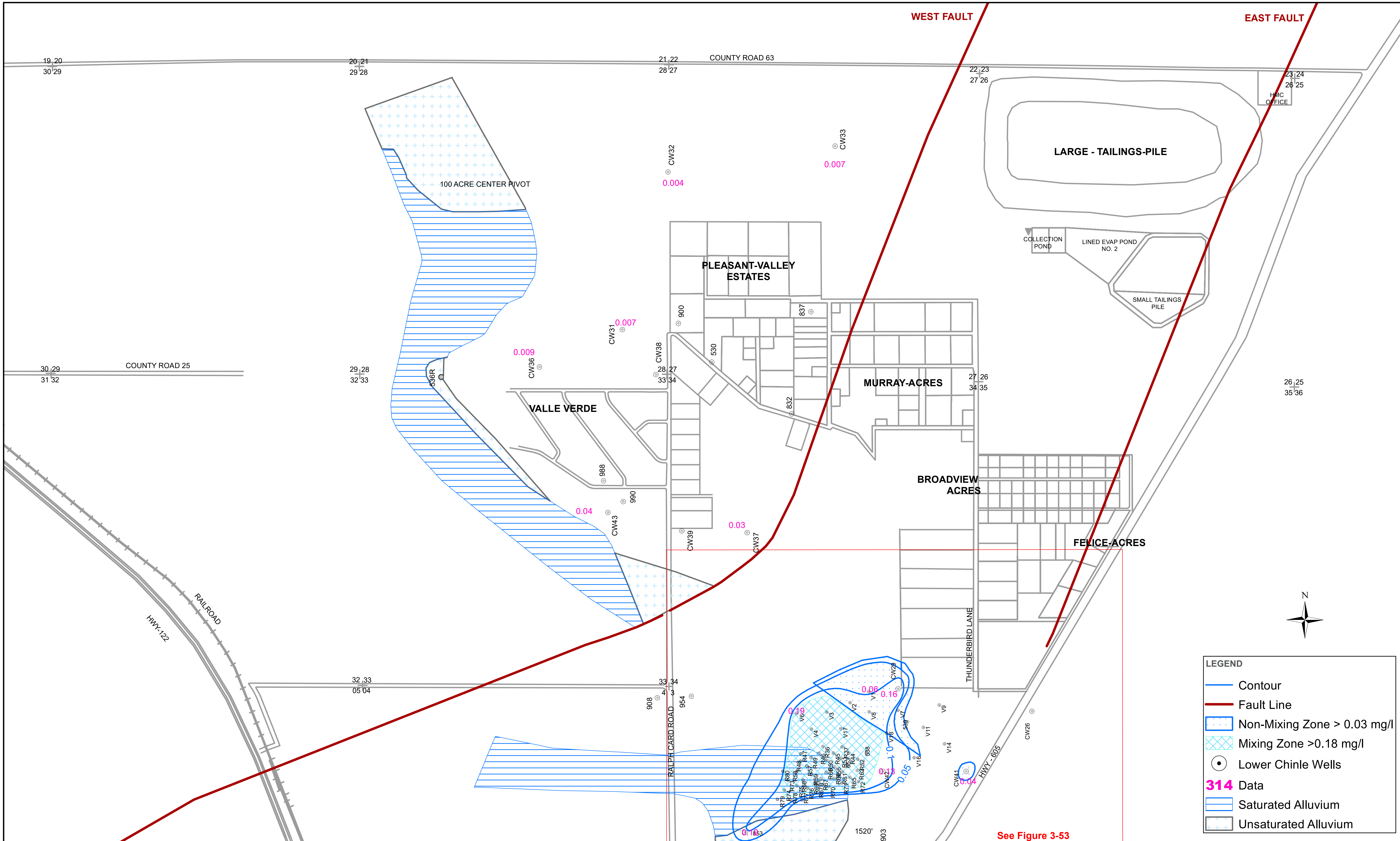
HOMESTAKE

LOWER CHINLE MIXING ZONE

OVERVIEW MAP

FIGURE 3-51

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-51_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

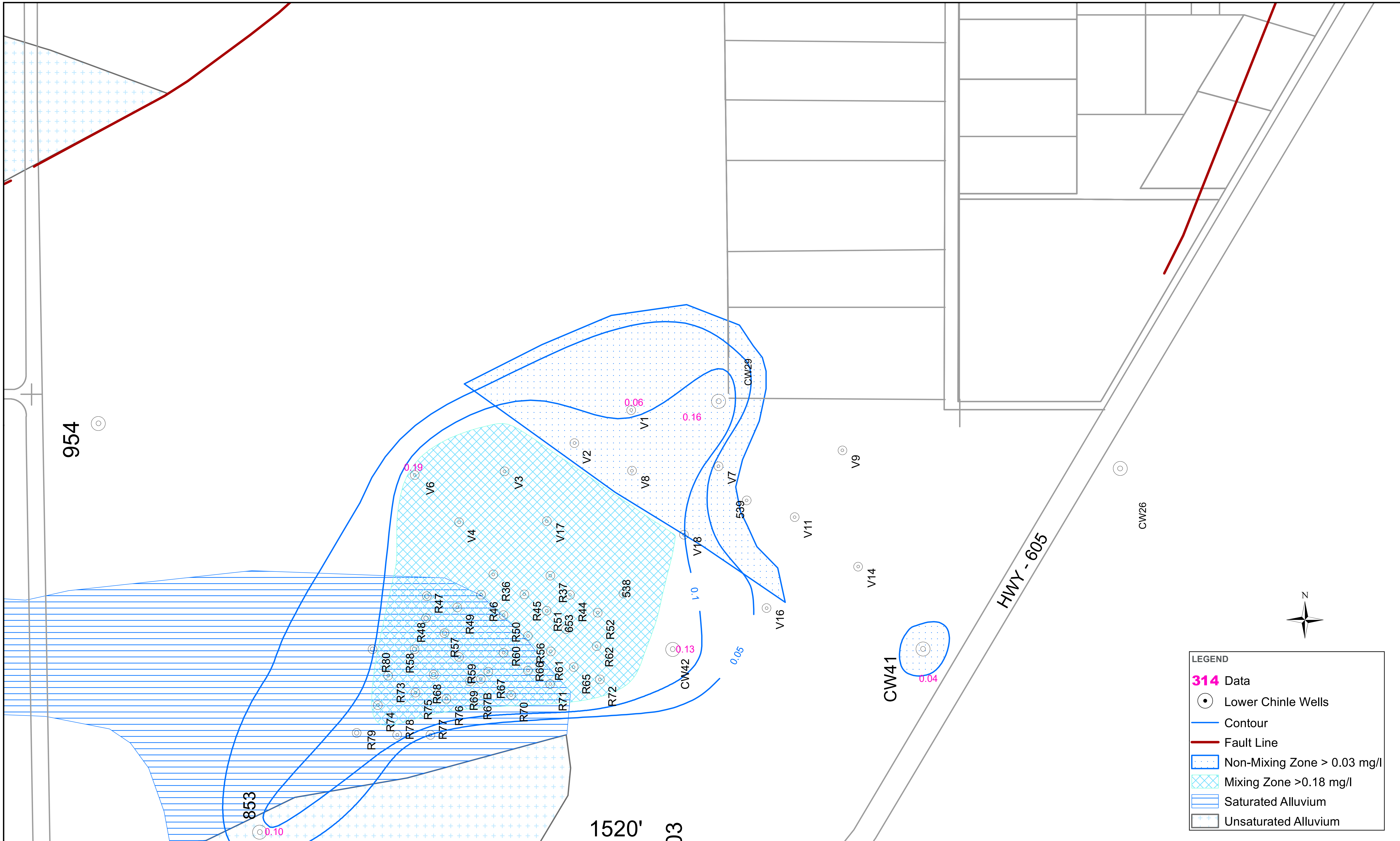
0 1,500 Feet

LOWER CHINLE AQUIFER URANIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-52

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-52_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019

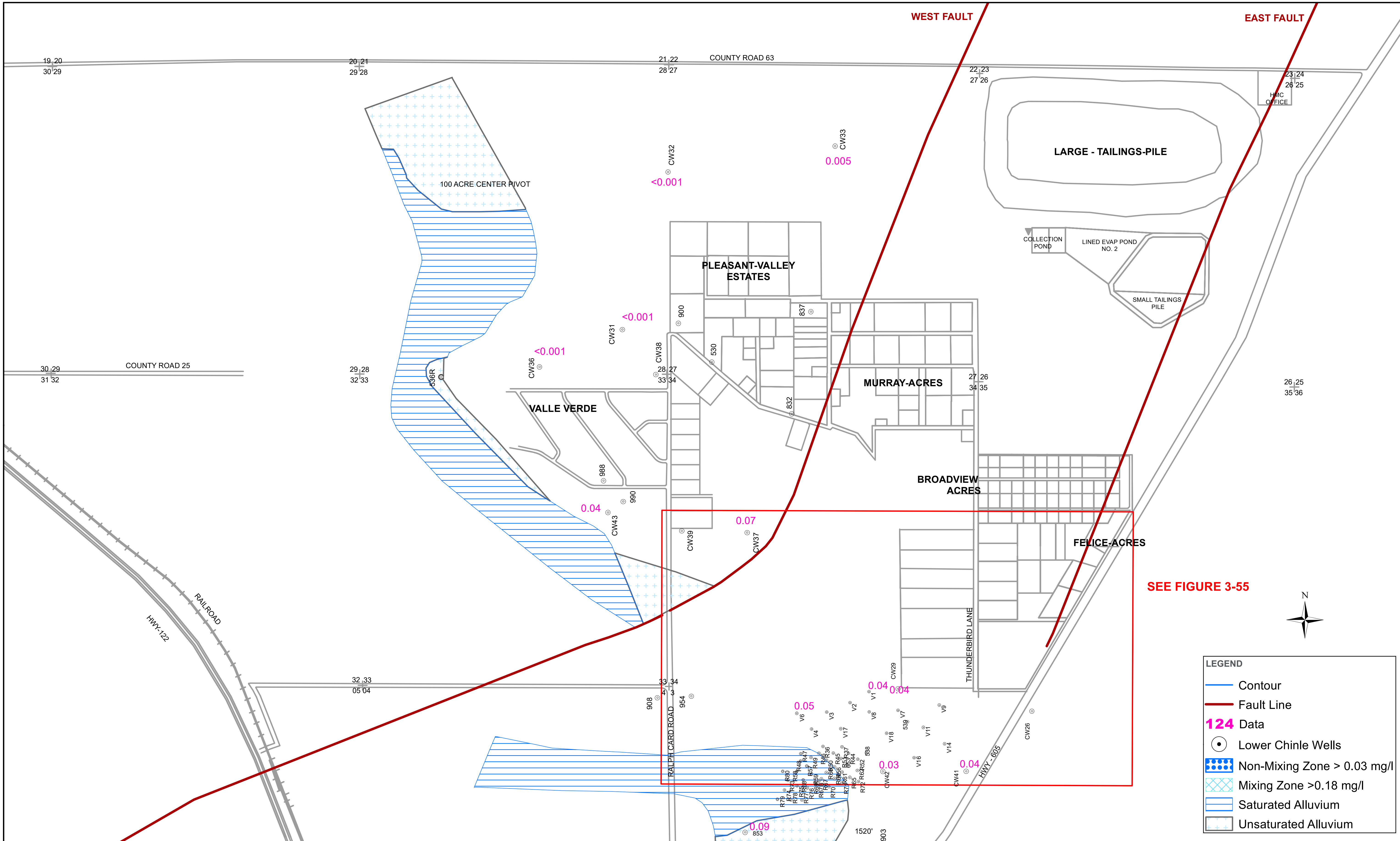


Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

LOWER CHINLE AQUIFER URANIUM CONCENTRATIONS

DETAIL MAP

FIGURE 3-53



HOMESTAKE

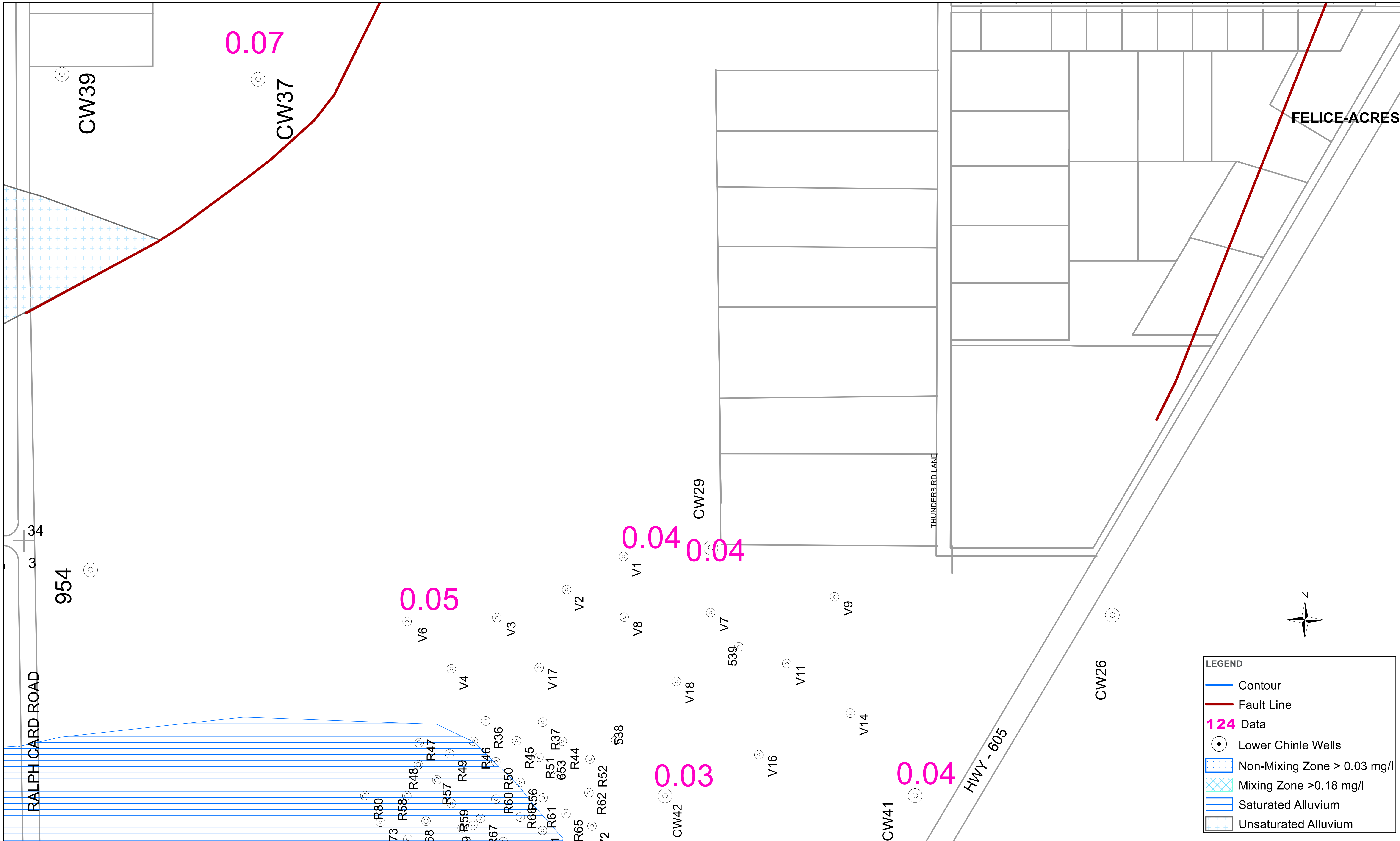
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

LOWER CHINLE SELENIUM CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-54

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-54_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



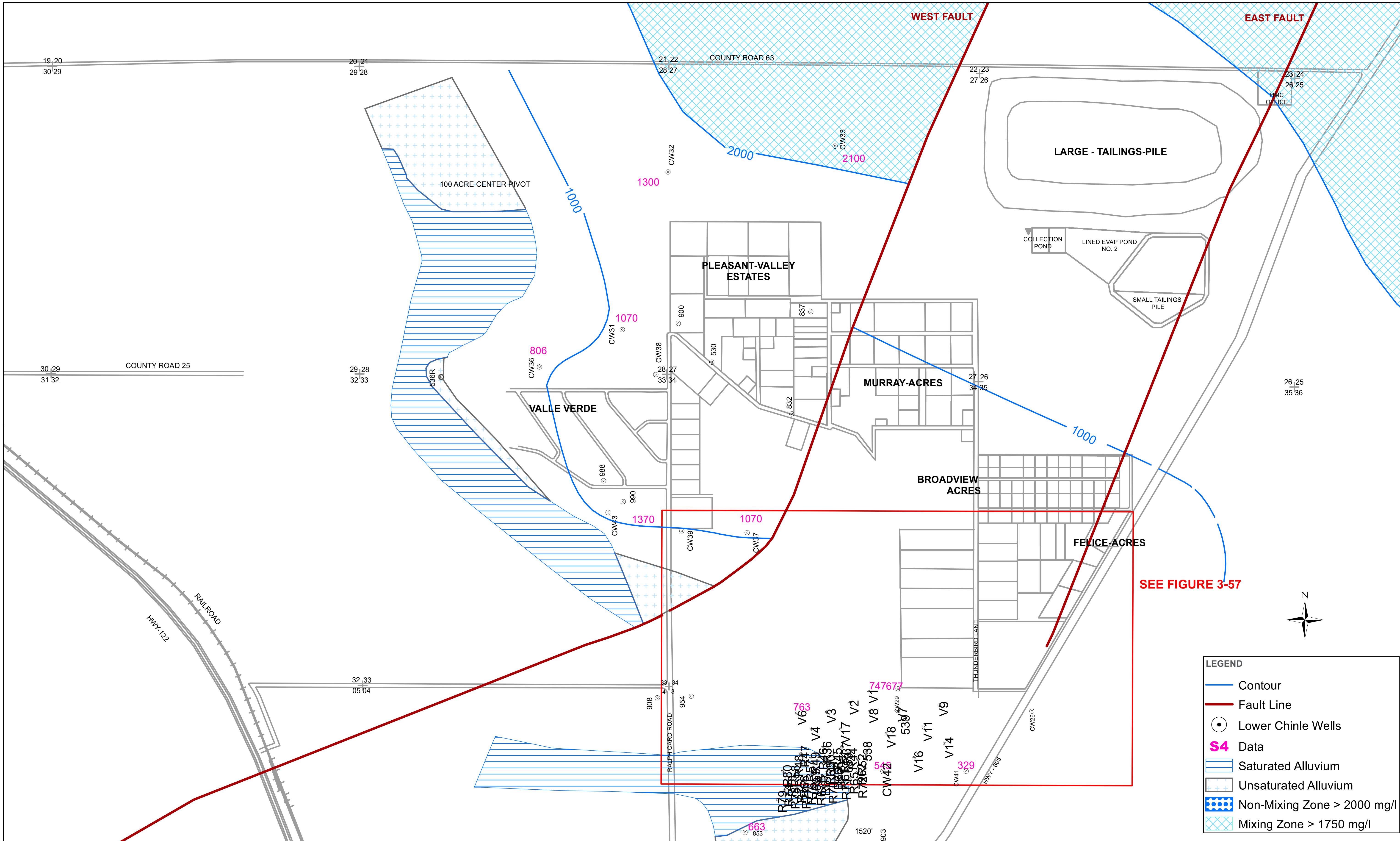
Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

LOWER CHINLE SELENIUM CONCENTRATIONS

DETAIL MAP

FIGURE 3-55

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-55_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

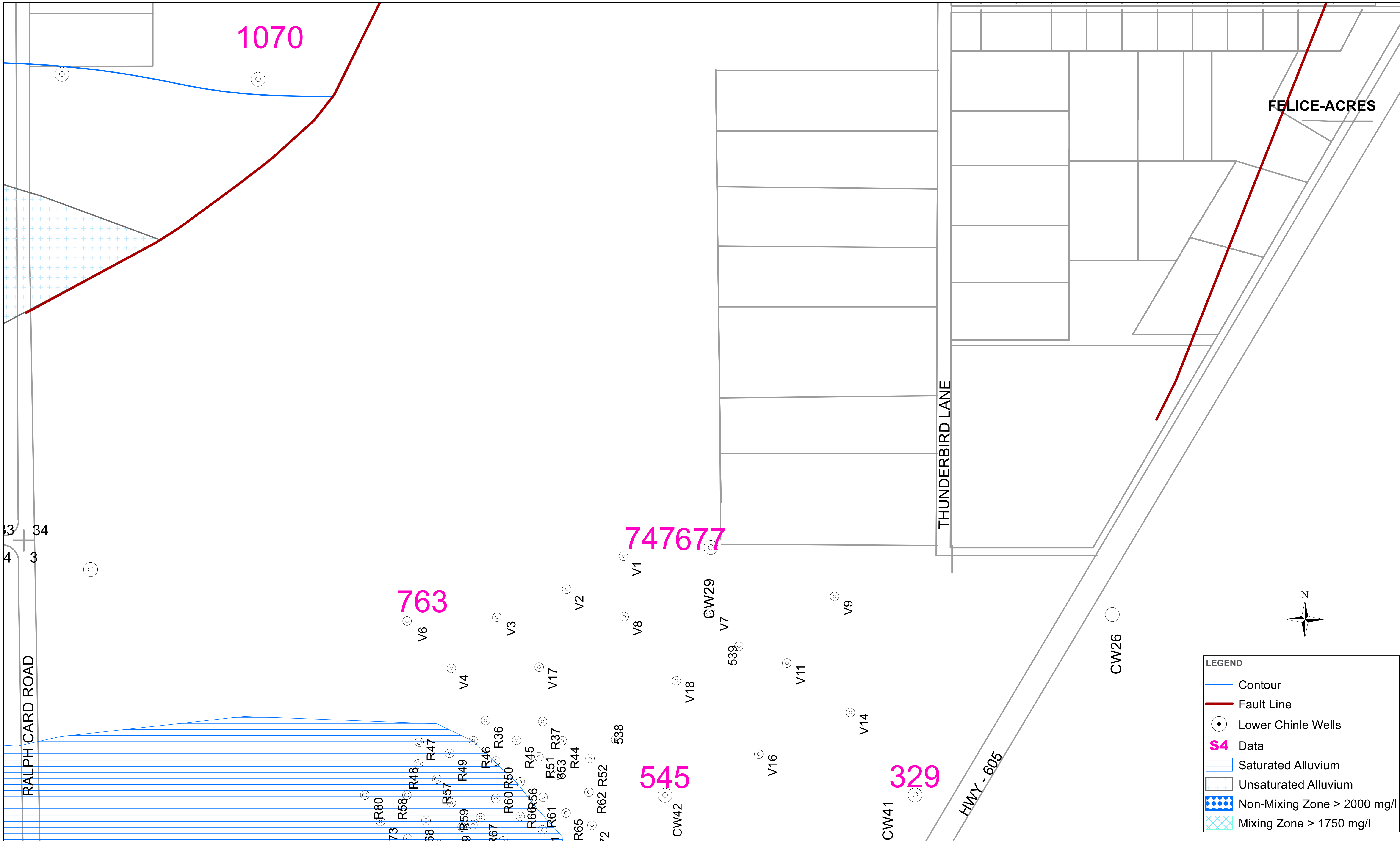
0 1,500 Feet

LOWER CHINLE AQUIFER SULFATE CONCENTRATIONS

OVERVIEW MAP

FIGURE 3-56

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-56_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019



HOMESTAKE

Source: 2018 Annual Monitoring Report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC 2019

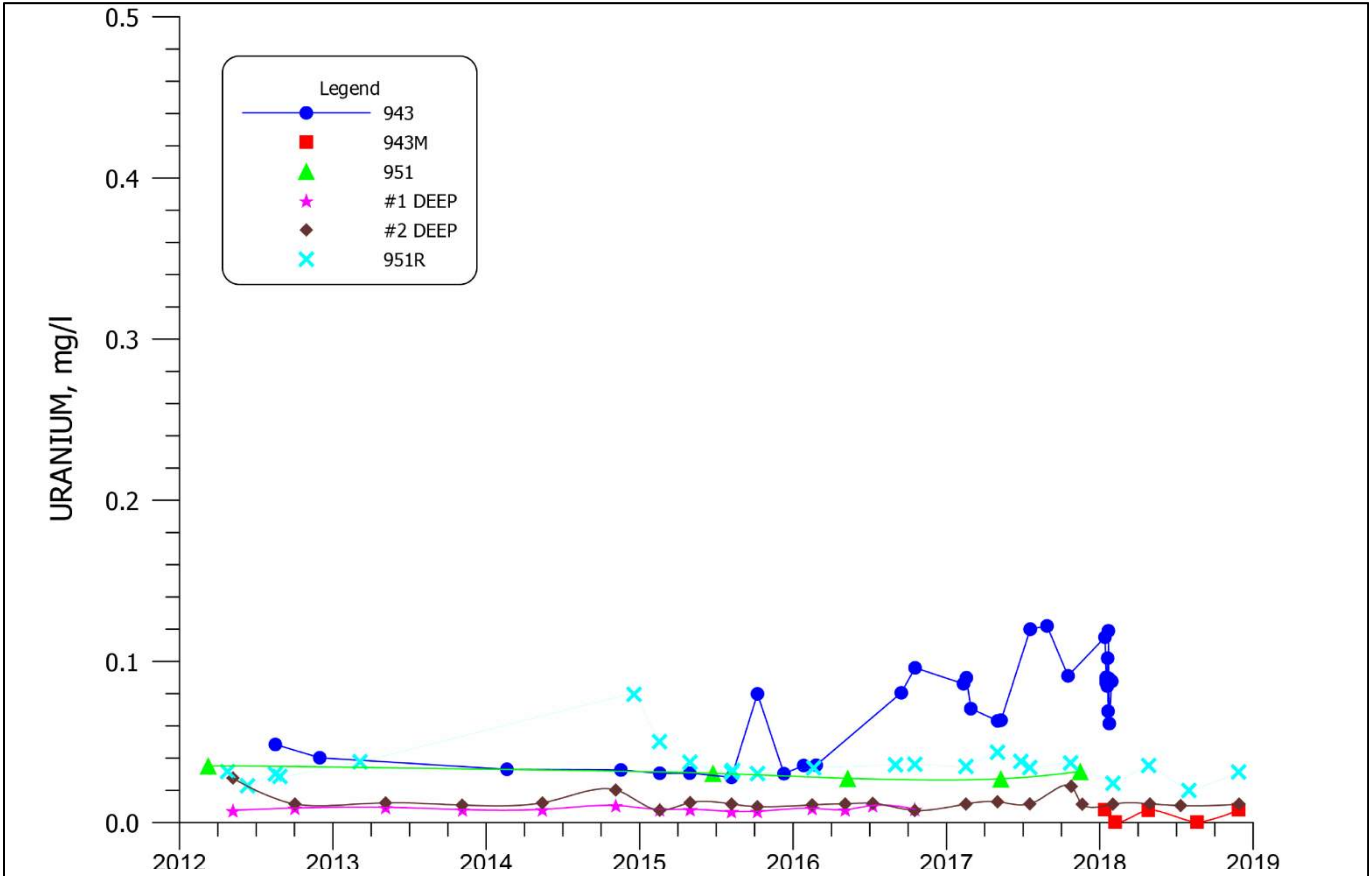
0 500 Feet

LOWER CHINLE AQUIFER SULFATE CONCENTRATIONS

DETAIL MAP

FIGURE 3-57

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-57_LANDSCAPE11X17.MXD - USER: RWOEHL - DATE: 9/6/2019

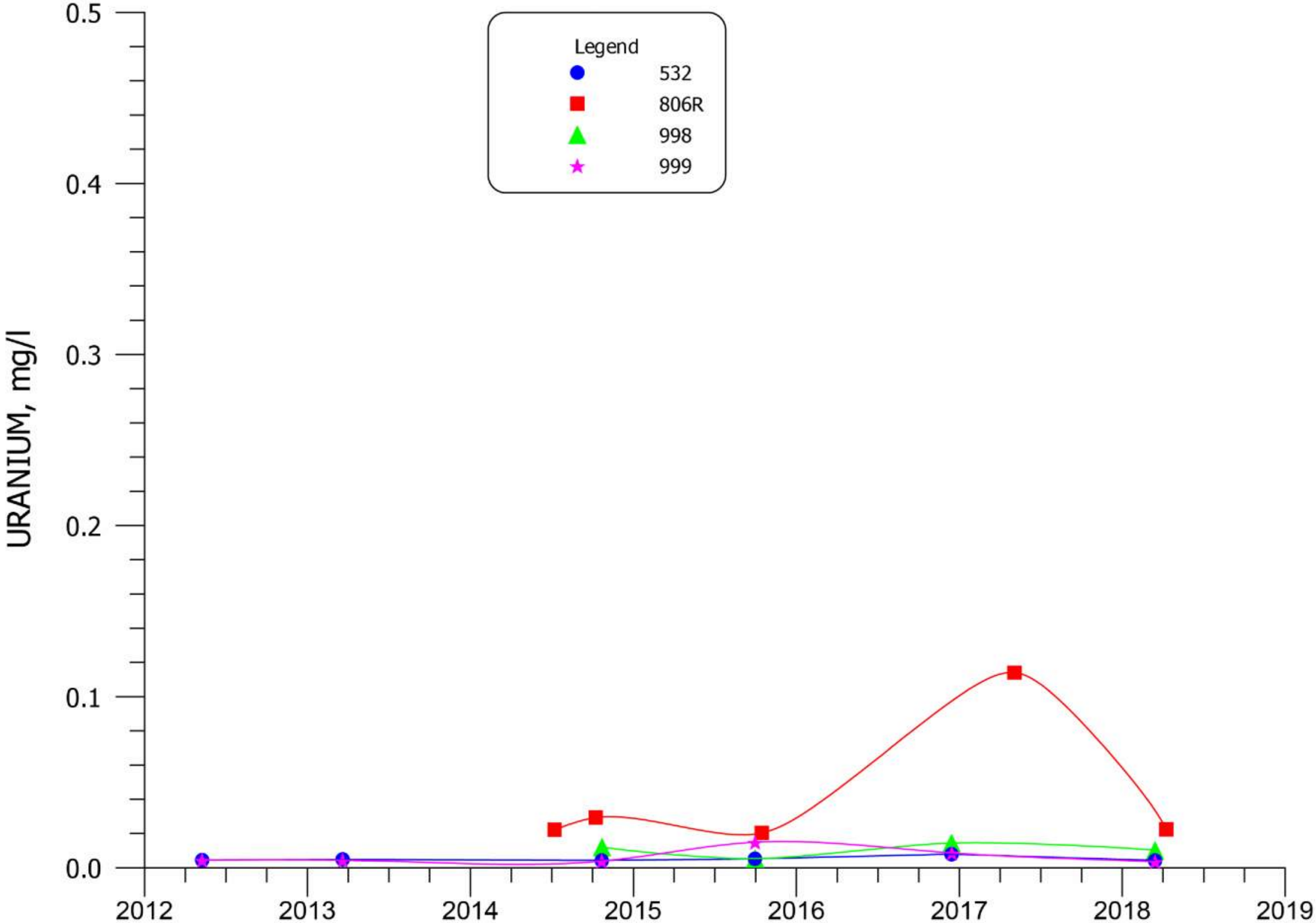


HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM CONCENTRATIONS VS TIME IN THE SAG AQUIFER:
WELLS 943, 943M, 951, 951R, #1 DEEP AND #2 DEEP

FIGURE 3-58

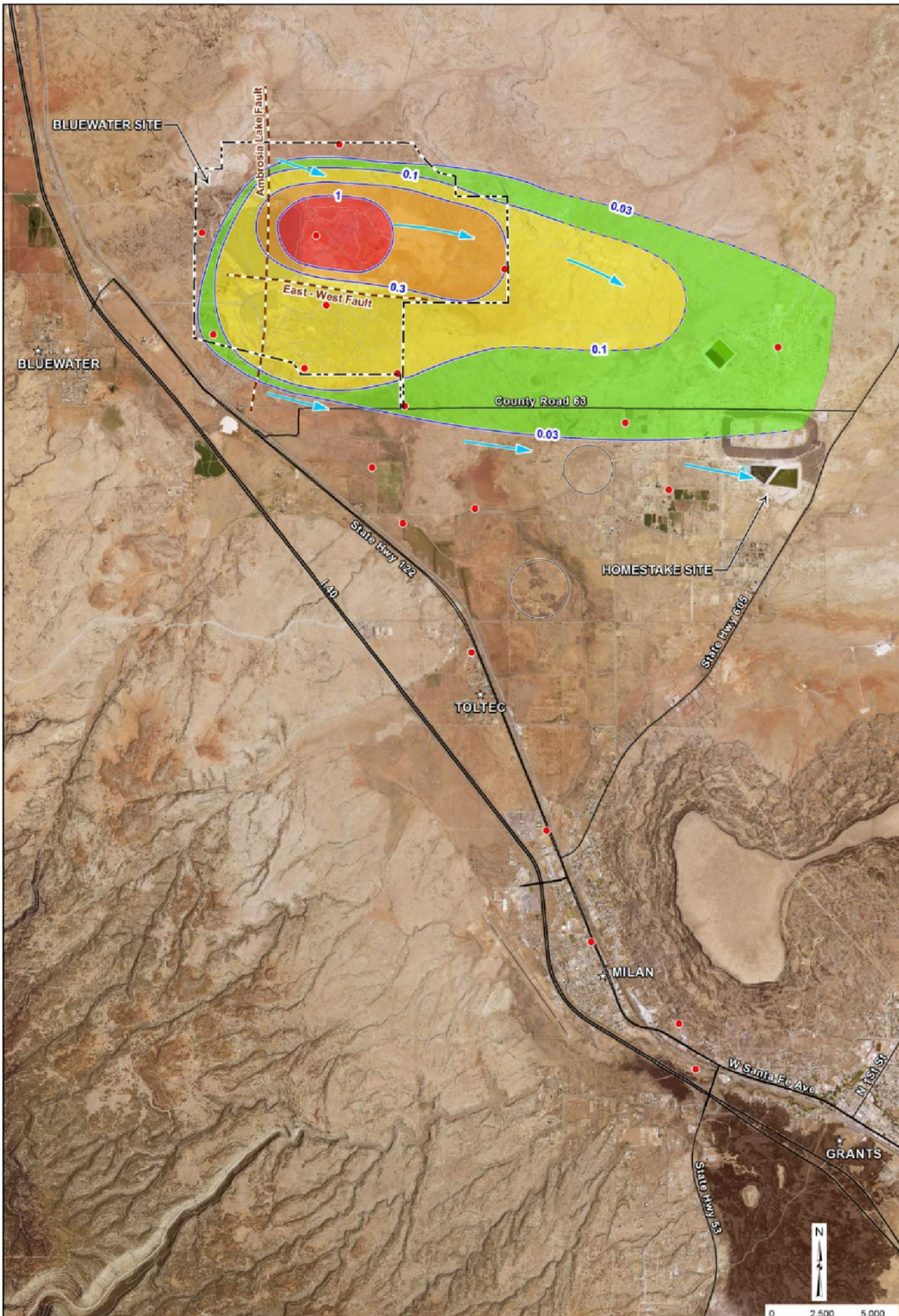


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM CONCENTRATIONS VS TIME IN THE SAG AQUIFER:

WELLS 532, 806R, 998 AND 999

FIGURE 3-59



Uranium Concentration (mg/L)

- 0.03 - 0.1
- 0.1 - 0.3
- 0.3 - 1.0
- > 1.0

−0.1− Uranium Concentration (dashed where approximated)

- ● San Andres-Glorieta Aquifer (SAG) Well
- Flow Direction
- Fault Line
- ☆ Municipality
- Bluewater Site Boundary
- Interstate Highway
- State Highway

U.S. DEPARTMENT OF ENERGY
OFFICE OF LEGACY MANAGEMENT

Work Performed by
Navarro Research & Engineering, Inc.
Under DOE Contract Number DE-LM0000421

DATE PREPARED: July 25, 2018

FILE NAME: S1938606

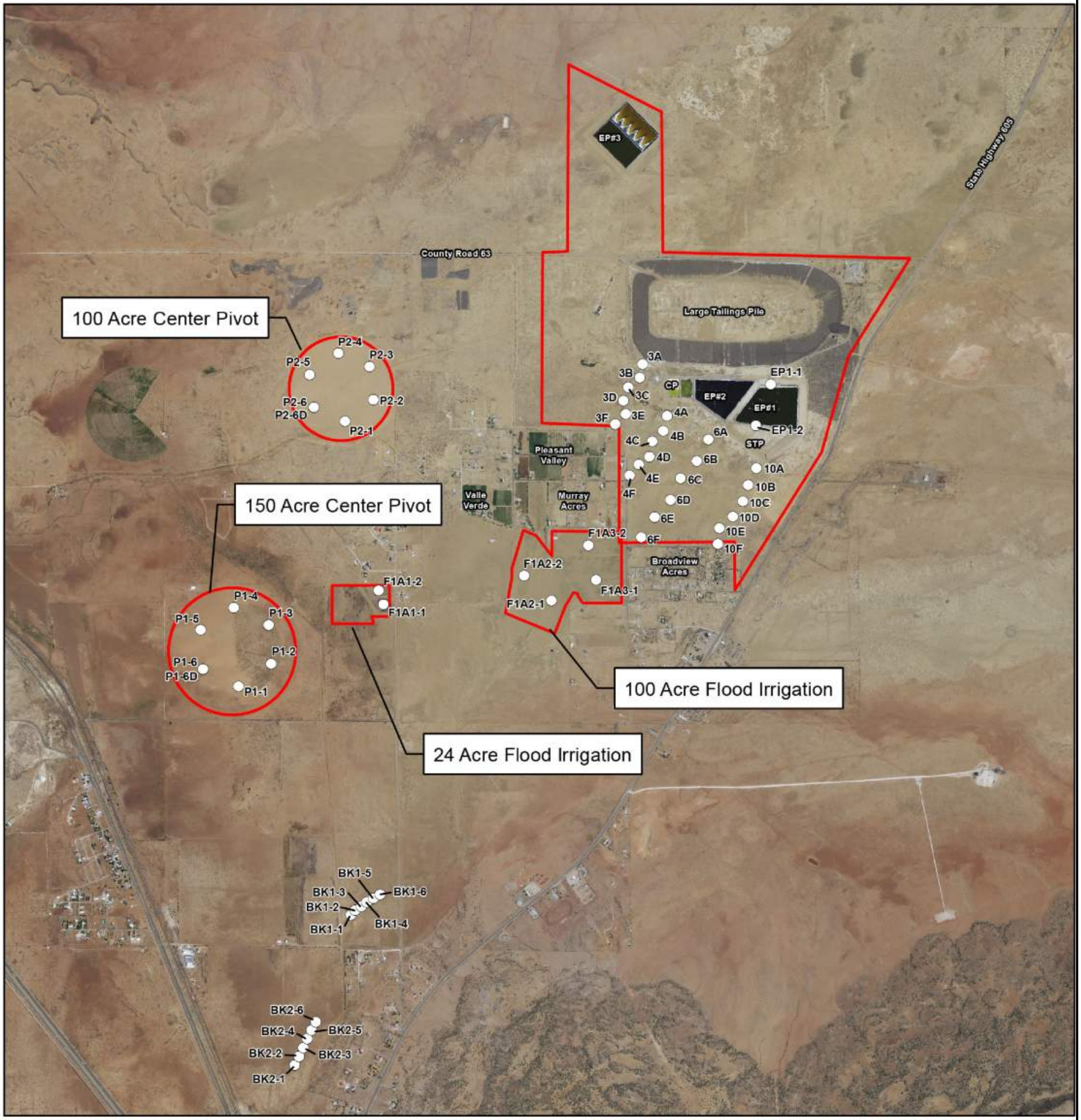
\\LM\ess\EnvProjects\EBM\LTS\111\0024\15\000\S19386\S1938606.mxd smithw 07/25/2018 11:54:11 AM

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-60_PORTRAIT11X17.MXD - USER: RWOEHL - DATE: 9/6/2019

HOMESTAKE

RECENT URANIUM CONCENTRATIONS IN THE SAG AQUIFER

FIGURE 3-60



LEGEND:

○ EPA Soil Sampling Location

Site Areas

0 0.5 1 Miles

Aerial Source: NAIP 2011

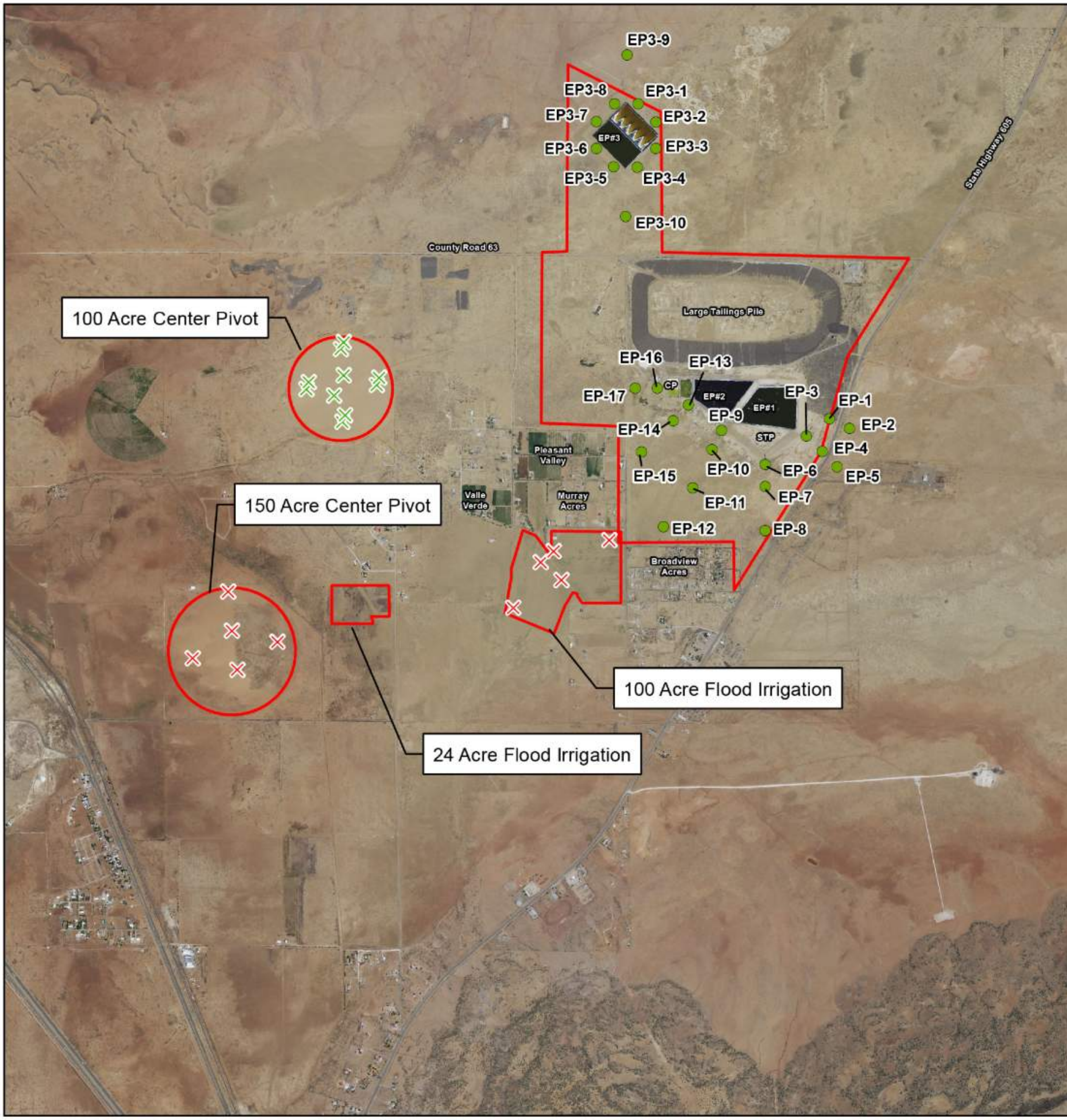
Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

HOMESTAKE

SOIL SAMPLING LOCATIONS FROM EPA HUMAN HEALTH RISK ASSESSMENT

LOCATION MAP

FIGURE 3-61



LEGEND:

- EP Soil Sampling Location
- ERG Flood Irrigation Soil
- 100-Acre Center Pivot Sampling Point
- 150-Acre Center Pivot Sampling Point
- Site Areas

0 0.5 1 Miles

Aerial Source: NAIP 2011

Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

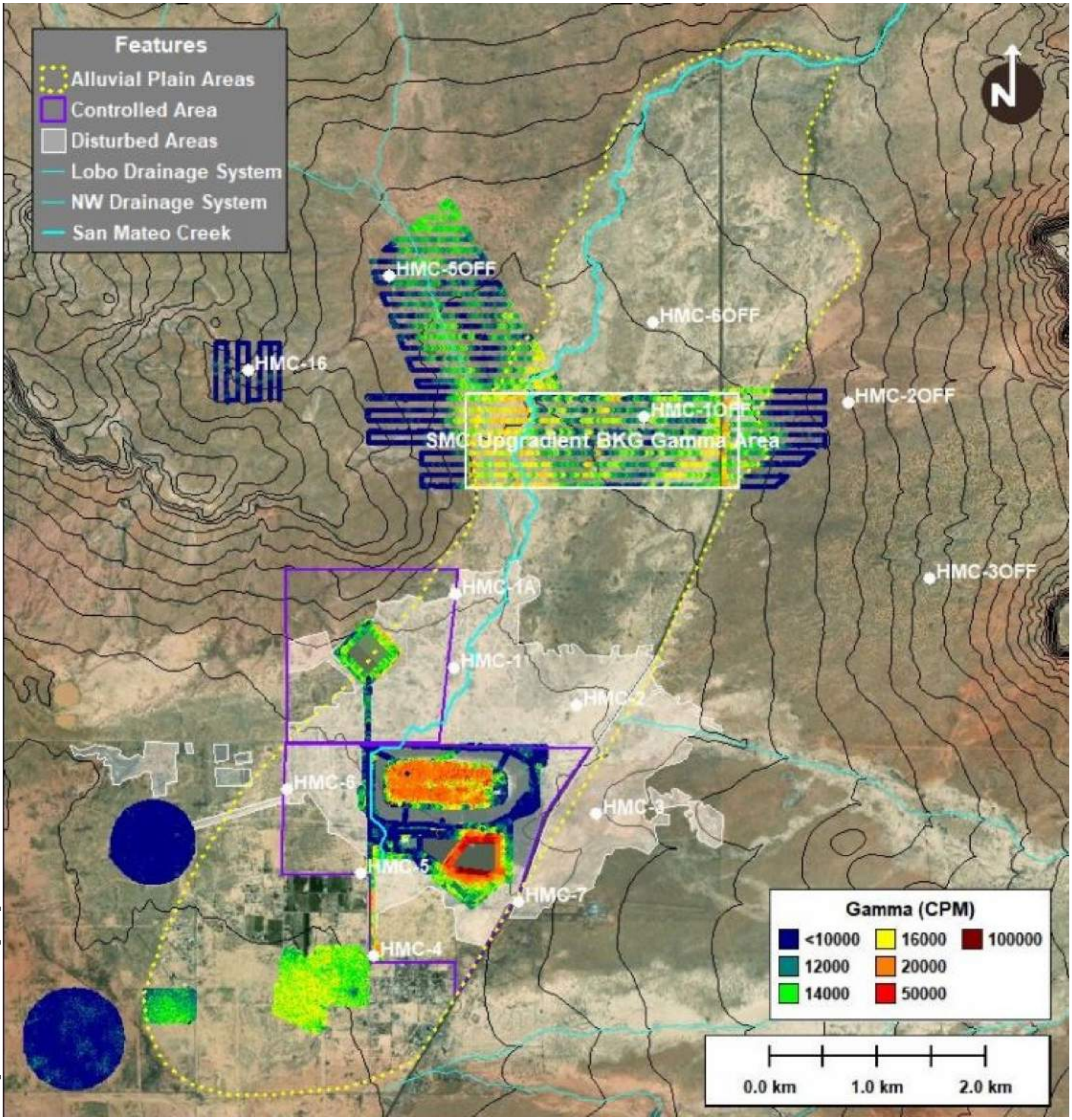
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-62_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

HOMESTAKE

HMC SF SITE SOIL SAMPLING LOCATIONS

LOCATION MAP

FIGURE 3-62



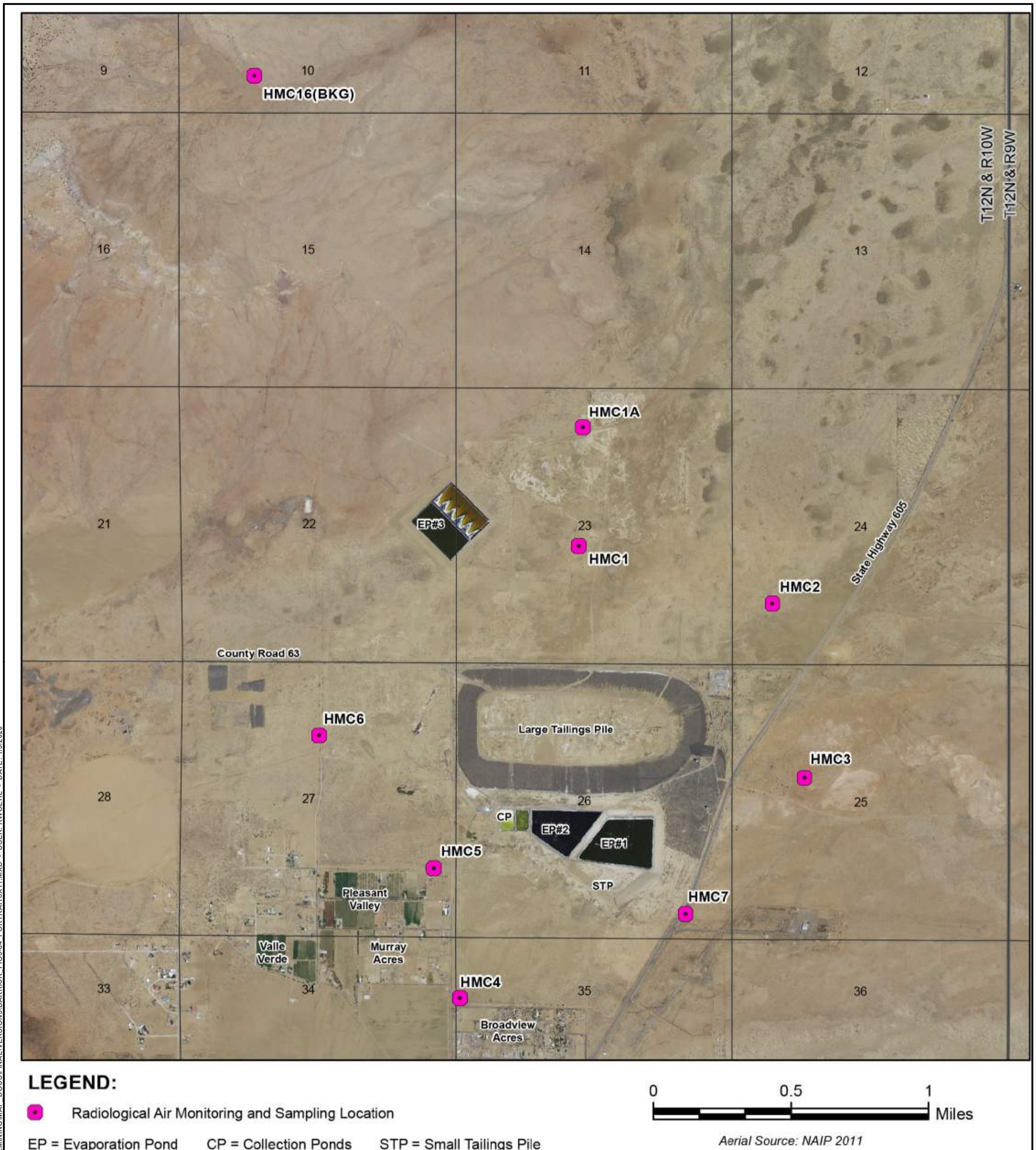
PATH: Z:\PROJECTS\PROPOSALS\1971518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-63_PORTRAIT8X11.MXD USER: DWOEHL DATE: 1/2/2020

HOMESTAKE

GAMMA BACKGROUND FOR SAN MATEO ALLUVIAL FLOOD PLAIN

LOCATION MAP

FIGURE 3-63



Adopted from: Grants Reclamation Project Updated Corrective Action Program, HMC, 2012

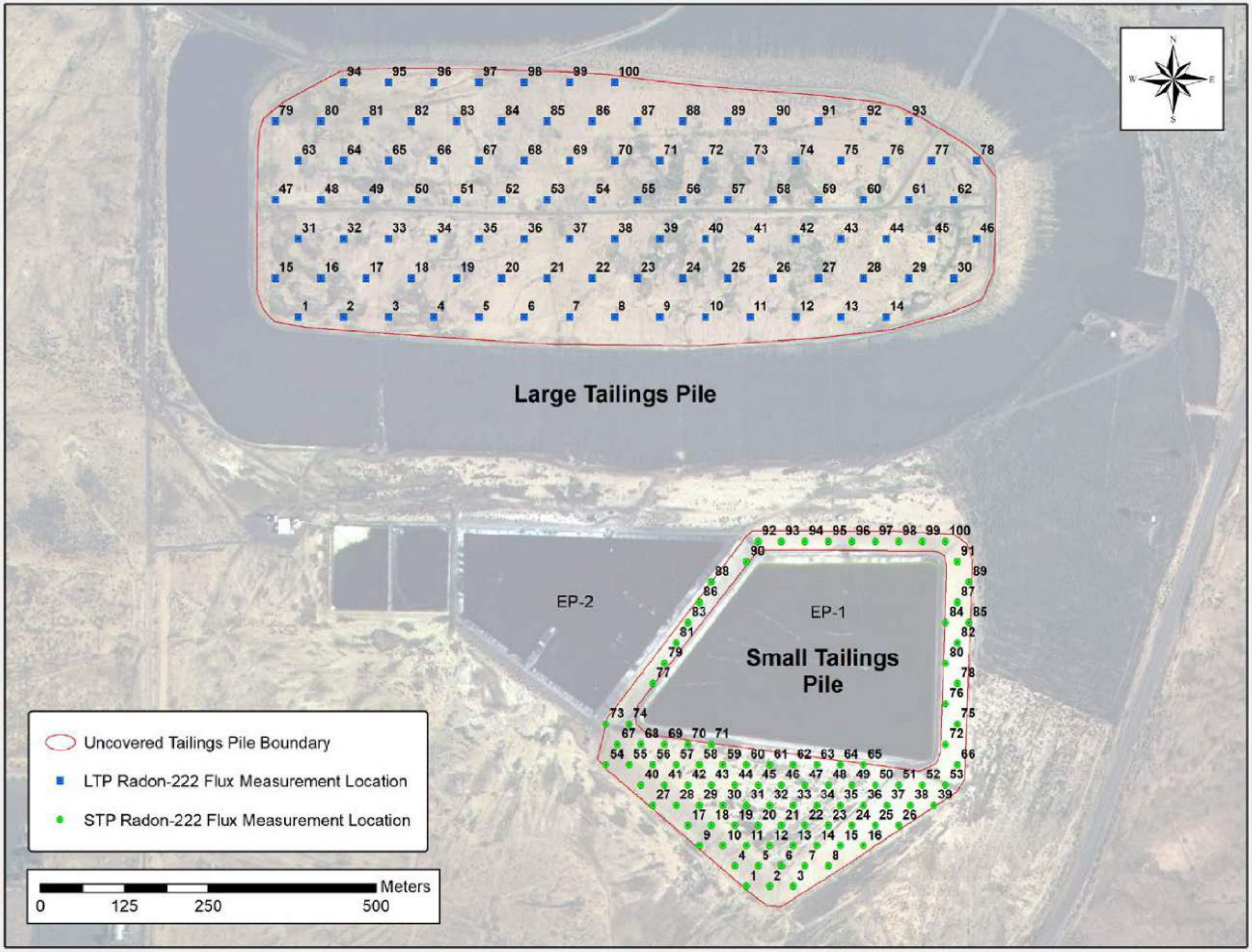
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-64_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

HOMESTAKE

RADIOLOGICAL AIR MONITORING AND SAMPLING LOCATIONS

LOCATION MAP

FIGURE 3-64



RADON FLUX MONITORING LOCATIONS

LOCATION MAP

FIGURE 3-65

HOMESTAKE

EPA NORTH RADON SAMPLING LOCATIONS

FIGURE 3-66

LEGEND

● Detector Locations

0 1,200 2,400
Feet

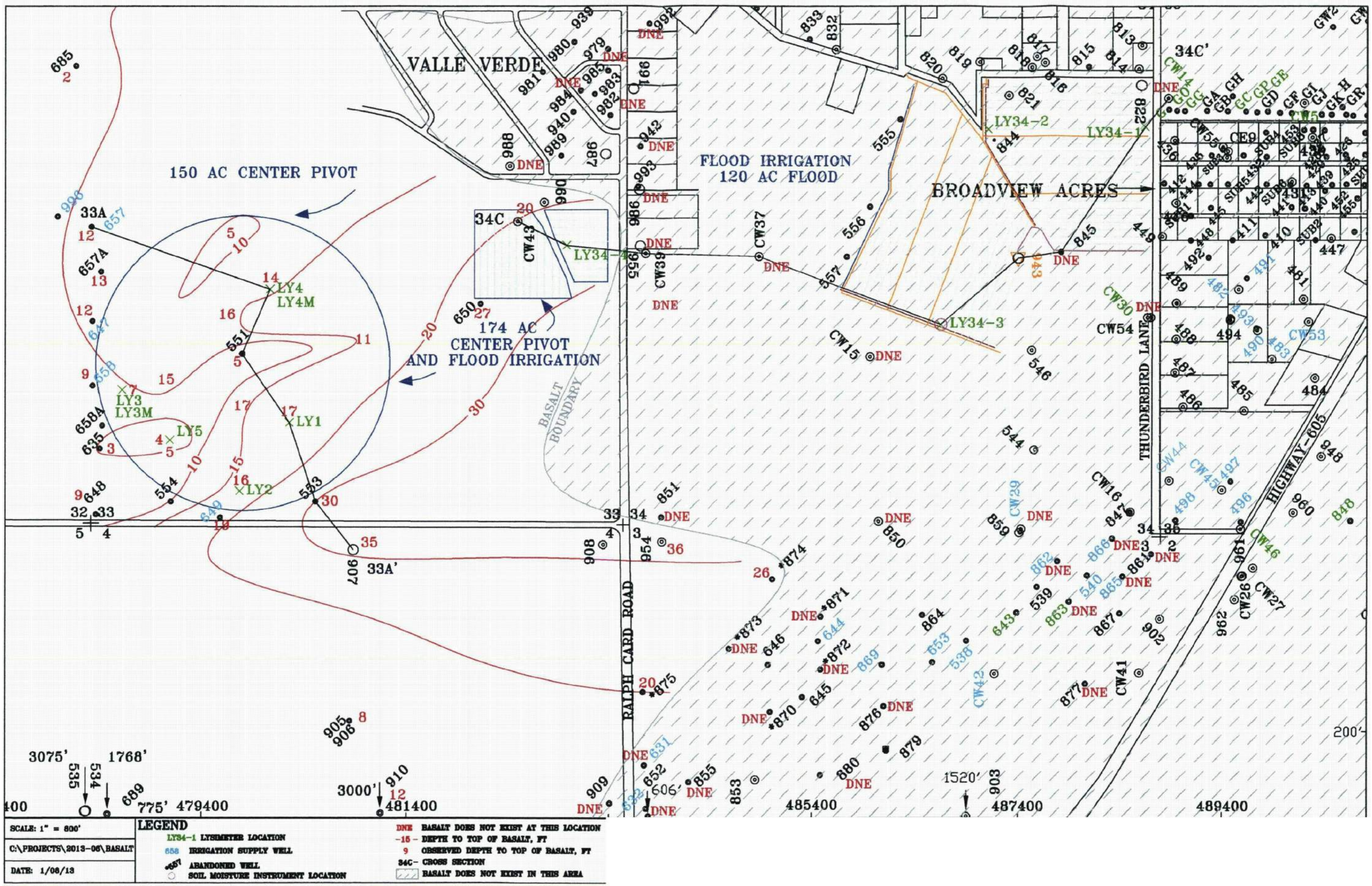
IMAGERY SOURCE: (c) 2011 Microsoft Corporation

HOMESTAKE

EPA SOUTH RADON SAMPLING LOCATIONS

FIGURE 3-67

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-67_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020



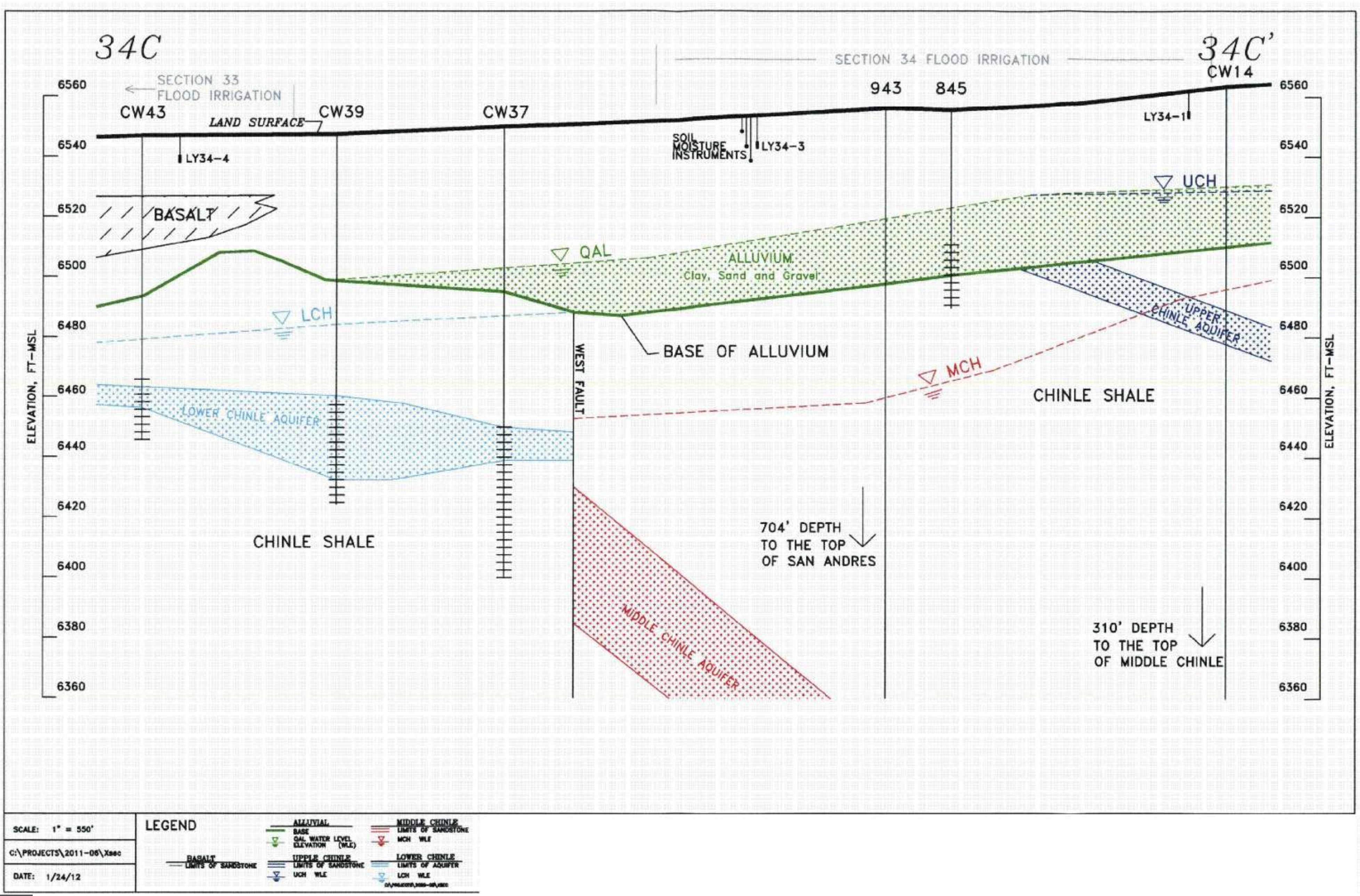
HOMESTAKE

Source: 2018 Annual Monitoring report/Performance Review, for Homestake's Grants Project Pursuant to NRC License, SUA1471 and Discharge Plan DP-200, HMC, 2015

PLAN VIEW OF 120-ACRE AND 24-ACRE FLOOD IRRIGATION FIELDS AND WELL LOCATIONS

OVERVIEW MAP

FIGURE 3-68



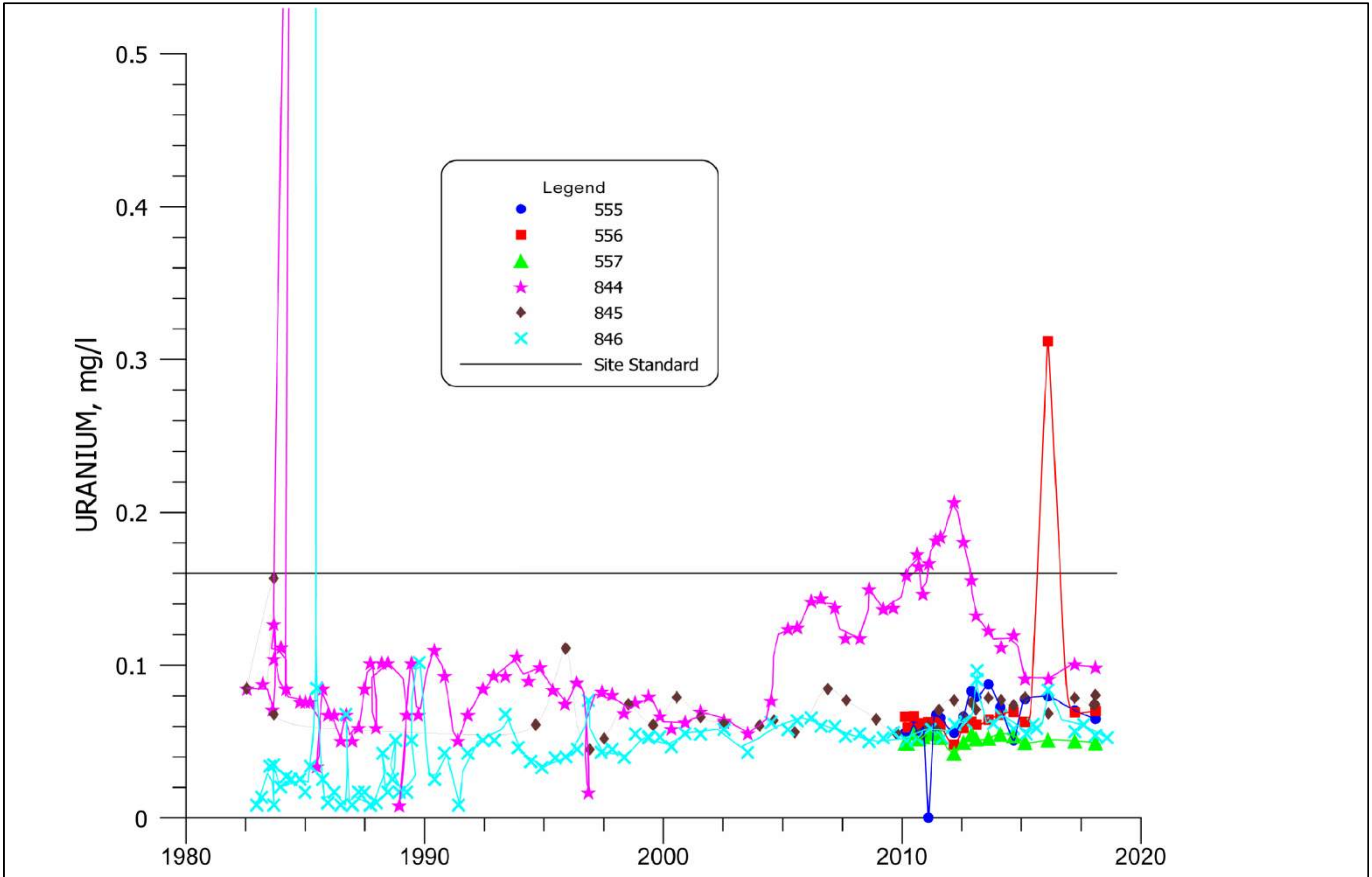
HOMESTAKE

Adopted from: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

120-ACRE AND 24-ACRE FLOOD IRRIGATION FIELDS

GEOLOGIC CROSS-SECTION 34C-34C'

FIGURE 3-69



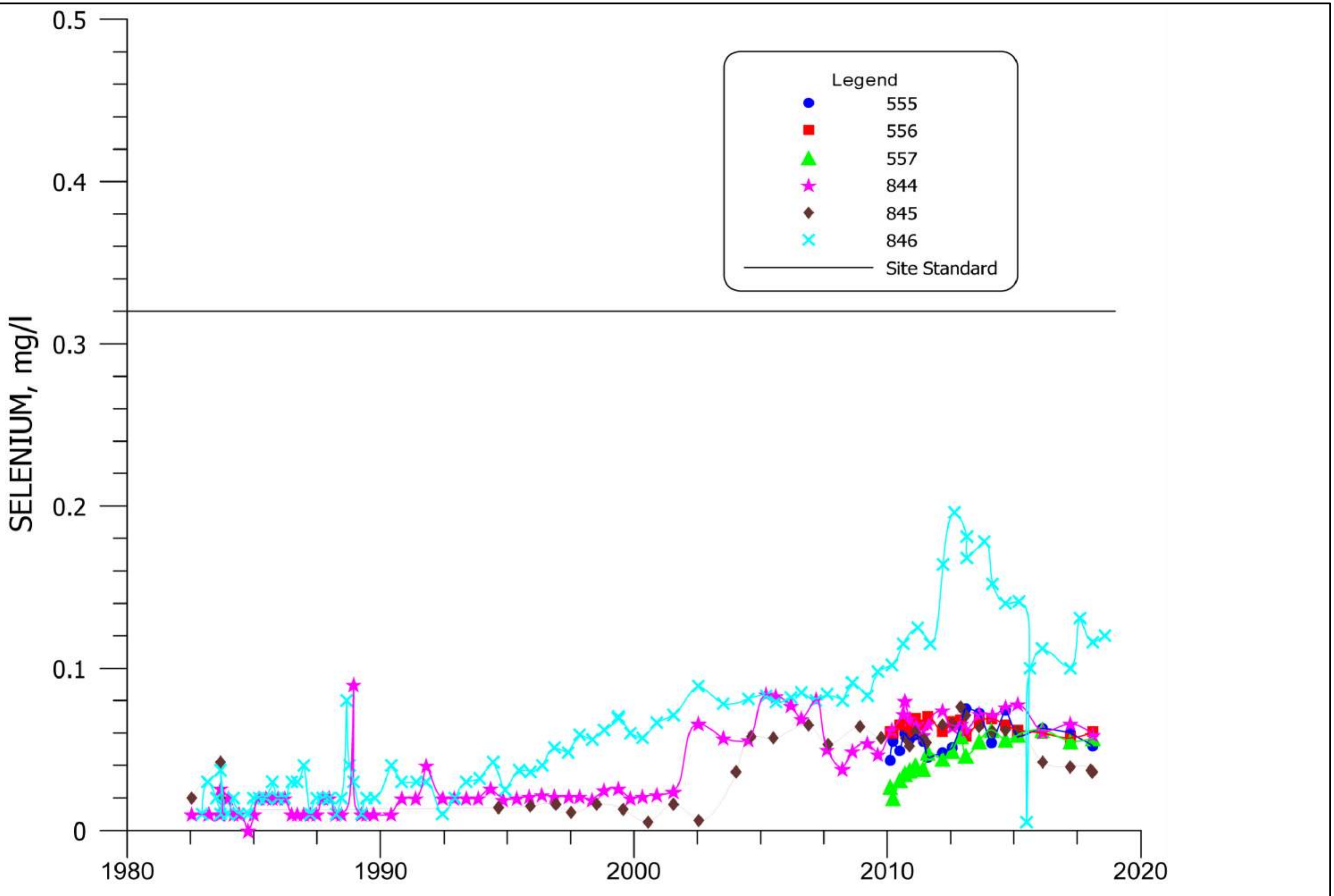
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM IN GROUND WATER

FROM WELLS MONITORING THE 120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-70

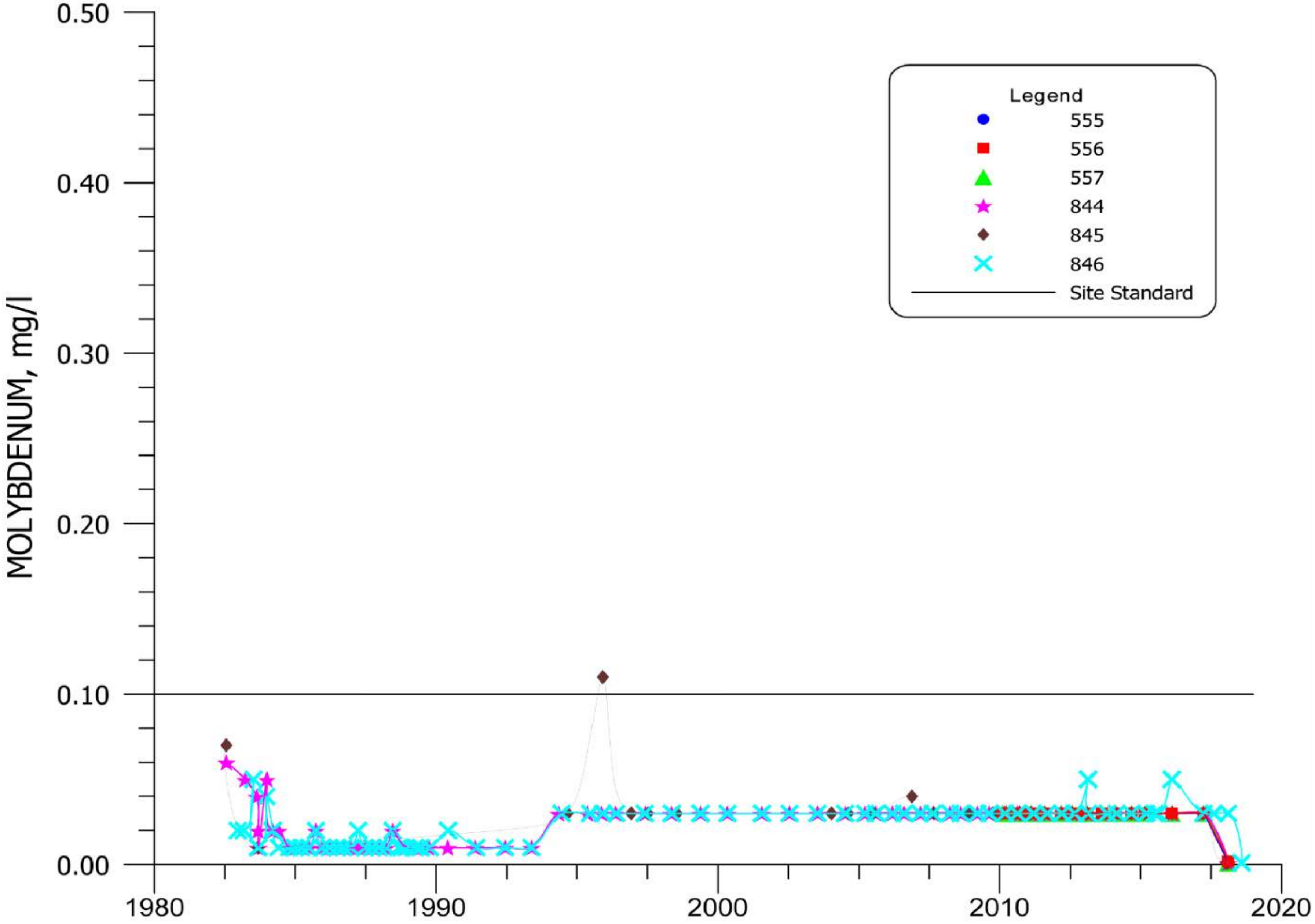


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SELENIUM IN GROUND WATER

FROM WELLS MONITORING THE 120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-71

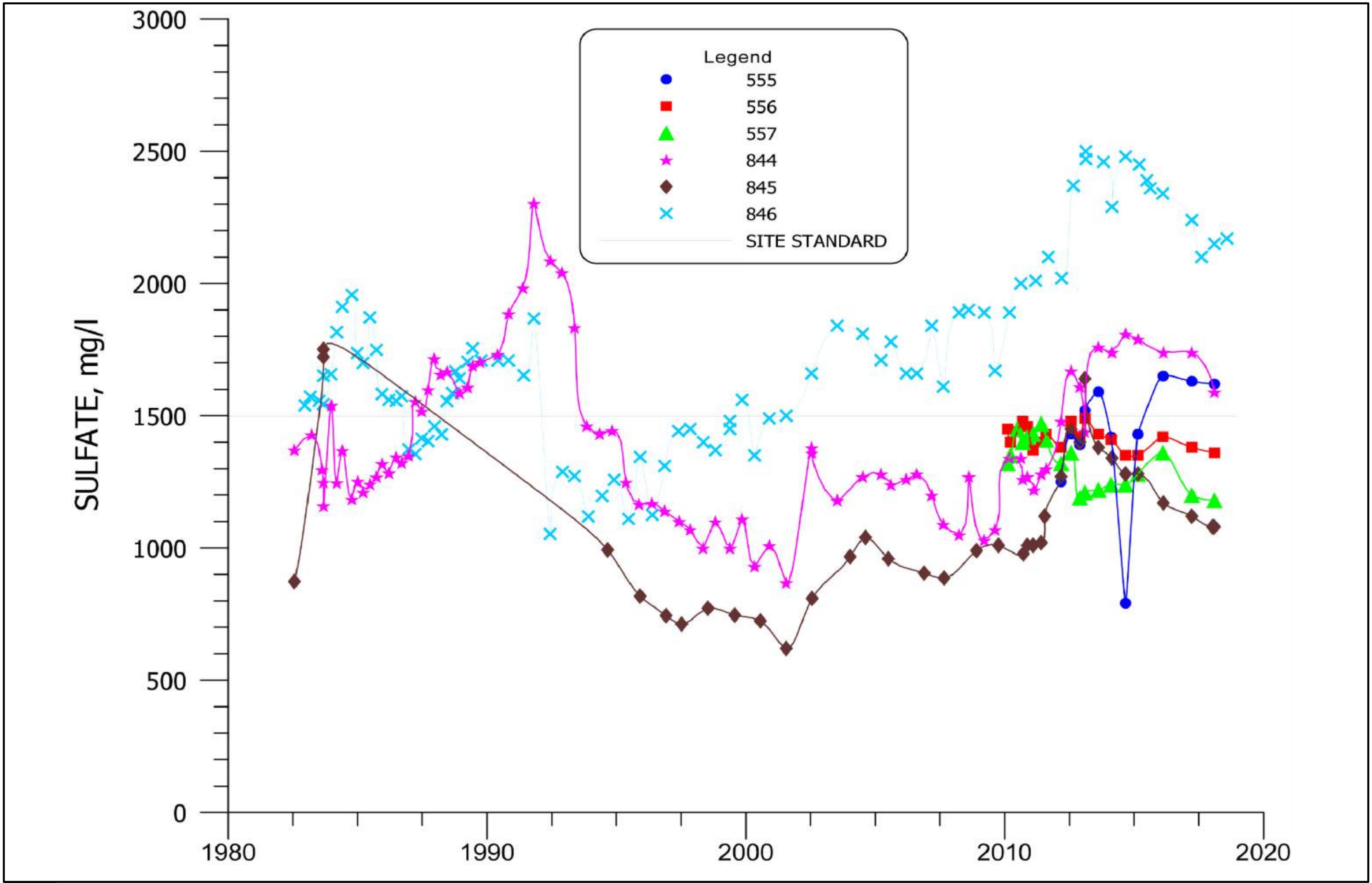


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

MOLYBDENUM IN GROUND WATER

FROM WELLS MONITORING THE 120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-72

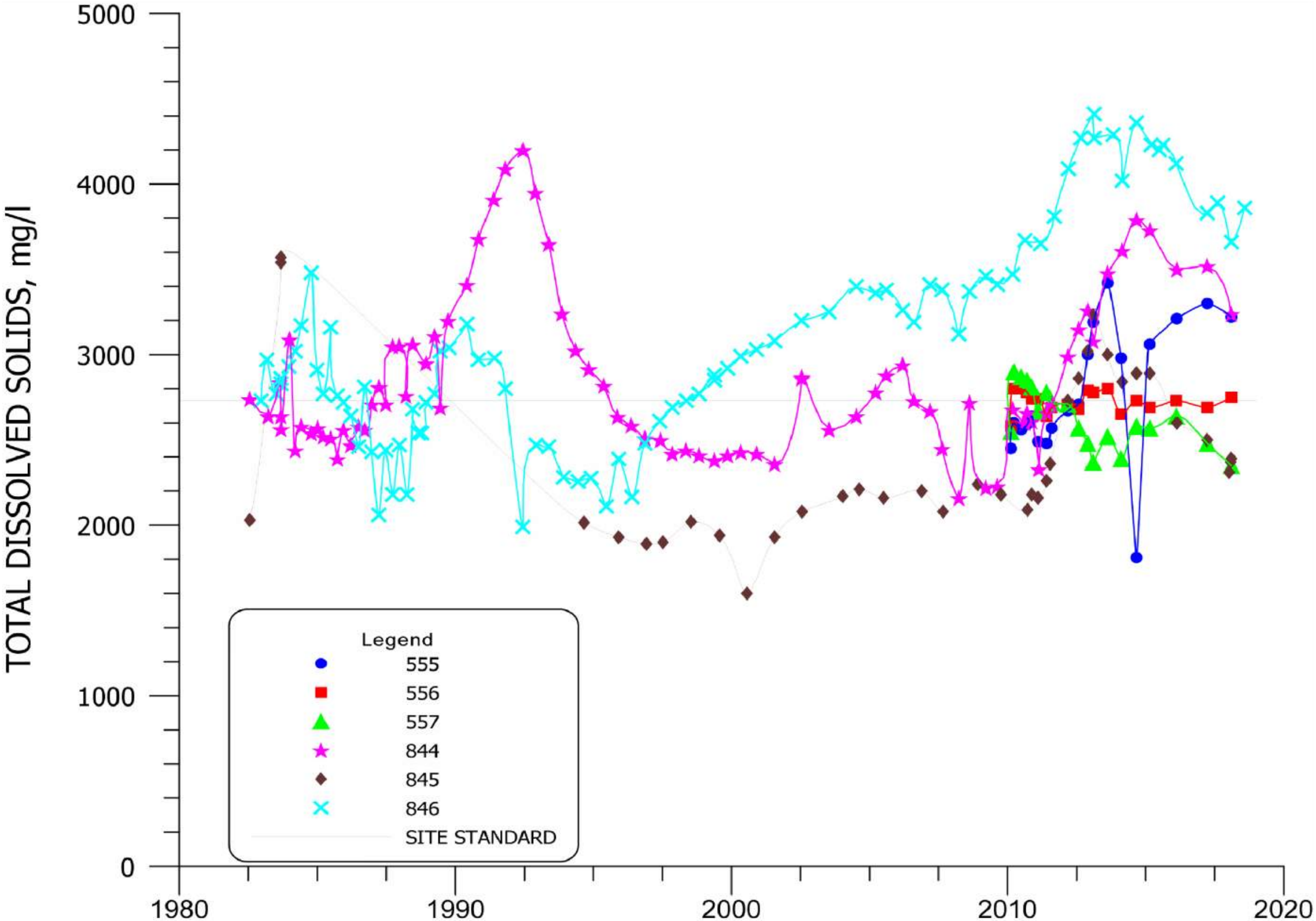


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SULFATE IN GROUND WATER

FROM WELLS MONITORING THE 120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-73

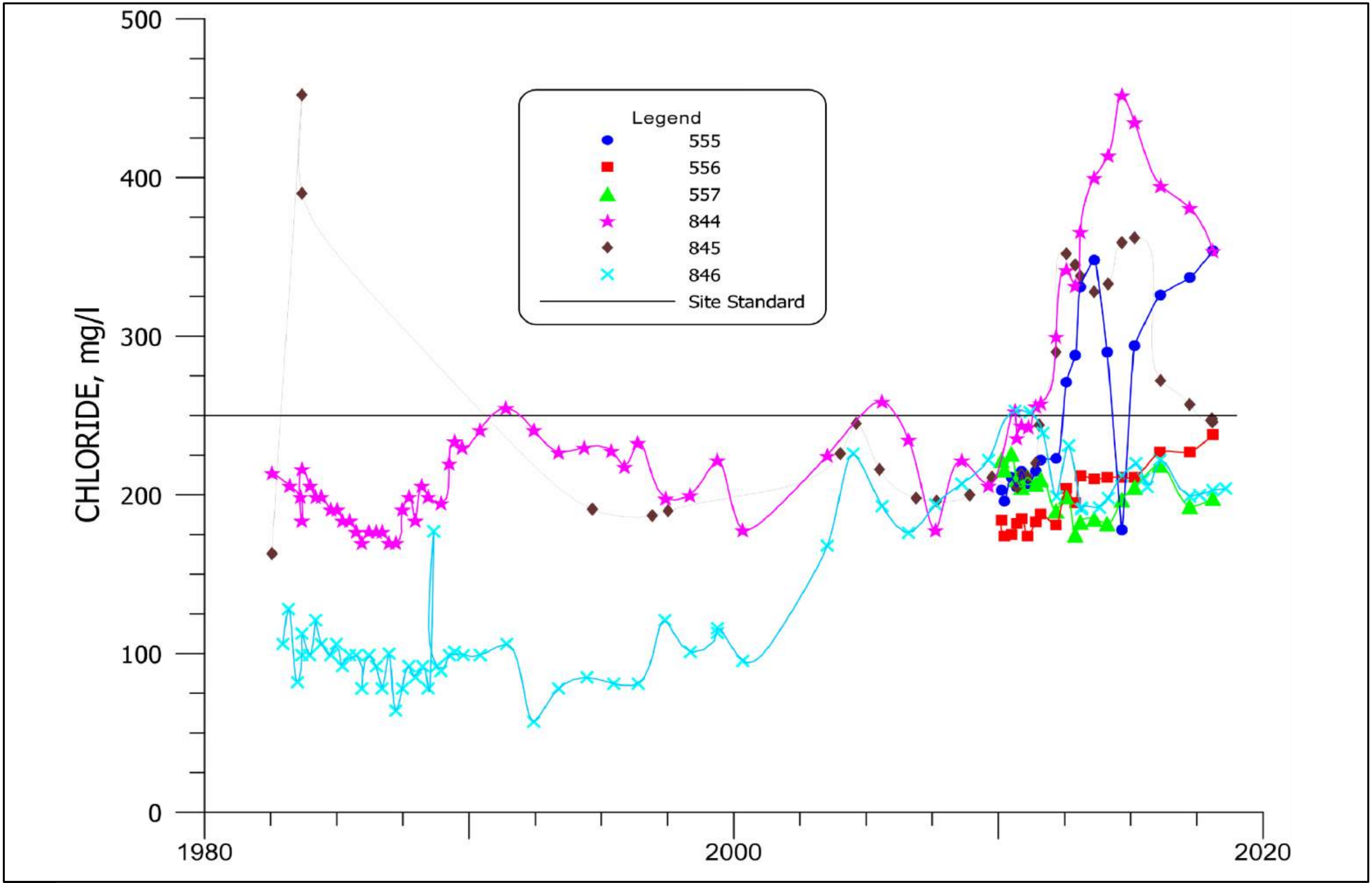


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

TDS IN GROUND WATER

FROM WELLS MONITORING THE 120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-74

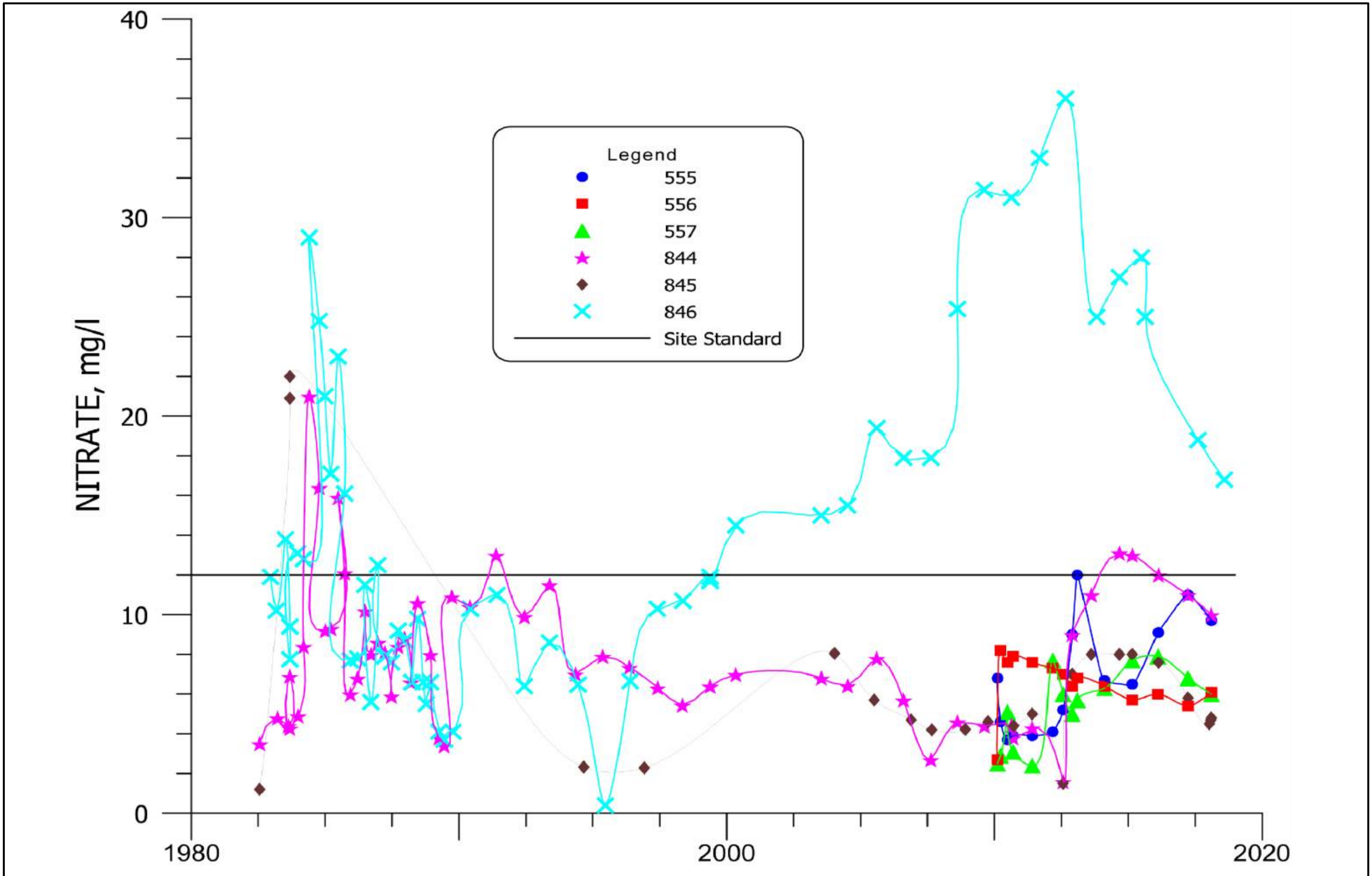


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

CHLORIDE IN GROUND WATER

FROM WELLS MONITORING THE 120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-75



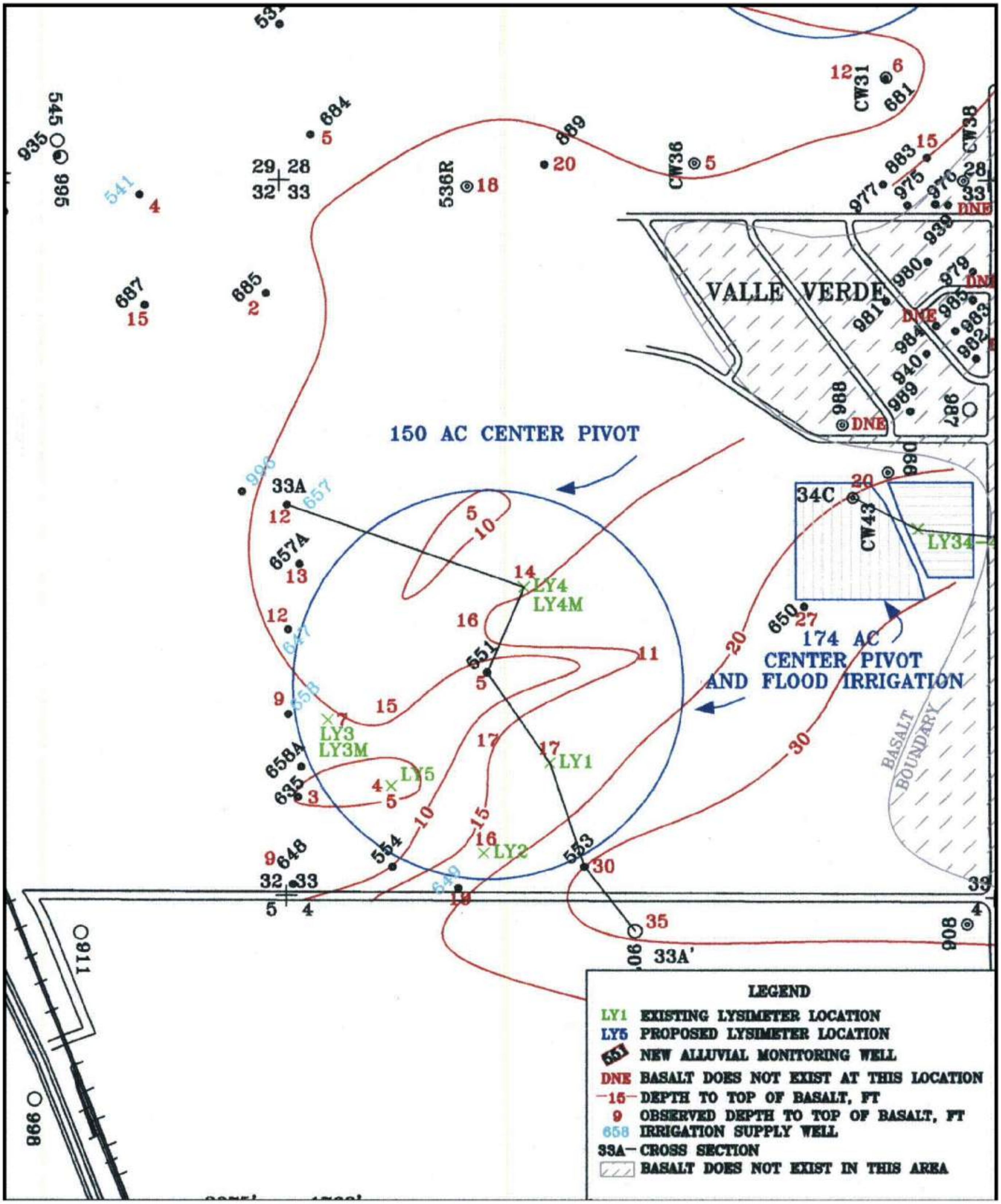
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

NITRATE IN GROUND WATER

FROM WELLS MONITORING THE 120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-76



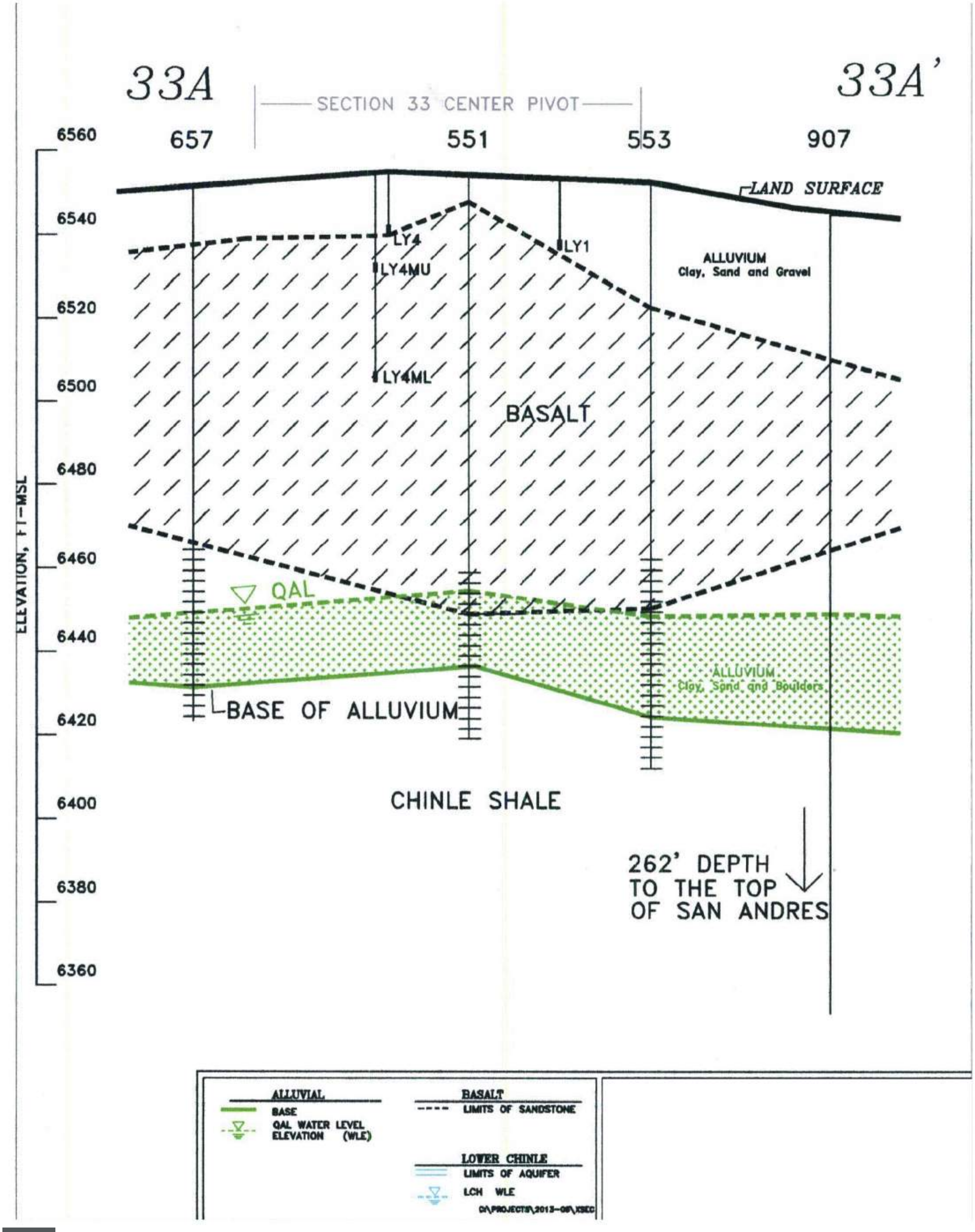
HOMESTAKE

PLAN VIEW OF 150-ACRE CENTER PIVOT FIELD AND WELL LOCATIONS

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

OVERVIEW MAP

FIGURE 3-77



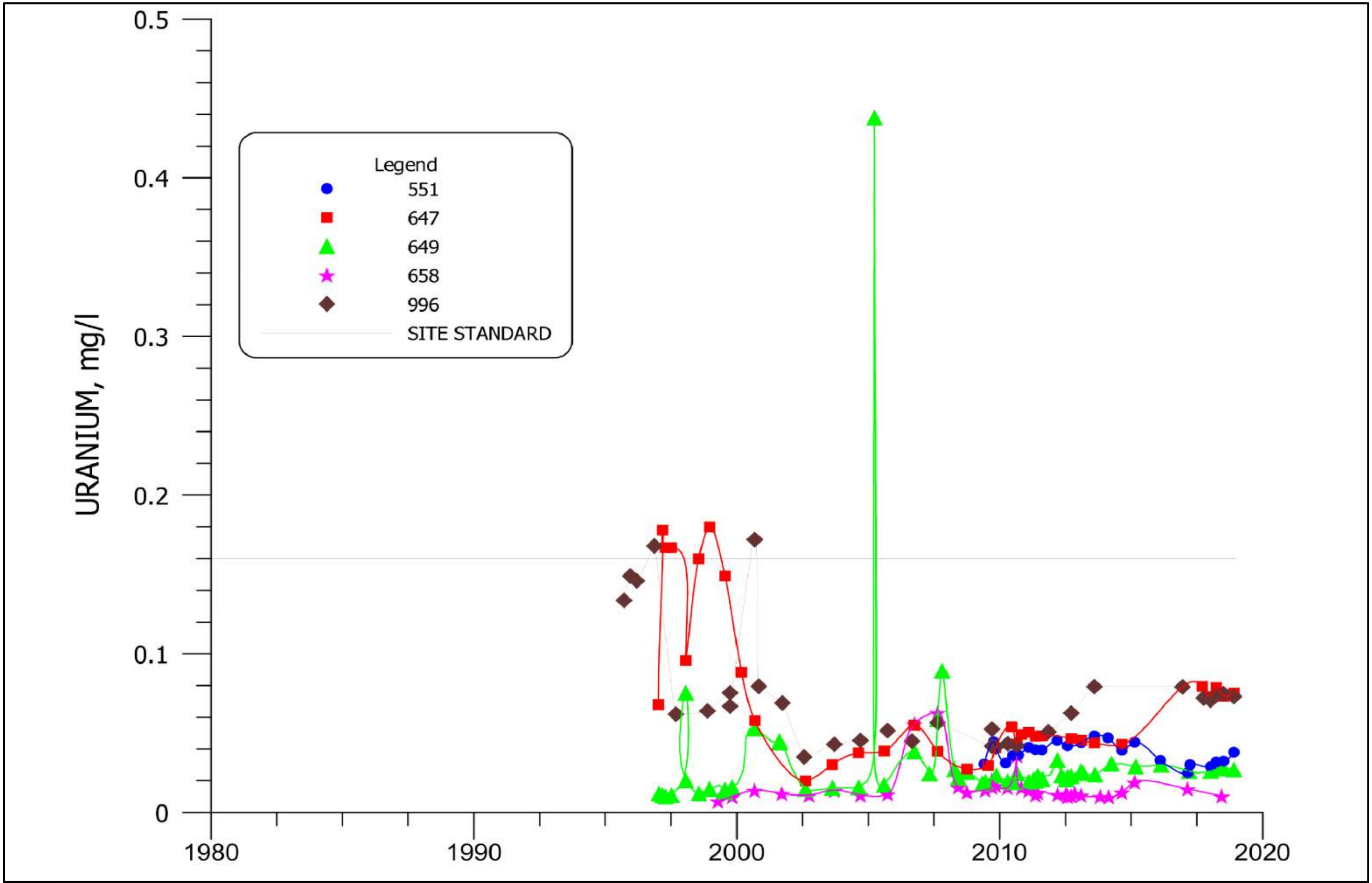
PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-78_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

150-ACRE CENTER PIOT FIELD

GEOLOGIC CROSS-SECTION 33A-33A'

FIGURE 3-78

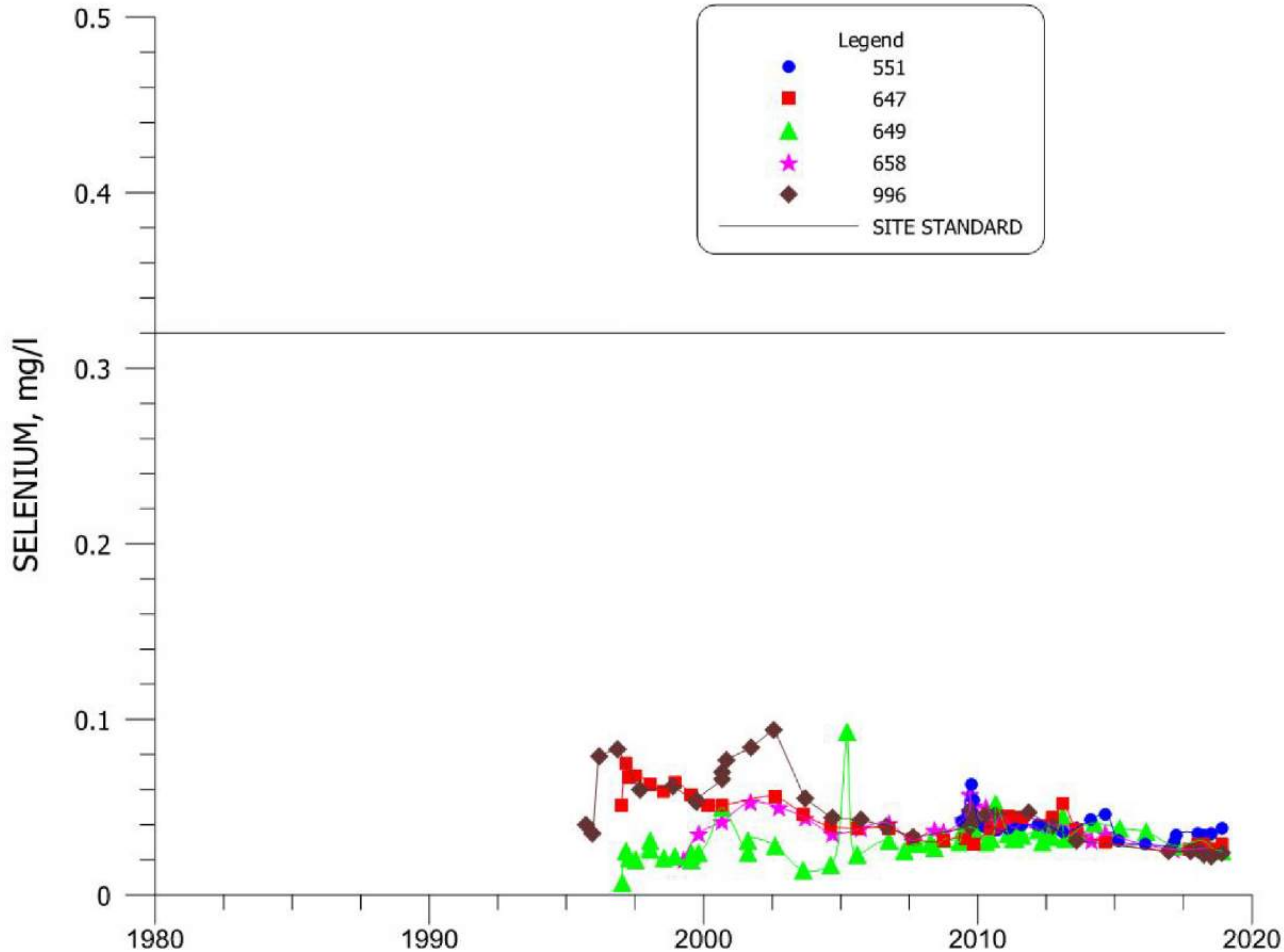


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM IN GROUND WATER

FROM WELLS MONITORING THE 150-ACRE FLOOD PIVOT FIELD

FIGURE 3-79



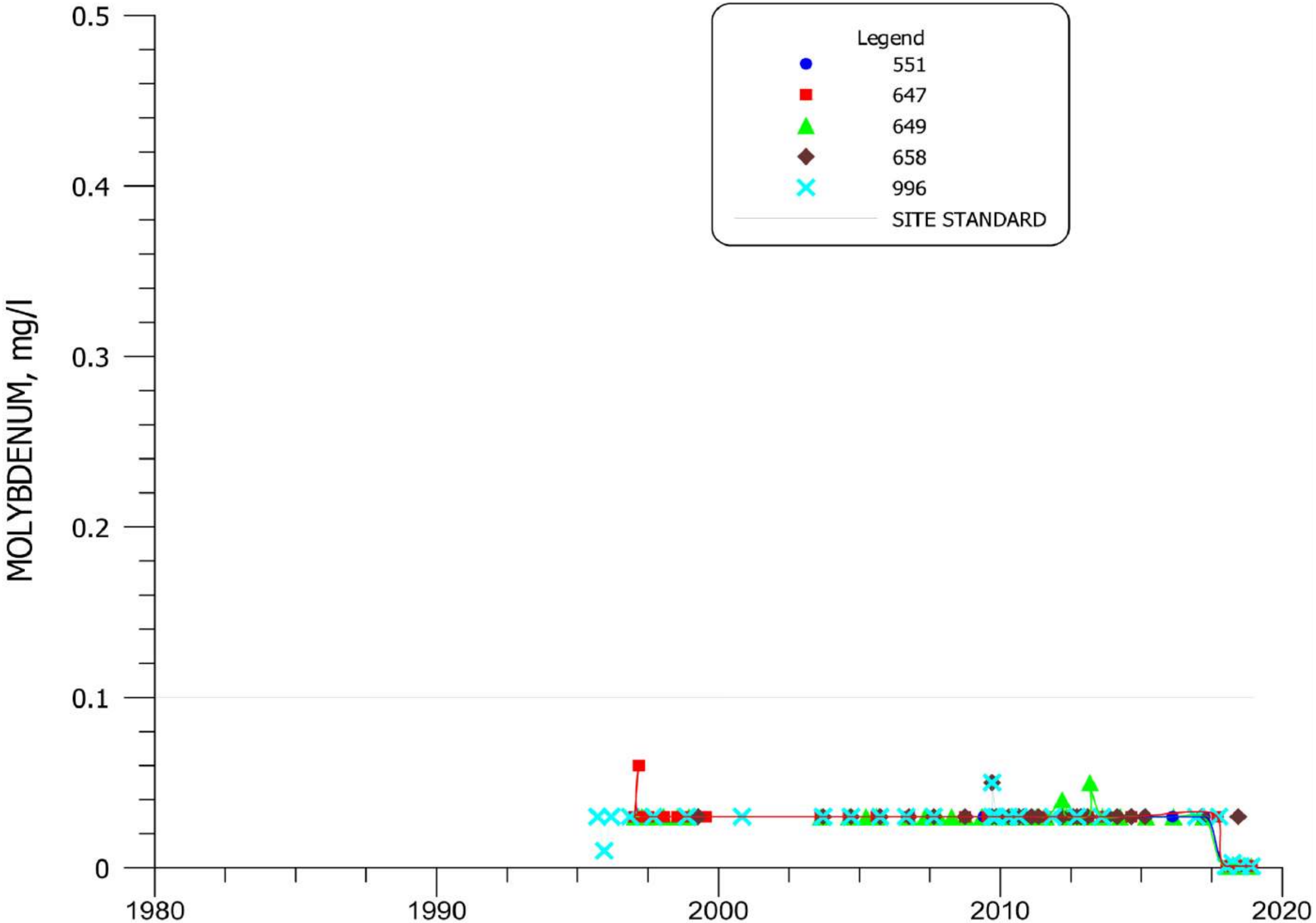
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SELENIUM IN GROUND WATER

FROM WELLS MONITORING THE 150-ACRE FLOOD PIVOT FIELD

FIGURE 3-80

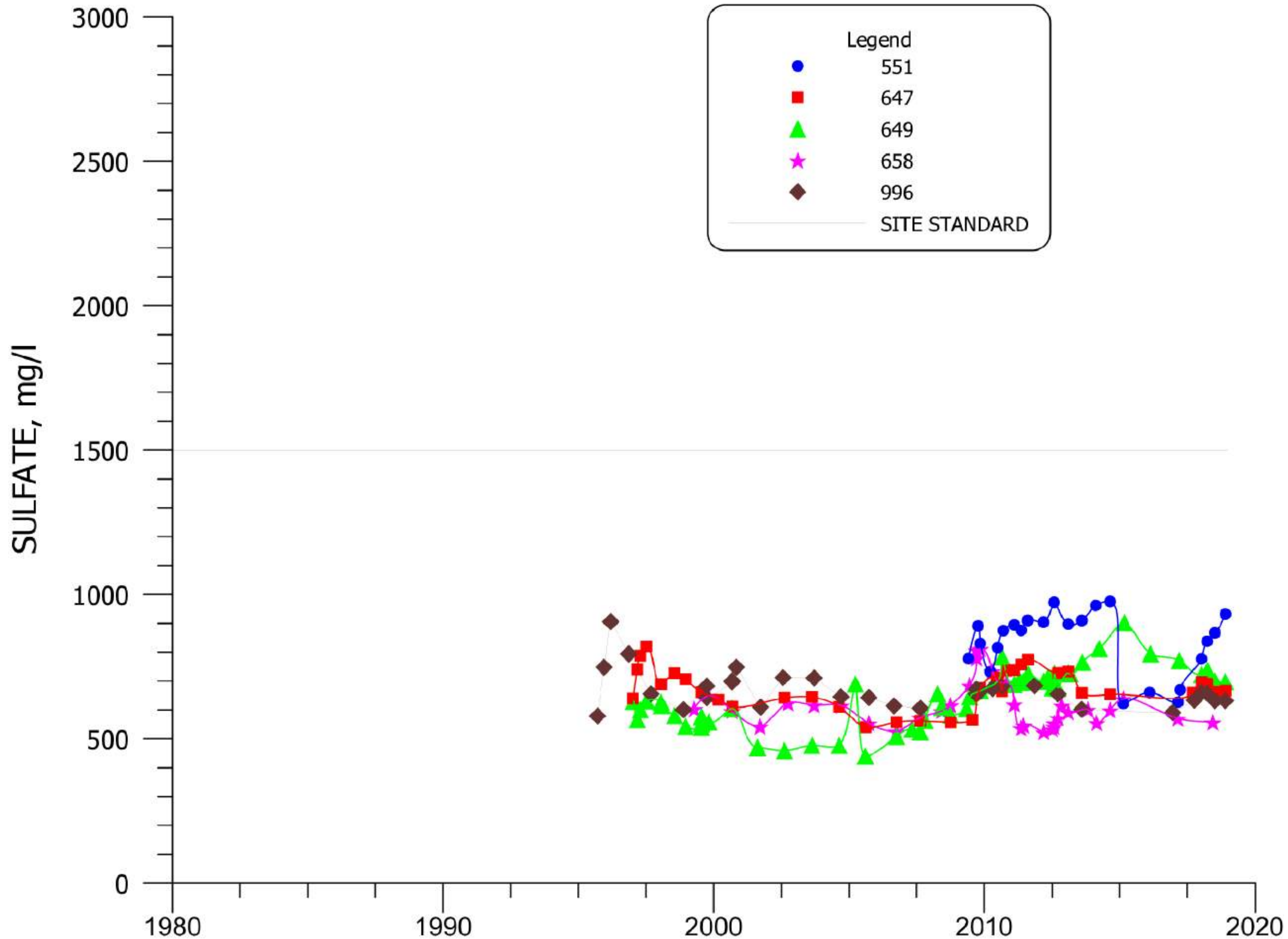


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

MOLYBDENUM IN GROUND WATER

FROM WELLS MONITORING THE 150-ACRE FLOOD PIVOT FIELD

FIGURE 3-81



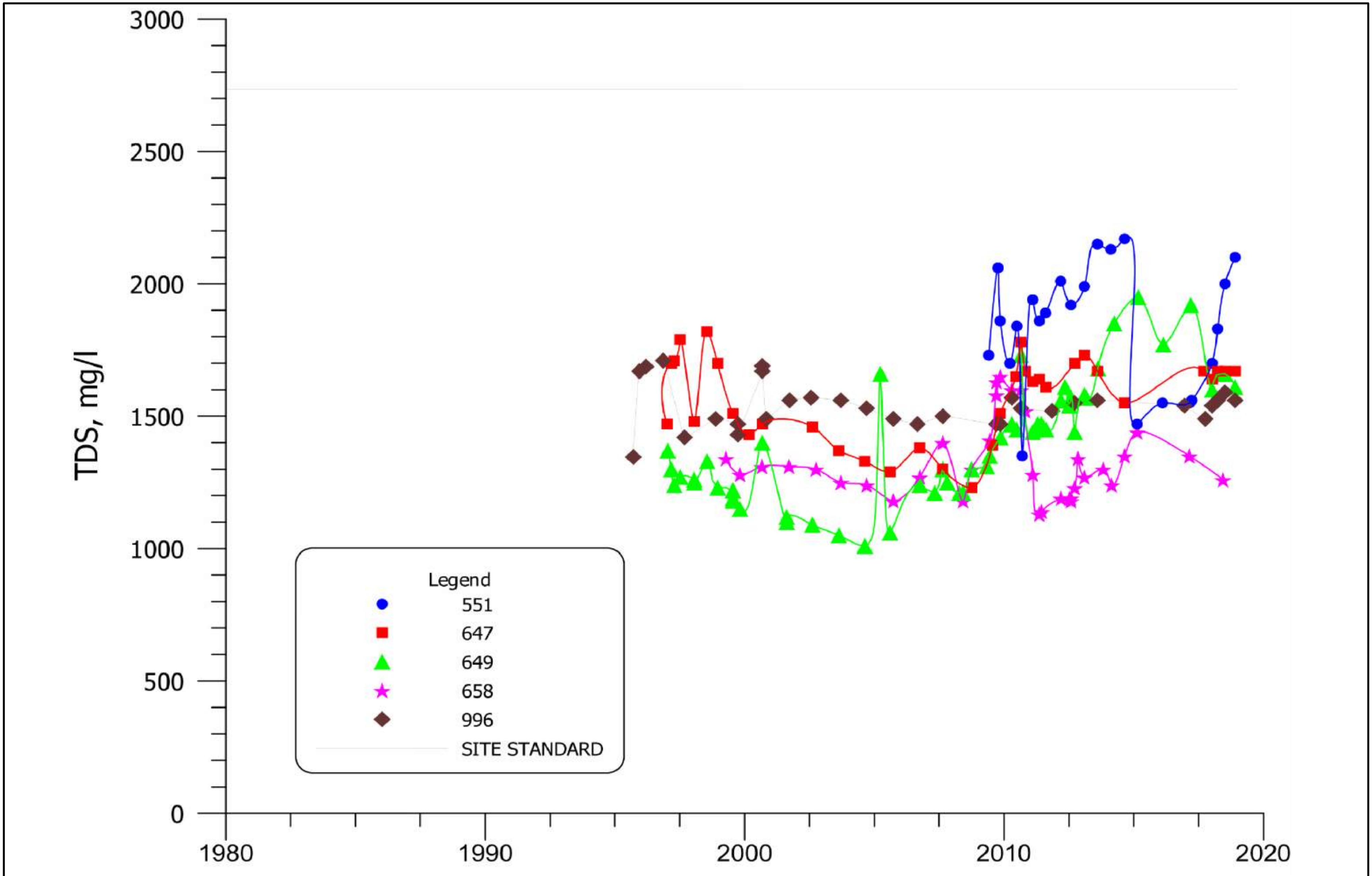
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SULFATE IN GROUND WATER

FROM WELLS MONITORING THE 150-ACRE CENTER PIVOT FIELD

FIGURE 3-82



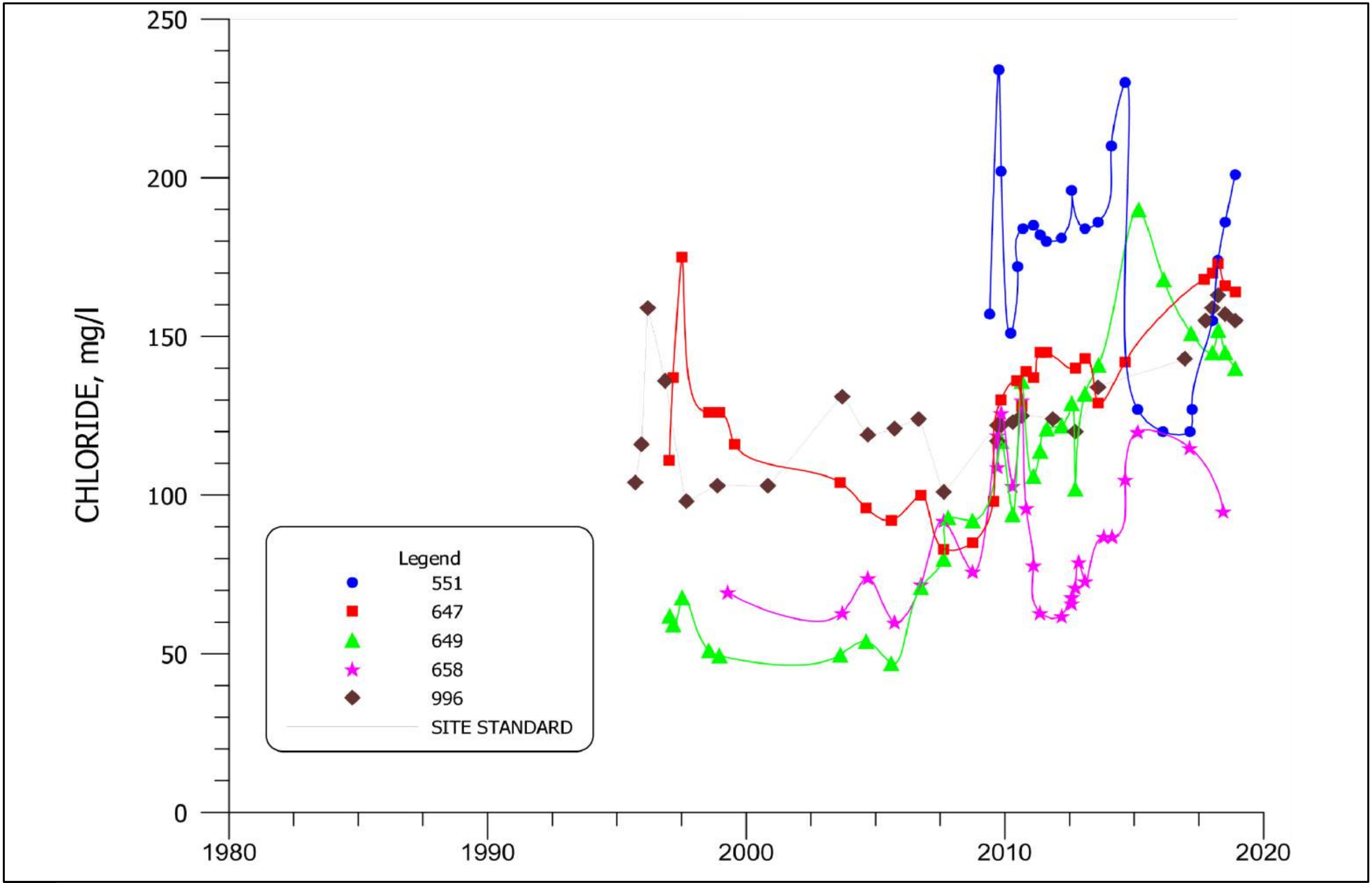
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

TDS IN GROUND WATER

FROM WELLS MONITORING THE 150-ACRE FLOOD PIVOT FIELD

FIGURE 3-83



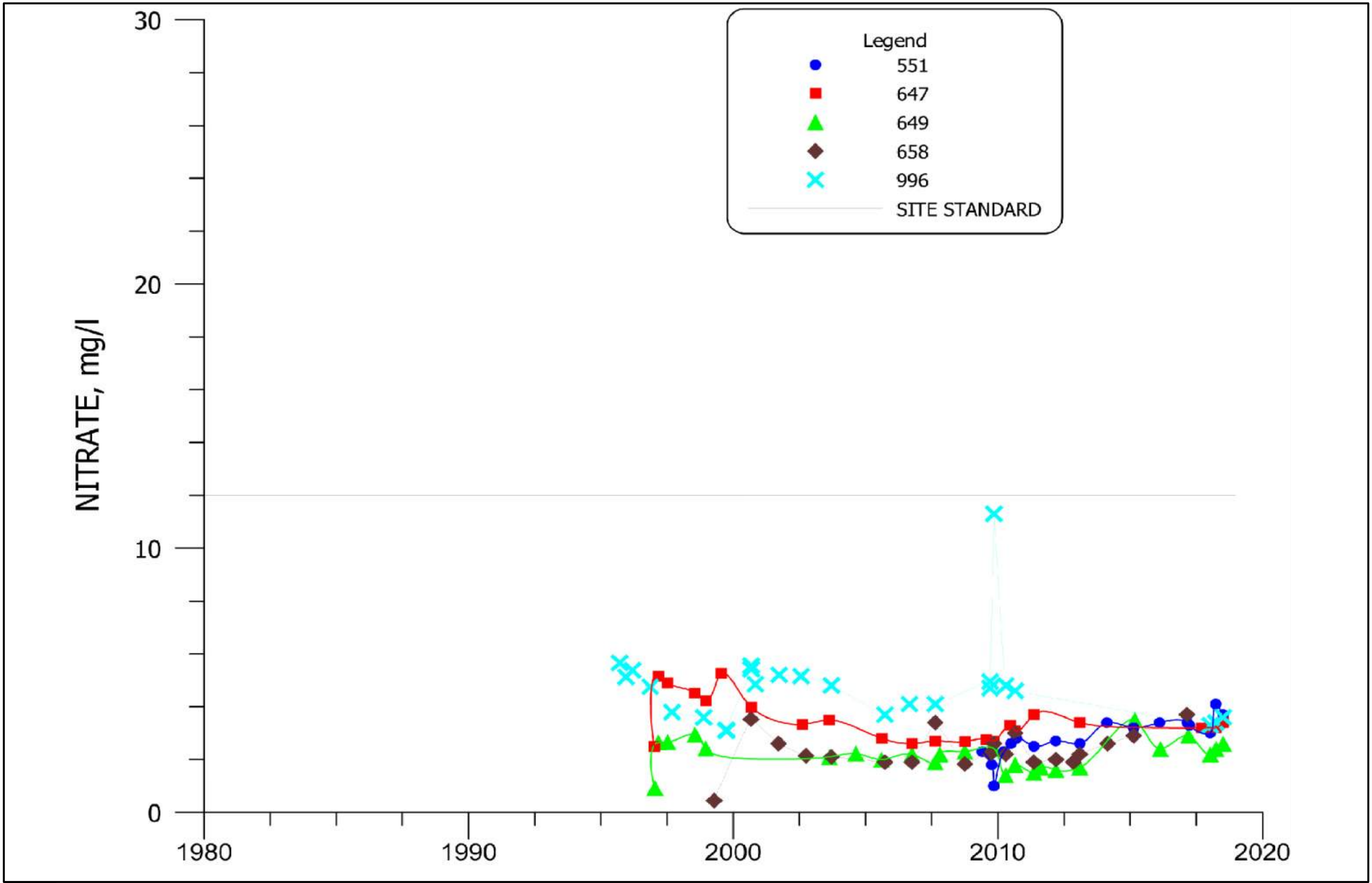
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

CHLORIDE IN GROUND WATER

FROM WELLS MONITORING THE 150-ACRE FLOOD PIVOT FIELD

FIGURE 3-84



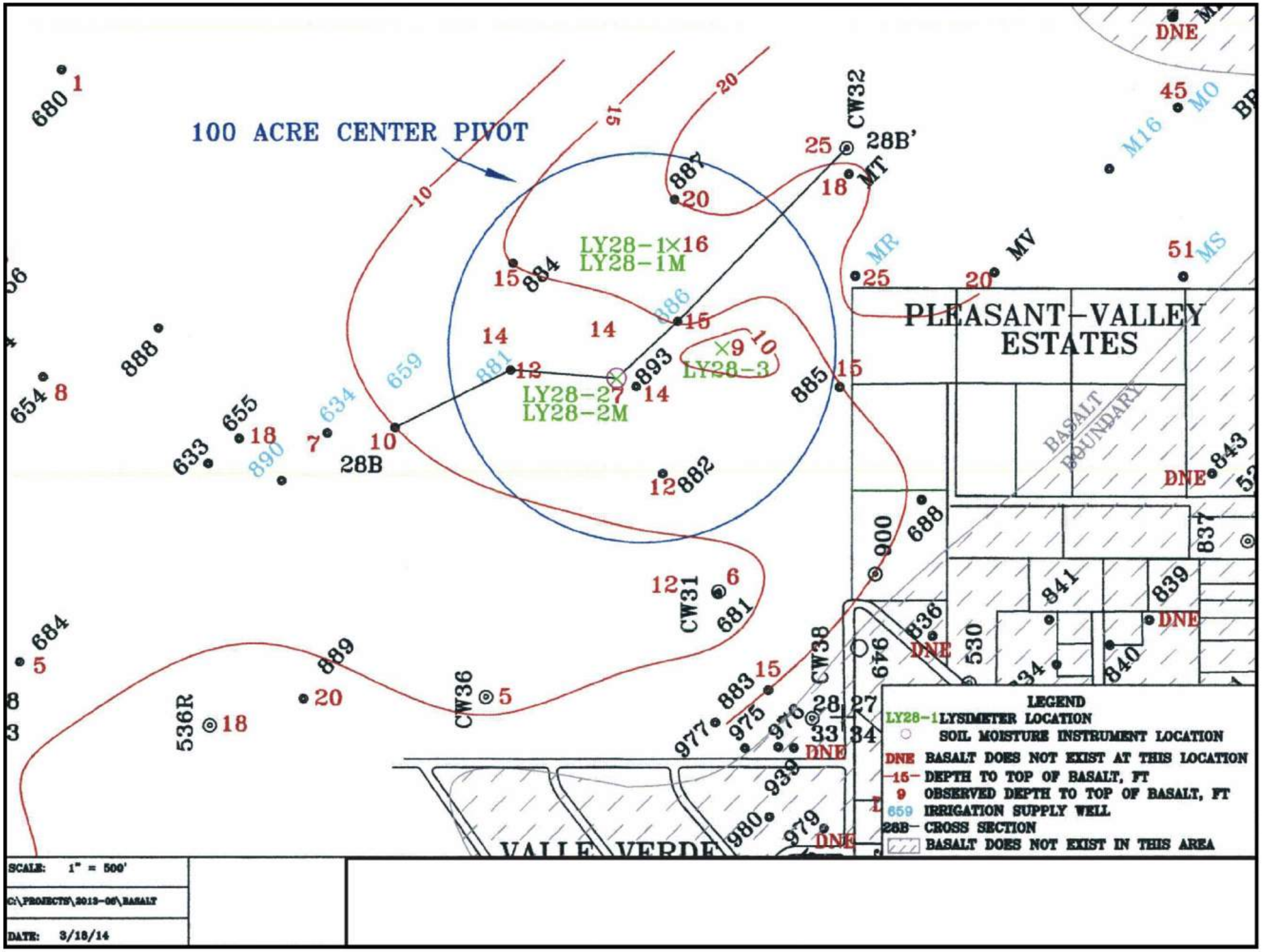
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

NITRATE IN GROUND WATER

FROM WELLS MONITORING THE 150-ACRE CENTER PIVOT FIELD

FIGURE 3-85

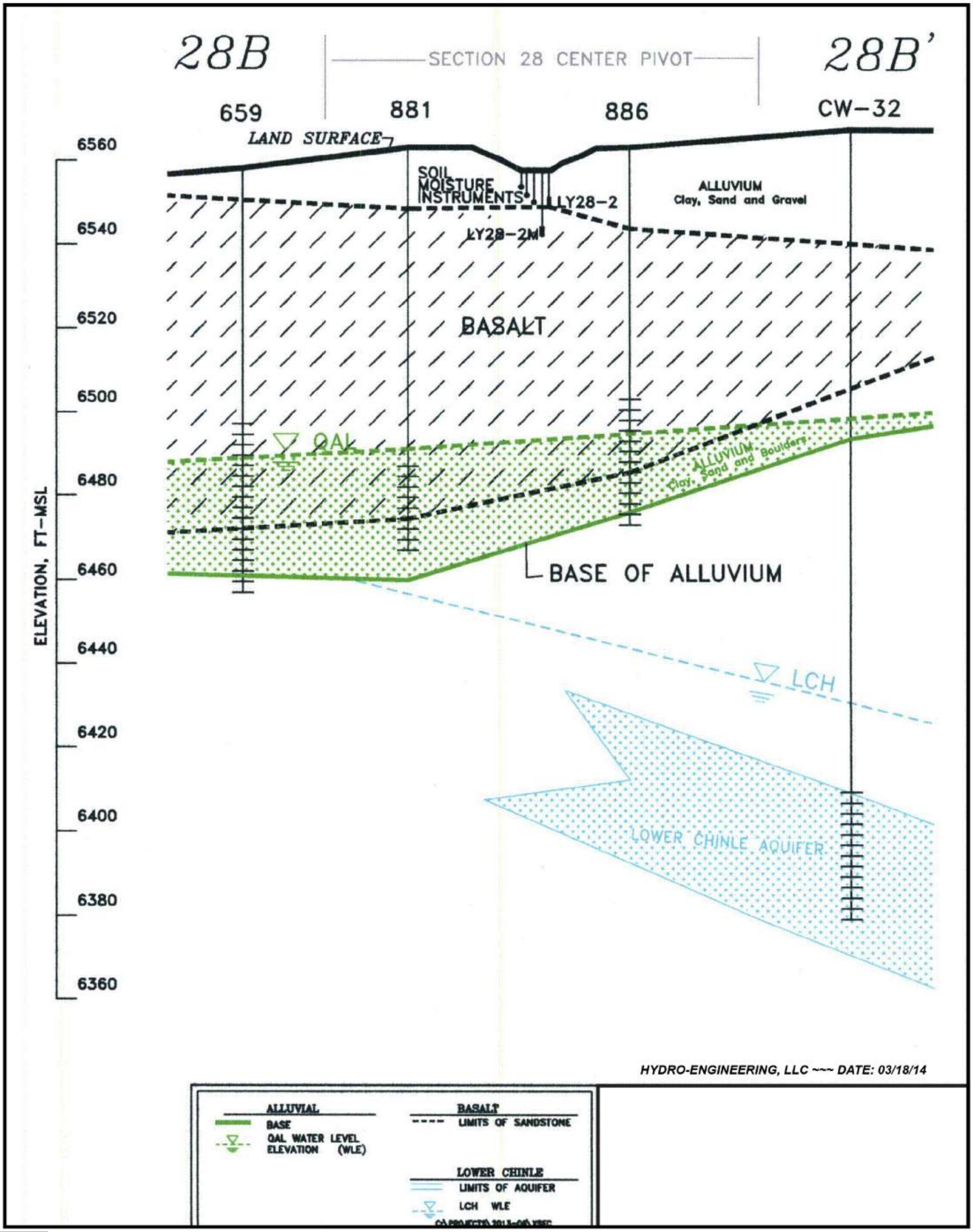


PLAN VIEW OF 100-ACRE CENTER PIVOT FIELD AND WELL LOCATIONS

OVERVIEW MAPS

FIGURE 3-86

Adopted from: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014



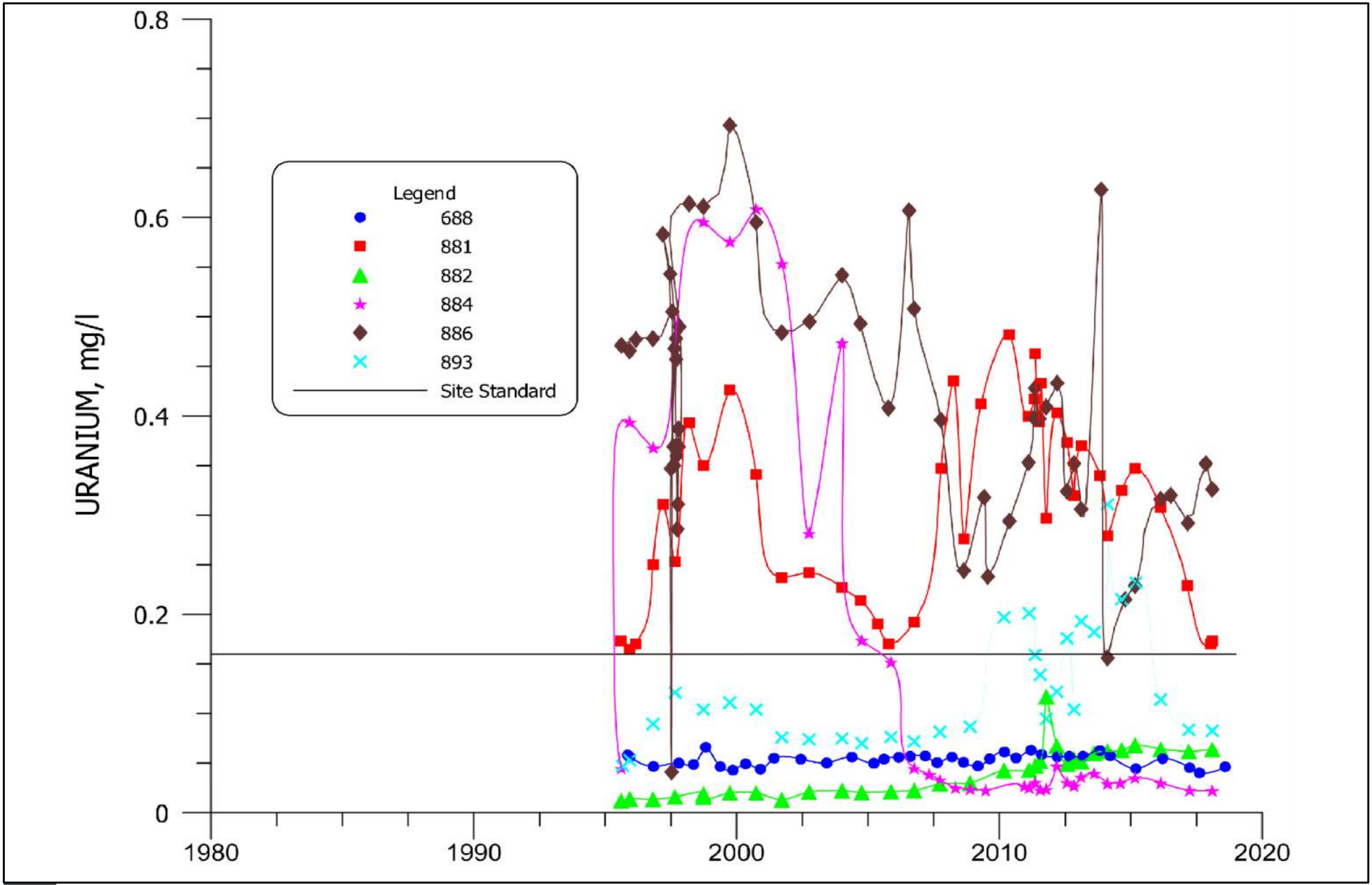
HOMESTAKE

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

100-ACRE CENTER PIVOT FIELD

GEOLOGIC CROSS-SECTION 28B-28B'

FIGURE 3-87

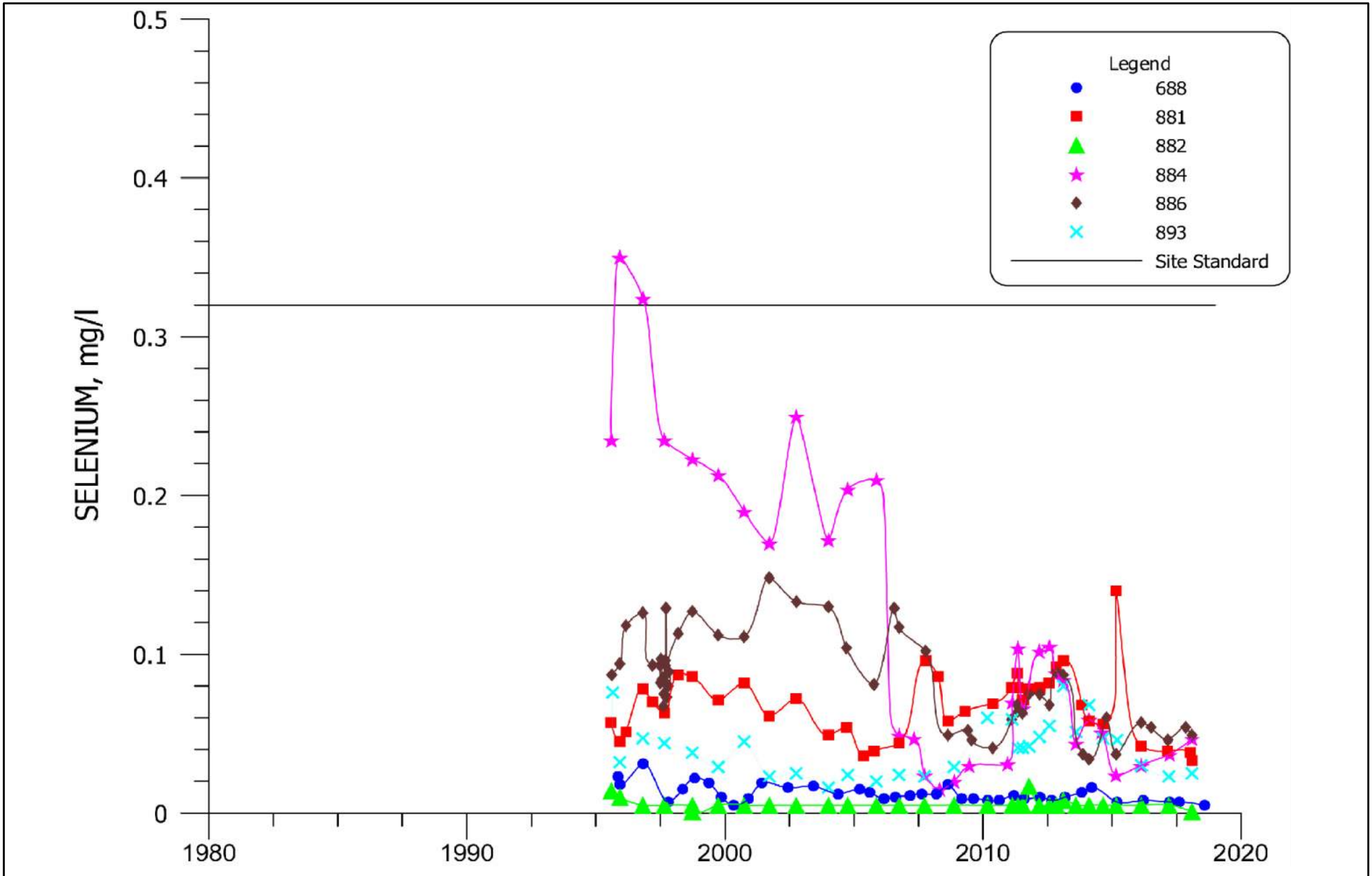


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM IN GROUND WATER

FROM WELLS MONITORING THE 100-ACRE CENTER PIVOT FIELD

FIGURE 3-88



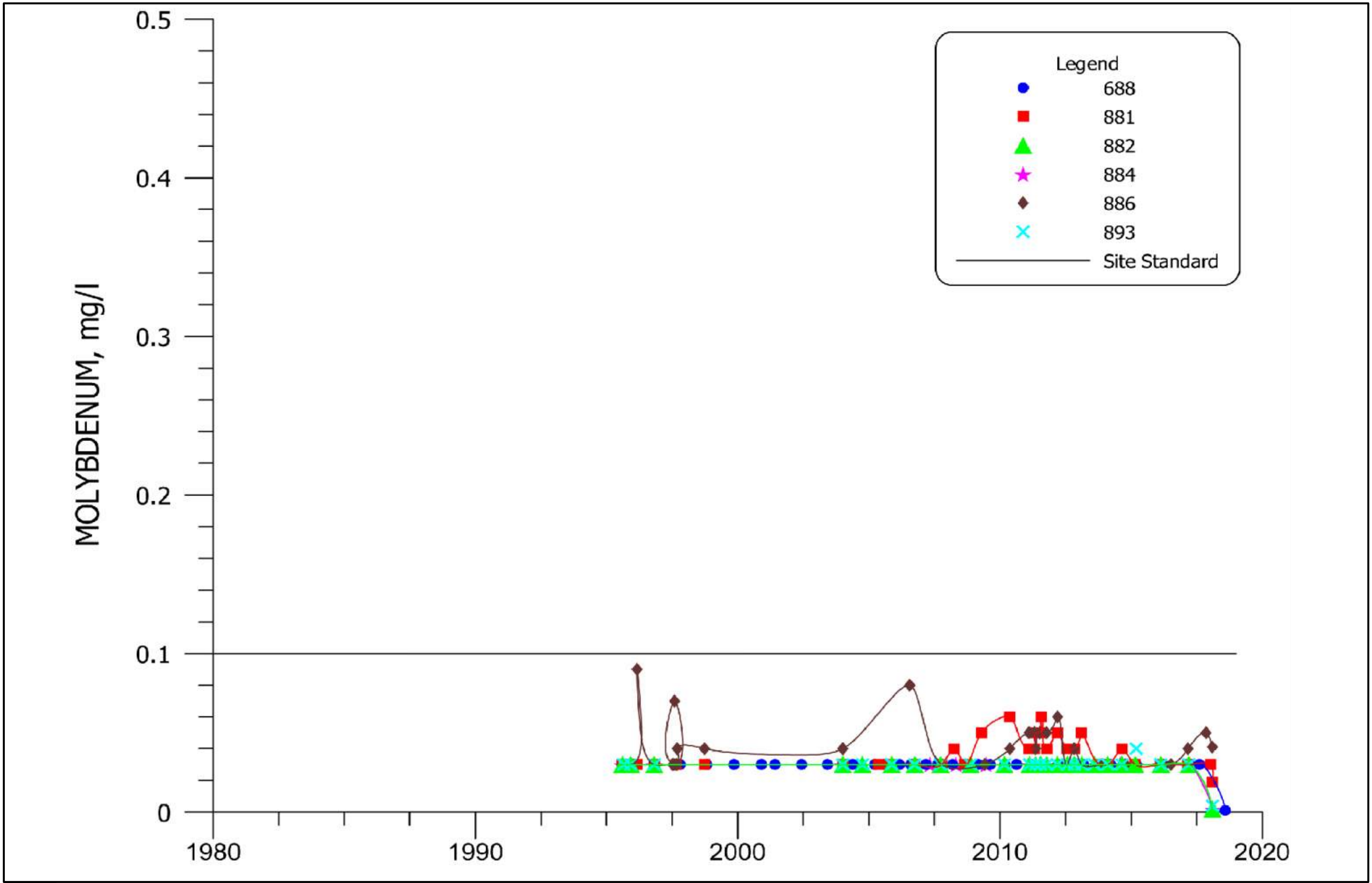
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SELENIUM IN GROUND WATER

FROM WELLS MONITORING THE 100-ACRE CENTER PIVOT FIELD

FIGURE 3-89



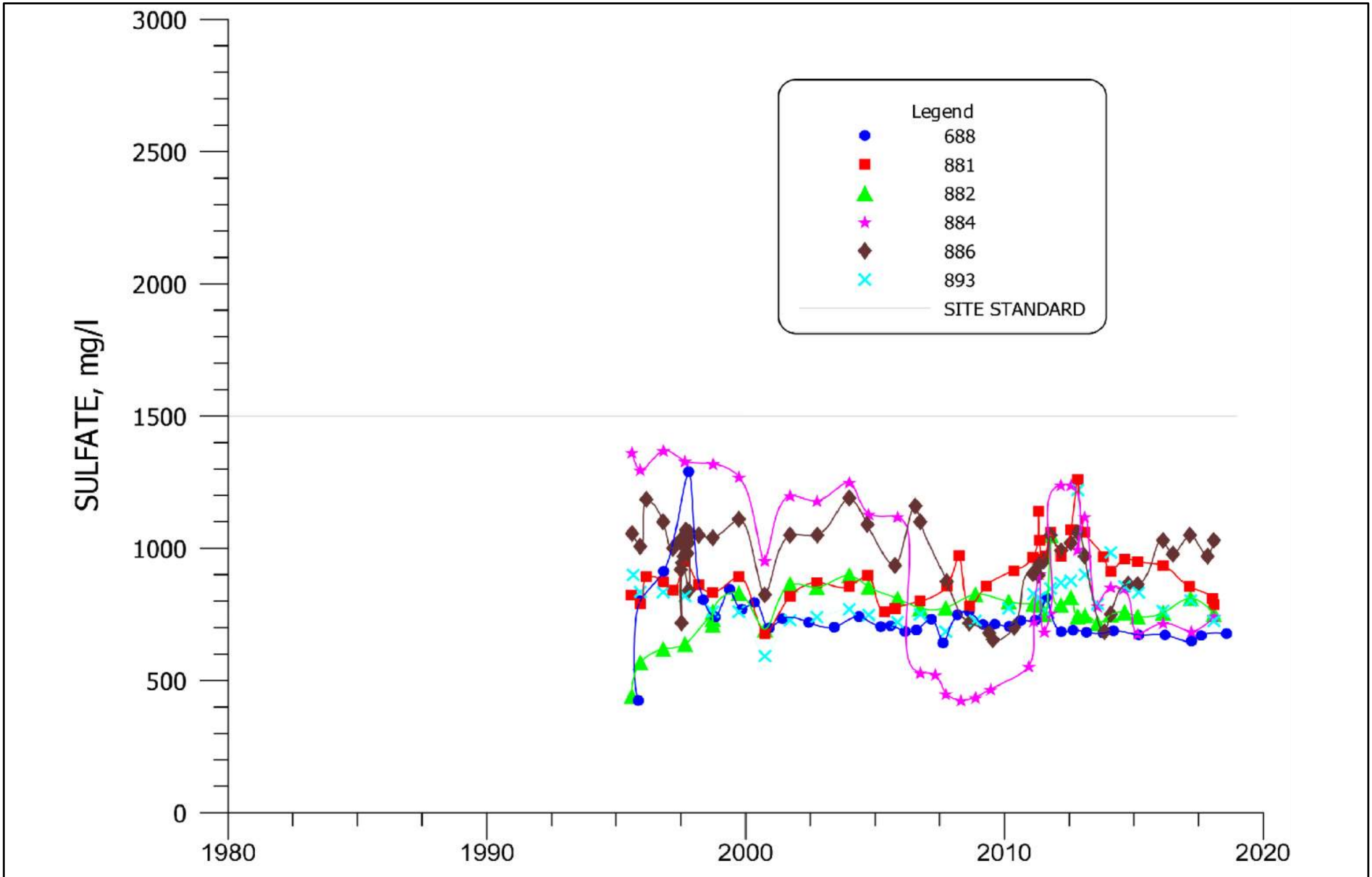
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

MOLYBDENUM IN GROUND WATER

FROM WELLS MONITORING THE 100-ACRE CENTER PIVOT FIELD

FIGURE 3-90

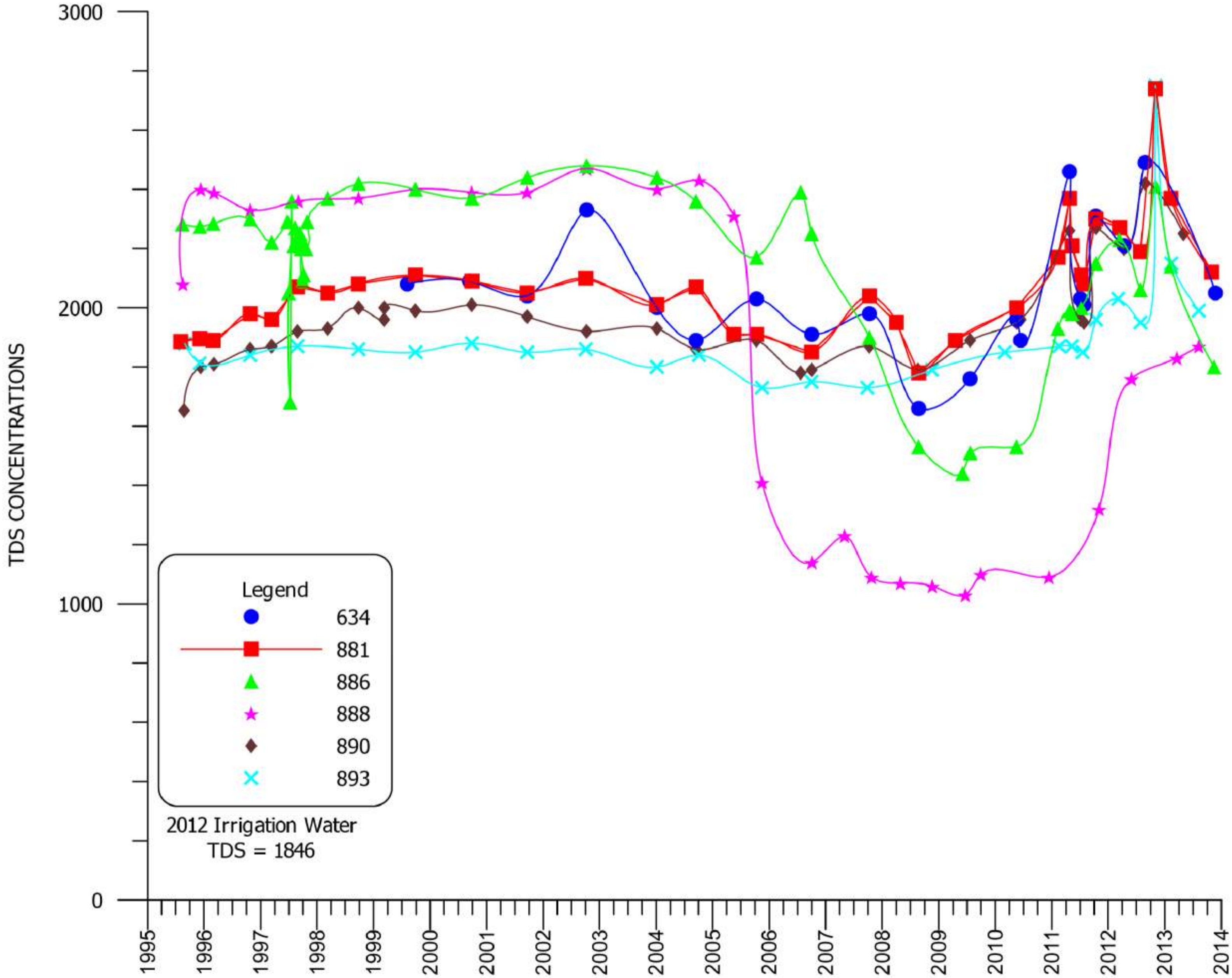


SULFATE IN GROUND WATER

FROM WELLS MONITORING THE 100-ACRE CENTER PIVOT FIELD

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FIGURE 3-91



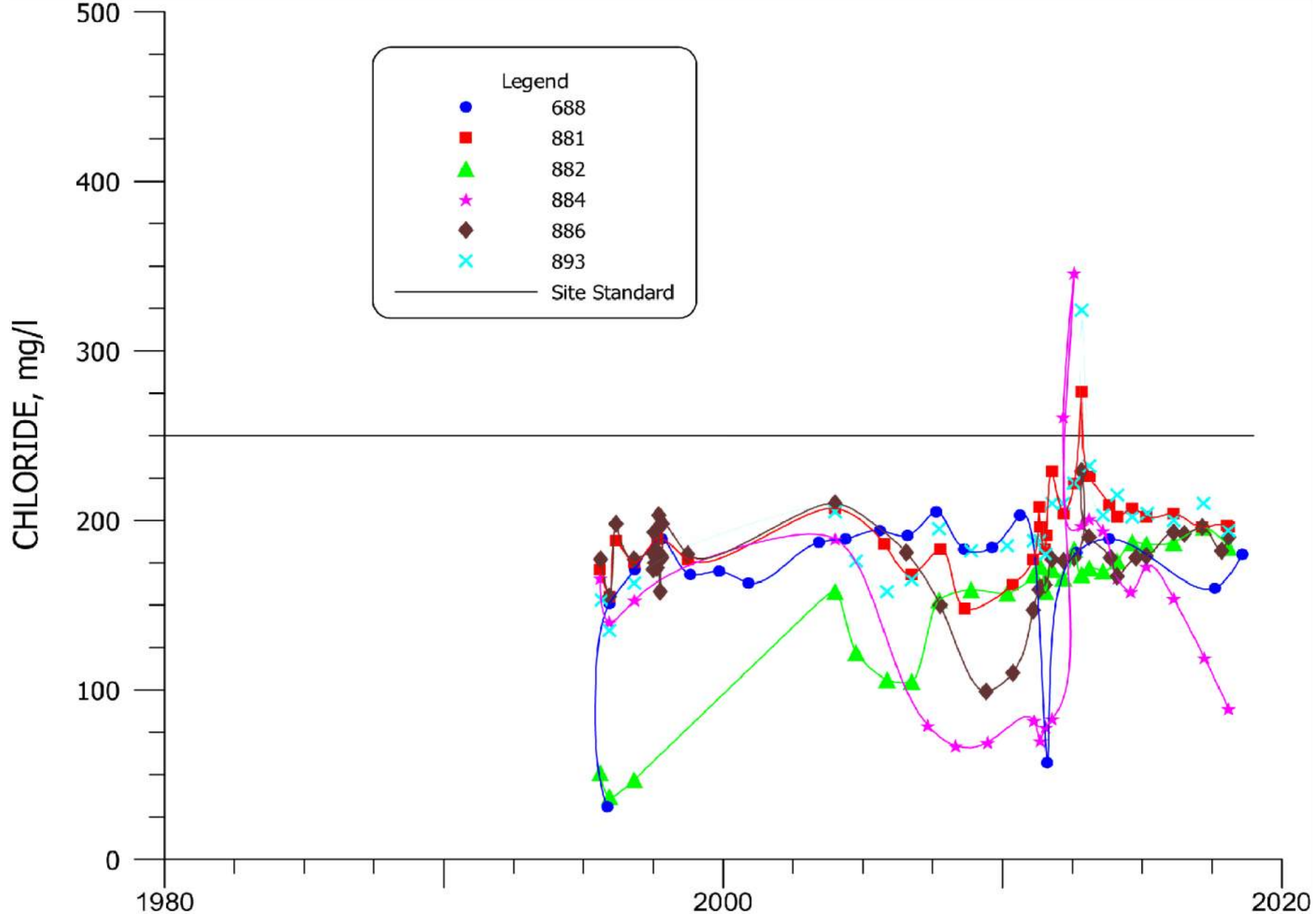
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

TDS IN GW FROM WELLS

MONITORING THE 100-ACRE CENTER PIVOT FIELD

FIGURE 3-92



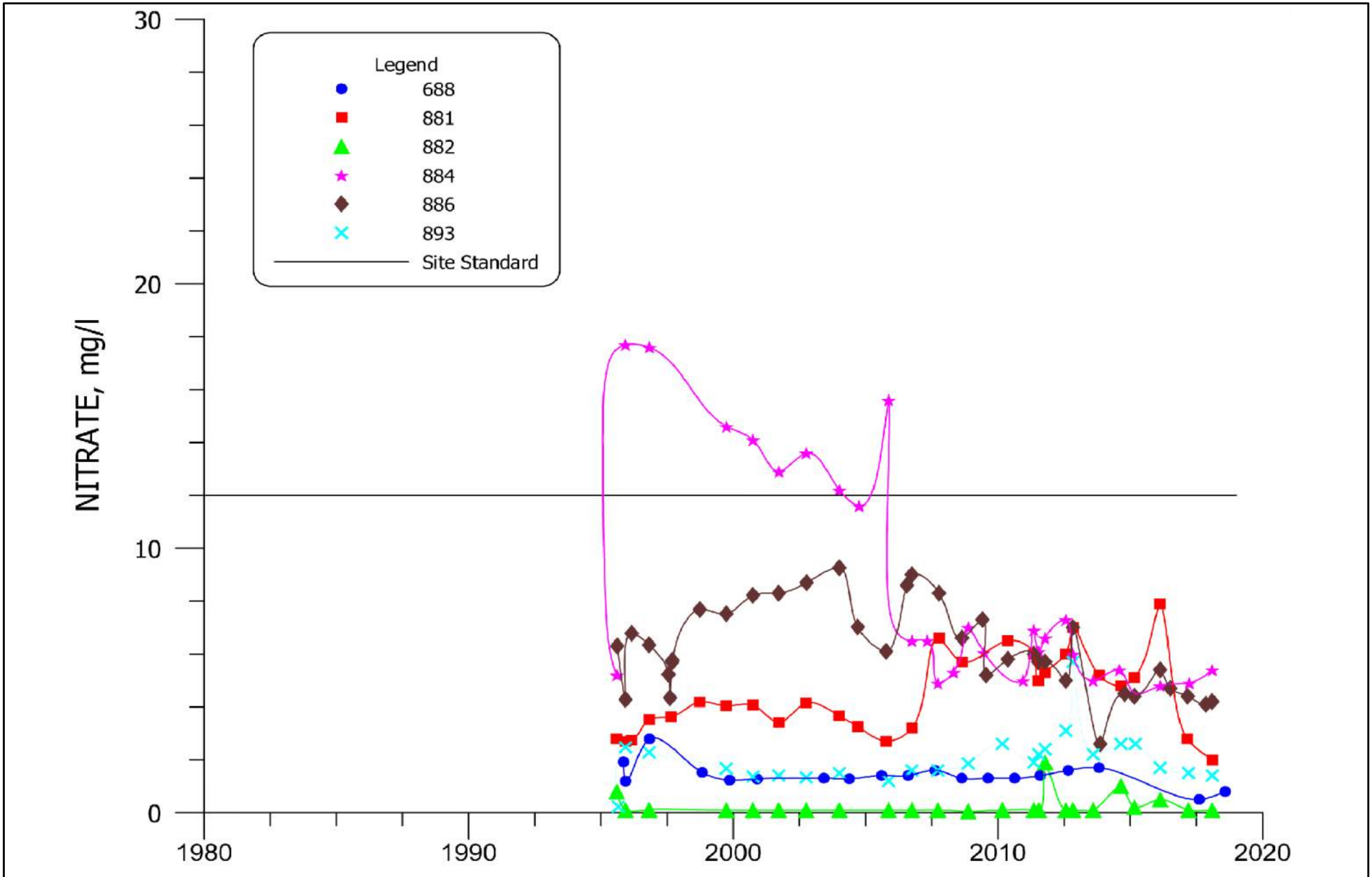
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

CHLORIDE IN GROUND WATER

FROM WELLS MONITORING THE 100-ACRE CENTER PIVOT FIELD

FIGURE 3-93

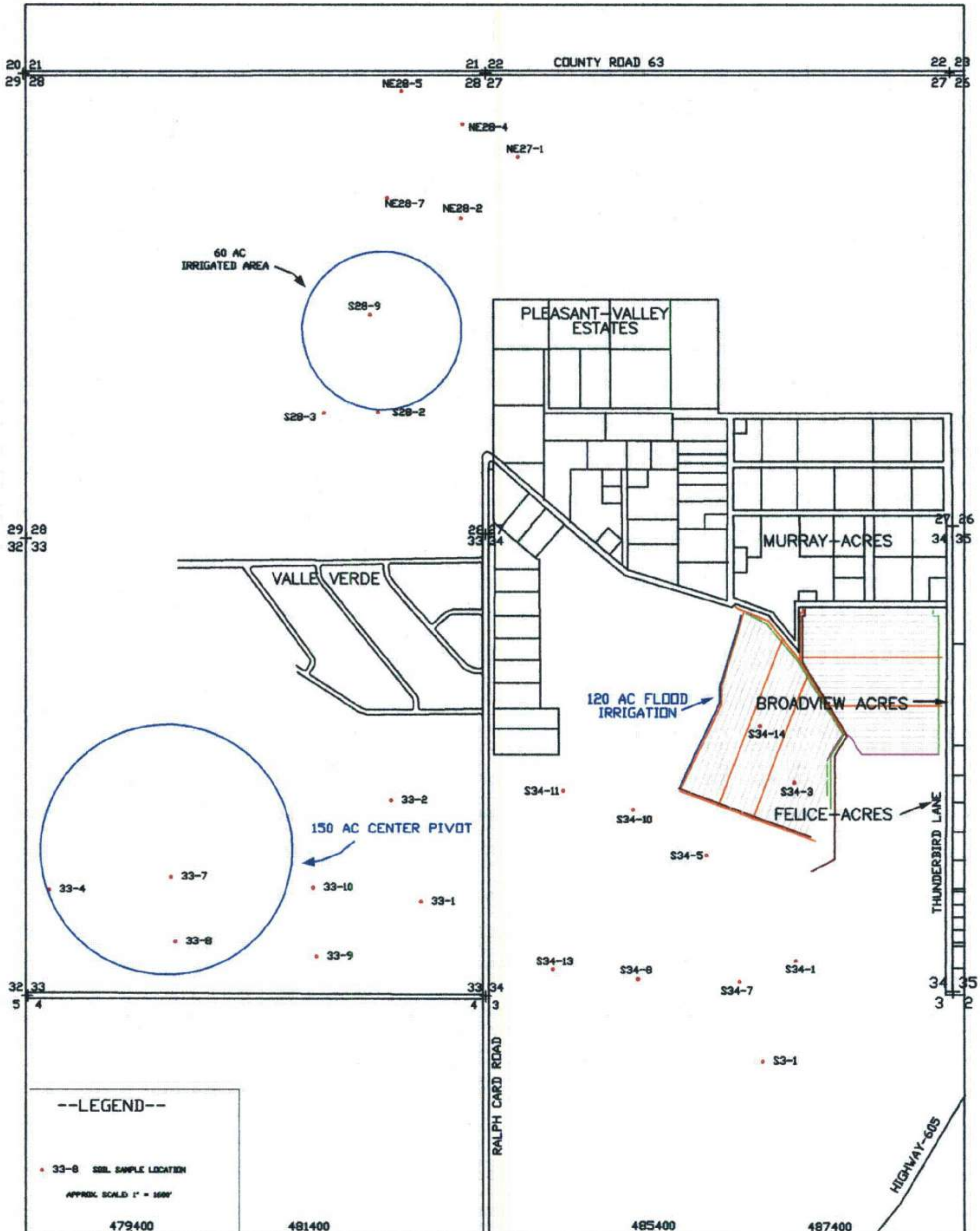


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

NITRATE IN GROUND WATER

FROM WELLS MONITORING THE 100-ACRE CENTER PIVOT FIELD

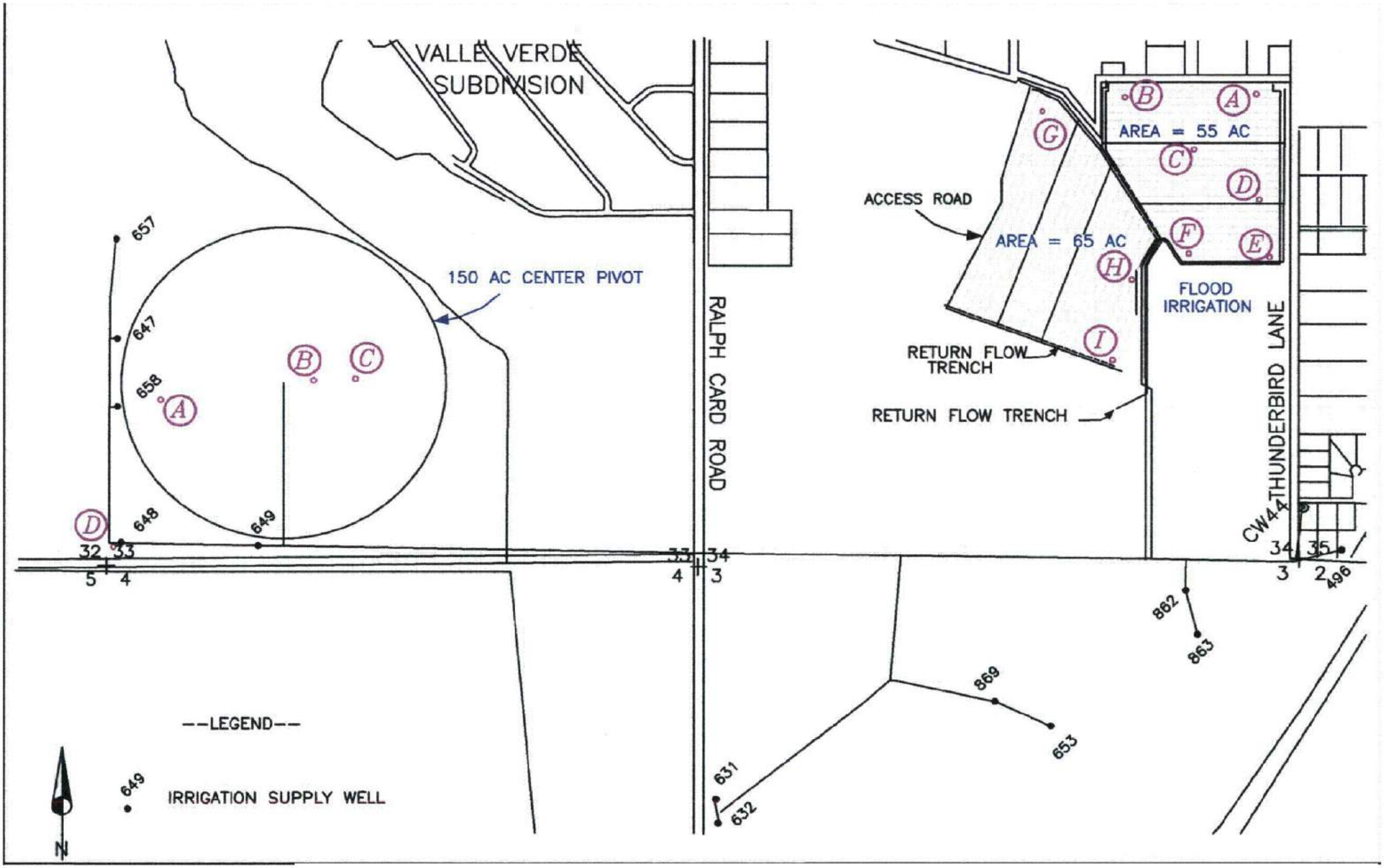
FIGURE 3-94



1998 PRE-IRRIGATION SOIL SAMPLING LOCATIONS

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

FIGURE 3-95

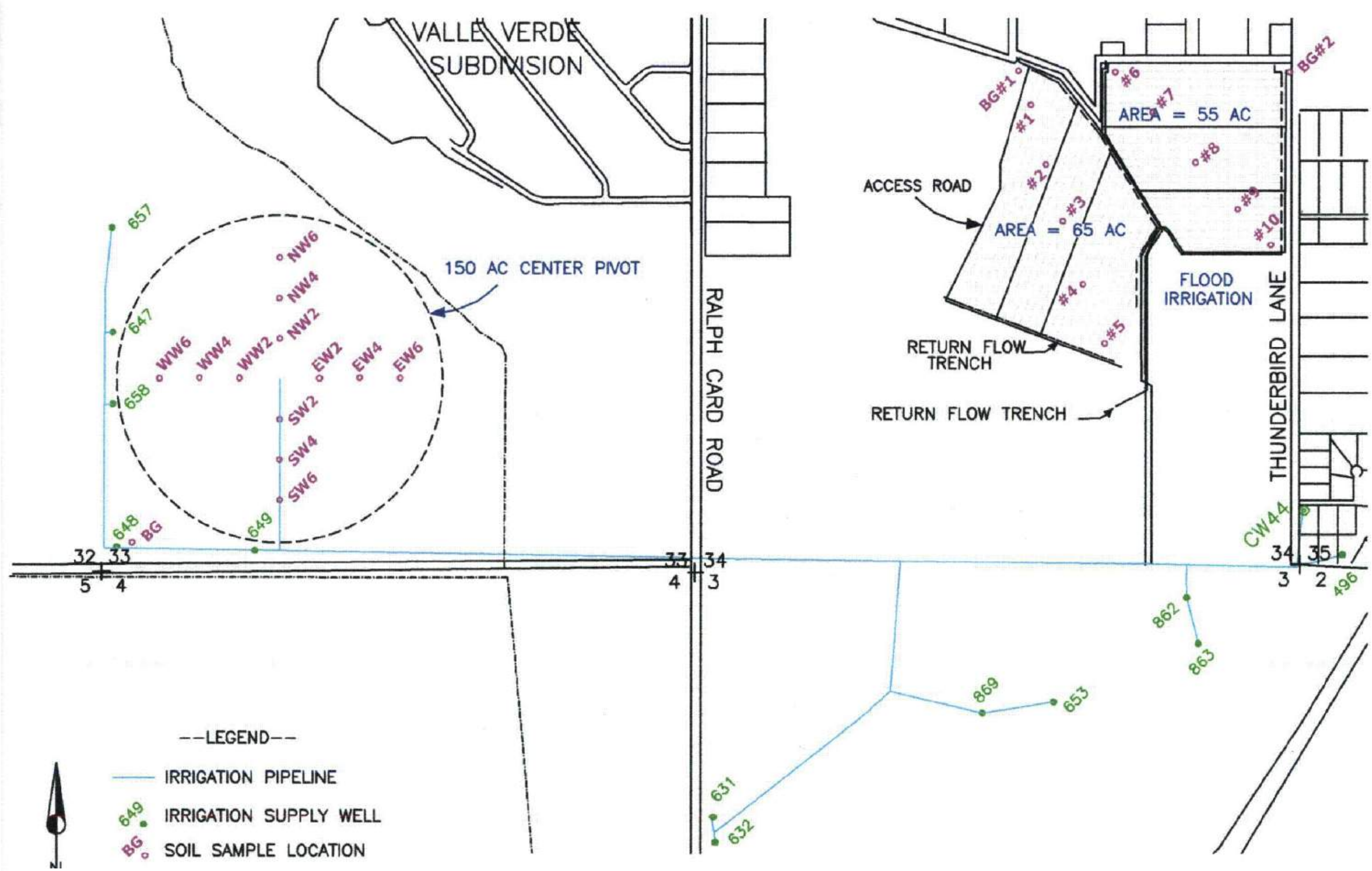


FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

1999 AND 2000

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FIGURE 3-96

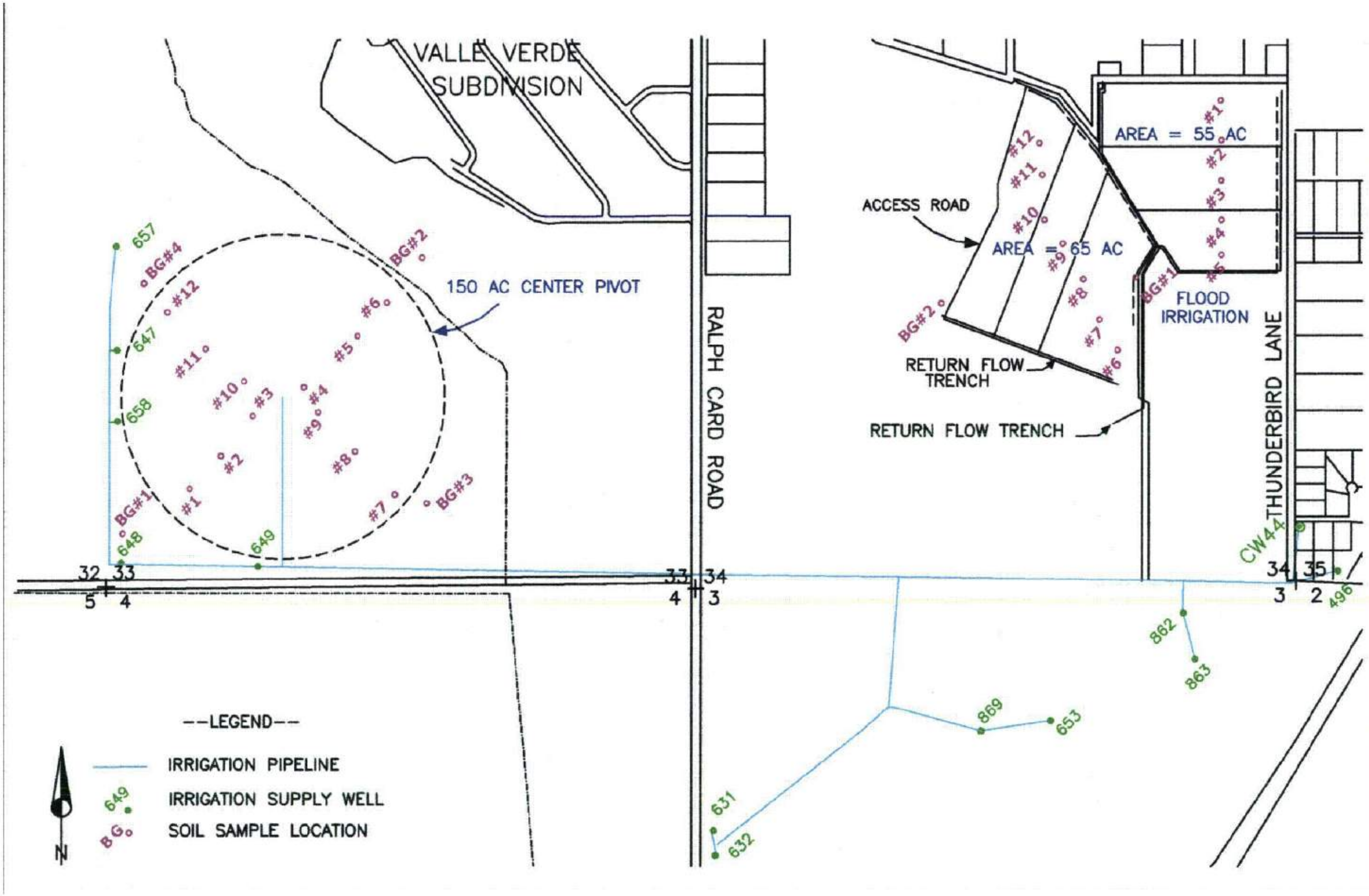


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2001

FIGURE 3-97



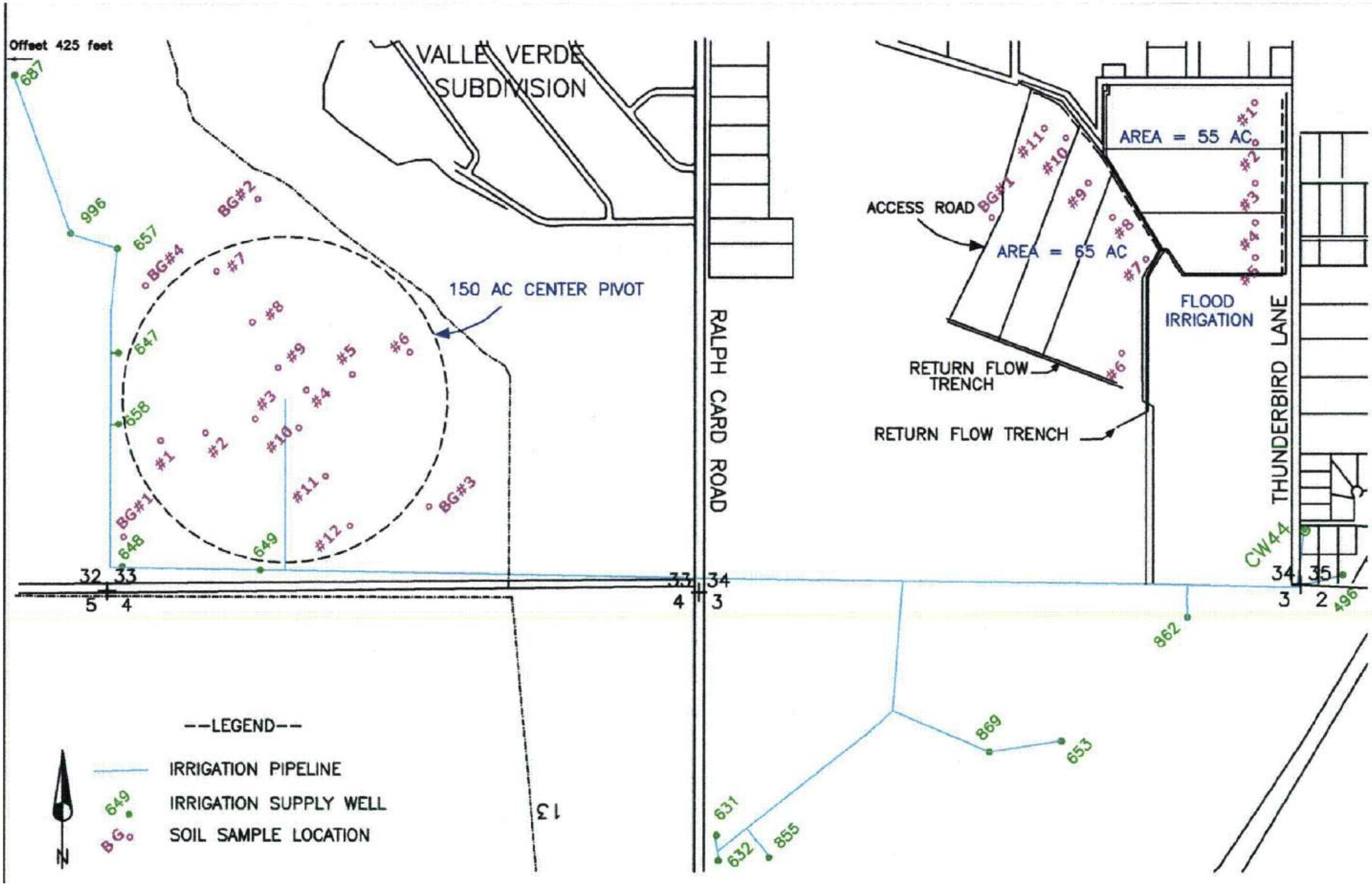
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2002

FIGURE 3-98



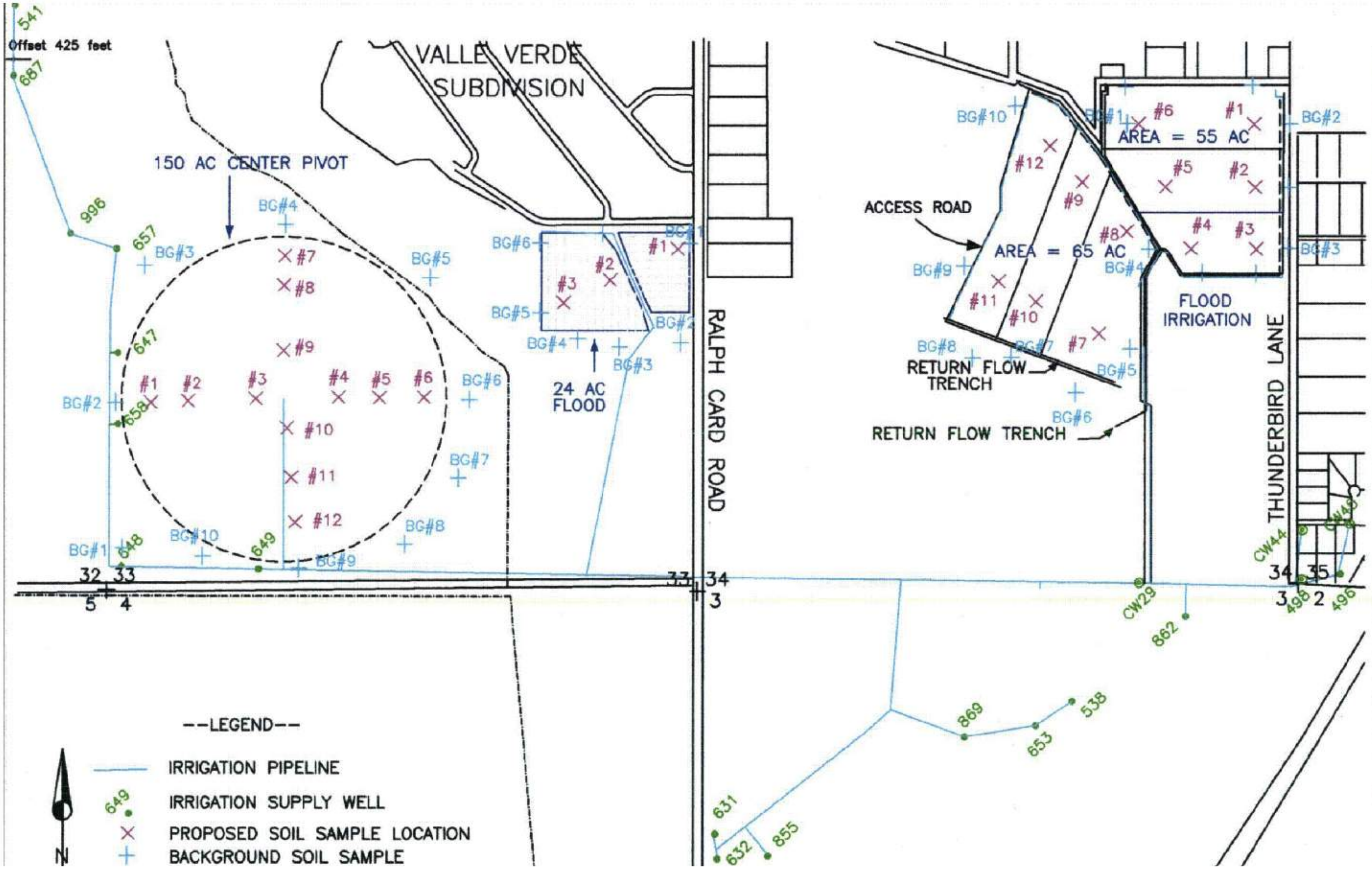
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2003

FIGURE 3-99



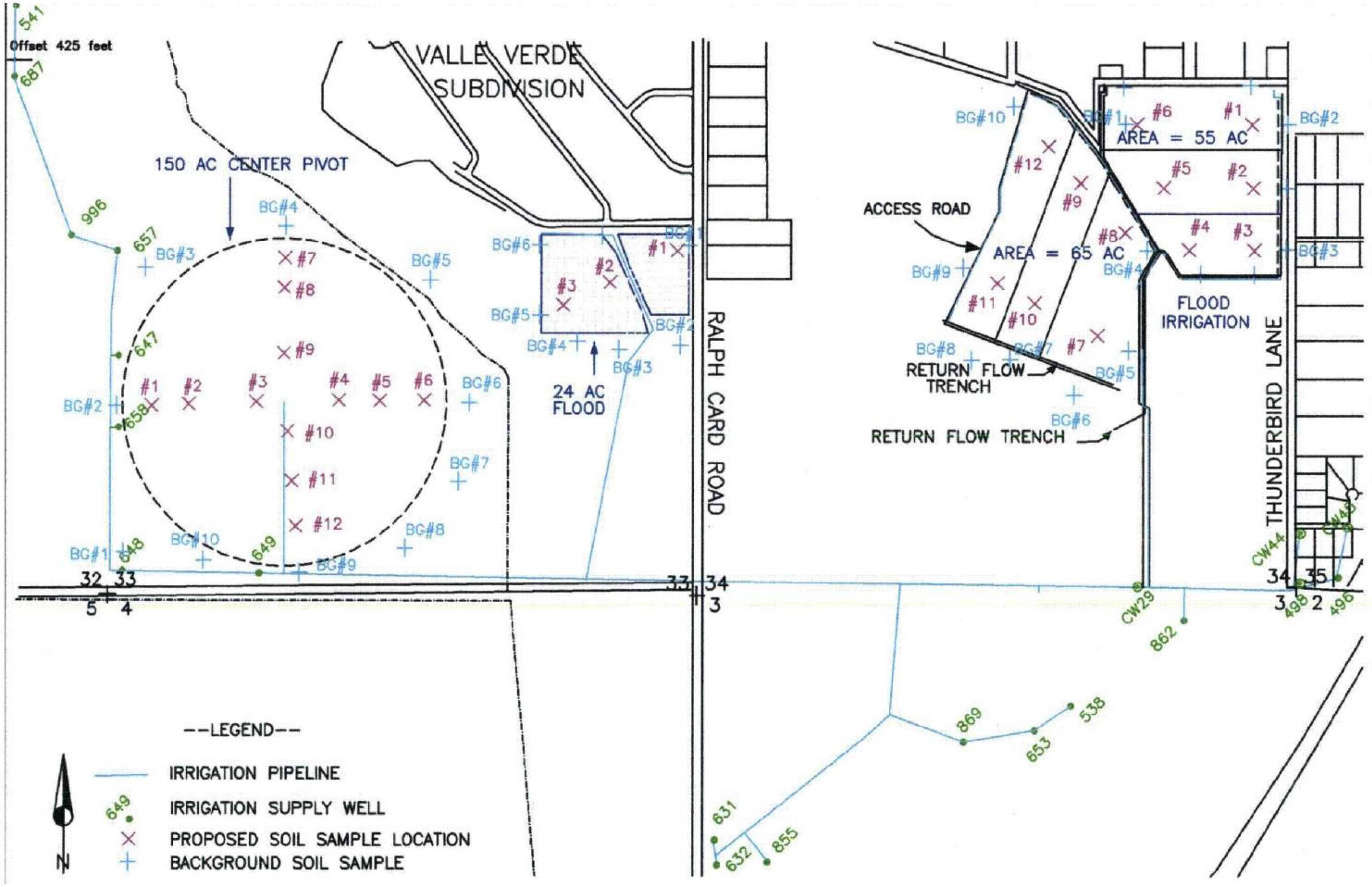
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2004

FIGURE 3-100

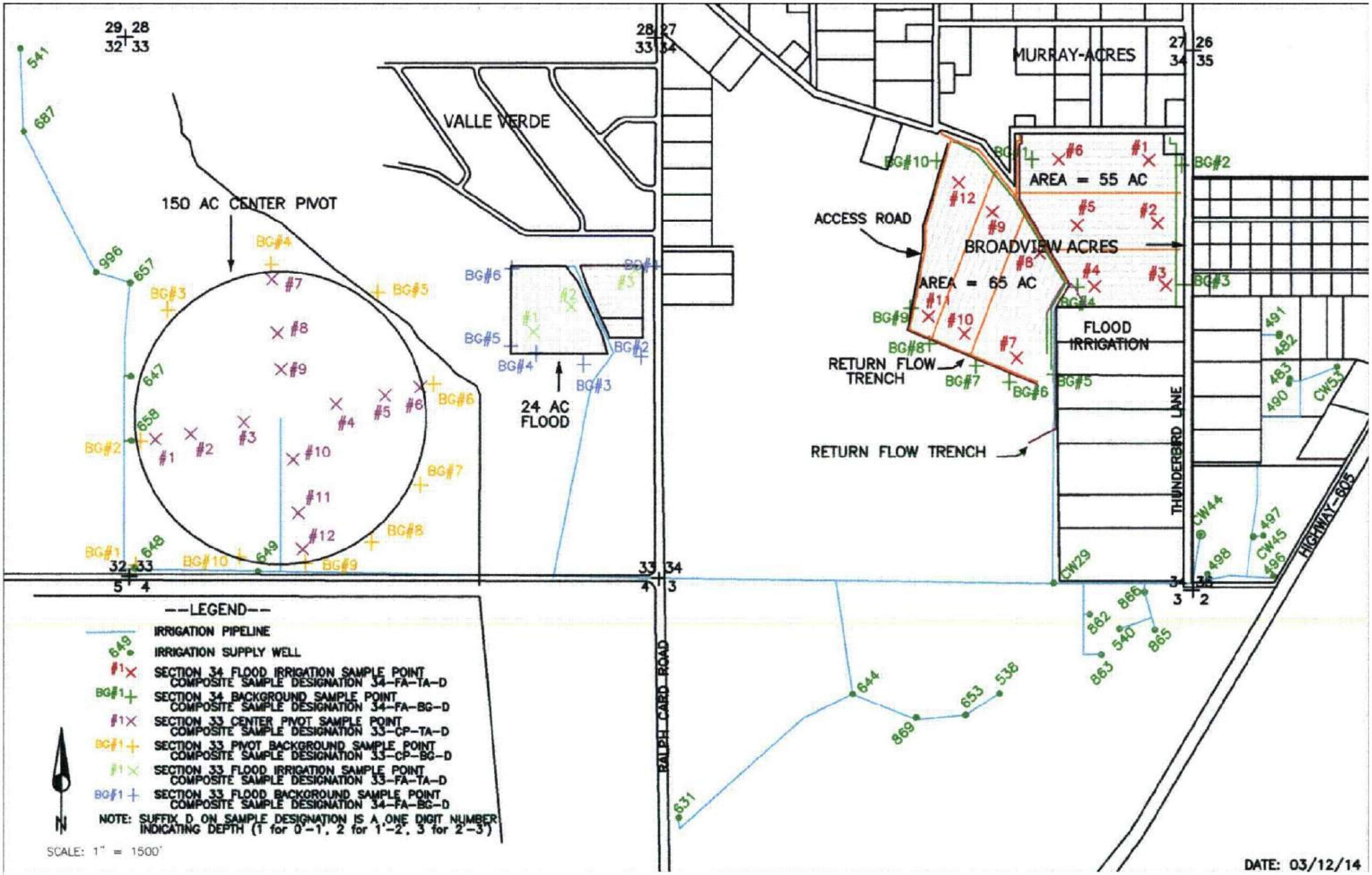


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2005

FIGURE 3-101



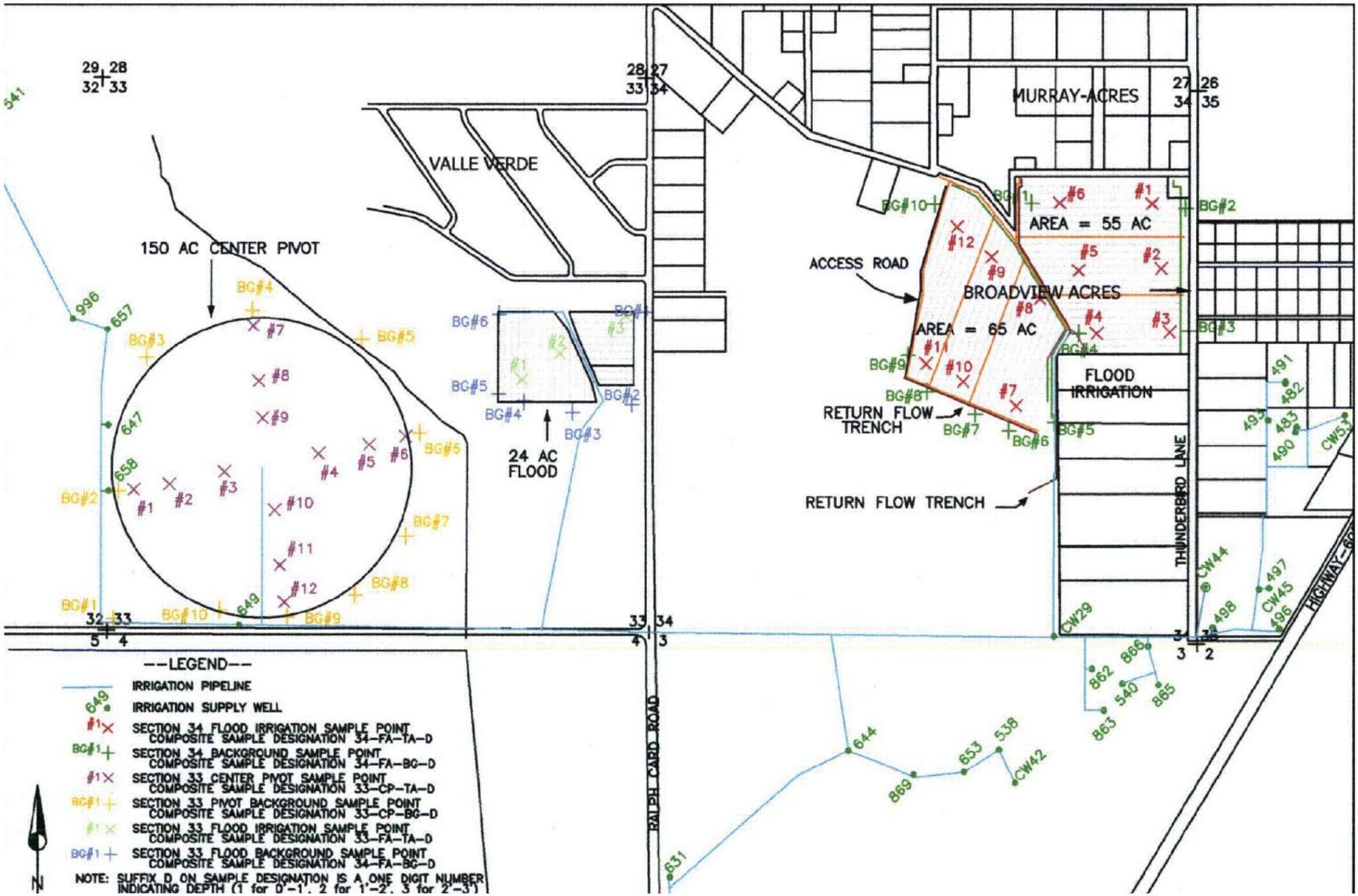
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2006

FIGURE 3-102

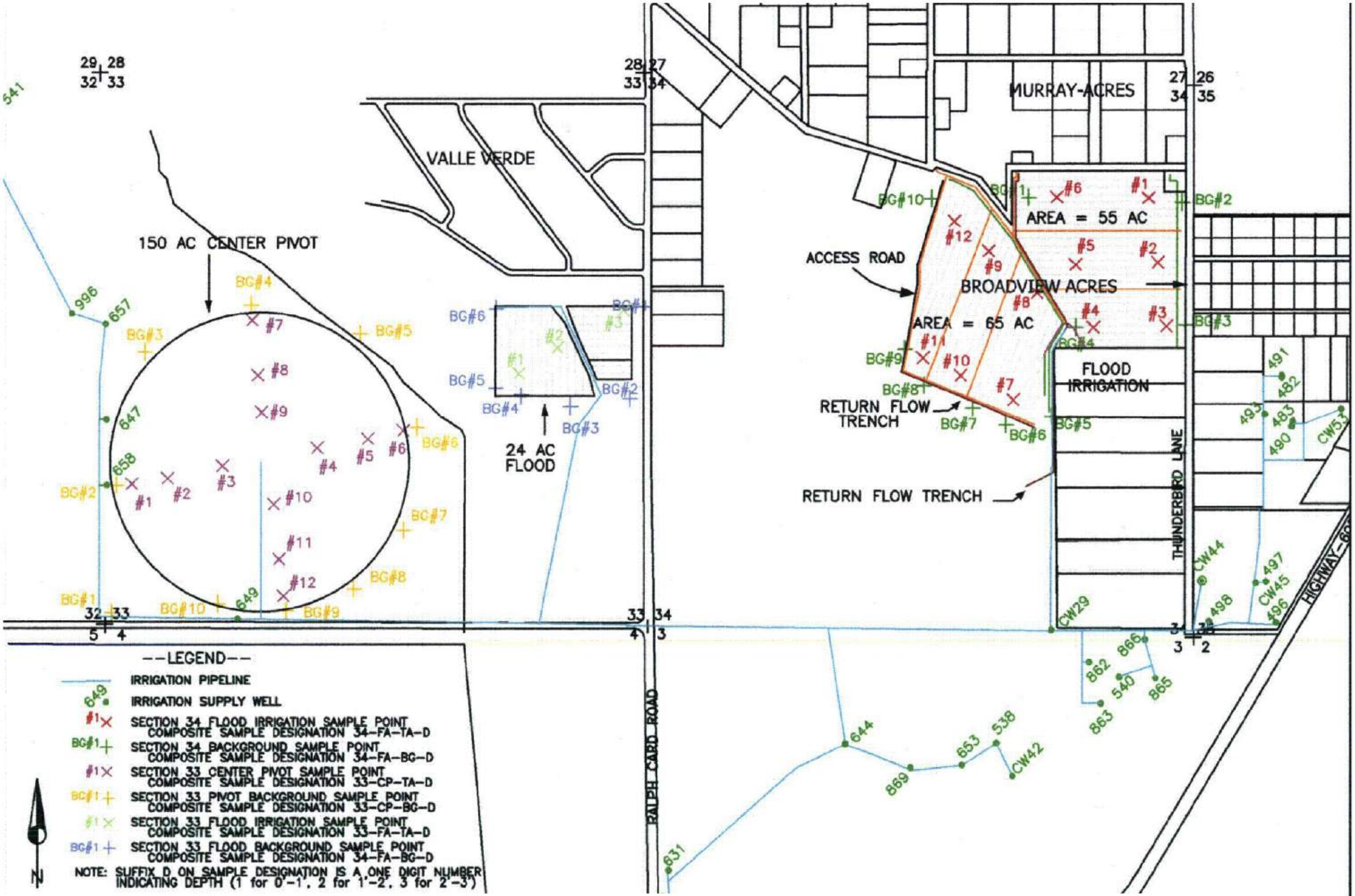


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2007

FIGURE 3-103



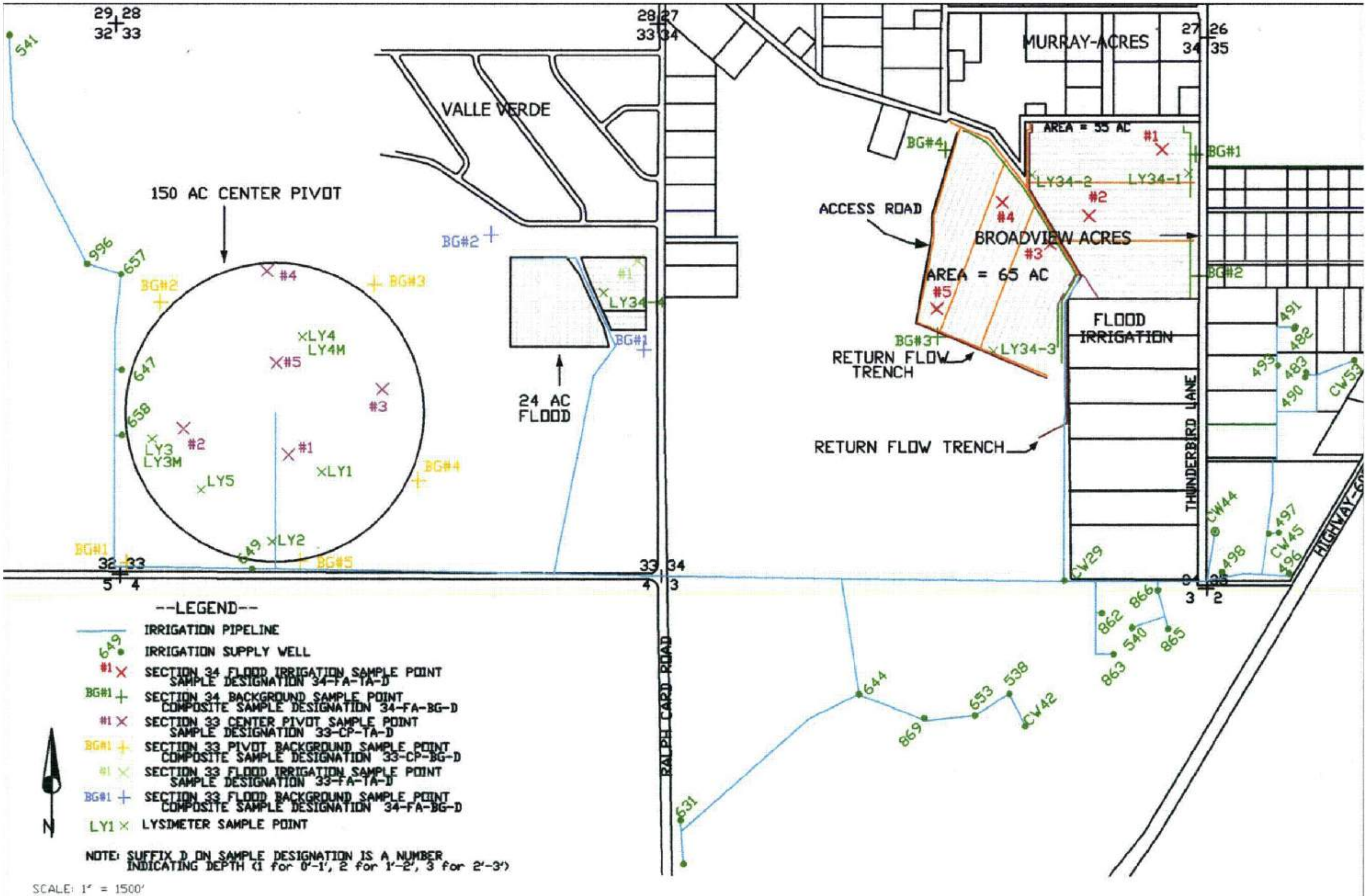
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2008

FIGURE 3-104

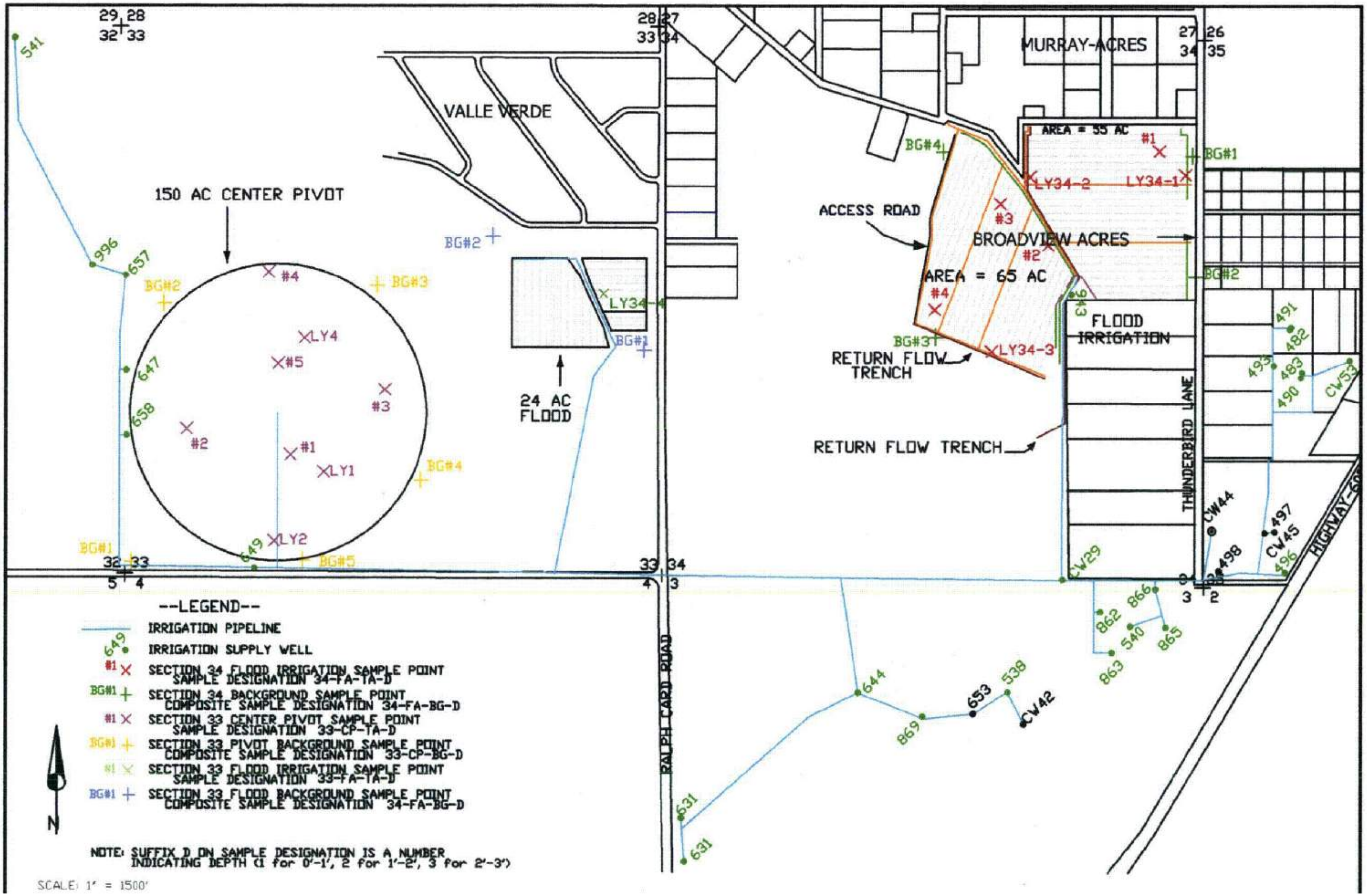


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2009

FIGURE 3-105

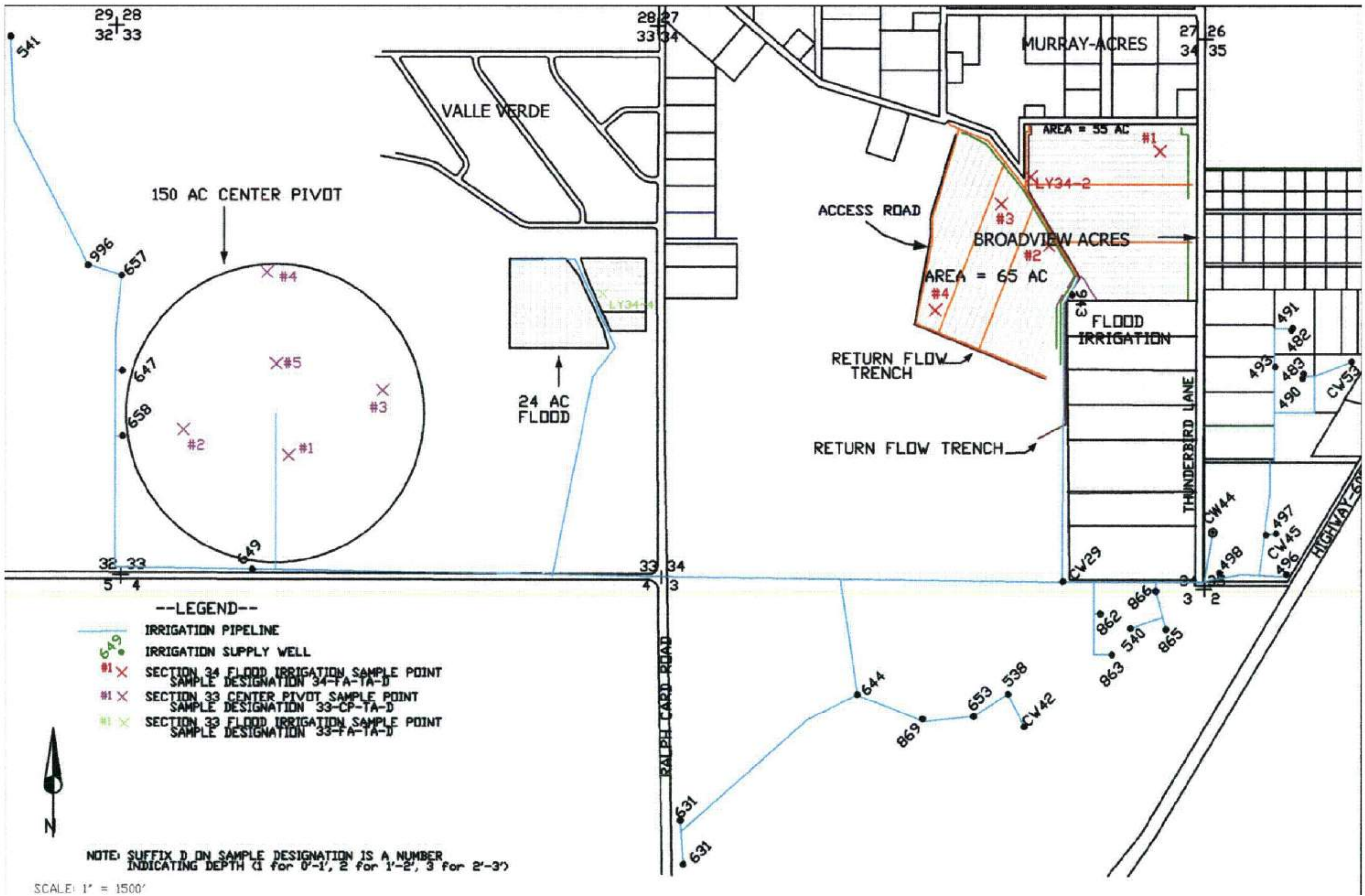


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2010

FIGURE 3-106



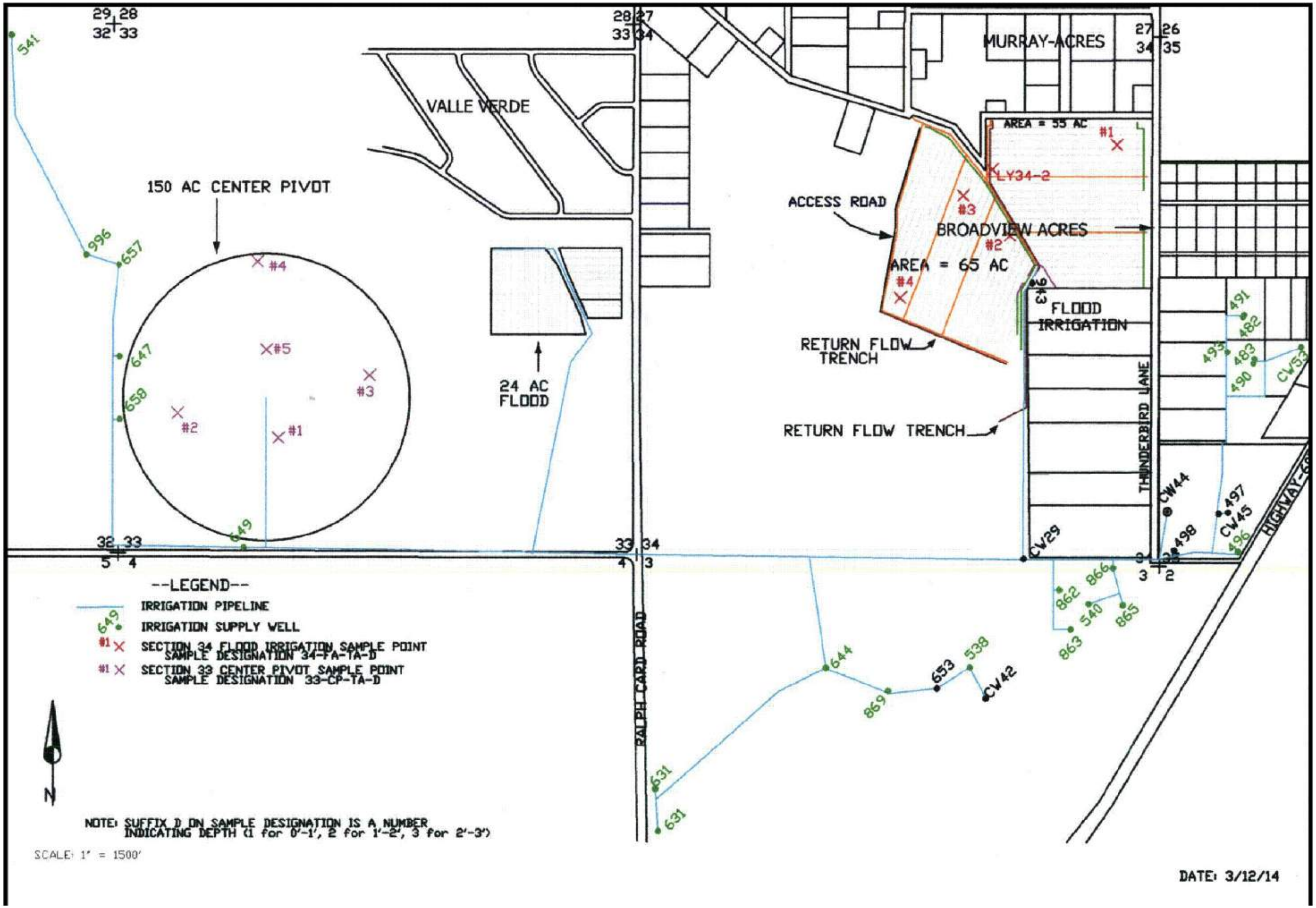
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2011

FIGURE 3-107



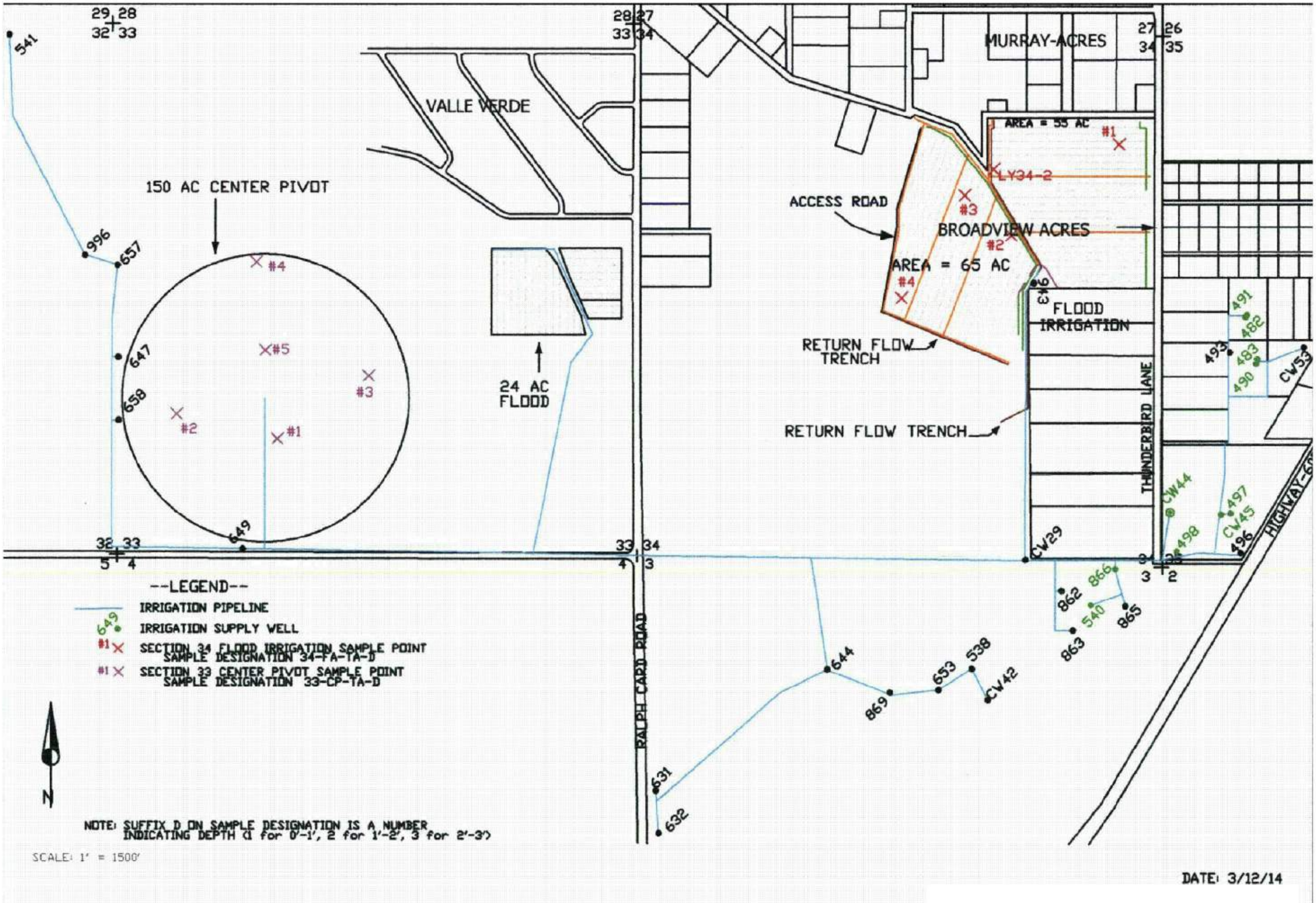
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2012

FIGURE 3-108



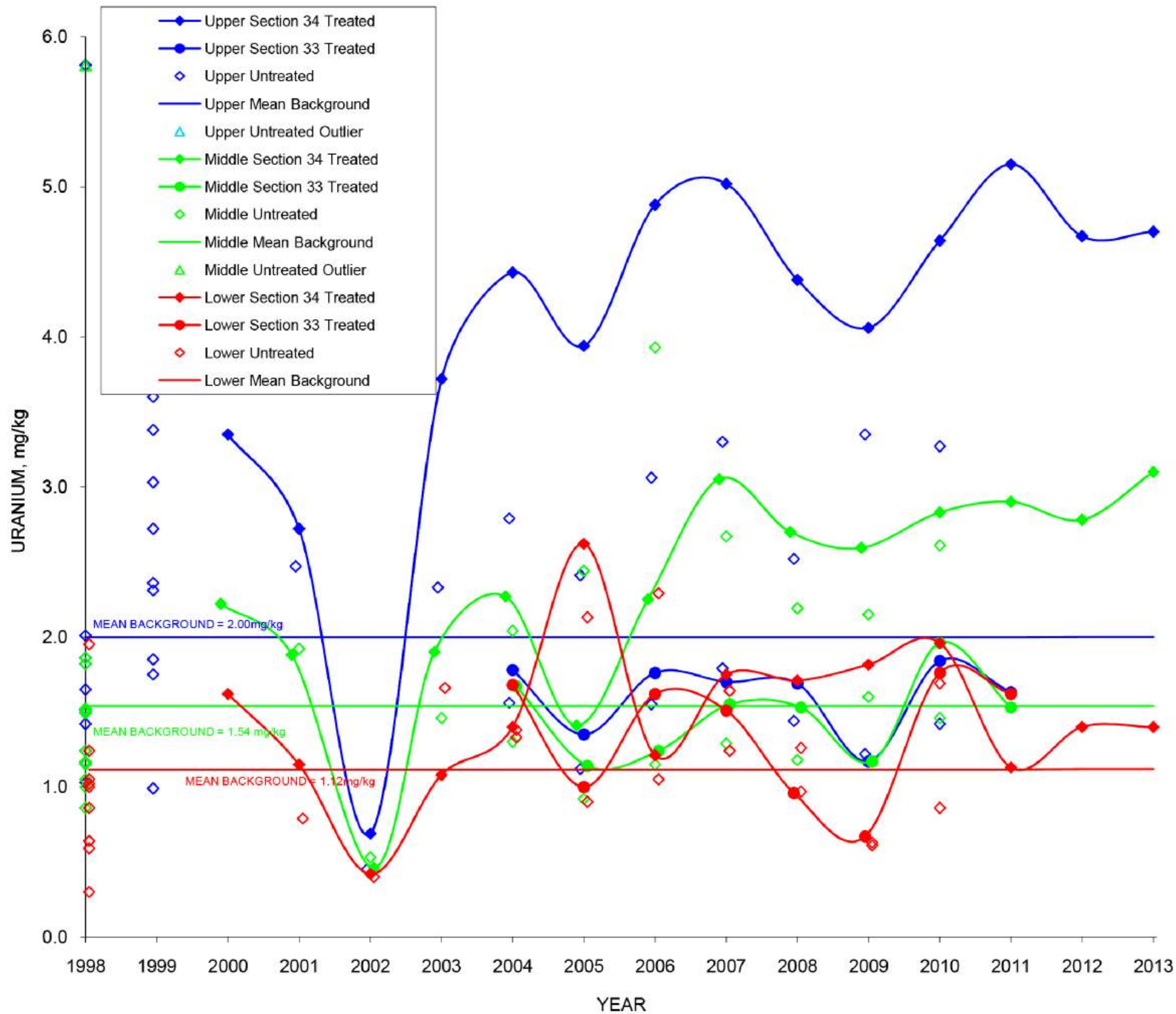
FLOOD IRRIGATION/ 150 ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2013

FIGURE 3-109

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-109_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020



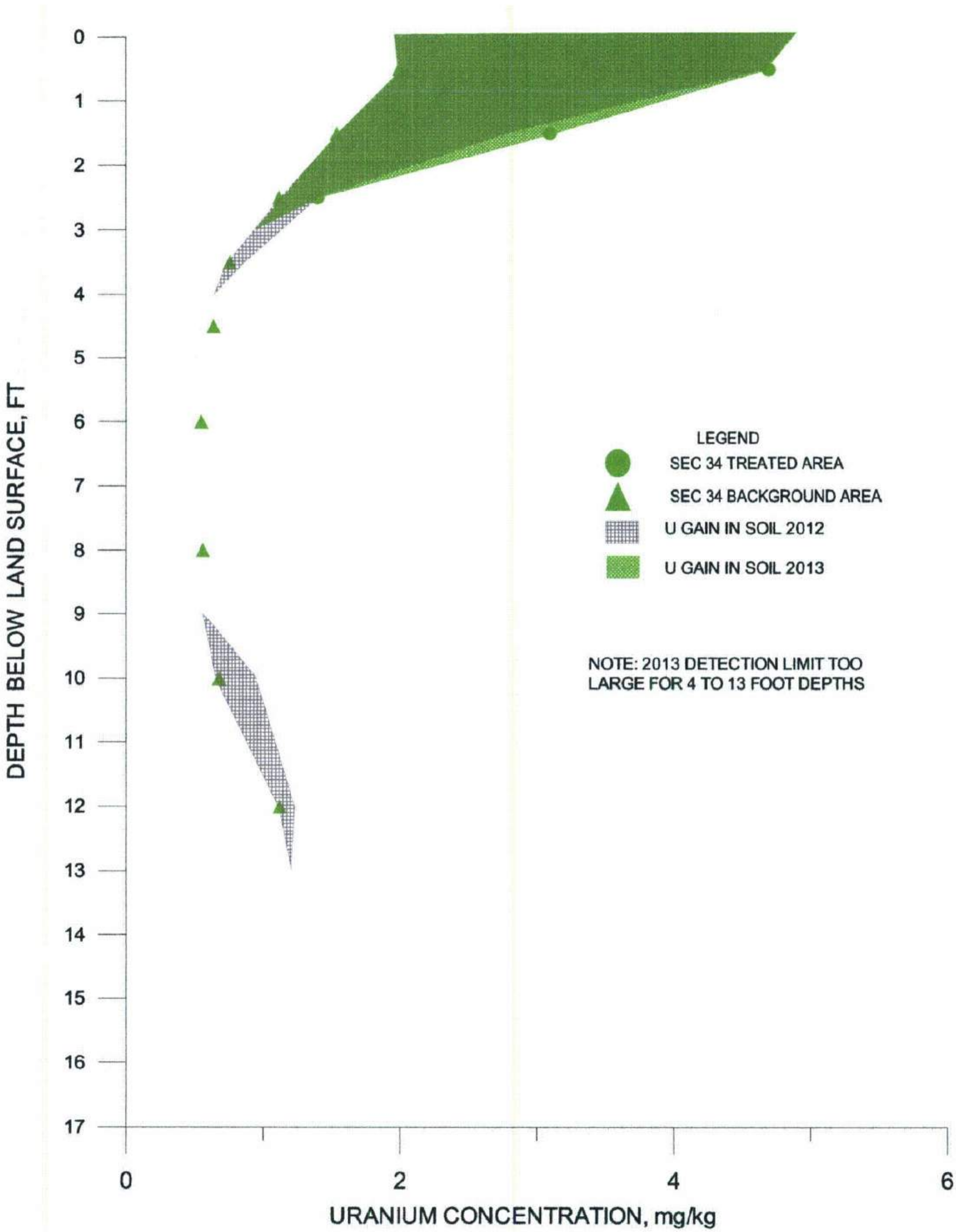
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM IN SOIL CONCENTRATION OVER TIME

FLOOD IRRIGATION FIELDS

FIGURE 3-110

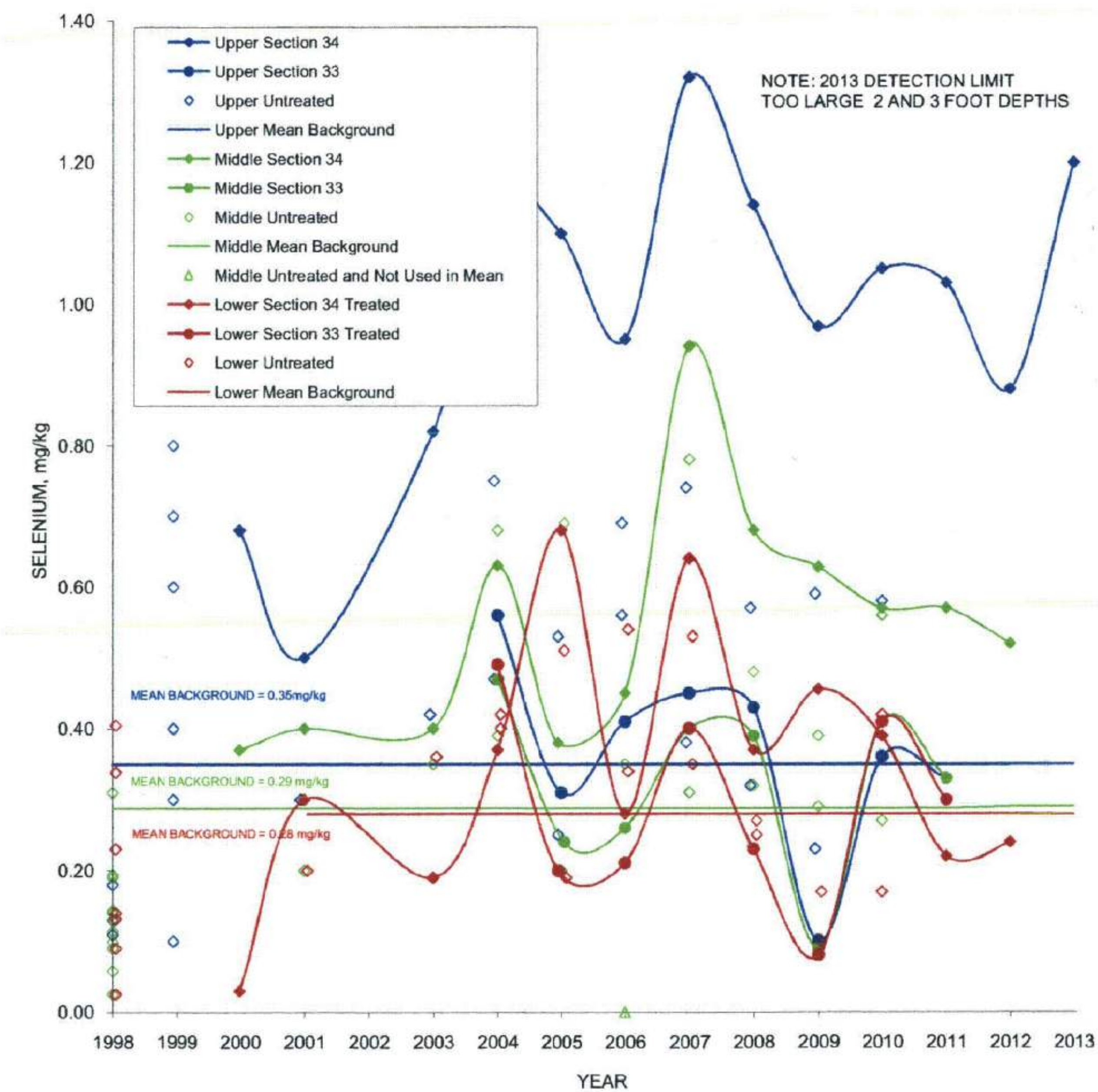


URANIUM IN SOIL CONCENTRATION VERSUS DEPTH

120-ACRE FLOOD IRRIGATION FIELD

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

FIGURE 3-111

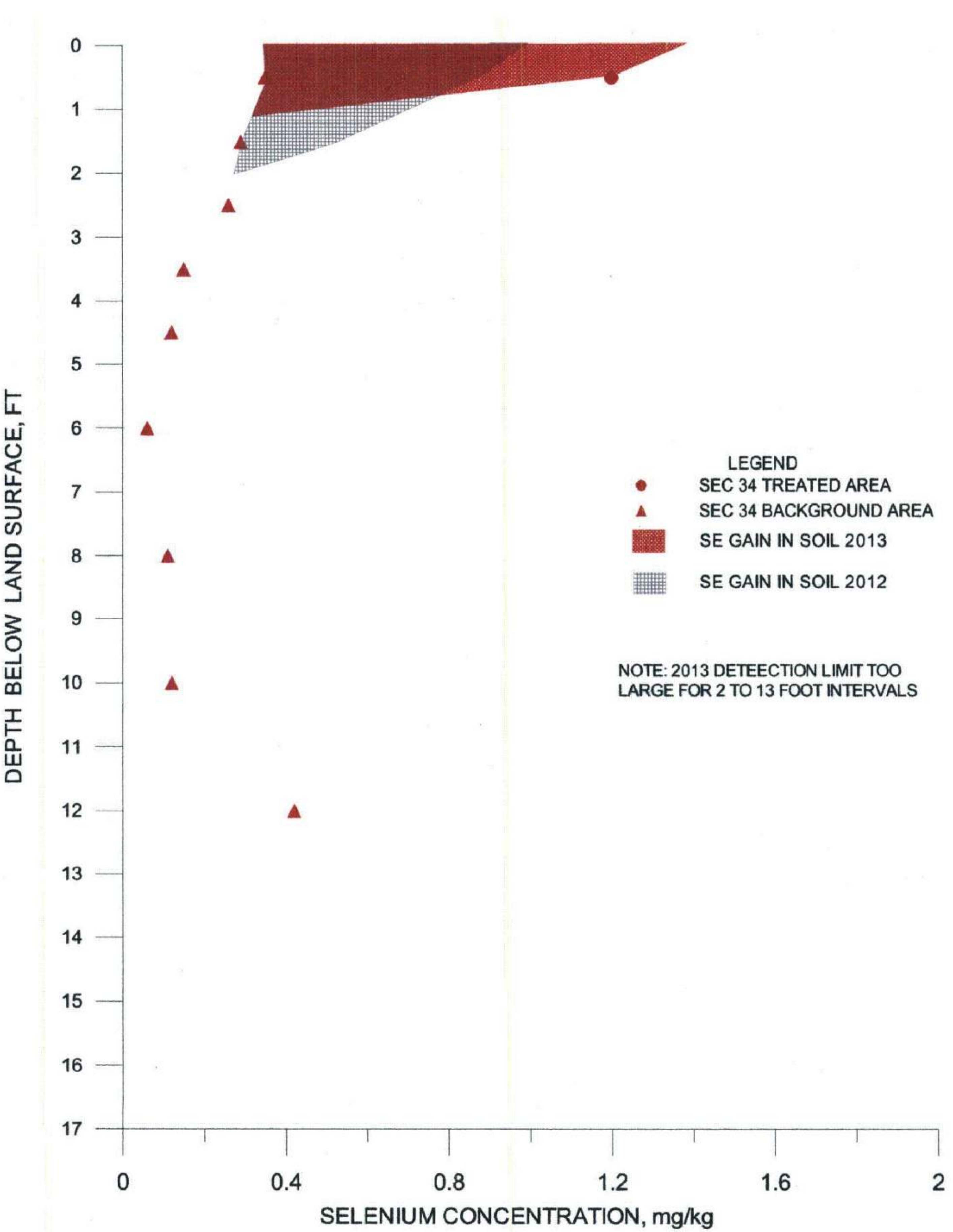


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SELENIUM IN SOIL CONCENTRATION OVER TIME

FLOOD IRRIGATION FIELDS

FIGURE 3-112



PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-113_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

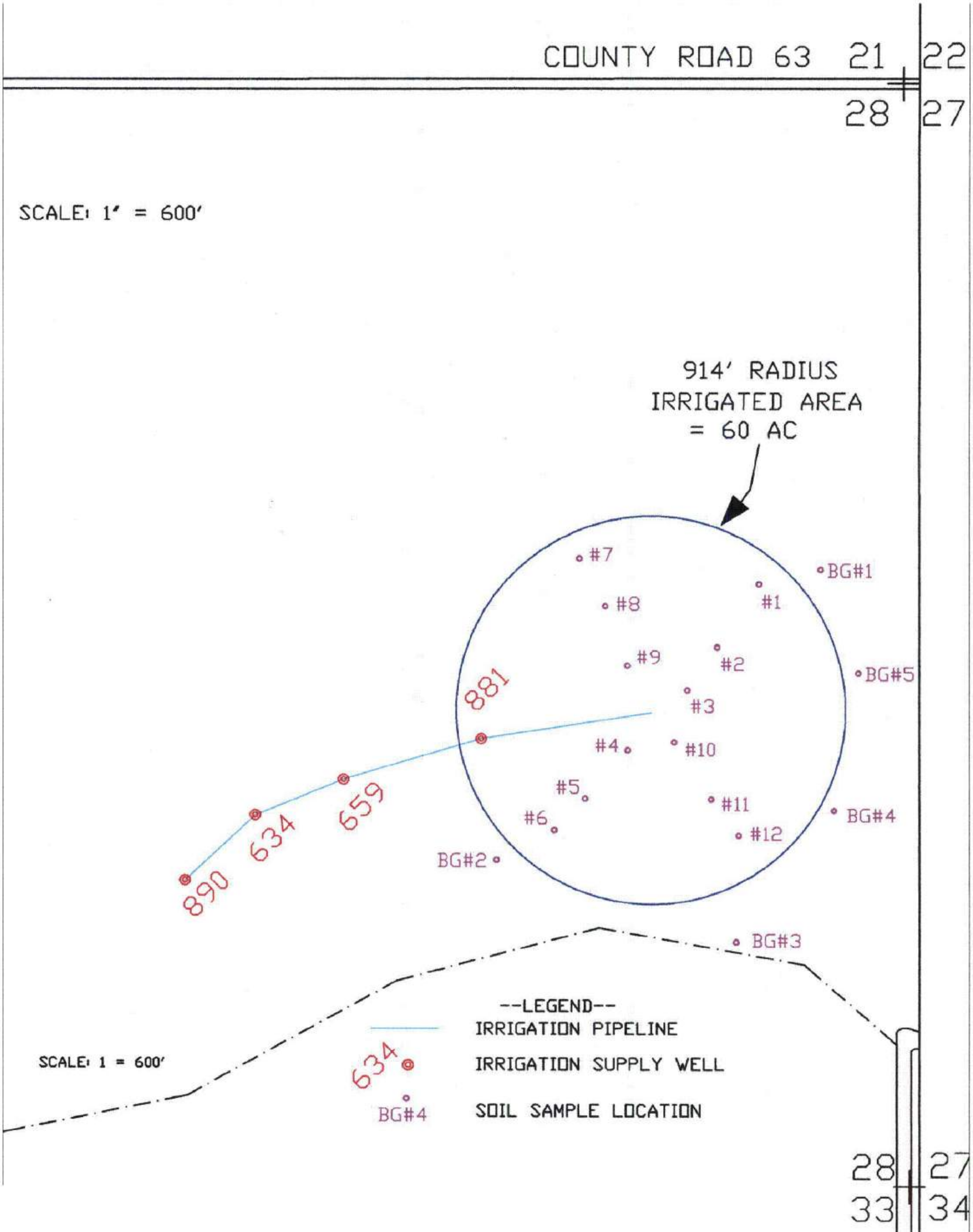
HOMESTAKE

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

SELENIUM IN SOIL CONCENTRATION VERSUS DEPTH

120-ACRE FLOOD IRRIGATION FIELD

FIGURE 3-113



PATH: Z:\PROJECTS\PROPOSALS\1017151B_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-114_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

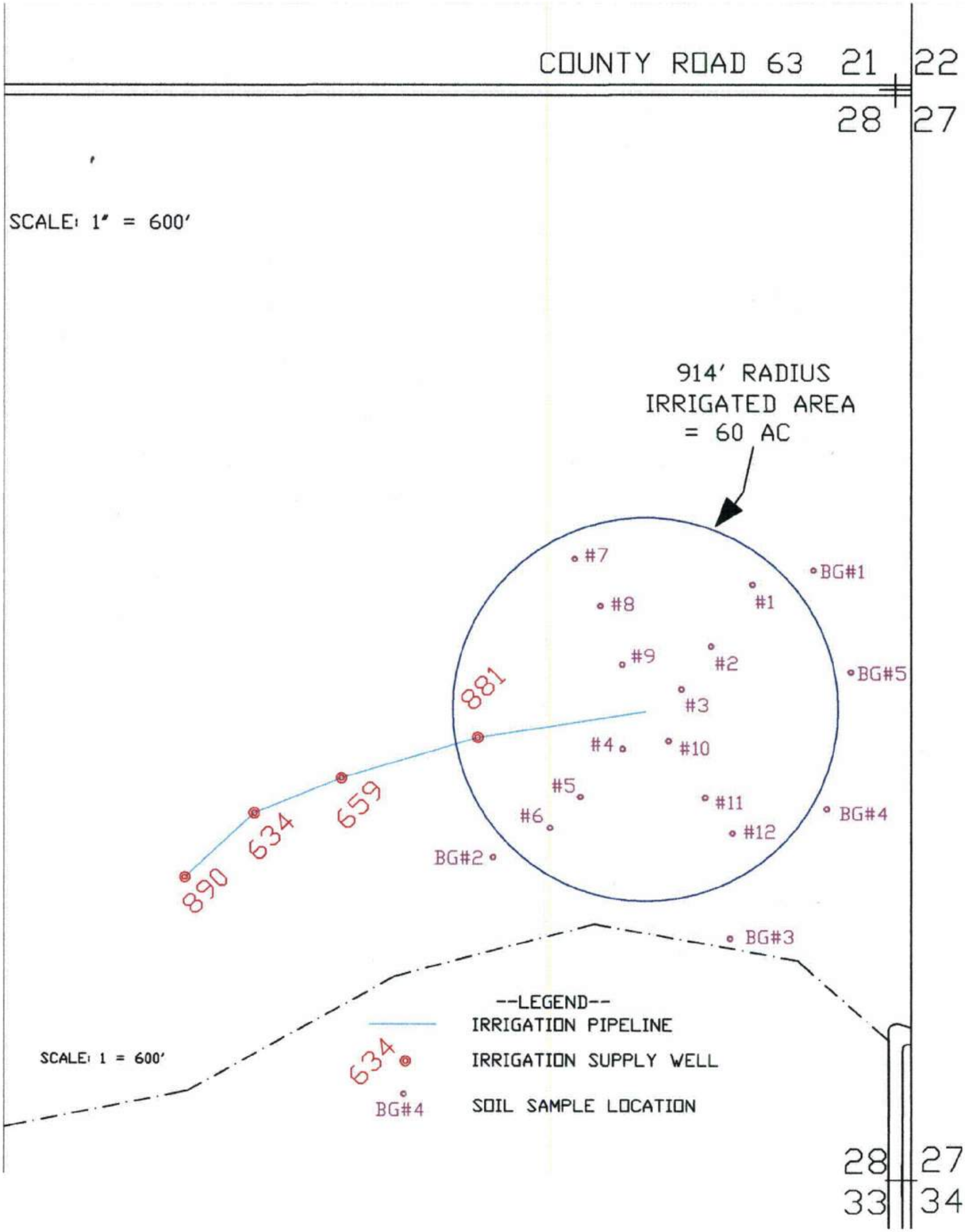
HOMESTAKE

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2002

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

FIGURE 3-114



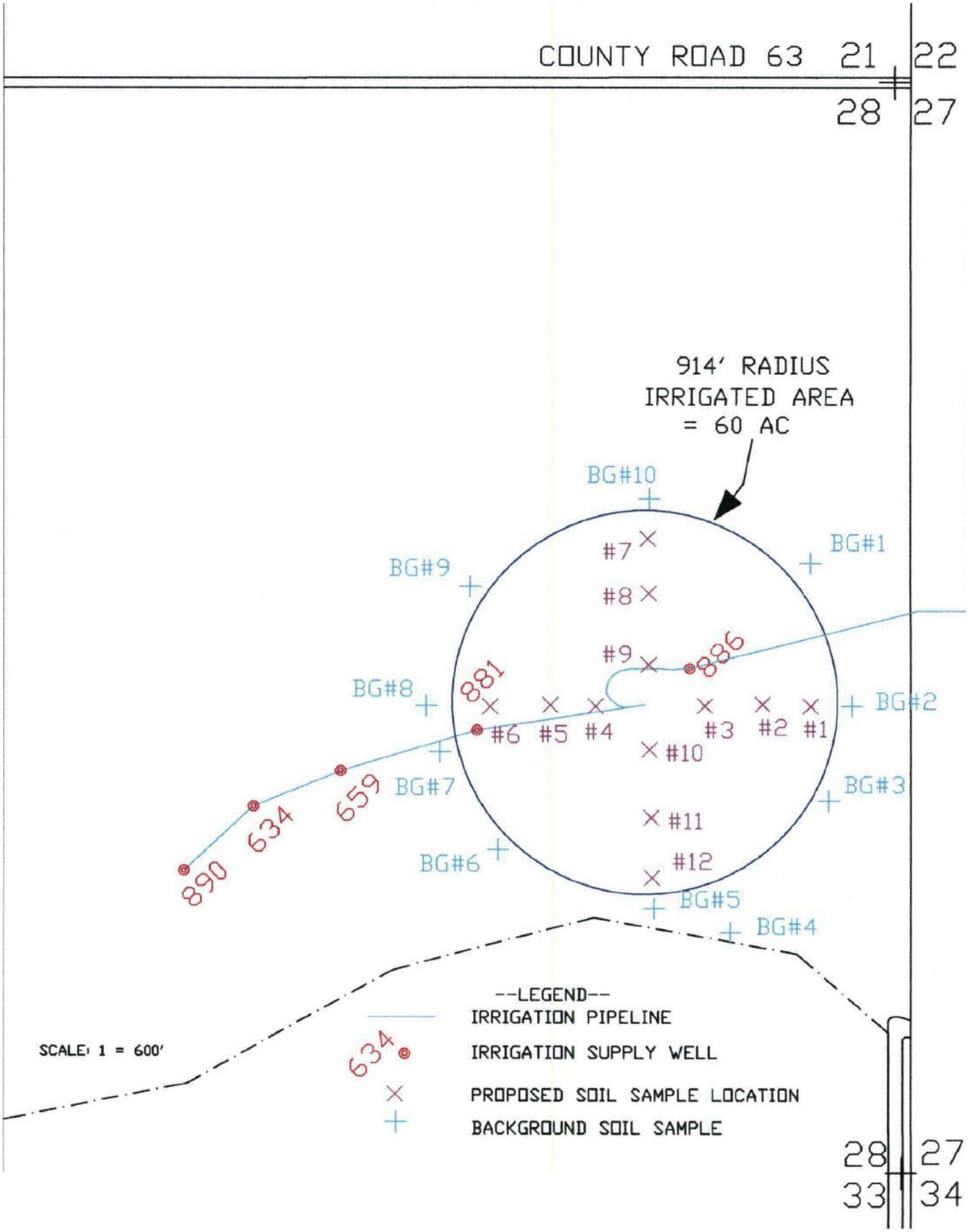
HOMESTAKE

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2003

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

FIGURE 3-115

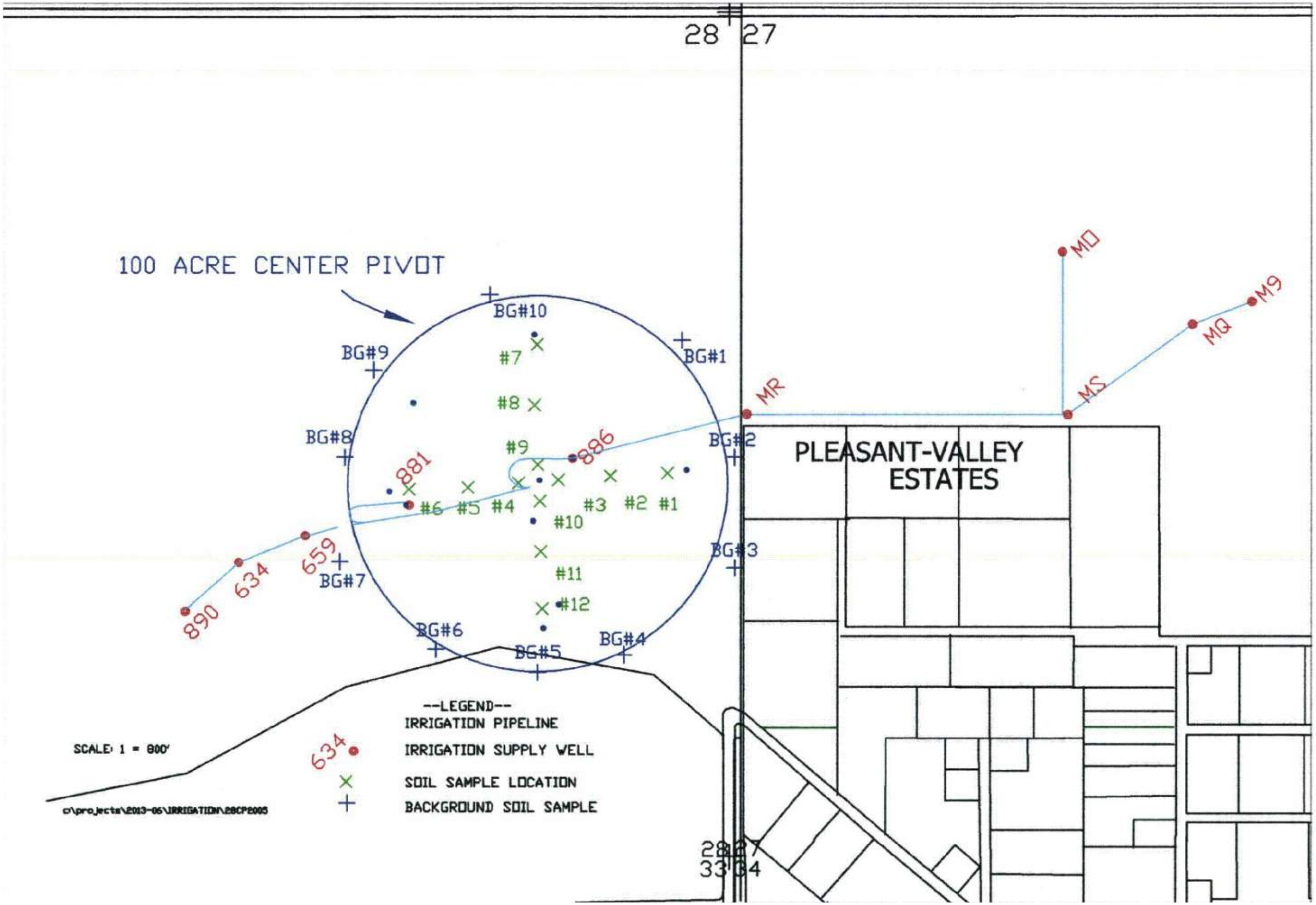


100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2004

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

FIGURE 3-116



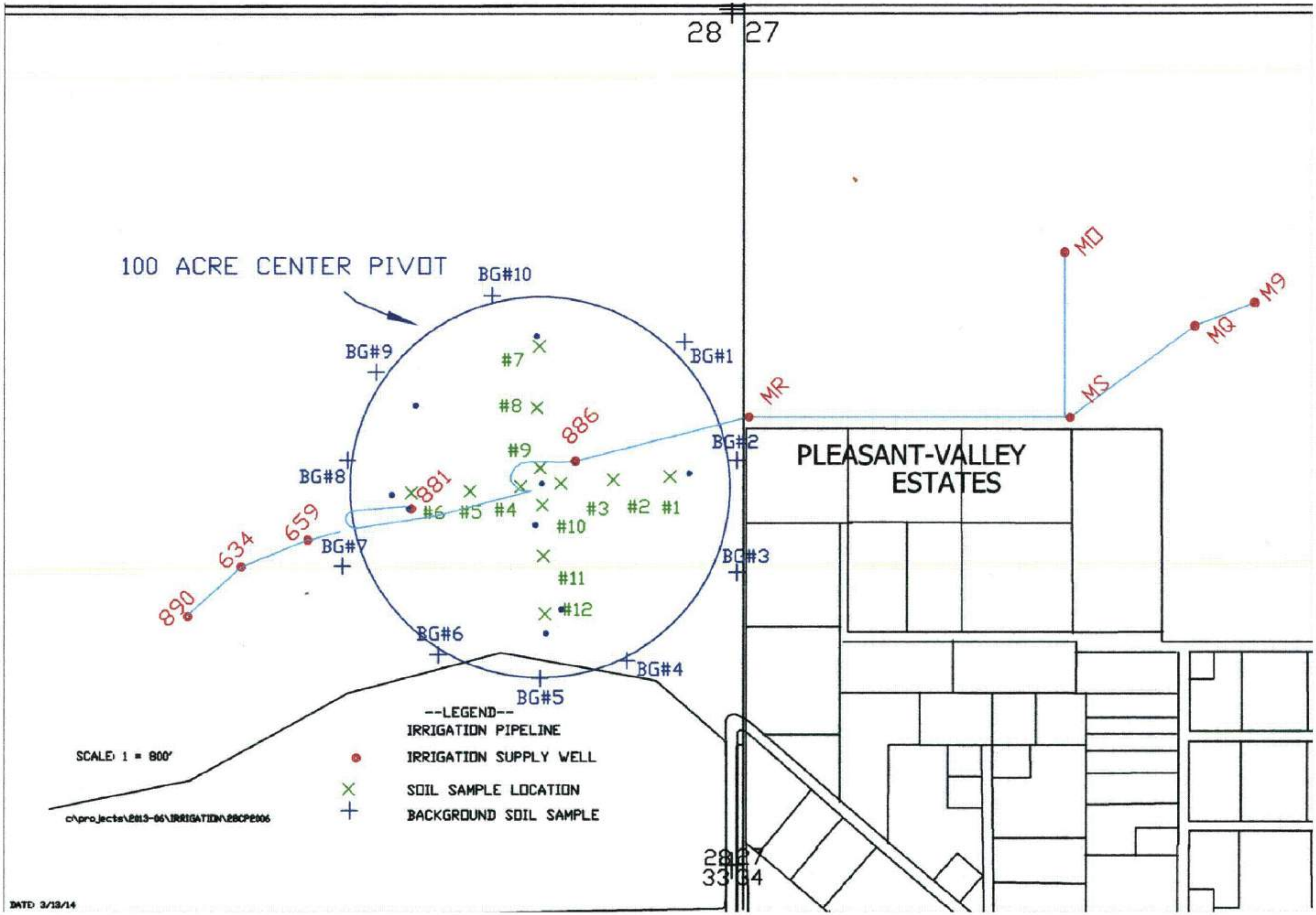
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2005

FIGURE 3-117

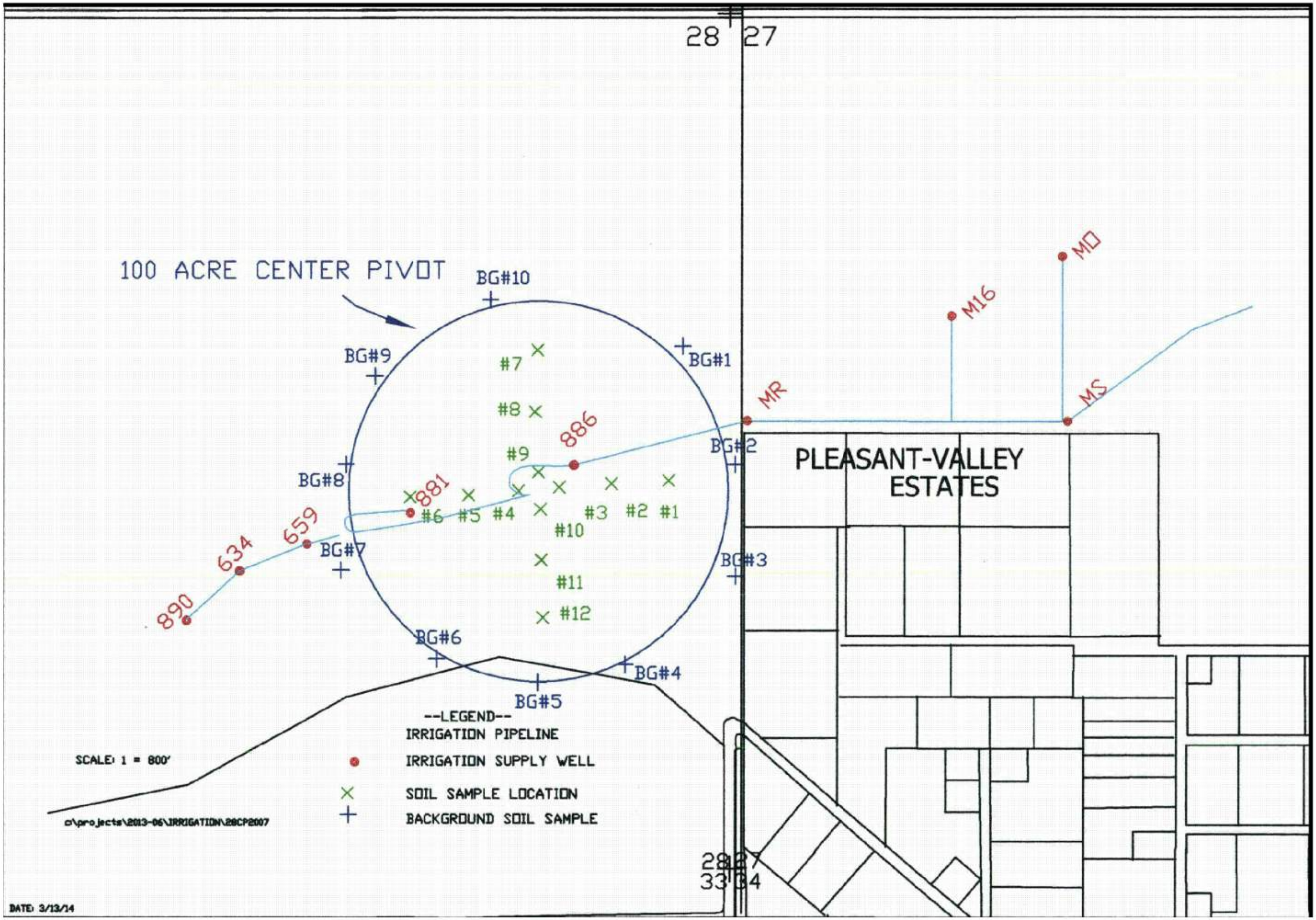


100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2006

FIGURE 3-118

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

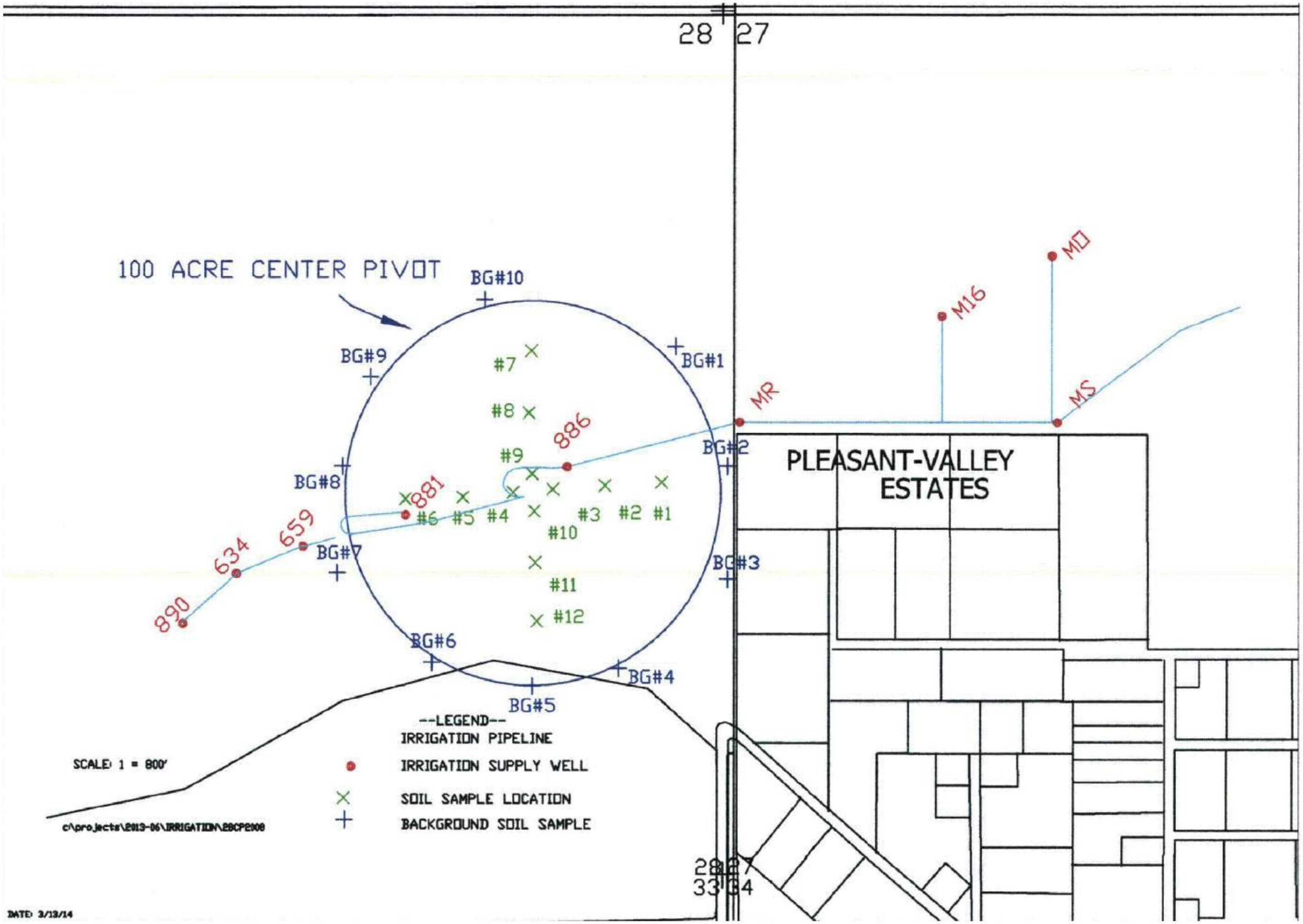


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2007

FIGURE 3-119

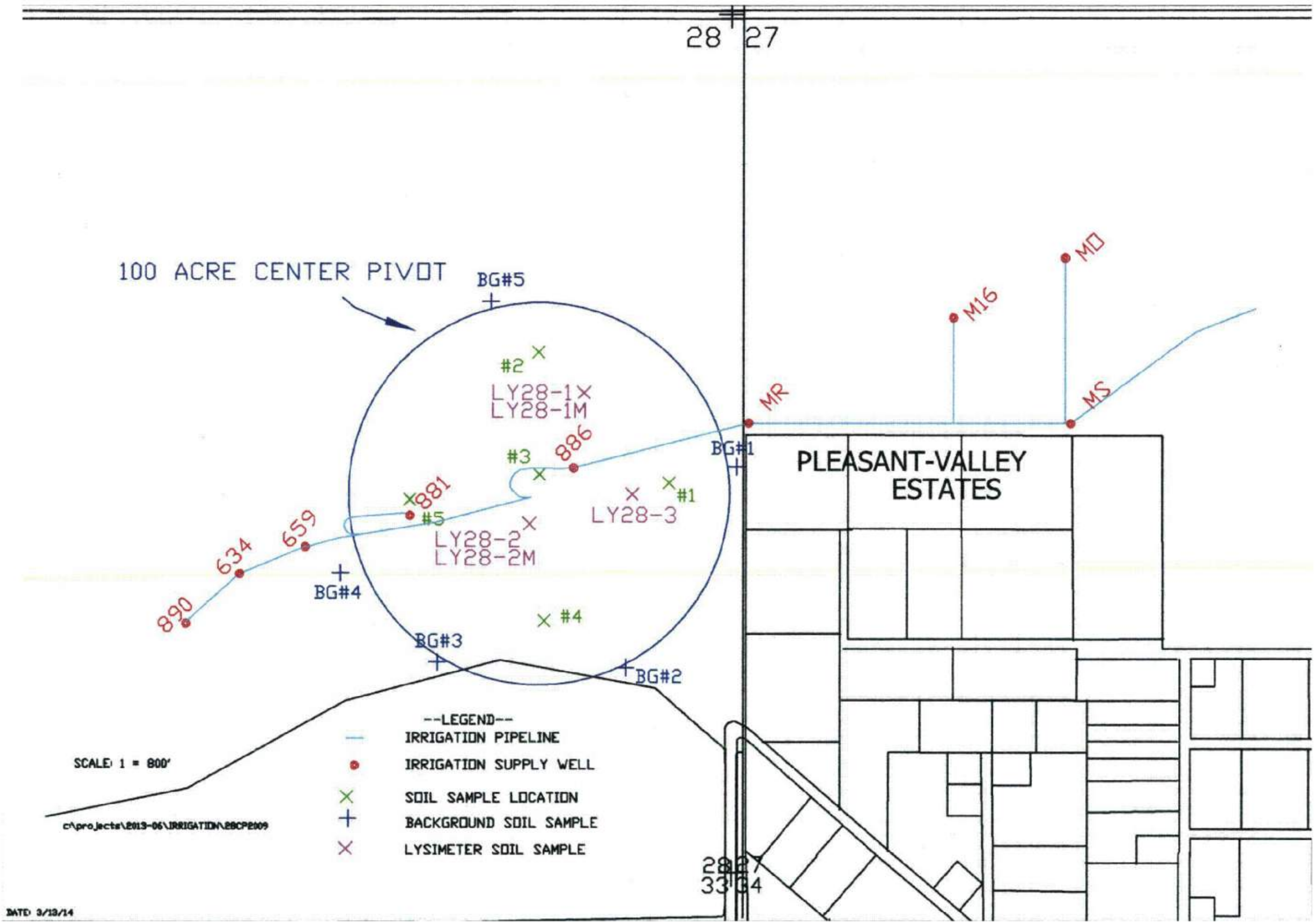


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2008

FIGURE 3-120

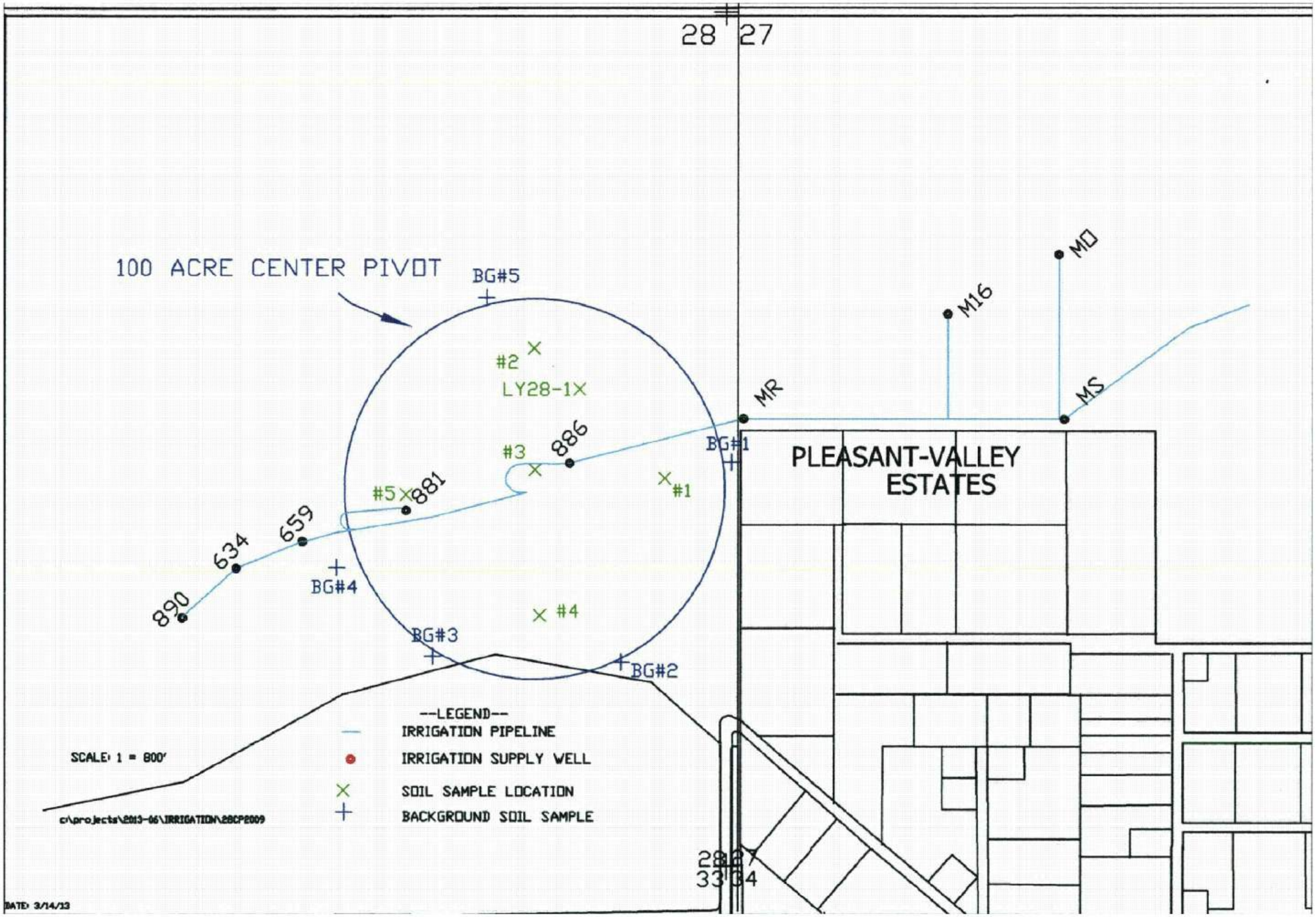


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2009

FIGURE 3-121



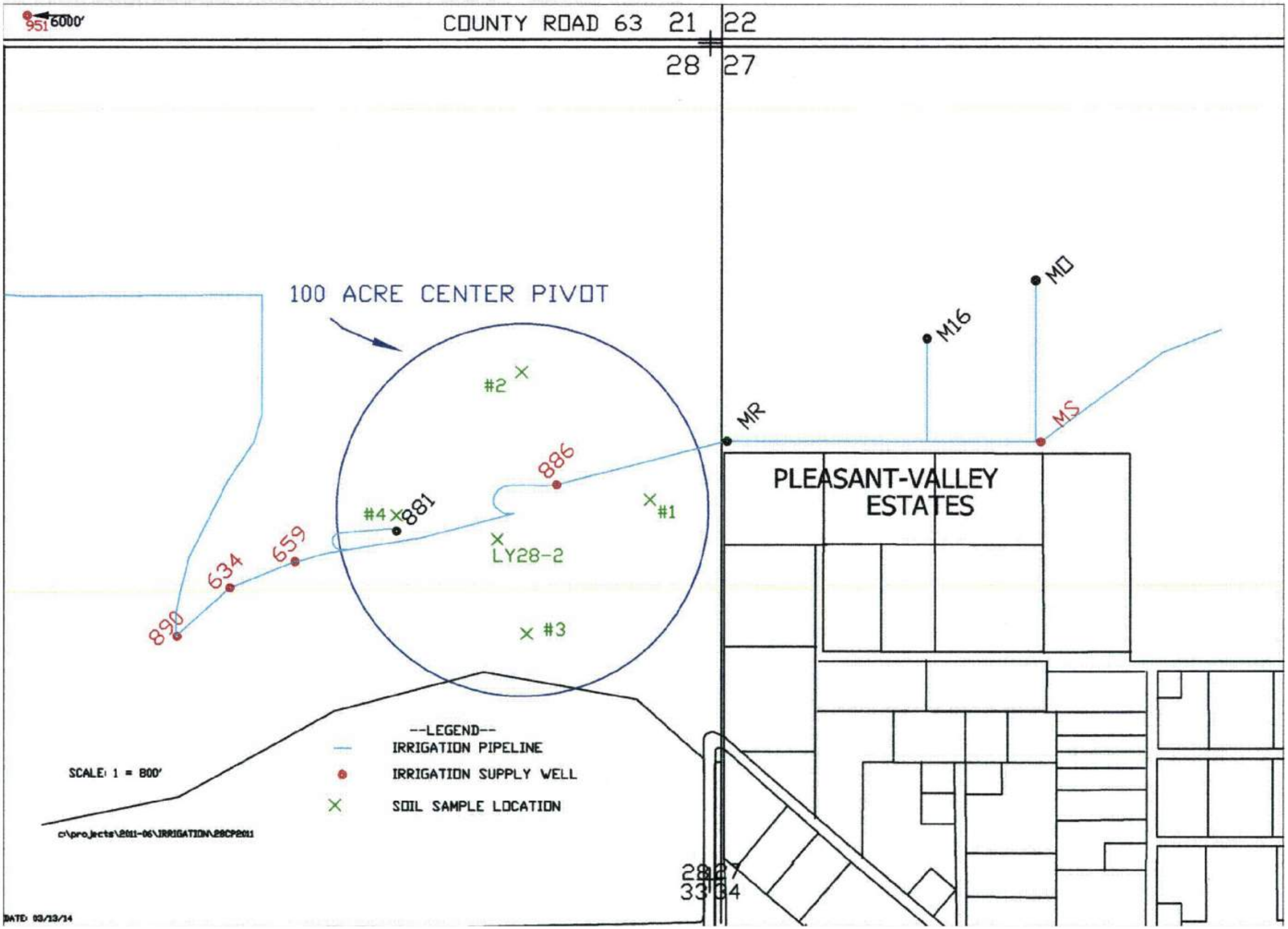
Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2010

FIGURE 3-122

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-122_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

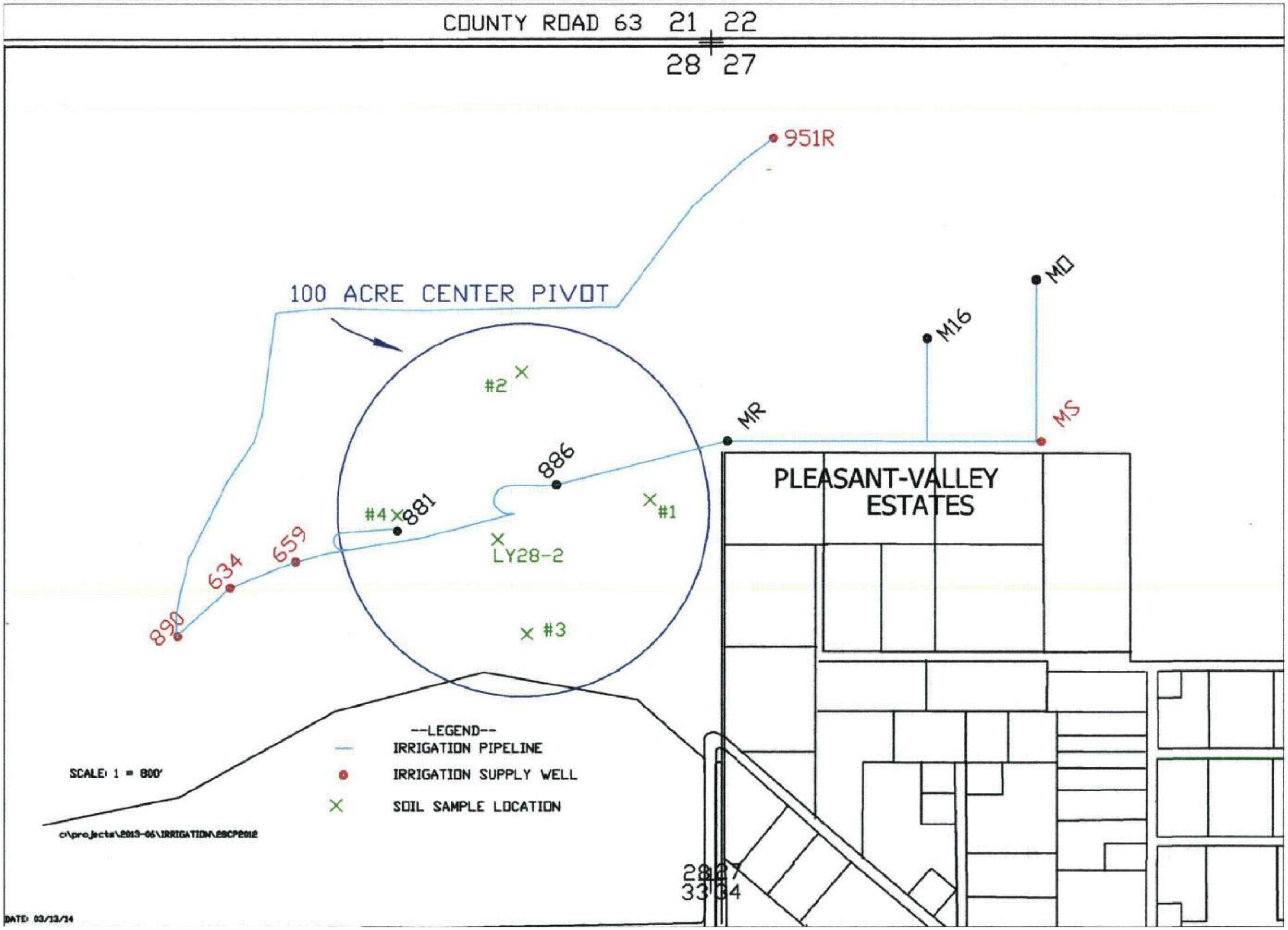


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2011

FIGURE 3-123



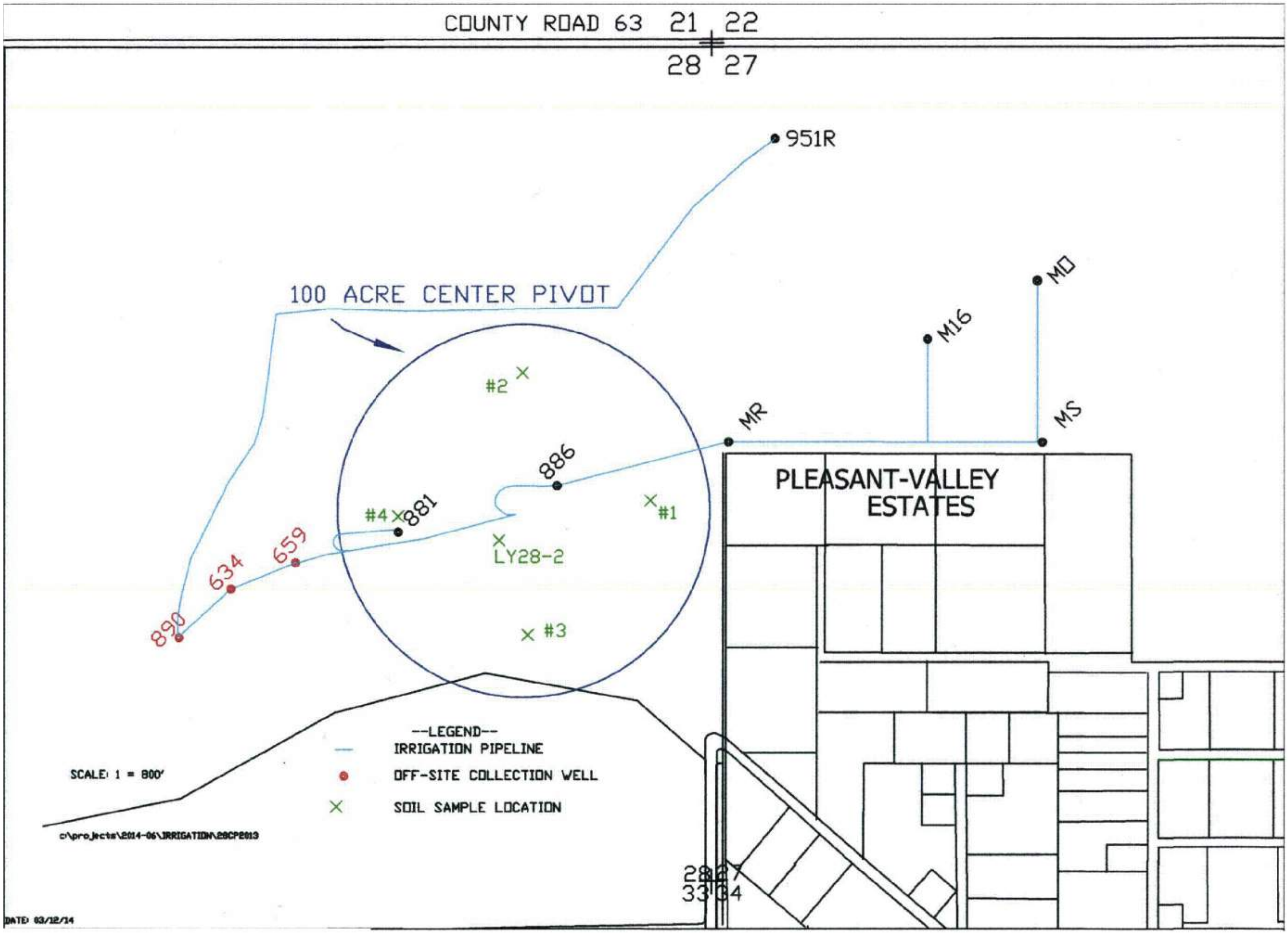
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2012

FIGURE 3-124



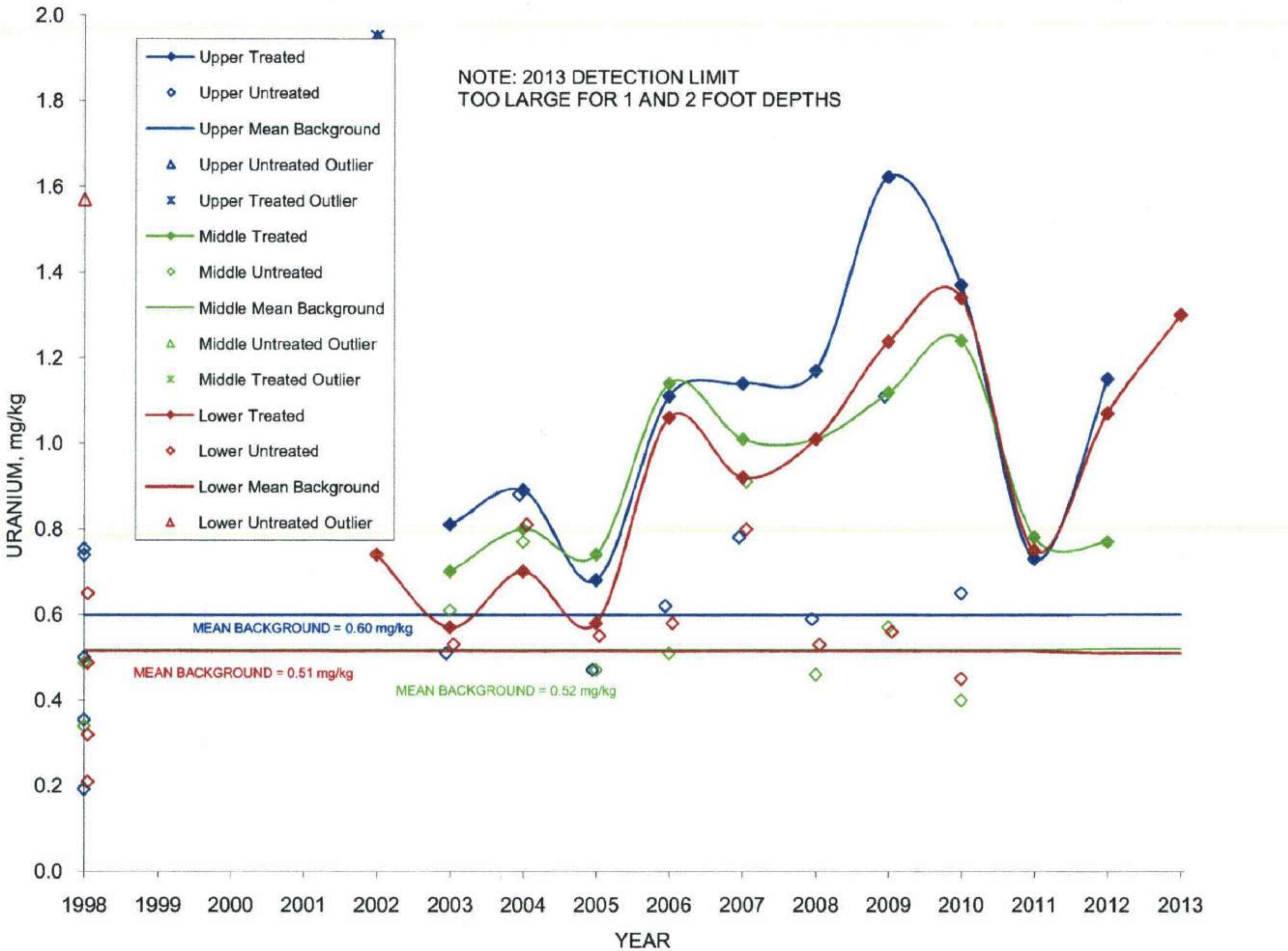
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

2013

FIGURE 3-125



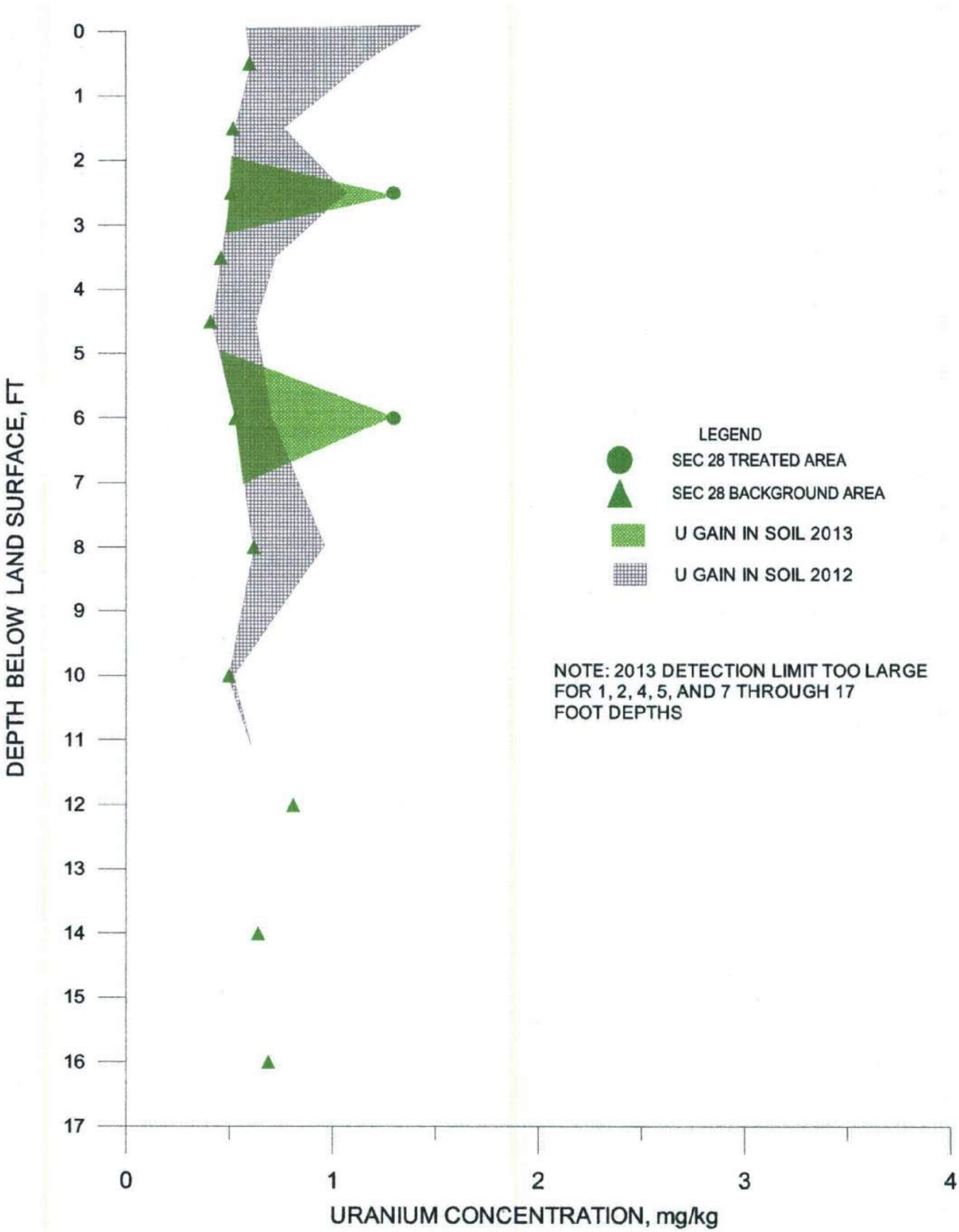
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM IN SOIL CONCENTRATION VERSUS TIME

100-ACRE CENTER PIVOT FIELD

FIGURE 3-126



PATH: Z:\PROJECTS\PROPOSALS\1017151\8_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-126_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 9/5/2019

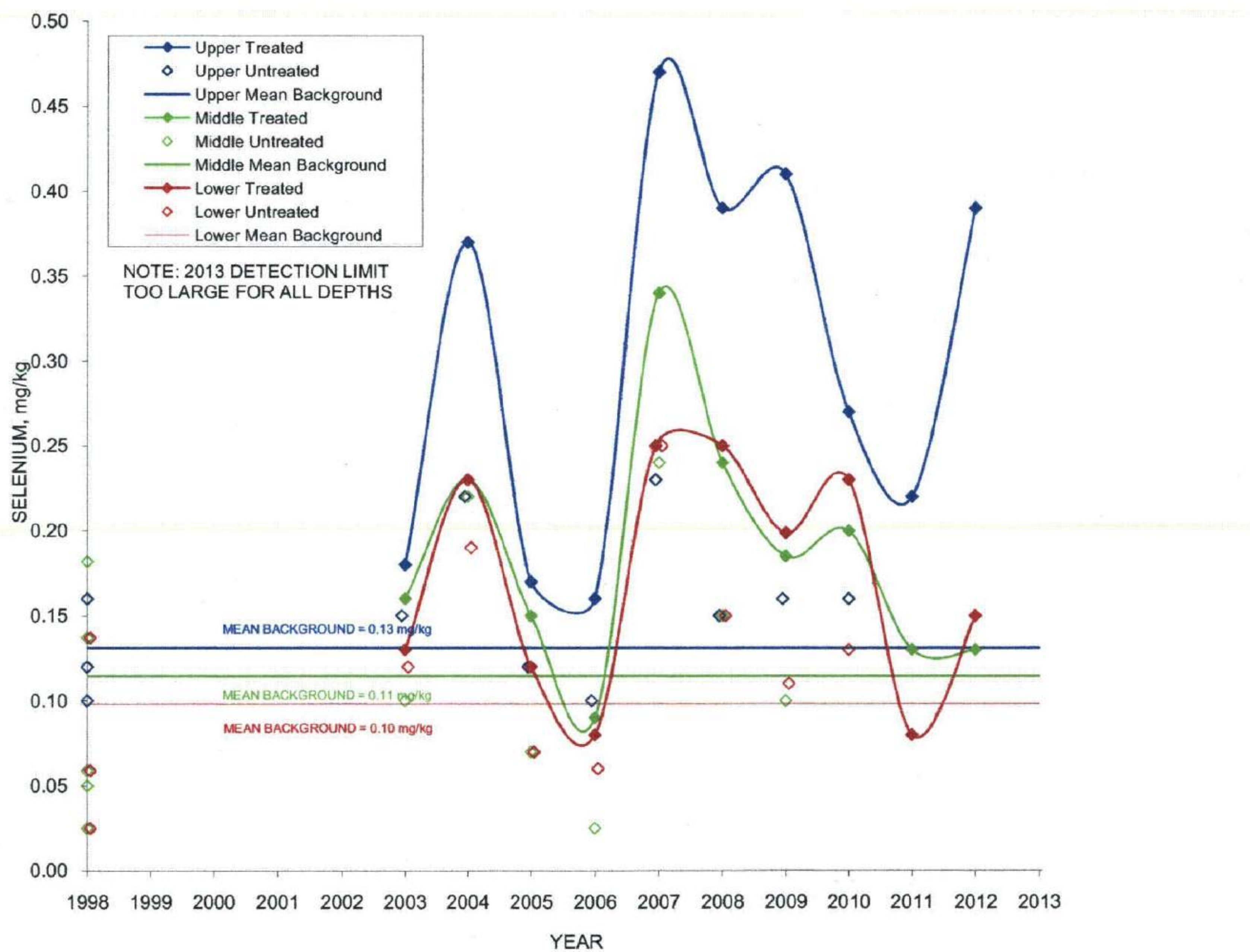
HOMESTAKE

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

URANIUM IN SOIL CONCENTRATION VERSUS DEPTH

100-ACRE CENTER PIVOT FIELD

FIGURE 3-127

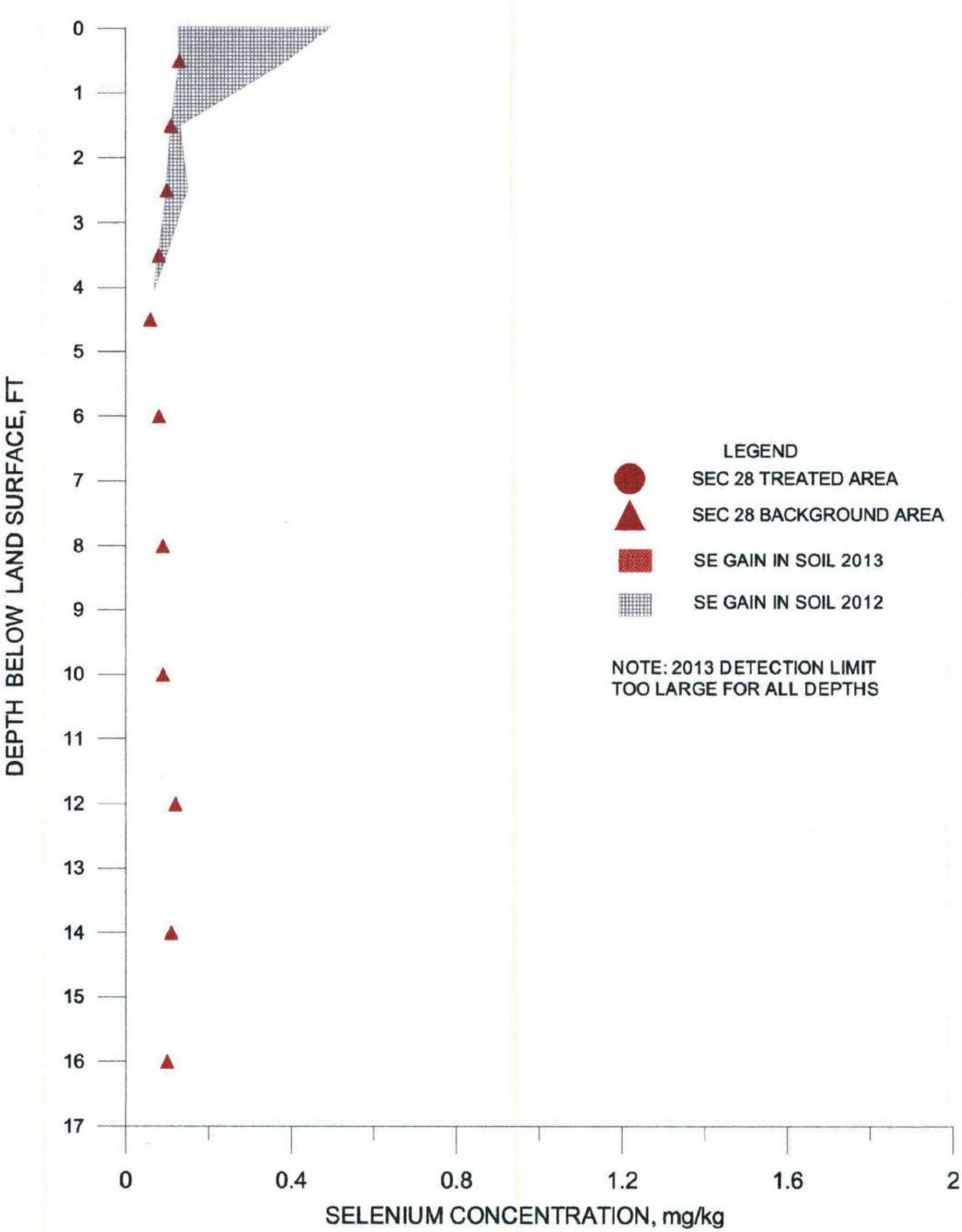


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SELENIUM IN SOIL CONCENTRATION VERSUS TIME

100-ACRE CENTER PIVOT FIELD

FIGURE 3-128



PATH: Z:\PROJECTS\PROPOSALS\1017151\8_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-129_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

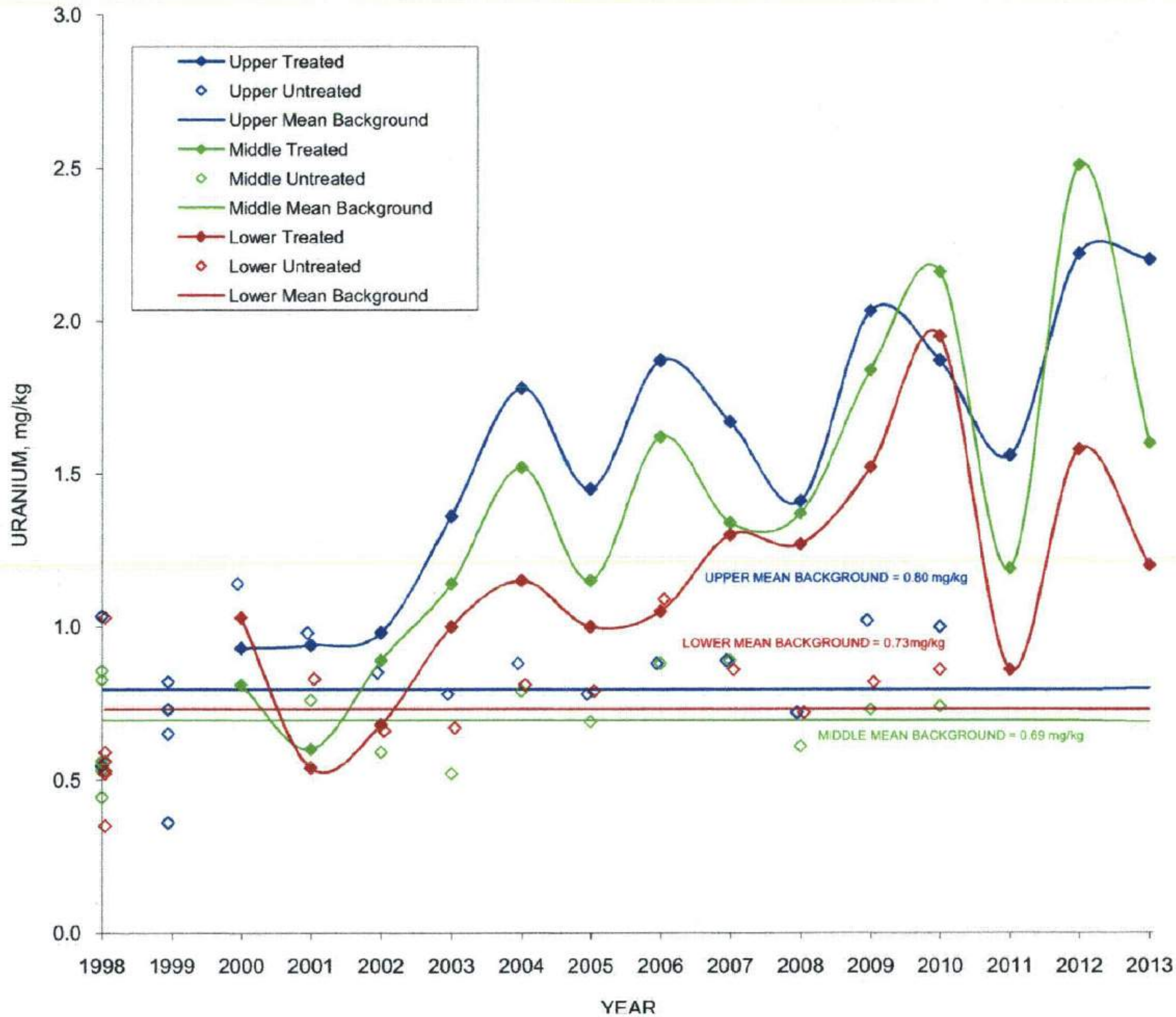
HOMESTAKE

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

SELENIUM IN SOIL CONCENTRATION VERSUS DEPTH

100-ACRE CENTER PIVOT FIELD

FIGURE 3-129



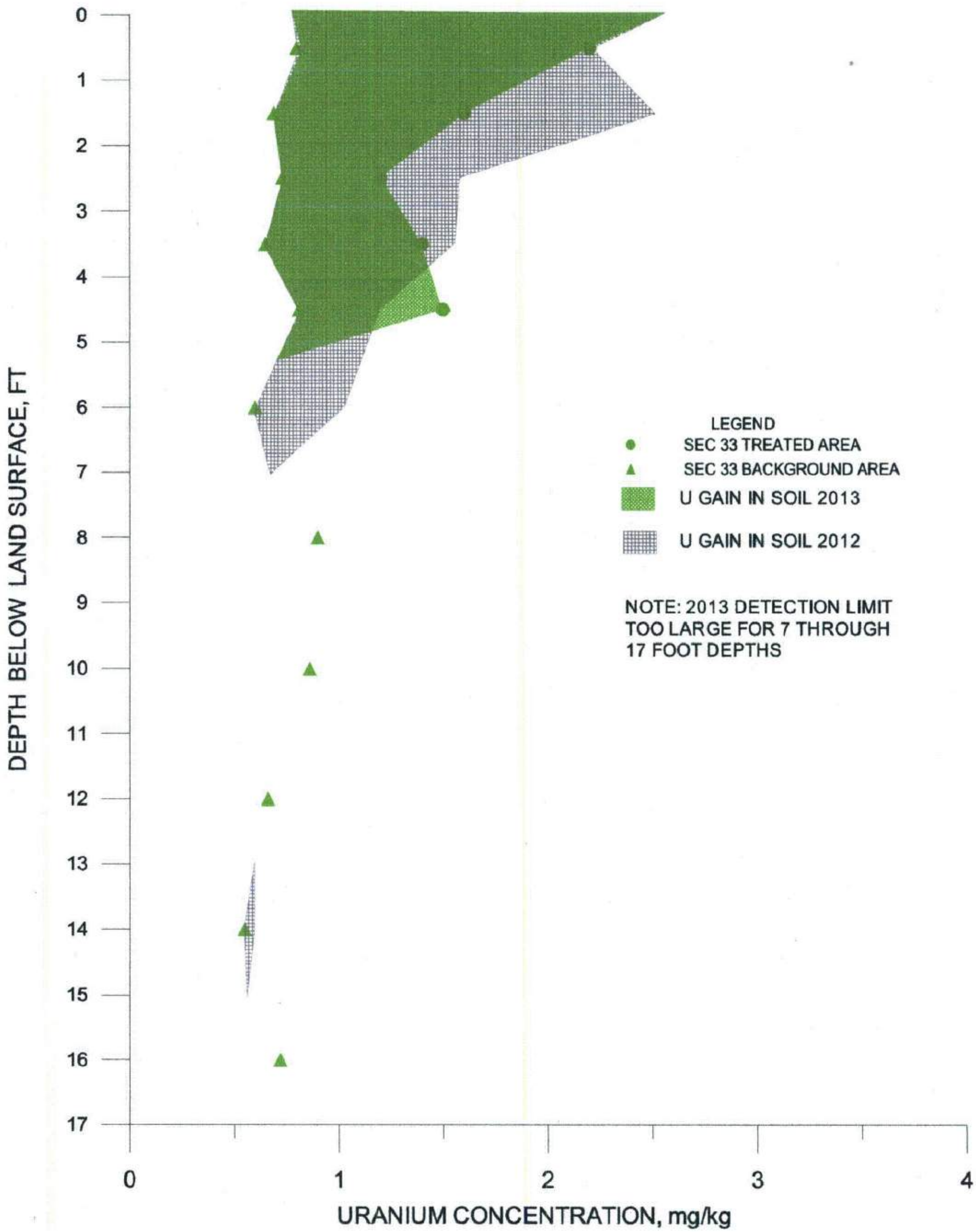
HOMESTAKE

Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

URANIUM IN SOIL CONCENTRATION VERSUS TIME

150-ACRE CENTER PIVOT FIELD

FIGURE 3-130



PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-131_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

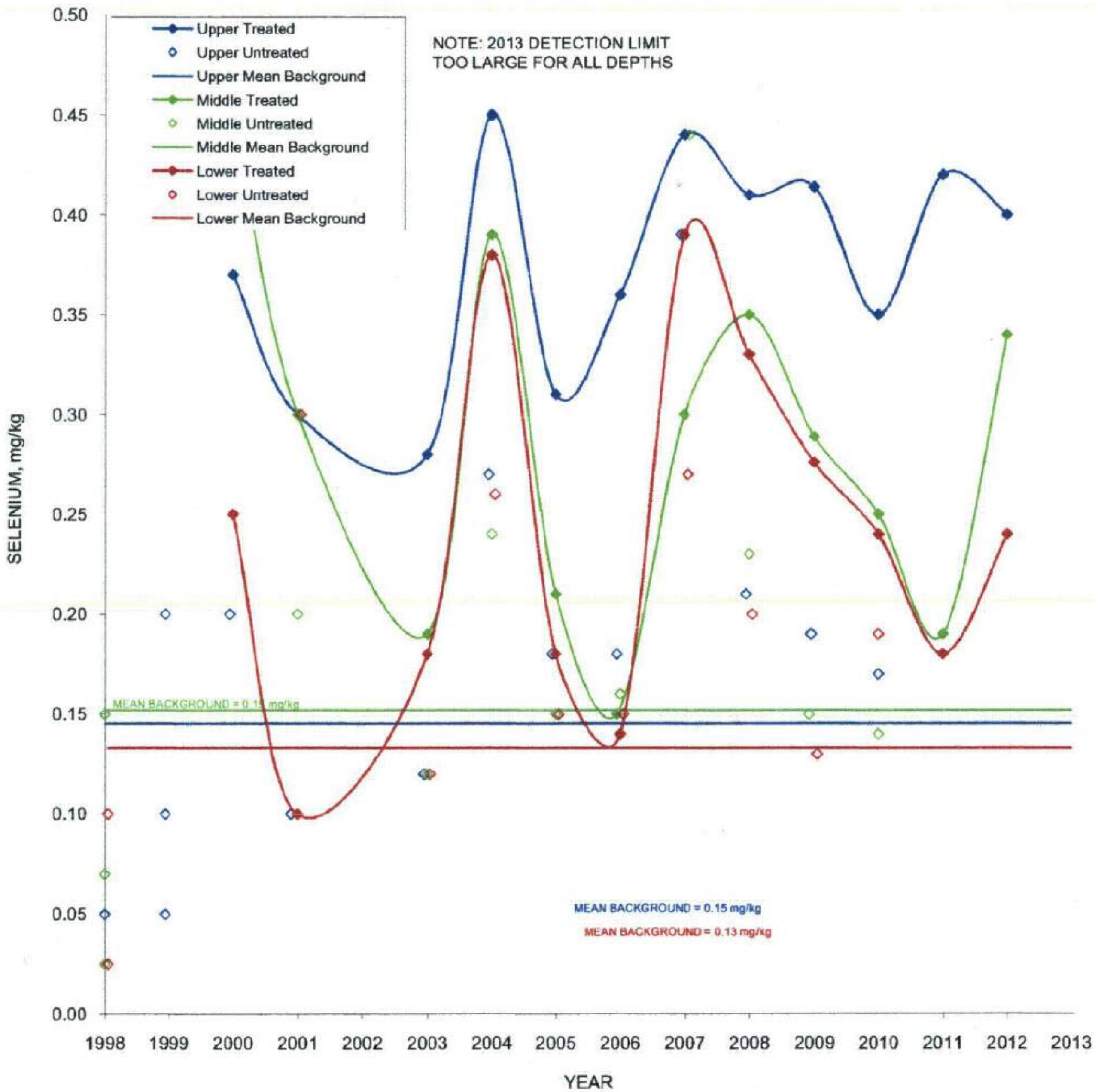
HOMESTAKE

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

URANIUM IN SOIL CONCENTRATION VERSUS DEPTH

150-ACRE CENTER PIVOT FIELD

FIGURE 3-131

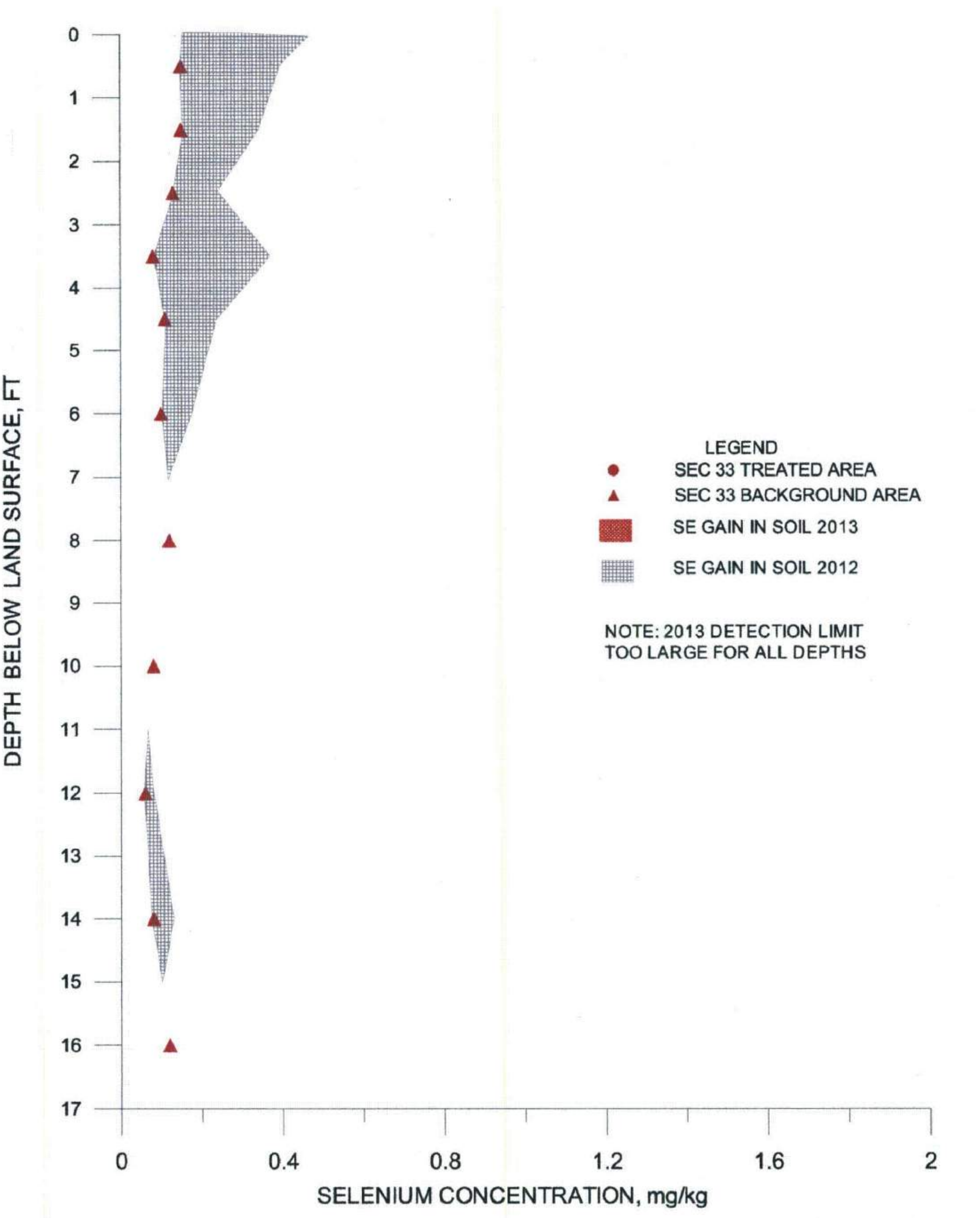


Adopted from: Evaluation of Years 2000 through 2019 irrigation with Alluvial Ground Water, HMC, 2014

SELENIUM IN SOIL CONCENTRATION VERSUS TIME

150-ACRE CENTER PIVOT FIELD

FIGURE 3-132



PATH: Z:\PROJECTS\PROPOSALS\1017151\8_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-133_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

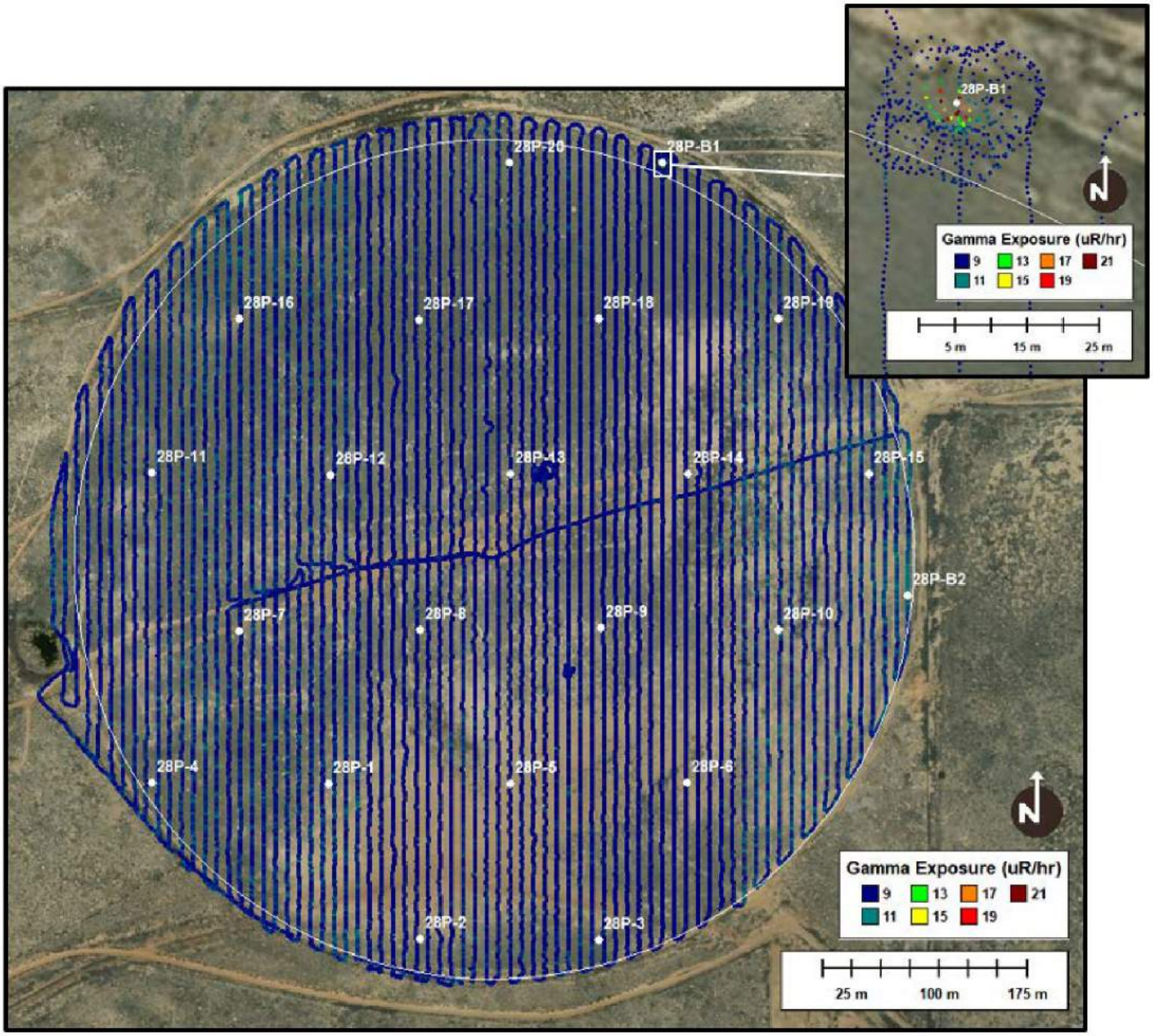
HOMESTAKE

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

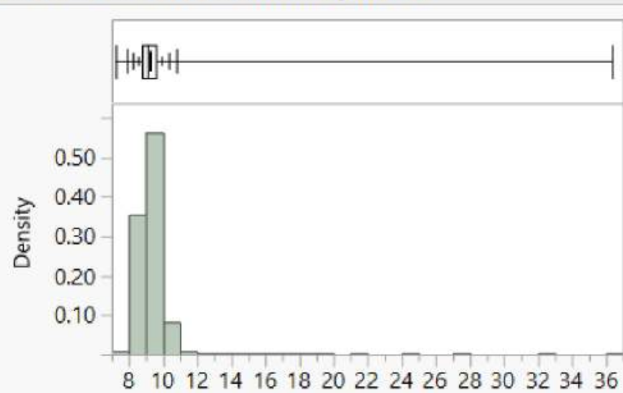
SELENIUM IN SOIL CONCENTRATION VERSUS DEPTH

150-ACRE CENTER PIVOT FIELD

FIGURE 3-133



Section 28 Pivot Gamma (µR/hr)



Quantiles

100.0%	maximum	36.3
99.5%		10.8
97.5%		10.3
90.0%		9.9
75.0%	quartile	9.5
50.0%	median	9.1
25.0%	quartile	8.8
10.0%		8.5
2.5%		8.2
0.5%		7.9
0.0%	minimum	7.2

Summary Statistics

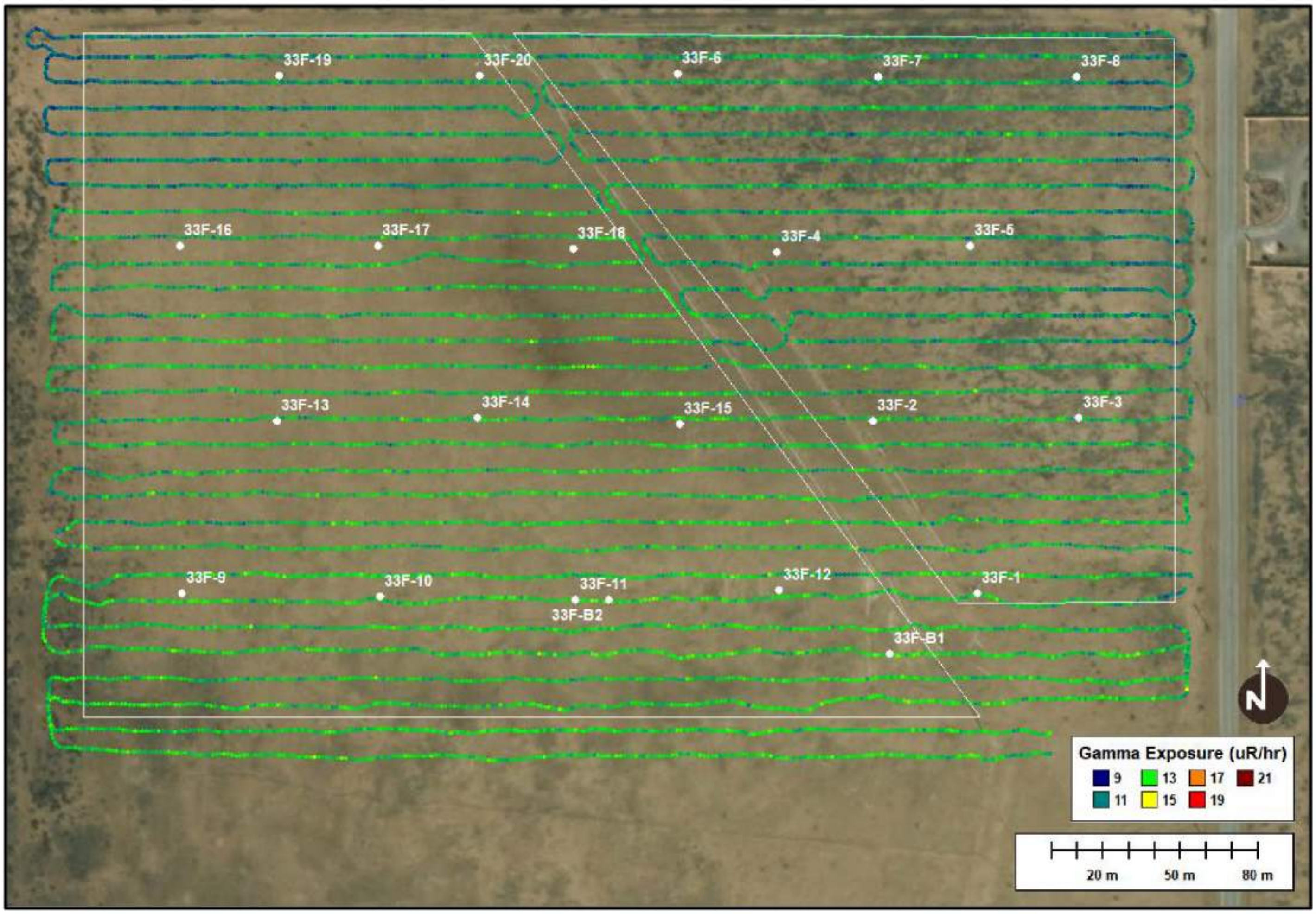
Mean	9.2
Std Dev	0.6
Std Err Mean	0.0
Upper 95% Mean	9.2
Lower 95% Mean	9.2
N	41838

100-ACRE CENTER PIVOT SOIL SAMPLING LOCATIONS

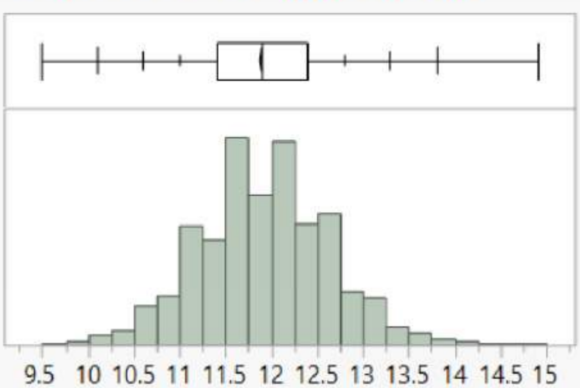
2017

FIGURE 3-134

Source: Final Status Survey Report for Release of Former Land Application Areas, Grants Reclamation Project, Cibola County, New Mexico. ERG 2018.



Section 33 Flood Gamma (µR/hr)



Quantiles

100.0%	maximum	14.9
99.5%		13.8
97.5%		13.3
90.0%		12.8
75.0%	quartile	12.4
50.0%	median	11.9
25.0%	quartile	11.4
10.0%		11
2.5%		10.6
0.5%		10.1
0.0%	minimum	9.5

Summary Statistics

Mean	11.9
Std Dev	0.7
Std Err Mean	0.0
Upper 95% Mean	11.9
Lower 95% Mean	11.9
N	9734

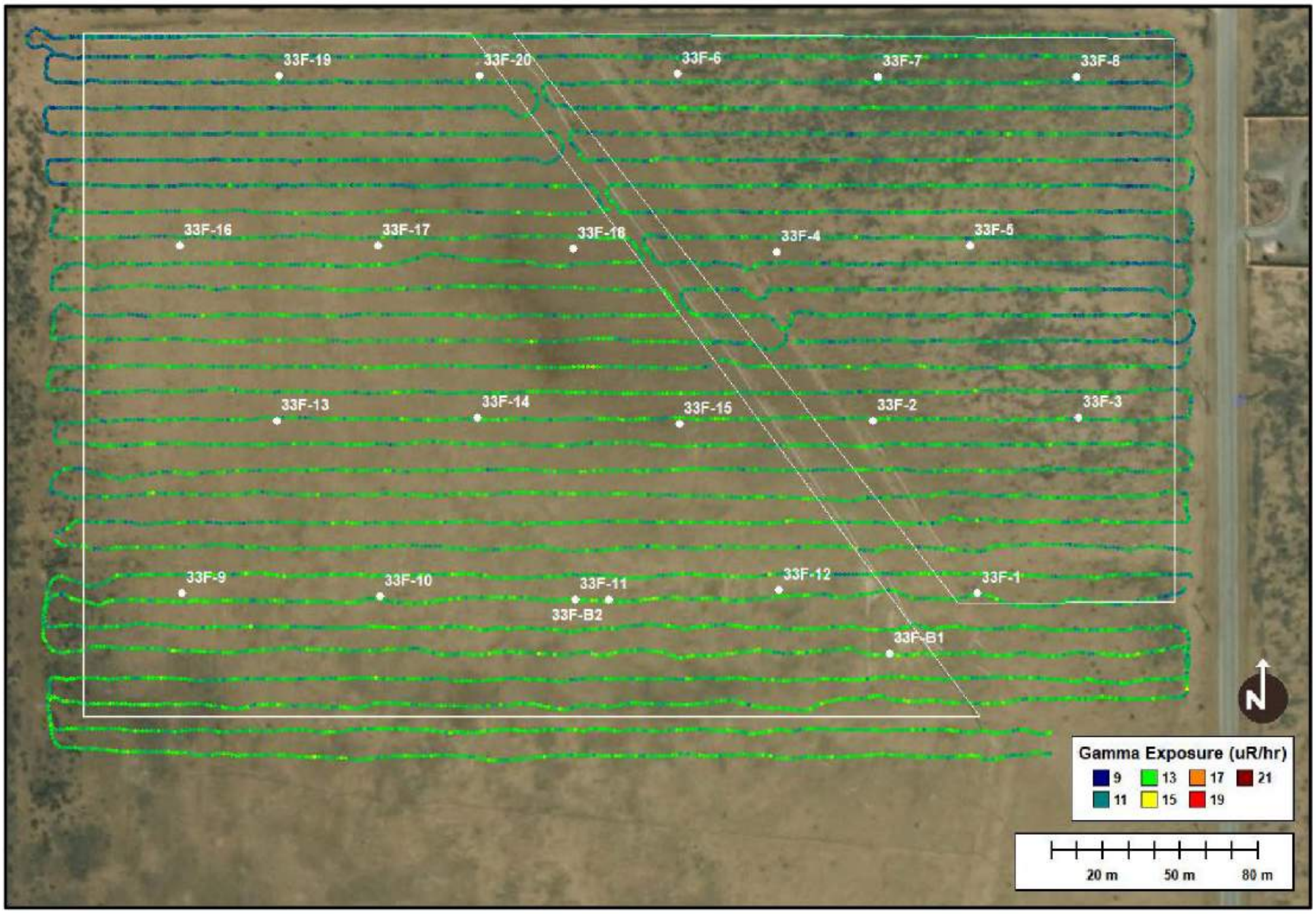
HOMESTAKE

24-ACRE FLOOD IRRIGATION SOIL SAMPLING LOCATIONS

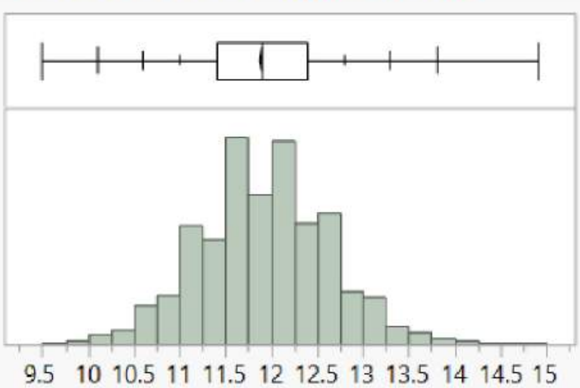
2017

Source: EVALUATION OF YEARS 2000 THROUGH 2013 IRRIGATION WITH ALLUVIAL GROUND WATER, HMC, 2014

FIGURE 3-135



Section 33 Flood Gamma (µR/hr)



Quantiles

100.0%	maximum	14.9
99.5%		13.8
97.5%		13.3
90.0%		12.8
75.0%	quartile	12.4
50.0%	median	11.9
25.0%	quartile	11.4
10.0%		11
2.5%		10.6
0.5%		10.1
0.0%	minimum	9.5

Summary Statistics

Mean	11.9
Std Dev	0.7
Std Err Mean	0.0
Upper 95% Mean	11.9
Lower 95% Mean	11.9
N	9734

PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-136_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

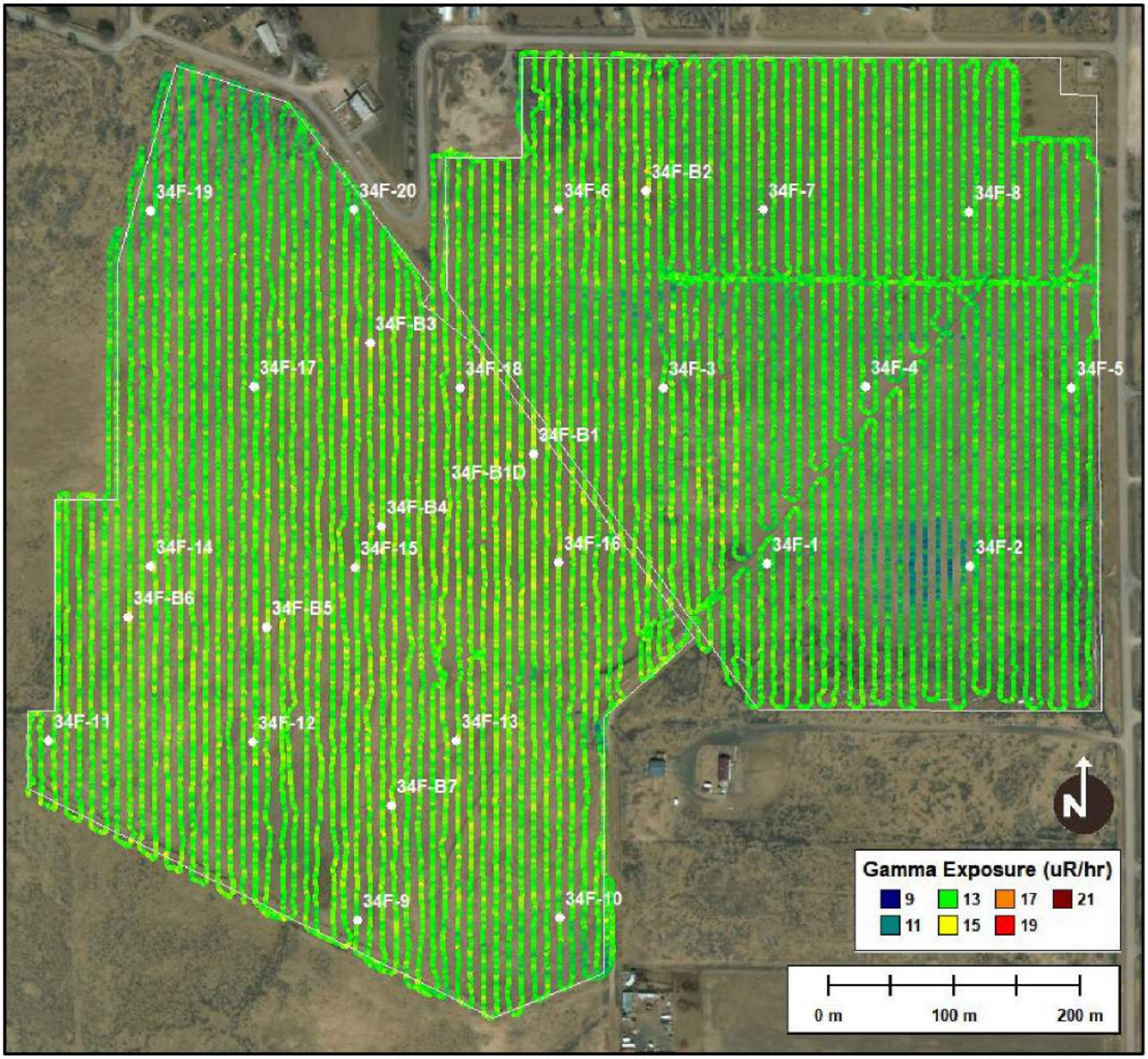
HOMESTAKE

Source: Final Status Survey Report for Release of Former Land Application Areas, Grants Reclamation Project, Cibola County, New Mexico. ERG 2018.

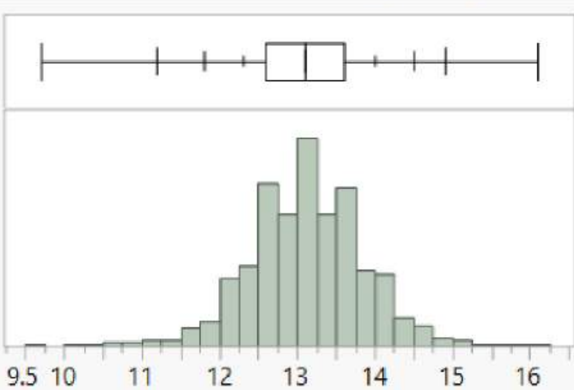
24-ACRE FLOOD IRRIGATION SOIL SAMPLING LOCATIONS

2017

FIGURE 3-136



Section 34 Flood Gamma (µR/hr)



Quantiles

100.0%	maximum	16.1
99.5%		14.9
97.5%		14.5
90.0%		14
75.0%	quartile	13.6
50.0%	median	13.1
25.0%	quartile	12.6
10.0%		12.3
2.5%		11.8
0.5%		11.2
0.0%	minimum	9.7

Summary Statistics

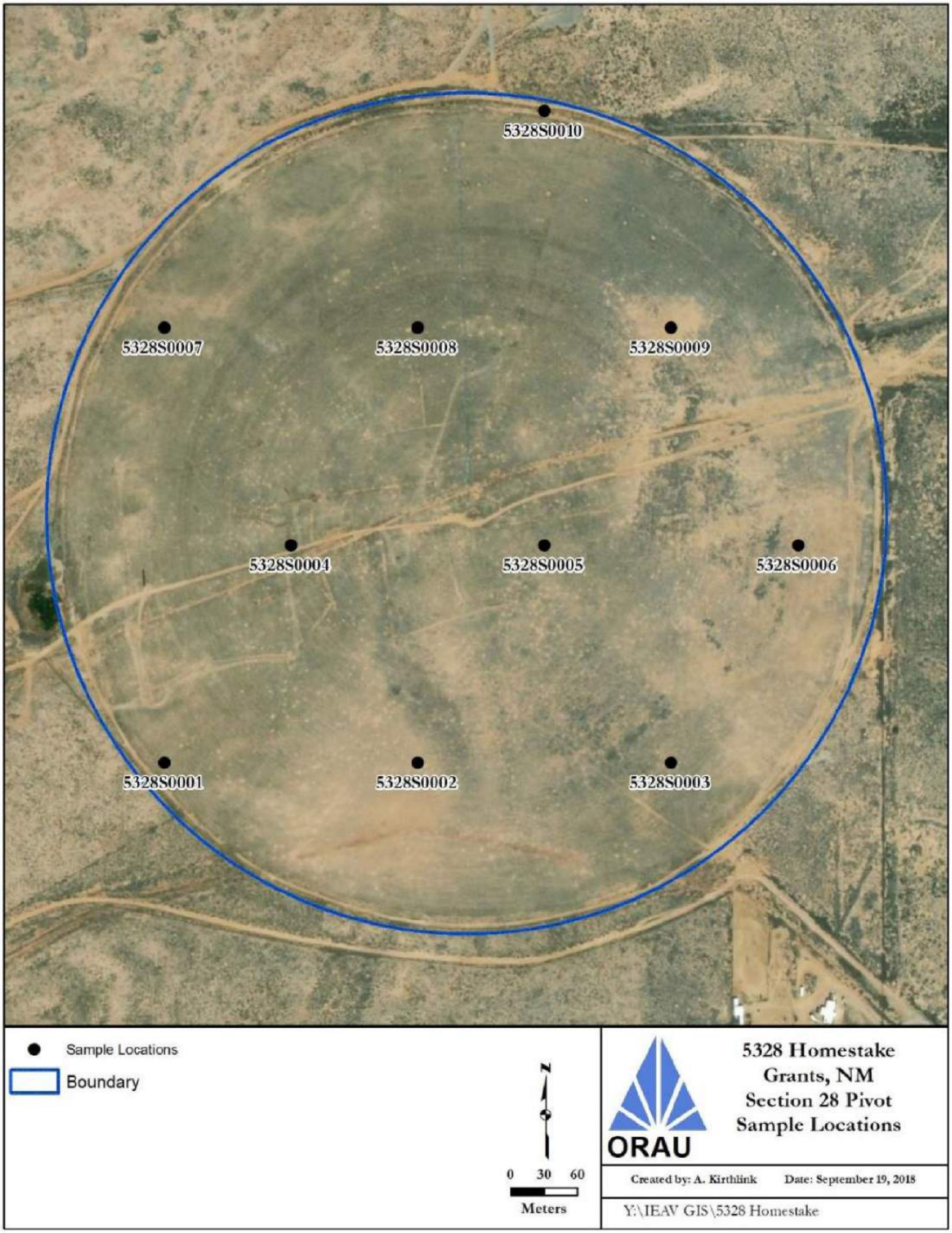
Mean	13.1
Std Dev	0.7
Std Err Mean	0.0
Upper 95% Mean	13.1
Lower 95% Mean	13.1
N	39568

120-ACRE FLOOD IRRIGATION SOIL SAMPLING LOCATIONS

2017

Source: Final Status Survey Report for Release of Former Land Application Areas, Grants Reclamation Project, Cibola County, New Mexico. ERG 2018.

FIGURE 3-137

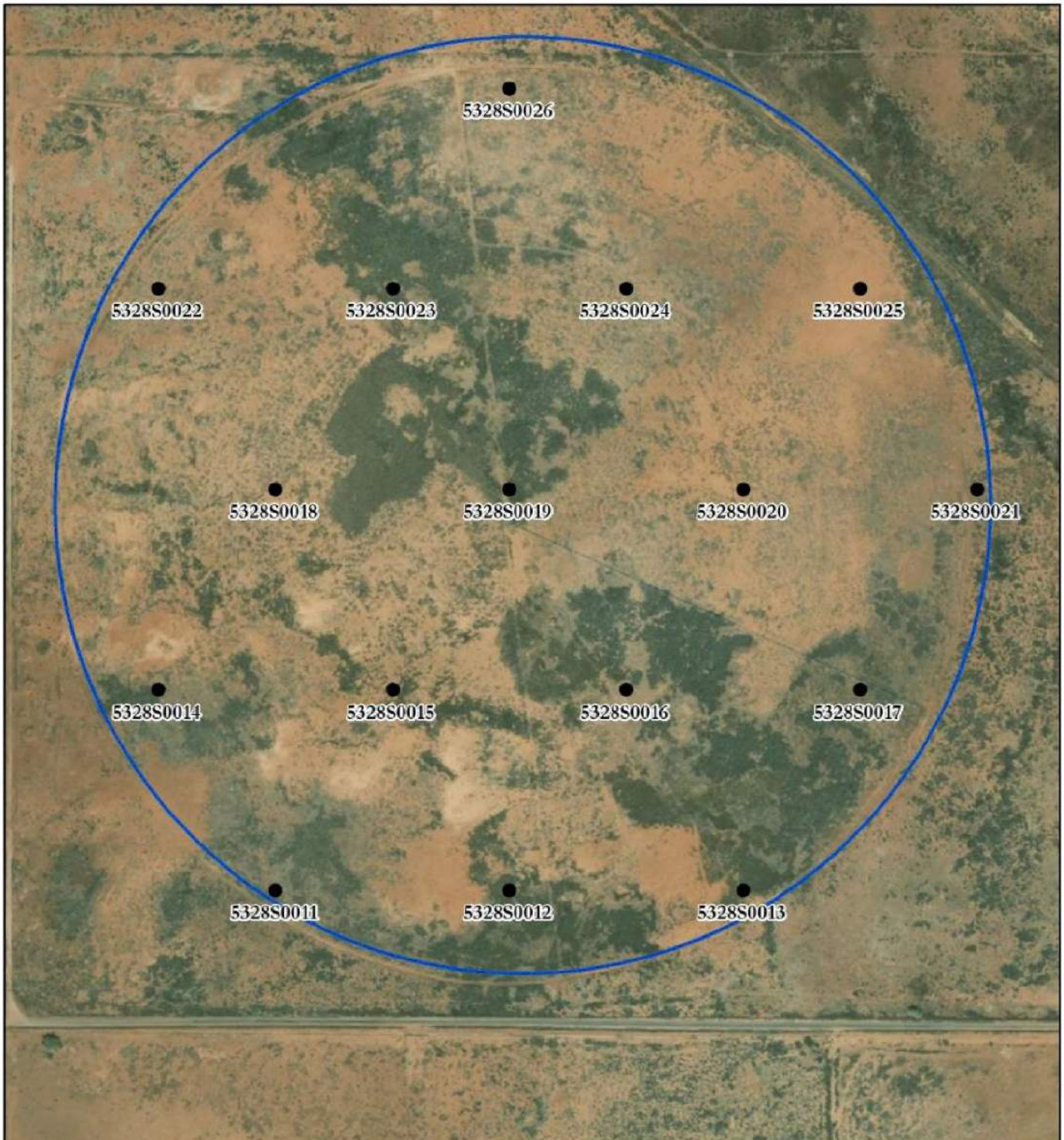


PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-138_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

100-ACRE CENTER PIVOT ORISE SOIL SAMPLING LOCATIONS

Source: Independent Confirmatory Survey of Land Application Irrigation Areas at the Homestake Mining Company of California Grants Reclamation Project Site, Cibola County, New Mexico. Oak Ridge Institute for Science and Education. ORISE 2019.

FIGURE 3-138



● Sample Locations

Boundary

N

0 40 80

Meters

ORAU

5328 Homestake
Grants, NM
Section 33 Pivot
Sample Locations

Created by: A. Kirthlink Date: September 19, 2018

Y:\IEAV GIS\5328 Homestake

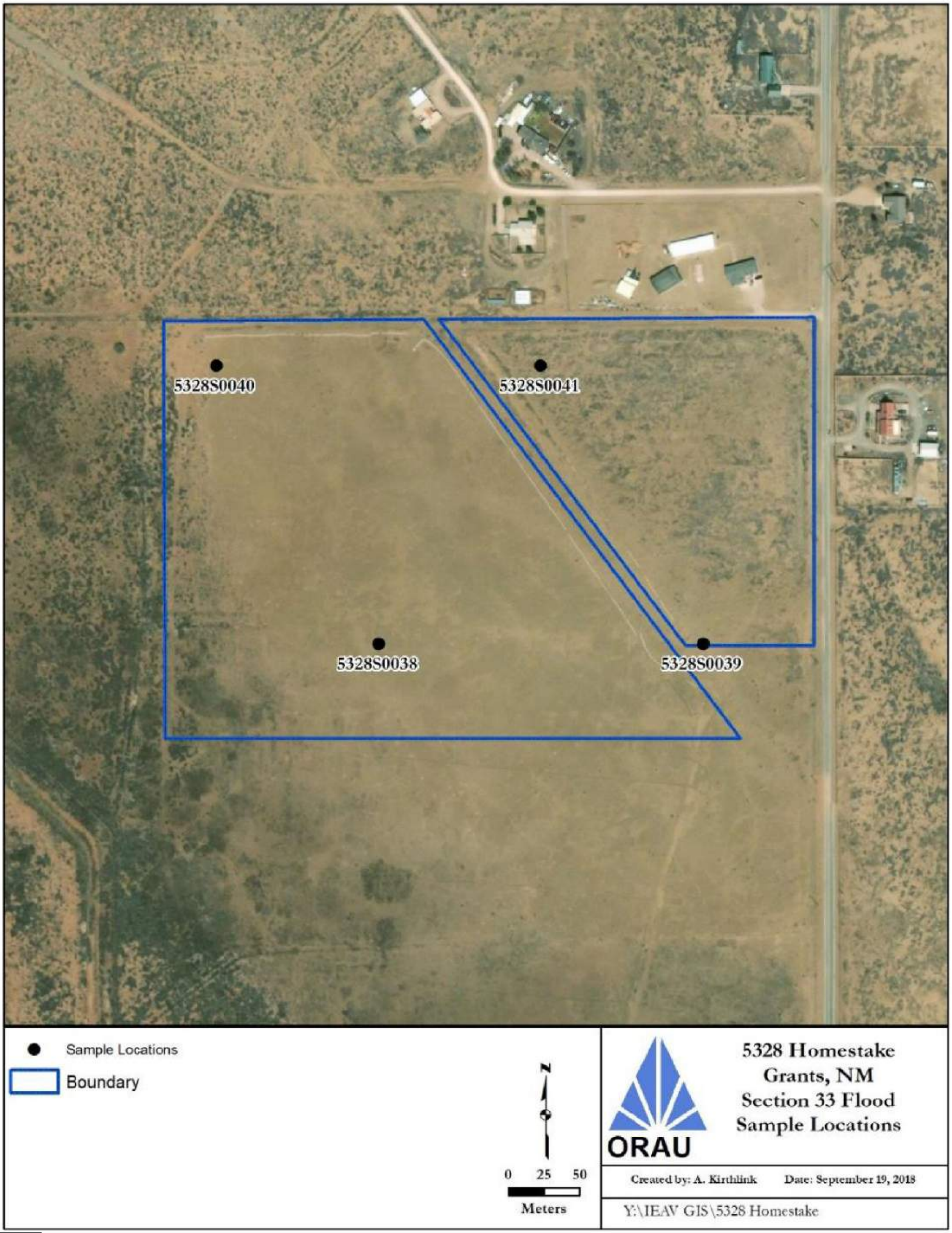
PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-139_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

HOMESTAKE

150-ACRE CENTER PIVOT ORISE SOIL SAMPLING LOCATIONS

Source: Independent Confirmatory Survey of Land Application Irrigation Areas at the Homestake Mining Company of California Grants Reclamation Project Site, Cibola County, New Mexico. Oak Ridge Institute for Science and Education. ORISE 2019.

FIGURE 3-139



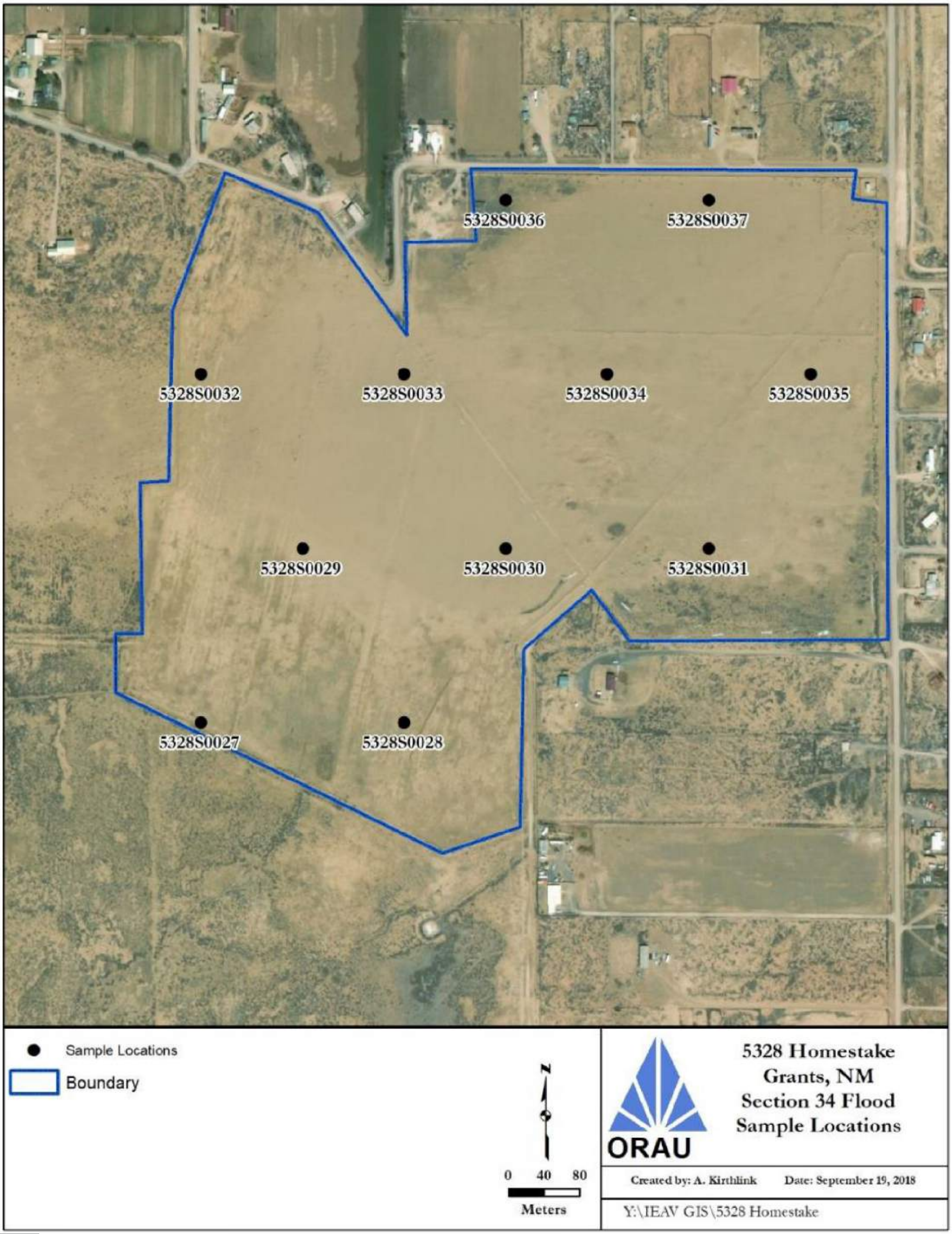
PATH: Z:\PROJECTS\PROPOSALS\1017518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION3\BARRICK_FIG3-140_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 1/3/2020

HOMESTAKE

24-ACRE FLOOD IRRIGATION ORISE SOIL SAMPLING LOCATIONS

Source: Independent Confirmatory Survey of Land Application Irrigation Areas at the Homestake Mining Company of California Grants Reclamation Project Site, Cibola County, New Mexico. Oak Ridge Institute for Science and Education. ORISE 2019.

FIGURE 3-140



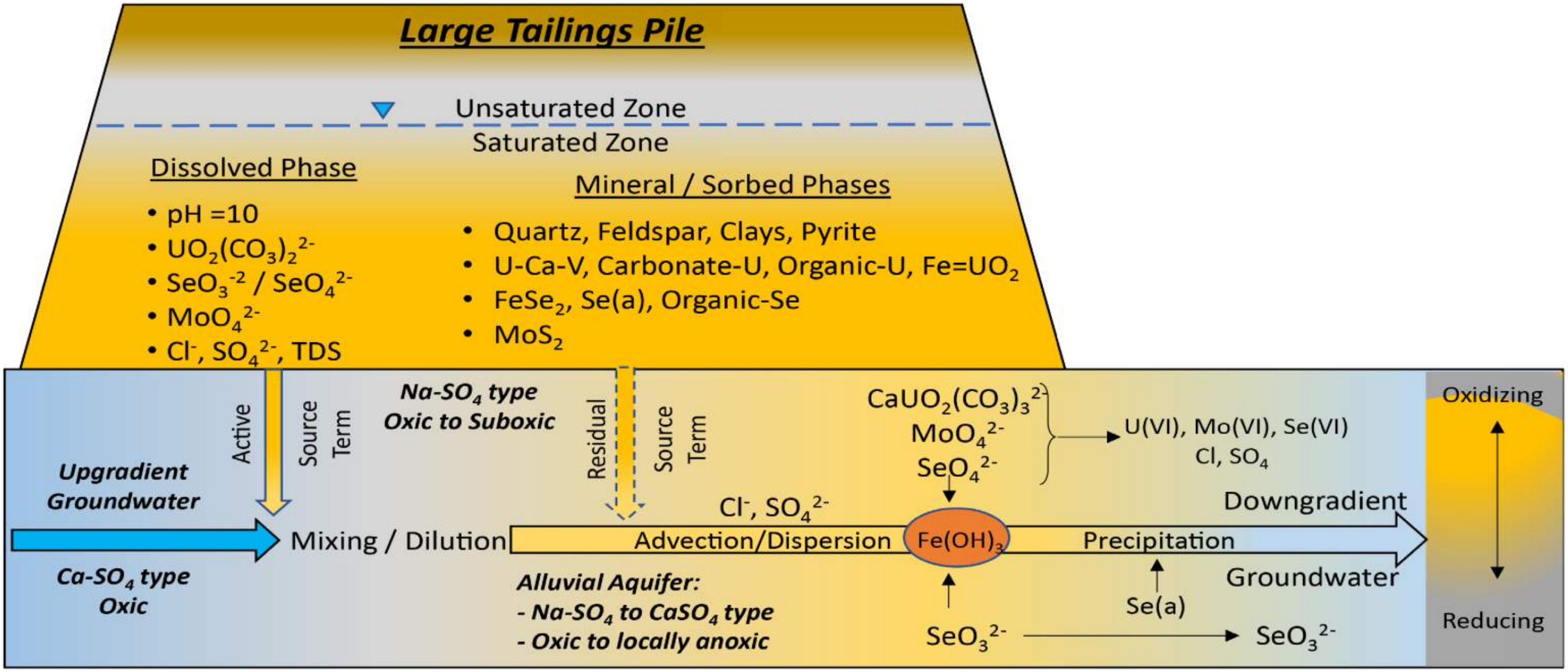
PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG3-140_PORTRAIT8X11.MXD - USER: RWOEHL - DATE: 9/9/2019

HOMESTAKE

120-ACRE FLOOD IRRIGATION ORISE SOIL SAMPLING LOCATIONS

Source: Independent Confirmatory Survey of Land Application Irrigation Areas at the Homestake Mining Company of California Grants Reclamation Project Site, Cibola County, New Mexico. Oak Ridge Institute for Science and Education. ORISE 2019.

FIGURE 3-141



HOMESTAKE

CONCEPTUAL GEOCHEMICAL MODEL FOR THE LTP

OVERVIEW

FIGURE 4-1

PATH: Z:\PROJECTS\PROPOSALS\10171518_BARRICK_RIF_HOMESTAKEMINING\MAP_DOCS\FINAL\VERSION2\BARRICK_FIG4-1_LANDSCAPE8X11.MXD - USER: RWOEHL - DATE: 9/6/2019

Appendix A

Mill Tailings Chemistry, Engineering Properties, and Stability

GRANTS RECLAMATION PROJECT
UPDATED CORRECTIVE ACTION PROGRAM (CAP)

APPENDIX B – MILL TAILINGS

TABLE OF CONTENTS

ATTACHMENTS

INTRODUCTION

Uranium ore was processed at the site using alkaline carbonate leaching from 1958 to 1990; approximately 1.22 million tons of tailings were placed in the Small Tailings Pile (STP) and 21.05 million tons of tailings were placed in the Large Tailings Pile (LTP). Appendix B provides a detailed summary of the milling operations, including process chemistry and tailings characteristics, to comply with NUREG-1620 requirements.

Attachment B-1 includes detailed information on the geotechnical properties of the tailings deposited in the LTP, including grain size analyses. **Attachment B-2** includes detailed information on the milling process.

ORE CHEMISTRY

Sandstone accounted for 80-85% of the ore and limestone accounted for the remainder of the ore processed at the mill. The principle ore mineralization included:

- Coffinite $U(SiO_4)_{1-x}(OH)_{4x}$
- Uraninite $(U^{+4}_{1-x},U^{+6}_{x})O_{2+x}$ [ideally UO_2]
- Tyuyamunite $[Ca(UO_2)_2(VO_4)_2 \cdot 5 – 8\ H_2O]$
- Carnotite $[K_2(UO_2)_2(VO_4)_2 \cdot 3\ H_2O]$.

The majority of mineralization occurred as impregnation (pore filling), or as cement between sand grains. Commonly, these uranium minerals were associated with carbonaceous minerals. Aside from uranium, trace amounts of molybdenum, selenium, titanium, gold and silver were present in the ore (Skiff and Turner 1981).

MILL PROCESSING

Figures 1 through 6b in **Attachment B-2** present flow diagrams of the milling processes, from ore delivery through shipping of yellow cake. During mill processing the following chemicals were used (Skiff and Turner 1981):

- sodium carbonate (37 grams per liter [g/L])
- sodium bicarbonate (7 g/L)
- polyacrylamide flocculant
- dilute solution of flocculant
- sodium hydroxide (caustic soda)
- vanadium

- sulfuric acid
- ammonia

YELLOW CAKE CHARACTERIZATION

The primary precipitation of yellow cake produced from milling processes consisted of approximately 75-77% U_3O_8, 5-6% V_2O_5, 2-2.5% CO_3, and 7.5% Na. Further purification removed vanadium and sodium (Skiff and Turner 1981).

TAILING AND NATIVE SOIL CHARACTERIZATION

Composition

The tailings are composed of silt to fine sand sized particles. On the Unified Soil Classification System, the finer tailings are classified as SM and the coarser tailings are classified as SP-SM. The coarser tailings, the sands, are 5 – 12% silt by weight; the finer tailings, the slimes, are 13 – 50% silt by weight.

The native soil is characterized by alluvial deposits of uniform, fine-grained sand with 5 to 30% fines. Randomly interspersed clay lenses, classified as still clays, are present throughout the alluvial deposit. The tailings soil and native soil compositionally are very similar; however, the native soil is more variable compared to the tailings soil (D'Appolonia 1980).

Grain Size

In 1980, grain size analyses on 22 tailing soil borings were conducted. Of the 22 soil samples analyzed, 90% of the soil passed through the No. 40 sieve and 5 – 20% passed through the No. 200 sieve. The grain size curves were similar across all locations of the tailings pile, indicating little spatial grain size variation (D'Appolonia 1980).

Permeability

In 1980, field permeability testing was conducted. The tailing soil had an average permeability of 1×10^{-4} cm/sec. Moisture content in the coarser tailings was approximately 8.3% and 23.8% for the unsaturated and saturated zones, respectively. The moisture content in the unsaturated finer tailings was approximately 25%. Field tests of average permeability of the native soil indicate a permeability of 5×10^{-5} cm/sec. Two constant head permeability tests were conducted on native soil in triaxial shear and an average permeability of 7×10^{-4} cm/sec was calculated. This value is much higher than the field-calculated permeabilities. This difference is probably a result of the laboratory sample not being a representative sample of the native soil (D'Appolonia 1980).

Standard Penetration Test

In 1980, a Standard Penetration Test was conducted. In unsaturated coarse tailings, blowcounts ranged from 2 to 26 blows per foot. In unsaturated finer tailings, blowcounts ranged from 2 to 11 blows per foot. In zones of saturated tailings, blowcounts were considerably lower. In the native soil, blowcounts ranged from 30 to 60 blows per foot (D'Appolonia 1980).

Density

In 1977 and 1980, the average density of tailings soil was measured from on or near the embankment; during both events, the *in situ* sample tube density measurements calculated an average density of 96 pounds per cubic foot (pcf). In 1973, laboratory relative density test were conducted. The maximum density was 115.5 pcf and the minimum density was 78.4 pcf (D'Appolonia 1980).

GEOTECHNICAL CONSIDERATIONS

Geotechnical Properties of the Tailings

In 1980, a stability assessment was conducted on the tailings embankment and results of evaluating static slope loadings, earthquake induced slope loadings, and earthquake induced liquefaction (soil strength loss) are discussed herein. Results of the evaluation concerning seepage forces and probably maximum precipitation and the resultant floods are presented in **Attachment B-1** (D'Appolonia 1980).

Th**e** NRC guideline for safety factors for static slope loadings is 1.5 (10 CFR 40 Appendix A Criterion 4 (c)) and the cross-sections evaluated in 1980 evaluated two phreatic surfaces from piezometric readings from September 1980. Safety factors ranged from 1.46 to 1.84 for the west phreatic zone while the east phreatic zone ranged from 1.18 to 1.56. The lower safety factors for the east phreatic zone are due to steeper slopes along the southeastern corner of the tailing pond. The report provides analytical cross sections, phreatic conditions and most critical failure surface along with their safety factors (D'Appolonia 1980).

During seismic events, transient horizontal and vertical forces are applied to surface structures due to the movement of the earth. This process was simulated during the evaluation of earthquake induced slope loadings. The safety factors for earthquake induced slope loadings varied from 1.01 to 1.42 for all cross-sections evaluated; a reduction of 20% in the safety factor from the static slope loading was indicated (D'Appolonia 1980).

Loose, saturated, cohesionless soils are subject to the phenomenon known as liquefaction, which is initiated by either a rapid monotonically increasing load or by a cyclic load as in an earthquake. Soils between the two grain size extremes (i.e., sands/gravels to silts/clays) are subject to liquefaction. Grain size analysis completed at the site indicated the average grain size falls within the "easily liquefied zone" (D'Appolonia 1980). As a result the east and west phreatic zones have safety factors of 0.9 in the toe areas but with only a few feet of unsaturated coarse tailings coverings increases the safety factor to above 1.5 (D'Appolonia 1980).

Tailings Cover

The small tailings pile (STP) was partially reclaimed from 1993 to 1995 due to the construction of an evaporation pond (EP-1) in 1995. An interim cover was completed in May 1997 for the portion of the STP not covered by EP-1. The 12-inch compacted interim cover material for the STP was obtained from borrow areas near the large tailings pile (LTP). An average depth of 1-foot of soil was placed on top of

the STP as an interim cover and is awaiting final settlement before the final radon barrier is placed on top of the current cover. A design for the radon barrier was submitted in April 1996 and approved by the NRC in September 1997 as License Amendment 27.

The LTP was partially reclaimed from 1993 to 1995 in order to allow for settlement of the fill material and due to ongoing groundwater restoration activities. Placement of the radon barrier to the north, west, and south side slopes and interim cover on top of the LTP was completed in the fall of 1994. Placement of the radon barrier on the east side slope and aprons occurred in July 1995. A final erosion protection layer of rock of approximately 6 to 9 inches was placed on the side slopes of the LTP. In December 1996, minor fill replacement and maintenance of the interim cover on the top surface of the LTP was completed. The top cover consists of an average of 1-foot of soil; the cover is awaiting final settlement before the final radon barrier and rock cover are placed on top of the current cover. The 1-foot compacted interim cover material for the LTP was also obtained from borrow areas near the LTP.

References

D'Appolonia Consulting Engineers, Inc. (D'Appolonia). 1980. Engineer's Report: Stability Assessment

Skiff, K., and Turner, J. 1981. A Report on Alkaline Carbonate Leaching at Homestake Mining Company

Attachment B-1

Engineer's Report: Stability Assessment

Project No. RM80-311
Nov. 80

D'APPOLONIA
CONSULTING ENGINEERS, INC.

Engineer's Report

Stability Assessment

Uranium Mill Tailings Pond

United Nuclear – Homestake Partners
Grants, New Mexico

Homestake RI Appendix A

#4

Engineer's Report

Stability Assessment

D'APPOLONIA

TABLE OF CONTENTS

TABLE OF CONTENTS

(cont)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES
(cont.)

1.0 INTRODUCTION AND SUMMARY

The United Nuclear-Homestake Partners (UNHP) operate a mill near Grants, New Mexico, which extracts uranium from ore mined in the Grants District. Figure 1 shows the mill location in relation to the State of New Mexico and in relation to the Grants area. The extraction process is an alkaline leach process, from which approximately 600,000 cubic yards of tailings are produced annually. The tailings are disposed on site in an embankment of approximately 160 acres in surface area. The east half of the embankment was started in 1958 by construction of a rectangular starter dam composed of native sandy clay excavated from the surface soil at the embankment site. The embankment has been expanded and raised since that time by hydraulic placement of tailings from the dam centerline. Cyclone separation was used to place the coarser fractions to the downstream side, and finer fractions to the upstream side of the dam crest. The embankment presently consists of two nearly square cells referred to herein as the East and West ponds.

In a 1979 report by Tierra Engineering Consultants for the U.S. Army Corps of Engineers, questions were raised concerning the stability of the embankment. In response to that report, the New Mexico State Engineer's office directed UNHP to address the stability questions. UNHP retained D'Appolonia Consulting Engineers, Inc. (D'Appolonia), to address those questions. D'Appolonia performed a stability assessment using a phased approach in order to provide a thorough evaluation and yet meet a June 23 deadline. The first phase "Preliminary Stability Assessment Report", satisfied the immediate health and safety concerns and met the June 23, 1980, date. This document is the second phase "Final Stability Assessment Report" which uses additional data collected during the D'Appolonia field and laboratory investigations to address the long term stability of the UNHP tailings embankment and to assess compliance with the State of New Mexico Criteria for Uranium Mills. The

State of New Mexico in their Uranium Mill License Application Handbook, 1980, references the USNRC Regulatory Guide 3.11 as the procedural document upon which stability assessment guidelines should be formulated.

D'Appolonia's stability analysis and performance assessment of the tailings disposal facilities uses the performance specifications of USNRC Regulatory Guide 3.11 "Design, Construction and Inspection of Embankment Retention Systems for Uranium Mills," dated December 1977, and specifically Section C "Regulatory Position." The USNRC criteria basically call for:

- Adequate stability with the following applicable factors of safety

Condition	Factor of Safety
- Partial or maximum pond with steady state seepage	1.5
- Earthquake	1.0

- Control of seepage to prevent instability, piping and sloughing loss of toxic materials
- Freeboard sufficient to prevent wave erosion and overtopping
- Storage capacity to retain the Probable Maximum Precipitation Series (140% probable maximum percipitation followed by the 100 year storm).

The embankment has been evaluated to assess its performance and stability at eight typical cross-sections. These cross-sections were chosen both for their critical nature and to provide adequate spatial variation on each of the two ponds. The cross-sections have been evaluated for:

- Static slope stability
- Pseudo-static slope stability under earthquake loading

- Liquefaction potential under earthquake loading
- Potential for seepage forces causing piping and sloughing
- Performance during severe hydrologic events.

The evaluation has been performed using the existing embankment and phreatic water surface conditions of September 1980. The definition of the phreatic surface and the soil strength properties have resulted from the D'Appolonia field and laboratory investigations which were performed during July, August and September of 1980. The information collected during and after the D'Appolonia field and laboratory programs has been combined with other available information on the UNHP tailings disposal facility to provide the basis for the conclusions and recommendations reached in this report. The other basic data sources on the UNHP tailings disposal facility are:

- Stability Analysis, Uranium Tailings Ponds, Grants, New Mexico, United Nuclear-Homestake Partners, by International Engineering Company, Inc., 1977.
- Phase I Inspection Report, United Nuclear-Homestake Partners Tailings Dam by Tierra Engineering Consultants, Inc. for U. S. Army Corps of Engineers and the State of New Mexico, 1979.
- Preliminary Stability Assessment, Uranium Mill Tailings Pond, United Nuclear-Homestake Partners by D'Appolonia Consulting Engineers, Inc., 1980.

Many other standard publications were consulted in arriving at the proper hydrologic, soil and seismic data necessary for this assessment. These publications are referenced throughout the text.

This report assesses the additional data collected as a result of the recommendations made in the Preliminary Report. With these new data and the previously existing data, a final assessment of the embankment

stability has been made and compared to the USNRC criteria. The results of the assessment indicate that remedial measures are necessary on certain sections of the tailings embankment to meet these criteria, but other sections are in compliance.

In summary the stability assessment has indicated the following:

- Static Slope Stability
  The static slope stability factor of safety for the retention embankment is (a) less than the required value of 1.5 on the eastern and southeastern sides of the East pond (b) is greater than or equal to the required 1.5 value on all of the West pond and on the north and northeastern sides of the East pond. The piezometers within the retention embankment have phreatic levels lower than or equal to those assumed for the hypothetical case in the "Preliminary Stability Assessment." The slope stability factors of safety are, therefore, dependent almost entirely upon the slope of the embankment's outer surface. An overall flattening of the outer embankment slope will increase the factor of safety.

- Pseudo-Static Slope Stability Under Earthquake Loading
  The pseudo-static earthquake slope stability analysis indicates all factors of safety meet the minimum factor of safety of 1.0 on all embankment sections.

- Liquefaction Potential Under Earthquake Loading
  The potential for liquefaction under earthquake loading does not appear to endanger the embankment stability. The very low phreatic levels within the embankment do not provide the buoyancy necessary to produce high shear stresses when coupled with the site maximum accelerations. However, the cyclic liquefaction resistance of the tailings was found to be very low in laboratory testing. The minimum factor of safety was found to be less than 1.0 on the seepage face at the toe of the embankment. However, all areas under the embankment had safety factors against liquefaction greater than 1.5. The effect of liquefaction at the embankment toe on static slope stability was investigated, with the result that safety factors are greater than 1.0 for both the East and West ponds.

- Potential for Seepage Forces Causing Piping and Sloughing
  The seepage assessment has indicated that sloughing of the embankment toe at the seepage face occurs with current operational procedures. Piping does not appear to be a possible failure mechanism because all essential mechanisms necessary for propagation of piping are not present. The localized quick zones at the embankment toe appear to be present on the areas of the embankment which have the highest flow through the embankment, in particular the South and East sides of the East pond. This condition results from high flow velocities and is self-correcting with time as toe sloughing lengthens the flow path and thereby offsets the high velocities. Overall, seepage forces do not affect the stability of the tailings embankment in other than non-critical localized sloughing failures at the toe.

- Performance During Severe Hydrologic Events
  The flood assessment has indicated that encroachment of the flood waters on the embankment toe will occur during the probable maximum precipitation (PMP) events. This flood flow may erode substantial portions of the embankment toe. Slope stability analyses have shown that complete erosion of the embankment toe to the highest level of the PMP flood will not be sufficient to produce critical safety factors less than 1.0. The flood assessment has also shown that the 100 year flood will encroach upon the embankment toe on the West pond only.

From the results of the stability assessment, the following remedial measures are recommended:

- Embankment slope stability should be increased by implementing one of three options: a) build a berm on the embankment toe, b) flatten the outer embankment by grading, or c) begin an upstream buildout process with the new buildout sufficiently removed from the present embankment crest to provide adequate overall stability.

- Measures should be taken to protect the embankment toe of the West pond from erosion resulting from the 100 year flood.

The present embankment configuration appears to provide adequate factors of safety under any severe loading condition (earthquake or PMP flood). The normal loading conditions, however, do not provide safety factors greater than 1.5 on all sections examined. Sections along the east and southeastern sides of the East pond will need remedial measures to attain the safety factor of 1.5 required for static load conditions. The embankment erosion potential of the 100 year flood (not a severe loading condition) should also be protected against, along the north and west sides of the West pond. These remedial measures should provide adequate performance of the UNHP tailings embankment and meet the regulatory criteria of the USNRC.

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2.0 FIELD INVESTIGATIONS

The stability assessments described in this report are based primarily on field investigations performed by D'Appolonia, supplemented by previous work of IECO (1977). The D'Appolonia field investigations and the resulting site characterization are described in detail below.

2.1 GENERAL SITE CHARACTERISTICS

The embankment site lies within what is known as the Chaco Slope of the San Juan Basin Physiographic Province. The San Juan Basin, located in northwestern New Mexico and southwestern Colorado, is a structural basin of which the Chaco Slope comprises the southern, north-dipping flank.

The embankment is situated on the broad alluvial valley of San Mateo Creek. This creek drains the northwestern slopes of Mt. Taylor (11,301 feet) and southern San Mateo Mesa (8,230 feet). It has a drainage basin of approximately 291 square miles. At the embankment site, the valley is approximately 12 miles wide. The valley at that point is bounded on the northwest by Haystack Mountain (7,833 feet) and on the southeast by Grants Ridge (8,247 feet). The vegetation in the drainage basin consists of creosote bush, mesquite and sand sage below about 6,800 feet and includes pinon and juniper above that elevation.

The alluvium consists mostly of a medium to fine silty sand with thin layers of sandy silt and silty clay. The alluvium is assumed to have been deposited during the flood stages of San Mateo Creek. The alluvium was reported to be approximately 64 feet thick (IECO, 1977) below the toe of the embankment at the East Pond.

Underlying the alluvium is the Triassic Chinle Formation. It consists of the Correo Sandstone Member (sandstone, siltstone and some shale) and the Shinarump Conglomerate Member. Thicknesses under the embankment are not known. The IECO drilling program had encountered "pink to

violet siltstone with scattered small white rock fragments" at an elevation of 6514.3 feet. Quarternary basalt flows lie in the lower elevations to the east, south and west of the project area. These flows have been extruded from numerous volcanic vents surrounding the project area.

2.2 SCOPE OF INVESTIGATIONS

After examining the information on the tailings embankment which existed in May, 1980, D'Appolonia determined that previous investigations and piezometric data were not adequate to make a complete assessment of embankment stability. Therefore, additional field investigations were planned and conducted in July-August, 1980. The field investigation program consisted of 14 borings and the installation and testing of 20 piezometers. The borings were advanced with six inch hollow-stem augers, with an inside diameter of three inches allowing all soil sampling to take place inside the augers. Piezometers were installed in all borings after sampling was completed. At six boring locations, two piezometers were installed. The boring locations, shown on Figure 2, are identified by the prefix DB. Six borings were advanced from the crest, four from the toe, two along the outer slope between the crest and toe, and two in the beach areas of the ponds.

The borings advanced during the field investigation served two purposes. Firstly, the borings provided soil samples of both tailings and native soils for strength, permeability and classification testing. At the same time additional stratigraphic details were obtained and combined with those from the 1977 field investigation. Secondly, the borings provided access necessary for installing piezometers to measure the water levels both within the tailings embankment and the native soils. The separation of tailings embankment piezometers and native soil piezometers was accomplished by augering an additional adjacent borehole and installing a second piezometer at the six boring locations specified as double piezometer settings, see Figure 2.

During exploration standard split-spoon penetration tests (SPT's) were performed at five foot intervals and at major soil interfaces. These tests were performed by dropping a 140 pound hammer 30 inches and measuring the number of drops or blows necessary to drive the sampling spoon 12 inches. Undisturbed soil samples for laboratory testing were taken using Shelby tube samplers. A Shelby tube sampler is a thin-walled steel tube which is pushed into the soil by down pressure from the drilling rig. Shelby tubes 30 inches in length with 3 inch outside diameters were used. This allowed for recovery of 24 inch long undisturbed samples. Undisturbed samples were used to assess the in situ density and provide material for static and cyclic strength testing.

2.3 SOIL CHARACTERIZATION

The borings made during the field investigation, when combined with the borings from the 1977 field investigation, allowed for the construction of eight soil cross sections through the embankment. Five cross sections are located on the east pond and three on the west pond, see Figure 2. The eight sections are presented in Figures 3 through 10.

Sections 1-1' and 6-6' are based on information from the D'Appolonia field investigation. Sections 3-3' and 8-8' are based on information from the 1977 field investigation. The other sections are based on a combination of information from both field investigations. The D'Appolonia soil boring logs from which these cross sections were assembled are presented in Appendix A. The 1977 field investigation soil boring logs are taken from IECO (1977).

The soils encountered at the site can be separated into the general classification of either tailings or native soils. The tailings occur above the original ground surface (elevation 6570 to 6580 feet). The tailings embankment has been constructed by the centerline method in which the centerline of the embankment remains over the center of the original starter dam for the pond. The embankment is built from coarse

tailings material while the water and fine tailings are deposited in the pond formed by the embankment. The UNHP tailings pond was constructed in the early years by spigotting the tailings off a starter dam centerline and recovering the coarse material for use in building the outer embankment. After only a few years of this construction procedure, a cycloning method was instituted. In the cycloning method, a cyclone sitting on the centerline of the embankment discharges coarse tailings to build the outer embankment and allows the fine tailings to run into the pool. The resulting distribution of coarse and fine particle sizes is discussed below. The starter dam centerline has been maintained at all but the southeast and northeast corners of the East pond where rounding of the corners has led to a slight upstream build-out.

2.3 1 Tailings Soils

The tailings soils are composed of silt to fine sand sized particles. Segregation of the coarse and fine sizes is made by the cyclone before deposition. Generally the coarse tailings are classified as SP-SM (Unified Soil Classification System); 5 to 12% of the total weight is silt. The fine tailings are classified as SM (Unified Soil Classification System); 13 to 50% of the total weight is silt.

The coarse tailings are a very uniform material with only scattered zones along the natural soil contact classified as SM material rather than SP-SM (for example see Section 4-4'). These zones may result when fine tailings silt migrates along with water seeping through the embankment, or these areas may indicate deposition of fine tailings at some earlier time. The SPT (Standard Penetration Test) blowcounts ranged from 2 to 26 blows per foot in the unsaturated coarse tailings. Figure 11 presents a plot of blow count versus depth for all the borings, illustrating the magnitude and variability of SPT values. The majority of the samples of coarse tailings are loose fine sand with blowcounts

between 5 and 10 blows per foot. The top few feet of coarse tailings are generally very loose sand with blowcounts less than 5. Blowcounts in the saturated tailings zone were considerably lower, which is common for saturated fine sand.

Low blowcounts in saturated fine sands result when the excess pore pressures induced by the blows from the sampling spoon are unable to dissipate, producing localized liquefied zones and the resulting low blowcounts. Blow-up or rising of the sand inside the hollow-stem augers also occurred during drilling. The blow-up results from an imbalance of soil and water pressures inside and outside the augers causing the relatively loose sand to flow in response to the pressure differential. In addition, very low blowcounts (one or two blows per foot) or drop of the sampling spoon occurred at one or two locations within the embankment. These incidences may possibly not be explained by the saturated fine sand phenomenon discussed above. In these instances, which occurred near the bottom of the tailings pile in boring ST-13 and DB-3, a zone of very soft material is the most likely cause. This zone of soft material is most prominent on Section 4-4', where it apparently extends from the embankment centerline outward through and under the toe of the embankment. The moisture contents, shown on the boring logs in Appendix A, average about 8.3% for the unsaturated coarse tailings and 23.8% for the saturated coarse tailings.

The fine tailings were encountered only in the two beach borings (DB-14 and DB-16, see cross sections 2-2' and 4-4'). Both of these borings were restricted by access difficulties to locations fairly close to the coarse tailings embankment. The borings, therefore, produced a mixture of materials, some being predominantly fine tailings and others being predominantly coarse tailings. This intermixture results from the sedimentation of progressively finer particles away from the cyclone, which is moved along the crest, creating successive and overlapping deltas. The regions near the coarse tails embankment receive mainly the

coarser fine tailings particles, which settle out of suspension first. The finer silt materials are then transported out into the center of the pond. Thus, no distinct interface exists between the cycloned coarse and fine tailings. The areas directly behind the coarse tails embankment are best characterized as being interfingered zones of coarse and fine tails with occasional thin, very silty lenses. The overall percentage of silty material within a boring would be expected to increase as the boring was moved further away from the embankment centerline. The fine tailings material was generally classified as loose with blowcounts between 2 and 11 blows per foot. The moisture contents average about 25%.

2.3.2 Native Soil

The native soils are alluvial deposits consisting of medium to fine silty sand material with randomly interspersed clay lenses. No continuous clay layers were encountered in either the D'Appolonia or the 1977 field investigations. The rock surface lies approximately 60 to 70 feet below the base of the tailings pile. The native sands and silty sands generally had blowcounts between 30 and 60 blows per foot, with an average of 48, a dense to very dense soil. The clay lenses within the native sand soils were all classified as stiff clays. The density of the native sands and the stiffness of the native clays may result from the surcharging load of the overlying tailings.

The uppermost few feet of native soil are the most important with respect to the stability of the embankment. The upper alluvium (interface zone) has a much higher silt and clay content than the lower portions of the native soils. In places this layer is a stiff clay with traces of organic material, while in other spots it is a very silty sand. The very fine grain size of this layer is instrumental in inhibiting flow vertically from the coarse tailings into the native soils.

Some borings made from the crest of the embankment (see DB-1, cross section 4-4') penetrated layers of this stiff clay several feet in thickness and several feet above the apparent original ground surface. This material is apparently the starter dam used to initiate the east tailings pond.

The location of the contacted starter dam system is delineated on the cross sections. The approximate location of the starter dam centerline for the east pond is also shown in Figure 2. The West pond starter dam location is unknown and was not encountered during the field investigation.

2.4 GROUNDWATER LEVELS

The field investigations confirmed that two separate water tables exist at the tailings embankment. Piezometers to measure the water table were installed in both the tailings and the native soils. Figure 12 shows a typical unsealed piezometer installation as made in the tailings. The piezometers installed in the native soils were sealed at the interface between the tailings and native soils. A typical sealed piezometer installation is shown in Figure 13. Six borings that penetrated the native soils were fitted with a sealed piezometer and a second piezometer was installed unsealed in the tailings alongside the sealed piezometer (see Figure 2). In addition, double piezometer installations made at the toe of the embankment during the 1977 field investigation were used.

The unsealed piezometers were constructed of 1.5 inch inside diameter PVC riser pipe with slotted PVC screen sections. The screen sections were 10 feet long at all but a few of the toe piezometer installations. The slotting in the PVC screens was cut by machine to 0.010 inch. The sealed piezometers used the same screen sections as the unsealed piezometers, but were outfitted with only 1 inch inside diameter riser pipe. The smaller riser pipe on the sealed piezometers was necessary to

provide clearance within the hollow-stem augers for placing the sealing material. The seals were composed of a 5% bentonite, 30% cement, and 65% water mixture by weight placed in slurry form at the interfacing zone in the native soils. The installation details for each piezometer are given diagramatically in Appendix B.

The piezometers installed during the 1977 field investigation were retrofitted to provide meaningful water level measurements. The ST series piezometers installed from the crest and mid-slopes of the tailings embankment were originally installed with screened sections penetrating both the tailings and the natural soils. To isolate a single zone of material, the tailings, the screened native soils section of the piezometers was filled with bentonite clay. This remedial measure restored function to some of the piezometers. A list of the ST series piezometers now considered functional is included along with the DB series piezometers in Table 1. The locations of both series piezometers are shown on Figure 2.

The piezometric level within the tailings embankment has a characteristic profile in both the East and the West pond. The piezometric surface in the East pond produces a total saturated depth of approximately 8 feet at the toe of the embankment. The depth of saturated seepage flow increases nearly linearly to approximately 20 feet under the crest of the embankment. The groundwater appears to exit from the embankment on a wet face which is sometimes above the level of the piezometric surface at the toe piezometer. The rise in the saturated surface is apparently due to capillary rise in the tailings sand. The actual phreatic surface exits on the seepage face at the same elevation as the phreatic level indicated in the toe piezometers. This typical flow holds true for sections 1-1', 4-4', 5-5', and 8-8'. The one exception, Section 6-6' (see Figure 8), has a much lower piezometric surface than the other East pond sections. The West pond tailings embankment is characterized by a much thinner saturated zone, approximately 3 feet at

the toe and 18 feet under the crest. The thinner saturated thickness in the West pond produces a much lower seepage face than on the East pond embankment. In addition, the water seeping through the West embankment appears to enter the native soils at the embankment toe on both sections 3-3' and 7-7'. Low piezometric levels in the West pond may be due to the low pond level and lack of recent disposal activity.

In the native soils the piezometric level is characterized by an abrupt drop of approximately 20 feet between the crest and toe of the embankment. This drop may be indicative of a groundwater mounding in the native soils under the pond areas. Groundwater mounding is defined as a hump-shaped rise in the natural groundwater surface produced by a source of downward seepage (recharge) above the normal groundwater level. The piezometric level at the toe is 30 to 40 feet below the native ground surface, leaving a large zone of unsaturated to partially saturated soil directly below the tailings embankment.

2.5 FIELD PERMEABILITY TESTING

During the field investigations the permeabilities of both the tailings and natural soils were tested. The piezometers were flushed after installation to develop the screen section by driving out fine material. Immediately after flushing the sensitivity of the piezometer was gauged by performing a falling head permeability test. This test assessed the functional capability of the piezometer and provided a measure of the permeability within the sensing zone.

The results of the permeability measurements for all piezometers are presented in Table 2. The tailings soils have an average permeability of 1×10^{-4} cm/sec. The native sandy soils have an average permeability of 5×10^{-5} cm/sec, approximately one-half the value for tailings. No measurements were made in the interface layer, which is quite variable and thin and, therefore, has no piezometer well screen sections. The piezometer details for each piezometer and a discussion of the field testing technique are included in Appendix B.

3.0 LABORATORY INVESTIGATIONS

Laboratory tests were performed on soil samples obtained during the field investigations for the purposes of 1) classifying and grouping the soils into materials of similar characteristics, and 2) determining the engineering properties of these groups for use in stability analyses of the tailings embankment.

The following types of tests were performed:

- Water content,
- Grain size (sieve analysis),
- Atterberg limits,
- Density,
- Relative density,
- Triaxial shear,
- Cyclic triaxial shear,
- Unconfined compression, and
- Permeability

Based on the results of field and laboratory classification and the results of laboratory testing of engineering properties, the site soils can be grouped into three categories for stability analysis:

- Tailings
- Native sands
- Native clays

The types of tests and test results for each of these three categories are discussed below.

3.1 TAILINGS

3.1.1 Grain Sizes

Grain size analyses were performed on 22 samples of tailings from the soil borings, and also on one sample each of coarse and fine tailings as discharged by the cyclone truck on top of the embankment. Grain size curves from these tests are presented in Figure 14.

The grain size curves for all of the tailings are similar, regardless of sampling location. The tailings are a uniform, predominantly fine sand, with generally more than 90% passing the No. 40 sieve and 5% to 20% passing the No. 200 sieve (fines). The USCS soil classification is SP to SM. While it was initially expected that the borings drilled out on the fine tailings beach (DB-14 and DB-16) would encounter much finer material than the borings on the crest and toe of the embankment, the grain size tests show little difference in gradation between these borings. The grain size curves on the fine and coarse tailings from the cyclone truck (Figure 14) show that the fine tailings have approximately 50% fines as compared to 11% fines for coarse tailings; however, it appears that the fine tailings slurry which is discharged near the crest segregates as it flows out to the pond. Thus, the material which is deposited near the crest is very similar to the coarse tailings fraction from the cyclone truck. There are a few zones in some of the borings where the fines content is greater than 20%, but their occurrence is infrequent and random. For purposes of strength evaluation, all tailings samples were considered in a single group.

3.1.2 Static Shear Strength

The strength parameters of the tailings were measured using consolidated-undrained (CU) triaxial tests with pore pressure measurements. CU tests were performed because they yield effective strength parameters, where soil strength is characterized in terms of effective stresses. The slope stability evaluation described in Section 4.0 analyzes drained conditions in the embankment using effective strength parameters. The use of effective strength parameters and drained conditions is appropriate for stability problems involving relatively free draining materials and relatively slow construction rates. In any potential failures of the slope, the soil pore pressures will not change prior to failure and the soil strength can therefore be predicted based on existing pore pressures and effective stresses. These are necessary conditions for use of an undrained analysis using effective strength parameters.

A total of 10 tests were performed on the following samples:

Boring	Sample	Depth (Ft)
DB-14	ST-1	30.0-32.0
DB-2A	ST-1	7.5 -9.5
DB-18	ST-3	32.0-34.0

Because it was impossible to prepare and test undisturbed samples, remolded samples were tested in all cases. The samples were tested over a range of densities representative of the range of densities which exist in situ. The results of the triaxial tests on tailings are presented in Figure 15.

The test results indicate that the effective friction angle of the tailings is highly dependent on the density of the sample prior to testing. Samples with low densities exhibited lower friction angles than samples with high densities. In order to establish a relationship between friction angle and dry density, a friction angle was selected from each indicated test. Cohesion was neglected in friction angle determinations. This assumption is appropriate for relatively clean granular materials such as these tailings. The effective friction angle and the dry density obtained from each test are presented in Figure 15. A plot of effective friction angle versus dry density is presented in Figure 16, where the trend for increasing friction angle with increasing density is clearly shown.

Choice of a single friction angle for tailings in the stability analysis requires the selection of an "average" in situ density. Determination of the average in situ density was obtained from two sets of data. An average density was calculated from the density measurements reported by IECO (1977), from undisturbed samples taken in the 1977 field investigation. The average density for samples obtained on or near the embankment

was 96 pounds per cubic foot (pcf). An average undisturbed sample tube density was also calculated from the samples obtained in the D'Appolonia investigations. The average density was also 96 pcf.

As a check on the average density obtained from the tubes, the average in situ relative density was evaluated using the SPT blow counts from the D'Appolonia borings and the results of relative density tests. Figure 11 presents a composite plot of SPT blow counts (N) versus depth in all borings. Using the average N vs. depth relationship, the correlation of Marcuson and Bieganousky (1977), between relative density (D_r) and N was used to obtain an average in situ relative density of 44 percent. Laboratory relative density tests indicated that the maximum density is 115.5 pcf and the minimum density is 78.4 pcf. Using these maximum and minimum densities, a D_r equal to 44 percent corresponds to a density of 91 pcf. This density correlates well with the 96 pcf from tube densities considering the variability and uncertainty associated with the use of relative density correlations (Selig and Ladd, 1973).

The average density from the tube samples, 96 pcf, was used to obtain a friction angle for stability analysis. Referring to Figure 15, with an average density of 96 pcf, the effective friction angle is 29°. This is the friction angle used in the stability analyses described in Section 4.1.

3.1.3 Permeability

Constant head permeability tests were performed on four samples, the same as those tested for triaxial shear. The results are summarized in Table 3. Remolded samples were used for testing since undisturbed samples could not be prepared. The variation in permeability is quite large, from 1×10^{-6} cm/sec to 1×10^{-4} cm/sec with an average of 2.7×10^{-5} cm/sec. This value is lower than the average permeability of 1.0×10^{-4} cm/sec obtained from piezometer sensitivity tests.

Values of permeability were used in performing the seepage assessment described in Section 4.3. The permeability was chosen to be 1.0 x 10^{-4} cm/sec to provide the more conservative assessment of seepage effects on embankment stability.

3.1.4 Cyclic Triaxial Testing

A stress-controlled cyclic triaxial test was used to determine the resistance of saturated coarse tailings to liquefaction. The general procedure for the cyclic triaxial test is described by Seed and Peacock (1971). In the cyclic triaxial test a reconstituted sample of coarse tailings is saturated with water and subjected to a sinusoidal cyclic loading (extension and compression cycles). The maximum load is precalculated to produce a desired shear stress to confining stress ratio. This ratio is designated by $\sigma_d/2\sigma$, where $\sigma_d/2$ equals the maximum shear stress and σ is the effective confining stress. During the cyclic triaxial test, the stress ratio is monitored and recorded together with the strain and pore pressure time histories (see Appendix C for these results).

A typical cyclic triaxial test for a loose soil sample proceeds through three basic stages:

- During the first stage the sample exhibits very small strains but shows an extensive pore pressure increase.
- During the second stage a point is reached where the pore pressure is nearly equal to the effective confining pressure. This point is termed "liquefaction". The number of cycles required to reach liquefaction is mainly dependent upon initial sample density, magnitude of cyclic loading, and grain-size and shape characteristics.
- During the third stage the strain shows large increases with the pore pressure showing a drop due to dilation during the compression loading cycle.

The stress ratios, $\sigma_d/2\sigma_c$ were varied over the range of 0.35 to 0.125 with a total of 7 specimens tested. All samples were reconstituted to a dry density of approximately 94 pcf. Figure 19 shows a plot of the stress ratio versus number of cycles to liquefaction. In general, the liquefaction failure curve shows rapid decrease in resistance to liquefaction as high stress ratios are approached. The laboratory curve was corrected for field conditions, as shown in Figure 19. The field correction factor was chosen to be 0.6 (Seed, 1976). This correction factor accounts for the difference in loading conditions between the laboratory and in situ case. The correction factor also empirically accounts for the disturbance or loss of in situ soil structure resulting from reconstituting laboratory samples. The corrected field curve is used when assessing the in situ liquefaction potential.

3.2 NATIVE SAND

3.2.1 Grain Size

The field investigation revealed that most of the native material below the embankment is sand. Grain size analyses were performed on nine samples of native sand from the borings and are illustrated in Figure 17. The material is a relatively clean, uniform, fine sand with 5 to 30% fines, classified SP to SM in the USCS classification system. It is very similar to the tailings sand in size and gradation, although it tends to be slightly more variable.

3.2.2 Static Shear Strength

The strength characteristics of the native sand were measured in a series of three consolidated undrained triaxial tests on a sample from boring DB-2A. As with the triaxial tests on tailings, it was necessary to remold the samples for testing. The remolded densities were the same as those of the sand in situ, as determined from density tests on undisturbed samples. The results are presented in Figure 17. The failure envelope is well defined for the three tests, with a resulting effective friction angle of 29° and an effective cohesion of zero.

3.2.3 Permeability

Two constant head permeability tests were performed on the same sample of native sand tested in triaxial shear. The results are presented in Table 3, with an average value of 7 x 10^{-4}cm/sec. This value is considerably higher than the values from field testing (Table 2) on native sand, where the average value is 5 x 10^{-5} cm/sec. The laboratory average value is also much higher than both lab and field permeability test values for tailings. Apparently the permeability value of the native sand determined in the laboratory is not representative of the majority of in situ native material.

3.3 NATIVE CLAY

The field investigations revealed numerous relatively thin clay layers throughout the embankment foundation. Atterberg limits tests were performed on 12 samples from the borings, as presented in the plasticity chart of Figure 18. The results of the tests are also presented in Table 4, and the boring logs contained in Appendix A. Most of the samples are clays of low plasticity (CL) although two samples are clays of high plasticity (CH).

Unconfined compression tests were performed on four clay samples from borings DB-2A, 2B, 5A, and 6A, in order to provide an estimate of their strength for the stability assessment. Only four tests were performed because of the limited amount of undisturbed cohesive samples available with sufficient length for testing. The unconfined compressive strengths ranged from 0.2 to 3.2 kips per square foot, corresponding to shear strengths of 0.1 to 1.6 kips per square foot (see Table 5). Discussion of the cohesive strength values chosen for stability analysis is contained in the stability assessment of Section 4.1.3.

4.0 STABILITY ASSESSMENTS

The stability of the UNHP tailings embankment was investigated under both normal and severe loading conditions. The stability of the embankment was evaluated for the following:

- Static slope loadings
- Earthquake induced slope loadings
- Earthquake induced liquefaction (soil strength loss)
- Seepage forces
- Probable maximum precipitation and the resultant floods

Appropriate factors of safety against embankment distress by any of these mechanisms were utilized to assess the current stability condition of the embankment.

4.1 SLOPE STABILITY ASSESSMENTS

4.1.1 Methodology

The stability analyses were performed using the generalized procedure of slices, most often referred to as the Janbu Method (Hirschfield and Poulos, 1972). The procedure is a limiting equilibrium solution. One hundred potential failure surfaces were computer-generated for each of the eight investigated cross sections shown on Figure 2. The soil mass above each trial failure surface is divided into several slices with the unknown forces reduced by the following assumptions:

- Plane strain conditions apply
- Resisting shear stress is equal to the Coulomb strength divided by a factor of safety
- The normal resultant acts at the point where the vector sum of vertical driving forces acts
- The position of the horizontal thrust force is known.

Knowledge of both the assumed and actual forces acting on each slice allows each individual slice to be treated as a free-body. The conditions necessary for a limiting equilibrium for each slice were calculated, and the forces between slices were summed to determine the ratio of driving to resisting forces (the factor of safety). For proper embankment performance, the NRC Regulatory Guide 3.11 requires a factor of safety of 1.5 for static loading and 1.0 for dynamic (pseudo-static or earthquake) loading conditions at maximum pool elevation.

The eight cross sections shown on Figure 2 were chosen for analysis as being the most critical for stability assessment based on the following criteria:

- Steepest outside slopes
- Highest elevation breakout of the phreatic surface
- Least horizontal distance from pond to embankment toe
- Least thickness of coarse tailings
- Most critical location (near mill site)

4.1.2 Analytical Soil Profiles

For each cross section an analytical soil profile was formulated based upon the 1977 field investigation data, the May 1980 aerial photos, the May 1980 mill site topographic map by Koogle and Pouls Engineering and the D'Appolonia field investigation data. These detailed soil profiles were then used for the computer slope stability analysis. The profiles used in the analyses are simplified from the cross sections presented in Figures 3 through 10, as discussed below.

The tailings retention embankment has been constructed by the centerline method. In this process, the cyclone truck which separates the coarse tailings fraction from the fine tailings fraction maintains a position over the original starter dam as it travels around the embankment.

There is some evidence, however, that a combination of both the centerline and upstream methods have been utilized in the southeast and northeast corners (Sections 1-1' and 6-6', respectively) since the starter dam is downstream of the existing crest. The location of the East pond starter dam, shown on Figure 2, has been inferred from penetration of thick, slightly organic clay layers made during the field investigation and from the UNHP starter dam configuration East pond drawing, date unknown. The centerline locations for the starter dams are shown on each of the appropriate soil cross sections (Figures 3 through 10), however, the starter dams were not included in the analytical cross sections for stability analysis. The effect of the starter dam in the stability analyses was investigated by performing a stability calculation in which a failure circle passing through the location of the starter dam was analyzed with and without the starter dam. The difference in safety factors between the two calculations was within 2%. The starter dam was, therefore, removed from consideration in all further analyses.

The coarse tailings are discharged along the outside of the dike, on top of the crest and along the inside beach area, creating the zone of unstratified uniform fine sand designated as SP-SM and SM. At the same time, the fine tailings are discharged with water toward the pond, upstream from the crest. Because of the nature of this deposition, the coarser fraction of the fine tailings settles out nearer the crest. The beach area, therefore, is composed of the coarser fraction of the fine tailings interfingered with the coarse tailings. This forms a soil, classified as SP-SM and SM, with properties very similar to those of the coarse tailings. The soil properties (see Section 3.1) of both the fine and coarse tailings in this beach area were assumed to be the same for the embankment within the limits of the failure circle.

In some borings, pockets of silt (ML) and/or silty clay (ML-CL) were encountered within the coarse tailings. Since these layers were shown to be very thin and localized, they would have very little, if any, effect on embankment stability. For analysis purposes, their presence was neglected.

The in situ native soils underlying the tailings are composed mainly of alternating layers of silty sand (SP-SM to SM) and clay (CL to CH). In general, the sand layers make up the greatest portion of these native soils. The clay layers were shown to be thin, occurring within a sandy matrix and not found in clearly distinguishable continuous layers. For this reason, these thin clay layers were not included in all of the analytical profiles for stability analysis. However, the special case of a hypothetical continuous clay layer beneath the embankment was evaluated for one cross section as discussed later herein.

The soil parameters selected for the analytical soil profiles are conservative values based upon previous investigations, laboratory test results and/or well-established, empirical relationships between soil properties and strength parameters. The soil properties selection and their corresponding strength parameters are discussed in Sections 3.1 and 3.2.

4.1.3 Static Slope Stability

The static load cases were analyzed using the analytical soil profiles with the two phreatic surfaces from piezometric readings of September, 1980.

Evaluation of slope stability requires that limits on the location of potential failure surfaces be set in order to evaluate only those surfaces which are applicable. In the analyses described below, shallow failure surfaces located near the embankment face were not evaluated. Surface sloughing may occur because the coarse tailings are placed at the

angle of repose of the material, making them inherently unstable, but this type of failure poses no danger of loss of pond water or fine tailing slimes.

Limits on the location of potential surfaces were set by controlling the location of end points of all surfaces, as illustrated in Figure 20. The failure circles were allowed to initiate from any point downstream of the toe inflection point, which generally corresponds to the phreatic surface breakout at the toe. The failure circles were required to terminate upstream from the 6662 feet elevation on the East Pond and the 6651 feet elevation on the West Pond.

These termination elevations correspond to the lowest crest elevation of the sections from each pond (as of September, 1980). The lowest crest elevation would be the minimum elevation to which the embankment could be lowered by a slope failure and still maintain five feet of freeboard. This assumes that in the worst case, the pond is up to the five foot freeboard or maximum working pond elevation.

Since the phreatic levels in the embankment sections are nearly the same, the factor of safety for each cross section is directly related to the slope angle and the chosen termination limit for the failure circles. If the termination limits were at the same point for each section, the factor of safety would be directly related to the slope angle.

Table 6 presents the results of the static slope stability analysis. Figure 20, 21, 22 and 23 present the analytical cross sections, phreatic conditions and most critical failure surface along with their factors of safety.

The factors of safety for cross sections in the West pond vary between 1.46 and 1.84. The safety factors for Section 2-2' and Section 7-7' (1.84 and 1.79, respectively) are well above the NRC guideline criteria

of 1.5. Section 3-3', with a factor of safety of 1.46, falls slightly below the recommended 1.5. This is because Section 3-3' has the steepest slope angle and also the lowest crest elevation, making it the critical cross-section for the West pond.

Although for analysis purposes the water level in the West pond was brought up to the five foot freeboard level, the West pond sections generally have a higher factor of safety than the East pond. This is due in part to the lower slope angles which occur on the West pond. These flatter slopes may result from resculpturing of the slopes due to the prevailing westerly winds or erosion from runoff which has occurred over the last year, when no disposal took place on the West pond.

The factor of safety for cross sections in the East pond varies between 1.18 and 1.56. Sections 6-6' and 8-8' (with factors of safety of 1.53 and 1.56, respectively) are above the NRC guideline criteria. Sections 1-1', 4-4', and 5-5' (factors of safety of 1.42, 1.18 and 1.35, respectively) all fall below the NRC guideline criteria. This is because of the steeper slopes along the southeastern corner of the tailings pond (leeward side of prevailing westerly winds). Remedial measures to increase the factor of safety to meet the NRC stability criterion should be implemented, as discussed in Section 5.0.

The clays which were encountered in some borings immediately below the tailings (at the original ground surface) provide a potential layer of weakness along which sliding might occur. A critical failure surface involving a significant portion of this potential weak layer would be a wedge type surface rather than a circular type surface. For this reason, a wedge type failure was analyzed for stability, as presented in Figure 24. The section used is a typical section from the East pond.

For this hypothetical analysis, a continuous clay layer is assumed to exist along the entire base of the embankment. Although lateral continuity of the clay deposits is not indicated by field data, the continuous layer assumption is conservatively made. The driving forces in this problem are soil forces from an "active" wedge of tailings and water forces, both acting to push the embankment wedge along the clay layer. The material parameters for the tailings used in this analysis are the same as those used for the circular type failure analysis. The cohesive strength of the clay layer required to maintain a factor of safety of 1.5 against sliding was back-calculated to be 850 psf.

This required strength can be compared to laboratory strength values of clay samples as presented in Table 5. The limited number of tests reported in Table 5 show considerable variability, from very soft to stiff, with an average value of 930 psf. Review of the visual classifications from the boring logs indicates that the very soft clay which was reported in Table 5 is somewhat anomalous, and the other three tests are probably more representative of any extensive clay deposits in the area. The average from these three tests is 1200 psf. In any case, the strength of any potentially continuous clay layer is more than adequate to produce a factor of safety of 1.5 against a wedge type failure.

The very soft clay with a cohesive strength of 120 psf (see Table 5) came from boring DB-2. This boring is at the toe of Section 4-4', which has a possible continuous layer of very soft silty sand and clay running from the toe to a position approaching the crest of the embankment. This section was, therefore, analyzed for a wedge failure condition in which approximately one-half of the length was underlain by this weak clayey material. The remainder of the section was assigned an average cohesive shear strength typical of the other three samples in Table 5. The safety factor against this wedge failure was 1.17, almost exactly the same as the safety factor determined for the critical circular failure surface on this section.

Wedge failures, even under a rather conservative, low strength assumption, do not produce safety factors any lower than their circular failure counterparts. The soft interface clay or silt materials are most prevalent on Sections 1-1', 4-4', and 5-5', which also have the lowest circular failure surface safety factors. The necessity to fortify against wedge failures may, therefore, be handled at the same time as circular failure conditions.

An additional static stability case analyzed was the change in phreatic surface during the Probable Maximum Precipitation (PMP). One of the effects of the PMP will be to raise the water level in the pond, causing increased seepage and a raise in the phreatic level in the pond. (Other effects of the PMP on embankment stability are discussed in Section 4.4). The change in phreatic surface was evaluated for a typical section in the East pond (see Section 6.0), where it is conservatively estimated that a 14 foot rise in the phreatic surface beneath the crest will occur from the PMP. The factor of safety is 1.3 for this case, decreasing from 1.4 for the case of normal operating phreatic conditions. Since this is a severe loading condition where a minimum factor of safety of 1.0 would apply, this loading case is not critical to the stability of the embankment.

4.1.4 Pseudo-Static (Earthquake) Stability

During seismic events, transient horizontal and vertical forces are applied to surface structures due to the movement of the earth. For the pseudo-static analysis conducted herein, horizontal and vertical loadings were modeled using seismic coefficients. The coefficients were set equal to peak horizontal and vertical ground acceleration associated with a postulated seismic event having a relatively long return period. Specifically, a maximum horizontal acceleration of 0.1g and a vertical acceleration of 0.067g were used as the seismic coefficients for the dynamic stability analysis. The maximum horizontal acceleration was selected from a plot of maximum acceleration levels for the United

States as shown in Figure 25 (selection of the maximum horizonal acceleration is discussed further in Section 4.2.). The vertical acceleration is taken as 2/3 of the maximum horizontal acceleration as suggested in USNRC Regulatory Guide 1.60 and by Newmark, Blume and Kapur (1973).

The same computer-generated generalized procedure of slices used for static stability analysis was employed for the pseudo-static analyses. The sum of static and seismic forces on the slices were compared to the resisting forces to assess the factor of safety. The same toe and crest limits and soil parameters were used in the pseudo-static as were used in the static stability analysis.

Table 6 presents the results of the pseudo-static stability analysis. Figure 20, 21, 22 and 23 present the analytical cross-sections, phreatic conditions and most critical failure surface along with their static and pseudo-static factors of safety.

The factors of safety for pseudo-static loading vary from 1.01 to 1.42 for all cross-sections. A reduction in factor of safety of approximately 20 percent from the static case was indicated. In all cases, the static and pseudo-static most critical failure surfaces were in identical locations.

The stability of the embankment under seismic loading, as assessed by the pseudo-static method of analysis, is adequate and in accordance with the Regulatory Requirements (NRC's guideline criteria is 1.0 for seismic loading) and prudent engineering practice.

4.2 Liquefaction Assessment

Loose saturated cohesionless soils are subject to the phenomenon known as liquefaction. The liquefaction phenomenon is initiated by either a rapid monotonically increasing load or by a cyclic load as in an earthquake. A cohesionless soil liquefies when the applied loading is

carried by the porewater rather than the grain-to-grain contact in the soil skelton. Soils which allow rapid porewater pressure dissipation, coarse sands and gravels, do not liquefy. Soils which allow very slow porewater pressure build-up (silts and clays), also do not liquefy. Soils between these two grain size extremes are subject to liquefaction. Figure 26 shows grain size limits for liquefiable uniformly graded soils as presented by the Japan Society of Civil Engineers (1977). The average grain size of the UNHP coarse tailings is superimposed on this figure, and falls totally within the very easily liquefied zone.

Liquefaction occurs only in saturated cohesionless soils. The liquefaction potential at the UNHP tailings embankment is, therefore, very dependent on the location of the phreatic surface. Since a maximum acceleration earthquake is being considered as the loading source, the liquefaction potential will be assessed for normal phreatic level in the embankment. Once the phreatic level is fixed, the liquefaction potential depends mainly upon the characteristics of the earthquake and the soil.

An earthquake can generally be delineated by three major characteristics:

- Amplitude of earthquake vibration
- Duration of earthquake vibration
- Frequency of earthquake vibration

Earthquake amplitudes are available from several sources in the form of contoured or zoned maps of the U.S.A. The duration and frequency on the other hand may only be estimated from studies of the regional geology to determine the existence and effect of local seismic structure.

The potential for seismic activity in the vicinity of the site was evaluated from the work of Algermissen and Perkins (1976). Their study, published under the auspices of the U. S. Geologic Survey, presents a probabilistic estimate of maximum acceleration in rock for the United States. The maximum acceleration level was determined to be 0.1g based

on the plot of maximum accelerations for the U. S. A., Figure 25. The duration and frequency of the earthquake were not determined in this seismic assessment.

The maximum acceleration from Algermissen and Perkins is for rock. This acceleration will amplify or attenuate as the earthquake motion passes through the overlying soils. The amplification or attenuation characteristics are dependent upon both soil properties and upon earthquake frequency characteristics. Since the soil profile is quite shallow and since no study of local seismic structure was performed, the maximum rock acceleration was applied at the embankment surface.

The characteristics of the coarse tailings under cyclic loading (simulated earthquake) were determined by laboratory cyclic triaxial tests, as discussed in Section 3.1.4. The laboratory curve of stress ratio versus number of cycles to liquefaction failure, Figure 19, was corrected for in situ conditions according to Seed (1976). The correction factor was conservatively chosen to be 0.6 and the resulting in situ curve is delineated on Figure 19. To apply the in situ curve the irregular cyclic nature of the earthquake must be characterized by an equivalent number of uniform sinusoidal cycles. The largest viable earthquake with a 0.1g maximum acceleration was considered to be a modified Mercalli magnitude 7.0 event. This magnitude event corresponds to a causitive fault distance of approximately 50 miles (Housner, 1965). Once the modified Mercalli magnitude was assigned, an average number of equivalent sinusoidal cycles was determined. The mean number of equivalent cycles for a magnitude 7.0 earthquake was chosen to be 10 cycles (Seed, 1976).

Ten cycles was then used on the in situ liquefaction resistance curve, Figure 19, to arrive at a liquefaction resistance stress ratio of 0.12. This stress ratio was compared to the actual earthquake-induced stress ratios to obtain a factor of safety against liquefaction.

The stress ratios induced by the 0.1g maximum acceleration earthquake were determined by the simplified Seed and Idriss method, (Seed and Idriss, 1971). In this technique a one-dimensional column of soil and water is treated as a single mass, accelerated at the top by the force from the 0.1g earthquake. In this manner a shear stress at the base of the one-dimensional column may be determined. This stress for the UNHP tailings embankment is heavily influenced by the position of the phreatic surface. The equation for determining the earthquake-induced shear stress or stress ratio is:

$$\tau_{eq}/\sigma_o = 0.65\, a_{Max}\, (\sigma/\sigma_o) r_d$$

τ_{eq} = Earthquake Induced Shear Stress

σ_o = Effective Overburden Stress

a_{Max} = Maximum Earthquake Acceleration (expressed as a fraction of the acceleration of gravity, g)

σ = Total Overburden Stress

r_d = Reduction Factor for Earthquake Amplification

The stress ratios calculated by this method were compared to the stress ratio corresponding to 10 equivalent cycles as determined from the in situ liquefaction resistance curve, Figure 19. The safety factors thus determined are presented in Table 7.

The East and West ponds have a minimum safety factor against liquefaction of 0.9. This low safety factor applies only to the toe areas of the embankment where the phreatic surface breaks out or draws very near to the surface of the embankment. With only a few feet of unsaturated coarse tailings covering the saturated zone,the factor of safety against liquefaction rises above 1.5.

Since the safety factor against liquefaction under the embankment is above 1.5, the occurrence of liquefaction at the embankment toe will not endanger the stability of the embankment (the overall safety factor for the slope will be greater than 1.0). In addition, the calculated safety

factors are very conservative, due to the conservative choice of correction factor for converting the laboratory liquefaction resistance curve to the in situ liquefaction resistance curve.

4.3 SEEPAGE ASSESSMENT

The effect of seepage forces on embankment stability was assessed using the piezometric data and soil permeabilities gathered during the field investigations. These data demonstrate the confining effect of the top surface of the natural soil, retarding downward flow of water from the coarse tailings. Although this layer in no way completely prevents downward flow, the piezometer measurements indicate negligible downward flow when compared to horizontal flow potential. The seepage assessments take advantage of this confining influence, treating flow in the tailings embankment as a nearly horizontal flow regime.

The seepage forces could affect the stability of the tailings embankment in three ways:

- Seepage forces may result in heave (quick condition) and resulting sloughing failures at the seepage face.
- Seepage forces may produce piping either at the seepage face or internally within the embankment.
- Seepage forces may contribute as driving forces under certain static stability conditions.

The first two seepage force effects are covered in the following sections; the last has been considered earlier in Section 4.1.3.

4.3.1 Sloughing Failure

Sloughing failures at the seepage face are caused by the steepness of the outer embankment surface produced when cycloning and depositing coarse tailings. The coarse tailings in a dry condition will stand at an angle of repose equal to the internal friction angle of the coarse

tailings. For the UNHP coarse tailings, the angle is approximately equivalent to a 2 to 1 slope. When the seepage face breaks out on a dry angle of repose slope, the interlocking soil particle forces are unable to resist the additional loading of the seepage force. The slope, therefore, flattens or sloughs to a milder angle. This sloughing process recurs as the embankment is enlarged, with the majority of sloughing occurring during the build-out of the section. During build-out the seepage forces are higher than usual and new material is loading the upper parts of the slope. Since sloughing occurs mainly during build-out, it represents no danger to the overall stability of the embankment. The final slope of the seepage face appears to be proportional to the calculated total flow at a given embankment section (see Figure 27).

Sloughing failures are closely related to the development of localized quick areas on the seepage face. The piezometric surface defined during the field investigations appears to follow a flow path similar to the generalized flow path shown on Figure 28. If no build-out is occurring, this flow path eventually produces a stable seepage face with no sloughing. If the piezometric surface were to rise at the toe, additional toe sloughing would be expected. In addition, this flow path produces apparent seepage exit conditions above the phreatic levels in the toe piezometers. This saturated zone appears to result from capillary rise and may contribute to the general driving mechanism for toe sloughing.

Localized quick zones have been observed at the seepage face. These zones appear to be closely associated with sections which have recently received or are receiving build-out material. The approximate flow rates were estimated using Darcy's Law. The total flows are dependent on the soil permeability, hydraulic gradient and cross sectional flow area. The total flows on the East pond sections are approximately 5.0 gallons per day per foot of embankment length. The West pond flows, on the other hand, are closer to 1.0 gallon per day per foot. The constant flow

quantities produce high flow velocities at the toe of the embankment where the cross-sectional flow areas are smallest. This increase in velocity, particularly for the high flow volume East pond section, is responsible for the development of the localized quick zones.

4.3.2 Piping

Piping is defined as the transportion of soil particles through the soil skeleton by seepage forces, producing an open flow conduit or pipe and leading to the eventual failure of the embankment. The mechanisms which produce piping are quite well known and are prevented in engineered embankments by proper zoning and the use of filter blankets. However, a quantitative assessment of piping potential at the UNHP embankment cannot be made under current state-of-art practice in soil mechanics. Generally two piping failure mechanisms may be responsible for the failure of an embankment:

- Piping initiated by removal of soil at the seepage face producing a pipe back into the embankment.
- Piping initiated internally within the embankment at a point where the seepage exits from a fine-grained material into a coarse-grained material.

The first mechanism requires that rapidly flowing water must be available to remove the piped soil particles from the seepage face. No such condition exists at the UNHP tailings embankment and the piped particles, if there, remain at the toe of the slope preventing development of the pipe. The second mechanism requires an interface between a very coarse and a very fine material within the embankment. The cyclone method of construction with additional separation of the fine fraction by progressive sedimentation does not produce such an interface. Neither piping mechanism fully exists in the UNHP tailings embankment, and embankment failure cannot be initiated by the piping phenomenon.

4.4 FLOOD ASSESSMENT

The flood assessment consists of two major portions. The first portion involves a hydrologic assessment of the drainage basin above the UNHP tailings mill. The second portion involves an assessment of the impact of flood erosion on embankment stability. The hydrologic assessment has been previously reported by D'Appolonia (1980). The results from the hydrologic assessment will be briefly summarized before discussing the impact of the flood on the embankment stability.

4.4.1 Hydrologic Assessment

The hydrologic characteristics of the watershed upstream from the UNHP tailings embankment were assessed for their runoff potential based on slope, soil characteristics and vegatative cover. These parameters were used to prepare a runoff hydrograph using the procedure developed by the Soil Conservation Service (1972).

The drainage area for the basin was determined from United States Geological Survey 7.5 minute quadrangle topographic maps of the area. The total drainage basin is shown on Figure 29 and contains approximately 291 square miles.

The Probable Maximum Precipitation (PMP) was determined from a publication by the U.S. Department of Commerce (1960). Storm rainfalls for 24-hour, 6-hour and 1-hour. PMP's as well as the 100 year rainfall were considered. These rainfalls were adjusted for the watershed size and are given on Table 8 along with the maximum discharges at the UNHP tailings embankment. Further details of the hydrologic assessment are contained in a previous report (D'Appolonia, 1980).

4.4.2 Embankment Erosion Assessment

A topographic survey of the valley cross section at the embankment location was performed by UNHP personnel. This survey determined the actual ground surface features within the cross section, including any diversion ditches and roadway embankments as presented in Figure 30. The

northwestern corner of the tailings embankment lies across the dry stream bed of San Mateo Creek. A diversion ditch structure around this corner has an apparent capacity to handle flood flows up to approximately 200 cubic feet per second (cfs). The flood levels on the northwest and southeast corners of the embankment are shown on Figure 30. This figure also shows the capacities of the ditches around the outer edges of the embankment.

The 6-hour PMP flood produces peak water levels up to elevation 6592 feet, approximately 14 feet over the toe of the embankment. The average flow velocities in this flood were calculated to be 7.5 feet per second. The velocities along the embankment may be considerably lower, although points such as the northwest corner might be subjected to relatively high velocities. The velocity necessary to erode coarse tailings, which have a mean grain size of about 0.2 mm, would be one-half to one foot per second (ASCE, 1977). Therefore, it appears that erosion of the embankment under PMP flood conditions is likely.

Assessment of erosion depth is not a highly developed state-of-art methodology. Several possible methods may be used with each presenting widely differing answers and depending upon different assumptions. Two methods were applied in this analysis. The first method uses empirical scour formulas as developed for bridge pier design. These formulas are available in several references, (e.g., U.S. Department of Transportation, 1975; U. S. Department of the Interior, 1959; Laursen and Toch, 1956). These empirical formulas depend upon flow velocity, particle grain size, and flow depth. The scour depths into the embankment calculated by these formulas ranged from 10 to 100 feet of scour under the 6-hour PMP flood conditions.

The second approach uses maximum sediment loading potential for a given stream section and condition. These formulas are both empirical and theoretical in nature (ASCE, 1977; Leopold, Wolman, and Miller, 1964; and Chow, 1964). They produce the potential for sediment transport if

velocities, grain size and stream volume available for transport are known. They do not directly produce scour depth assessments unless some very basic assumptions are made. Firstly, the sediment loading already in the flood waters when they reach the embankment must be assumed. Secondly, the area of the embankment which will provide the eroded sediment must be assumed. This last assumption has a direct bearing on the depth of erosion, since larger areas providing a given volume of sediment will erode less than smaller areas providing the same volume of sediment. Erosional loss was, therefore, not assessable to a degree reliable enough to form a conclusive assessment of the eroded depth.

This shortcoming in the state-of-art in erosion assessment was overcome by assuming certain elevation limits of erosion during the PMP event. The typical East and West pond profiles, see Table 9, were subjected to stability analyses in which their entire toe region below elevation 6592 feet was removed. These analyses also included the effect of a raised water table and water on the toe of the embankment when computing the factor of safety. Figure 31 shows the critical failure modes for both the East and West ponds with the toes eroded from the flood passage. The critical factor of safety for the East pond is 1.22 and the West pond 1.31 under these extreme conditions.

Although the exact amount of erosion produced by the PMP storm flows can not be calculated, stability analyses with a large portion of the toe removed indicated that the embankment will remain at safety factors greater than 1.0 during the PMP event. The 100 year flood level, on the other hand, is not a severe loading situation and must qualify under the NRC requirement to maintain a safety factor of 1.5 against slope failure. To meet this requirement protective berms to elevation 6582 feet should be placed to prevent 100 year flood water flows from encroaching on the West pond embankment toe. This berm may be most easily constructed by raising the existing roadway around the outside of the West pond embankment the two or three feet necessary to provide a crest elevation of 6582 feet on the road surface.

As a final note regarding transport of the radioactive tailings during a PMP event, the amount of sediment and other debris in the flood would be significantly higher than the amount of tailings in the flood. The PMP flow past the embankment would be more than 100,000 cfs. Even if the maximum amount of material were eroded from the embankment, the concentration of tailings in the flood water would be very low.

4.4.3 PMP Rainfall Storage

Based on NRC Regulatory Guide 3.11, the tailings pond must be able to store direct rainfall without discharge for a concurrent procession of the 100 year storm, the PMP, and 40% of the PMP. From the values given in Table 8, the ponds must store approximately 34 inches of water. Maintenance of the five foot freeboard (60 inches) will adequately meet this storage requirement.

5.0 REMEDIAL MEASURES

The stability assessments presented in Section 4.0 indicate that certain portions of the embankment do not possess a sufficiently high factor of safety (1.5) against embankment slope failure under present conditions. Thus it is apparent that some remedial measures are required to provide adequate stability under both current and future operating conditions for portions of the embankment. The remedial measures can also provide additional stability for future build-out conditions.

Three different types of remedial measures to increase embankment stability have been evaluated:

- Option 1 -- Construction of a berm on the toe of the existing slope, with continued tailings disposal on the crest and slopes of the embankment.
- Option 2 -- Flattening of the existing slope, with continued build-up on the new crest of the flattened slope and a reduced pond area;
- Option 3 -- Reduction of the pond size by moving tailings disposal inward from the crest of the existing embankment, with continued build-up and a reduced pond area.

Each of these options has been developed under the assumption that tailings will be disposed at the pond for 5 more years. A configuration was developed for each option with the requirement that a minimum factor of safety of 1.5 be maintained for static embankment stability under normal operating conditions. To analyze stability for each option, the typical cross section from the East pond was used (see Table 9). Each remedial measure is described in more detail below.

5.1 OPTION 1 - TOE BERM CONSTRUCTION

This option involves placing fill at the toe of the existing slope to form a berm, as illustrated in Figures 32. To raise the safety factors on the critical areas of the East pond, this berm would have to extend approximately 2500 feet along the embankment toe as shown in plan on

Figure 32. Tailings disposal would continue according to the present procedure, with tailings placed on the crest and slopes of the existing embankment. The berm must be raised to an elevation of 6610 feet with a width of 80 feet to provide adequate stability for a five year build up period. The build up during this 5 year period would be approximately 13 feet, raising the typical embankment crest to an elevation of 6678 feet.

Stability of the toe berm option was evaluated with the phreatic surface at the bottom of the toe berm fill. This allows the toe berm to provide greater resisting effect against slope failure. In order to lower the water table under the toe berm and provide this greater resisting effect, a drain system must be installed before placement of the toe berm. This drain system might consist of either (1) a free draining coarse sand and gravel drainage blanket or (2) a slotted PVC horizontal pipe underdrain system.

The fill required to construct the berm, approximately 220,000 cubic yards, could be obtained from the old tailings disposal area south of the existing pond or by stripping native soils. This option is the only option which involves hauling of fill, a disadvantage from a cost standpoint. An advantage of this option is that operation can continue with present procedures and without disruption to the disposal operation.

5.2 OPTION 2 - FLATTENED EXISTING SLOPES

This option involves flattening of the existing embankment slopes to a slope of 5 Horizontal to 1 Vertical, as illustrated in Figure 33. Continued tailings disposal would take place at the top of the flattened slope, requiring approximately 24 feet of increase in embankment height over a 5 year period. Flattening of the slope could most economically be accomplished by cutting the crest of the slope off and using it for fill at the bottom of the slope. A cut-fill balance would result in no hauling of fill from borrow areas. The resulting available disposal area

dimensions are reduced by approximately 160 feet from each edge with this option (a 33% reduction in total pond area).

A 5:1 slope was chosen for this option because it provides a stable configuration which is more acceptable for final reclamation of the pond. This measure involves a considerable amount of earthmoving, but it is earthmoving that may be required for final reclamation and abandonment. Tailings disposed by cycloning on top of this graded slope would also require further grading if the tailings pile were to be abandoned after this 5 year operational period.

A disadvantage of this option is the need to either dry out or considerably lower the water surface in the pond before commencing with the grading. This might be accomplished without affecting mill operations by confining disposal activities to one pond while draining and grading the other pond to its new slope configuration.

5.3 OPTION 3 - UPSTREAM BUILD-OUT

This option involves retreat to a smaller disposal area by moving disposal inward on the existing embankment crest, as illustrated in Figure 33. By moving the crest inward, the overall slope of embankment is reduced and the stability is increased. To maintain adequate stability over a five year period, the toe of the new portion of the embankment must remain approximately 40 feet inward of the downstream edge of the present crest. To meet this requirement at 5 years, the centerline of the embankment must be moved inward 80 feet. This results in a 15% reduction in available pond area for the remaining disposal period. A build-out of approximately 20 feet will be required for a 5 year disposal period.

This option involves little or no earthwork, but it reduces the disposal area. However, the area reduction is less than that for the second option of flattening the slopes (about one-half the reduction of

Option 2). Final reclamation can be accomplished by regrading the slope at abandonment.

This option might be implemented by discontinuing disposal in one pond, lowering the water level or drying out the pond completely, regrading the crest in a position for restarting cycloning operations. In this way the five foot freeboard would be maintained at all times during disposal activities.

5.4 SUMMARY OF OPTIONS

Each of the conceptual options described above provide a means of maintaining adequate embankment stability for 5 years of continued pond use. The build-out considerations for each option are summarized below:

- Option 1 -- Build-out continues under the present procedure, adding an additional embankment height of approximately 13 feet over a 5 year period. The pond sizes remain the same.
- Option 2 -- Build-out takes place at the top of the flattened slope. The disposal area is reduced, requiring an additional embankment height of approximately 24 feet over a 5 year period. The pond sizes are reduced by 33% from present sizes.
- Option 3 -- Build-out takes place on top of the existing embankment, but at a location moved approximately 80 feet inward from the edge of the crest. An additional embankment height of approximately 20 feet will be required over a 5 year period. The pond sizes are reduced by 15% from present sizes.

6.0 INTERIM PIEZOMETER MONITORING PLAN

Phreatic levels provide an easily monitored source of information on embankment stability performance. Increasing phreatic levels within the embankment result in decreasing slope stability. Thus, the factor of safety of the embankment against slope failures may be directly related to the phreatic levels measured in the piezometers. The interim piezometer monitoring plan described herein is intended to provide a means of evaluating slope stability up through the time that the final tailings management plan is adopted.

Increasing phreatic levels will also increase the liquefaction potential of the embankment, however, static stability is more critical than liquefaction at the present time. For this reason the evaluation described in this section focused on the effect of the phreatic level on static embankment slope stability.

6.1 ANALYTICAL APPROACH AND RESULTS

A typical cross section from both the East and West pond was analyzed for static slope stability using current actual and various postulated phreatic surfaces. The cross sections were assigned geometries typical of those of the actual cross sections of each respective pond. The embankment slopes, crest heights, and phreatic levels are given on Table 9 for the typical East and West pond profiles. Using failure circle limits described in section 4.1 and the phreatic surface as measured in September, 1980, the East pond had a critical safety factor of 1.39 and the West pond had a critical safety factor of 1.63. These safety factors agree with the average values reported on Table 6 and in section 4.1.

The typical cross sections were further analyzed for an increase in phreatic surface, with results presented in Figures 34 and 35. In these analyses, rises in phreatic level at the crest piezometers are directly coupled to equal percentages of rise in the toe piezometers (based on the original saturated thickness). The effect on safety factor for the critical circle is, therefore, dependent on both piezometers showing phreatic surface increases. Phreatic surface increases at either a crest

piezometer without respective increases at toe piezometer or vice-versa are not covered by these plots. Based on measured phreatic levels and a knowledge of tailings pond operation, individual responses of either a crest or toe piezometer at the same section, without similar responses in the other, are not expected.

Both Figure 34 and 35 show a lack of safety factor dependence on phreatic level up to a phreatic surface 50% greater than the September, 1980, levels. This response was confirmed by analyzing the lower bound case with no phreatic surface within the embankment. The critical factor of safety shows a nearly linear dependence on phreatic level beyond the 50% turning point. The critical failure surface below the 50% point is a shallow circle typical of those shown on Figure 20. The critical failure surface above the 50% point is a much deeper circle extending down to the bottom of the tailings embankment.

The effect of increasing the native soil phreatic surface on the critical failure circle was also investigated. The phreatic surface in the native soils was allowed to rise to the tailings embankment, creating a completely saturated section, but this produced no change in the results shown on Figures 34 and 35.

6.2 RECOMMENDED MONITORING

Prior to adoption of the Tailings Management Program, the functional piezometers should be monitored at least on a monthly basis. This schedule should not be interrupted for piezometers at a section being built-out. Piezometers should have accurately measured extensions added ahead of build-out with measurements made on a more frequent basis as build-out passes the monitored section. Readings from the tailings piezometers, listed on Figures 34 and 35, may be evaluated using Figures 34 and 35 to assess slope stability. These readings plus readings from the natural soil piezometers should be recorded to provide a record of their change with build-out progress. A list of all functional piezometers and their September, 1980, phreatic levels is included as Table 1. Recording sheets for the piezometric readings are included in Appendix B with all previous recordings since July, 1980.

7.0 CONCLUSIONS

The static slope stability was assessed using the phreatic levels and tailings soil strength parameters gathered during the field and laboratory investigations. This assessment has indicated that cross sections 1-1', 4-4' and 5-5', (see Figure 2), do not presently meet the 1.5 safety factor specified in the USNRC Regulatory Guide 3.11. Three conceptual alternates have been investigated as possible remedial actions for these sections. All three of these alternates provide a general overall flattening of the outer slope and provide sufficient increase in stability to allow for up to 5 years of continued tailings disposal without falling below a factor of 1.5.

The seepage force assessment has indicated that the embankment is stable from seepage related distress under the present seepage conditions. However, the seepage forces do contribute to localized instabilities at the seepage face and some silt materials may be carried to the seepage face by the flow of water. The necessary mechanisms to propagate piping are not present in the UNHP tailings embankment.

The stability of the embankment was assessed under the severe loading conditions from earthquake and from PMP flood waters. The pseudo-static earthquake stability of the embankment is adequate under present conditions. Liquefaction induced strength loss under earthquake loading has been shown to not be substantial, with all significant factors of safety against liquefaction greater than 1.5. The toe of the embankment at the seepage face was the only area of the embankment which might liquefy during an earthquake (safety factor 0.92). A loss of soil strength from liquefaction at the toe would not produce an overall loss of stability in the embankment. The effect of erosion on the embankment during the PMP flood was investigated by assuming total removal of the toe section of the embankment. In this mode both ponds showed factors of safety greater than 1.0. Overall, the embankment stability during severe loading events is better than a safety factor of 1.0 and, therefore, meets the USNRC Regulatory Guide 3.11.

In the event of the 100 year flood, which is not a severe loading event, erosion of the toe of the embankment may occur reducing the safety factor below the required 1.5. The construction of a protective berm, by raising the existing road on the west side of the pond, would provide protection against erosion for this event.

The stability of the tailings embankment is highly dependent upon the slope of the outer embankment surface. The phreatic surface does not play a major role in the stability of the embankment at levels near those measured in September, 1980, but could begin to govern stability if they rose significantly. Consequently, remedial measures are recommended to flatten the outside slope. Monitoring and evaluation of the phreatic surface is also recommended.

The options as discussed herein should be evaluated from a cost and benefit standpoint considering both existing and future tailings disposal activities including the eventual requirements for abandonment. Once an option is selected, a tailings management plan will be developed for the continued operation of the existing facility and/or the transfer to a new disposal facility at some time in the future.

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TABLE 1

PIEZOMETER WATER LEVEL READINGS

DB SERIES[1] PIEZOMETERS		ST SERIES[2] PIEZOMETERS	
PIEZOMETER	ELEVATION	PIEZOMETER	ELEVATION
DB-1A	6560.6	ST-3	6599.4
DB-1B	6599.4	ST-7	6580.4
DB-2A	6538.9	ST-9	6583.7
DB-2B	6585.3	ST-11	6551.3
DB-3	6603.0	ST-11A	6580.3
DB-4	6584.5	ST-12	6522.8
DB-5A	6563.5	ST-12A	6580.8
DB-5B	6600.6	ST-13	6594.2
DB-6A	6536.0	ST-16	6575.5
DB-6B	6584.6	ST-17	6600.9
DB-7	6595.3	ST-18	6592.7
DB-11	6585.5	ST-19	6538.5
DB-12	6593.6	ST-19A	6587.6
DB-14	6602.8	ST-20	6534.4
DB-16	6591.9	ST-20A	6589.2
DB-17A	6548.7	ST-21	6547.9
DB-17B	6595.9	ST-21A	6582.7
DB-18	6587.9	ST-23	6525.9
DB-19A	6540.8	ST-23A	6579.4
DB-19B	6590.0		

1 DB series piezometer readings taken September 12, 1980
2 ST series piezometer readings taken August 19, 1980

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TABLE 2

FALLING HEAD
PERMEABILITY DATA

PIEZOMETER NUMBER	TYPE OF PIEZOMETER	AVERAGE PERMEABILITY (cm/sec)
IN COARSE TAILINGS		
DB-1B	UNSEALED	1.8×10^{-4}
DB-2B	"	3.1×10^{-4}
DB-3	"	9.6×10^{-5}
DB-4	"	5.3×10^{-5}
DB-5B	"	9.8×10^{-5}
DB-6B	"	3.5×10^{-4}
DB-7	"	5.0×10^{-5}
DB-11	"	3.5×10^{-4}
DB-12	"	7.0×10^{-5}
DB-17B	"	7.9×10^{-5}
DB-18	"	1.0×10^{-4}
DB-19B	"	6.6×10^{-5}
IN FINE TAILINGS		
DB-14	"	1.9×10^{-4}
DB-16	"	6.6×10^{-5}
IN NATIVE SANDS		
DB-1A	SEALED	5.7×10^{-5}
DB-2A	"	1.0×10^{-4}
DB-5A	"	3.2×10^{-5}
DB-6A	"	5.3×10^{-5}
DB-17A	"	5.6×10^{-5}
DB-19A	"	1.2×10^{-5}

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TABLE 3

LABORATORY PERMEABILITY TEST SUMMARY

BORING	SAMPLE NO.	DEPTH (FT)	SOIL TYPE	DRY DENSITY (pcf)	PERMEABILITY (cm/sec)
DB-2A	ST-1	20.0-22.0	Tailings	102.8	2.1×10^{-5}
				99.2	1.3×10^{-5}
DB-2A	ST-4	41.5-43.5	Native	100.2	7.6×10^{-4}
			Sand	103.4	5.7×10^{-4}
DB-14	ST-1	30.0-32.0	Tailings	103.0	1.9×10^{-6}
				102.9	1.3×10^{-6}
DB-18	ST-3	32.0-34.0	Tailings	98.1	1.2×10^{-4}
				92.8	1.4×10^{-5}

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TABLE 4

ATTERBERG LIMITS TEST SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (FT.)	LL[1] (%)	PI[2] (%)	USCS[3]
DB-1A	S-16B	80.7-81.5	38	22	CL
DB-2A	S-11	55.0-56.5	25	9	CL
DB-6A	S-4T	23.5-24.0	69	52	CH
DB-6A	S-6B	41.0-41.5	31	17	CL
DB-7	S-15	75.0-76.5	37	27	CL
DB-11	S-3	15.0-16.5	51	32	CH
DB-14	S-13	75.0-76.5	--	NP[4]	--
DB-17	S-7B	35.8-36.5	27	8	CL
DB-17	S-14	80.0-81.5	39	15	CL-ML
DB-17	S-9	45.0-46.5	34	19	CL
DB-18	S-1B	5.4-5.9	29	13	CL
DB-19	S-7	35.0-36.5	47	30	CL

[1] Liquid Limit

[2] Plasticity Index

[3] Unified Soil Classification System

[4] Non-plastic

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TABLE 5

UNCONFINED COMPRESSION TEST SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (FT.)	DESCRIPTION	PEAK SHEAR STRENGTH (psf)	WATER CONTENT (%)
DB-2A	ST-2	10.6-11.1	Dark brown silty clay, very soft	120	36
DB-5A	ST-3	87.5-87.8	Dark brown clayey silt stiff	1290	27
DB-6A	ST-2	36.4-36.9	Yellow brown silty clay, stiff	1560	27
DB-2B	ST-2	14.0-14.5	Dark brown silty clay, medium stiff	750	35

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TABLE 6

STATIC AND PSEUDO-STATIC FACTORS OF SAFETY

SECTION NUMBER	LOCATION	STATIC FACTOR OF SAFETY	PSEUDO-STATIC FACTOR OF SAFETY
1-1'	EAST POND/SOUTHEAST	1.42	1.16
2-2'	WEST POND/SOUTH	1.84	1.42
3-3'	WEST POND/NORTH	1.46	1.20
4-4'	EAST POND/EAST	1.18	1.01
5-5'	EAST POND/SOUTH	1.35	1.12
6-6'	EAST POND/NORTHEAST	1.53	1.25
7-7'	WEST POND/WEST	1.79	1.42
8-8'	EAST POND/NORTH	1.56	1.26

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TABLE 7

LIQUEFACTION SAFETY FACTOR SUMMARY

DISTANCE FROM EMBANKMENT TOE, (FT.)	EAST POND ELEVATION 6580 FT.	WEST POND ELEVATION 6576 FT.
0	0.92	0.92
20	1.50	1.71
40	1.71	1.71
60	1.71	2.00
80	2.00	2.00
100	2.40	2.40
120	2.40	2.40
140	2.40	2.40
160	2.40	2.40
180	2.00	2.00
200	1.50	1.50
220	1.33	1.33

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TABLE 8

DESIGN PRECIPITATION AND FLOOD FLOW

RAINFALL DURATION	10 SQUARE MILE PRECIPITATION (in.)	291 SQUARE MILE PRECIPITATION (in.)	PEAK FLOOD FLOW (cfs)
24-hour PMP	22.5	19.8	285,000
6-hour PMP	18.5	15.4	324,000
1-hour PMP	12.0	7.7	165,000
6-hour 100 Year Storm	2.2	1.8	11,000

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TABLE 9

TYPICAL EAST AND WEST POND
ANALYTICAL PROFILE
CHARACTERISTICS

	EAST POND	WEST POND
OUTER EMBANKMENT SLOPE	2.1:1	2.3:1
TOE PHREATIC SURFACE	6586 ft.	6578 ft.
CREST PHREATIC SURFACE	6599 ft.	6593 ft.
CREST ELEVATION	6665 ft.	6656 ft.
NATIVE SOIL TOP ELEVATION	6579 ft.	6574 ft.

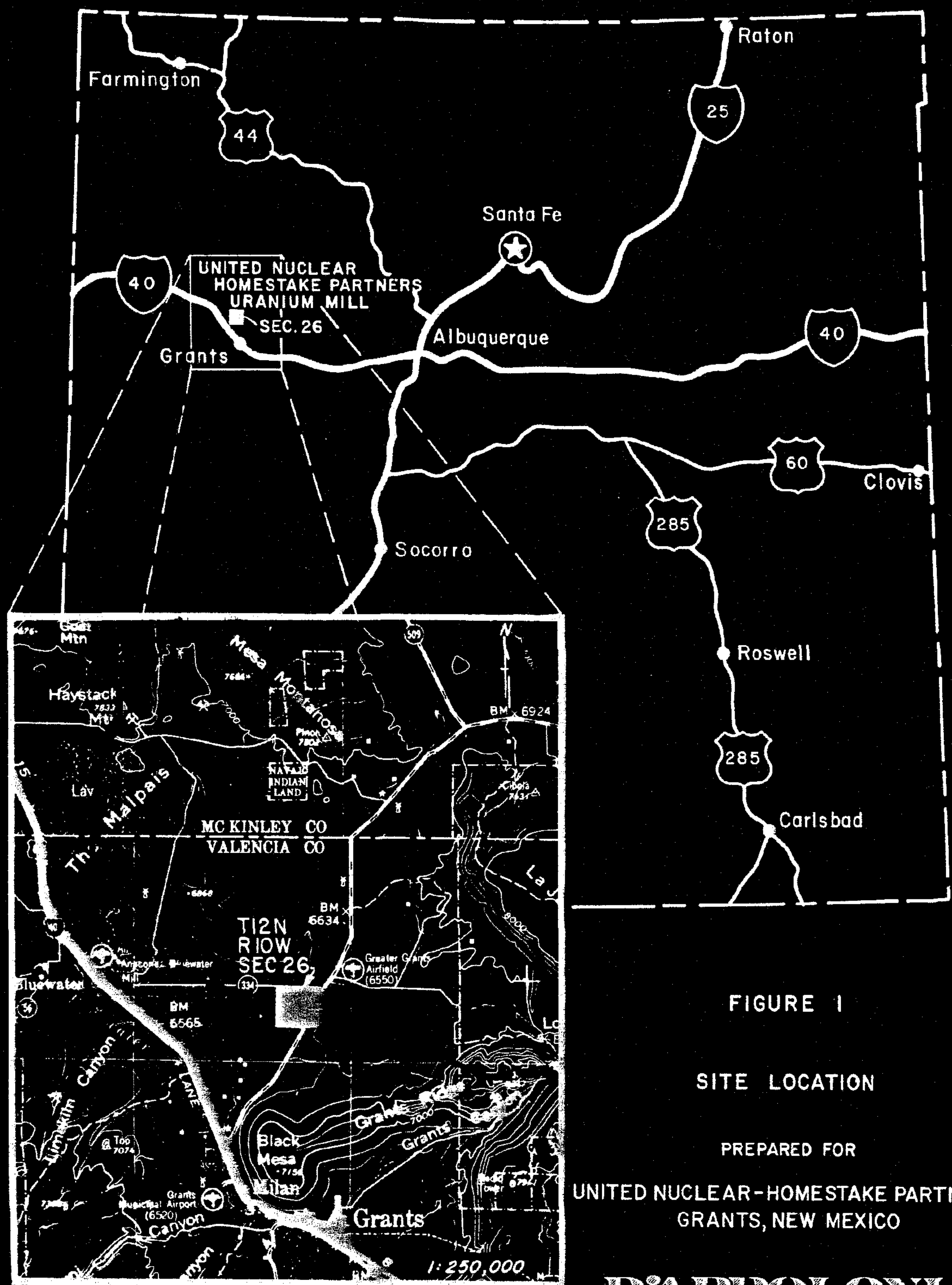

FIGURE 1

SITE LOCATION

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GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjg 6/11/80	TJH 10-27-80	AKK 10-27-80	RM 80311-A1

CROSS SECTION	FIGURE NUMBER
1 - 1'	3
2 - 2'	4
3 - 3'	5
4 - 4'	6
5 - 5'	7
6 - 6'	8
7 - 7'	9
8 - 8'	10

400 0 400

SCALE IN FEET

LEGEND

⊕ D'APPOLONIA BORINGS WITH SINGLE PIEZOMETERS

● PIEZOMETER FROM 1977 FIELD INVESTIGATIONS

D'APPOLONIA BORINGS WITH DOUBLE PIEZOMETERS

(1)—(1') TYPICAL CROSS SECTION

FIGURE 2

BORING AND PIEZOMETER LOCATION PLAN

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GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	MJG	10/14/80
CHECKED BY	TJH	10-27-80
APPROVED BY	AKK	10-27-80
DRAWING NUMBER	RM80-311B-1	

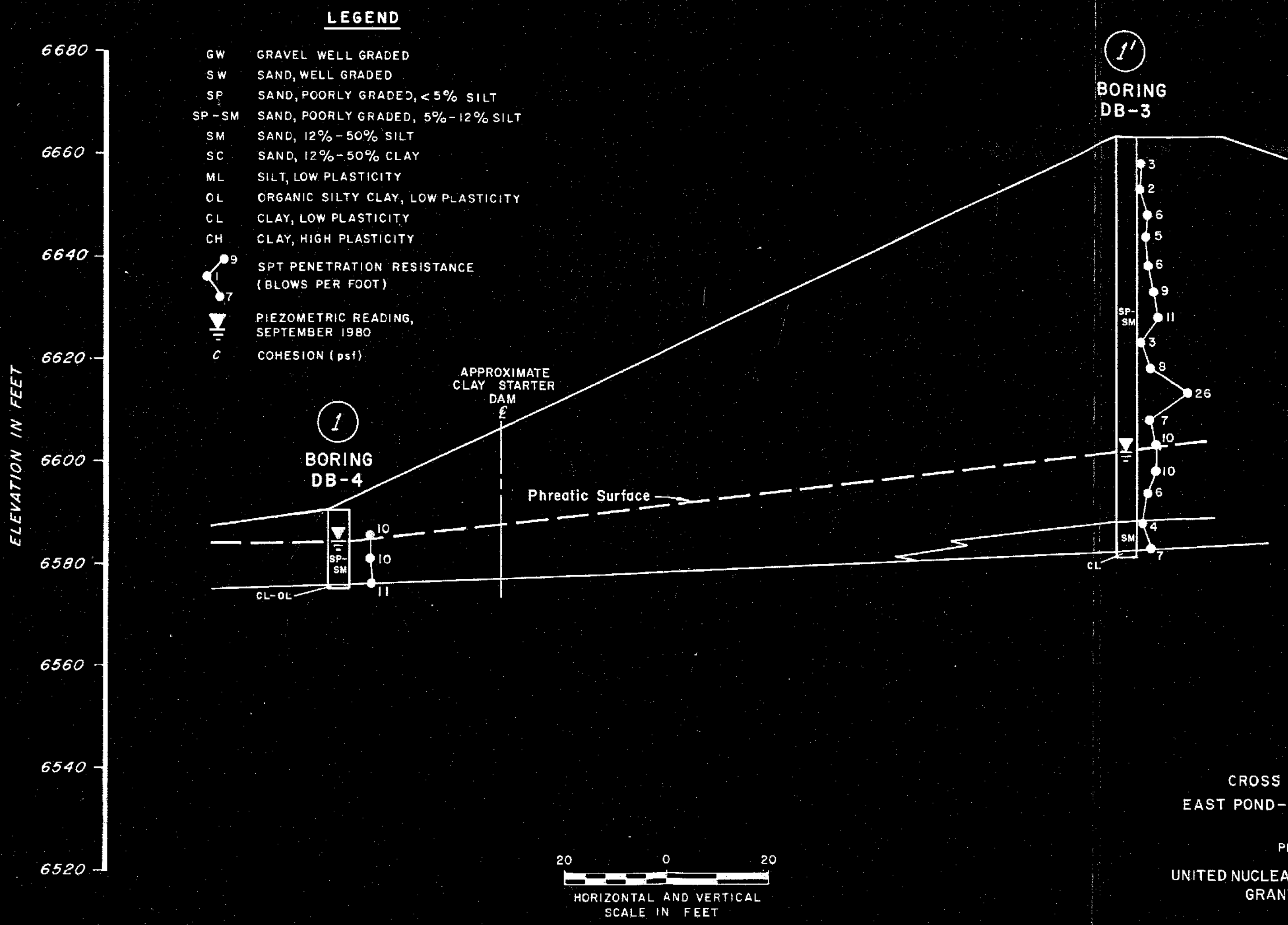

FIGURE 3

CROSS SECTION 1 - 1'
EAST POND-SOUTHEAST CORNER

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GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY M.J.G. 10/17/80 | CHECKED BY T.J.H. | APPROVED BY | DRAWING NUMBER RM80-311-B6

19 1253 HERCULENE ABB SMITH CO PGH PA LT1530-1079

HMCSL024425

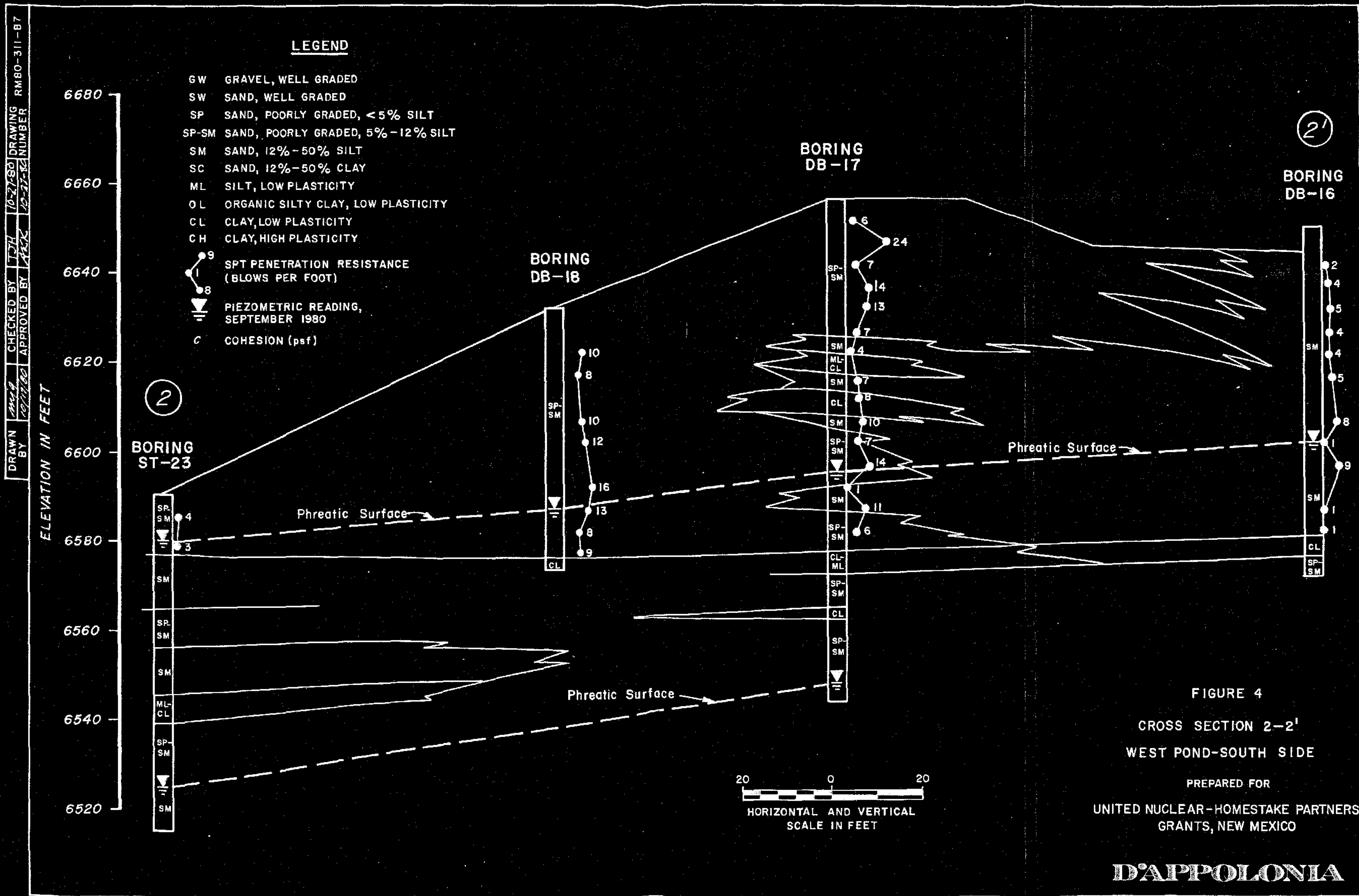

FIGURE 4

CROSS SECTION 2-2'

WEST POND-SOUTH SIDE

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GRANTS, NEW MEXICO

D'APPOLONIA

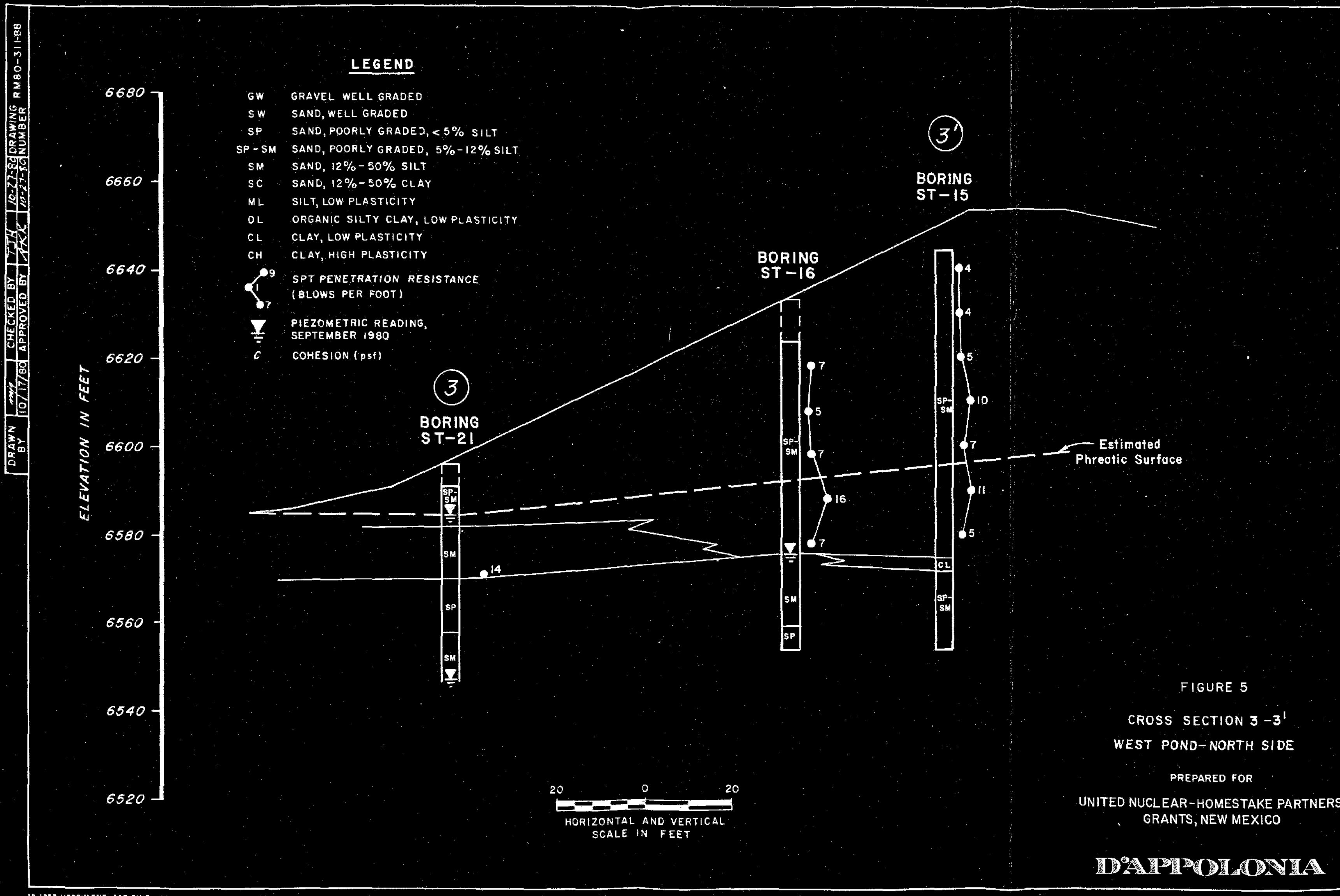

FIGURE 5

CROSS SECTION 3-3'

WEST POND-NORTH SIDE

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

HMCSL024427

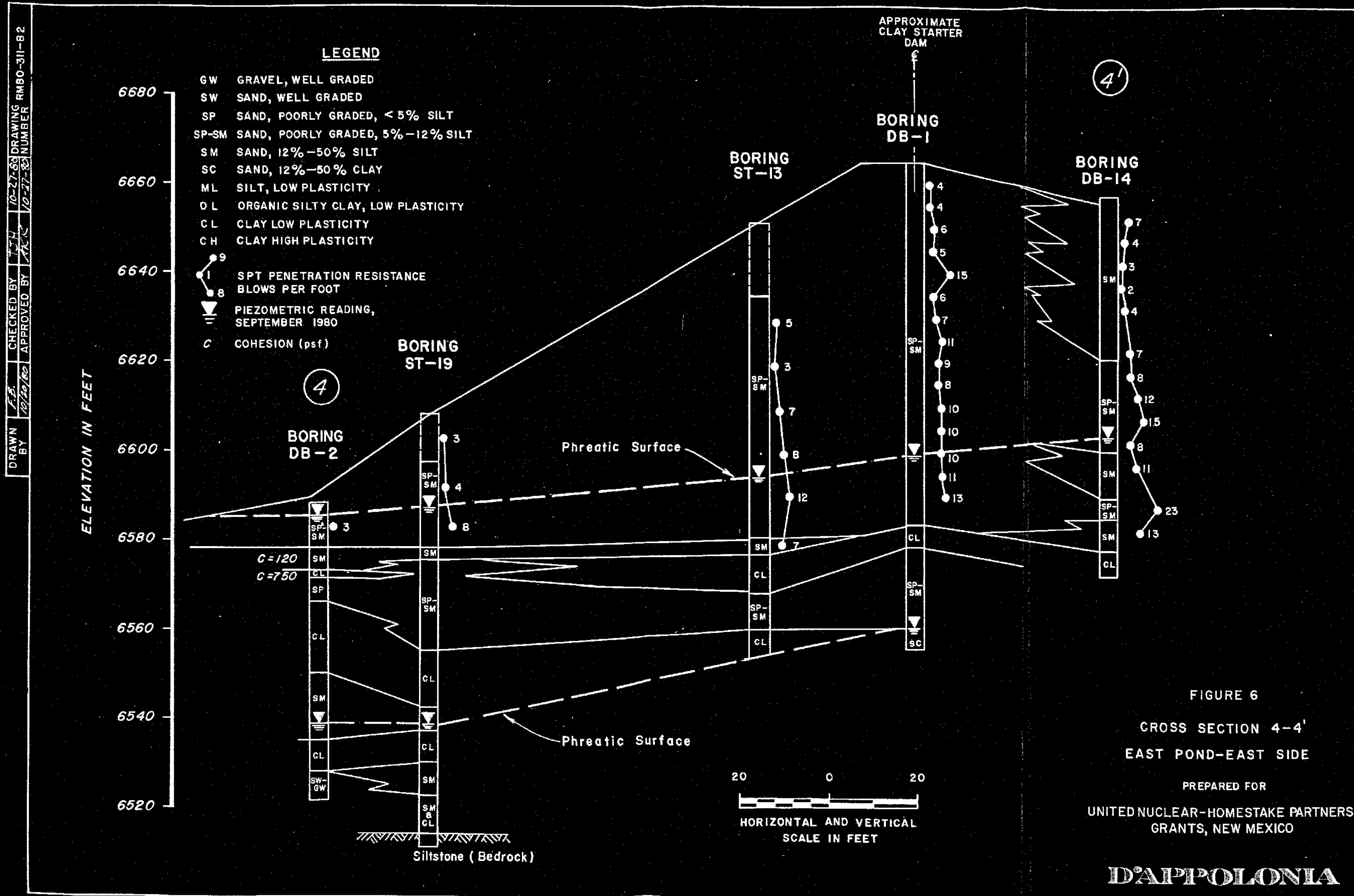

FIGURE 6

CROSS SECTION 4-4'

EAST POND-EAST SIDE

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GRANTS, NEW MEXICO

D'APPOLONIA

10 1253 HERCULENE, A&B SMITH CO., PGH., PA LT1530-1079

HMCSL024428

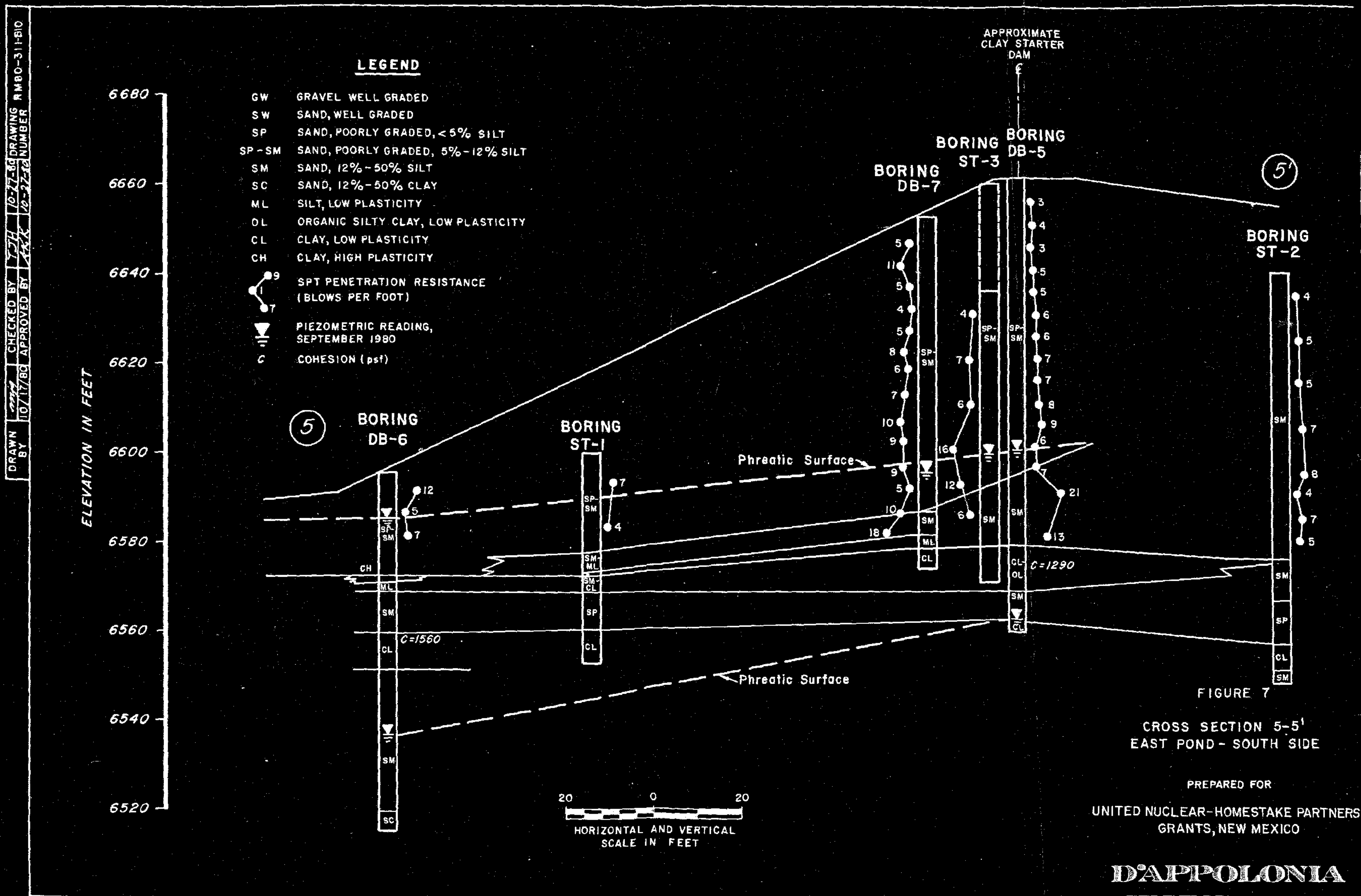

FIGURE 7

CROSS SECTION 5-5'
EAST POND - SOUTH SIDE

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HMCSL02442

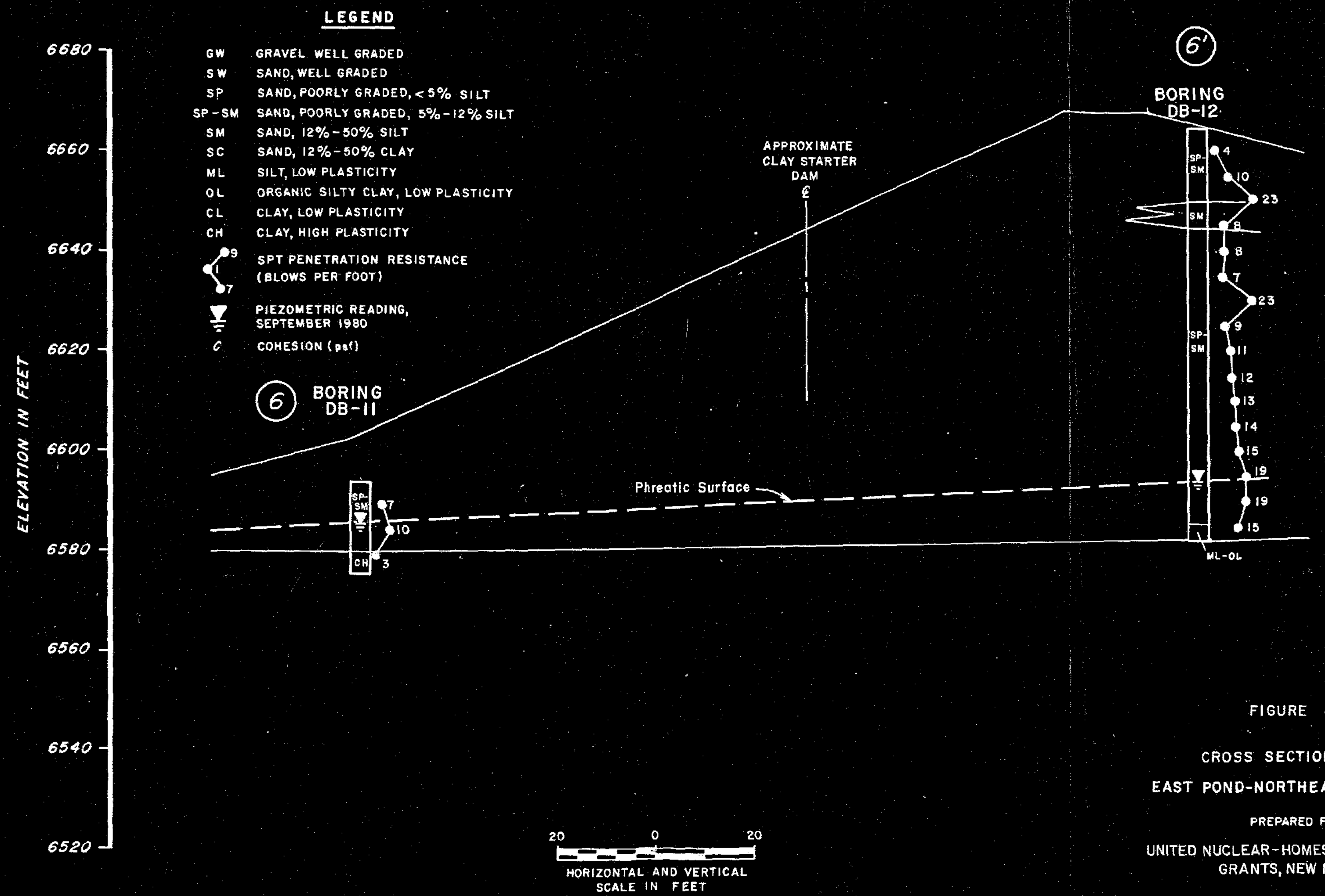

FIGURE 8

CROSS SECTION 6-6'

EAST POND-NORTHEAST CORNER

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GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY | CHECKED BY TJH | APPROVED BY | DRAWING NUMBER RM80-31-811
10/17/80 | 10-27-80 | 10-27-80

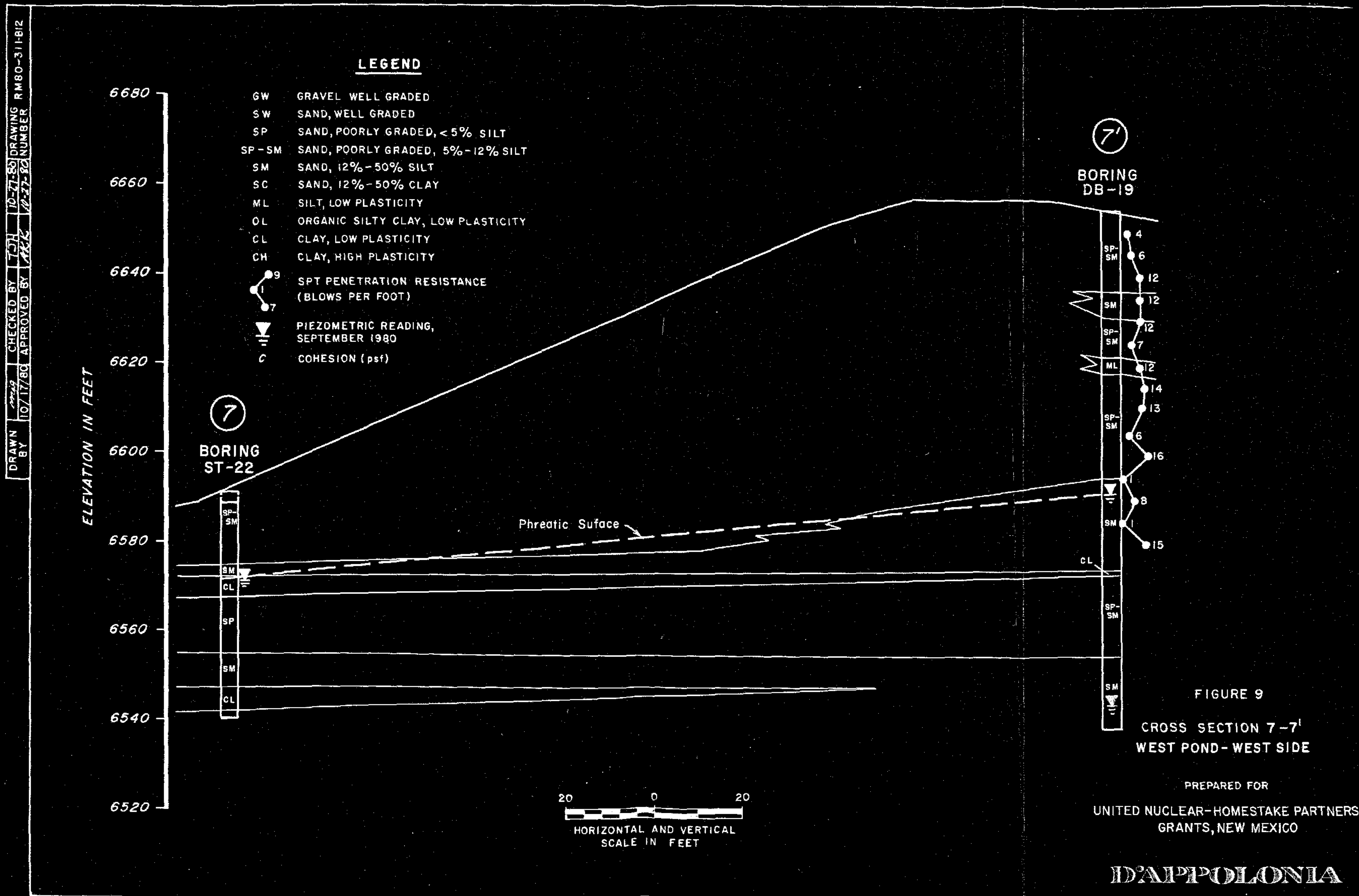

FIGURE 9

CROSS SECTION 7-7'
WEST POND-WEST SIDE

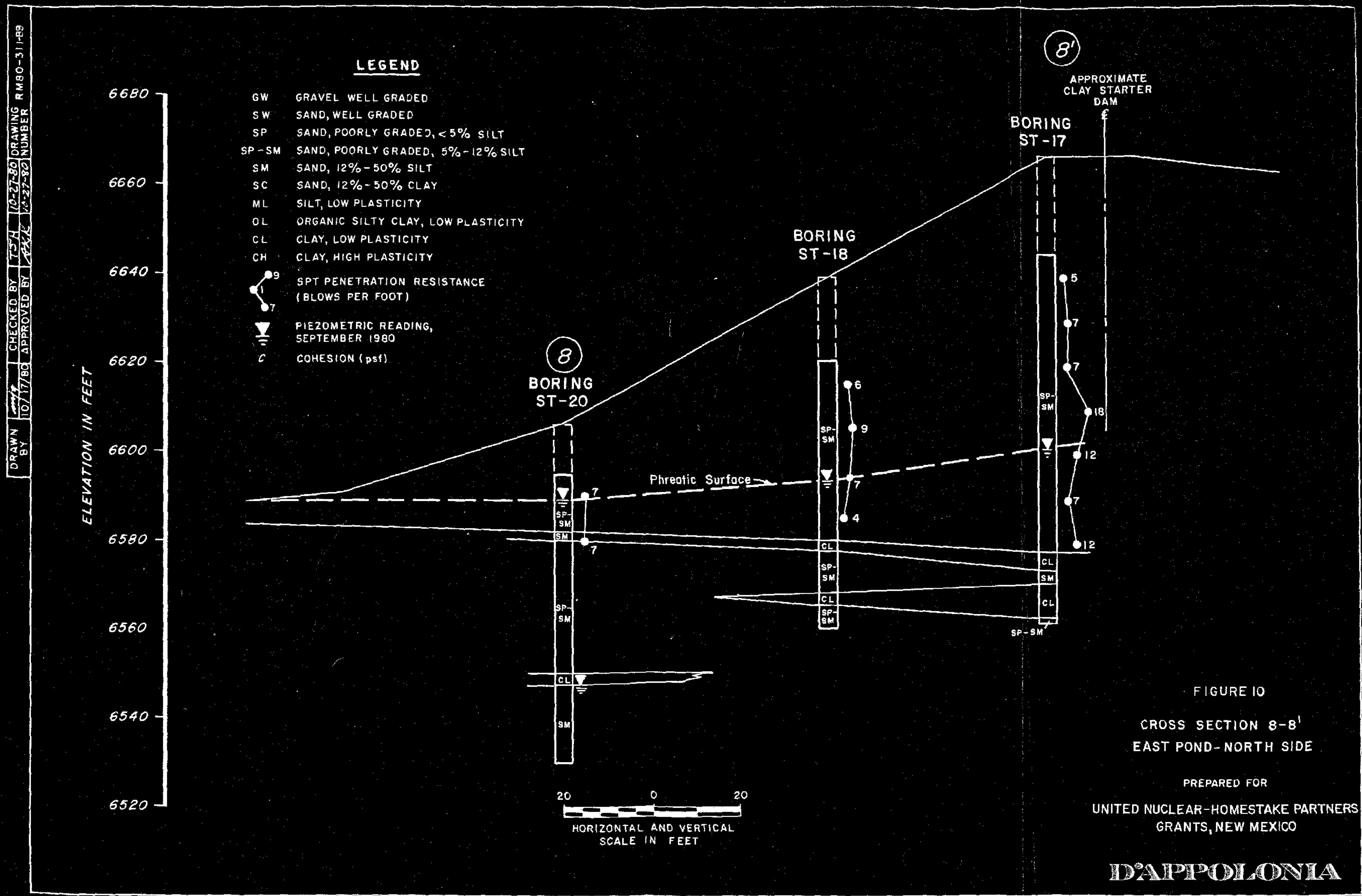

FIGURE 10

CROSS SECTION 8-8'
EAST POND-NORTH SIDE

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HMCSL024432

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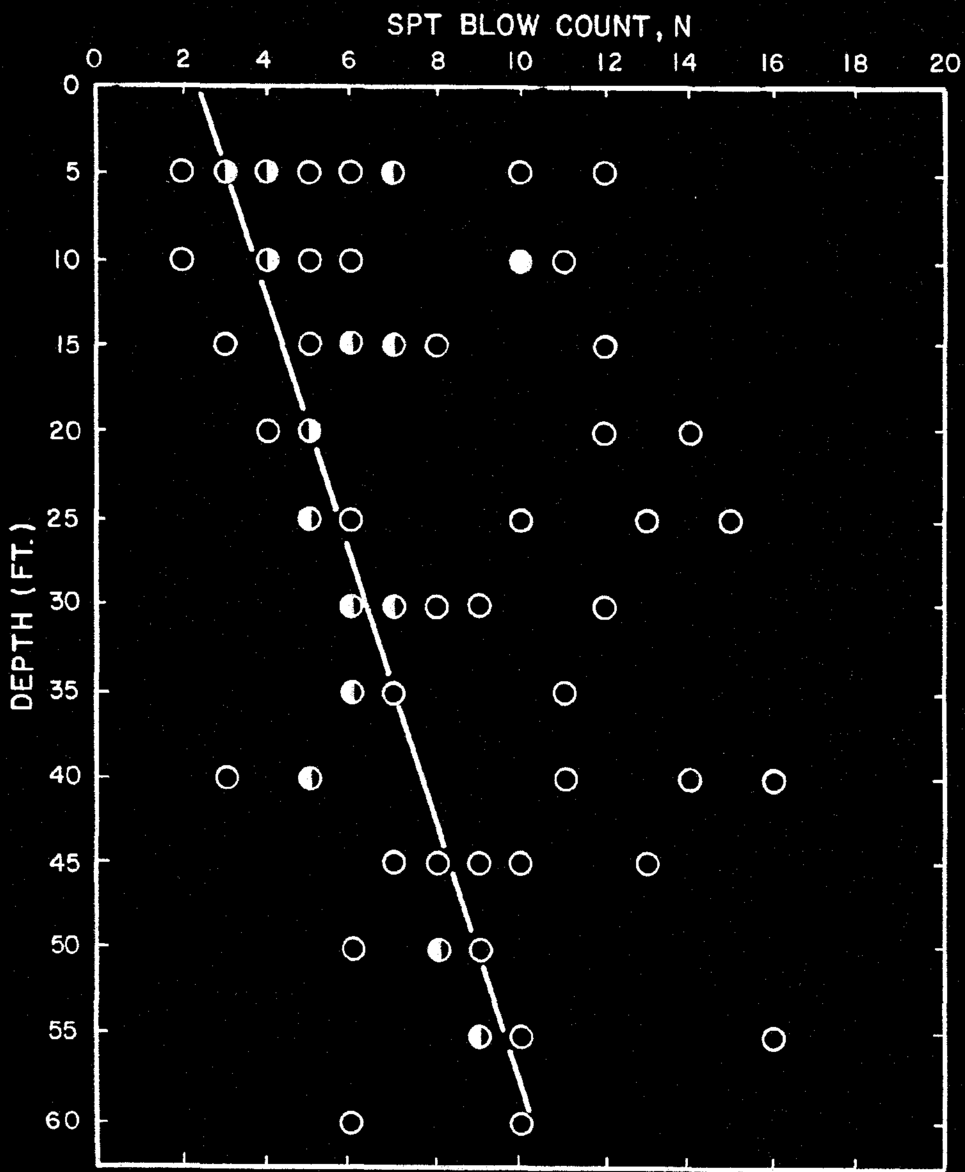
CHECKED BY JWN 10-25-80

APPROVED BY AKK 10-27-80



LEGEND

- ○ 1 POINT
- ◐ 2 POINTS
- ◑ 3 POINTS
- ● 4 POINTS

NOTE:

DATA POINTS ONLY INCLUDE TESTS ABOVE THE WATER TABLE, IN TAILINGS SAND.

FIGURE 11

BLOWCOUNT VERSUS DEPTH

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GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE A&B SM O PGH PA LT1530-1079

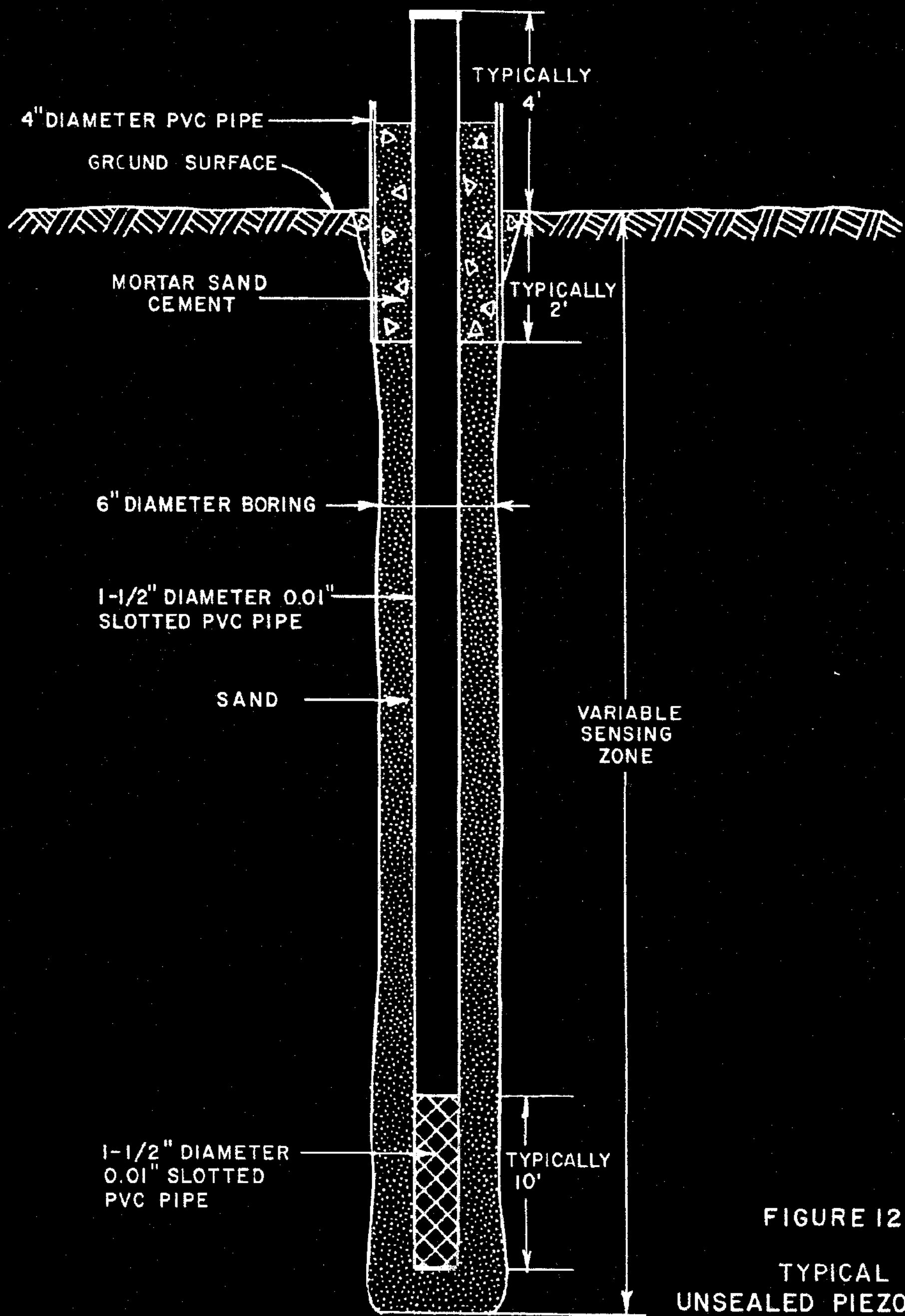


FIGURE 12

TYPICAL UNSEALED PIEZOMETER INSTALLATION

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWING NUMBER RM80-311-A5

CHECKED BY

APPROVED BY

DRAWN BY

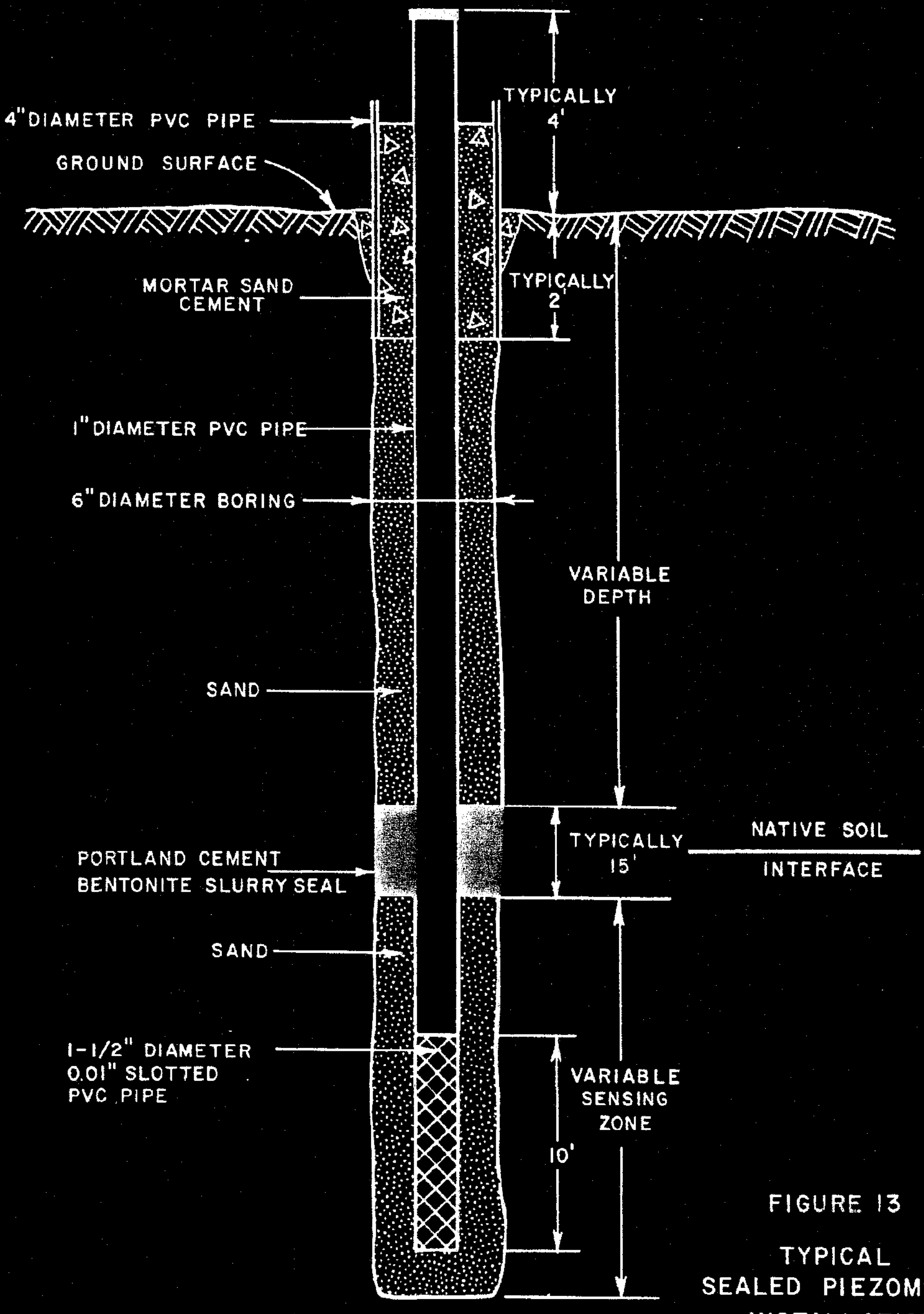


FIGURE 13

TYPICAL
SEALED PIEZOMETER
INSTALLATION

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

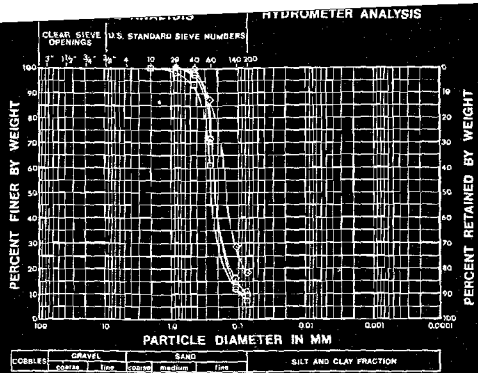
D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
8/20/80			RM80-311-A6

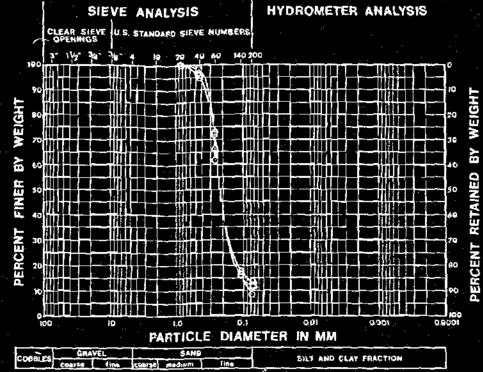
19 1253 HERCULENE

HMCSL024435

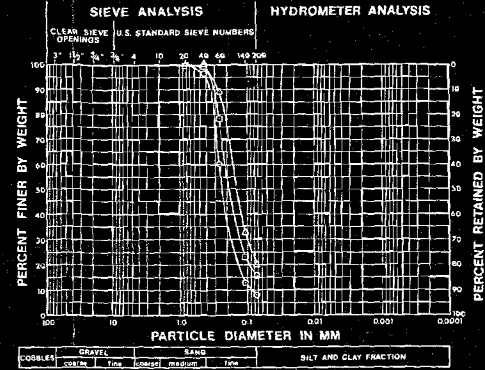
DRAWN BY	TEJ	CHECKED BY	JWN	10-24-80	DRAWING NUMBER RM80-311-E1
	10-22-80	APPROVED BY	MJT	10-24-80	



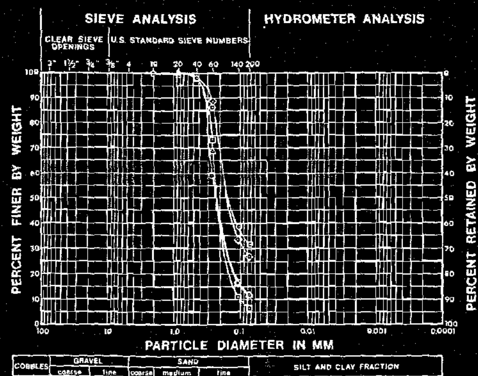
SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊙	D880-1A	S-6	25.0-26.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.09	2.7	6
△	D880-1A	S-9	45.0-46.5	BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	13
⊡	D880-2A	ST-1	7.5-9.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.095	2.6	20
⊙	D880-3	ST-5	25.0-26.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.09	3.3	19
◇	D880-3	S-15	75.0-76.5	BROWN-GRAY, FINE SAND, SOME SILT	SM	N/A	N/A	24



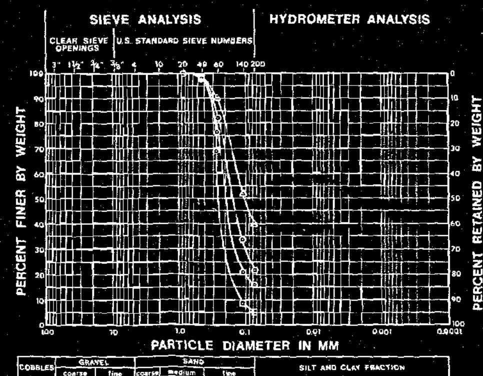
SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊙	D880-6A	S-5	15.0-16.5	LIGHT BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	8
⊡	D880-5A	S-13	65.0-66.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	23
△	D880-6A	S-2	10.0-11.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	18
⊙	D880-7	S-4	20.0-21.5	TAN, FINE SAND, SOME SILT	SP-SM	0.08	3.0	8
◇	D880-7	S-8	40.0-41.5	DARK BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	11



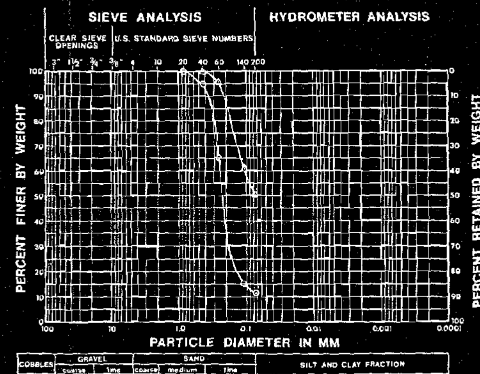
SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊙	D880-16	S-3	15.0-16.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.090	2.9	23
⊡	D880-16	ST-1	35.0-37.0	GRAY, FINE SAND, SOME SILT	SM	N/A	N/A	25
△	D880-16	S-9	45.0-46.5	GRAY, FINE SAND, SOME SILT	SM	N/A	N/A	25



SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊙	D880-14	S-3	16.0-16.5	BROWN, FINE SAND AND SILT	SM	N/A	N/A	27
⊡	D880-14	S-5	25.0-26.5	BROWN, FINE SAND, SOME SILT	SP-SM	0.10	2.4	27
△	D880-14	ST-1	30.0-32.0	BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	18
⊙	D880-14	S-8	40.0-41.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	15
◇	D880-14	S-11	60.0-61.5	GRAY FINE SAND, SOME SILT	SM	N/A	N/A	25



SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊙	D880-7	S-13	65.0-66.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	22
⊙	D880-17	S-4	20.0-21.5	BROWN, FINE SAND, TRACE OF SILT	SP	0.12	2.3	4
⊙	D880-17	S-6	30.0-31.5	BROWN, SILTY SAND	SM	N/A	N/A	24
⊙	D880-19	S-4	20.0-21.5	BROWN, FINE SAND, SOME SILT	SP	N/A	N/A	14



SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
⊖	FROM CYCLONE TRUCK	COARSE TAILINGS		BROWN, SILT AND FINE SAND	SM-ML	N/A	N/A	N/A
⊖		FINE TAILINGS		BROWN, FINE SAND, SOME SILT	SP-SM	N/A	N/A	N/A

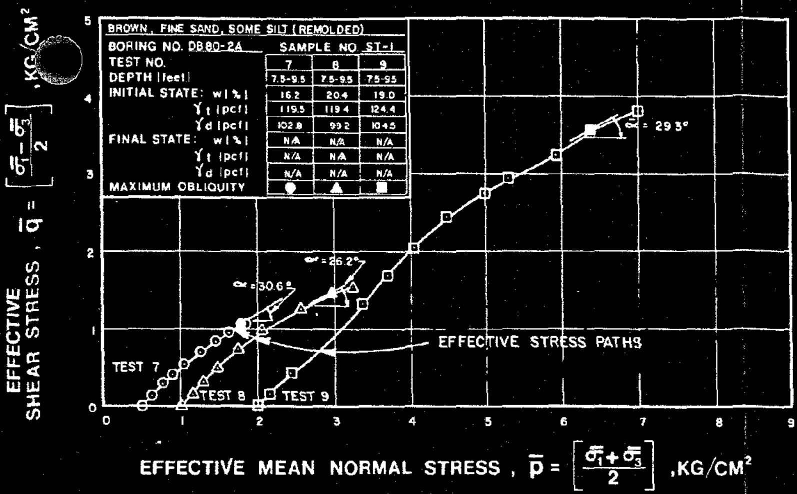
FIGURE 14

TAILINGS GRAIN SIZE CURVES

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA



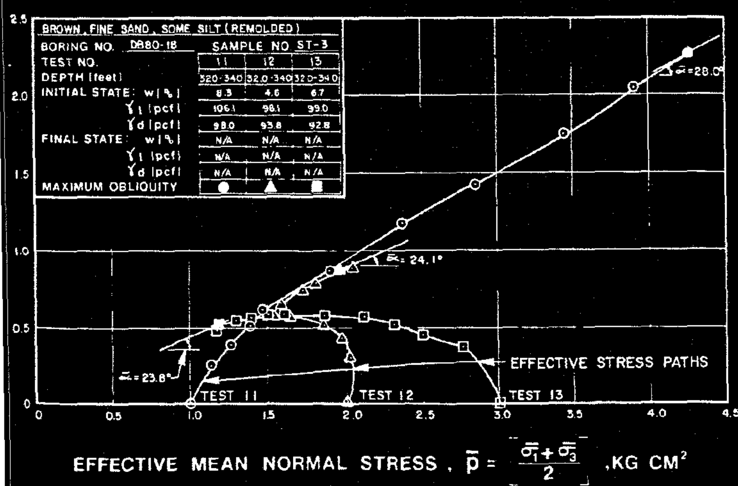
$\sin \bar{\phi} = \tan \bar{\alpha}$

$\bar{c} = \frac{\bar{a}}{\cos \bar{\phi}}$

TEST NO.	7	8	9
$\bar{\alpha}$	30.6°	26.2°	29.3°
$\bar{\phi}$	36.3°	29.5°	34.1°
$\bar{c}$	0	0	0

TEST PARAMETERS			
TEST NO.	7	8	9
STRAIN RATE (in./min.)	0.009	0.011	0.0067
BACK PRESSURE (kg./cm.²)	0.5	1.0	2.0
CONSOLIDATION TIME (days)	3.0	0.17	0.17

SAMPLE DIMENSIONS			
DIAMETER (inches)	2.85	2.90	2.85
LENGTH (inches)	5.70	5.70	5.65



$\sin \bar{\phi} = \tan \bar{\alpha}$

$\bar{c} = \frac{\bar{a}}{\cos \bar{\phi}}$

TEST NO.	11	12	13
$\bar{\alpha}$	28.0°	24.1°	23.8°
$\bar{\phi}$	32.1°	26.6°	26.1°
$\bar{c}$	0	0	0

TEST PARAMETERS			
TEST NO.	11	12	13
STRAIN RATE (in. min.)	0.016	0.018	0.013
BACK PRESSURE (kg. cm²)	1.0	2.0	2.5
CONSOLIDATION TIME (days)	0.21	0.17	0.21

SAMPLE DIMENSIONS			
DIAMETER (inches)	2.88	2.88	2.86
LENGTH (inches)	5.40	5.72	5.75

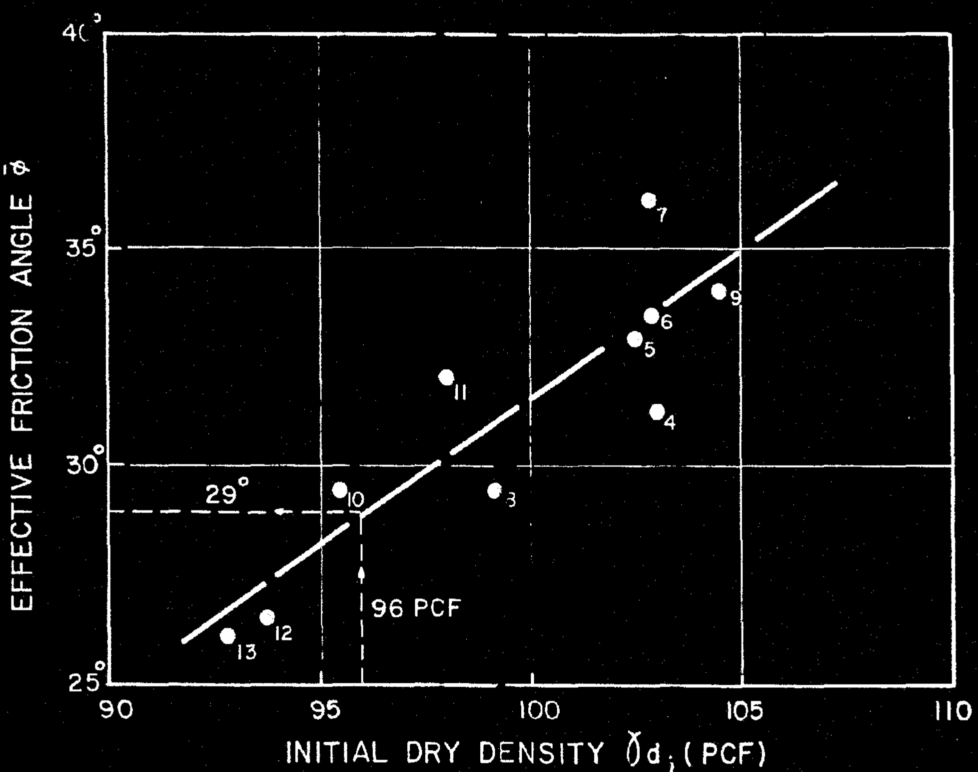
FIGURE 15

TAILINGS TRIAXIAL SHEAR TEST RESULTS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA



NOTE:

FRICTION ANGLES WERE MEASURED IN CONSOLIDATED-UNDRAINED TRIAXIAL TESTS ON REMOLDED TAILINGS SAMPLES. NUMBERS ADJACENT TO DATA POINTS INDICATE TEST NUMBER. SEE FIGURE 15 FOR DETAILS OF INDIVIDUAL TESTS.

FIGURE 16

TAILINGS FRICTION ANGLE VERSUS DRY DENSITY

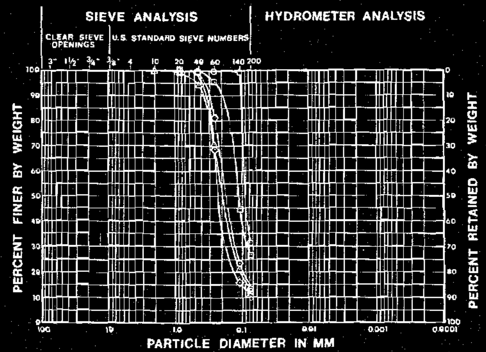
PREPARED FOR

UNITED NUCLEAR–HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

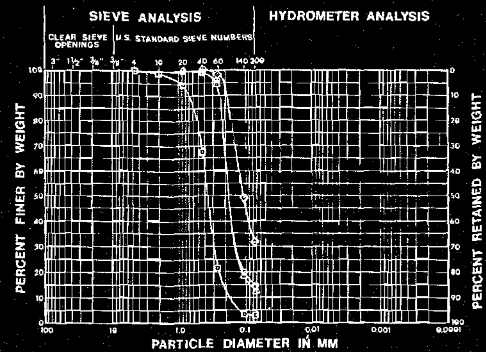
DRAWN BY	TEJ 10-21-80
CHECKED BY	10-25-80
APPROVED BY	10-27-80
DRAWING NUMBER	RM 80-311-A4

DRAWN BY	TEJ	CHECKED BY	JWN	10-24-80	DRAWING NUMBER RM80-311-E3
	10-22-80	APPROVED BY	MJT	10-24-80	



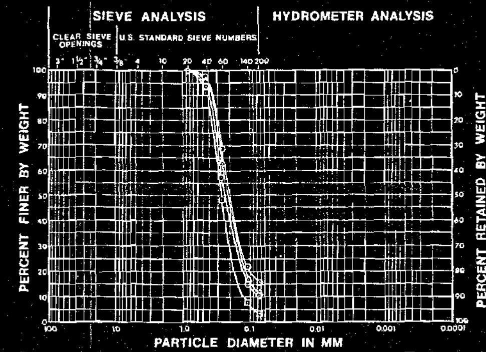
COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-2A	S-2	12.5 - 14.0	BROWN, SILTY FINE SAND	SM	N/A	N/A	30
□	DB80-2A	S-9	40.0 - 41.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	8
△	DB80-2A	ST-4	41.5 - 42.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	6
⊙	DB80-12	S-4	20.0 - 21.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	6
◇	DB80-12	S-13	65.0 - 66.5	BROWN, FINE SAND, SOME SILT	SP - SM	N/A	N/A	11



COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

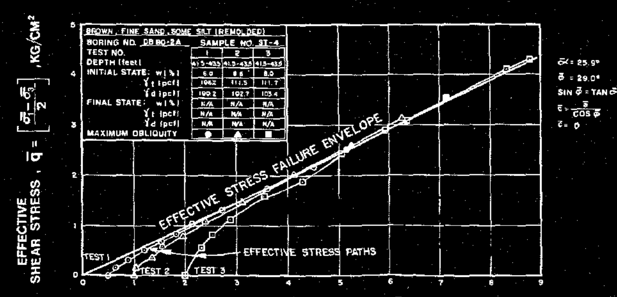
SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-1A	S-18	90.0 - 91.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	20
□	DB80-1A	S-19	100.0 - 101.5	TAN, FINE TO MEDIUM SAND, TRACE SILT	SP	0.14	2.9	3
△	DB80-6A	S-5	30.0 - 31.5	TAN, FINE SAND, SOME SILT	SM	N/A	N/A	7
⊙	DB80-6A	S-8	50.0 - 51.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	16



COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	WC,%
○	DB80-16	S-4	25.0 - 26.5	BROWN, FINE SAND, SOME SILT	SP - SM	N/A	N/A	7
□	DB80-18	ST-3	35.0 - 37.0	BROWN, FINE SAND, TRACE SILT	SP	0.9	3.1	N/A
△	DB80-18	S-8	50.0 - 51.5	GRAY, FINE SAND, SOME SILT	SP - SM	N/A	N/A	21
⊙	DB80-19	S-12	60.0 - 61.5	BROWN, FINE SAND, SOME SILT	SM	N/A	N/A	24

GRAIN SIZE CURVES



BROWN, FINE SAND, SOME SILT (REMOLDED)			
BORING NO. DB80-2A	SAMPLE NO. ST-4		
TEST NO.	1	2	3
DEPTH (feet)	41.5-43.5	41.5-43.5	41.5-43.5
INITIAL STATE: w (%)	6.0	8.6	8.0
γ_t (pcf)	106.2	111.5	111.7
γ_d (pcf)	100.2	102.7	103.4
FINAL STATE: w (%)	N/A	N/A	N/A
γ_t (pcf)	N/A	N/A	N/A
γ_d (pcf)	N/A	N/A	N/A
MAXIMUM OBLIQUITY	●	▲	■

EFFECTIVE MEAN NORMAL STRESS, $\bar{p} = \left[\frac{\bar{\sigma}_1 + \bar{\sigma}_3}{2}\right]$, KG/CM²

TEST PARAMETERS			
TEST NO.	1	2	3
STRAIN RATE (in/min)	0.015	0.017	0.017
BACK PRESSURE (kg/cm²)	2.50	2.50	2.50
CONSOLIDATION TIME (days)	0.21	0.21	0.21

SAMPLE DIMENSIONS			
DIAMETER (inches)	2.86	2.86	2.85
LENGTH (inches)	5.70	5.72	5.72

TRIAXIAL SHEAR TESTS

FIGURE 17

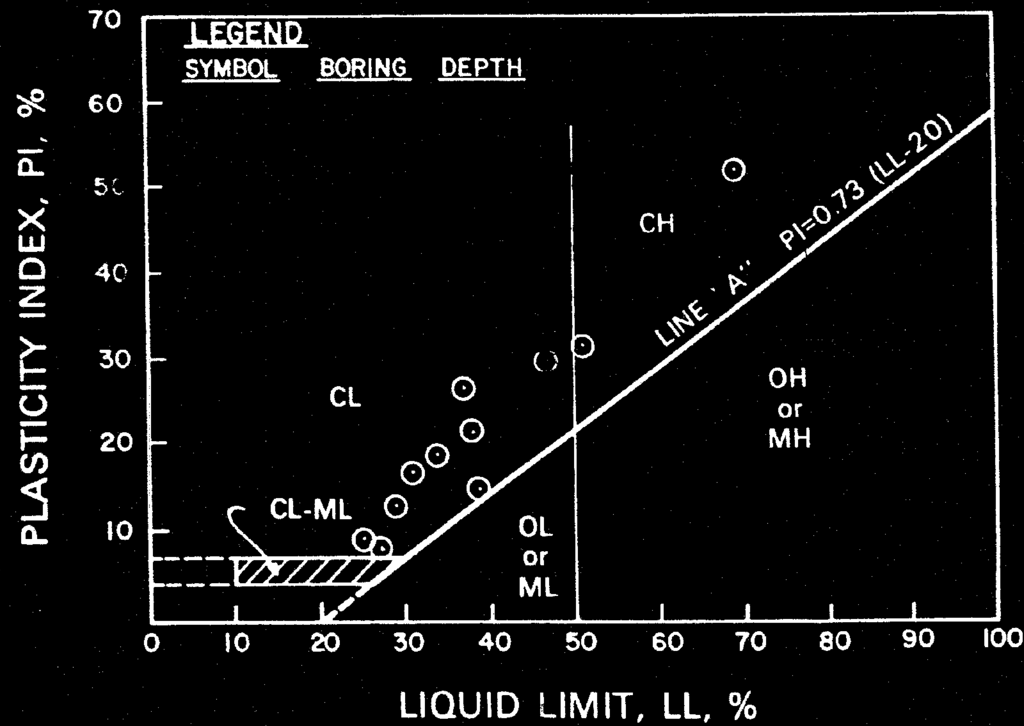
NATIVE SAND
LABORATORY
TEST RESULTS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

HMCSL024439



SILTS AND CLAYS LIQUID LIMIT 50% OR LESS	ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY

FIGURE 18

NATIVE CLAY
ATTERBERG LIMITS TEST RESULTS

PREPARED FOR
UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY TEJ 10-24-80
CHECKED BY WWN 10-25-80
APPROVED BY
DRAWING NUMBER RM80-311-A3

DRAWN BY MJG 10/22/80 | CHECKED BY | APPROVED BY | DRAWING NUMBER RM80-311-A7

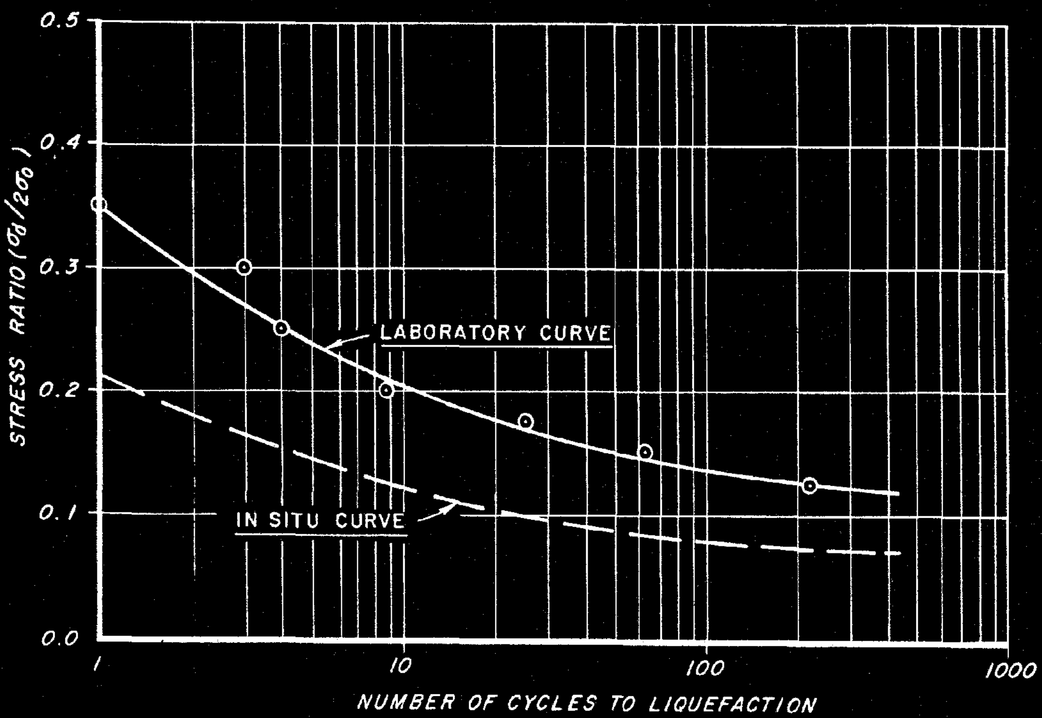


FIGURE 19

LIQUEFACTION RESISTANCE OF COARSE TAILINGS STRESS RATIO VERSUS NUMBER OF CYCLES TO LIQUEFACTION

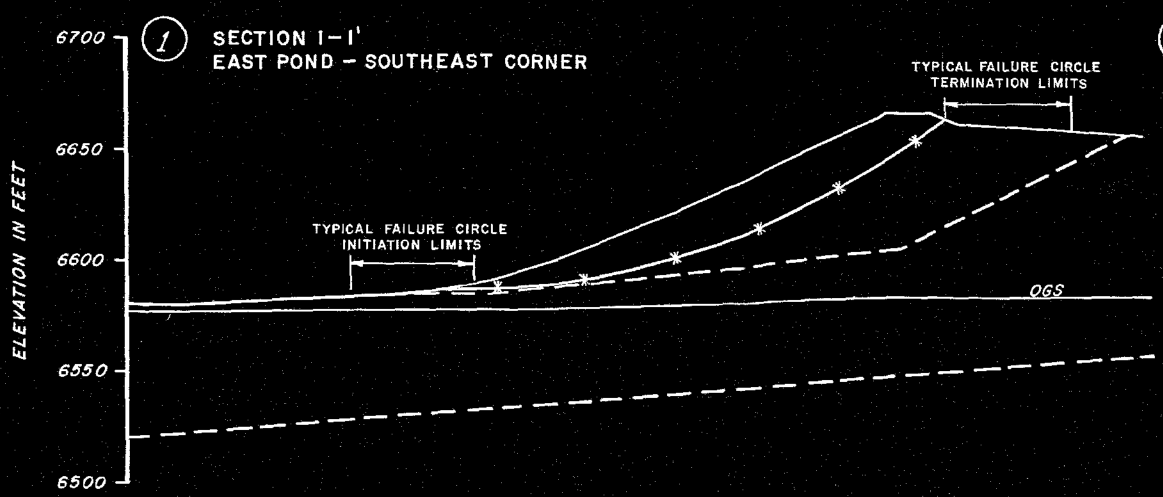
PREPARED FOR

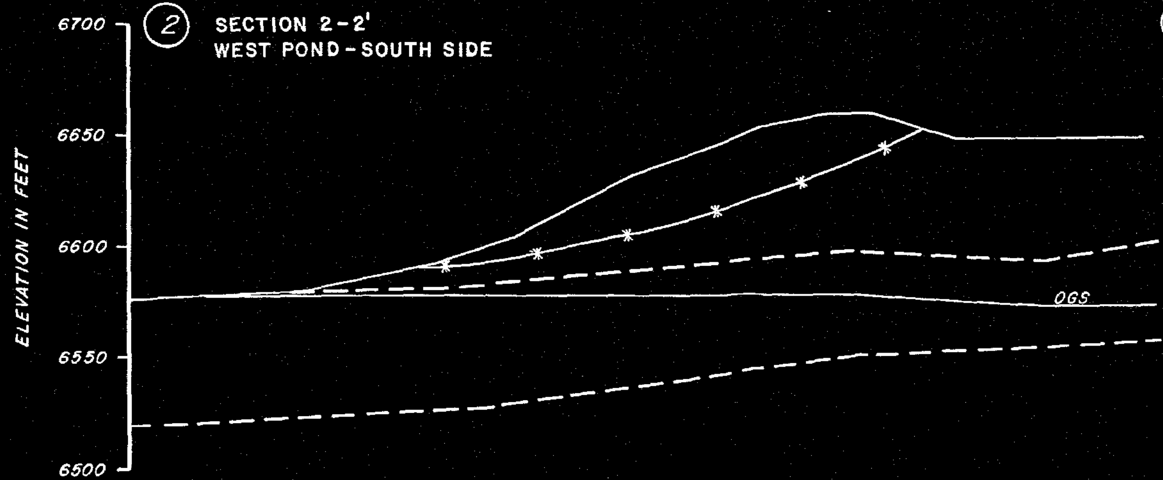
UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

HMCSL024441

DRAWN BY		CHECKED BY	TJH	10-27-80	DRAWING NUMBER	RM80-311-B13
		APPROVED BY	AKK	10-27-80		





NOTE: PROFILE AND PHREATIC SURFACE, SEPTEMBER 1980

LEGEND

- —*— CRITICAL FAILURE SURFACE FOR STATIC AND PSEUDO STATIC STABILITY
- — — PHREATIC SURFACE
- OGS APPROXIMATE ORIGINAL GROUND SURFACE

CRITICAL FACTORS OF SAFETY		
	STATIC	PSEUDO STATIC
SECTION 1-1'	1.42	1.16
SECTION 2-2'	1.84	1.42

50 0 50
SCALE IN FEET

FIGURE 20

STATIC AND PSEUDO STATIC FACTORS OF SAFETY SECTION 1-1' AND SECTION 2-2'

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GRANTS, NEW MEXICO

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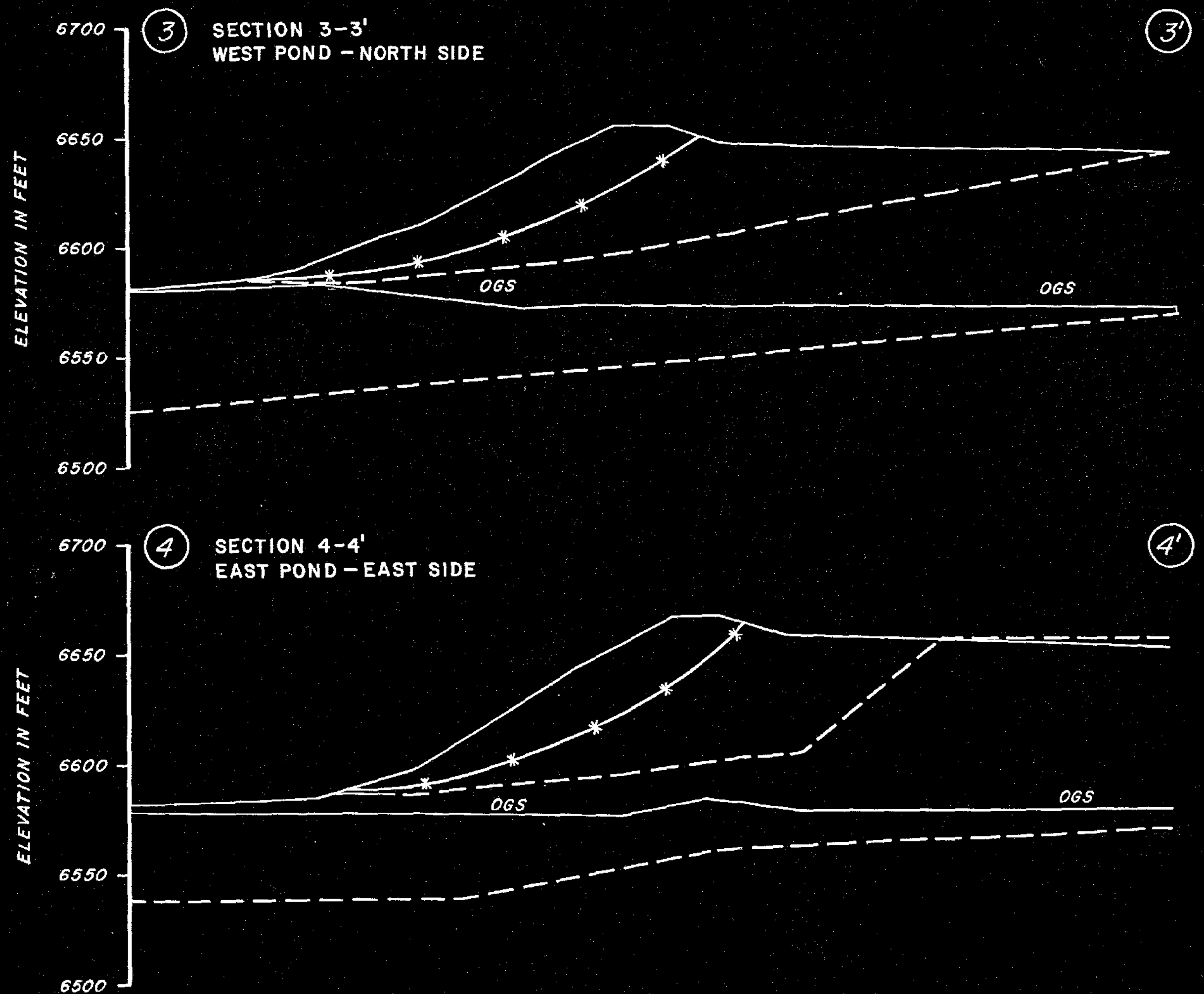
DRAWN BY [illegible] 10/22/80 | CHECKED BY TJH 10-27-80 | APPROVED BY [illegible] 10-27-80 | DRAWING NUMBER RM80-311-B14



NOTE: PROFILE AND PHREATIC SURFACE, SEPTEMBER 1980

LEGEND

—✱— CRITICAL FAILURE SURFACE FOR STATIC AND PSEUDO STATIC STABILITY

— — PHREATIC SURFACE

OGS APPROXIMATE ORIGINAL GROUND SURFACE

CRITICAL FACTORS OF SAFETY		
LOCATION	STATIC	PSEUDO STATIC
SECTION 3-3'	1.46	1.20
SECTION 4-4'	1.18	1.01

50 0 50
SCALE IN FEET

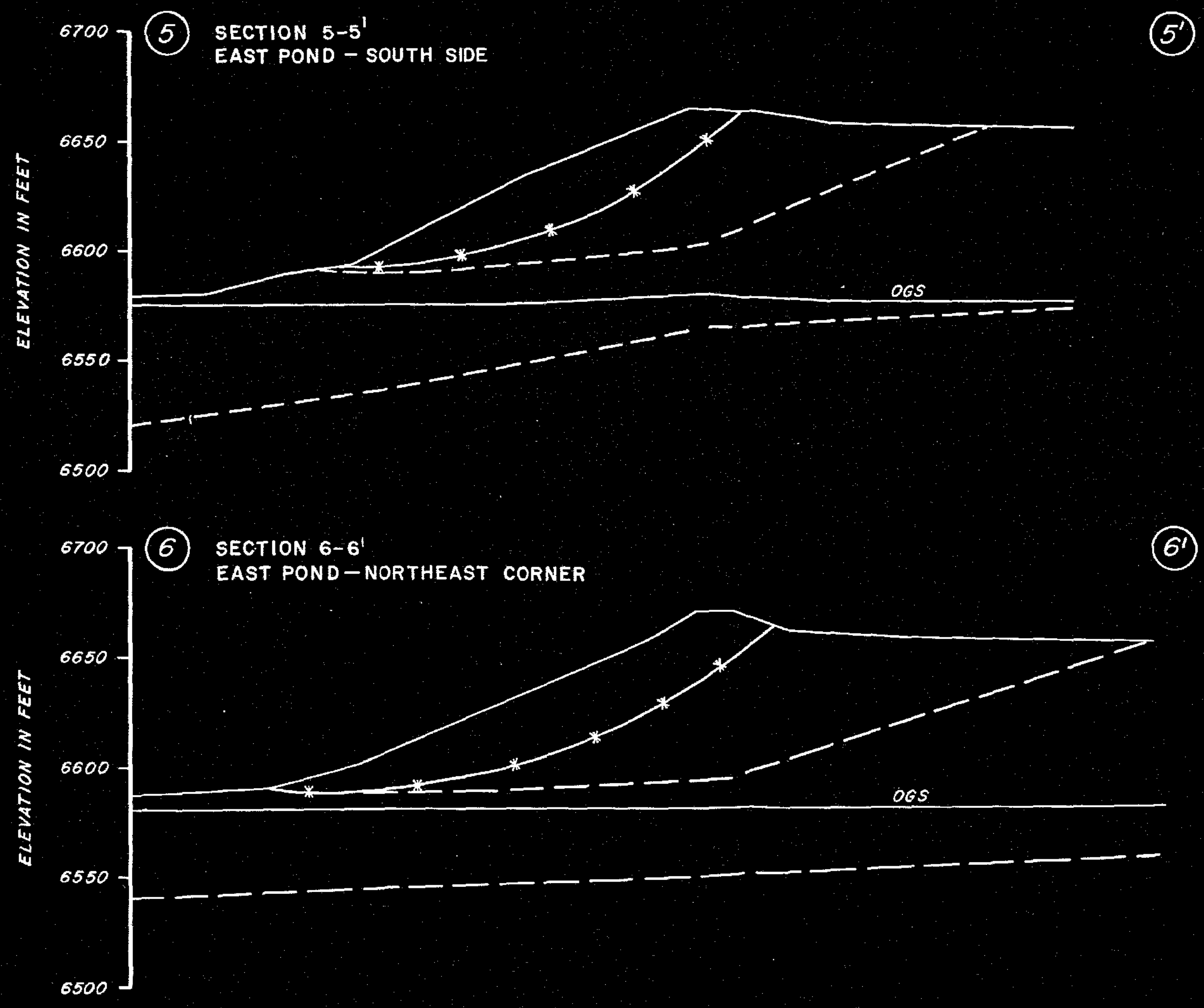
FIGURE 21

STATIC AND PSEUDO STATIC FACTORS OF SAFETY SECTION 3-3' AND SECTION 4-4'

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA



NOTE: PROFILE AND PHREATIC SURFACE, SEPTEMBER 1980

LEGEND

—✱— CRITICAL FAILURE SURFACE FOR STATIC AND PSEUDO STATIC STABILITY

— — PHREATIC SURFACE

OGS APPROXIMATE ORIGINAL GROUND SURFACE

CRITICAL FACTORS OF SAFETY		
LOCATION	STATIC	PSEUDO STATIC
SECTION 5-5'	1.35	1.12
SECTION 6-6'	1.53	1.25

50 0 50
SCALE IN FEET

FIGURE 22

STATIC AND PSEUDO STATIC FACTORS OF SAFETY SECTION 5-5' AND SECTION 6-6'

PREPARED FOR

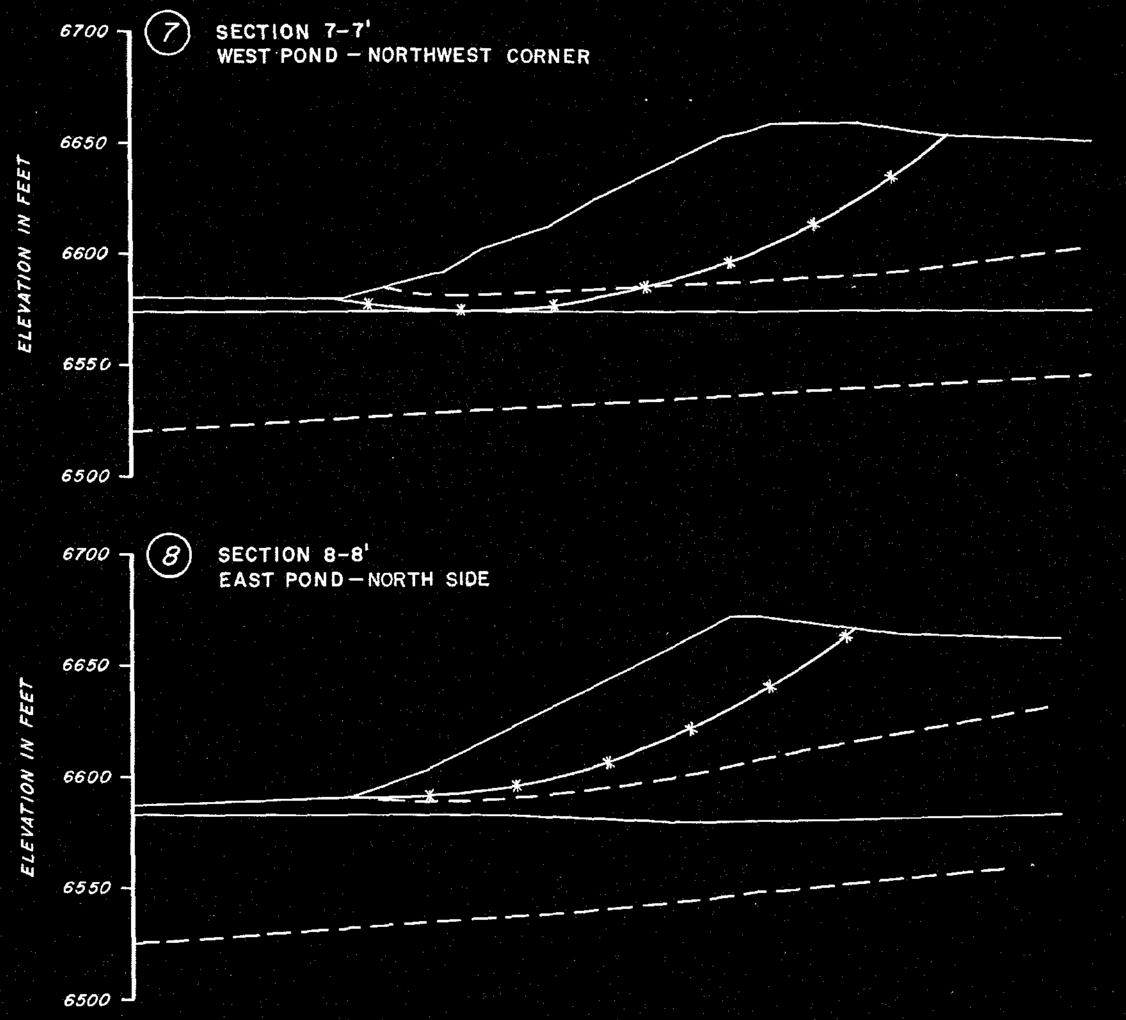
UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	F.B.	10/22/80	CHECKED BY	TJH	10-27-80	DRAWING NUMBER	RM80-311-B15
			APPROVED BY	[illegible]	[illegible]		

19 1253 HERCULENE. ASB SMITH CO., PGH., PA LT1530-1079

HMCSL024444



NOTE: PROFILE AND PHREATIC SURFACE, SEPTEMBER 1980

LEGEND

—✱— CRITICAL FAILURE SURFACE FOR STATIC AND PSEUDO STATIC STABILITY

— — PHREATIC SURFACE

OGS APPROXIMATE ORIGINAL GROUND SURFACE

CRITICAL FACTORS OF SAFETY		
	STATIC	PSEUDO STATIC
SECTION 7-7'	1.79	1.42
SECTION 8-8'	1.56	1.26

50 0 50
SCALE IN FEET

FIGURE 23

STATIC AND PSEUDO STATIC FACTORS OF SAFETY SECTION 7-7' AND SECTION 8-8'

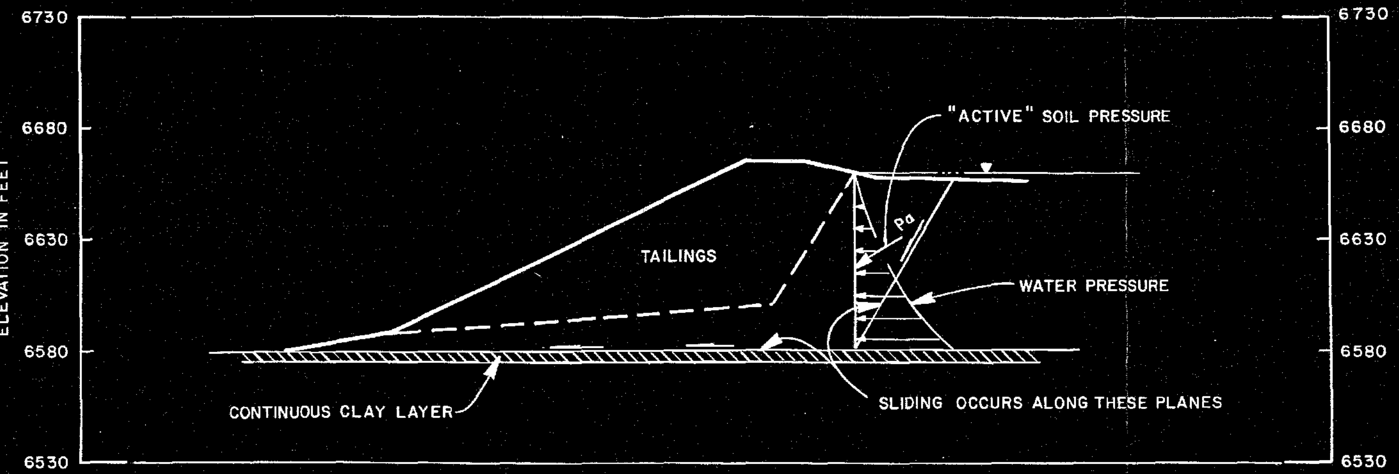
PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	JB 10/24/80	CHECKED BY	TJH 10-27-80	DRAWING NUMBER	RM80-311-B16
		APPROVED BY	AKK 10-27-80		

DRAWN BY	TEJ 10-25-80	CHECKED BY	KWN 10-25-80	APPROVED BY	10-27-80	DRAWING NUMBER	RM80-311-B3



TYPICAL CROSS SECTION EAST POND

FIGURE 24

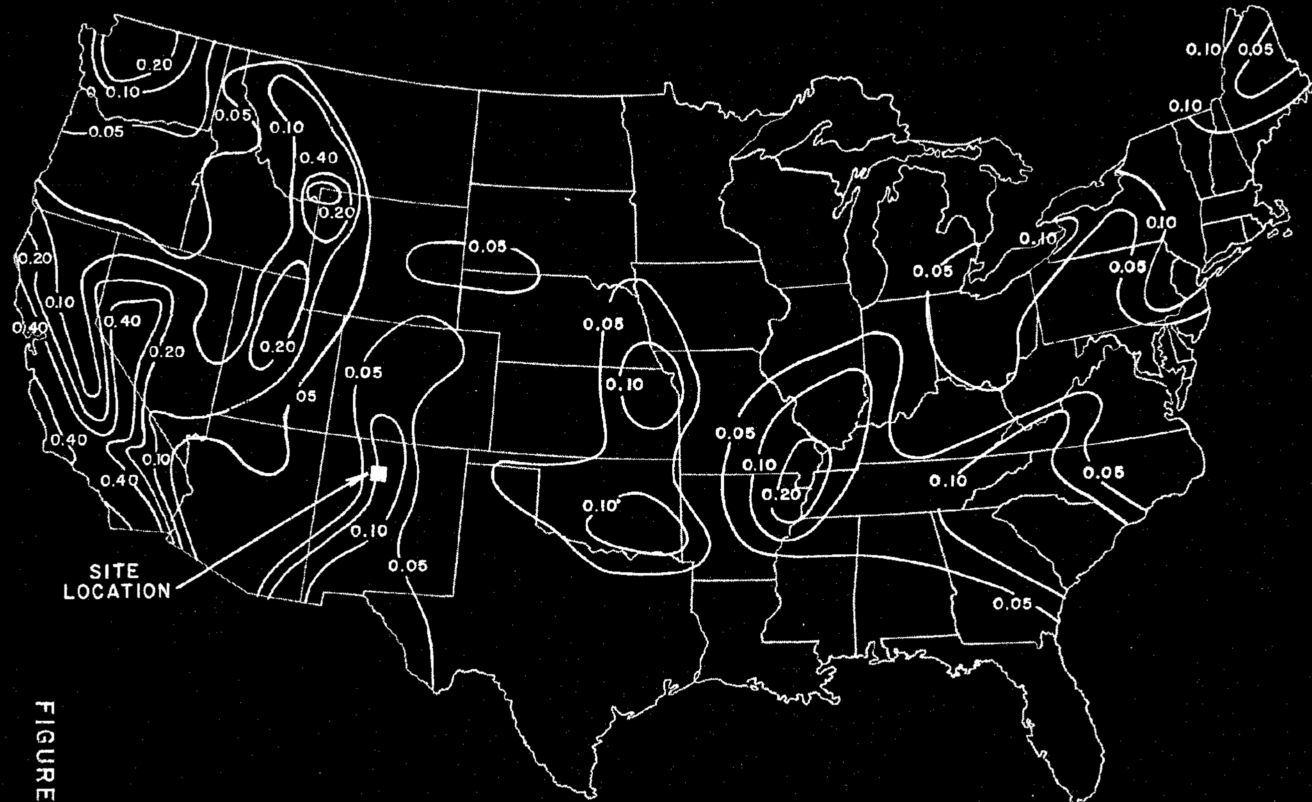
SLIDING WEDGE ANALYSIS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	mjg 6/5/80	CHECKED BY / APPROVED BY	TJH / MJT	6-14-8 / [illegible]	DRAWING NUMBER	RM80-311-A8



NOTE: The numbers on the contours are values of EPA in units of acceleration of gravity.
Taken from "Tenative Provisions for the Development of Seismic Regulations for Buildings" prepared by Applied Technology Council, June 1978.

FIGURE 25

CONTOUR MAP
FOR
EFFECTIVE PEAK ACCELERATION

PREPARED FOR
UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE. A&B SMITH CO. PGH., PA LT1530.1079

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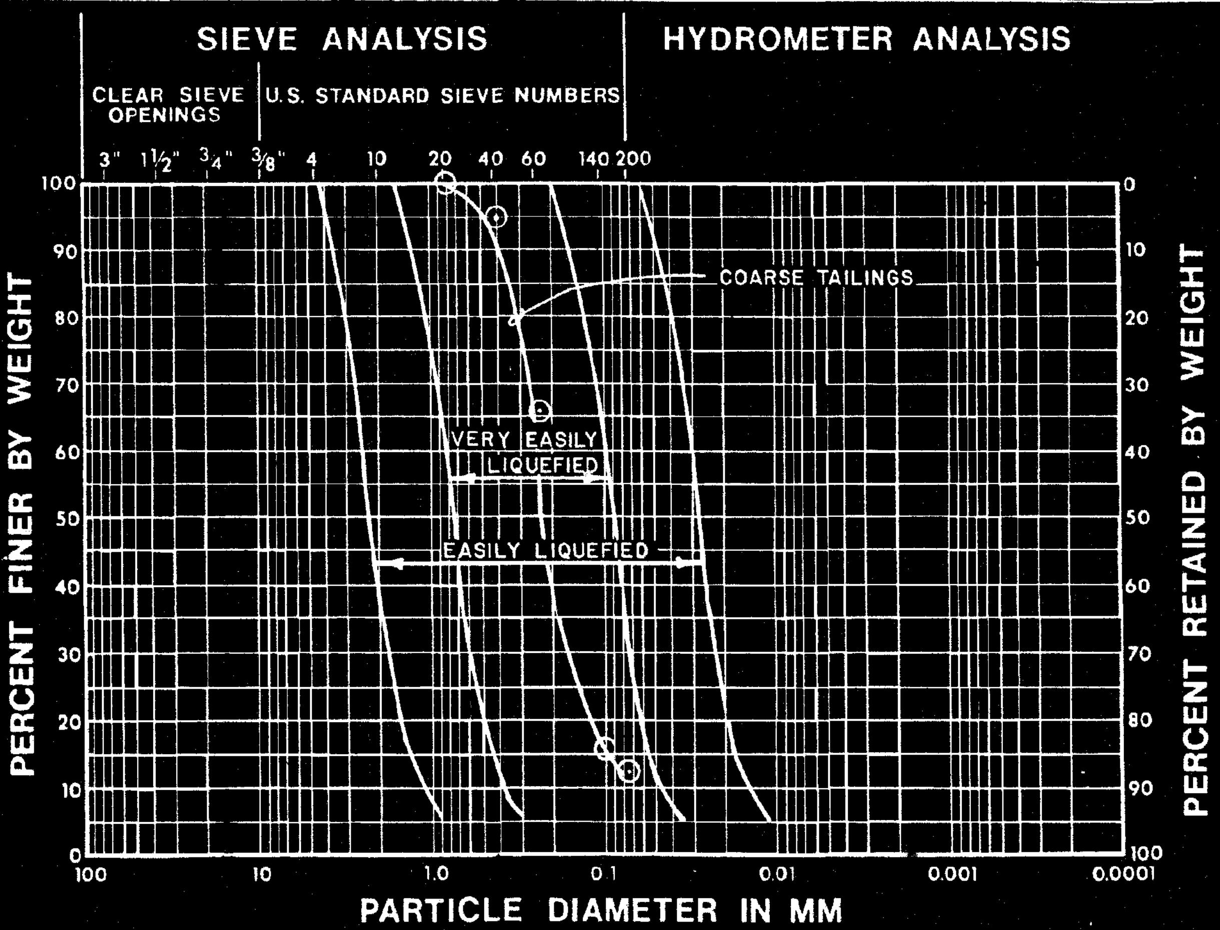

COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	D_{10}	C_u	W,%

FIGURE 26

COARSE TAILINGS COMPARED TO RANGE OF LIQUEFIABLE UNIFORMLY GRADED SOILS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

NOTE:
LIQUEFACTION RANGE REFERENCE: EARTHQUAKE RESISTANT DESIGN FOR CIVIL ENGINEERING STRUCTURES, EARTH STRUCTURES AND FOUNDATIONS IN JAPAN, 1977

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			APPROVED BY	[illegible]	10-27-80	RM80-311-A10

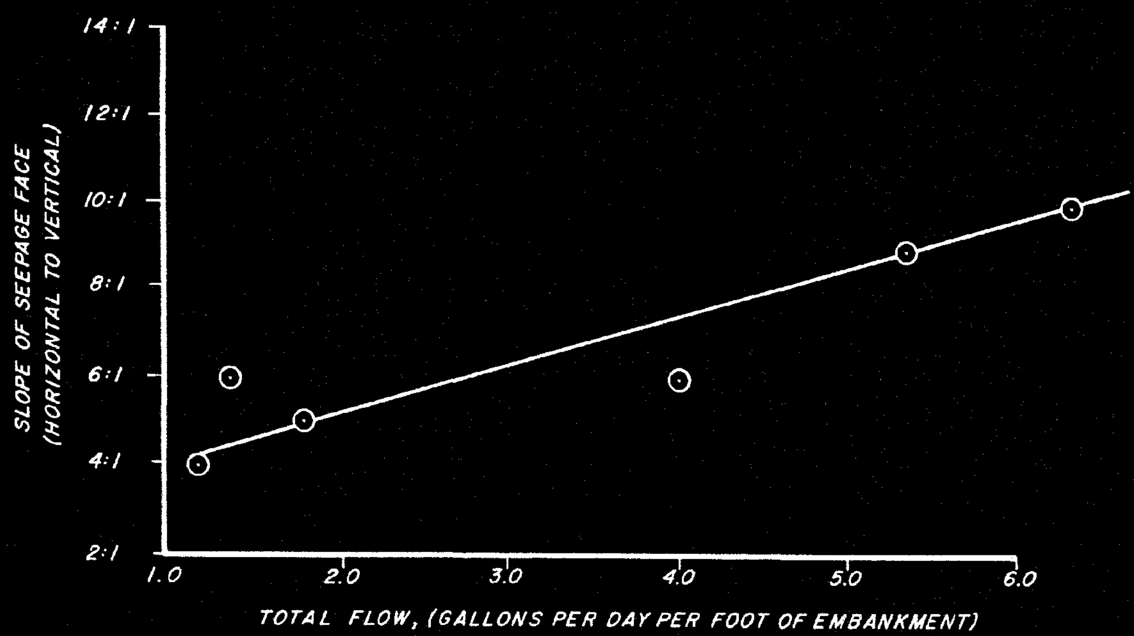

FIGURE 27

SEEPAGE FACE SLOPE
VERSUS
TOTAL CALCULATED FLOW

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE. A&B ... ITH CO., PGH. PA LT1530-1079

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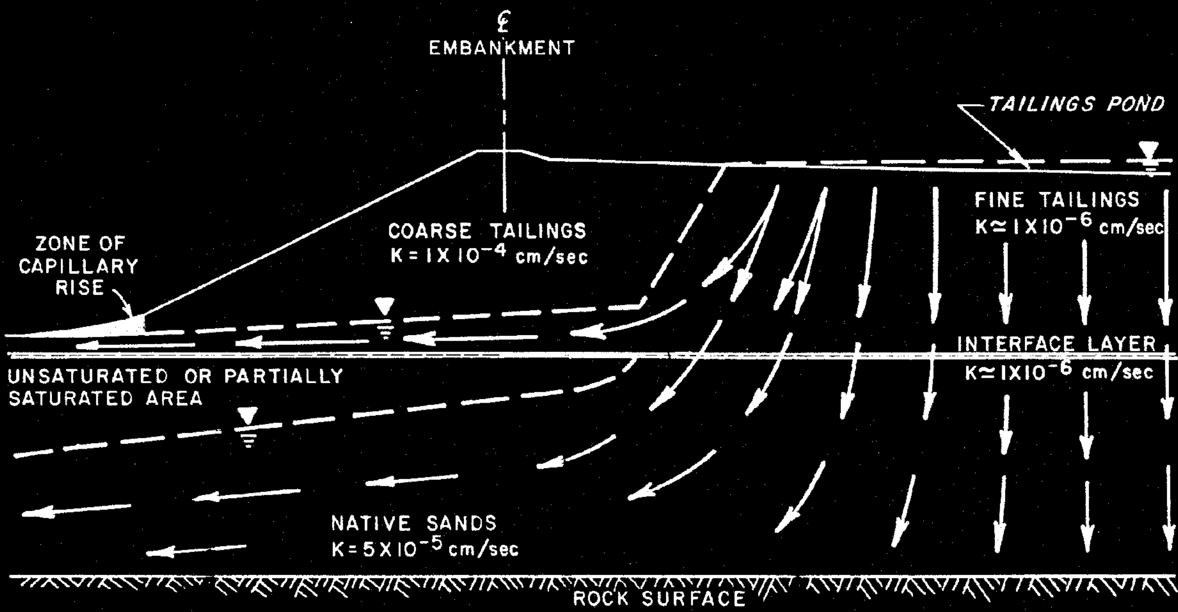
TYPICAL EMBANKMENT CROSS SECTION



LEGEND

← DIRECTION OF TAILINGS WATER SEEPAGE

FIGURE 28

CONCEPTUAL FLOW REGIME IN TAILINGS EMBANKMENT

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

FROM U.S.G.S. ALBUQUERQUE, NEW MEXICO QUADRANGLE SHEET
SCALE 1:250,000

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mg 6/11/80	TJH 6-11-80	6-11-80	RM80-311-A12

FIGURE 29

DRAINAGE BASIN

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

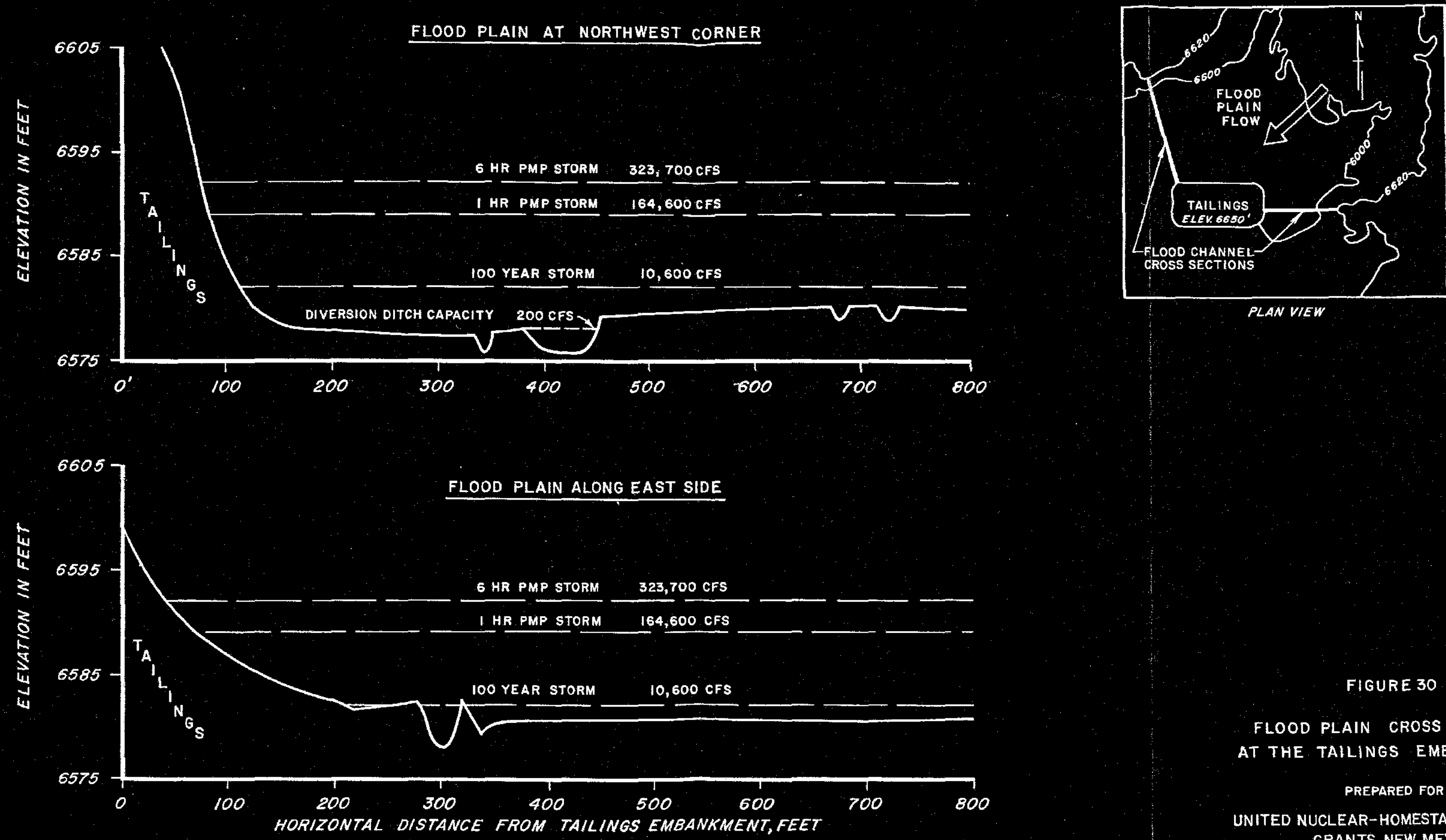

FIGURE 30

FLOOD PLAIN CROSS SECTION AT THE TAILINGS EMBANKMENT

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

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10/27/80	TJH 10-27-80	10-27-80	RM80-311-B17

HMCSL024452

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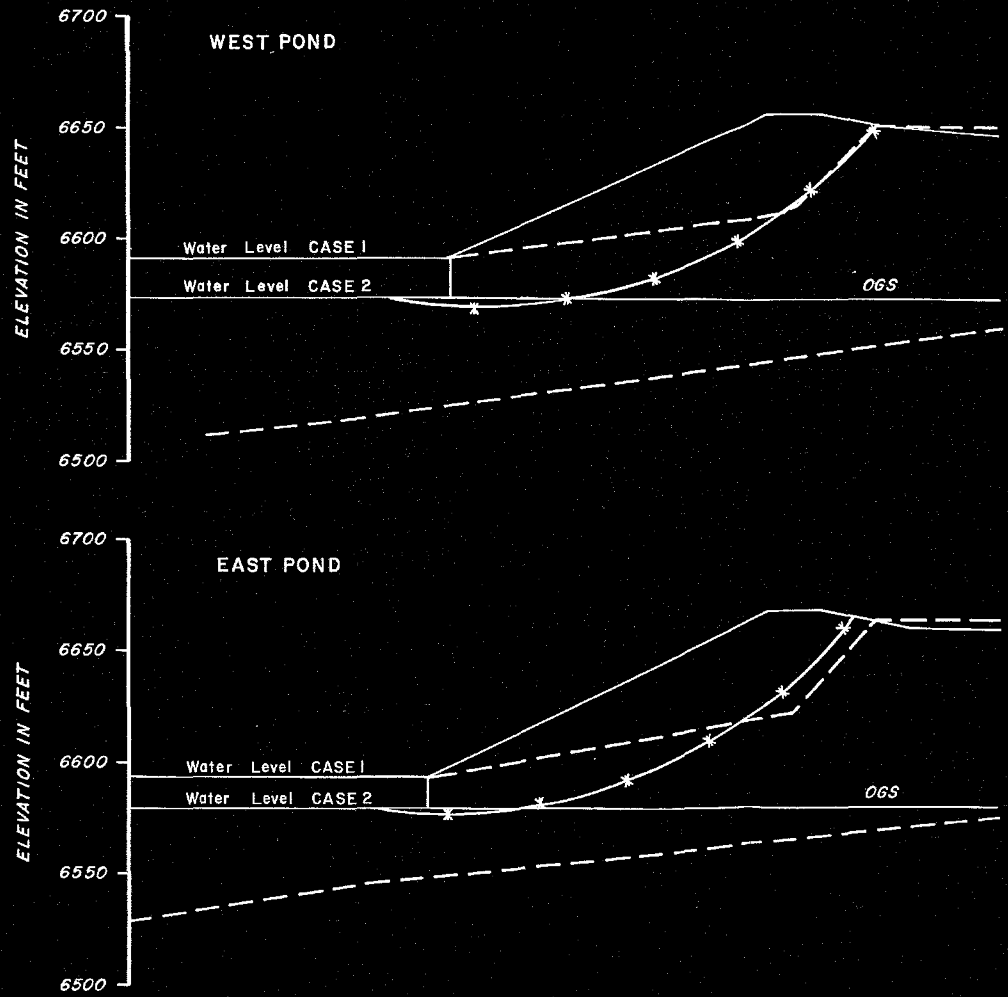


NOTE: PHREATIC SURFACE AT ASSUMED FLOOD LEVEL

LEGEND

CRITICAL FAILURE SURFACE

PHREATIC SURFACE

OGS APPROXIMATE ORIGINAL GROUND SURFACE

CASE 1 WATER LEVEL AT 6592' ON TOE, PEAK FLOOD FLOW

CASE 2 WATER LEVEL AT ORIGINAL GROUND SURFACE, AFTER FLOOD

CRITICAL FACTORS OF SAFETY		
	EAST POND	WEST POND
CASE I	1.25	1.36
CASE 2	1.22	1.31

50 0 50

SCALE IN FEET

FIGURE 31

PMP FLOOD EFFECT ON CRITICAL STABILITY FROM TOE EROSION

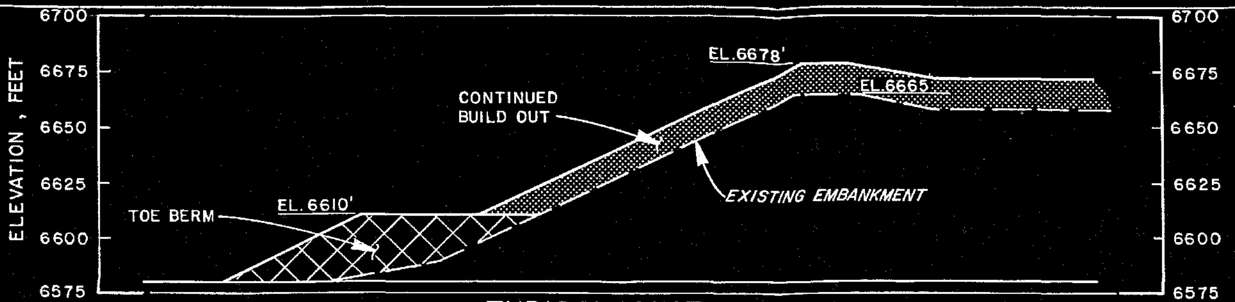
PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

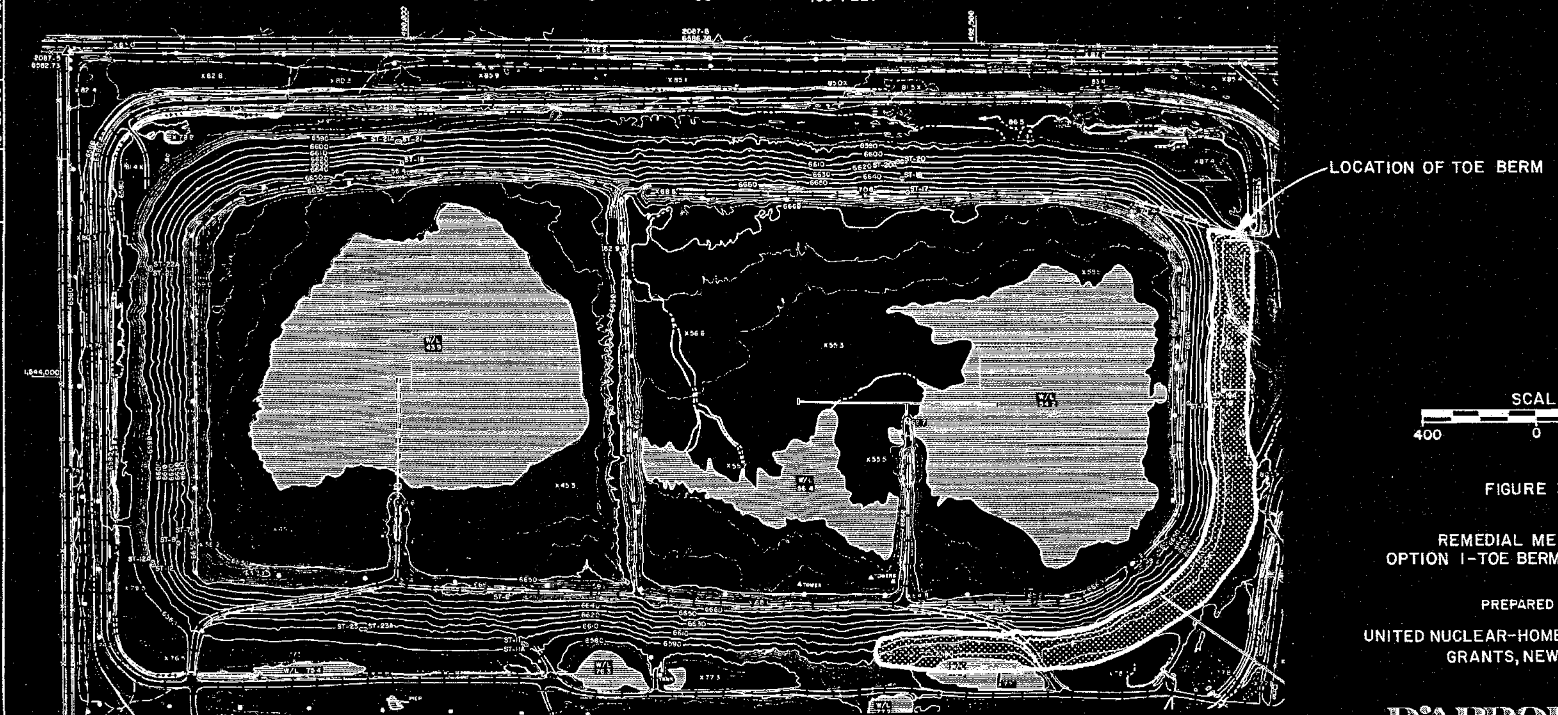
19 1253 HERCULENE. A&B SMITH CO., PGH., PA LT1530-1079

HMCSL024453



TYPICAL SECTION

SCALE 50 0 50 100 FEET



PLAN

SCALE 400 0 400 FEET

FIGURE 32

REMEDIAL MEASURES
OPTION 1-TOE BERM CONSTRUCTION

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

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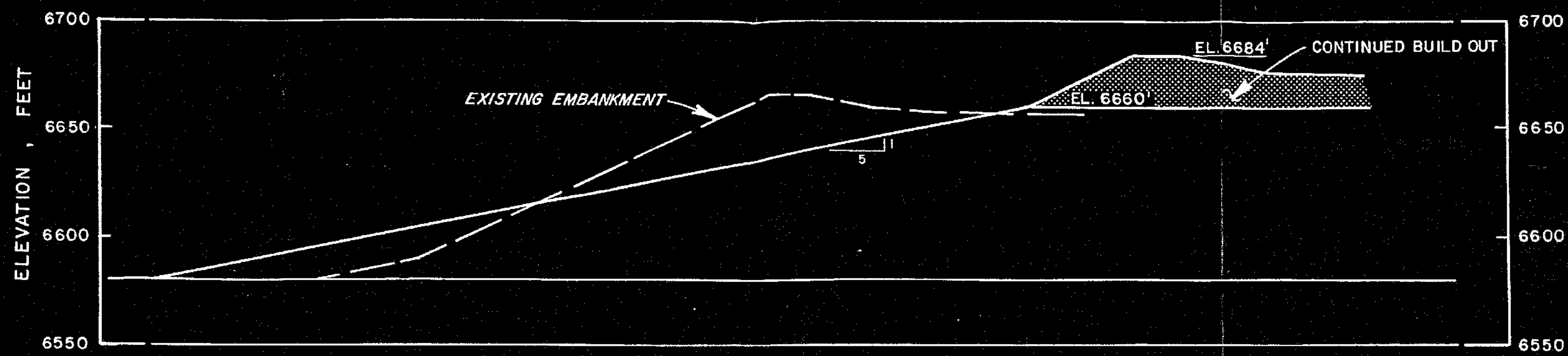
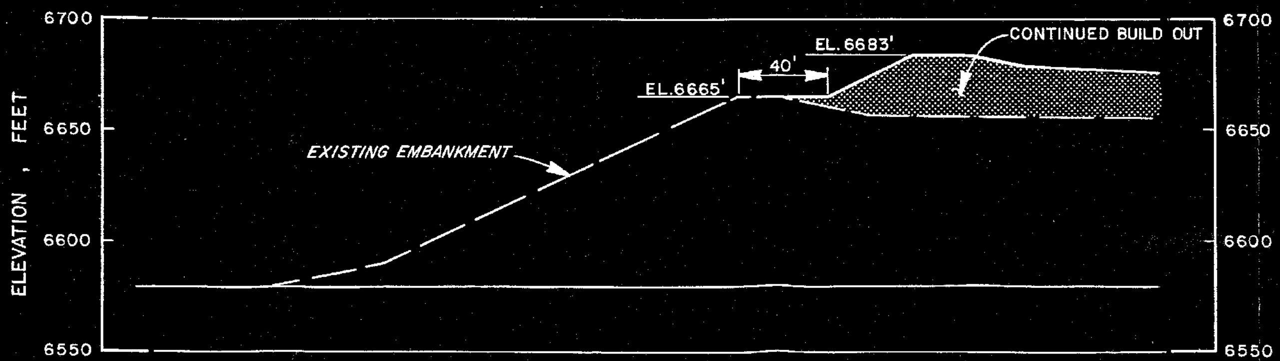


OPTION 2 - FLATTENING OF EXISTING SLOPE



OPTION 3 - REDUCTION IN POND SIZE

SCALE
50 0 50 FEET

FIGURE 33

REMEDIAL MEASURES
OPTION 2 AND OPTION 3

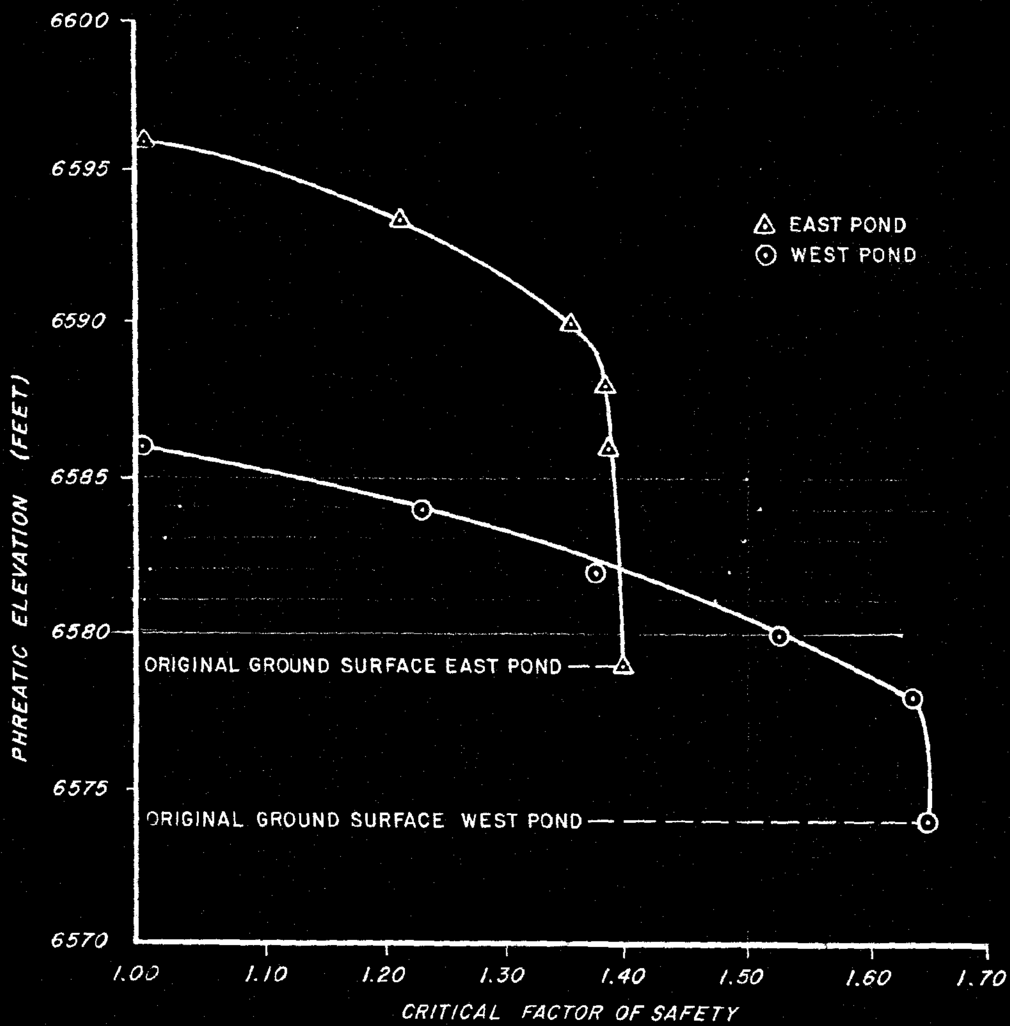
PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	TEJ 10-24-80	CHECKED BY	JWN 10-25-80	APPROVED BY	10-27-80	DRAWING NUMBER	RM80-311-B5

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
MJG 10/21/80	TSH 10-27-80	MKK 10-27-80	RM80-311-A13



TOE PIEZOMETERS
DB-2B
DB-4
DB-6B
DB-11
ST-11A
ST-12A
ST-19A
ST-20A
ST-21A
ST-23A

FIGURE 34

EMBANKMENT
CRITICAL FACTOR OF SAFETY
VERSUS PHREATIC ELEVATION
TOE PIEZOMETERS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

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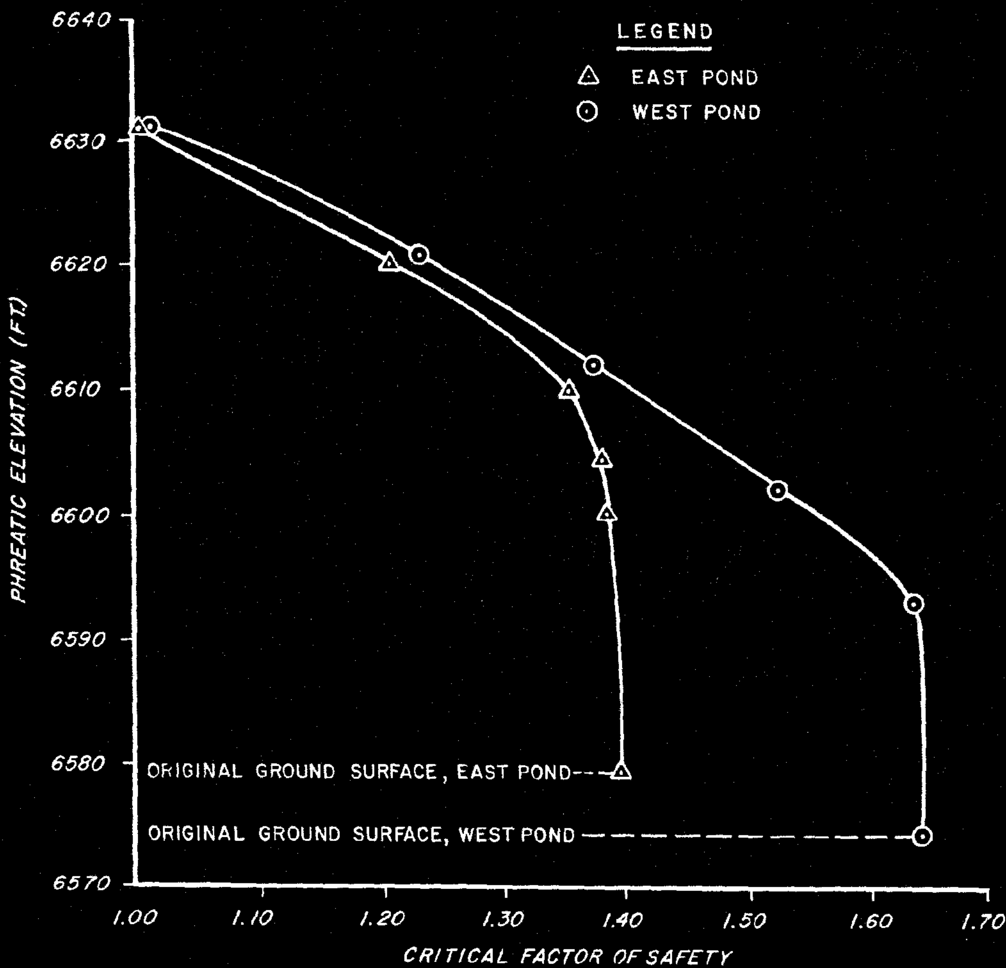

CREST PIEZOMETERS
DB-1B
DB-3
DB-5B
DB-7
DB-12
DB-17B
DB-19B
ST-3
ST-7
ST-17

FIGURE 35

EMBANKMENT
CRITICAL FACTOR OF SAFETY
VERSUS PHREATIC ELEVATION
CREST PIEZOMETERS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

Symbols to be used for designation of subsurface materials on all boring logs and subsurface sections

OVERBURDEN:
- Glacial till
- Gravel
- Sand
- Silt
- Clay
- Organic Material

SEDIMENTARY ROCKS
- Limestone
- Siltstone
- Sandstone
- Massive Mudstone or Claystone
- Shale
- Coal
- Dolomite
- Conglomerate
- Breccia
- Crystalline Limestone
- Bedded Chert
- Marble
- Chalk
- Gypsum
- Salt
- Anhydrite
- Limestone Containing Nodules Of Chert Or Flint

METAMORPHIC & IGNEOUS ROCKS:
- Schistose Or Gneissoid Granite
- Granite
- Gneiss
- Quartzite
- Schist
- Basic Lava Flows
- Bedded Tuff

MISCELLANEOUS
- Slag
- Fill
- Concrete
- Void (Indicate Size of Void)
- Water
- Approximate Existing Ground Surface
- Approximate Top Of Rock

P INDICATES PITCHER BARREL SAMPLER
2" O.D. SPLIT BARREL SAMPLE NUMBER

75/0.5' PENETRATION REFUSAL RESISTANCE AND FRACTIONAL INCREMENT DRIVEN IN FEET

12-10-75 GROUND WATER LEVEL AND DATE

U.S.C.S. UNIFIED SOIL CLASSIFICATION SYSTEM (CAPITAL LETTERS INDICATE LAB TEST CLASSIFICATION, LOWER CASE LETTERS INDICATE VISUAL FIELD CLASSIFICATION).

SAMPLE NUMBER
3" UNDISTURBED SAMPLE (SHELBY TUBE)
RECOVERY INCHES

PLASTIC LIMIT (PL)
ATTERBERG LIMITS
LIQUID LIMIT (LL)

RQD (ROCK QUALITY DESIGNATION - PERCENT) (LENGTH OF NUMBER OF PIECES GREATER THAN 4 INCHES DIVIDED BY THE LENGTH OF THE CORE RUN)
(60)
90
INDICATES PERCENT OF CORE RECOVERED (LENGTH OF CORE RECOVERED DIVIDED BY LENGTH OF CORE RUN)

DRILLING FLUID LOSS ____%

DRILLING FLUID REGAINED ____%

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH TONS PER SQUARE FOOT
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DESIGNATION	BLOWS PER FOOT
VERY LOOSE	0-4
LOOSE	5-10
MEDIUM DENSE	11-30
DENSE	31-50
VERY DENSE	OVER 50

STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2 INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140 POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER WAS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6 INCH INTERVAL. THE RESISTANCE TO PENETRATION IS INDICATED ON THE DRAWING AS BLOWS PER FOOT.

TRACE - INDICATES PRESENCE OF LESS THAN 5% OF SUBJECT MATERIAL BY WEIGHT.
SOME - INDICATES PRESENCE OF 5 TO 30% OF SUBJECT MATERIAL BY WEIGHT.
AND - INDICATES PRESENCE OF 30 TO 50% OF SUBJECT MATERIAL BY WEIGHT.

COBBLES	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

USCS CLASSIFICATION FOR SOILS

BOULDER	COBBLE	PEBBLE	GRANULE	VERY COARSE SAND	COARSE SAND	MEDIUM SAND	FINE SAND	VERY FINE SAND	SILT	CLAY	INDIVIDUAL PARTICLES
BOULDER CONGLOMERATE	COBBLE CONGLOMERATE	PEBBLE CONGLOMERATE	GRANULE CONGLOMERATE	VERY COARSE SANDSTONE	COARSE SANDSTONE	MEDIUM SANDSTONE	FINE SANDSTONE	VERY FINE SANDSTONE	SILTSTONE	CLAYSTONE AND SHALE	CONSOLIDATED ROCK

WENTWORTH SCALE FOR ROCK

TERMS USED TO DESCRIBE THE RELATIVE DEGREES OF ROCK CORE HARDNESS

DESCRIPTIVE TERMS	DEFINING CHARACTERISTICS
VERY SOFT	CRUSHES UNDER PRESSURE OF FINGERS AND/OR THUMB
SOFT	CRUSHES UNDER PRESSURE OF PRESSED HAMMER
MEDIUM HARD	BREAKS EASILY UNDER SINGLE HAMMER BLOW BUT WITH CRUMBLY EDGES
HARD	BREAKS UNDER ONE OR TWO STRONG HAMMER BLOWS BUT WITH RESISTANT SHARP EDGES
VERY HARD	BREAKS UNDER SEVERAL STRONG HAMMER BLOWS BUT WITH VERY RESISTANT SHARP EDGES AND MAY SPALL LEAVING CONCHOIDAL FRACTURES

THE SPACING OF THE DISCONTINUITIES IN THE ROCK MAY BE DESCRIBED BY ONE OF THE FOLLOWING TERMS

DESCRIPTIVE TERMS	SPACING
VERY BROKEN	LESS THAN 1 IN.
BROKEN	1 IN. TO 3 IN.
SLIGHTLY BROKEN	3 IN. TO 6 IN.
MASSIVE	6 IN. AND GREATER

THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS. ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS.

SUBSURFACE DESCRIPTIONS SHOWN IN PARENTHESES ( ) INDICATE CLASSIFICATION FROM WASH SOIL RETAINED ON DRILL TOOLS OR ACTION OF DRILL TOOLS DURING ADVANCEMENT OF BORING.

FIGURE A1

GENERAL NOTES & LEGEND

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

HMCSL0244

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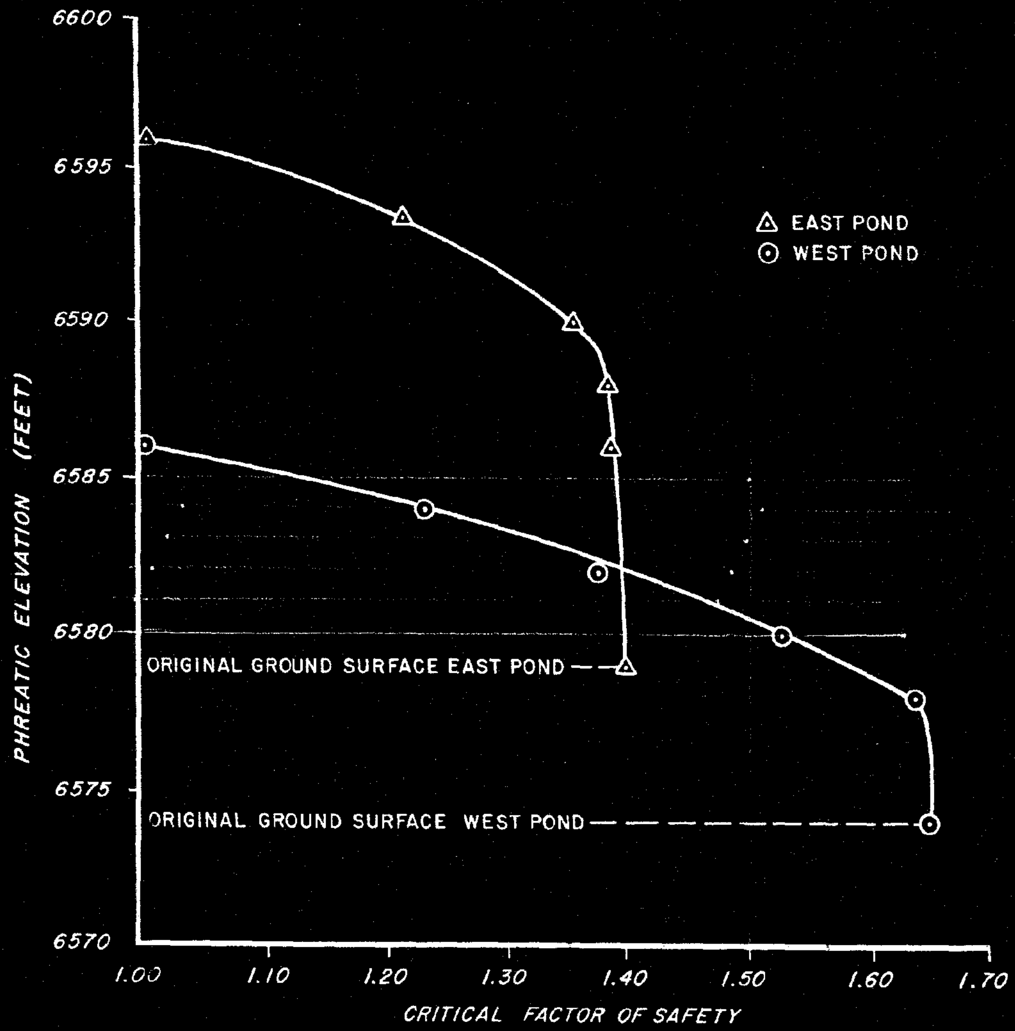

TOE PIEZOMETERS
DB-2B
DB-4
DB-6B
DB-11
ST-11A
ST-12A
ST-19A
ST-20A
ST-21A
ST-23A

FIGURE 34

EMBANKMENT
CRITICAL FACTOR OF SAFETY
VERSUS PHREATIC ELEVATION
TOE PIEZOMETERS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE A61 H CO PGH PA LT1530-1079

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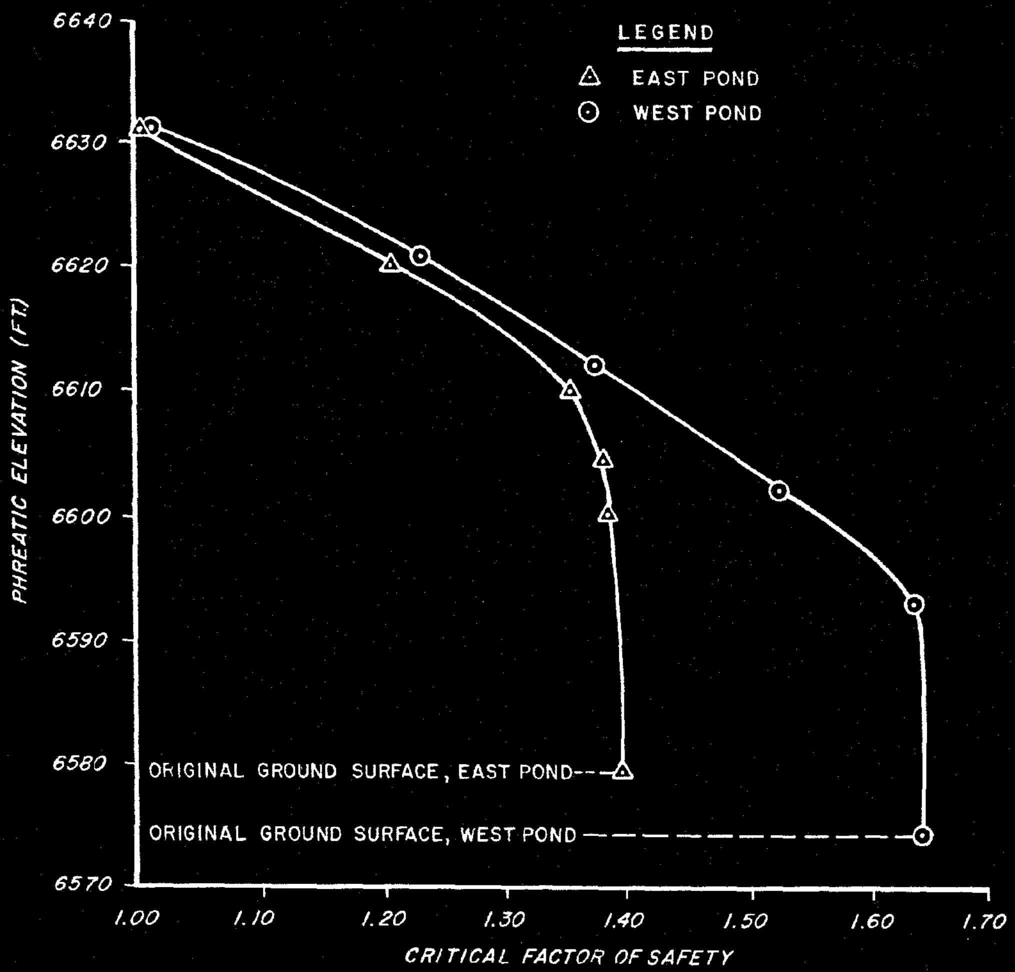
CHECKED BY	TJH 10-27-80
APPROVED BY	AKK 10-27-80
DRAWING NUMBER	RM80-311-A14



CREST PIEZOMETERS
DB-1B
DB-3
DB-5B
DB-7
DB-12
DB-17B
DB-19B
ST-3
ST-7
ST-17

FIGURE 35

EMBANKMENT
CRITICAL FACTOR OF SAFETY
VERSUS PHREATIC ELEVATION
CREST PIEZOMETERS

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DATE BEGAN: 8/7/80
DATE FINISHED: 8/7/80
GROUND SURFACE EL.: 6664.3

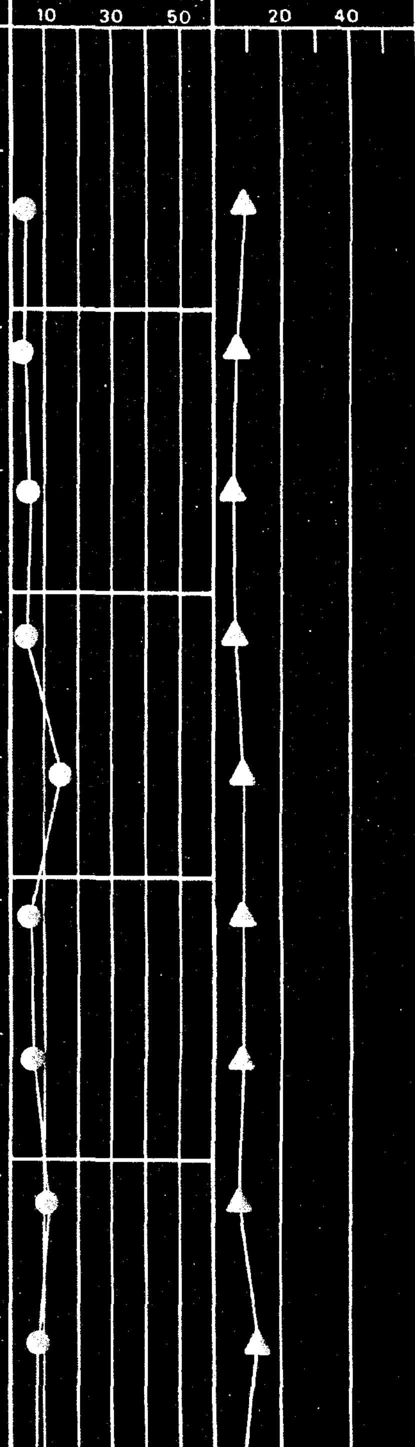
BORING NO DB-1A

N 1,543,960 **E** 492,703

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS
6660	5	S 1		VERY LOOSE, BROWN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
	10	S 2		AS ABOVE	sp-sm
6650	15	S 3		LOOSE, BROWN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
	20	S 4		AS ABOVE	sp-sm
6640	25	S 5		MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	30	S 6		LOOSE, BROWN FINE SAND, TRACE OF SILT, MOIST	sp-sm
6630	35	S 7		AS ABOVE	sp-sm
	40	S 8		MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6620	45	S 9		LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	50				

PENETRATION RESISTANCE (BLOWS PER FOOT) — WATER CONTENT (PERCENT)



D'APPOLONIA

HMCSL024461

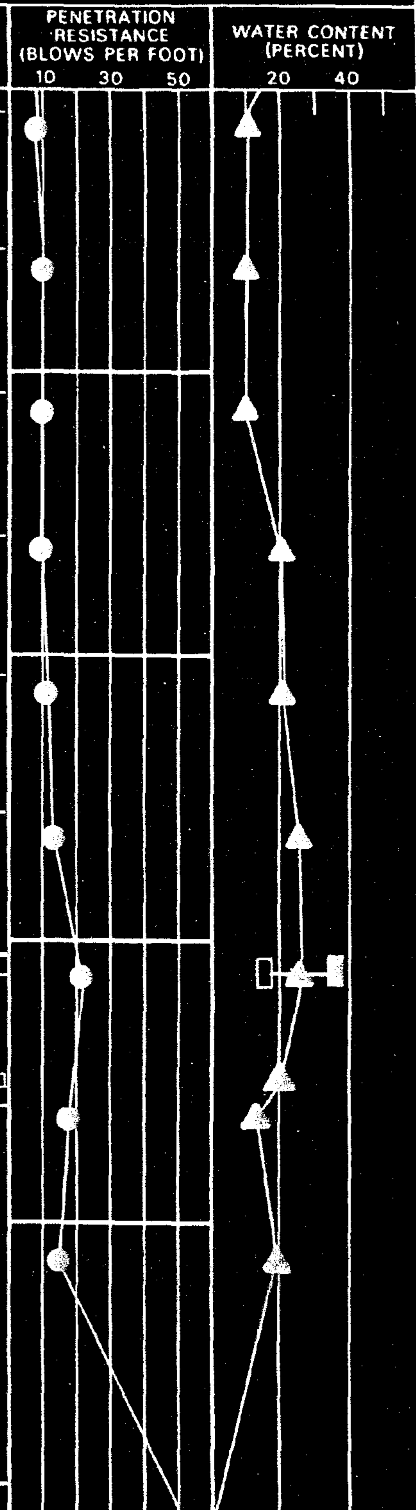
DATE BEGAN: 8/7/80
DATE FINISHED: 8/7/80
GROUND SURFACE EL.: 6664.3

BORING NO. DB-1A

N 1,543,960 E 492,703

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
		S 10	AS ABOVE	sp-sm
6610	55	S 11	AS ABOVE	sp-sm
	60	S 12	AS ABOVE	sp-sm
6600 8-7-80 ▽	65	S 13	LOOSE, BROWN, FINE SAND, TRACE OF SILT, WET	sp-sm
	70	S 14	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, WET	sp-sm
6590	75	S 15	AS ABOVE	sp-sm
	80	S 16	AS ABOVE 80.7'	
6580			STIFF, BLACK TO BROWN, SILTY CLAY, TRACE OF ORGANIC REMAINS, MOIST	cl-ol
	85	S 17	AS ABOVE 86.0'	clol
			MEDIUM DENSE, BROWN, SILTY FINE SAND, MOIST	sm
	90	S 18	AS ABOVE	sm
6570	95	1 22	AS ABOVE	sm
	100		99.0'	



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Boring Log. No. DB-1A
Page 2 of 3

D'APPOLONIA

HMCSL024462

DATE BEGAN: 8/7/80

DATE FINISHED: 8/7/80

GROUND SURFACE EL.: 6664.3

BORING NO DB-1A

N 1,543,960 E 492,703

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
		S 19		VERY DENSE, TAN, VERY FINE TO MEDIUM SAND, IRON-STAINING PRESENT, MOIST 104.0'	SP		
6560	105						
6557.8		S 20		VERY DENSE, REDDISH BROWN, FINE SAND, SOME CLAY, MOIST 106.5'	SC		
				BOTTOM OF BORING 106.5'			
	110			PIEZOMETERS DB-1A AND DB-1B INSTALLED WITH TIPS AT 105.0' AND 80.5', RESPECTIVELY			

D'APPOLONIA

HMCSL024463

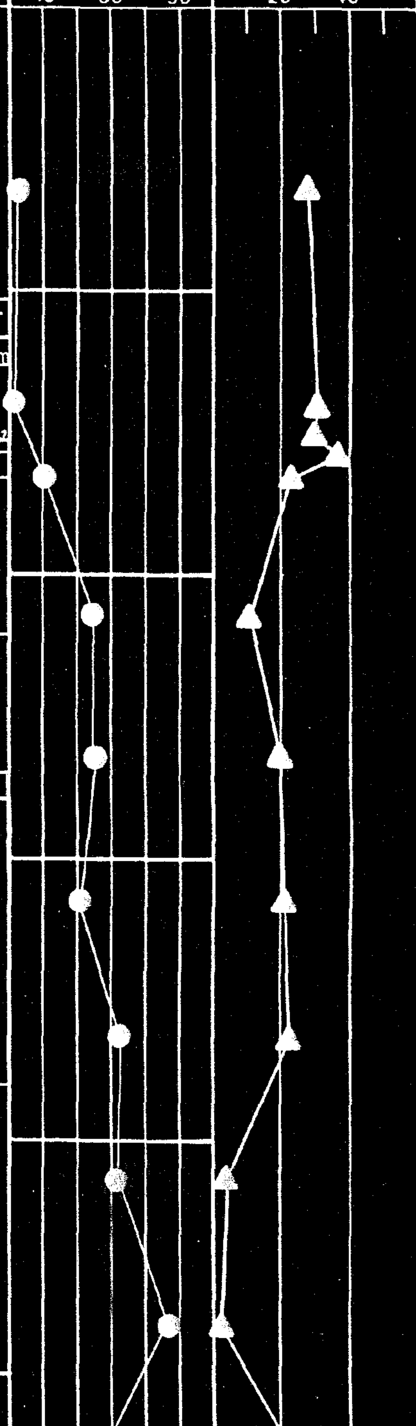
DATE BEGAN: 7/30/80
DATE FINISHED: 7/30/80
GROUND SURFACE EL.: 6588.2

BORING NO DB-2A

N 1,543,974 **E** 492,840

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U S C S	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
7-30-80 (water level)						
	5	S 1	VERY LOOSE, BROWN FINE SAND, TRACE OF SILT, WET	sp-sm		
6580		1 / 24	LOOSE, BROWN FINE SAND, TRACE OF SILT, WET 10.3'	sp-sm		
	10	2 / 26	VERY SOFT, BROWN, SILTY SAND, TRACE OF CLAY, WET 11.6'	sm-spsm		
		S 2	VERY LOOSE, BROWN FINE SAND, TRACE OF SILT, WET 12.5'	sm		
	15	S 3	VERY SOFT, BROWN, SILTY SAND TRACE ORGANIC REMAINS, SOME 15.3'	cl-ch		
6570			STIFF, BROWN, SILTY CLAY, TRACE ORGANIC REMAINS, WET 15.8'	cl		
	20	S 4	VERY STIFF, BLACK, SILTY CLAY, TRACE OF SAND, WET 16.5'	sp		
			MEDIUM DENSE, LIGHT BROWN, FINE TO MEDIUM SAND, BANDS OF IRON STAINING ABOUT (1) INCH THICK, MOIST, TRACE OF CLAY 22.0'	cl		
	25	S 5				
6560		3 / 22	VERY STIFF, LIGHT BROWN, SILTY CLAY, FINE GRAVEL INTERMIXED, MOIST 27.0'	ch		
	30	S 6	STIFF, GRAY BROWN CLAY, MOIST 28.0'	ch		
			VERY STIFF, RED CLAY MOIST			
	35	S 7	HARD, RED, SILTY CLAY, TRACE OF ORGANIC REMAINS, MOIST 38.0'	ch		
6550						
	40	S 8	DENSE, BROWN, VERY FINE SAND, SOME SILT, MOIST	sm		
		4 / 22	DENSE, BROWN, VERY FINE SAND, SOME SILT, DRY TO MOIST	sm		
	45	S 9				
6540			48.0'			
	50					



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RM80-311

Boring Log No. DB-2A

D'APPOLONIA

DATE BEGAN: 7/30/80

DATE FINISHED: 7/30/80

GROUND SURFACE EL.: 6588.2

BORING NO. DB-2A

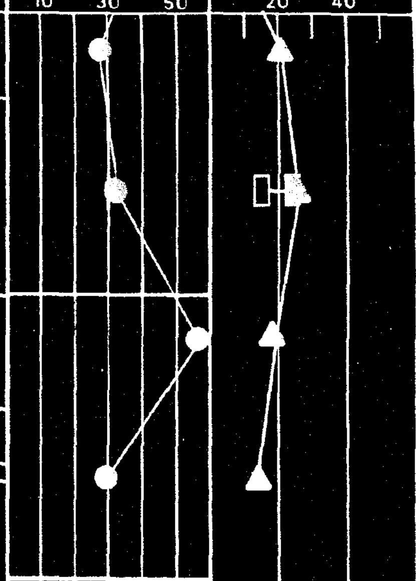
N 1,543,974 E 492,840

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
		S 10	MEDIUM DENSE, RED, SILTY FINE SAND WITH LAYERS (2) INCHES OF SANDY SILT, WET 53.0'	sp-sm
6530	55	S 11	SOFT, RED, SILTY CLAY, SOME CLAY, LAYERS OF SILTY SAND, WET 60.0'	cl
6521.7	60 / 65	S 12 / S 13	VERY DENSE, YELLOW TO BROWN, SILTY MEDIUM TO COARSE SAND, SOME MEDIUM GRAVEL INTERMIXED, LAYERS OF WHITE CLAY (CH) (STIFF) LESS THAN (1) INCH THICK, MOIST 64.0	sw
			MEDIUM DENSE, RED, SANDY FINE GRAVEL, WITH RED SILTY CLAY, MOIST TO WET 66.0	gw
	70		MEDIUM DENSE, BROWN SILTY, MEDIUM SAND, COARSE SAND INTERMIXED, WET 66.5'	sw

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50 — WATER CONTENT (PERCENT) 20 40



BOTTOM OF BORING 66.5'

PIEZOMETERS DB-2A AND DB-2B INSTALLED WITH TIPS AT AT 66.5' AND 11.0', RESPECTIVELY

DATE BEGAN: 7/28/80

DATE FINISHED: 7/28/80

GROUND SURFACE EL.: 6664.4

BORING NO DB-3

N 1,543,277 E 492,579

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
6660	5	S 1		VERY LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm		
	10	S 2		AS ABOVE	sp-sm		
6650	15	S 3		LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm		
	20	S 4		AS ABOVE	sp-sm		
6640	25	S 5		AS ABOVE	sp-sm		
	30	S 6		AS ABOVE	sp-sm		
6630	35	S 7		MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT AND SILTY LAYERS (LESS THAN 0.5 INCHES), MOIST	sp-sm		
	40	S 8		VERY LOOSE, BROWN, FINE SAND, TRACE OF SILT (IN LAYERS), TRACES OF CLAY, MOIST	sp-sm		
6620	45	S 9		LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm		
	50						

DATE BEGAN: 7/28/80
DATE FINISHED: 7/28/80
GROUND SURFACE EL.: 6664.4

BORING NO DB-3

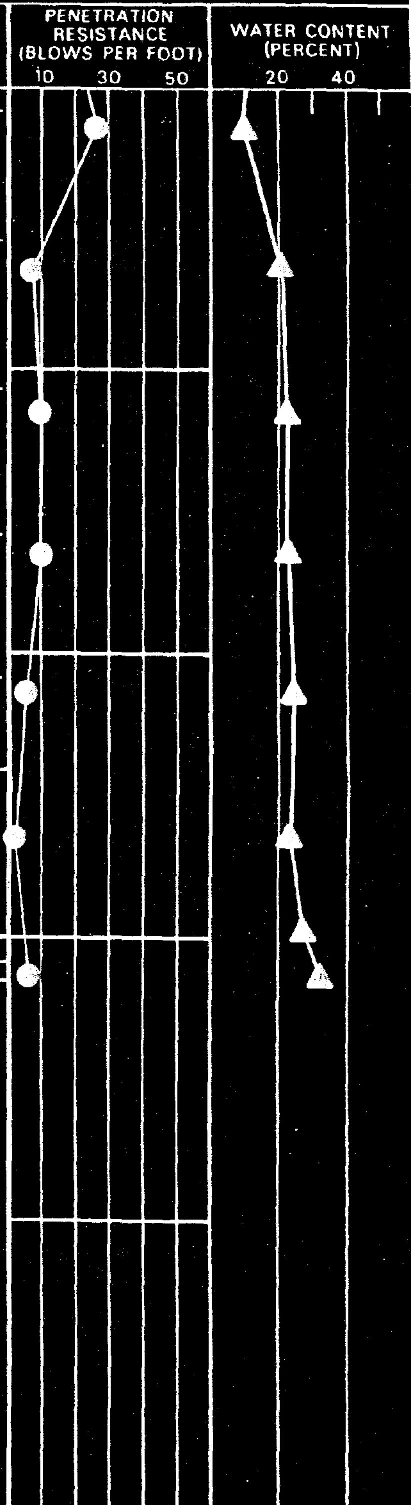
N 1,543,277 E 492,579

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
		S 10	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6610	55			
7-28-80		S 11	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST TO WET	sp-sm
	60	S 12	LOOSE, BROWN, FINE SAND, TRACE OF SILT, SOME SILT IN LAYERS LESS THAN (1) INCH THICK, WET	sp-sm
6600	65	S 13	LOOSE, BROWNISH GRAY, FINE SAND, TRACE OF SILT, WET	sp-sm
	70	S 14	AS ABOVE 74.0'	sp-sm
6590	75	S 15	VERY LOOSE, BROWNISH GRAY, FINE SAND, SOME SILT, WET 80.0'	sm
	80	S 16	LOOSE, BROWNISH GRAY, FINE SAND, SOME SILT, WET 81.0'	
6582.9			STIFF, GRAY, CLAY, SOME SILT, WET 81.5'	cl

BOTTOM OF BORING 81.5'

PIEZOMETER DB-3 INSTALLED WITH TIP AT 80.5'



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RM80-311

D'APPOLONIA

DATE BEGAN: 7/29/80
DATE FINISHED: 7/29/80
GROUND SURFACE EL.: 6590.7

BORING NO. DB-4

N 1,543,204 E 492,716

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
6590							
	5	S 1		LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm		
7-29-80 ▼							
6580	10	S 2		LOOSE, BROWN, FINE SAND, TRACE OF SILT AND CLAY, WET 14.0'	sp-sm		
6575.2	15	S 3		VERY STIFF, DARK BROWN TO BLACK, SILTY CLAY, ORGANIC REMAINS, WET 15.5'	cl-ol		
	20			BOTTOM OF BORING 15.5'			
				PIEZOMETER DB-4 INSTALLED WITH TIP AT 14.0'			

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RM 80-311

Boring Log No. DB-4

D'APPOLONIA

DATE BEGAN: 7/24/80
DATE FINISHED: 7/25/80
GROUND SURFACE EL: 6661.1

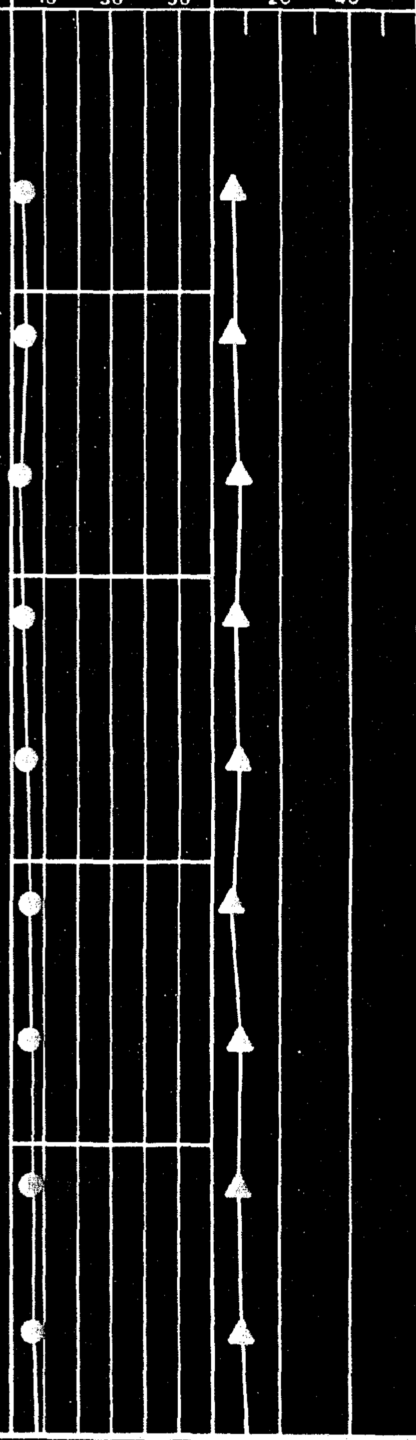
BORING NO. DB-5A

N 1,543,136 E 492,188

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
6660				
	5	S 1	VERY LOOSE, LIGHT BROWN, FINE SAND, TRACE OF SILT, DRY	sp-sm
6650	10	S 2	VERY LOOSE, LIGHT BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	15	S 3	AS ABOVE	sp-sm
6640	20	S 4	LOOSE, LIGHT BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	25	S 5	AS ABOVE	sp-sm
6630	30	S 6	AS ABOVE	sp-sm
	35	S 7	LOOSE, LIGHT BROWN, FINE SAND, LAYERS OF SILTY SAND (1) INCH THICK, MOIST	sp-sm
6620	40	S 8	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	45	S 9	AS ABOVE	sp-sm
	50			

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50 — WATER CONTENT (PERCENT) 20 40



D'APPOLONIA

DATE BEGAN: 7/24/80
DATE FINISHED: 7/25/80
GROUND SURFACE EL.: 6661.1

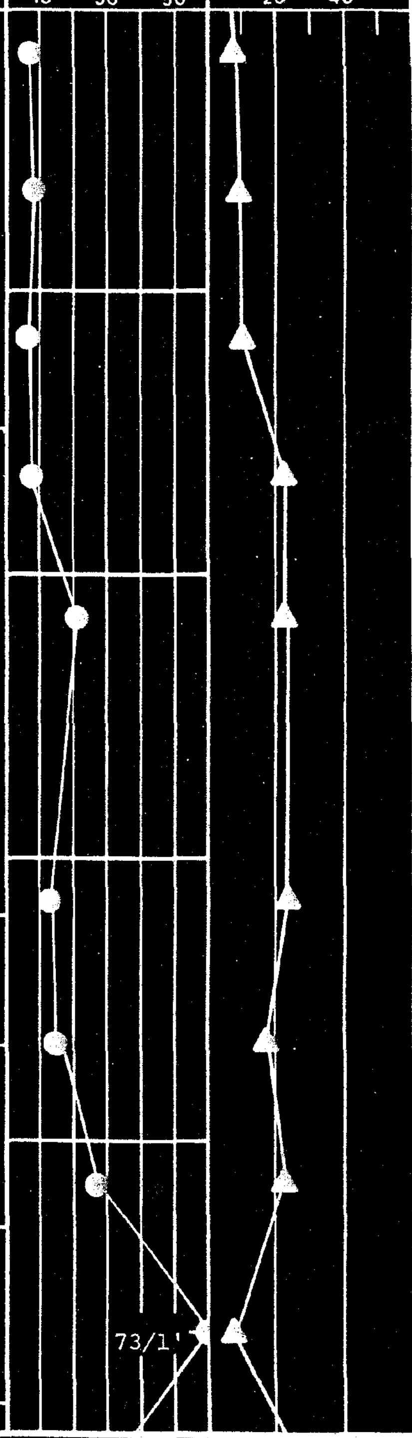
BORING NO. DB-5A

N 1,543,136 E 492,188

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
6610		S 10	AS ABOVE	sp-sm
	55	S 11	AS ABOVE	sp-sm
6600	60	S 12	AS ABOVE	sp-sm
7-29-80 (water level)	65		65.0'	
		S 13	LOOSE, BROWN, FINE SAND, SOME SILT, WET	sm
6590	70	S 14	MEDIUM DENSE, BROWN, FINE SAND, SOME SILT, WET	sm
		1 / 27	AS ABOVE	sm
	75	2 / 23	AS ABOVE	sm
6580	80	S 15	AS ABOVE 82.0'	sm
	85	S 16	STIFF, BROWNISH BLACK, SILTY CLAY, ORGANIC REMAINS, WET 86.5'	cl-ol
		3 / 17	VERY STIFF, BROWNISH BLACK, SILTY CLAY, WET	cl
6570	90	S 17	VERY STIFF, BLACK, SILTY CLAY, WET 93.0'	cl
	95	S 18	VERY DENSE, YELLOWISH BROWN, FINE TO MEDIUM SAND, TRACES OF SILT AND (0.2) INCH LAYERS OF CLAY, WET 99.0'	sm
	100			

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50 — WATER CONTENT (PERCENT) 20 40



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D'APPOLONIA

HMCSL024470

DATE BEGAN: 7/24/80

DATE FINISHED: 7/25/80

GROUND SURFACE EL.: 6661.1

BORING NO. DB-5A

N 1,543,136 **E** 492,188

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
6559.6		S 19		VERY STIFF, YELLOW TO RED, SILTY CLAY, LAYERS OF SILTY FINE SAND LESS THAN (1) INCH, SOME FINE GRAVEL INTERMIXED, WET 101.5'	cl		
	105			BOTTOM OF BORING 101.5'			
	110			PIEZOMETERS DB-5A AND DB-5B INSTALLED WITH TIPS AT 100.0' AND 81.5', RESPECTIVELY			
	115						
	120						
	125						

D'APPOLONIA

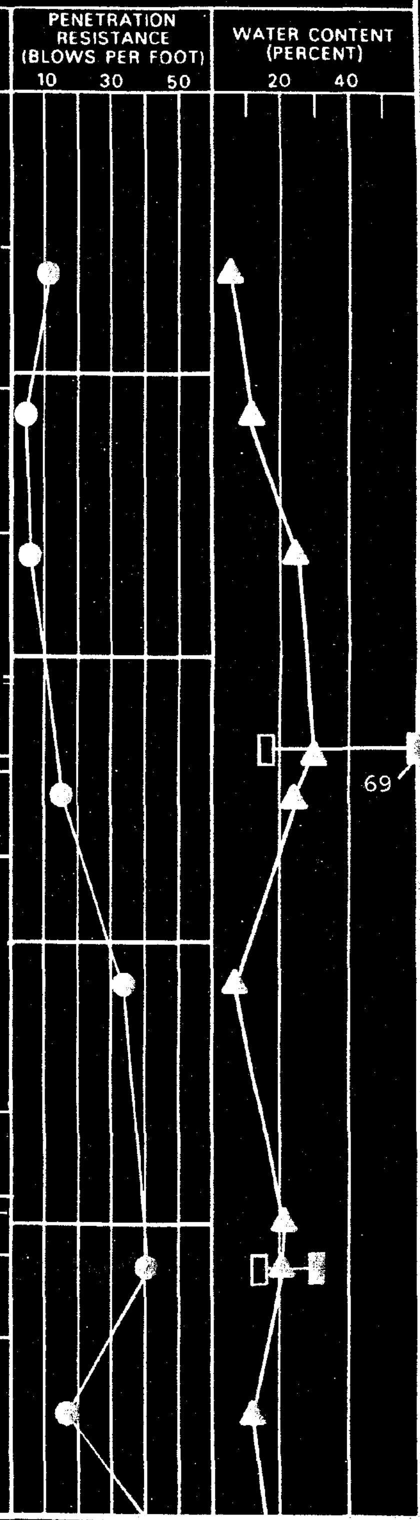
DATE BEGAN: 7/14/80
DATE FINISHED: 7/14/80
GROUND SURFACE EL.: 6595.2

BORING NO. DB-6A

N 1,542,992 E492,193

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
6590	5	S 1	MEDIUM DENSE, BROWN, FINE SAND, POORLY GRADED, TRACE OF SILT, MOIST TO DRY	sp-sm
7-14-80 (water level)	10	S 2	LOOSE, BROWN, FINE SAND, POORLY GRADED, TRACE OF SILT, WET	sp-sm
6580	15	S 3	LOOSE, BROWN, FINE SAND, TRACE OF SILT, WET	sp-sm
	20	1 / 23	LOOSE, LIGHT BROWN, FINE SAND, TRACE OF SILT, WET	sp-sm
			FOUNDATION INTERFACE 23.5'	
6570	25	S 4	MEDIUM STIFF, BROWN, SILTY CLAY, MOIST 24.0'	cl
			MEDIUM DENSE, BROWN SILT, SOME FINE SAND, TRACE OF CLAY, MOIST 27.0'	ml
	30	S 5	DENSE, TAN, FINE SAND, SOME SILT, DRY TO MOIST	sm
6560	35			sm
		2 / 20	AS ABOVE 36.1	
			VERY STIFF, BROWN CLAY WITH SAND POCKETS, MOIST 39.0'	cl
	40	S 6	DENSE, BROWN SILTY SAND, MOIST TO WET 41.0'	sp-sm
			STIFF TO MEDIUM STIFF, REDDISH BROWN SILTY CLAY, DRY TO MOIST 44.0'	cl
6550	45	S 7	MEDIUM DENSE, REDDISH BROWN, SILTY FINE SAND, DRY	sm
	50			



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RM80-311

D'APPOLONIA

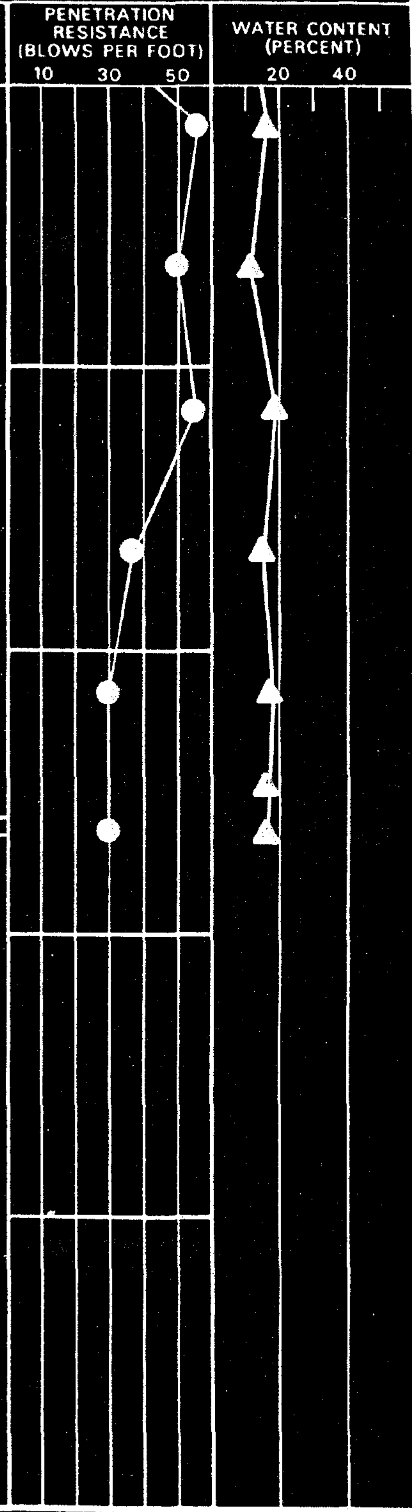
DATE BEGAN: 7/14/80
DATE FINISHED: 7/14/80
GROUND SURFACE EL.: 6595.2

BORING NO. DB-6A

N 1,542,992 E 492.193

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.
		S 8	VERY DENSE, BROWN, FINE SAND WITH SOME SILT POCKETS, DRY	sm
6540	55	S 9	VERY DENSE, REDDISH BROWN, FINE SAND, SOME SILT, DRY	sm
	60	S 10	VERY DENSE, REDDISH BROWN, FINE SAND, SOME SILT MOIST TO WET	sm
6530	65	S 11	AS ABOVE	sm
	70	S 12	MEDIUM DENSE, BROWN FINE SAND, SOME SILT, CLAYEY SAND SEAMS, WET	sm
6520	75	S 13	AS ABOVE 76.0'	sm
6518.7			MEDIUM DENSE, BROWN, FINE CLAYEY SAND, MOIST TO DRY 76.5'	sc
	80		BOTTOM OF BORING 76.5'	
	85		PIEZOMETERS DB-6A AND DB-6B INSTALLED WITH TIPS AT 74.5' AND 19.5', RESPECTIVELY	
	90			
	95			
	100			



D'APPOLONIA

HMCSL024473

DATE BEGAN: 7/22/80
DATE FINISHED: 7/23/80
GROUND SURFACE EL.: 6652.8

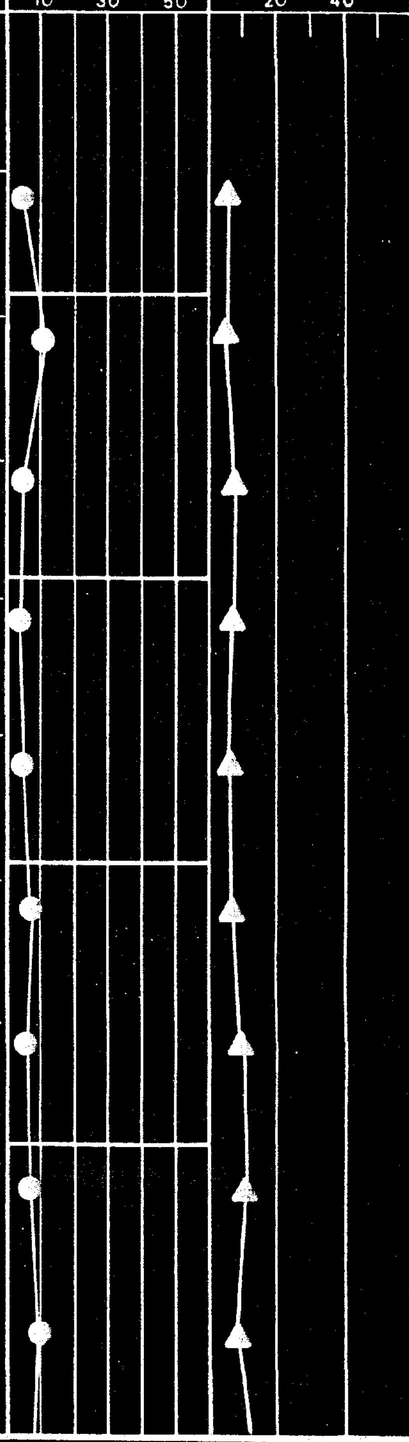
BORING NO. DB-7

N 1,543,120 E 491,729

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
6650	5	S 1	LOOSE, BROWN, FINE SAND, TRACE OF SILT, DRY	sp-sm
6640	10	S 2	MEDIUM DENSE, TAN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
	15	S 3	LOOSE, TAN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
6630	20	S 4	VERY LOOSE, TAN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
	25	S 5	LOOSE, TAN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
6620	30	S 6	AS ABOVE	sp-sm
	35	S 7	AS ABOVE	sp-sm
6610	40	S 8	LOOSE, DARK BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	45	S 9	LOOSE, DARK BROWN, FINE SAND, WITH SOFT SILT LAYERS LESS THAN (1) INCH, MOIST	sp-sm
	50			

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50 — WATER CONTENT (PERCENT) 20 40



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RM80-311

D'APPOLONIA

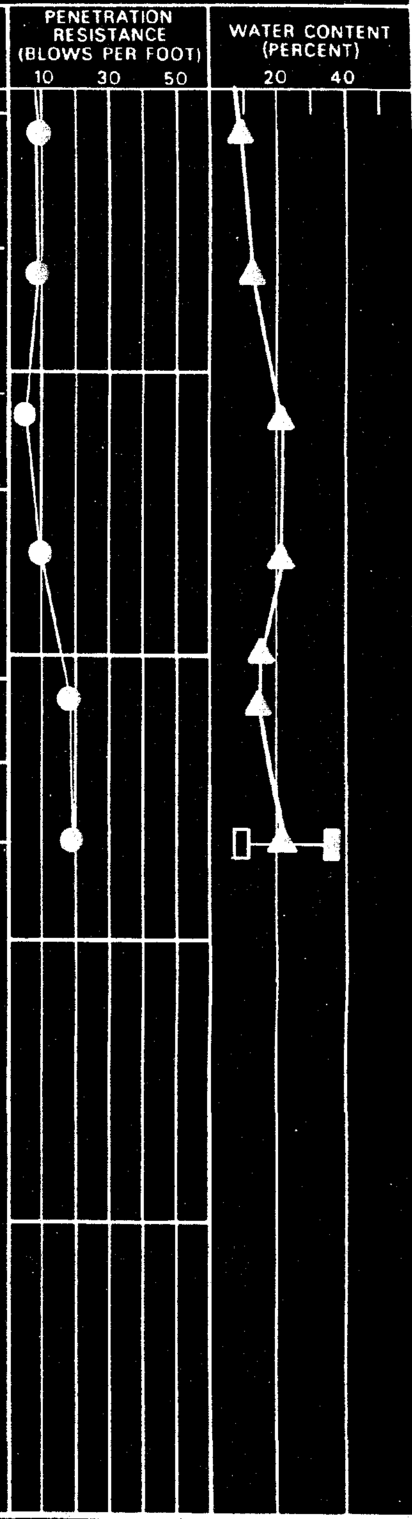
DATE BEGAN: 7/22/80
DATE FINISHED: 7/23/80
GROUND SURFACE EL.: 6652.8

BORING NO. DB-7

N 1,543,120 E 491,729

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U S C S
6600		S 10	LOOSE, DARK BROWN FINE SAND, WITH SOFT SILT LAYERS, (0.5) INCHES THICK, MOIST	sp-sm
7-23-80	55	S 11	LOOSE, DARK BROWN, FINE SAND, WITH SOFT SILT LAYERS, MOIST	sp-sm
6590	60	S 12	LOOSE, BROWN, FINE SAND, TRACE OF SILT, WET 64.0'	sp-sm
	65	S 13	LOOSE, BROWN, FINE SAND, SOME SILT, WET	sm
	70		LOOSE, BROWN, FINE SAND, SOME SILT, WET 70.8'	sm
6580		S 14	STIFF, DARK BROWN, SANDY SILT, SOME CLAY INTERMIXED, WET 74.0'	ml
6576.3	75	S 15	VERY STIFF, BROWNISH GRAY, SANDY CLAY, SOME SILT, WET 76.5'	cl
	80		BOTTOM OF BORING 76.5'	
			PIEZOMETER DB-7 INSTALLED WITH TIP AT 70.5'	
	85			
	90			
	95			
	100			



D'APPOLONIA

HMCSL024475

DATE BEGAN: 8-19-80

DATE FINISHED: 8-19-80

GROUND SURFACE EL: 6593.6

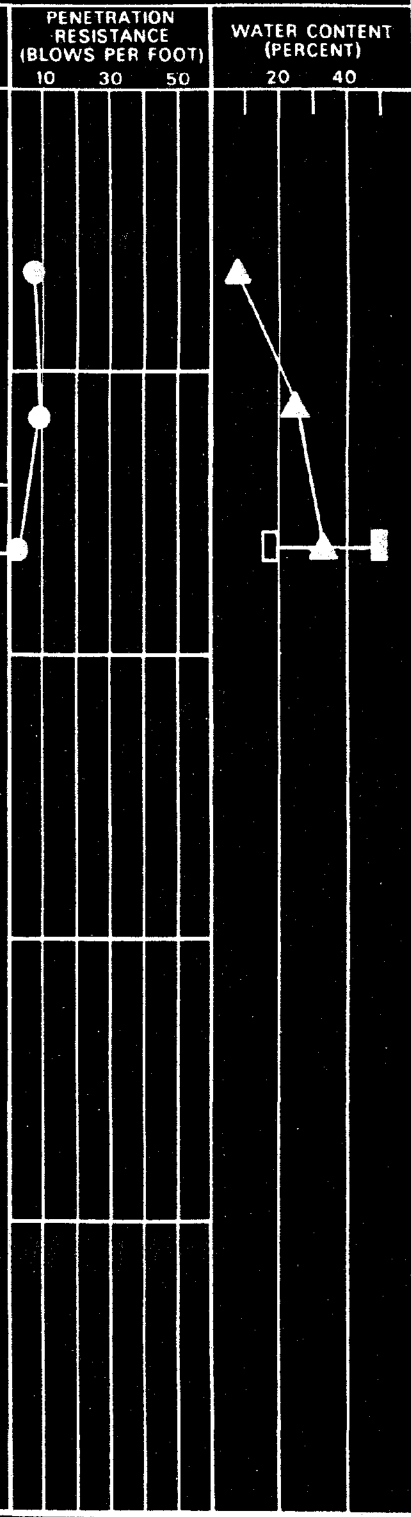
BORING NO DB-11

N 1,544,552 E 492,803

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.
6590	5				
8-19-80 (water level)		S 1		LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	10	S 2		LOOSE, BROWN, FINE SAND, TRACE OF SILT, WET	sp-sm
6580				14.0'	
6577.1	15	S 3		MEDIUM STIFF, BROWN TO BLACK, CLAYEY SILT, LENSES LESS THAN (1) INCH OF SILTY SAND, MOIST 16.5'	ml
	20			BOTTOM OF BORING 16.5'	
				PIEZOMETER DB-11 INSTALLED WITH TIP AT 14.0'	
	25, 30, 35, 40, 45, 50				



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RM80-311

Boring Log No.DB-11
Page 1 of 1

D'APPOLONIA

HMCSL024476

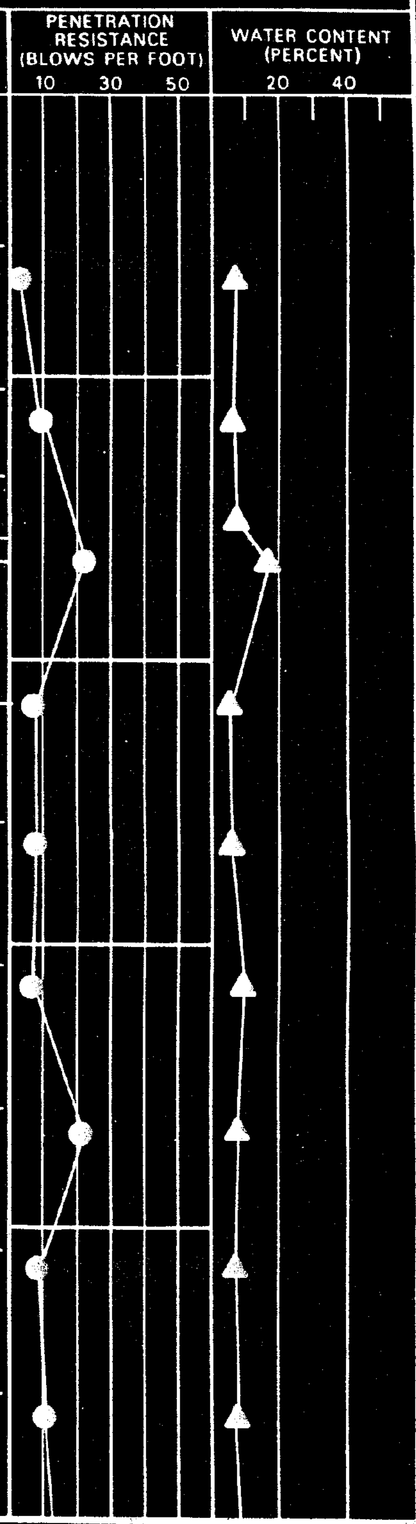
DATE BEGAN: 8/9/80
DATE FINISHED: 8/10/80
GROUND SURFACE EL.: 6665.3

BORING NO. DB-12

N 1,544,577 E 492,500

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
	0			
6660	5	S-1	VERY LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	10	S-2	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6650	15	S-3	AS ABOVE 15.7'	sp-sm
			STIFF TO VERY STIFF, BROWN CLAYEY SILT, LAYERS LESS THAN (1) INCH OF SILTY CLAY, FINE GRAVEL UP TO (3/4) INCHES INTERMIXED, SOME ORGANIC REMAINS, MOIST 16.2'	ml
	20	S-4	LOOSE, BROWN, FINE SAND, SOME SILT, MOIST 21.5'	sm
6640	25	S-5	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	30	S-6	AS ABOVE	sp-sm
6630	35	S-7	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	40	S-8	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6620	45	S-9	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	50			



D'APPOLONIA

DATE BEGAN: 8/9/80
DATE FINISHED: 8/10/80
GROUND SURFACE EL.: 6665.3

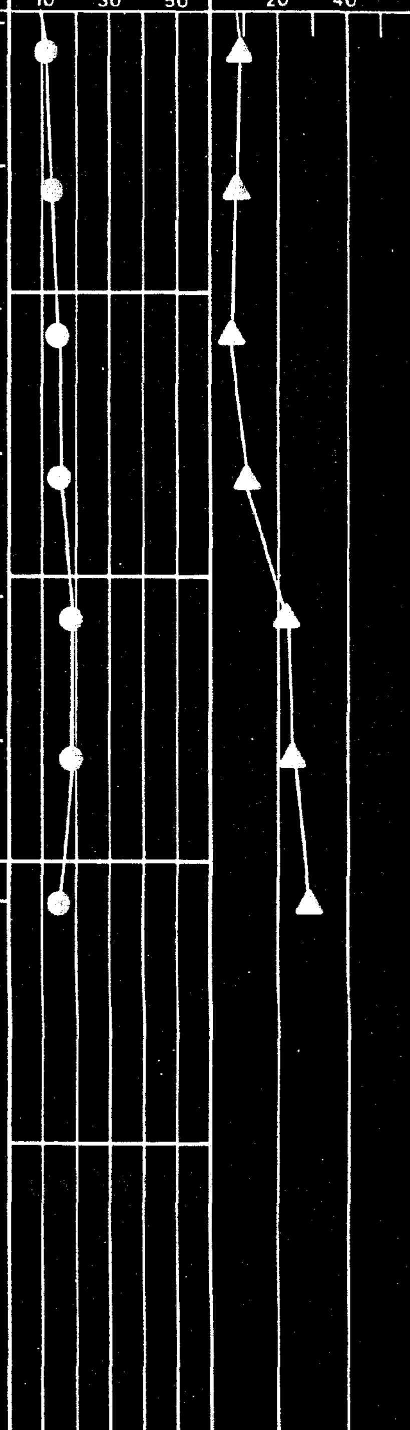
BORING NO DB-12

N 1,544,577 E 492,500

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS
	50	S 10		AS ABOVE	sp-sm
6610	55	S 11		AS ABOVE	sp-sm
	60	S 12		AS ABOVE	sp-sm
6600	65	S 13		AS ABOVE	sp-sm
8-10-80 ▽	70	S 14		MEDIUM DENSE, BROWNISH GRAY, FINE SAND, TRACE OF SILT, WET	sp-sm
6590	75	S 15		AS ABOVE 80.0'	sp-sm
6583.8	80	S 16		VERY SOFT TO SOFT, BROWN SANDY SILT, TRACE OF ORGANIC REMAINS, LARGE PIECES OF WOOD UP TO (3/4) INCH, WET 81.5'	ml
	85			BOTTOM OF BORING 81.5'	
	90			PIEZOMETER DB-12 INSTALLED WITH TIP AT 80.0'	
	95				
	100				

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50 — WATER CONTENT (PERCENT) 20 40



D'APPOLONIA

HMCSL024478

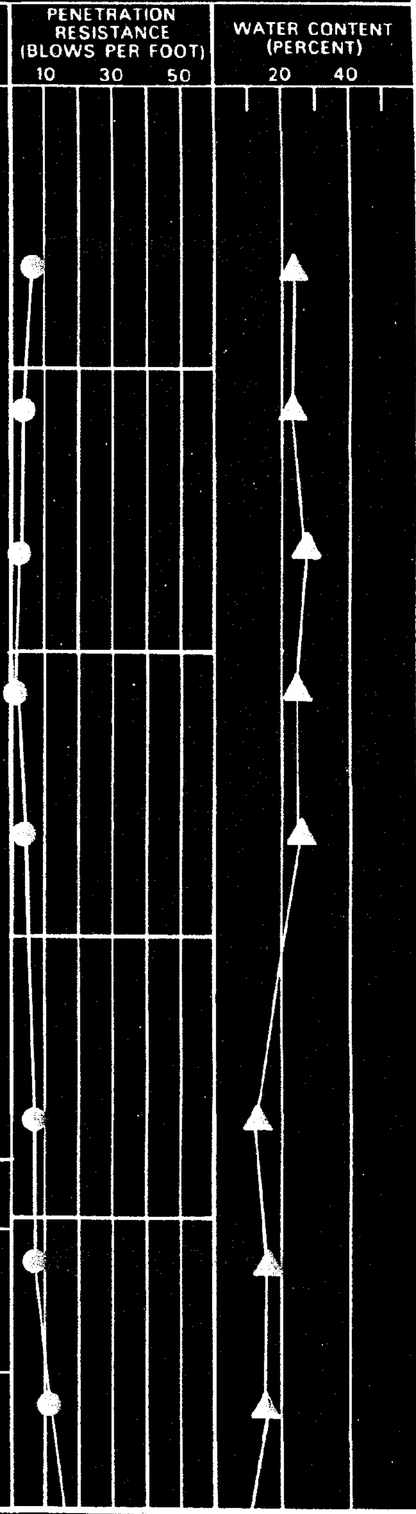
DATE BEGAN: 8/6/80
DATE FINISHED: 8/6/80
GROUND SURFACE EL.: 6657.6

BORING NO. DB-14

N 1,543,981 E 492,661

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U S C S
6650	5	S 1	LOOSE, BROWN, SILTY FINE SAND, TRACE OF CLAY, MOIST	sm
8-6-80 ▼	10	S 2	VERY LOOSE, BROWN, SILTY FINE SAND, TRACE OF CLAY, MOIST	sm
6640	15	S 3	VERY LOOSE, BROWN, ALTERNATING LAYERS OF SILTY FINE SAND AND CLAYEY SILT, LAYERS ABOUT (2) INCHES, WET	sm
	20	S 4	VERY LOOSE, BROWN, SILTY FINE SAND, WET	sm
6630	25	S 5	AS ABOVE	sm
	30	I 28	AS ABOVE	sm
6620	35	S 6	LOOSE, BROWN, SILTY FINE SAND, MOIST TO WET 38.0'	sm
	40	S 7	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST TO WET	sp-sm
6610	45	S 8	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST TO WET	sp-sm
	50			



D'APPOLONIA

HMCSL024479

DATE BEGAN: 8/6/80
DATE FINISHED: 8/6/80
GROUND SURFACE EL.: 6657.6

BORING NO. DB-14

N 1,543,981 E 492,661

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
	50	S 9	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6600	55	S 10	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST 59.0'	sp-sm
	60	S 11	MEDIUM DENSE, GRAY, SILTY FINE SAND, MOIST	sm
6590	65	2 25	AS ABOVE 68.5'	sm
	70	S 12	MEDIUM DENSE, GRAY, FINE SAND, TRACE OF SILT, MOIST 74.0'	sp-sm
6580	75	S 13	MEDIUM DENSE, GRAY, SILTY FINE SAND, MOIST	sm
	80		AS ABOVE 80.5'	
6575.6		3 24	STIFF, BROWN, SILTY CLAY, MOIST	cl
	85		PIEZOMETER DB-14 INSTALLED WITH TIP AT 78.0'	
	90			
	95			
	100			

PENETRATION RESISTANCE (BLOWS PER FOOT): 10 30 50
WATER CONTENT (PERCENT): 20 40

D'APPOLONIA

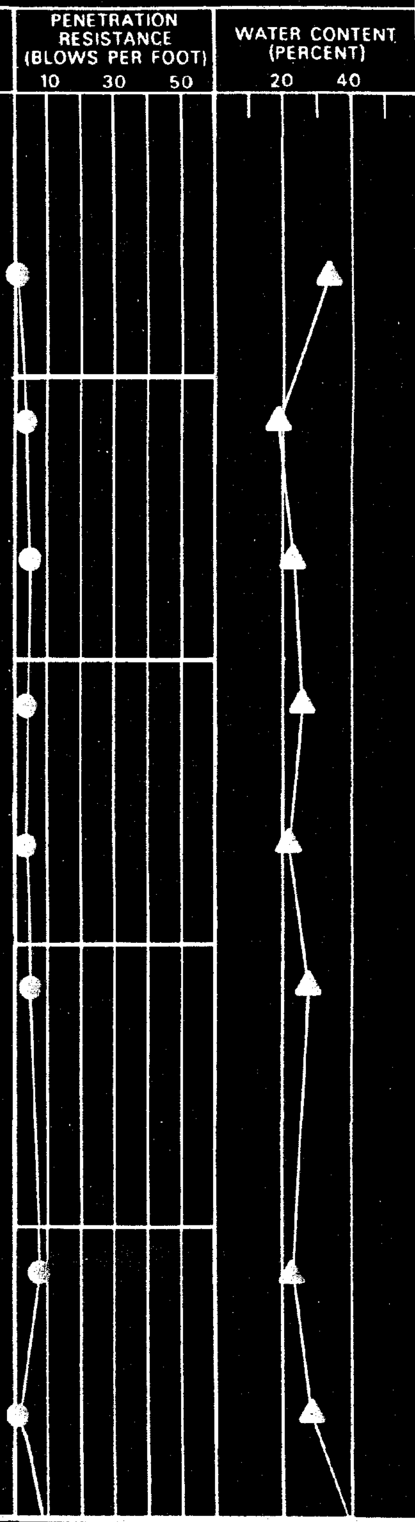
DATE BEGAN: 8/21/80
DATE FINISHED: 8/21/80
GROUND SURFACE EL.: 6647.8

BORING NO. DB-16

N 1,543,362 E 489,734

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
	0			
	5	S 1	VERY LOOSE, BROWN, SILTY FINE SAND, LAYERS ABOUT (1.5) INCHES OF SANDY SILT WITH TRACE OF CLAY, WET	sm
6640				
	10	S 2	VERY LOOSE, BROWN, FINE SAND, SOME SILT, MOIST	sm
8-21-80 ▽				
	15	S 3	LOOSE, BROWN, FINE SAND, SOME SILT, WET	sm
6630				
	20	S 4	VERY LOOSE, BROWN, FINE SAND, SOME SILT, LAYERS LESS THAN (0.5) INCHES OF CLAYEY SILT, WET	sm
	25	S 5	VERY LOOSE, BROWN, FINE SAND, SOME SILT, WET	sm
6620				
	30	S 6	LOOSE, GRAY, SILTY FINE SAND, LAYERS LESS THAN (0.5) INCHES OF CLAYEY SILT, WET	sm
	35	I 24	LOOSE, GRAY, SILTY FINE SAND, WET	sm
6610				
	40	S 7	AS ABOVE	sm
	45	S 8	VERY LOOSE, GRAY, SILTY FINE SAND, LAYERS LESS THAN (0.5) INCHES OF CLAYEY SILT, WET	sm
6600				
	50			



D'APPOLONIA

HMCSL024481

DATE BEGAN: 8/21/80

DATE FINISHED: 8/21/80

GROUND SURFACE EL.: 6647.8

BORING NO DB-16

N 1,543,362 E 489,734

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
	50	S 9		LOOSE, GRAY, SILTY FINE SAND, WET	sm		
	55	2 24		AS ABOVE	sm		
6590							
	60	S 10		AS ABOVE	sm		
	65	S 11		AS ABOVE 66.0'	sm		
6580				MEDIUM STIFF, GRAY, SILTY CLAY, MOIST	cl		
	70	S 12		AS ABOVE 71.3'			
6576.3				DENSE, TAN, FINE SAND, TRACE OF SILT, WET 71.5'	sp-sm		
	75			BOTTOM OF BORING 71.5'			
				PIEZOMETER DB-16 INSTALLED WITH TIP AT 65.0'			
	80						
	85						
	90						
	95						
	100						

DATE BEGAN: 8/19/80
DATE FINISHED: 8/20/80
GROUND SURFACE EL.: 6656.8

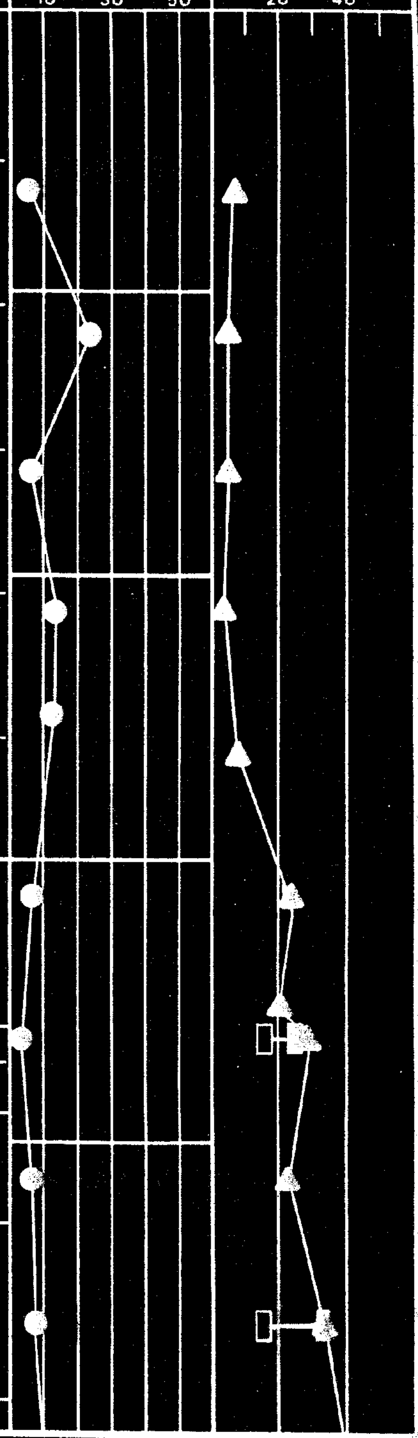
BORING NO. DB-17A

N 1,543,254 E 489,655

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	USCS
	0			
6650	5	S 1	LOOSE, BROWN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
	10	S 2	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6640	15	S 3	LOOSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	20	S 4	MEDIUM DENSE, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6630	25	S 5	AS ABOVE 30.0'	sp-sm
	30	S 6	LOOSE, BROWN, FINE SAND, SOME SILT, LAYERS (1.5) INCH THICK OF CLAYEY SILT, MOIST	sm
			VERY LOOSE, BROWN, FINE SAND, SOME SILT, MOIST 35.8'	sm
6620	35	S 7	SOFT, GRAY, CLAYEY SILT TO SILTY CLAY, IN LAYERS, MOIST 39.0'	ml-cl
	40	S 8	LOOSE, BROWN, SILTY SAND, MOIST TO WET 43.0'	sm
6610	45	S 9	MEDIUM STIFF, GRAY, SANDY CLAY, MOIST 49.0'	cl
	50			

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50 — WATER CONTENT (PERCENT) 20 40



United Nuclear - Homestake Partners
RM80-311

Boring Log No. DB-17A
Page 1 of 3

D'APPOLONIA

DATE BEGAN: 8/19/80
DATE FINISHED: 8/20/80
GROUND SURFACE EL.: 6656.8

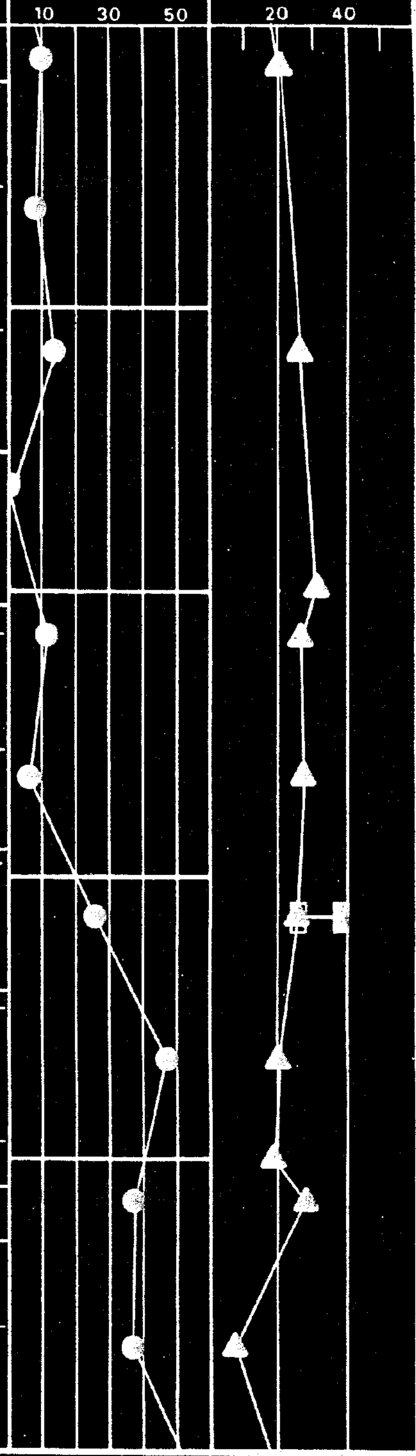
BORING NO. DB-17A

N 1,543,254 E 489,655

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.
	50	S 10	LOOSE, GRAY, FINE SILTY SAND, MOIST 52.0'	sm
6600	55		LOOSE, GRAY, FINE SAND, TRACE OF SILT, MOIST TO WET	sp-sm
8-20-80	60	S 11	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, LAYERS ABOUT (1) INCH OF GRAY, SANDY, SILT, MOIST TO WET 65.0'	sp-sm
6590	65		VERY LOOSE, GRAY, SILTY, FINE SAND, WET	sm
	70		AS ABOVE 70.5'	sm
		S 12	MEDIUM DENSE, GRAY, FINE SAND, TRACE OF SILT, WET	sp-sm
6580	75	S 13	LOOSE, GRAY, FINE SAND, TRACE OF SILT, WET 79.0'	sp-sm
	80	S 14	MEDIUM STIFF, BROWN TO BLACK, CLAYEY SILT, AREAS OF STIFF CLAY, MOIST 84.0'	cl-ml
6570	85	S 15	DENSE TAN, FINE SAND, TRACE OF SILT, WET	sp-sm
	90	S 16	AS ABOVE 91.0'	sp-sm
			VERY STIFF, BROWN TO BLACK CLAY, MOIST 93.0'	cl
6560	95	S 17	DENSE, TAN, FINE SAND, TRACE OF SILT, IRON STAININGS, MOIST	sp-sm
	100			

PENETRATION RESISTANCE (BLOWS PER FOOT) / WATER CONTENT (PERCENT)



D'APPOLONIA

HMCSL024484

DATE BEGAN: 8/19/80

DATE FINISHED: 8/20/80

GROUND SURFACE EL.: 6656.8

BORING NO DB-17A

N 1,543,254 E 489,655

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
	100	S 18		VERY DENSE, TAN, FINE TO MEDIUM SAND, TRACE OF SILT, MOIST 105.0'	sp-sm	97/1'	
6550	105	S 19		VERY DENSE, TAN, SILTY, FINE SAND, MOIST 110.0'	sm	63/1'	
6545.3	110	S 20		VERY DENSE, TAN, FINE SAND, SOME SILT, LAYERS LESS THAN (0.5) INCH OF CLAY, MOIST 111.5	sm	50/1'	
	115			BOTTOM OF BORING 111.5'			
				PIEZOMETERS DB-17A AND DB-17B INSTALLED WITH TIPS AT 110.0' AND 80.0', RESPECTIVELY			

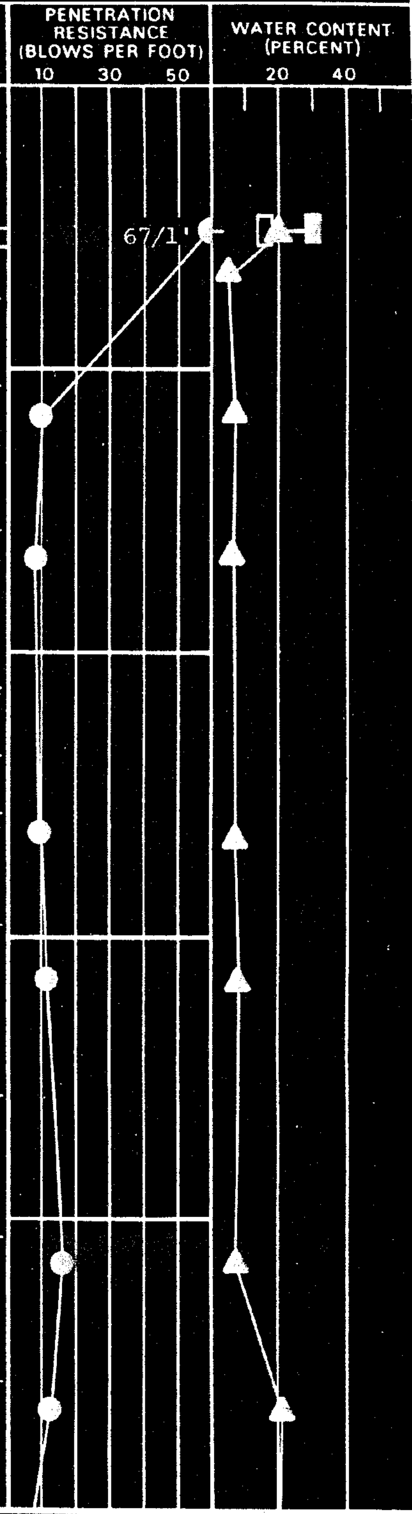
DATE BEGAN: 8/24/80
DATE FINISHED: 8/24/80
GROUND SURFACE EL.: 6632.4

BORING NO DB-18

N 1,543,193 E 489,611

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U S C S
6630	0–5.4		DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	5.4–5.9	S 1	STIFF, BROWN SILTY CLAY, MOIST (5.4'–5.9')	cl
	5.9		VERY DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
6620	10	S 2	LOOSE BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	15	S 3	AS ABOVE	sp-sm
6610	20	1 / 26	AS ABOVE	sp-sm
		2 / 26	AS ABOVE	sp-sm
	25	S 4	AS ABOVE	sp-sm
6600	30	S 5	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	35	3 / 25	AS ABOVE	sp-sm
6590	40	S 6	AS ABOVE	sp-sm
8-24-80 (water level)	45	S 7	MEDIUM DENSE, GRAY, FINE SAND, TRACE OF SILT, WET	sp-sm
	50			



United Nuclear - Homestake Partners
RM80-311

Boring Log No. DB-18

D'APPOLONIA

DATE BEGAN: 8/24/80
DATE FINISHED: 8/24/80
GROUND SURFACE EL.: 6632.4

BORING NO. DB-18

N 1,543,193 E 489,611

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	USCS	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	WATER CONTENT (PERCENT) 20 40
6580	50	S 8		LOOSE, GRAY, FINE SAND, TRACE OF SILT, WET	sp-sm		
6575.9	55	S 9		AS ABOVE 56.3'			
				VERY STIFF, GRAY, SILTY CLAY, ORGANIC REMAINS, MOIST 56.5'	cl-ol		
	60			BOTTOM OF BORING 56.5'			
				PIEZOMETER DB-18 INSTALLED WITH TIP AT 55.0'			

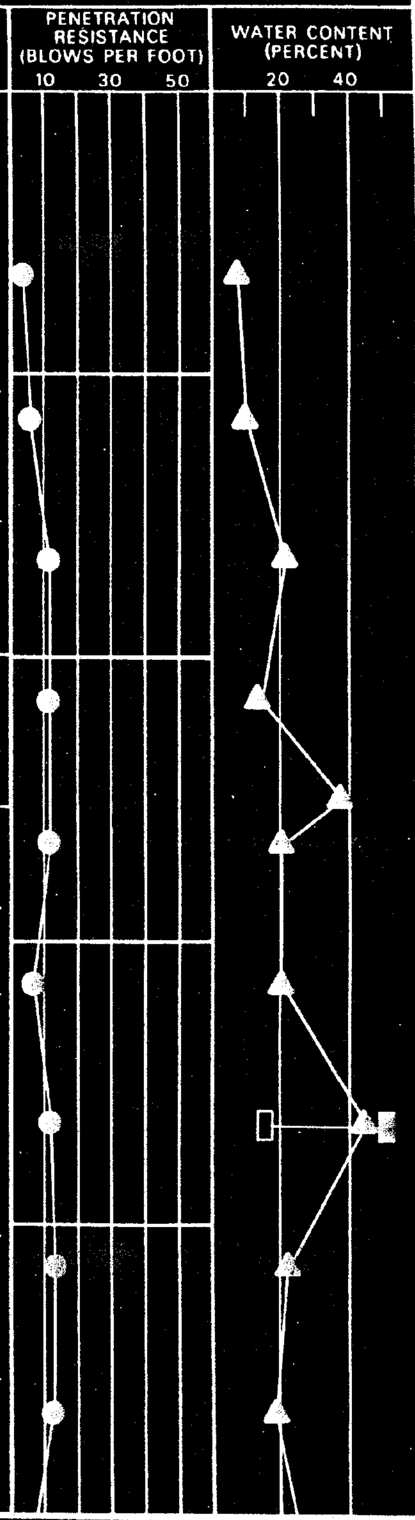
DATE BEGAN: 8/22/80
DATE FINISHED: 8/23/80
GROUND SURFACE EL.: 6654.0

BORING NO. DB-19A

N 1,544,416 E 489,275

FIELD ENGINEER: JGF
CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.
6650	5	S 1	VERY LOOSE, BROWN, FINE SAND, TRACE OF SILT, DRY TO MOIST	sp-sm
	10	S 2	LOOSE, BROWN, FINE SAND TRACE OF SILT, LAYERS LESS THAN (0.3) INCHES OF SILT, MOIST	sp-sm
6640	15	S 3	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, THIN BANDS OF IRON-STAINING, MOIST TO WET 20.0'	sp-sm
	20	S 4	MEDIUM DENSE, BROWN, FINE SAND, SOME SILT, LAYERS LESS THAN (0.4) INCHES OF CLAYEY SILT, MOIST	sm
6630	25		AS ABOVE 25.2'	
		S 5	VERY SOFT, GRAY, CLAYEY SILT MOIST 26.0'	ml
			MEDIUM DENSE, BLACK TO BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	30	S 6	LOOSE, BROWN, FINE SAND, TRACE OF SILT, THIN LAYERS OF CLAYEY SILT, MOIST 33.0'	sp-sm
6620	35	S 7	SOFT, DARK GRAY, CLAYEY SILT, MOIST 36.5'	ml
	40	S 8	MEDIUM DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST TO WET	sp-sm
6610	45	S 9	AS ABOVE	sp-sm
	50			



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RM80-311

Boring Log No. DB -19A

D'APPOLONIA

HMCSL024488

DATE BEGAN: 8/22/80

DATE FINISHED: 8/23/80

GROUND SURFACE EL.: 6654.0

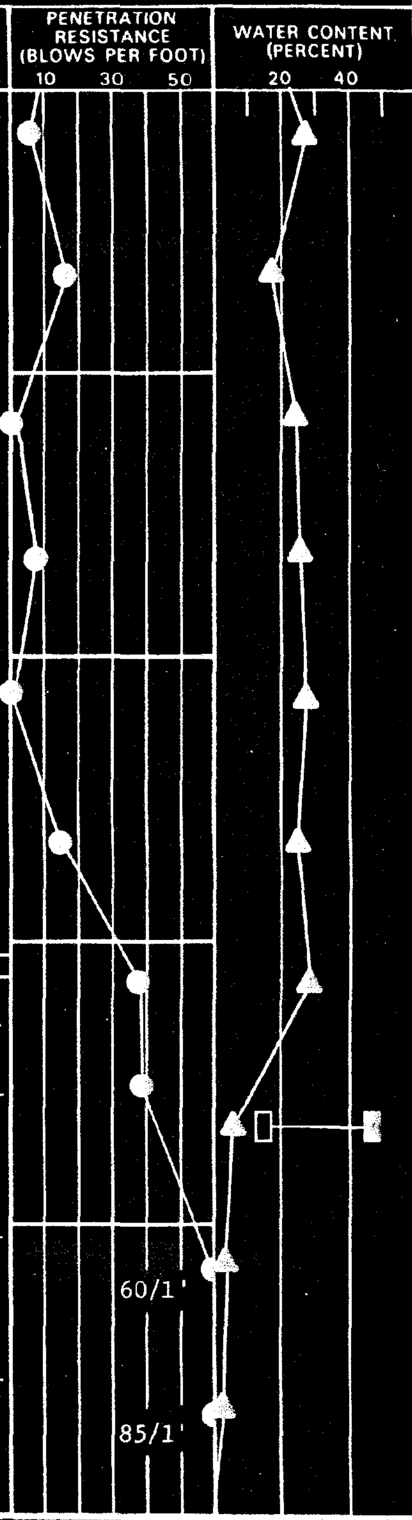
BORING NO. DB-19A

N 1,544,416 E 489,275

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U S C S
	50	S 10	LOOSE, GRAY, FINE SAND, TRACE OF SILT, MOIST TO WET	sp-sm
6600	55	S 11	MEDIUM DENSE, GRAY, FINE SAND, TRACE OF SILT, MOIST TO WET	sp-sm
8-23-80 (water level)	60	S 12	VERY LOOSE, BROWN, FINE SAND, SOME SILT, WET	sm
6590	65	S 13	LOOSE, BROWN TO GRAY, FINE SAND, SOME SILT, WET	sm
	70	S 14	VERY LOOSE, BROWN TO GRAY, FINE SAND, SOME SILT, WET	sm
6580	75	S 15	MEDIUM DENSE, BROWN TO GRAY, FINE SAND, SOME SILT, WET	sm
	80	S 16	TOP: AS ABOVE 80.5'	sm
			STIFF, DARK GRAY, SILTY CLAY, MOIST 81.4'	cl
6570			DENSE, BROWN, FINE SAND, TRACE OF SILT, MOIST	sp-sm
	85	S 17	DENSE, REDDISH BROWN, MEDIUM FINE SAND, TRACE OF SILT, LAYERS OF VERY STIFF, PLASTIC CLAY, MOIST	sp-sm
	90	S 18	VERY DENSE, BROWN, FINE TO MEDIUM FINE SAND, MOIST	sp-sm
6560	95	S 19	VERY DENSE, LIGHT BROWN, CLEAN, FINE TO MEDIUM FINE SAND, MOIST	sp-sm
	100			



United Nuclear - Homestake Partners
RM80-311

D'APPOLONIA

HMCSL024489

DATE BEGAN: 8/22/80

DATE FINISHED: 8/23/80

GROUND SURFACE EL.: 6654.0

BORING NO. DB-19A

N 1,544,416 E 489,275

FIELD ENGINEER: JGF

CHECKED BY: TJH

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.
	100	S 20	VERY DENSE, REDDISH BROWN, CLEAN, FINE TO MEDIUM FINE SAND, WET 100.5'	sw
6550			VERY STIFF, BROWN, SANDY CLAY, MOIST 102.0'	cl
	105	S 21	ALTERNATING LAYERS ABOUT (1.5) INCHES OF: 1) VERY DENSE LIGHT BROWN, CLEAN, FINE SAND, MOIST 2) STIFF, BROWN, SANDY SILT, WHITE CLAY PARTICLES IN LAYERS, MOIST	sp& ml
6540	110	S 22	VERY DENSE, LIGHT BROWN, FINE TO MEDIUM SAND, CLEAN, THIN LAYERS (0.4) INCHES OF STIFF, SILTY CLAY, MOIST	sw
6537.5	115	S 23	VERY DENSE, BROWN, MEDIUM SAND, TRACE OF SILT, SOME COARSE SAND, WET	

Depth scale: 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150

PENETRATION RESISTANCE (BLOWS PER FOOT): 10 30 50 — 60/1

WATER CONTENT (PERCENT): 20 40

BOTTOM OF BORING 116.5'

PIEZOMETERS DB-19A AND DB-19B INSTALLED WITH TIPS AT 116.5' AND 80.0', RESPECTIVELY

D'APPOLONIA

APPENDIX B

PIEZOMETER INSTALLATION PROCEDURES, FALLING HEAD PERMEABILITY/SENSITIVITY TESTING AND MONITORING

INSTALLATION PROCEDURE

The installation procedure utilized at United Nuclear-Homestake Partners Uranium Mill Tailings Pond for an unsealed piezometer was as follows:

- A 3-1/4 inch I. D. boring was advanced to the native soil-tailings interface using 6 inch O. D. hollow-stem augers.

- The piezometer screen, consisting of a 5 to 10 foot section of 0.010 inch machine slotted 1-1/2 inch I. D. PVC pipe, was installed at the bottom of the boring. The screen was connected to the ground surface using 10 foot sections of 1-1/2 inch I. D. PVC pipe fastened together with PVC cement and external couplings.

- The sensing zone around the screen was backfilled by caving of tailings sand. The loose nature of the tailings sand prevented backfilling of the sensing zone with washed mortar sand as originally intended. Sensitivity testing of the piezometers indicated that essential piezometer function was not impaired by a sensing zone of tailings sand.

- The piezometer pipe extended to at least 2-1/2 feet above the ground surface, with a 4-1/2 inch O. D. PVC protective outer casing set over the piezometer pipe. The annulus between the piezometer pipe and the protective casing was filled with dry cement grout. The protective casing was imbedded at least 2 feet into the ground surface and cemented in place. The outer surface of the protective casing was painted orange and the piezometer number clearly written in waterproof ink on the protective casing, on the piezometer pipe and under the piezometer pipe cap.

- The piezometer was flushed by lowering a 1/2 inch hose to within approximately 10 feet of the piezometer bottom. Clear water was pumped in, flushing out all the fines and "developing" the piezometer by pushing fines away from the sensing zone.

The installation details for the unsealed piezometers are shown on Figures B1 through B14.

Sealed piezometers were installed into the native soil in a fashion similar to the unsealed piezometers in the tailings using the following procedure:

- Six inch O. D. hollow-stem augers with a 3-1/4 inch I. D. were used to advance a boring through the tailings and into a zone of clean native sand.

- The piezometer screen, consisting of a full 10 foot section of 0.010 inch machine slotted 1-1/2 inch I. D. PVC pipe, was installed in the clean native sand. The screen was connected to the ground surface using both 1-1/2 inch and 1 inch I. D. PVC pipe. The piezometer pipe was reduced from 1-1/2 inch to 1 inch at approximately 16 feet below the native soil-tailings interface. All PVC pipe sections were fastened with PVC cement and external couplings.

- The sensing zone around the screen was backfilled by caving of the native sands when the hollow-stem augers were withdrawn. The auger casing was removed to an average depth of 5-1/2 feet below the native soil-tailings interface. At this point, a Portland Cement, bentonite and water slurry, (approximate percentages: 30%, 5% and 65%, by weight, respectively) was placed inside the augers using 1/2 inch hose to carry the slurry to the native soil-tailings interface zone. As the auger casing was removed, the slurry flowed out of the auger casing, effectively sealing off the native soil-tailings interface from approximately 5-1/2 feet below to 10 feet above the interface.

- A protective casing was installed using the same procedure given for unsealed piezometers.

- The piezometer was flushed using the same procedure given for unsealed piezometers.

The installation details for the sealed piezometers are shown on Figure B15 through B20.

FALLING HEAD PERMEABILITY AND SENSITIVITY TESTING

Shortly after installation, a falling head permeability/sensitivity test was performed on each piezometer. This served a dual purpose as the test provided both an in situ measure of the permeability of the soil into which the screen was placed, as well as a check to see if the piezometer was functioning properly.

The falling head test was performed by filling the piezometer to the top of the standpipe or to a constant elevation, if the soil was too permeable to allow filling to the top. The fresh water source was then shut-off and the initial depth measurement was taken by an electrical depth gauge at time zero. The drop in water level was recorded after one minute, two minutes, five minutes, etc., until the water level was back to the initial ground water level or had reached a stable level. These data, along with piezometer installation data (Figure B1 through B20), was used in the following formula to determine horizontal permeability (Lambe and Whitman, 1969):

$$k_h = \frac{d^2 \ \ln(2mL/D)}{8L\ (t_2-t_1)} \ln(H_1/H_2); \text{ for } mL/D > 4,$$

where:

k_h = horizontal permeability, (cm/sec)
d = standpipe diameter, (cm)
D = screen diameter, (cm)
L = screen length, (cm)
m = transformation ratio, $(k_h/k_v)^{1/2}$
t_1, t_2 = time, (sec)
H_1, H_2 = head in piezometer at t_1 And t_2, (cm)

D'APPOLONIA

The permeability equation was formulated for a screen length totally enveloped within a uniform soil layer. This test applies only to saturated, pervious soils. For the field analysis, an assumption of equal vertical and horizontal permeability was also assumed.

All piezometers were found to be "sensitive" as the water level never reached the top of the riser pipe after five minutes of continuous flushing and returned to the original groundwater surface within 30 minutes. The results from the falling head tests have been presented in the Engineer's Report.

PIEZOMETER MONITORING

The water levels in all D'Appolonia piezometers were read from installation through September 13, 1980 by a D'Appolonia engineer. Future piezometer readings will become the responsibility of the United Nuclear-Homestake Partners staff. A standard D'Appolonia piezometer reading sheet is provided in this Appendix (Table B1). In addition, piezometer readings taken between July 22 and September 13, 1980, have been recorded on D'Appolonia piezometer reading sheets and are presented on Tables B2 through B5.

Table B1

D'APPOLONIA

PIEZOMETER DATA SHEET

PROJECT NAME UNHP Tailings Pond PROJECT NO. RM80-311

(1) DEPTH TO THE WATER LEVEL FROM THE TOP OF PIPE
(2) ELEVATIONS SHOWN ARE TOP OF PIEZOMETER PIPE

DATE & RECORDER	PIEZOMETER READINGS - FEET (1) / ELEVATION OF WATER LEVEL - FEET										
	# EL. (2)	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.

Table B2

D'APPOLONIA

PIEZOMETER DATA SHEET

PROJECT NAME UNHP Tailings Pond PROJECT NO RM80-311

(1) DEPTH TO THE WATER LEVEL FROM THE TOP OF PIPE
(2) ELEVATIONS SHOWN ARE TOP OF PIEZOMETER PIPE

DATE & RECORDER JGF	PIEZOMETER READINGS-FEET (1) / ELEVATION OF WATER LEVEL-FEET										
	# DB-1A EL6668.8 (2)	#DB-1B EL6669.3	#DB-2A EL6592.1	#DB-2B EL6592.3	# DB-3 EL6668.7	# DB-4 E6594.0	#DB-5A EL6663.9	#DB-5B EL.6665.3	#DB-6A EL6599.7	# DB-6B EL6599.9	# DB-7 EL.6655.7
7-22-80									63.4	15.2	60.3
7-29-80					65.8		95.7	64.7	63.4	15.2	60.4
7-31-80			53.2		65.7	8.9	95.8	64.7	63.5	15.2	60.4
8-5-80			52.9		65.7	9.2	98.8	64.8	63.5	15.2	60.3
8-7-80			52.9	7.7	65.7	9.2	98.9	64.8	63.5	15.2	60.3
8-9-80	103.3	71.3	52.9	7.6	65.7	9.2	98.9	64.7	63.5	15.3	60.3
8-10-80	107.8	71.3	52.9	7.4	65.6	9.2	98.9	64.7	63.5	15.3	60.3
8-19-80	108.3	71.1	53.1	7.4	65.6	9.3	99.8	64.7	63.6	15.2	60.4
8-22-80	108.3	70.8	53.2	7.4	65.7	9.2	100.2	64.7	63.6	15.2	60.4
8-25-80	108.2	70.8	53.2	7.3	65.6	9.2	100.4	64.7	63.6	15.3	60.4
9-12-80	108.2 / 6560.6	69.9 / 6599.4	53.2 / 6538.9	7.0 / 6585.3	65.7 / 6603.0	9.5 / 6584.5	100.4 / 6563.5	64.7 / 6600.6	63.7 / 6536.0	15.3 / 6584.6	60.4 / 6595.3

Table B3

D'APPOLONIA

PIEZOMETER DATA SHEET

PROJECT NAME UNHP Tailings Pond PROJECT NO. RM80-311

(1) DEPTH TO THE WATER LEVEL FROM THE TOP OF PIPE
(2) ELEVATIONS SHOWN ARE TOP OF PIEZOMETER PIPE

DATE & RECORDER JGF	PIEZOMETER READINGS - FEET (1) / ELEVATION OF WATER LEVEL - FEET										
	#DB-11 EL.(2) 6599.1	#DB-12 EL 6669.3	#DB-14 EL 6661.9	#DB-16 EL. 6651.8	#DB-17A EL 6661.3	# DB-17B EL 6661.2	#DB-18 EL 6638.0	#DB-19A EL. 6659.5	#DB-19B EL 6659.5	# EL.	# EL.
8-7-80			60.1								
8-9-80			60.1								
8-10-80			60.1								
8-19-80	13.9	75.6	60.1								
8-22-80	13.8	75.6	60.0	50.0	110.6	66.1					
8-25-80	13.8	75.5	59.9	50.0	112.6	65.4	50.1	118.7	69.6		
9-12-80	13.6 / 6585.5	75.7 / 6593.6	59.1 / 6602.8	49.9 / 6601.9	112.8 / 6548.5	65.3 / 6595.9	50.1 / 6587.9	118.7 / 6540.8	69.5 / 6590.0		

Table B4

D'APPOLONIA

PIEZOMETER DATA SHEET

PROJECT NAME UNHP Tailings Pond PROJECT NO. RM80-311

(1) DEPTH TO THE WATER LEVEL FROM THE TOP OF PIPE
(2) ELEVATIONS SHOWN ARE TOP OF PIEZOMETER PIPE

DATE & RECORDER JGF	PIEZOMETER READINGS - FEET (1) / ELEVATION OF WATER LEVEL - FEET										
	#ST-3 EL (2) 6662.0	#ST-7 EL 6653.2	#ST-9 EL 6637.5	#ST-11 EL 6594.8	# ST-11A EL 6594.6	#ST-12 EL 6597.0	# ST-12A EL 6597.6	#ST-13 EL 6654.4	#ST-16 EL 6636.9	# ST-17 EL 6670.2	#ST-18 EL 6642.1
8-19-80	62.6 / 6599.4	72.8 / 6580.4	53.8 / 6583.7	43.5 / 6551.3	14.3 / 6580.3	74.2 / 6522.8	16.8 / 6580.8	60.2 / 6594.2	61.4 / 6575.5	69.3 / 6600.9	49.4 / 6592.7

Table B5

D'APPOLONIA

PIEZOMETER DATA SHEET

PROJECT NAME UNHP Tailings Pond PROJECT NO. RM80-311

(1) DEPTH TO THE WATER LEVEL FROM THE TOP OF PIPE
(2) ELEVATIONS SHOWN ARE TOP OF PIEZOMETER PIPE

DATE & RECORDER JGF	PIEZOMETER READINGS-FEET (1) / ELEVATION OF WATER LEVEL-FEET										
	# ST-19 EL (2) 6610.6	#ST-19A EL 6610.7	#ST-20 EL 6609.5	#ST-20A EL. 6608.4	# ST-21 EL 6600.3	# ST-21A EL 6599.9	# ST-23 EL 6594.3	#ST-23A EL 6593.6	# EL.	# EL.	# EL.
8-19-80	72.1 / 6538.5	23.1 / 6587.6	75.1 / 6534.4	19.2 / 6589.2	52.4 / 6547.9	17.2 / 6582.7	68.5 / 6525.8	14.2 / 6579.4			

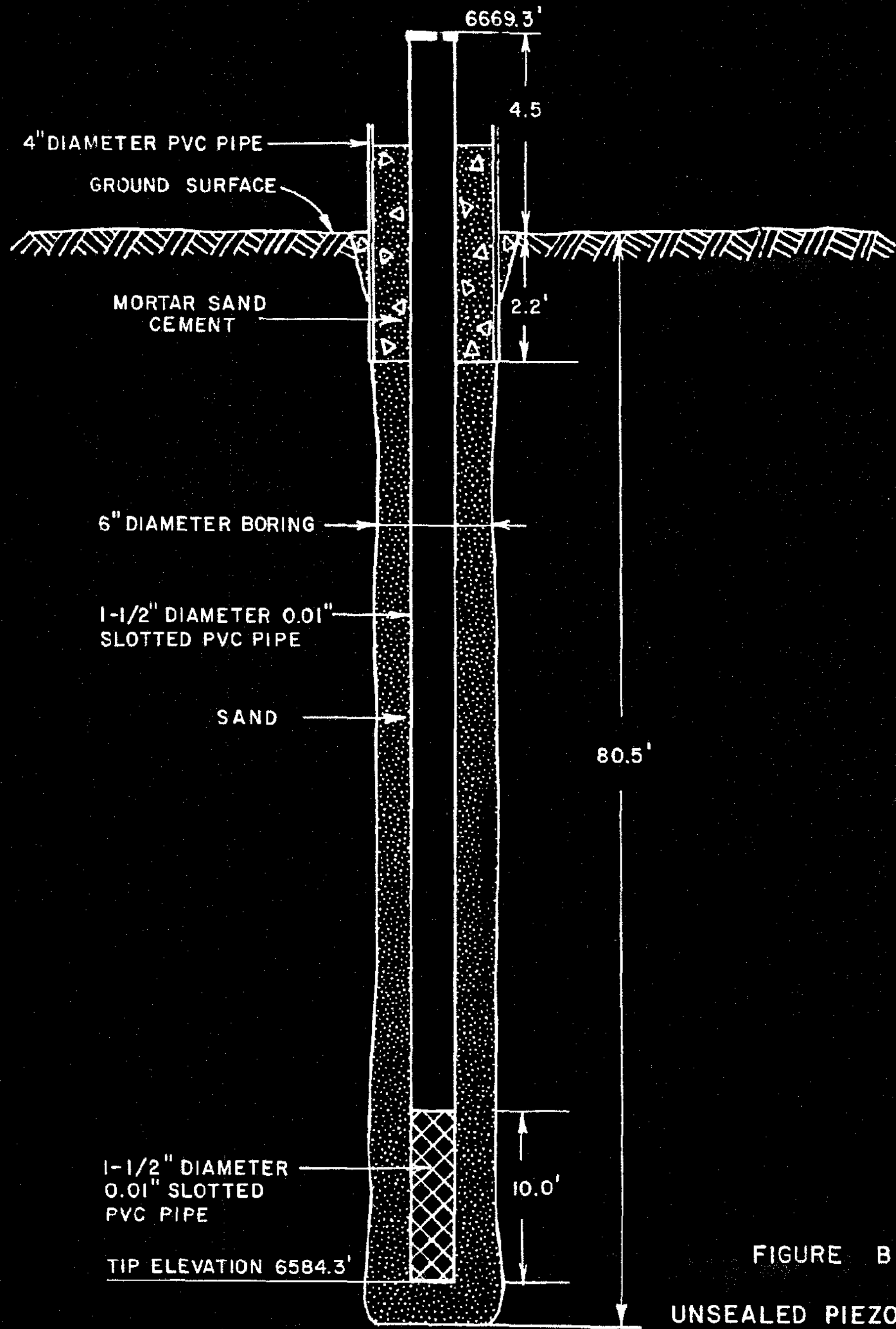


FIGURE B1

UNSEALED PIEZOMETER
DB-1B

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	mjg	11/1/80	CHECKED BY	TJH	11-12-80	APPROVED BY	[illegible]	11-12-80	DRAWING NUMBER	RM80-311-A28

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjg 11/5/80	TJH 11-12-80	[signature] 11-12-80	RM80-311-A29

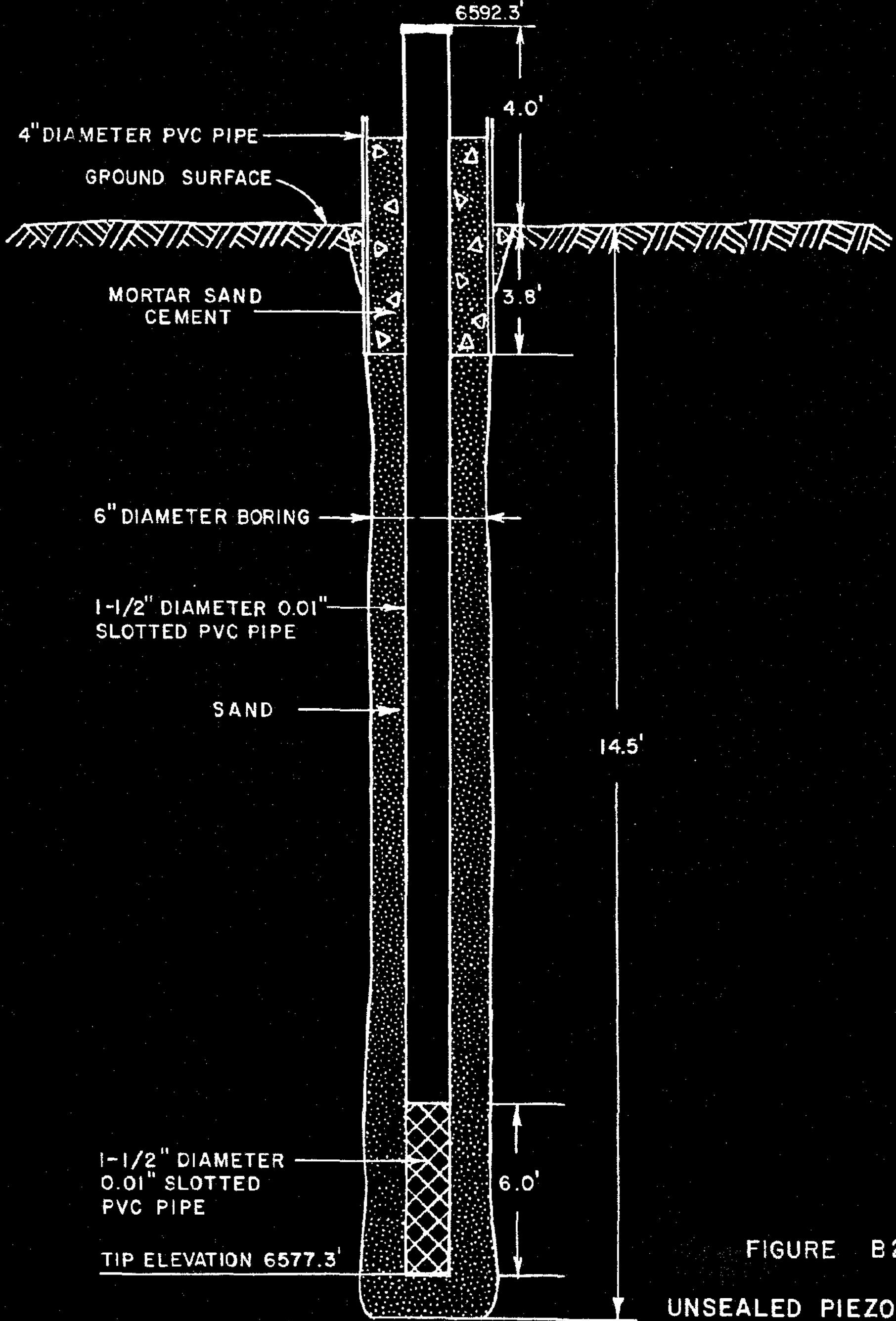


FIGURE B2

UNSEALED PIEZOMETER
DB-2B

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DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjg 11/1/80	TJH 11-12-80	[illegible] 11-12-80	RM80-311-A30

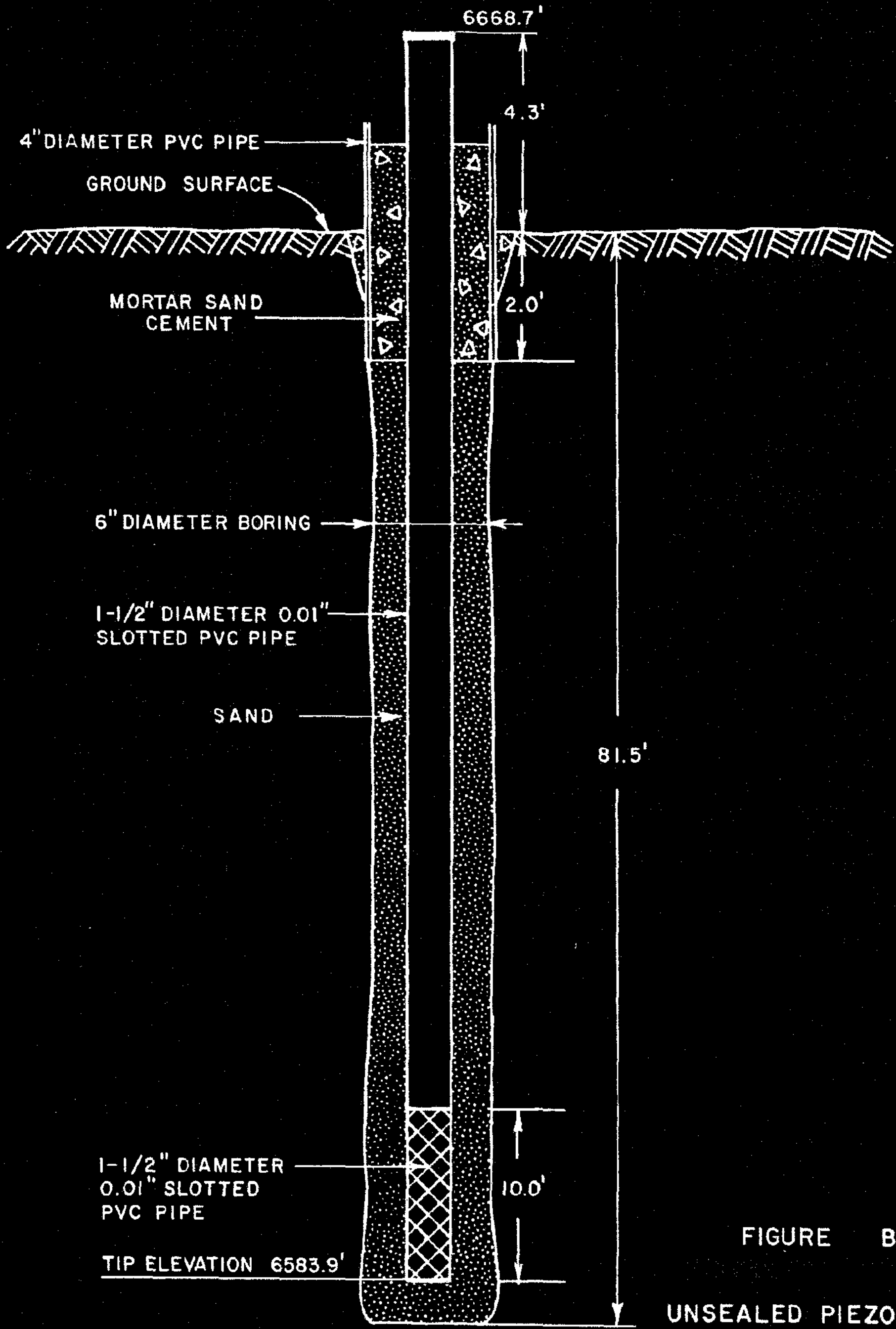

FIGURE B3

UNSEALED PIEZOMETER
DB-3

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DRAWING NUMBER RM80-311-A31

DRAWN BY	mjg	11/5/80
CHECKED BY	TJH	11-12-80
APPROVED BY	[illegible]	11-12-80

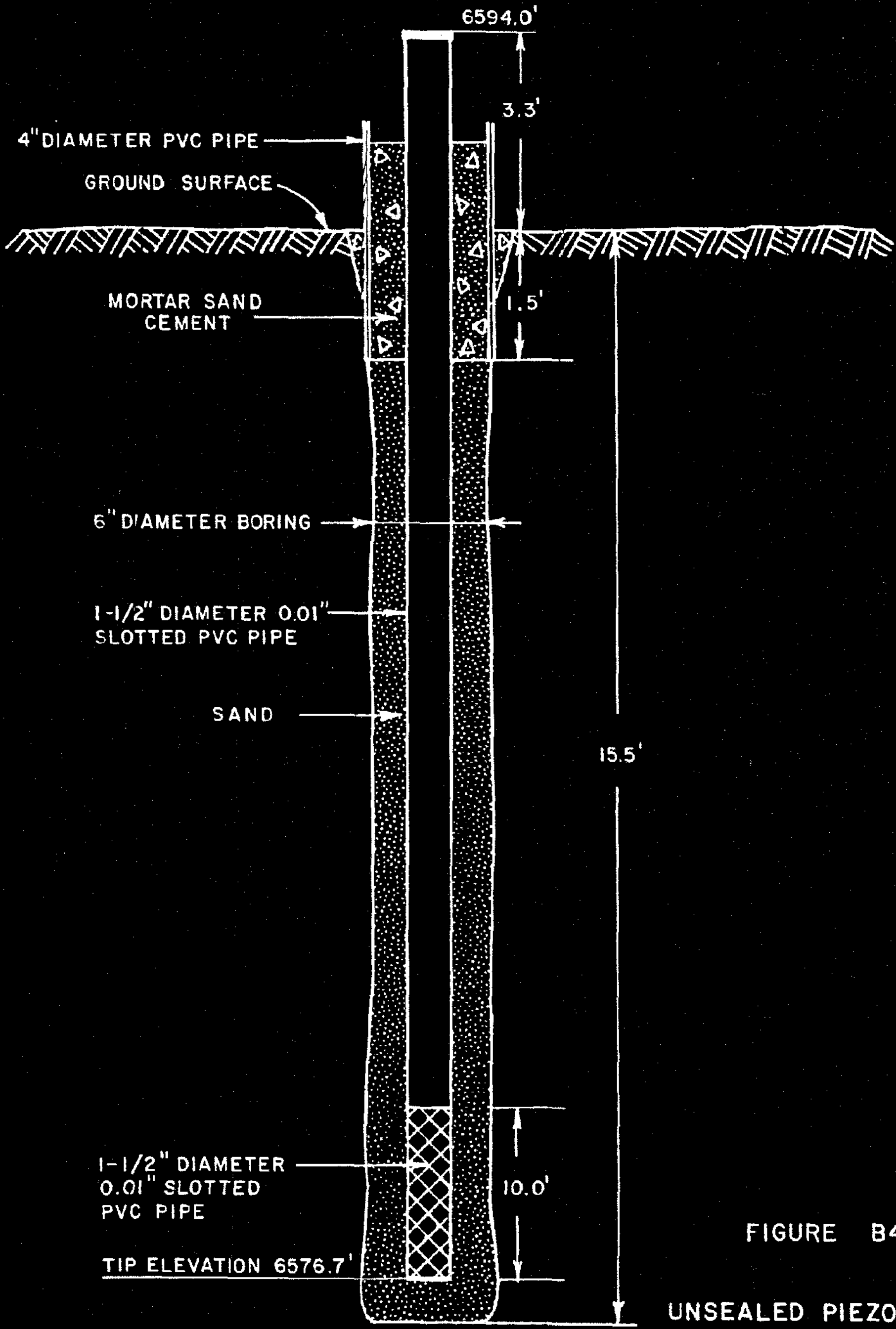

FIGURE B4

UNSEALED PIEZOMETER
DB-4

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DRAWN BY	mjg	11/5/80
CHECKED BY	TJH	11-12-80
APPROVED BY	ARK	11-12-80
DRAWING NUMBER	RM80-311-A32	

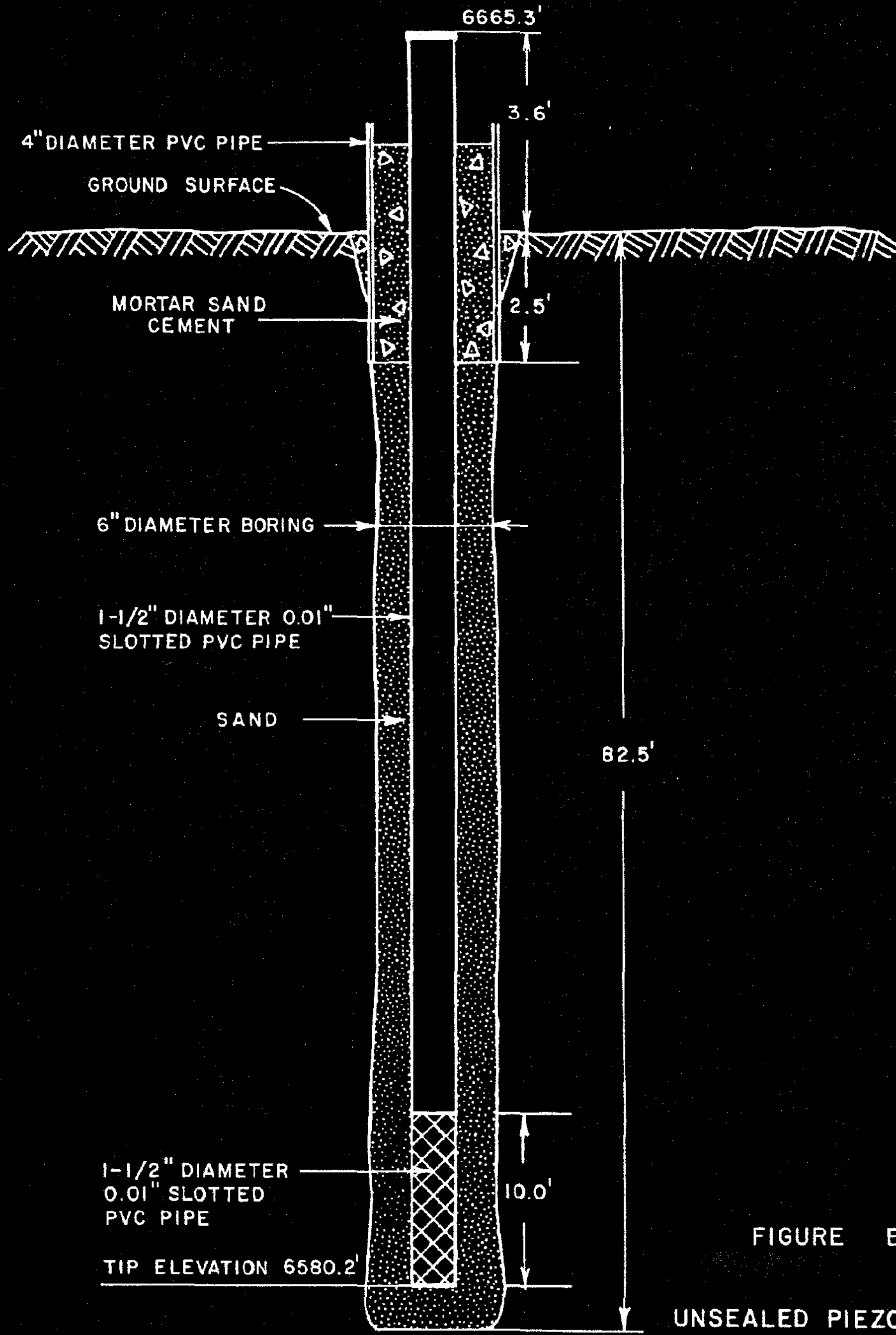

FIGURE B5

UNSEALED PIEZOMETER
DB-5B

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D'APPOLONIA

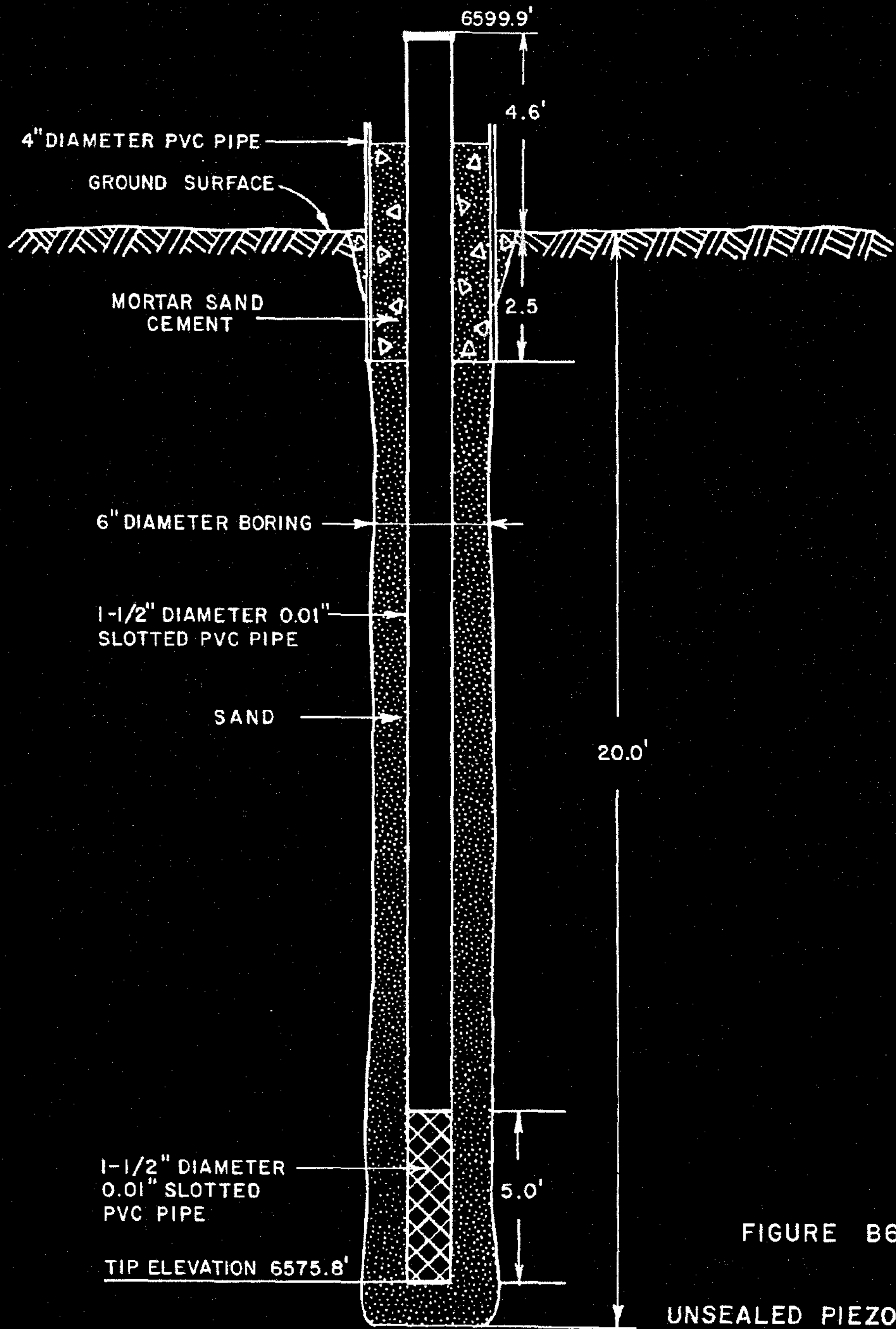

FIGURE B6

UNSEALED PIEZOMETER
DB-6B

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D'APPOLONIA

DRAWN BY	mjg	11/5/80
CHECKED BY	TJH	11-12-80
APPROVED BY	[illegible]	11-12-80
DRAWING NUMBER	RM80-311-A33	

DRAWN BY mjg 11/5/80 | CHECKED BY TJH 11-12-80 | APPROVED BY AAJC 11-12-80 | DRAWING NUMBER RM80-311-A34

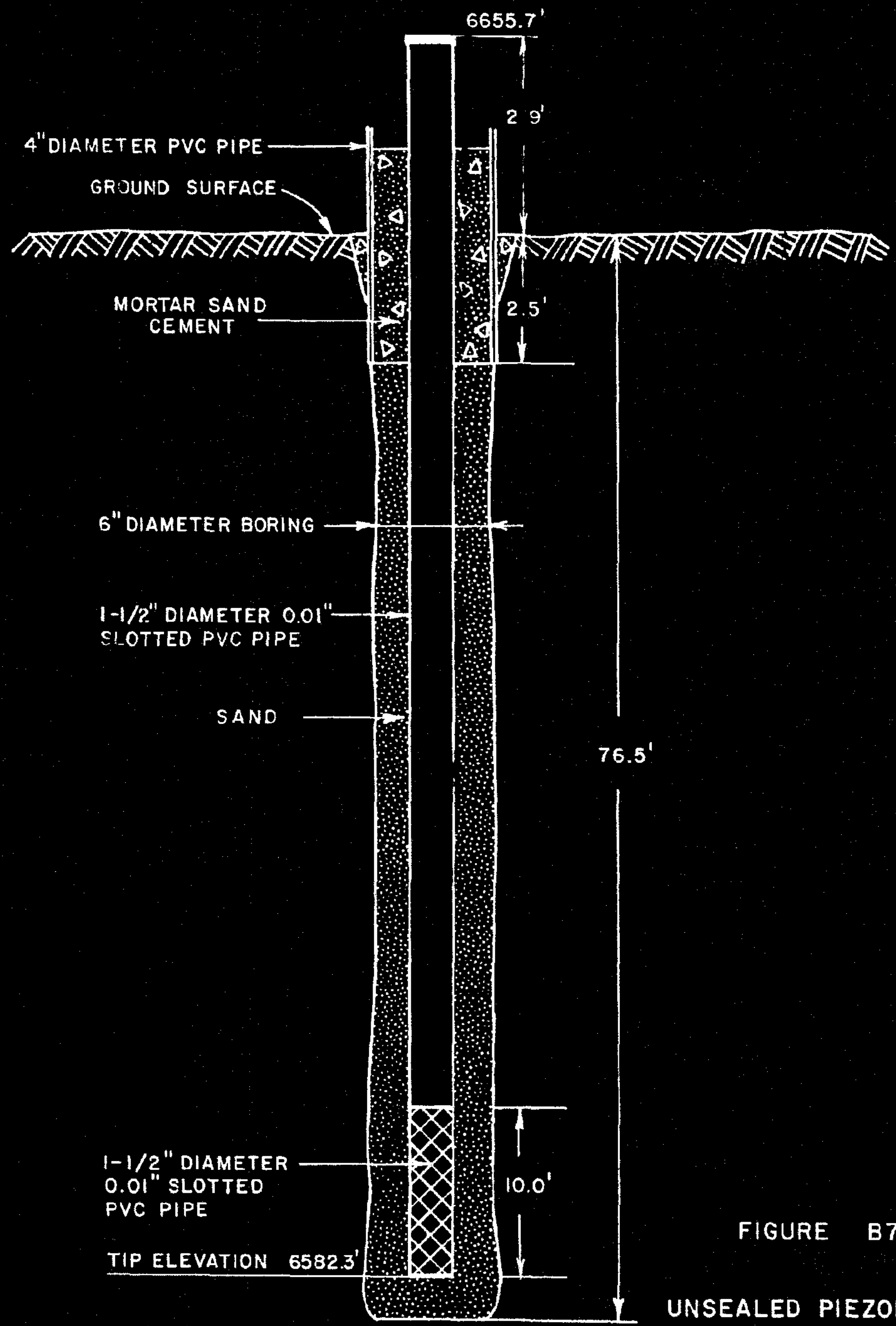

FIGURE B7

UNSEALED PIEZOMETER
DB-7

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UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWING NUMBER RM80-311-A35

DRAWN BY	CHECKED BY	APPROVED BY
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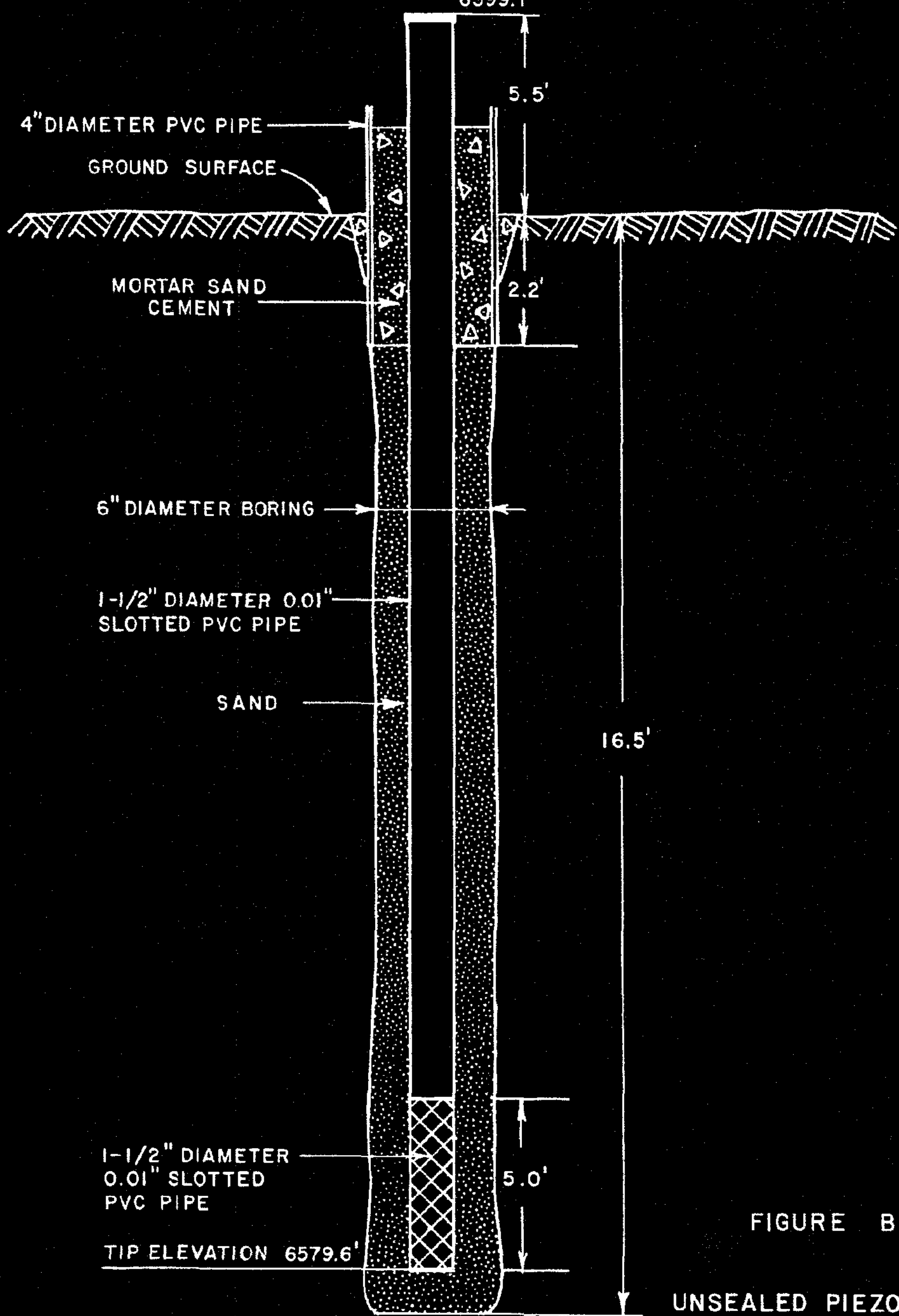

FIGURE B8

UNSEALED PIEZOMETER
DB-11

PREPARED FOR

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GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE ... PGH PA LT1530-1079

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjg 11/6/80	TJH 11/12-80	[illegible] 11-12-80	RM80-311-A36

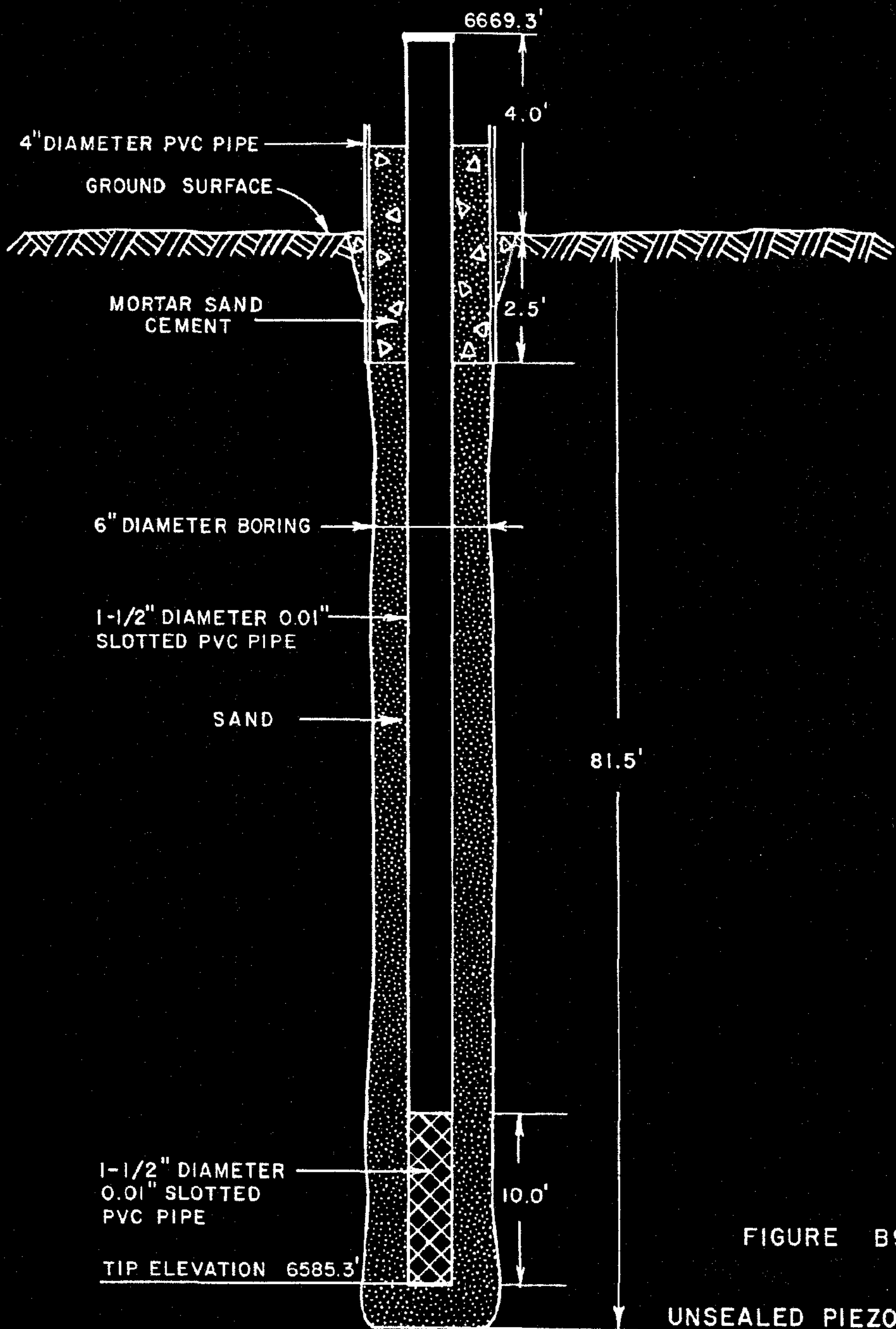


FIGURE B9

UNSEALED PIEZOMETER
DB-12

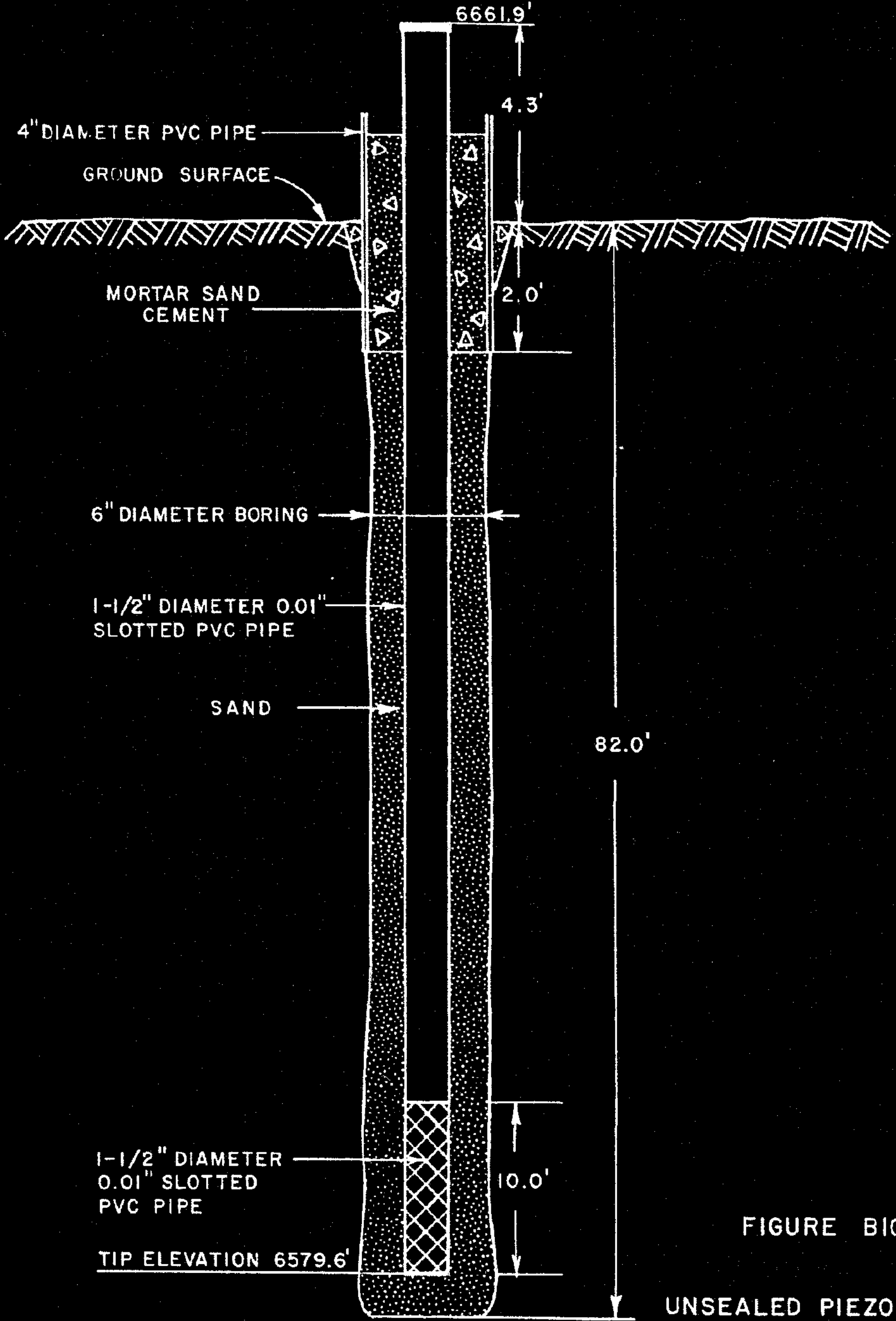
PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE A&B SMITH CO. PGH PA LT1530-1079

HMCSL024508



DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjg 11/6/80	TJH 11-12-80	[signature] 11-12-80	RM80-311-A37

FIGURE B10

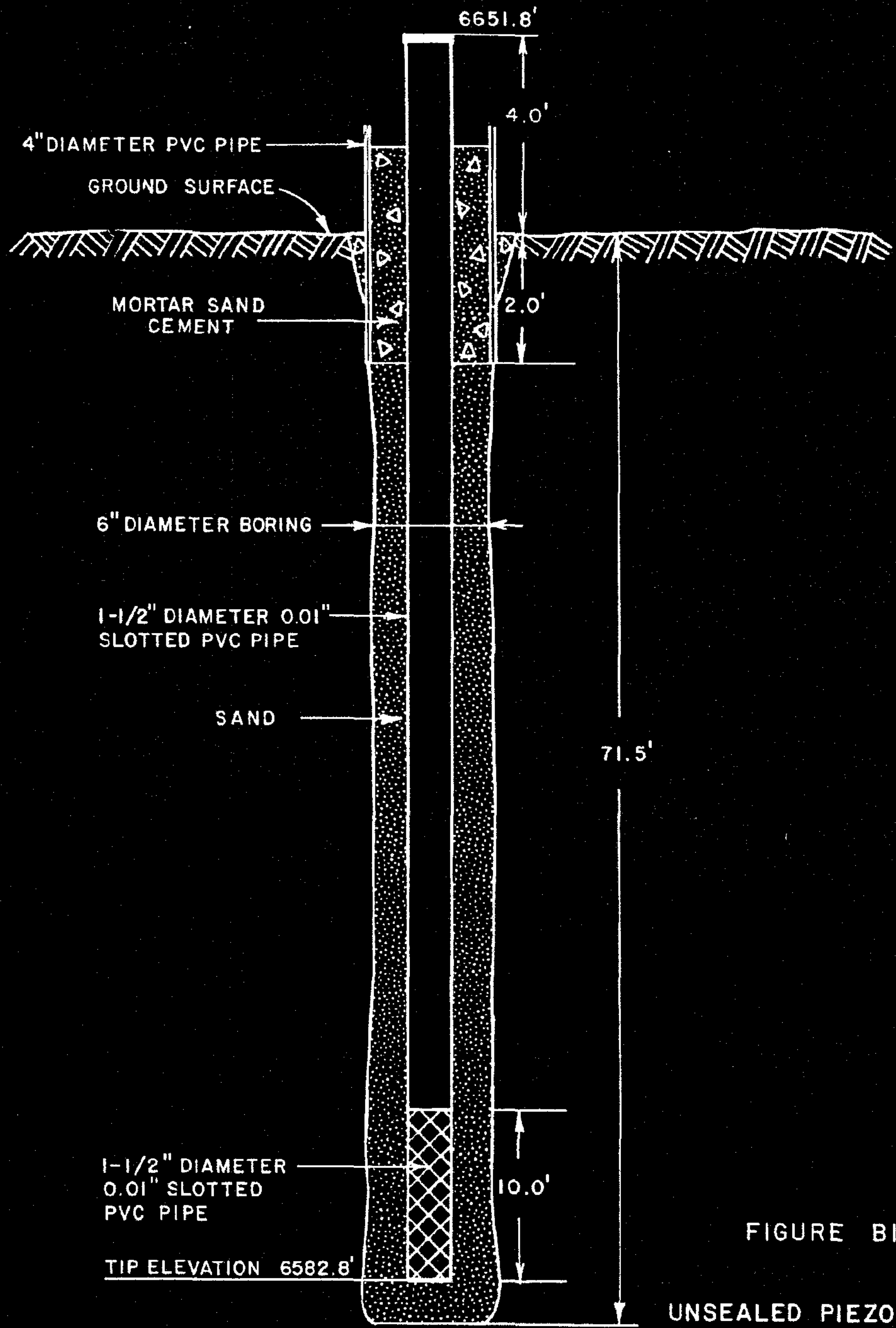
UNSEALED PIEZOMETER
DB-14

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE, A&B SMITH CO., PGH., PA LT1530-1079



DRAWN BY		CHECKED BY	TJH	11-12-80	DRAWING NUMBER RM80-311-A.38
	11/6/80	APPROVED BY		11-12-80	

FIGURE B11

UNSEALED PIEZOMETER

DB-16

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

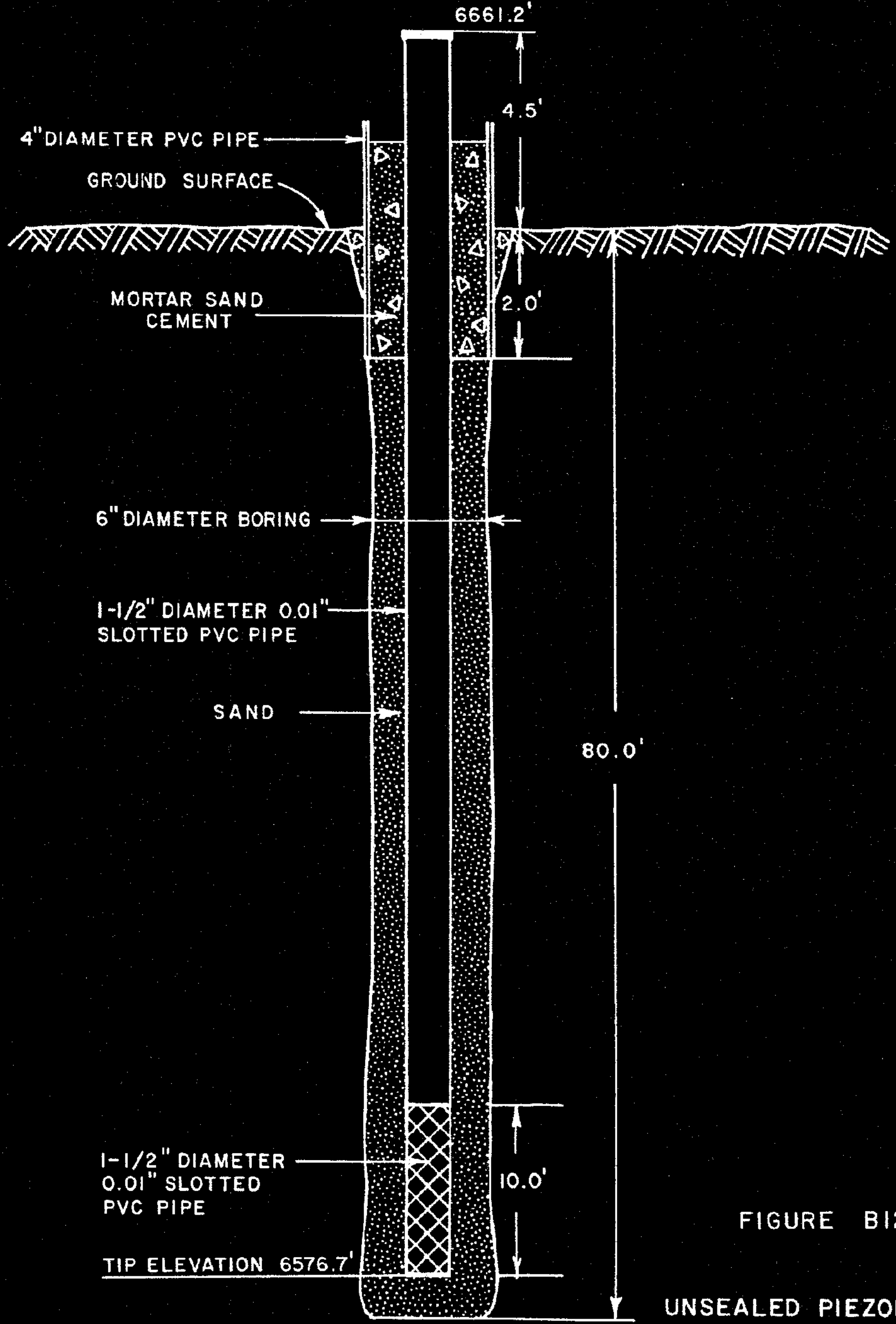


FIGURE B12

UNSEALED PIEZOMETER
DB-17B

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	11/6/80	CHECKED BY	TJH 11-12-80	DRAWING NUMBER	RM80-311-A39
		APPROVED BY	11-12-80		

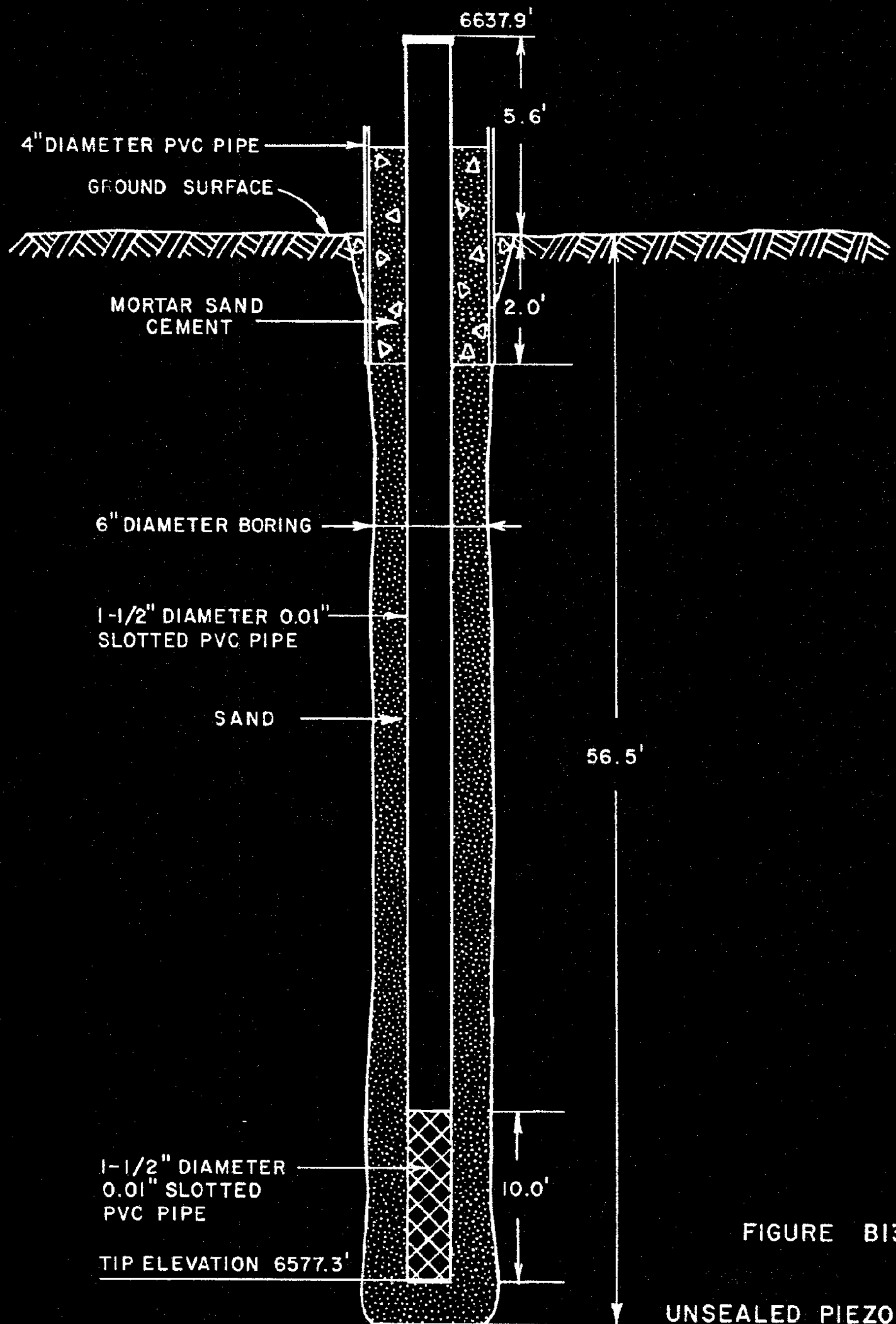


FIGURE B13

UNSEALED PIEZOMETER
DB-18

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjg 11/6/80	TJH 11-12-80	[illegible] 11-12-80	RM80-311-A40

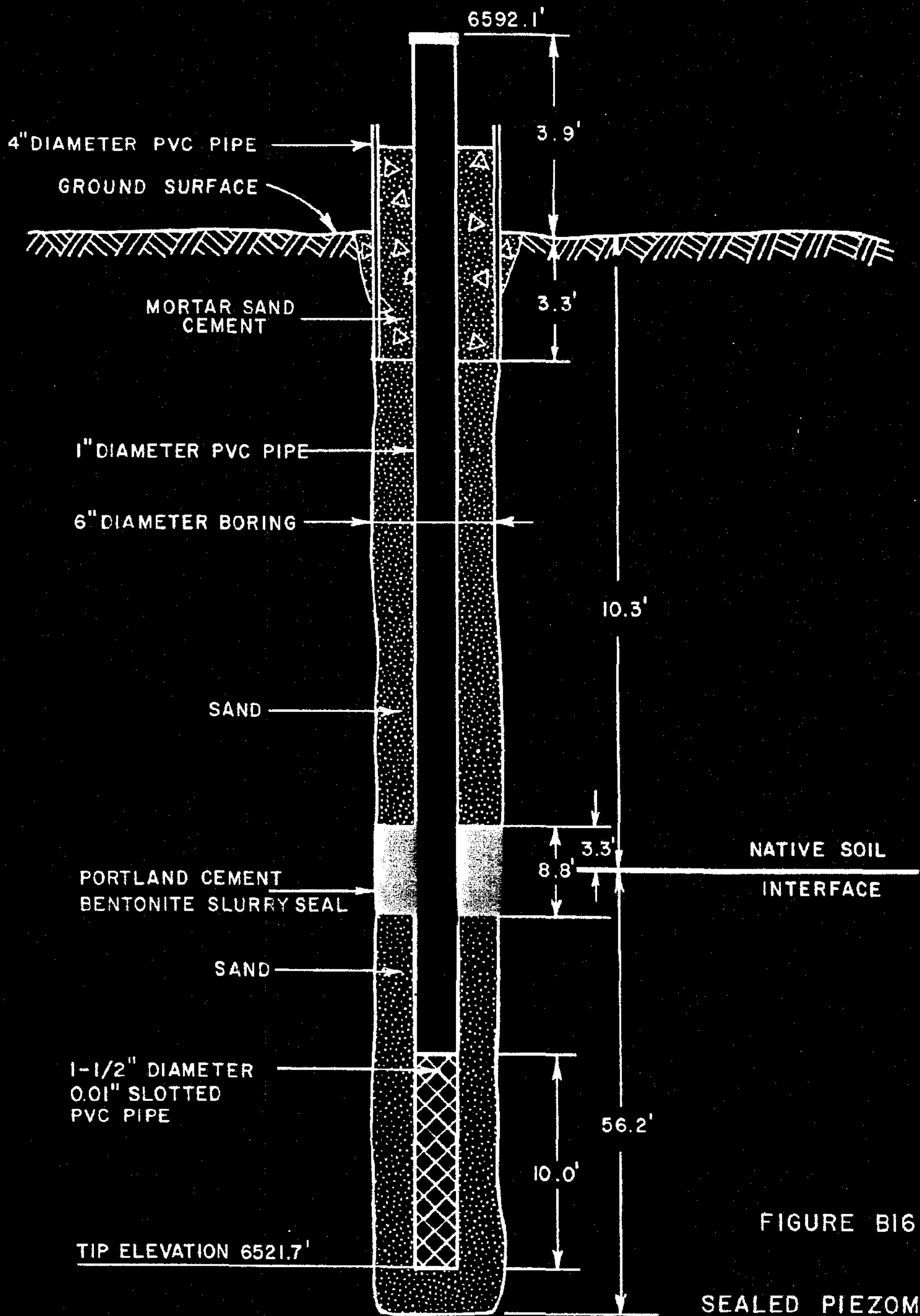


FIGURE B16

SEALED PIEZOMETER
DB-2A

PREPARED FOR

UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjj 8/20/80	TJH 11-12-80	AKK 11-12-80	RM80-311-A43

DRAWING NUMBER RM80-311-A44

CHECKED BY TJH 11-12-80

APPROVED BY 11-12-80

DRAWN BY 8/20/80

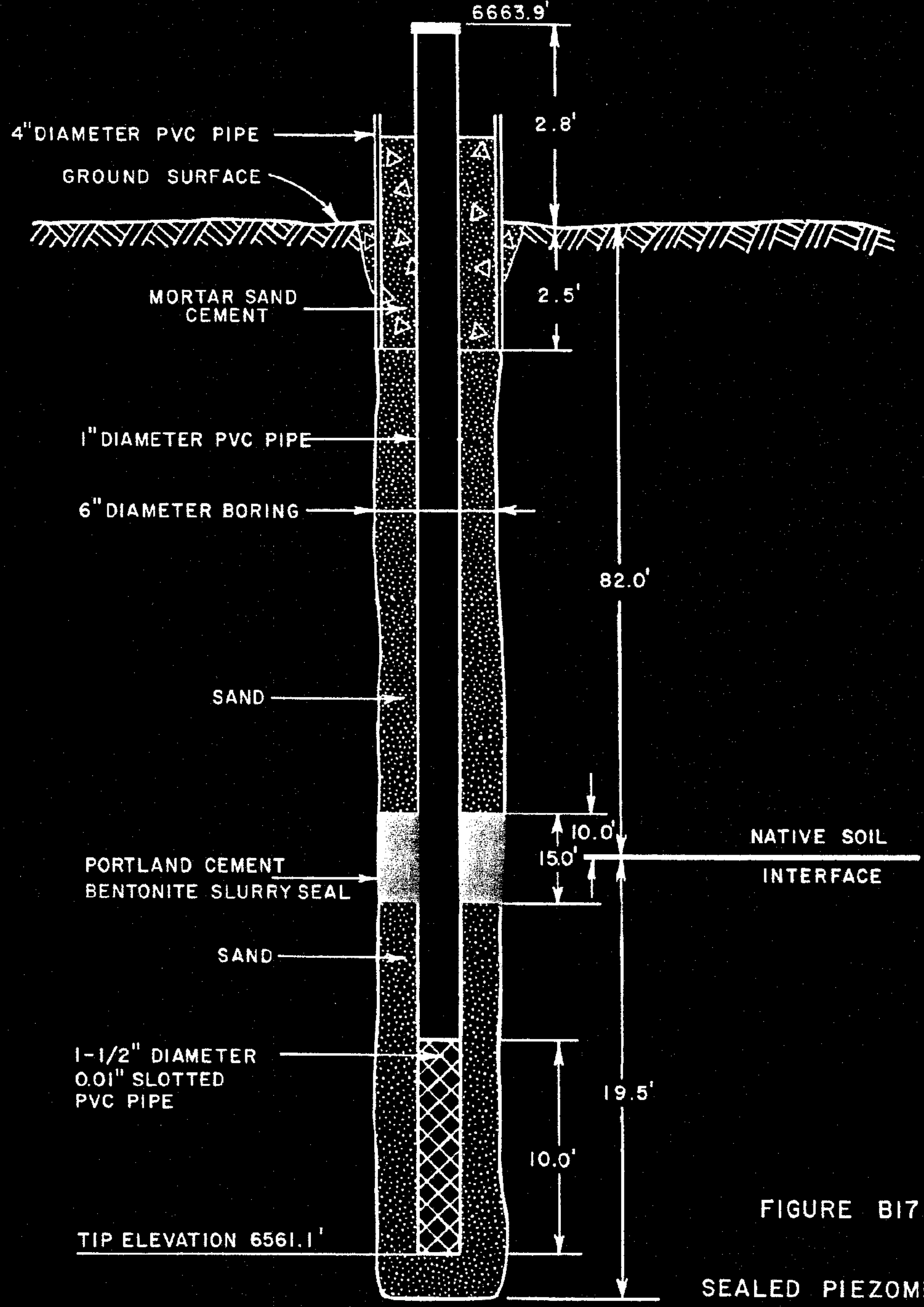


FIGURE B17

SEALED PIEZOMETER
DB-5A

PREPARED FOR

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GRANTS, NEW MEXICO

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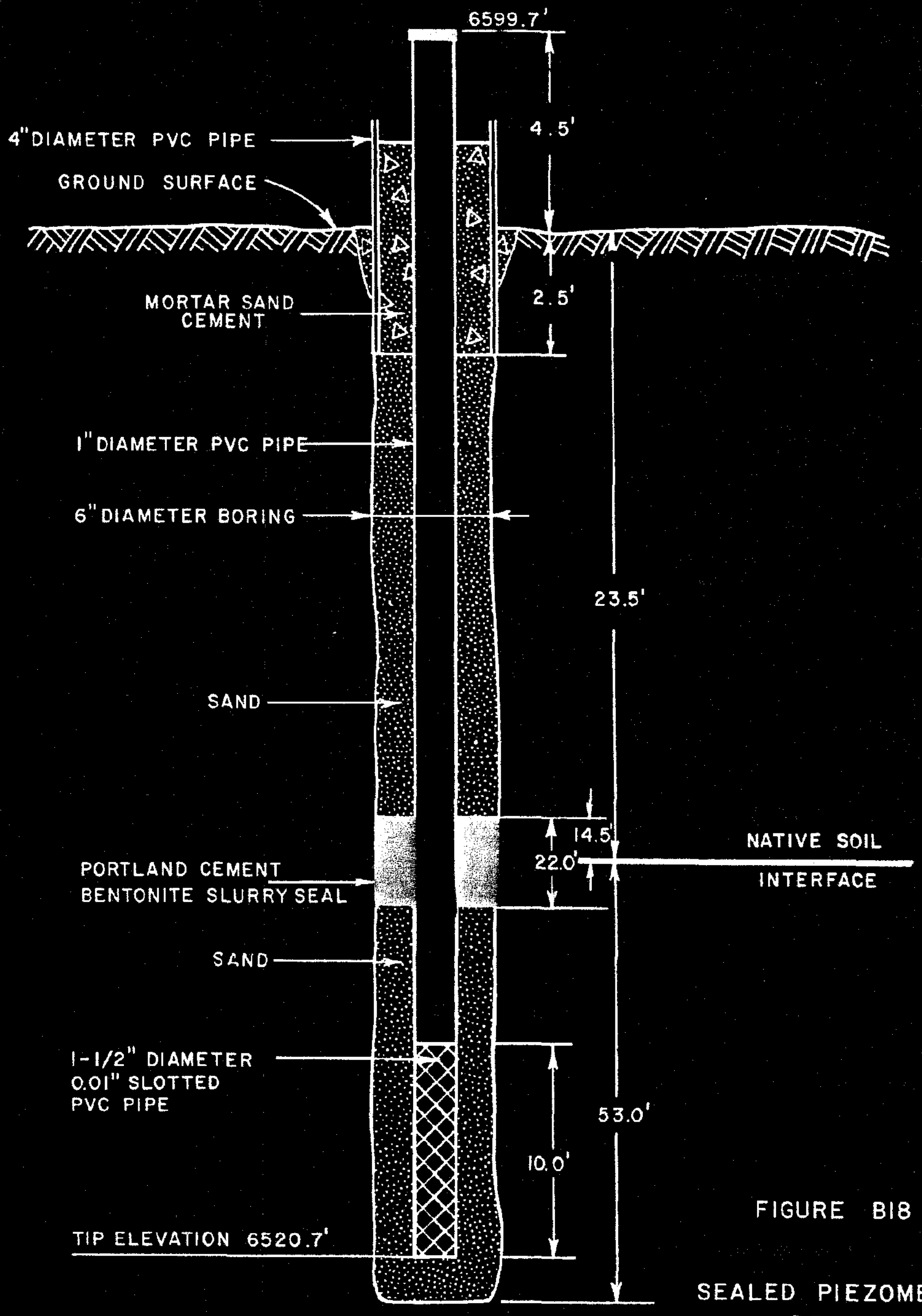

FIGURE B18

SEALED PIEZOMETER
DB-6A

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GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjs 8/20/80	TJH 11-12-80	AKK 11-12-80	RM80-311-A45

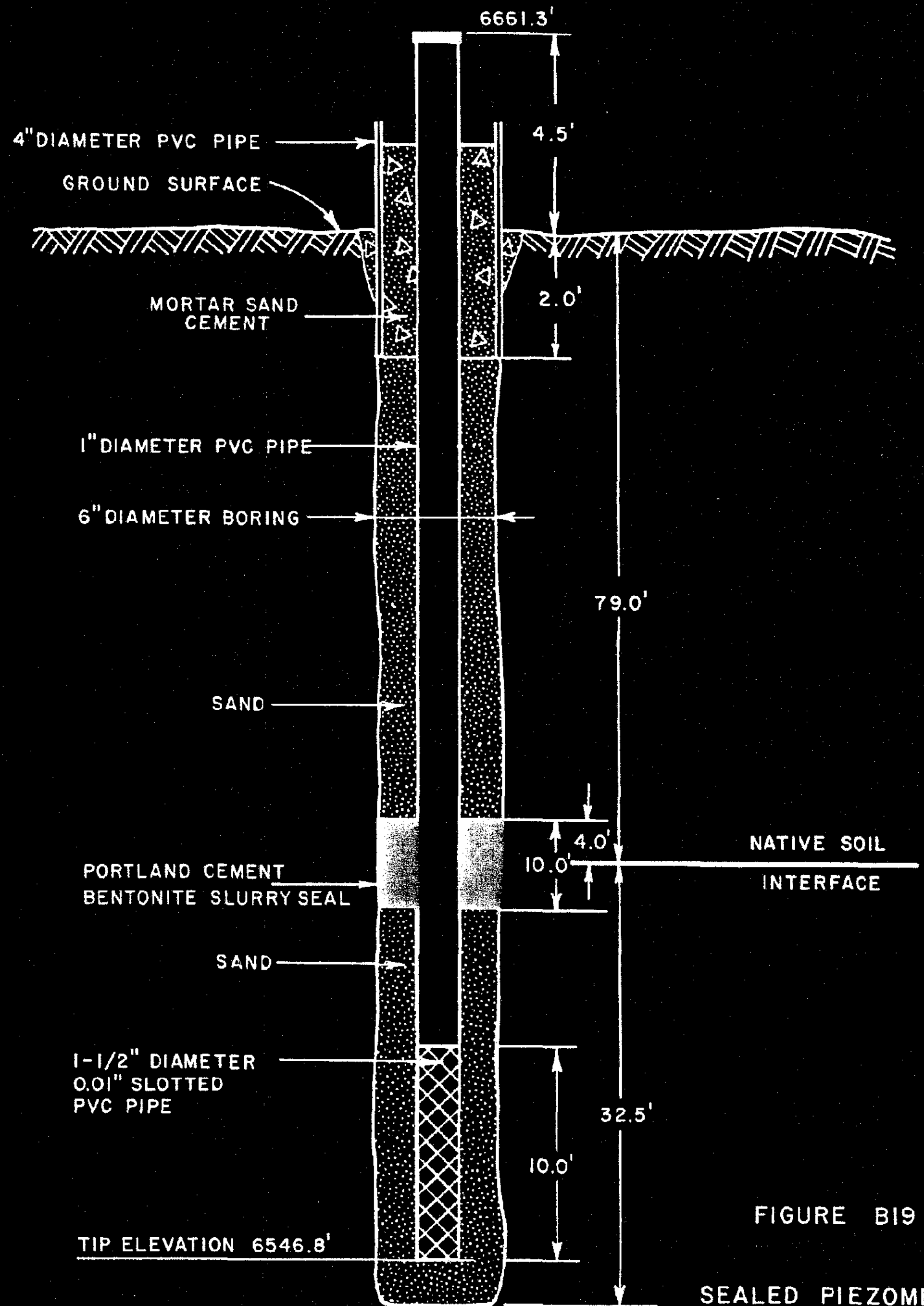

FIGURE B19

SEALED PIEZOMETER
DB-17A

PREPARED FOR

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GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	mrj	8/20/80
CHECKED BY	TJH	11-12-80
APPROVED BY	MKC	11-12-80
DRAWING NUMBER	RM80-311-A46	

19 1253 HERCULENE ... PGH PA LT1530-10/79

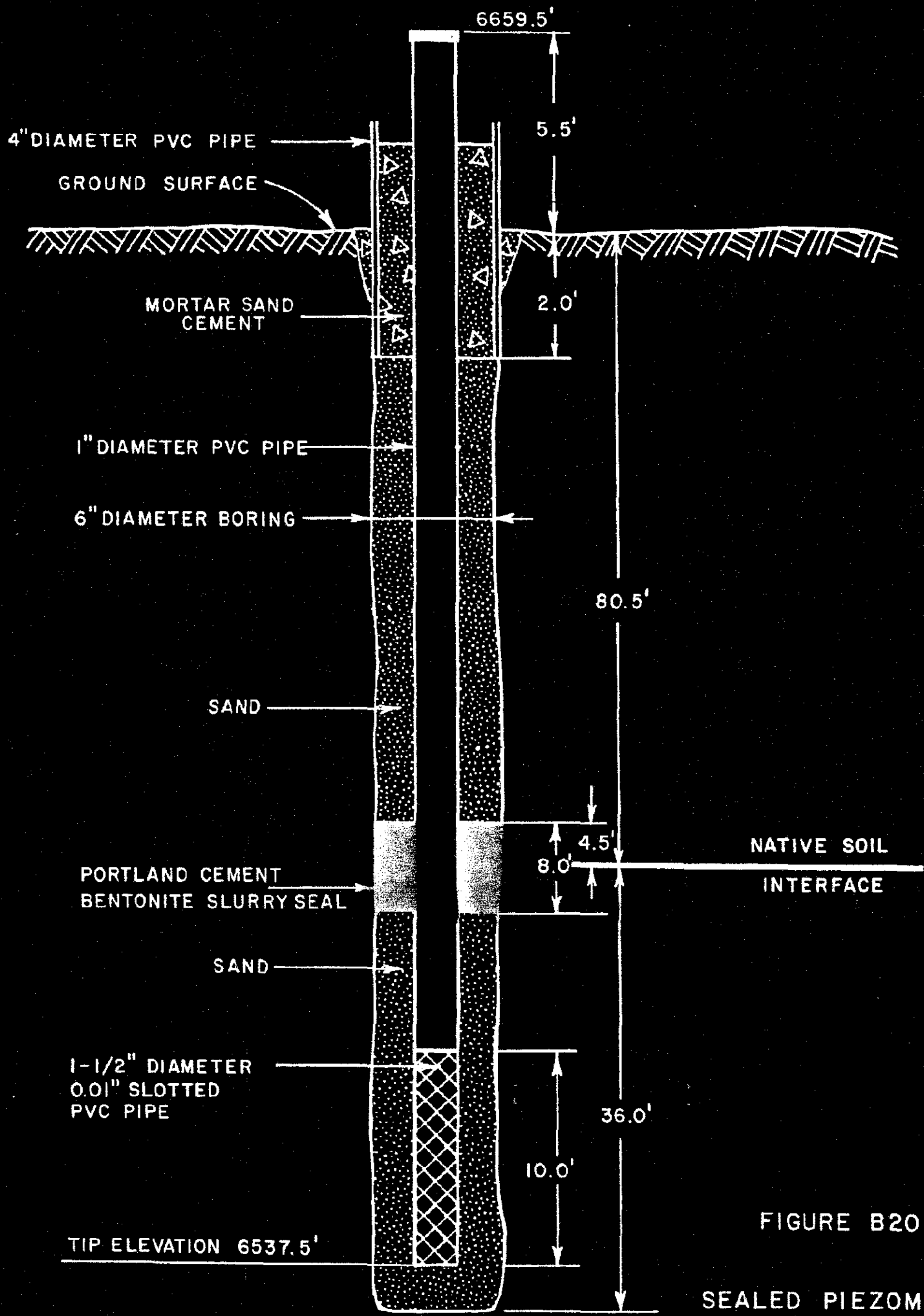

FIGURE B20

SEALED PIEZOMETER
DB-19A

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UNITED NUCLEAR-HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
mjj 8/20/80	TJH 11-12-80	ACK 11-12-80	RM80-311-A46

19 1253 HERCULENE AA ... ITH CO. PGH PA LT1530-1079

APPENDIX C

CYCLIC TRIAXIAL TEST PROCEDURE (AXIAL TYPE)

Cyclic triaxial testing determines the liquefaction resistance of saturated tailings. The D'Appolonia standard cyclic triaxial test is the following type:

- Controlled stress,
- Isotropic consolidation,
- Single-stage testing (one stress ratio per sample)

TEST EQUIPMENT

The apparatus used for cyclic triaxial testing consists of a triaxial cell mounted on a Material Testing Systems (MTS) load frame and loaded by an electrically controlled, hydraulically powered actuator. In addition to the loading system, the following apparatus are also used to perform the test: 1) a digital signal generator to provide an AC signal; 2) a signal control mechanism for control of the servo loop; 3) two X-Y plotters for stress versus strain and pore pressure versus strain plottings; 4) a Digital Voltage Meter (DVM) to measure electrical signal levels; 5) a digital counter for load cycle counting; and 6) an FM recorder to record time-history plottings of stress, strain and pore pressure. A photograph of the testing apparatus is shown in Figure C1.

TEST PROCEDURE

Figure C2 presents a flow chart depicting a go/no-go logic diagram for a single-stage cyclic triaxial test. The typical cyclic triaxial test proceeds through five basic stages:

- Sample preparation (either trimmed or reconstituted).
- Sample saturation under effective pressure.
- Determination of sample saturation, "B" value.
- Cyclic loading of sample.
- Presentation of test results.

At any of the first four stages certain go/no-go decisions must be reached as indicated in Figure C2.

A. Sample Preparation

Due to the loose nature of the tailings, it was not possible to prepare undisturbed samples for testing. Therefore, all sample preparation was done by reconstituting oven-dried tailings using the dry method of sample reconstitution. The dry method proceeds through four steps:

- Set up a mold of known volume inside the cell and line it with a rubber membrane.
- Pour a sample of known weight into the mold in layers. To obtain the desired density, compact the sample evenly by tamping each layer equally.
- Apply a vacuum to the pore pressure line such that approximately 1/4 of the final effective stress is created inside the sample.
- While applying the vacuum, remove the mold and measure the average height and average diameter of the sample to the nearest 0.001 inches.

The samples for the cyclic triaxial test were reconstituted with average diameters of 1.5 inch and heights of 3.0 inch. Reconstituted sample densities were determined for each sample and are presented in Table C1.

B. Sample Saturation and Determination of the "B" Value

To perform the cyclic triaxial test, the sample must be saturated. The saturation procedure is:

- With the prepared sample inside the cell, increase the cell pressure to approximately 1/2 the final effective stress.
- Close the vacuum supply line and apply a de-aired water pressure of approximately 1/4 the final effective stress to the sample.
- Close the de-aired water supply line after the de-aired water has ample time to saturate the sample.

- Increase the cell pressure in small increments noting the resultant change in pore pressure and calculate the "B" value.

- Increase the cell pressure and back pressure to create the final desired effective stress inside the sample.

The "B" values calculated in this way for each sample tested are presented in Table C1. The cell pressure and back pressure were 4.0 and 2.0 kg/cm^2 respectively for all samples tested. The Mohr's Circle stress condition on the sample at the end of saturation is shown on Figure C2.

C. Cyclic Loading of Sample

The cyclic loading is applied to the sample according to the procedures described by Seed and Peacock (1971). The Mohr's Circle stress conditions during the test are shown on Figure C2. The test procedure follows the basic steps:

- Before testing, X-Y plotters are set up to record all test parameters and the FM tape recorder is prepared for recording stress, strain and pore pressure time histories.

- The axial stress is increased and decreased alternately, to an assigned maximum deviator stress.

- Throughout the test, the deviator stress varies harmonically with time at a pre-determined frequency.

- The cyclic loading continues until the pore pressure equals the confining pressure (liquefaction) or until excessive strain develops (10% peak-to-peak strain).

- The number of load cycles required to liquefy or cause excessive strain is recorded.

- Cell pressure is reduced to zero and the sample is removed.

The stress ratio, $\sigma_d/2\sigma_0$, was varied from 0.35 to 0.125 for the eight samples tested. The stress ratio and number of cycles to failure for each test are shown in Table C1. All tests were performed with a 0.5 Hz sinusoidal loading.

D. Presentation of Test Results

The test results for each individual sample are presented on Figures C3 through C19. Table C1 shows individual test results and relates the figures to their respective test number designations. Pore pressure path, material softening and time history plots are presented for tests numbers 3 through 7. Test number one with one cycle has only a plot of material softening. Test number 2 was an aborted or no-go test and test number 8, due to the large number of loading cycles, has only a time history plot. The plot showing number of cycles to liquefaction versus stress ratio has been presented in the Engineer's Report.

TABLE C1

CYCLIC TRIAXIAL TESTING DATA

TEST NO.	STRESS RATIO	NUMBER OF CYCLES TO LIQUEFACTION	RECONSTITUTED* DRY DENSITY(PCF)	"B" VALUE	CORRESPONDING FIGURE Nos.
1	0.35	1	93.3	0.96	C3
2	0.30	ABORTED TEST			
3	0.15	64	93.5	0.96	C4, C5, C6
4	0.30	3	94.0	0.98	C7, C8, C9
5	0.25	4	95.0	0.98	C10, C11, C12
6	0.20	9	94.7	0.98	C13, C14, C15
7	0.175	26	93.6	0.98	C16, C17, C18
8	0.125	225	94.6	0.98	C19

*All samples were reconstituted using oven dried tailings compacted dry.

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
ck 10-31-80	TJH 11-12-80		RM80-311-A19

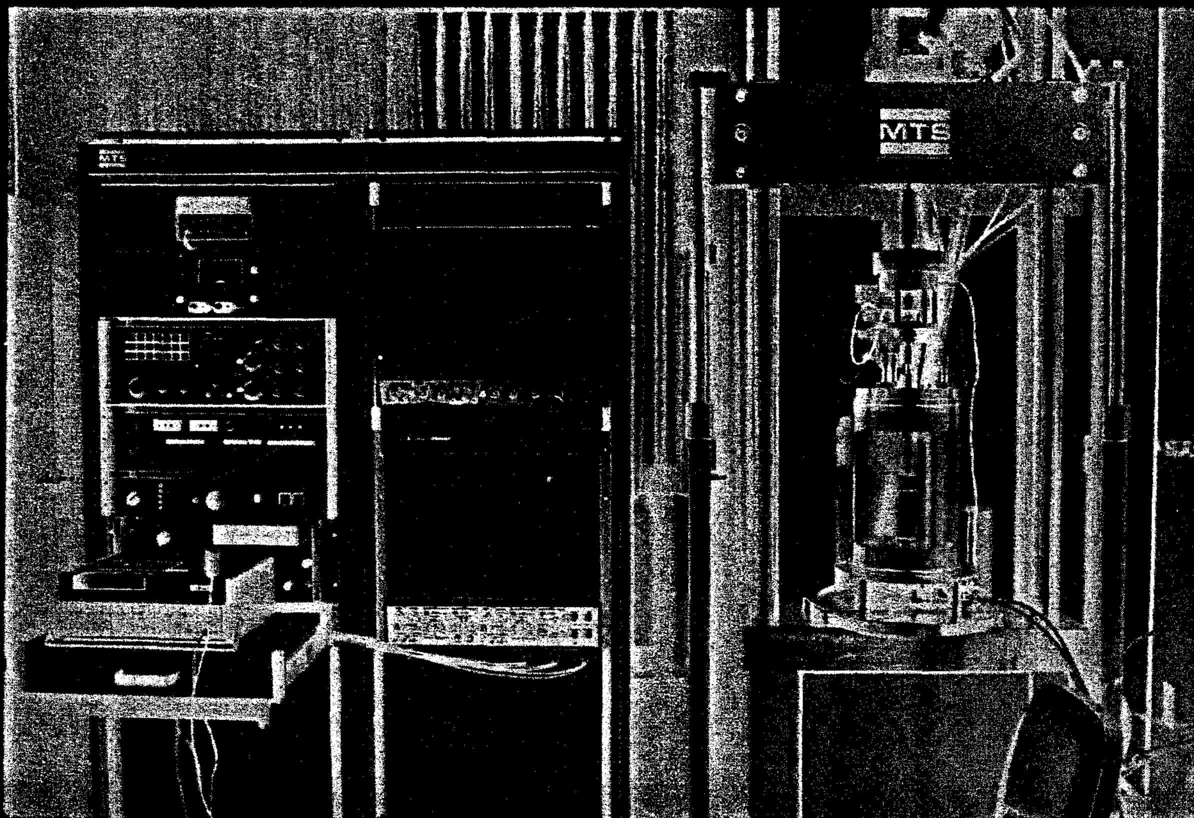

FIGURE C1

PHOTOGRAPH
OF CYCLIC TRIAXIAL
TESTING APPARATUS

PREPARED FOR

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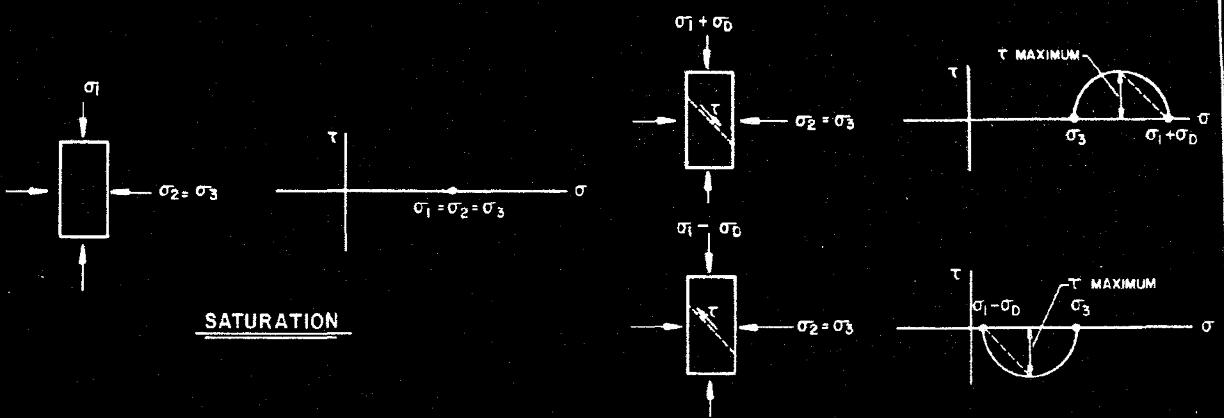
GRANTS, NEW MEXICO

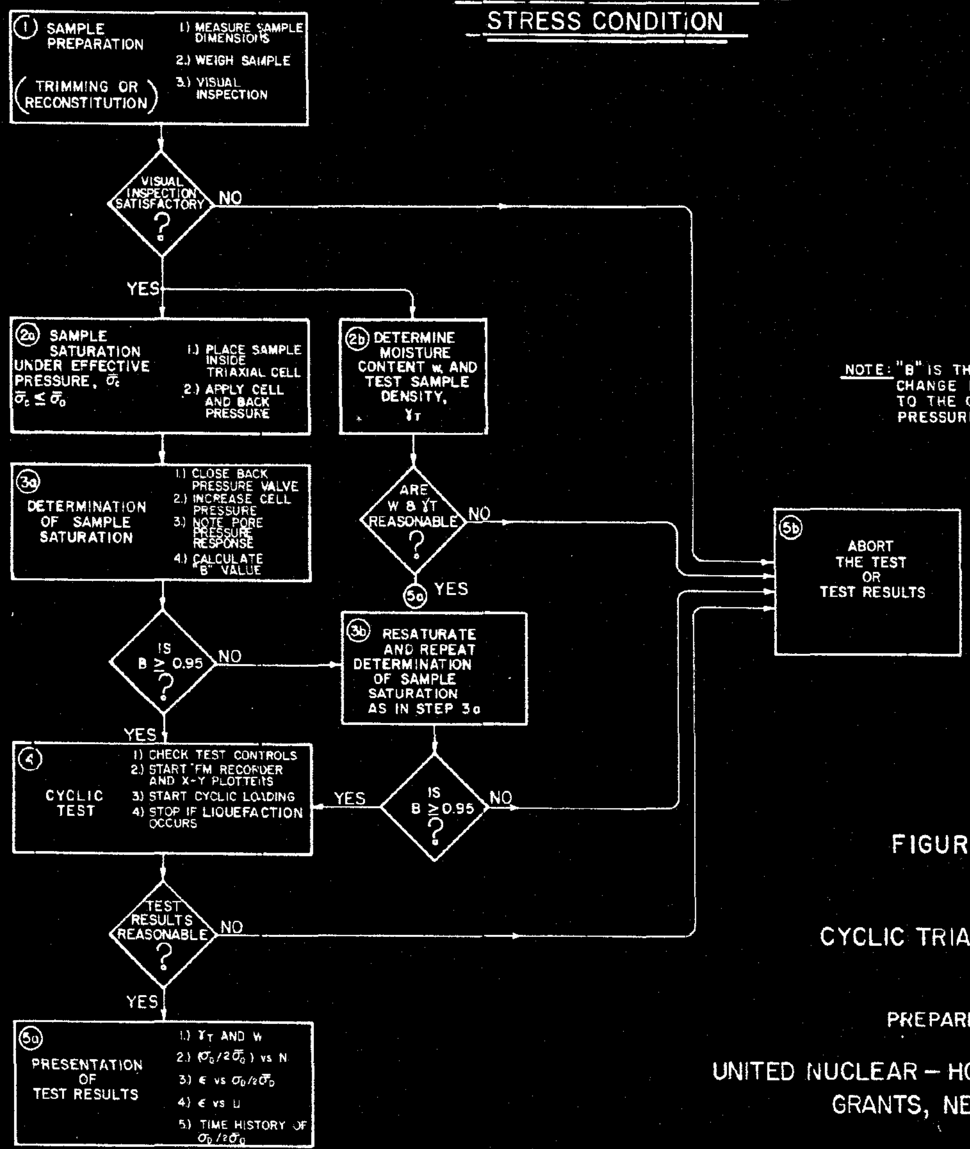
D'APPOLONIA

DRAWING NUMBER RM80-311-A18

DRAWN BY	ck	10-31-80
CHECKED BY	TJH	11-12-80
APPROVED BY	[illegible]	11-12-80



CYCLIC TRIAXIAL TEST
STRESS CONDITION



NOTE: "B" IS THE RATIO OF THE CHANGE IN PORE PRESSURE TO THE CHANGE IN CELL PRESSURE.

CYCLIC TRIAXIAL TEST
FLOW CHART

FIGURE C2

CYCLIC TRIAXIAL TEST

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GRANTS, NEW MEXICO

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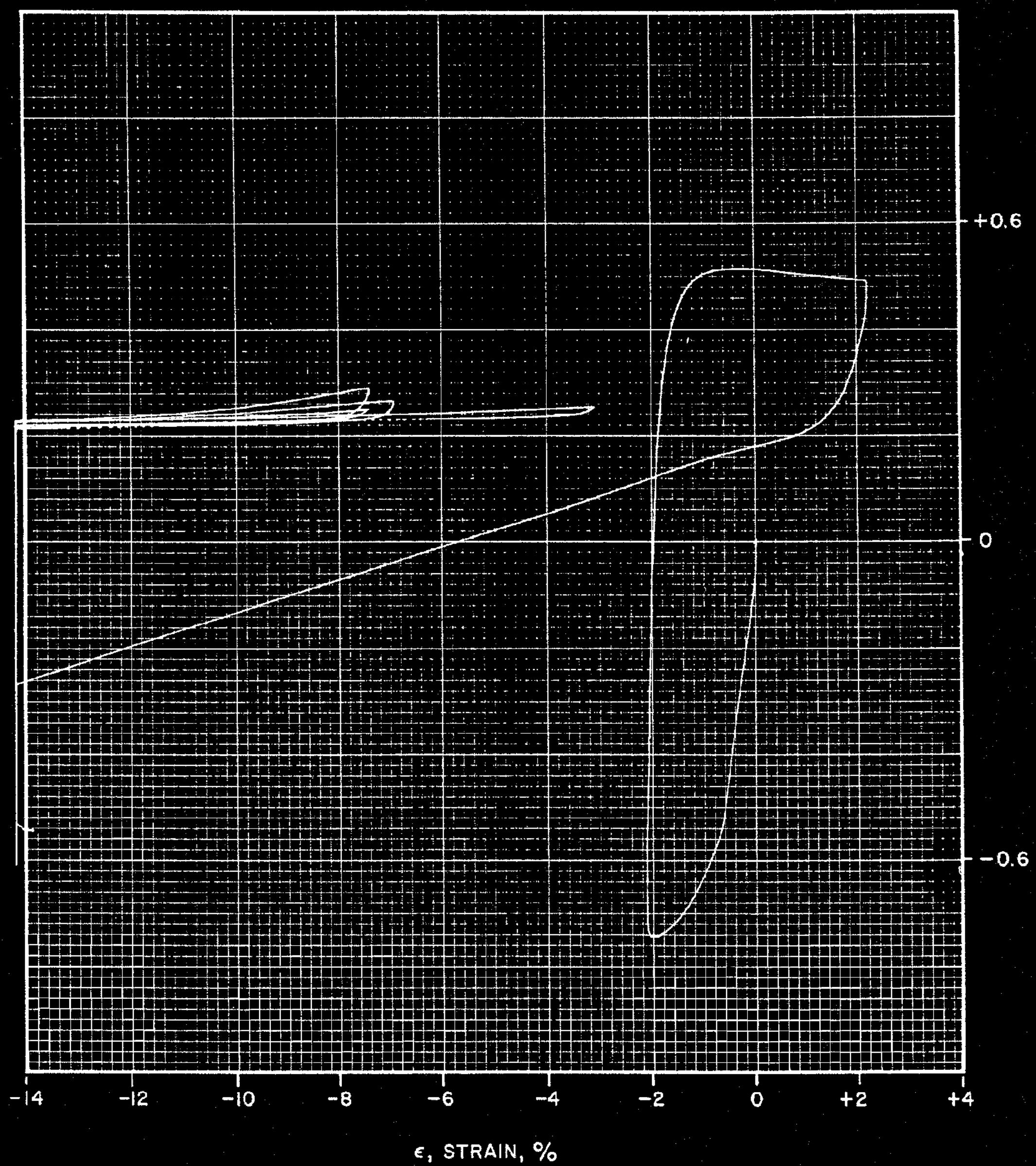

TEST NO. 1

γ_d = 1.49 gm/cm^3

$\overline{\sigma}_d / 2\overline{\sigma}_o$ = 0.35

FIGURE C3

MATERIAL SOFTENING DURING CYCLIC TRIAXIAL TEST NO. 1

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GRANTS, NEW MEXICO

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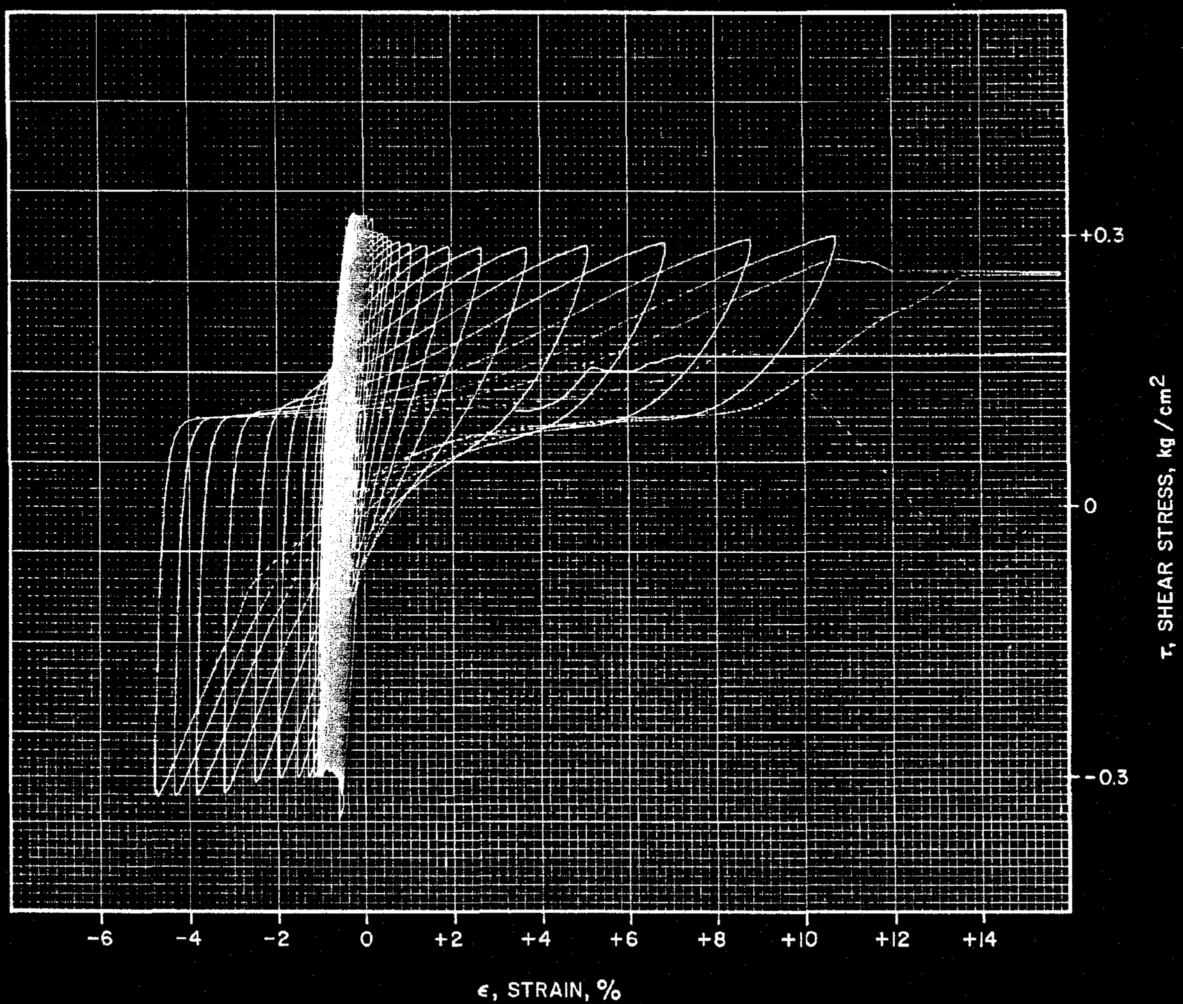
DRAWN BY	ck	10-29-80
CHECKED BY	TJH	11-12-80
APPROVED BY		
DRAWING NUMBER	RM80-311-A5	

DRAWN BY	ck	10-29-80	CHECKED BY	TJH	11-12-80	DRAWING NUMBER	RM80-311-A15
			APPROVED BY	[illegible]	[illegible]		



TEST NO. 3

$\gamma_d = 1.50$ gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_o = 0.15$

FIGURE C4

MATERIAL SOFTENING
DURING CYCLIC TRIAXIAL TEST
NO. 3

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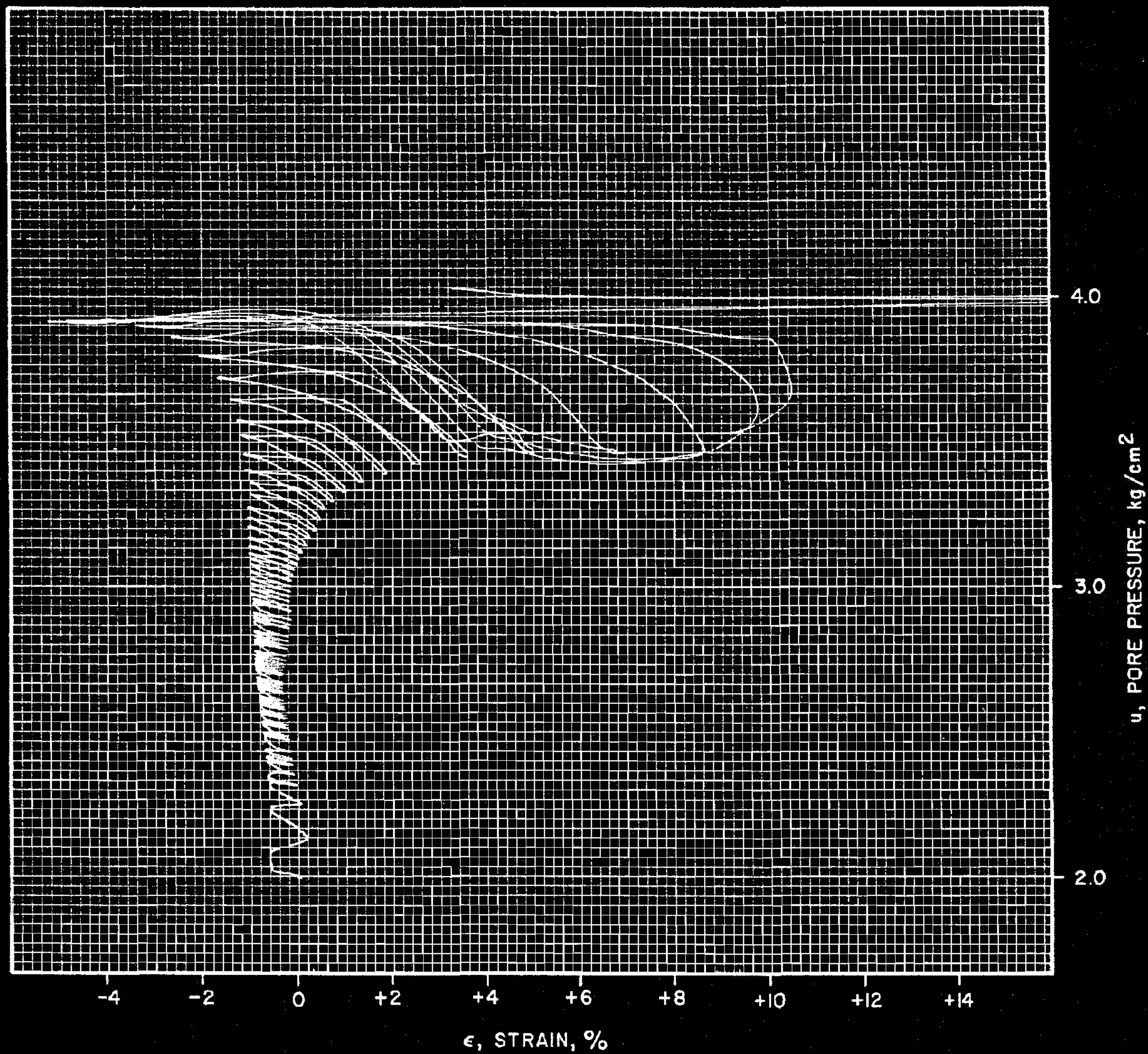
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
ck 10-29-80	TJH 11-12-80	AKL 11-12-80	RM80-311-A16



TEST NO. 3

$\gamma_d = 1.50$ gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_0 = 0.15$

FIGURE C5

PORE PRESSURE PATH
DURING CYCLIC TRIAXIAL TEST
NO. 3

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GRANTS, NEW MEXICO

D'APPOLONIA

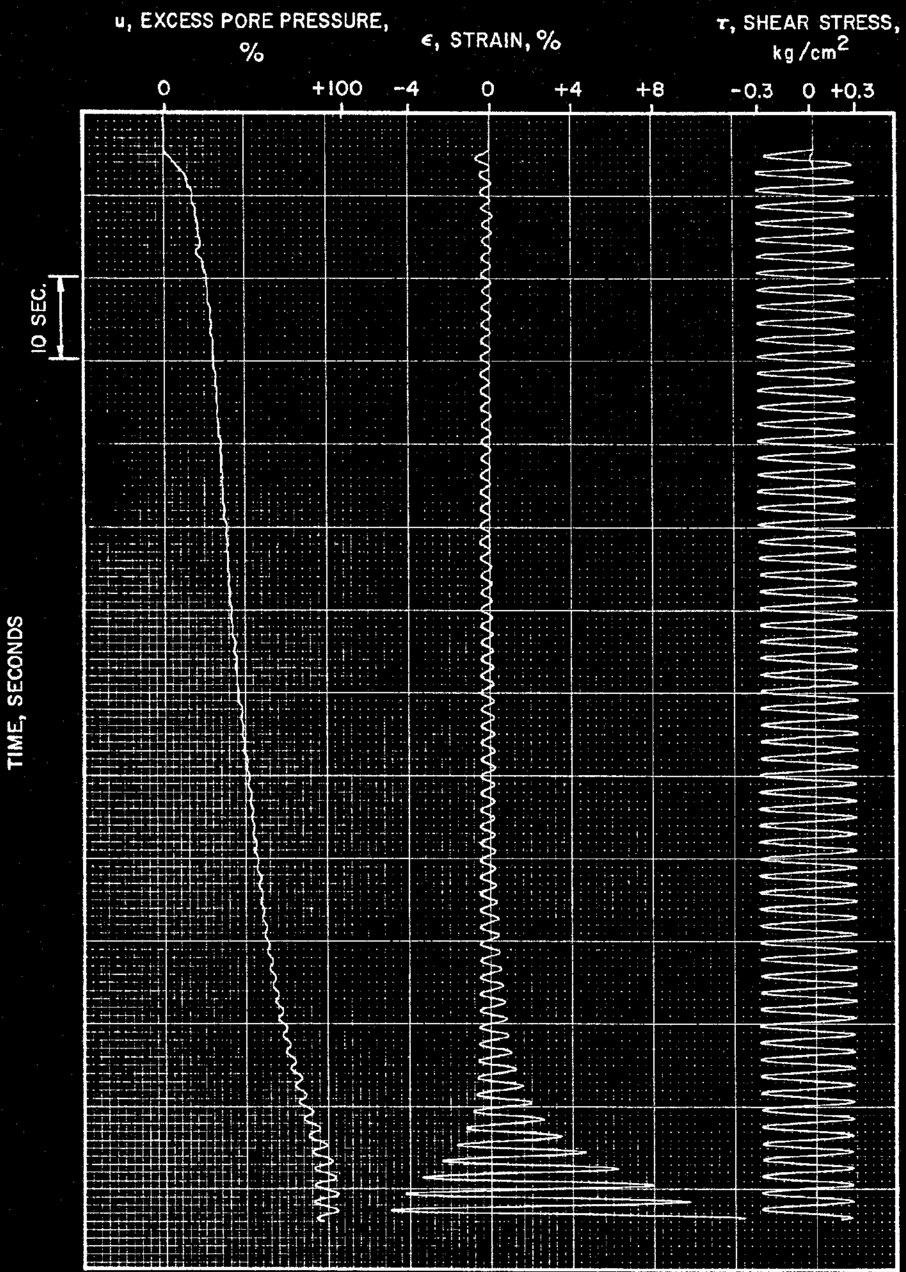


FIGURE C6

TEST NO. 3

γ_d = 1.50 gm/cm^3

$\overline{\sigma}_d / 2\overline{\sigma}_o$ = 0.15

TIME-HISTORY
CYCLIC TRIAXIAL TEST
NO. 3

PREPARED FOR

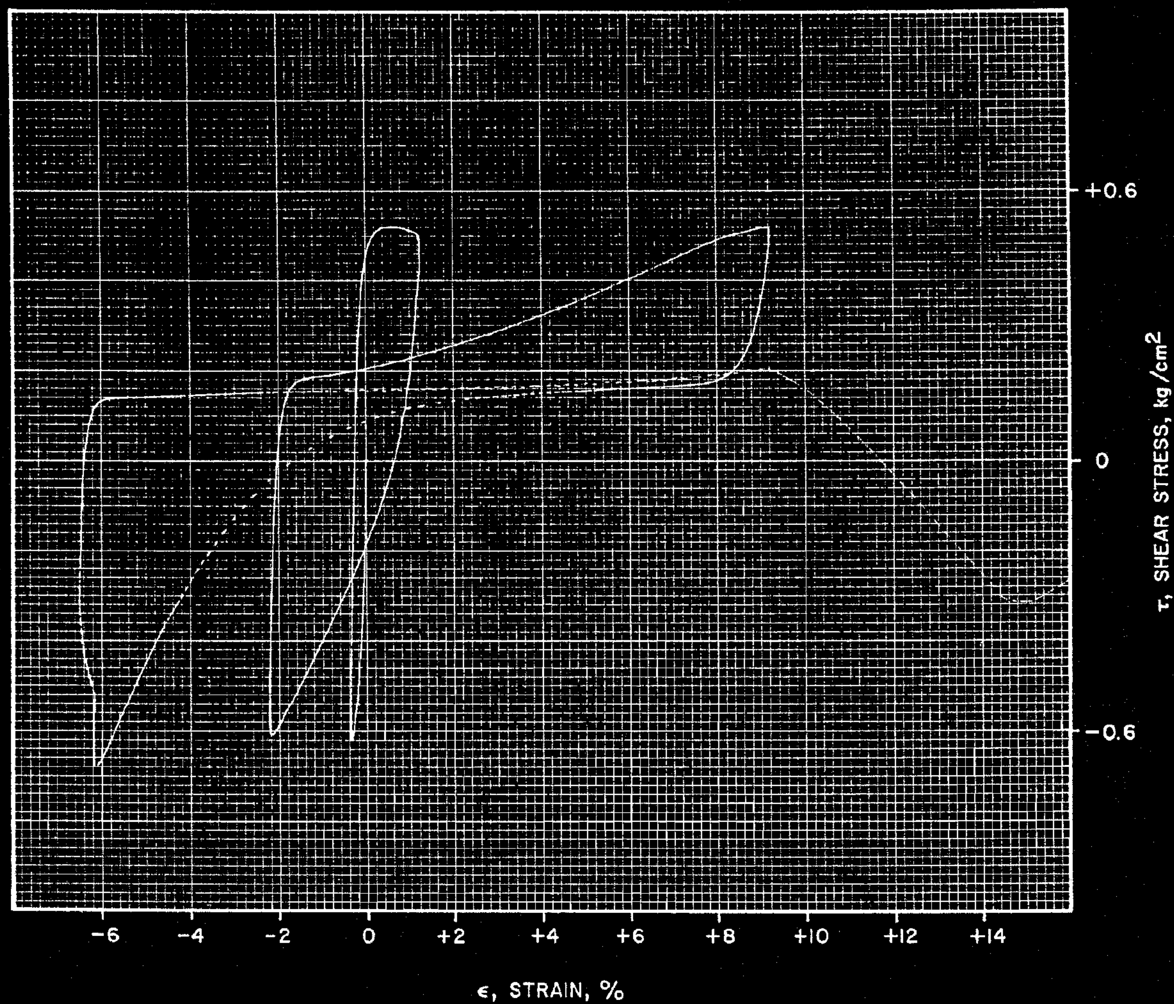
UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	ck	10-29-80
CHECKED BY	TJH	11-12-80
APPROVED BY	AAK	11-12-80
DRAWING NUMBER	RM80-311-A6	

HMCSL024528

DRAWN BY | ck | 10-30-80
CHECKED BY | TJH | 11-12-80
APPROVED BY | [illegible] | 11-12-80
DRAWING NUMBER | RM80-311-A20



TEST NO. 4

$\gamma_d = 1.50$ gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_o = 0.3$

FIGURE C7

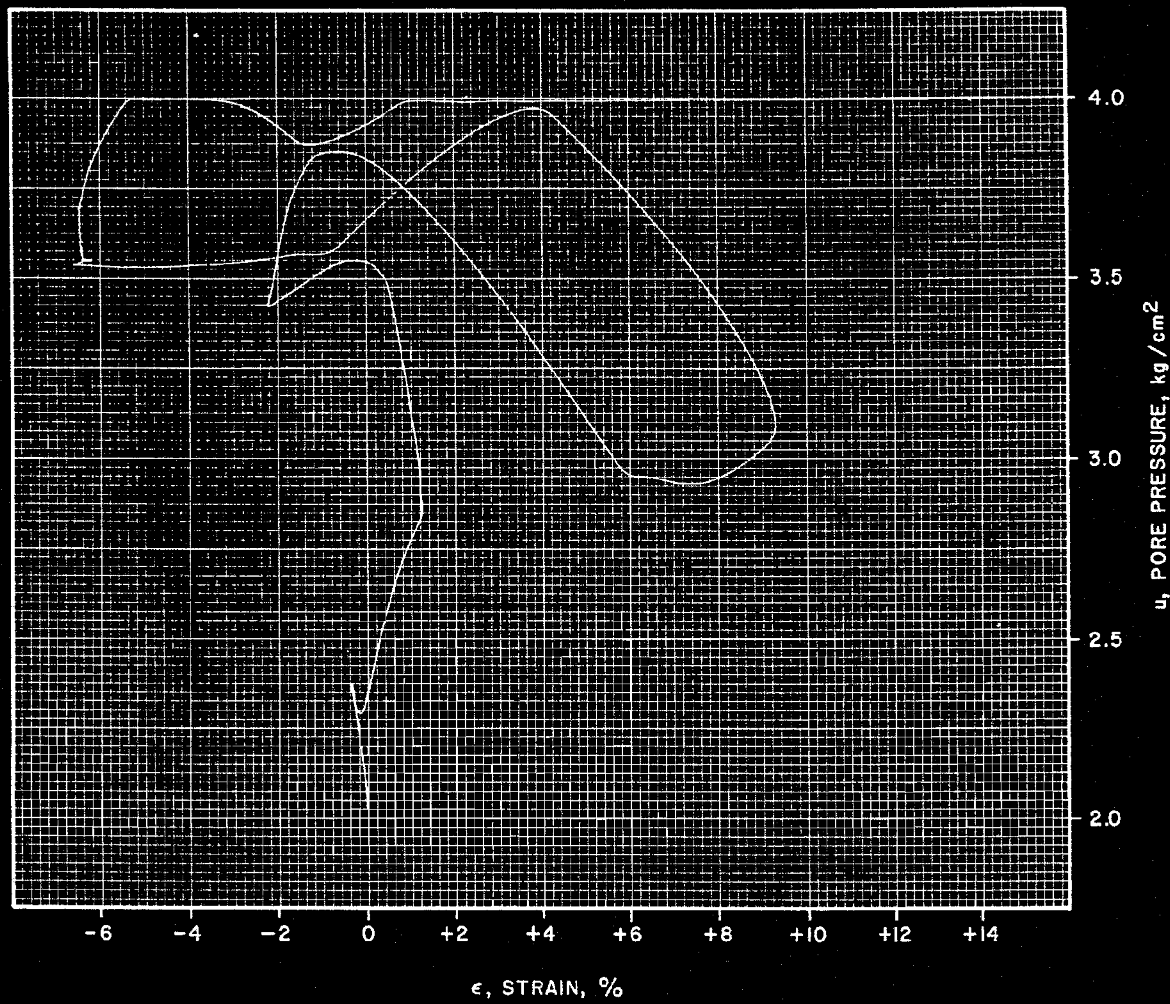
MATERIAL SOFTENING
DURING CYCLIC TRIAXIAL TEST
NO. 4

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	ck	10-30-80
CHECKED BY	TJH	11-12-80
APPROVED BY	MCK	11-12-80
DRAWING NUMBER	RM80-311-A21	



TEST NO. 4

$\gamma_d = 1.50 \text{ gm/cm}^3$

$\bar{\sigma}_d / 2\bar{\sigma}_o = 0.3$

FIGURE C8

PORE PRESSURE PATH
DURING CYCLIC TRIAXIAL TEST
NO. 4

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
ck 10-30-80	TJH 11-12-80	ACK 11-13-80	RM80-311-A17

TEST NO. 4

γ_d = 1.50 gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_o = 0.3$

FIGURE C9

TIME-HISTORY
CYCLIC TRIAXIAL TEST
NO. 4

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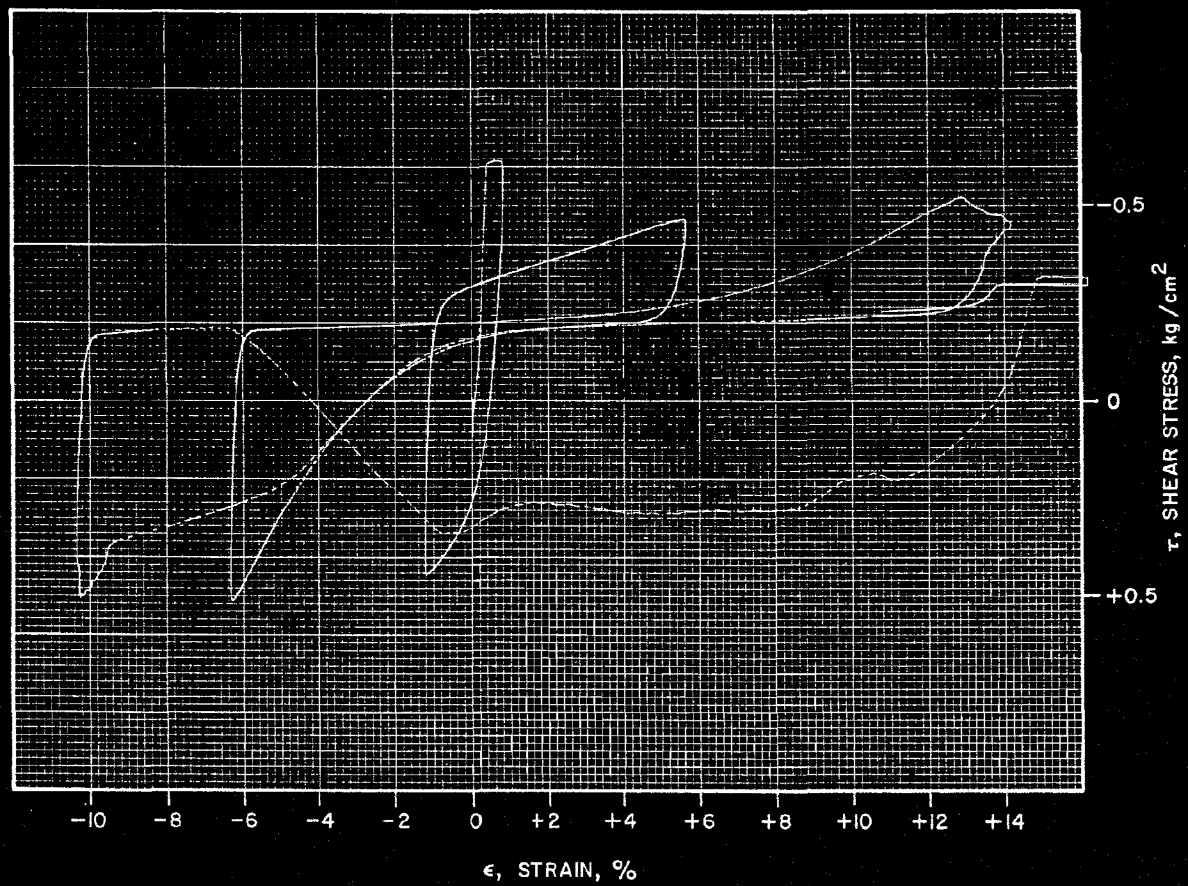
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY ck 10-30-80 | CHECKED BY TJH 11-12-80 | APPROVED BY 11-12-80 | DRAWING NUMBER RM80-311-A23



TEST NO. 5

γ_d = 1.52 gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_0$ = 0.25

FIGURE C10

MATERIAL SOFTENING DURING CYCLIC TRIAXIAL TEST NO. 5

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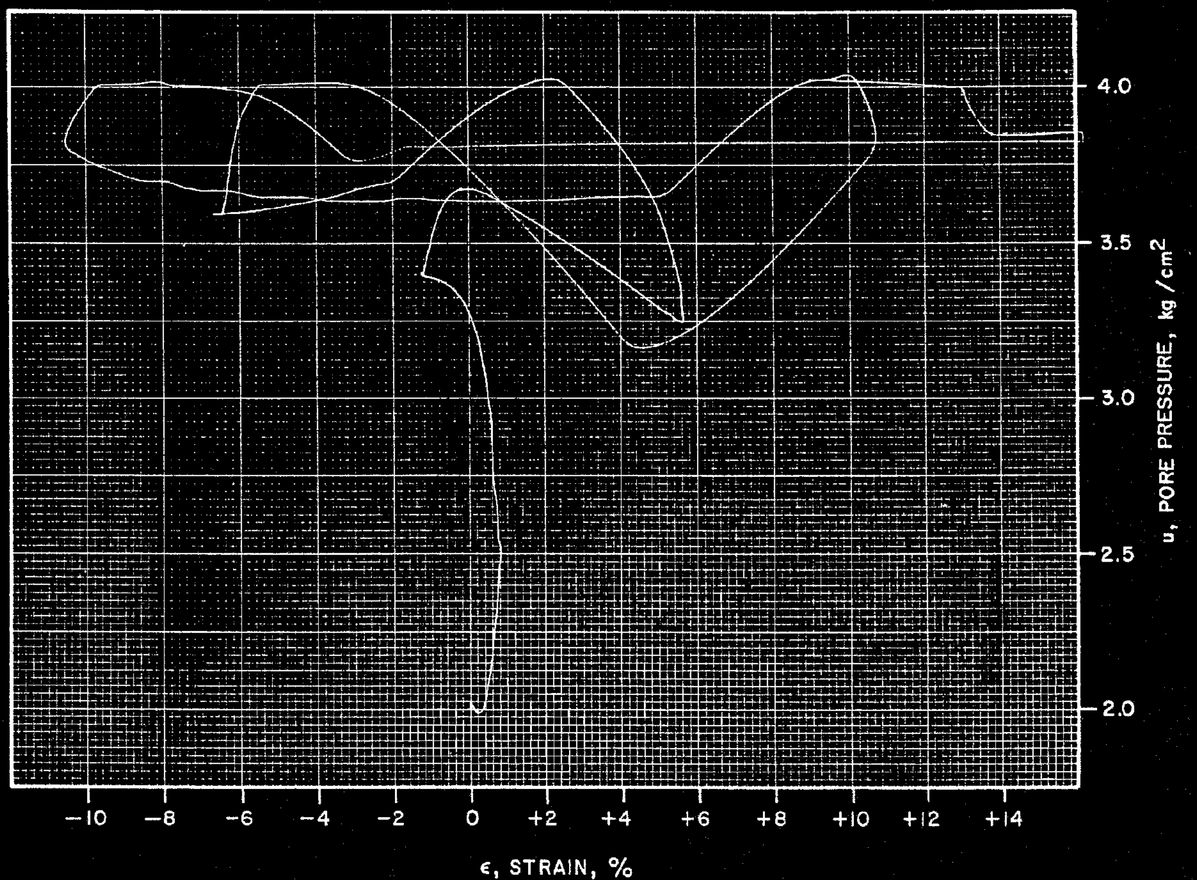
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE. A&B SMITH CO., PGH., PA LT1530-1079



TEST NO. 5

$\gamma_d = 1.52$ gm / cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_0 = 0.25$

FIGURE C11

PORE PRESSURE PATH
DURING CYCLIC TRIAXIAL TEST
NO. 5

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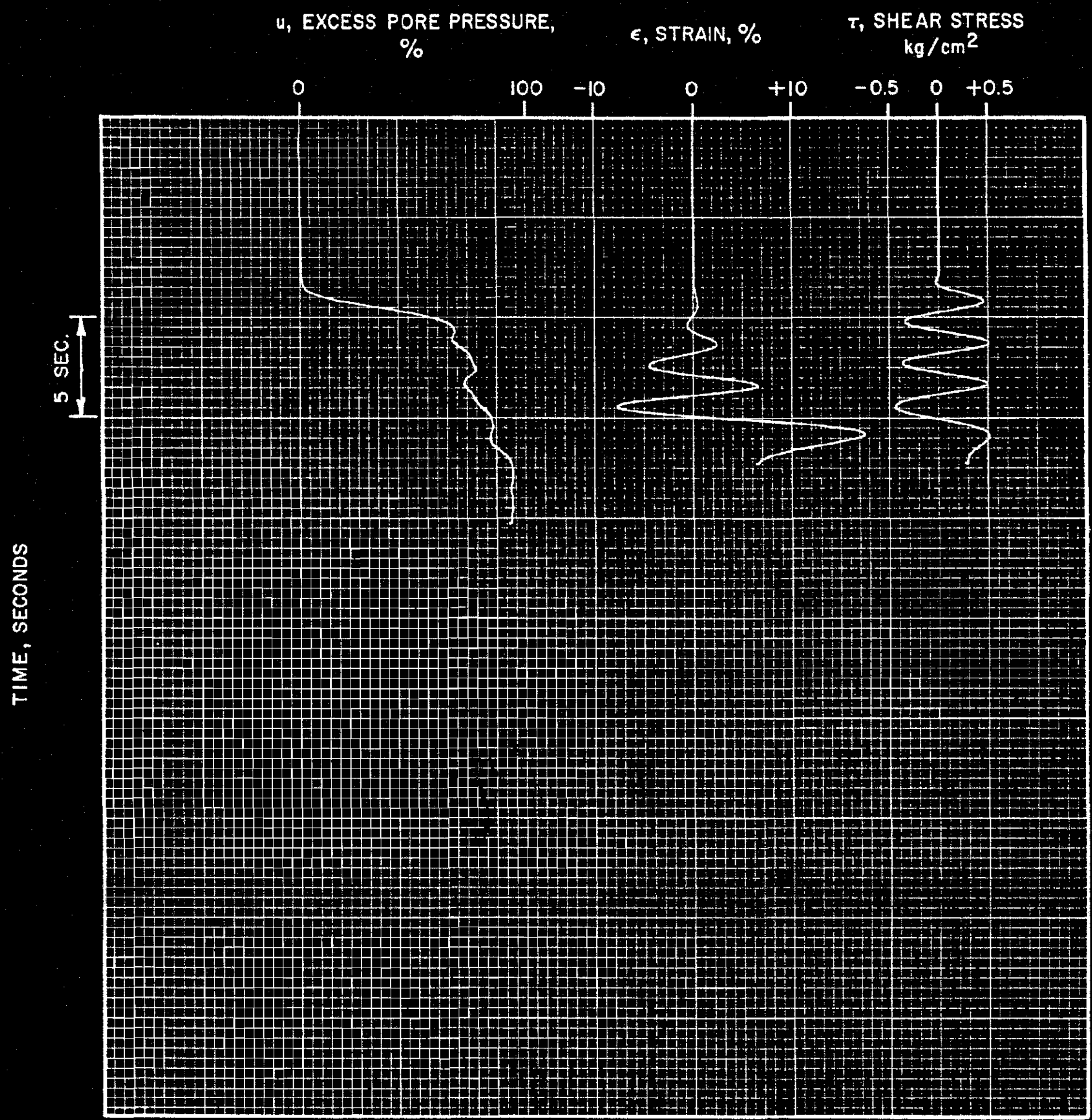
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	ck	10-30-80	CHECKED BY	TJH	11-12-80	DRAWING NUMBER	RM80-311-A24
			APPROVED BY	AHR	11-12-80		



TEST NO. 5

γ_d = 1.52 gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_o$ = 0.25

FIGURE C12

TIME-HISTORY
CYCLIC TRIAXIAL TEST
NO. 5

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	ck	10-30-80
CHECKED BY	TJH	11-12-80
APPROVED BY	AKK	11-12-80
DRAWING NUMBER	RM80-311-A22	

DRAWN BY	ck 10-30-80	CHECKED BY TJH 11-12-80	APPROVED BY ARL 11-12-80	DRAWING NUMBER RM80-311-A26

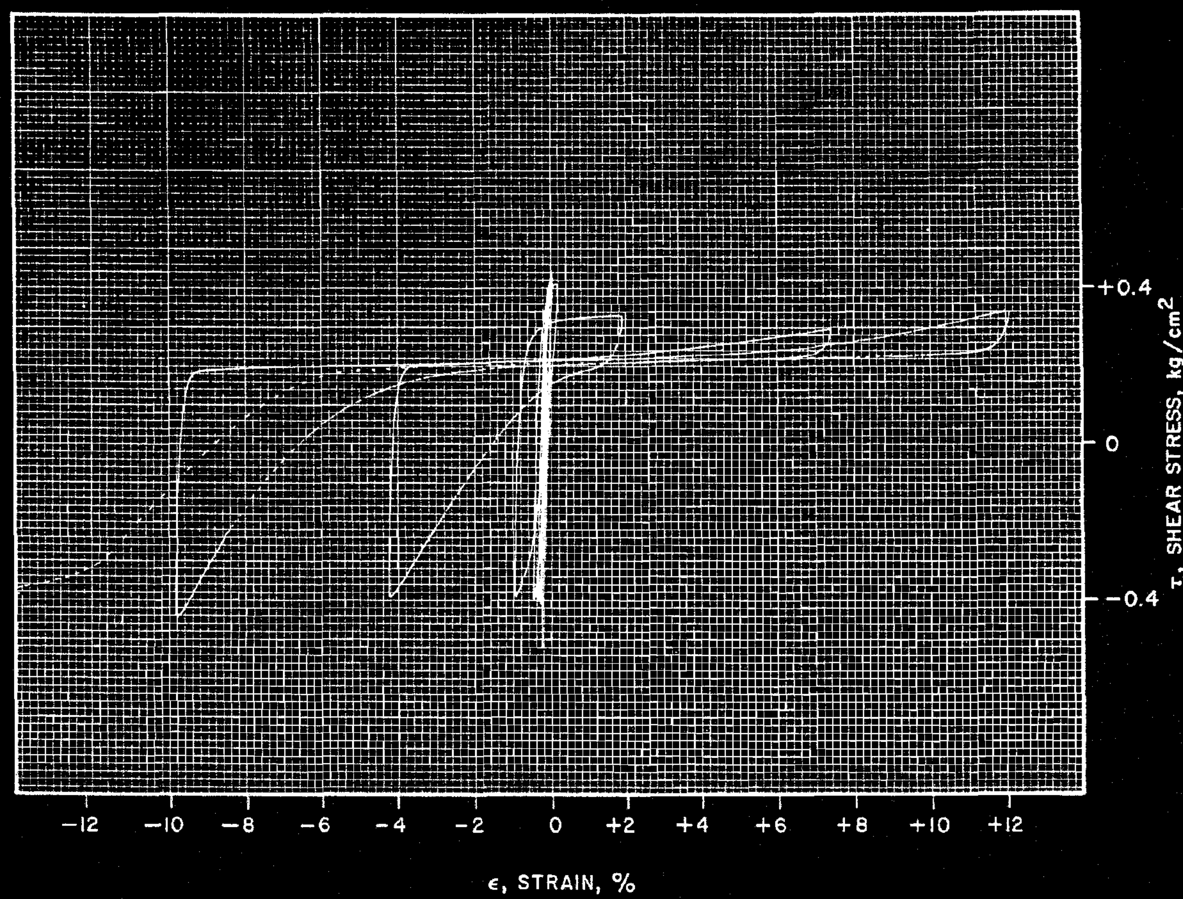


FIGURE C13

MATERIAL SOFTENING
DURING CYCLIC TRIAXIAL TEST
NO. 6

TEST NO. 6

$\gamma_d = 1.52$ gm/cm^3

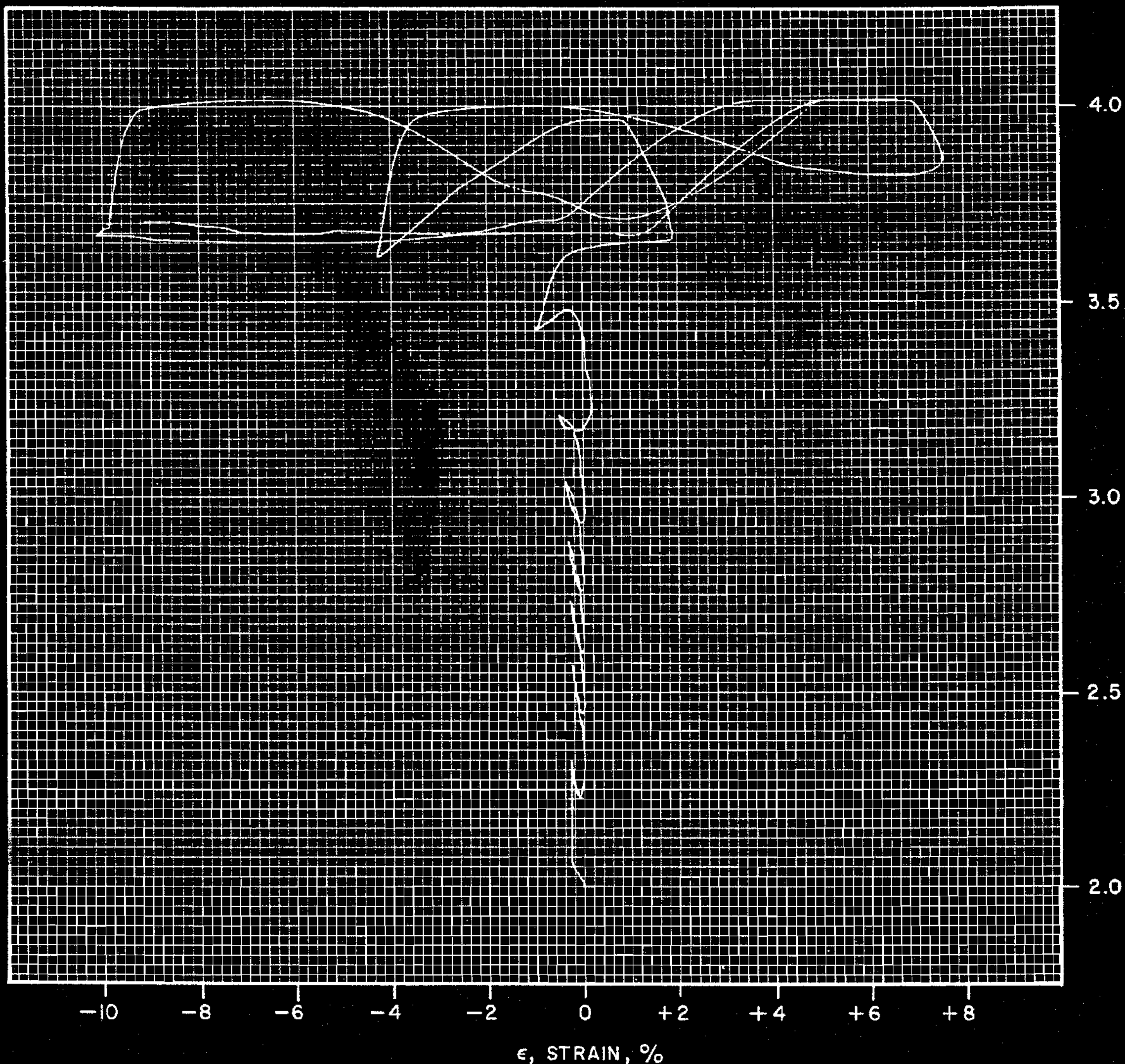
$\overline{\sigma}_d / 2\overline{\sigma}_o = 0.2$

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE. A&B SMITH CO., PGH., PA LT1530-1079



DRAWN BY | ck | 10-30-80 | CHECKED BY | TJH | 11-12-80 | APPROVED BY | 11-12-80 | DRAWING NUMBER RM80-311-A27

TEST NO. 6

γ_d = 1.52 gm

$\overline{\sigma}_d / 2\overline{\sigma}_0$ = (

FIGURE C14

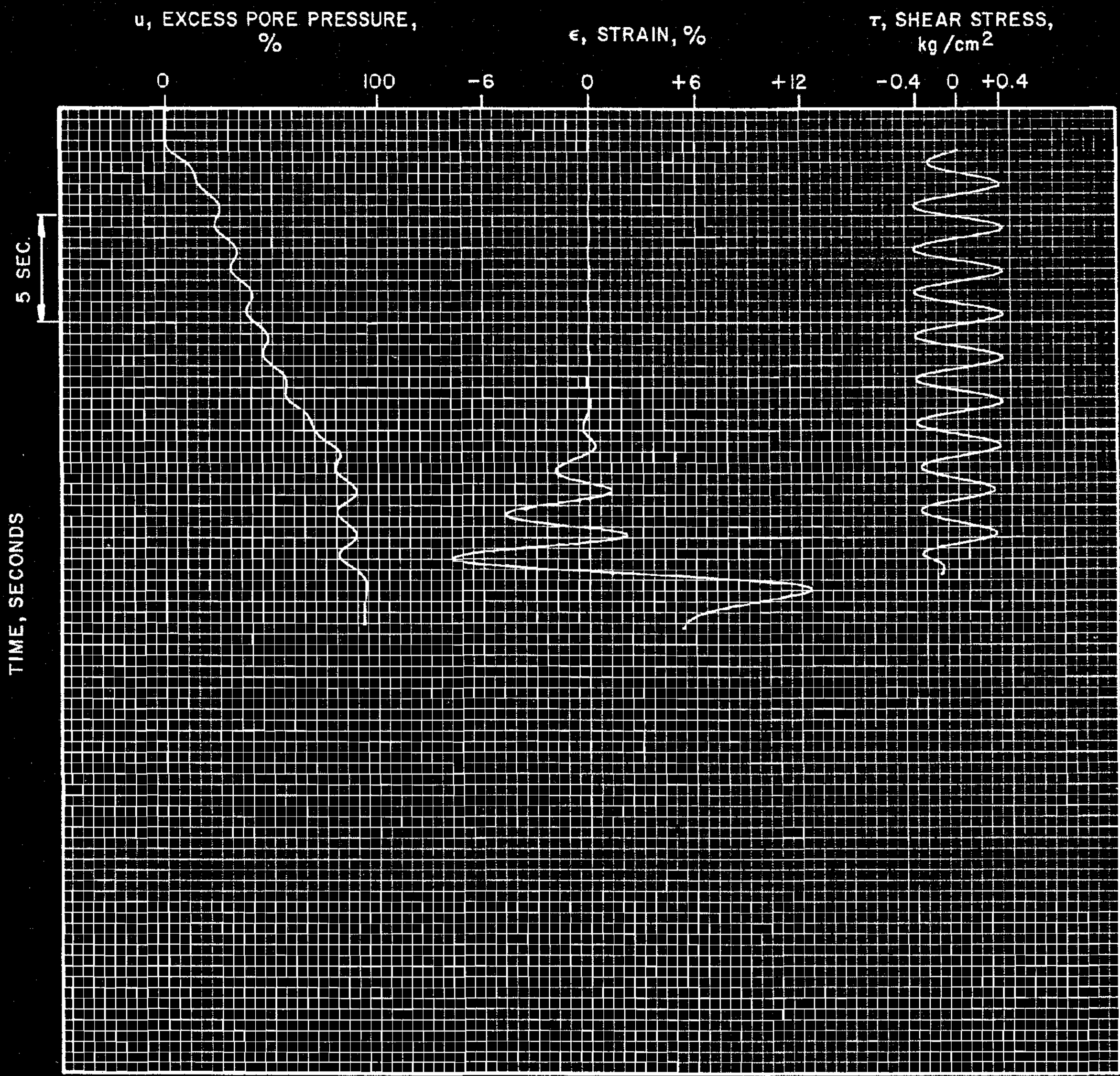
PORE PRESSURE PATH
DURING CYCLIC TRIAXIAL TEST
NO. 6

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
ck 10-30-80	TJH 11-12-80	AKK 11-12-80	RM80-311-A25



TEST NO. 6

γ_d = 1.52 gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_o$ = 0.2

FIGURE C15

TIME-HISTORY
CYCLIC TRIAXIAL TEST
NO. 6

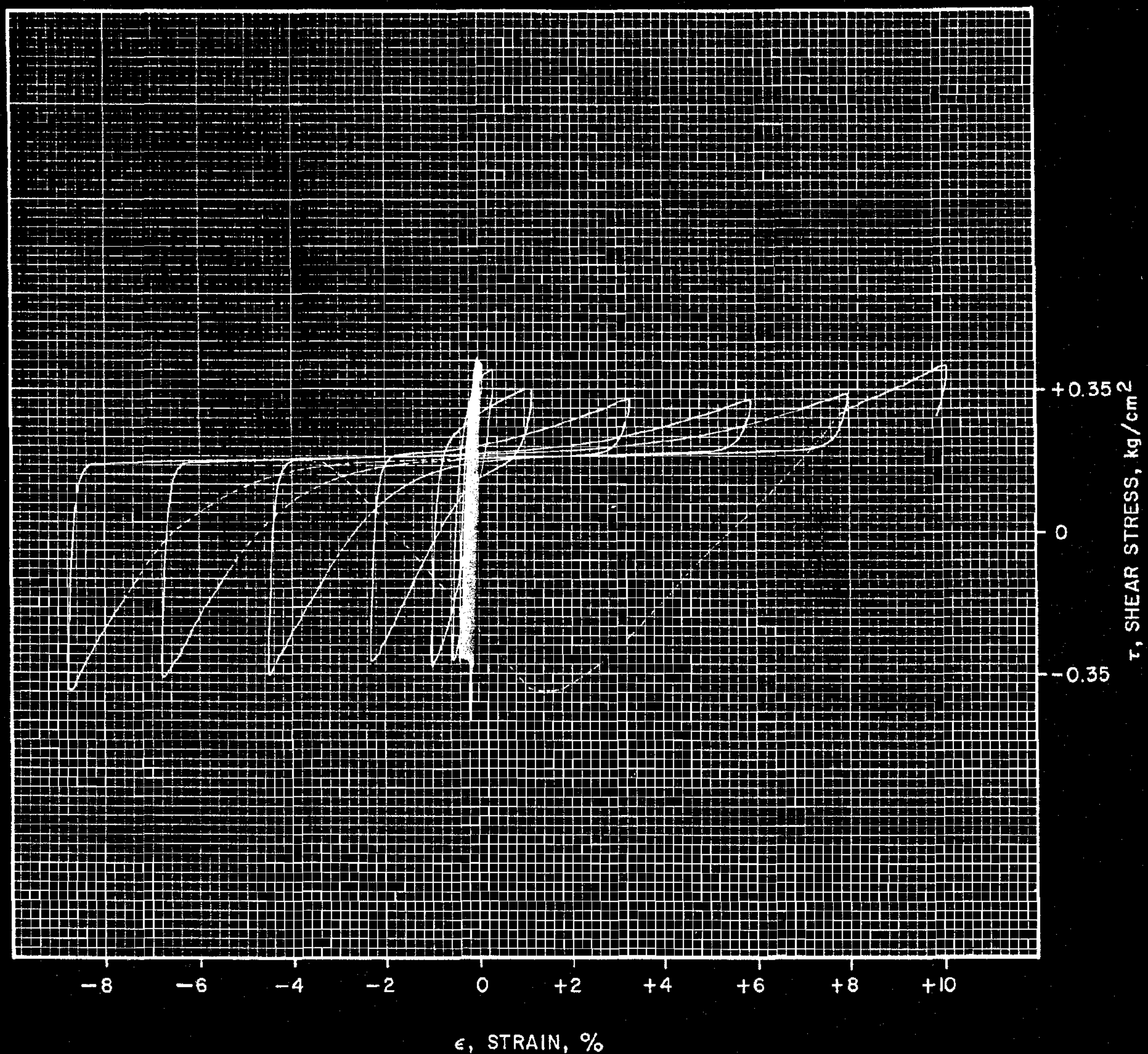
PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE. A&B SMITH CO., PGH., PA LT1530-1079

DRAWN BY | ck 10-30-80 | CHECKED BY TJH 11-12-80 | APPROVED BY [illegible] 11-12-80 | DRAWING NUMBER RM80-311-A15



TEST NO. 7

$\gamma_d = 1.50$ gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_o = 0.175$

FIGURE C16

MATERIAL SOFTENING
DURING CYCLIC TRIAXIAL TEST
NO. 7

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	ck	CHECKED BY	TJH	11-12-80	DRAWING NUMBER	RM80-311-A16
	10-30-80	APPROVED BY				

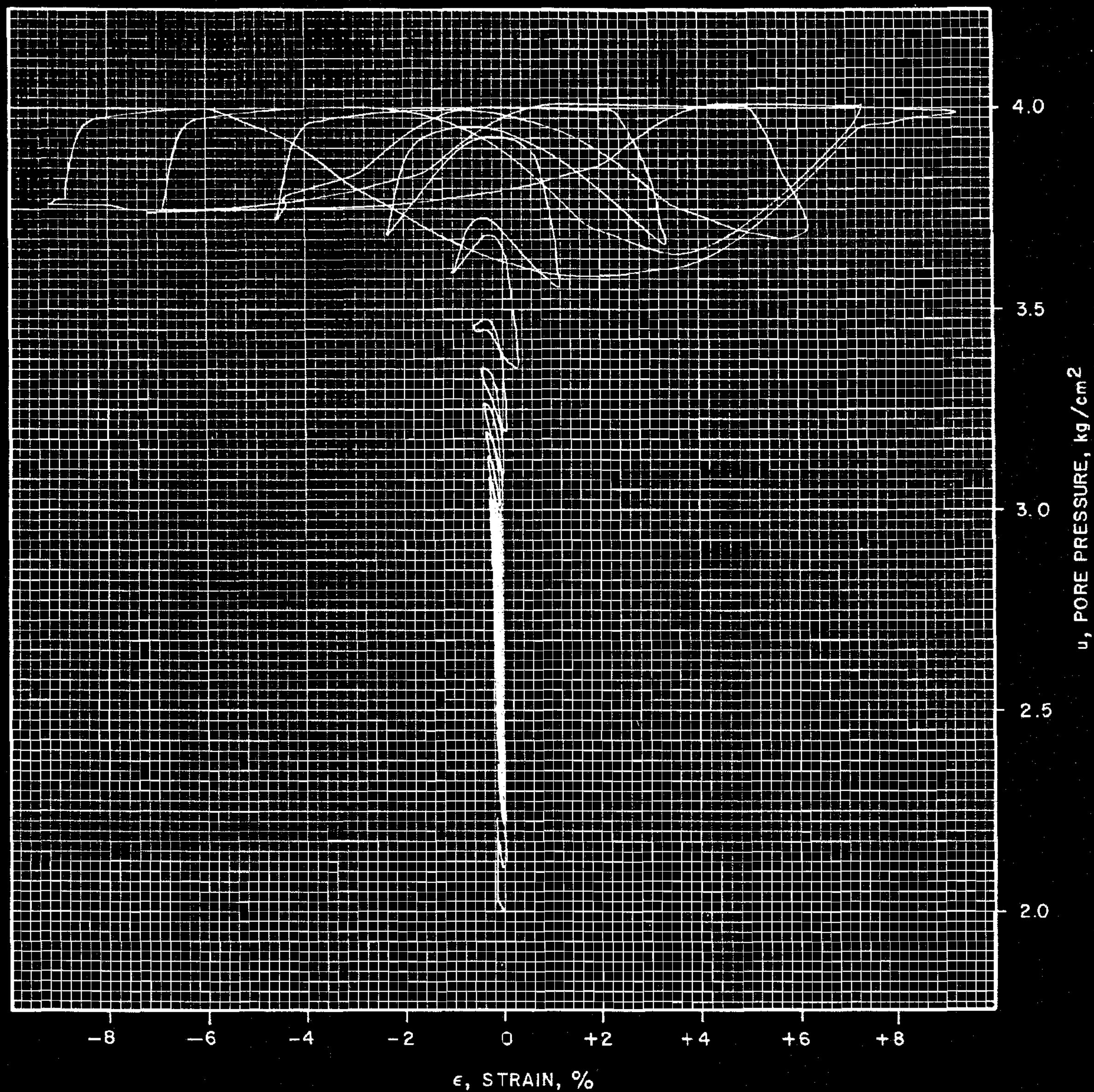


FIGURE C17

PORE PRESSURE PATH
DURING CYCLIC TRIAXIAL TEST
NO. 7

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

TEST NO. 7

γ_d = 1.50 gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_0$ = 0.175

D'APPOLONIA

DRAWN BY | ck 10-30-80 | CHECKED BY TJH 11-12-80 | APPROVED BY [illegible] 11-12-80 | DRAWING NUMBER RM80-311-A14

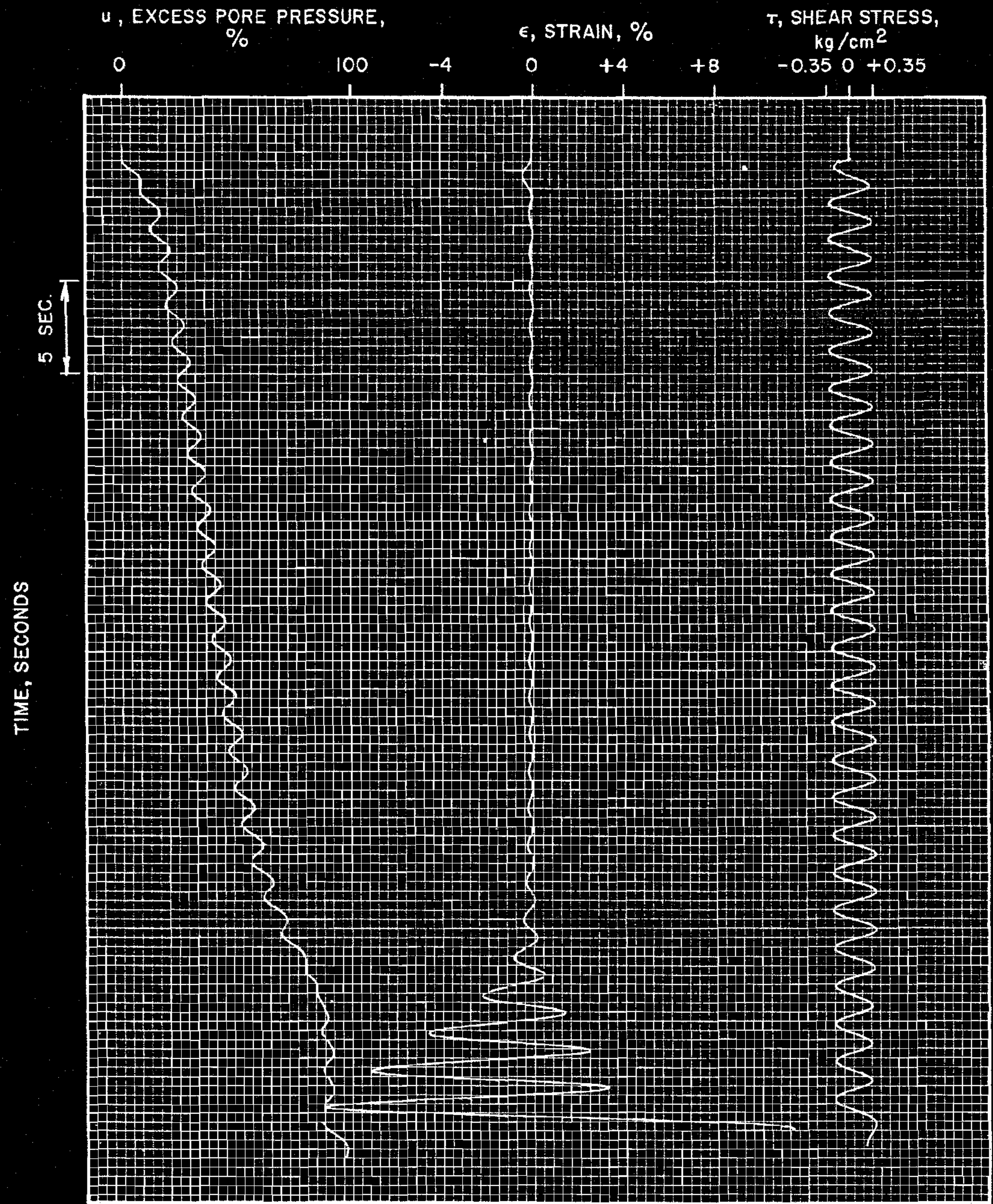


FIGURE C18

TIME-HISTORY
CYCLIC TRIAXIAL TEST
NO. 7

TEST NO. 7

$\gamma_d = 1.50\ gm/cm^3$

$\bar{\sigma}_d / 2\bar{\sigma}_o = 0.175$

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

DRAWN BY	ck	CHECKED BY	T.H.	11-6-80	DRAWING NUMBER	RM80-311-A17
	10-30-80	APPROVED BY	[illegible]	[illegible]		

TEST NO. 8

γ_d = 1.51 gm/cm^3

$\bar{\sigma}_d / 2\bar{\sigma}_o$ = 0.125

FIGURE C19

TIME-HISTORY
CYCLIC TRIAXIAL TEST
NO. 8

PREPARED FOR

UNITED NUCLEAR—HOMESTAKE PARTNERS
GRANTS, NEW MEXICO

D'APPOLONIA

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TEXAS 76011

Bad 16

MAY 22 1986

RECEIVED
23
EEF

Mr. Ed Kennedy
Director of Environmental Affairs
Homestake Mining Company
P. O. Box 98
Grants, New Mexico 87020

Gentlemen:

As you are aware, Governor Anaya recently requested that the U.S. Nuclear Regulatory Commission (NRC) reassert its regulatory responsibility for uranium recovery operations in the State of New Mexico. This is to notify you that the Commission has agreed to reassert jurisdiction over New Mexico licensees effective June 1, 1986. A forthcoming Federal Register publication regarding this action will be sent to you under separate cover. Reassertion of regulatory authority will also involve the publication in the Federal Register of a General Order which will say, in essence, that all existing requirements placed on you by the State of New Mexico will remain in effect.

In order to establish a basis for our future dealings on regulatory matters, I am inviting all current New Mexico licensees to a meeting with the NRC staff in Albuquerque on May 29, 1986. The purpose of this meeting is to provide a brief introduction to the NRC staff which have responsibility for the regulation of your operations, to acquaint you with NRC regulations, policies, and administrative requirements, and to discuss transitional matters. We ask that you telephonically confirm by May 27, 1986 the names of individuals representing your company who will be in attendance so that we can finalize meeting arrangements. We will provide more detailed information on the meeting location and follow up with a written confirmation as well as a meeting agenda. However, for planning purposes, you should assume the meeting will start in the late morning or early afternoon. You may coordinate your attendance with Mr. Pete Garcia of my staff at (303) 236-2805.

For those licensees possessing uranium byproduct tailings, the differences in reclamation requirements between New Mexico regulations and existing NRC regulations are substantive and, therefore, an important objective at the meeting will be to address: (1) the development and NRC approval of a tailings reclamation plan, and (2) the subsequent establishment of an NRC approved surety arrangement adequate to assure

AmFAC 1:00 pm

both mill decommissioning and tailings reclamation. For more detail on these subjects, I would refer you to Criteria 4, 6, 9, and 10 of Appendix A to 10 CFR Part 40.

The NRC staff expects to work with New Mexico licensees to develop and incorporate into the transferred licenses appropriate site reclamation plans which meet the specific requirements of Criteria 4 and 6. After the date of reassertion of NRC jurisdiction, we plan to request that you provide, by June 13, 1986, a written commitment to submit for NRC review and approval a reclamation plan designed to meet the NRC standards. Our request will ask for a commitment to submit the detailed reclamation plan by October 1, 1986.

Criteria 9 and 10 to Appendix A of 10 CFR Part 40 explain the required surety arrangements needed to cover the costs of decommissioning and reclamation according to an NRC-approved decommissioning and reclamation plan. Upon NRC approval of a specific reclamation plan, you, as a licensee, will be required to establish surety arrangements in accordance with 10 CFR Part 40.

We look forward to an effective working relationship with New Mexico licensees as we work together toward assuring that your operations meet the applicable federal standards. Should you have any questions regarding this letter, please feel free to contact Dr. Harry Pettengill or Mr. Pete Garcia at the above number. The majority of interactions with the NRC staff on both inspection and licensing related matters will occur through Region IV's Uranium Recovery Field Office, P.O. Box 25325, Denver, Colorado 80225 (303-236-2805).

Sincerely,

Robert D. Martin
Regional Administrator

Enclosure: As stated

cc: Denise Fort, Director
EID, New Mexico

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

RECEIVED
JUN 12

JUN 06 1986

URFO:HJP
URL 1

Mr. Ed Kennedy
Director of Environmental Affairs
Homestake Mining Company
P.O. Box 98
Grants, New Mexico 87020

Gentlemen:

By letter dated May 22, 1986, Mr. Robert D. Martin, Regional Administrator, informed you that the NRC would require you to submit, for review and approval, a tailings reclamation plan for your facility and a surety arrangement adequate to assure both mill decommissioning and complete tailings reclamation in accordance with Title 10, Code of Federal Regulations, Part 40, Appendix A. You are now requested to submit to the Uranium Recovery Field Office by June 13, 1986 a commitment to submit, by October 1, 1986, a detailed tailings reclamation plan. Your submittal should be in the form of a license amendment application.

Enclosed for your use is a topical outline which details the essential elements of a reclamation plan. A list of pertinent reference documents is also enclosed for your use. Several of these documents were also contained in the lists of reference materials provided to you during our meeting in Albuquerque on May 29, 1986.

After the Uranium Recovery Field Office receives confirmation of your intent to develop and submit the reclamation plan, I will assign an NRC project manager who will work directly with you and will advise you on preparation of your site specific plan. The project manager will be available to communicate with you and discuss scheduling to provide a completed package for NRC review and approval on a timely and reasonable basis.

Your voluntary cooperation in meeting this 10 CFR 40 requirement will preclude the need for our issuance of an Order requiring submittal of a plan. Your cooperation at this time does not affect your right to

request a hearing on issues arising out of the issuance by NRC of a license amendment enforcing Federal standards and regulations.

Any questions can be directed to me at telephone number (303) 236-2805.

Sincerely,

R. Dale Smith, Director
Uranium Recovery Field Office
Region IV

Enclosures: Tailings Reclamation Plan Details
List of Pertinent Reference Documents

Enclosure 1

TAILINGS RECLAMATION PLAN DETAILS

A tailings reclamation plan should address the following topics in detail:

1. A plan to dewater and consolidate the tailings prior to placing a final cover. This should include an interim stabilization program designed to minimize blowing of tails from the ponds and a plan for recontouring the tailings and placing an interim cover to prevent recharge during the period of consolidation.

2. A proposed methodology and plan to restore ground water quality to meet regulatory requirements. This should include a designed ground water recovery technique, a routine monitoring schedule, and the parameters to be analyzed and the procedures to be used to evaluate data.

3. Plan and cross sectional views of the final reclamation contours which detail the location and elevations of tailings and the associated cover materials. The cover should be designed to minimize erosion by wind, rain and surface water. The final contour should preclude ponding of water and recharge of the tailings. The placement of rock or vegetative coverings on the final reclaimed pile should be described and visually diagrammed. Analyses should be provided to document that flows and velocities resulting from a Probable Maximum Precipitation event will not compromise the integrity of the reclaimed pile. All procedures, computations, and assumptions used in the hydrologic analyses should be provided.

4. An analysis should accompany the plan to show that the proposed cover materials and their depths are adequate to provide appropriate attenuation of radon over a 1000-year period to the extent reasonably achievable, but in no case less than 200 years. The information provided should include all parameters used in calculating radon emanation from the reclaimed pile as well as parameters used in calculating estimated wind and sheet water erosion amounts over this period.

5. A proposed schedule and time sequence should be included which addresses the anticipated sequence of events described in items 1 through 3 above.

6. A detailed cost analysis should be performed for each phase of reclamation based on what costs would be incurred if the work were performed by an outside contractor, projected effects on costs due to inflation, a contingency fund and the costs associated with long term surveillance.

ENCLOSURE 2

LIST OF PERTINENT REFERENCE DOCUMENTS

LIST OF PERTINENT REFERENCE DOCUMENTS

NUREG/CR-2642 -	Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review, 6/82
NUREG/CR-2684 -	Rock Riprap Design Methods and Their Applicability to Long-Term Protection of Uranium Mill Tailings Impoundments, 8/82
NUREG/CR-2768 -	Literature Review of Models for Estimating Soil Erosion and Deposition from Wind Stresses on Uranium Mill Tailings Covers, 11/82
NUREG/CR-3027 -	Overland Erosion of Uranium Mill Tailings Impoundments: Physical Processes and Computational Methods, 3/83
NUREG/CR-3199 -	Guidance for Disposal of Uranium Mill Tailings: Long-Term Stabilization of Earthen Cover Materials, 10/83
NUREG/CR-3533 -	Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, 4/84
NUREG/CR-4076 -	Determination of Compliance with Criteria for Final Tailings Disposal Site Reclamation, 6/85
NUREG/CR-4118 -	Monitoring Methods for Determining Compliance With Decommissioning Cleanup Criteria of Uranium Recovery Sites, 6/85
NUREG/CR-3457 -	Validation of Methods for Evaluating Radon Flux Attenuation Through Earthen Covers, 10/84
NUREG/CR-4075 -	Designing Protective Covers for Uranium Mill Tailings Piles: A Review, 5/85
NUREG/CR-3747 -	The Selection and Testing for Armoring Uranium Tailings Impoundments, 5/85
NUREG/CR-3397 -	Design Considerations for Long-Term Stabilization of Uranium Mill Tailings Systems, 10/83

NUREG/CR-3751 -	Effects of Rock Riprap Design Parameters on Flood Protection Costs for Uranium Tailings Improvements, 7/84
NUREG/CR-3752 -	Effects of Hydrologic Variables on Rock Riprap Design for Uranium Tailings Impoundments, 1/85
NUREG/CR-2340 -	A Handbook for the Determination of Radon Attenuation Through Cover Materials, 12/81
NUREG/CR-2769 -	Comparison of Field-Measured Radon Diffusion Coefficients with Laboratory-Measured Coefficients, 4/83
NUREG/CR-2924 -	Radon Diffusion in Candidate Soils for Covering Uranium Mill Tailings, 4/83

HOMESTAKE MINING COMPANY
P.O. BOX 98
GRANTS, NEW MEXICO
87020-0011

June 13, 1986

CERTIFIED MAIL NO.: P 713 183 661

Mr. Robert D. Martin
Regional Administrator
United States Nuclear Regulatory
Commission
Region IV
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

Re: License No. SUA-708

Dear Mr. Martin:

This letter is written pursuant to your letter of March 22, 1986, asking for a voluntary commitment on Homestake's part to submit a detailed tailings reclamation plan. Homestake wishes to cooperate with your process in this matter, and will voluntarily submit such a plan. At the same time, Homestake wishes to reserve all of its legal positions in this matter, and will submit the plan without prejudice to any of its rights. We understand from our May 29 conference that this reservation is satisfactory to NRC.

Homestake and its contractor feel the NRC recommended date of October 1 is too tight for our operation. Homestake feels confident that a document can be provided by December 1, 1986. We will furnish you other details on the time schedule in the interim.

Sincerely yours,

HOMESTAKE MINING COMPANY

Edward E. Kennedy
Director of Environmental
Affairs

EEK:SC:jg

Enclosure

cc: Harry Pettengill
J. M. Parker
W. A. Humphrey
D. B. Crouch
G. S. Crout

HOMESTAKE MINING COMPANY - GRANTS

Schedule for Decommissioning and Reclamation
License SUA-708

1986

June: 9, 20, 23 | July: 1, 7, 15, 21, 31 | August: 4, 10, 31 | September: 1, 15, 30 | October: 1, 15, 31 | November: 1, 15, 30 | December: 1

1. Corporate (SFO) Review and Approval of Study Proposal.
2. Bid Task 1 Job - Borrow Material Study
3. Task 1 Field and Lab Work
4. Task 1 - Compile Data and Perform Analysis (Final Report)
5. Bid Task 2 Job - Radon Emanation and Control Modelling Study -vs- Real Data
6. Setup Task 2 Model, Verify, Debug, Sample Run
7. Task 2 - Model HMC Site Specific Rn Emanation Control (Final Report)
8. Task 3 - Review HMC's Current Decommissioning and Stabilization Proposal and Compare With NRC Criteria (Variance Report)
9. Task 4 - General a Site Decommissioning and Reclamation Plan
10. HMC Review and Approval
11. Submit Site Decommissioning and Reclamation Plan to NRC

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2.2.6

~~HOMESTAKE MINING COMPANY — GRANTS~~ (COMPANY)

TO J. M. Parker

FROM E. E. Kennedy

DATE June 5, 1986

SUBJECT June 13, 1986 Submitted to NRC

Attached, please find a copy of the proposed compliance letter to be submitted to the Nuclear Regulatory Commission (NRC) on June 13, 1986, pursuant to their letter of May 22, 1986. The proposal includes a schedule for submitting a site decommissioning and reclamation plan, in compliance with federal criteria, to the NRC on December 1, 1986. It also includes time for HMC review of the study proposal and review of the completed document prior to submittal to the NRC. We will be provided estimated costs for completing the studies, analyses and report generation on June 16, 1986. This information shall be telecopied to the appropriate individuals on that date for their review.

Should any adjustments to the proposal be necessary, please notify me by June 12, 1986.

Ed

Edward E. Kennedy

EEK:jg

Attachment

cc: W. A. Humphrey
D. B. Crouch
G. S. Crout

HOMESTAKE MINING COMPANY

P.O. BOX 98
GRANTS, NEW MEXICO
87020

June 5, 1986

CERTIFIED MAIL NO.: P 713 183 661

Mr. Harry Pettengill, Branch Chief
U.S. Nuclear Regulatory Commission
Region IV
Uranium Recovery Field Office
Post Office Box 25325
Denver, Colorado 80225

Re: License No. SUA-708

Dear Mr. Pettengill:

This letter is written pursuant to Mr. Robert Martin's letter of May 22, 1986 concerning a commitment to submit for NRC review and approval a reclamation plan designed to meet the NRC standards.

This commitment to submit a reclamation plan designed to meet the NRC standards is not, nor should it be deemed, an agreement or acknowledgement that those standards are lawful or applicable in New Mexico or that Homestake Mining Company must comply with those standards. Homestake Mining Company reserves the right to challenge, in administrative or judicial proceedings, the lawfulness of the NRC standards and the imposition of those standards in New Mexico. This commitment is subject to the final judicial determination in Quivera Mining Company, Kerr-McGee Chemical Corporation, Homestake Mining Company of California, and United Nuclear Corporation v. United States Nuclear Regulatory Commission, No. 85-2853 (10th Cir.).

Attached, please find a schedule for submitting Homestake Mining Company's (HMC's) site decommissioning and reclamation plan designed to comply with the NRC standards. You will note that HMC's proposed schedule shows a submittal date of December 1, rather than the NRC recommended October 1 deadline. Homestake and its contractor feel that the October 1 deadline is too tight to provide the NRC with a document that would demonstrate sufficient compliance with federal standards. The NRC has expressed on numerous occasions the importance of submitting complete and quality information so that an efficient high-caliber review can be accomplished. Homestake feels confident that such a document can be provided for NRC review and approval by December 1, 1986.

If you have any questions or comments concerning this schedule, please don't hesitate to contact me.

Very truly yours,

HOMESTAKE MINING COMPANY

Edward E. Kennedy
Director of Environmental
Affairs

EEK:jg

Attachment

cc: J. M. Parker
W. A. Humphrey
D. B. Crouch
G. S. Crout

ALAN K. KUHN, Ph.D., P.E.
CONSULTANT IN GEOLOGICAL ENGINEERING AND APPLIED GEOSCIENCES
13212 Manitoba Drive NE, Albuquerque, NM 87111-2955 505-298-9839

June 13, 1986

Mr. Ed Kennedy
Homestake Mining Company
P.O. Box 98
Grants, NM 87020

PROPOSED WORK PLAN
MILL DECOMMISSIONING AND TAILINGS STABILIZATION STUDIES
FOR NRC COMPLIANCE

Dear Ed:

This letter describes the scope of work, schedule, and estimated costs of the several tasks that will be required to evaluate the Homestake decommissioning and stabilization plan for compliance with NRC standards. In accordance with our discussions of June 4, four tasks will be performed. The following section describes these tasks. Later sections lay out the proposed schedule and the estimated costs of each task and the entire effort.

SCOPE OF WORK

This work will be performed primarily by myself, as principal investigator, with major assistance from Gene Jenkins. We were instrumental in preparation of the 1982 UMLRA Environmental Report and, consequently, can bring that experience to bear on this study. I will direct and oversee all tasks. Gene will contribute primarily to tasks 3 and 4. A drilling contract and soil testing contract will be issued by HMC for Task 1 services. For Task 2 modeling I suggest that Triad, Inc. be contracted. I have confidence that they can do the work well and cost effectively and that they will cooperate closely with us.

Task 1 - Borrow (Cover) Material Study

This task will investigate the quantities and physical properties of soils on the Homestake property north of the main tailings pile. Test borings and possibly test pits will be made to profile the soils and to collect samples for testing. An area of about 2000 by 5000 feet will be studied using 15-20 borings to depths of 20-25 feet. I will prepare a brief specification for Homestake (HMC) to use in contracting a drilling service. I or my representative will supervise the drilling, log the borings, and collect soil samples. Depending on the results of the borings, several test pits might be recommended. It is assumed that these pits would be dug by HMC.

Selected samples will be tested for grain size analysis, Atterberg limits, moisture content and Standard Proctor density. HMC will probably perform the grain size and moisture tests, and a commercial lab will perform the other tests. For planning purposes we should expect that 40-50 grain size analyses, 30 moisture contents, 20 Atterbergs, and about 20 Proctor density tests will be performed.

Following testing, final logs will be prepared and cross sections of the borrow area will be developed as the documentation for evaluation of the soils as potential cover material. This evaluation will consider the types and quantities of soils available, their compaction characteristics and compacted properties (e.g.; porosity, permeability, cohesion) and their likely stability behavior.

Task 2 - Radon Emanation Modeling

This task will consist of several types of modeling of the radon flux from the pile. Input will include HMC radon monitoring data, Task 1 soil properties, site meteorological data, and assumed thicknesses of soil cover. The NRC-approved code RAECOM will be used for the "forward" model (prediction of flux/concentration based on radium/radon analysis of tailings). The code HAZMAT will also be used in the "forward" model and will be used to model the "back-fit" analysis (prediction of emanation from perimeter radon measurements). HAZMAT combines AIRDOSE, an NRC-approved code for modeling release rates and dispersions, with the RADMAT code, approved by NRC for radwaste package performance assessment and reviewed by NRC for radiation accident modeling. RAECOM will be run on a microcomputer while HAZMAT will be run on an IBM 3600 accessed locally.

Both "forward" and "back-fit" modeling will require input of HMC radon monitoring data and data from HMC testing of tailings. These data and the data collection program will be evaluated for statistical validity of sampling per the EPA 520 guidelines, and for comparison to the NRC-recommended procedures for radon flux measurement (NUREG CR-3166). The latter will be used to select data for input to the models.

The major portion of this task will be performed by Triad, Inc. of Albuquerque if approved by HMC. Triad is a relatively new firm but composed of staff with extensive backgrounds in modeling of radiation emissions, dispersions, and exposures. A statement of their capabilities is attached to this letter.

The "forward" modeling will include scenarios both with and without a soil cover over the tailings. The version without a cover will be compared to the "back-fit" model. However, scenarios that depict a covered pile will not be comparable to the "back-fit" version and will be used to evaluate the effectiveness of several (probably three) different cover thicknesses.

Triad's work will be directed and coordinated by Alan Kuhn with assistance from Gene Jenkins. This will assure that the results of Task 1 are properly included in this task, and that the output of the modeling is integrated with the other tasks.

Task 3 - Review and Evaluation of Existing Plan

In this task the stabilization and reclamation plan contained in the 1982 UMLRA Environmental Report (ER) will be evaluated with respect to current applicable NRC and EPA regulations. This evaluation will consist of several parts. First, the old NMEID regulations will be compared to the current federal regulations to identify the differences that need to be addressed. Second, the current HMC operational and build-out plans will be contrasted to the 1982 plans, and the differences will be quantified to the extent possible. These comparisons will lead to the next step, the identification of data categories requiring updating (e.g.; final total volume of tailings) before an accurate compliance assessment can be made.

This task will be performed primarily by Alan Kuhn and Gene Jenkins. They will rely on input from HMC, of course, and will draw as needed on assistance from Triad.

Task 4 - Assessment of Compliance Status and Needs

This task brings together the results of the previous tasks and provides an assessment of HMC's status with respect to complying with federal standards. Each standard will be listed, HMC's level of compliance described, and the needed compliance measures, if any, identified. Recommendations for actions to achieve compliance will provided, as well.

The issues most likely to be in question as noncompliant include the thickness of the soil cover, provision for mill decommissioning and decontamination, and flood protection. The first two tasks will provide the data and analyses to address the soil cover question. The mill D & D issue is relatively straightforward and can be treated within the revised tailings stabilization plan. The flood protection issue will require calculations of the PMP and PMF; however, these calculations are not included in this work plan.

SCHEDULE

The schedule proposed for this scope of work conforms to the milestones and due dates that we discussed on June 4. The schedule for each task is outlined below and illustrated on the attached figure.

SCHEDULE OF TASK ACTIVITIES

Task 1 - Borrow Study

6/20 - 6/30 Prepare drilling and testing specs. and plan
7/1 - Request drilling and testing bids
7/10 - Award drilling and testing contracts
7/15 - 7/22 Soil drilling and sampling (test pits to follow if necessary)
7/17 - 8/10 Soil testing
8/10 - 8/31 Borrow material evaluation

Task 2 - Radon Emanation Modeling

6/20 - 7/1 Prepare task description and input data
7/1 - 7/21 Place modeling contract (If competitively bid: Issue RFP 7/1, Receive proposals 7/15, award 7/21). If Triad is sole source, this step is eliminated.
7/21 - 8/10 Model set-up and verification with sample run for approval.
8/11 - 8/31 "Forward" and "Back-fit" modeling and reporting

Task 3 - Review and Evaluation of Existing Plan

6/20 - 7/15 Compare old and current regulations
7/15 - 8/31 Evaluate plan and identify nonconformance issues

Task 4 - Assessment of Compliance Status and Needs

9/1 - 9/15 Assemble and integrate results of tasks 1,2, and 3.
9/15 - 10/31 Complete assessment and prepare report.
11/1 - 11/30 Report reviewed by HMC and revised as necessary.
12/1 - Submittal of report to NRC.

```
        JUNE      JULY       AUGUST     SEPT       OCT        NOV        DEC
   ---------*---------*---------*---------*---------*---------*---------*

TASK 1

 Drilling  20--30--15---22
              ^ spec    '
                  ^bid '
                      ^drill
                         '
 Testing   20--30--15--------8
              ^spec   ^test  '
                 ^bid        '
                             '
 Evaluation                  8------31> (input to Task 3,4)
                                    '
                                    '
TASK 2                              '
           20---1-------21----11----31> (input to Task 3,4)
              ^input
                    ^contract
                            ^sample run
                                  ^modeling

TASK 3
           20------15---------------31
                ^ regulation review   '
                           ^ plan evaluation
                                      '
                                      '
TASK 4                                '
                                      1---15------------31----------1
                                        ^ integrate task results
                                                ^ compliance needs/ report
                                                              ^ HMC review/
                                                                revisions
                                                                    ^
                                                              Submit to NRC

         JUNE      JULY       AUGUST     SEPT       OCT        NOV        DEC
    ---------*---------*---------*---------*---------*---------*--------*
------------------------------------------------------------------------------
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FIGURE 1. SCHEDULE OF TASKS

ESTIMATE OF COSTS

The scope of work described above is the effort that both you and I expect to be required. However, the actual work could be somewhat greater or less than anticipated. Given this uncertainty in level of effort, the following costs are only estimates, provided for planning and budgeting purposes. However, these estimates will be treated as upper limits not to be exceeded without prior approval of HMC. Furthermore, HMC will be informed as early as possible if any activity is likely to cost more than the estimate. In any case, accrued costs versus progress will be reported to HMC on a monthly basis.

The breakdown of estimated costs by category and task is given on the attached table. In summary, the estimated costs for each task are:

Task 1 - $16,530 ($5100 for drilling and testing)
Task 2 - $19,208 ($15065 for modeling)
Task 3 - $15,836
Task 4 - $13,948

The estimated total cost for all tasks, including all contracted parties, is $65,522.

If you have any questions about this study plan, please contact me. I look forward to working with you on these tasks.

Yours truly,

Alan K. Kuhn

Alan K. Kuhn

attachment

COST ESTIMATE
DECOMMISSIONING AND STABILIZATION STUDIES

TASK NO.	LABOR (category/hours/cost)	TRAVEL	OTHER DIRECT COSTS *	NMGRT	TOTAL
1	A/80/6000 C/80/3600 E/25/500	500	300	530	11,430
	Drilling Contract - mob/demob $400 + drilling $2160 + NMGRT + 10% contingency =				3,000
	Testing Contract (Proctor and Atterberg tests) - 20 each at $65 and $25, + NMGRT + 10% continency =				2,100
					16,530
2	A/50/3750	100	100	193	4,143
	Triad Contract B/90/5400 D/190/6665 E/25/500	400	1400 **	700	15,065
					19,208
3	A/120/9000 C/100/4500 E/10/200	1200	200	736	15,836
4	A/100/7500 C/80/3600 E/25/500	1200	500	648	13,948
		ESTIMATED TOTAL			$65,522

Categories and Rates
A - A.K. Kuhn, $75/hr
B - Health Physics/ Rad Safety Specialist (Triad), $60/hr
C - Scientist, W.E. Jenkins, $45/hr
D - Junior scientist/programmer (Triad), $35/hr
E - Clerical/ Drafting, $25/hr

* Other Direct Costs - Includes communications, reproduction, word processing and freight
** Includes cost of line time and run time on IBM 3600

ATTACHMENT TO PROPOSED WORK PLAN OF 6/13/86

STATEMENT OF CAPABILITIES
MODELING OF RADON EMANATION AND DISPERSION

TRIAD, INC.

Triad personnel routinely utilize modern high-speed computers for the efficient and economical solution of engineering and scientific problems. Triad adapts existing computer programs or develops custom-made programs to deal with specific problems. Triad uses the computers of the CDC CYBERNET, IBM, and Westinghouse CRAY-1 systems for most large commercial computing requirements. Government computers such as the CRAY-1 and CD CYBER 176 are used for federally sponsored programs.

Triad utilizes mainframe computers, linked through its microcomputers, to do statistical analysis and compilations. We have on hand a large number of very powerful data base management programs, statistical analysis programs, and modeling programs that cover an extensive range of analytical requirements. The most relevant to Homestake's needs are:

HAZMAT - Intergrates a data-base management system, 3-D plotting routine, and a very powerful statistical analysis program for significant cost savings in data reduction, analysis and report preparation. The program models the distribution of any type of contaminant plume, either in the air and in groundwater, using statistically significant analysis with a minimal number of data points required.

RAECOM - An NRC-approved program for the determination of radon emissions from disposal sites of radioactive materials. This code allows determination of effects expected or achieved from placement of cover materials over tailings.

ACT - A program that calculates the source term activity from a set of initial activities as a function of discrete time steps. ACT also calculates "Probable Release," which is the activity at a given time multiplied by both the fraction released and the probability of the release. The program supports analysis of release from radioactive waste disposal sites such as those required by 40 CFR 191.

AIRDOS-EPA - Assesses exposure impacts from all pathways for continuous releases of radionuclides.

DACRIN - Assesses inhalation exposure from short term releases of radionuclides.

LADTRAN - Assesses the impact of releases of radionuclides in surface water systems.

RADTRAN-II - Allows assessment of the impact of transportation of radioactive material.

These are just a few of our computer programs that allow Triad to analyze almost any type of hazardous or radiological type of condition, incident, or change. All of the programs that Triad utilizes have been either benchmarked and/or verified from an NQA-1 review requirement. All programs except RAECOM run on IBM 3600 mainframes or can be run on CRAY-1 computers. All programs except RAECOM are written in Fortran. Triad has direct access to all the codes and computers listed above, and is able to support HMC with all Task 2 modeling.

To meet the Task 2 modeling requirements, it is anticipated that RAECOM will be used for the calculations of radon emanation from the tailings both before the proposed covering and after, and that HAZMAT will be used for calculation of the source term in the analysis of the emanations from the tailings based on the sampling/testing information obtained from Homestake. This will allow cross verification of the results of RAECOM as well as determination of the magnitude of the release. A plume history will also be generated by the HAZMAT program.

The extensive data base management programs that are in HAZMAT as well as our own DB management systems will allow for input and manipulation of the large amount of data that will be entered. This capability makes very economic and effective use of the information in a logical and efficient manner.

T.R. Beck

HOMESTAKE MINING COMPANY
P.O. BOX 98
GRANTS, NEW MEXICO
87020

December 1, 1986

Mr. Harry Pettengill, Chief
Uranium Recovery Field Office, Lic. Br. 2
Region IV
U.S. Nuclear Regulatory Commission
P.O. Box 25325
Denver, CO 80225

Re: License No. SUA-1471
Docket No. 40-8903

Dear Mr. Pettengill:

In accordance with our commitment dated June 13, 1986, Homestake Mining Company hereby submits 6 copies of its Tailings Stabilization and Site Reclamation Plan for the Grants, New Mexico Uranium Mill and Tailings Facilities. This plan addresses the design criteria and cost analysis as required under Title 10 CFR 40, Appendix A. It addresses mill decommissioning, land cleanup and complete tailings reclamation. It includes activities for interim stabilization to control dusting under 10 CFR 40, Appendix A, Criterion 8. It addresses the control of non-radiological protection criteria through extensive ground water protection programs as required under 10 CFR 40, Appendix A, Criterion 6.

This plan addresses Homestake's active tailing pile, the mill and mine ion exchange facilities, and their associated surrounding land areas. It does not address the Homestake-New Mexico Partners tailings pile, which has been inactive since 1962, per our telephone discussion of November 24, 1986. Your recommendation is being taken under advisement and Homestake will respond in a timely manner.

As set forth in our letter of June 13, 1986, Homestake wishes to reserve all of its legal positions related to this matter, and Homestake's voluntary submission of the reclamation plan is without prejudice to any of its rights. It is our continuing understanding that this reservation is satisfactory to NRC.

Homestake Mining Company is prepared to meet with you and other members of the NRC staff at any time to discuss the report or any of its sections in detail.

Very truly yours,

HOMESTAKE MINING COMPANY-GRANTS
ORIGINAL
Signed By:

Edward E. Kennedy
Director of Environmental
Affairs

Delivered by: ____________________

Received by: ____________________

Date: ____________________

EEK/bgl

Text, Tables and Figures

Tailings Stabilization and Site Reclamation Plan License No. SUA-1471 Docket No. 40-8903

Homestake Mining Company-Grants

12/86

TAILINGS STABILIZATION

AND

SITE RECLAMATION PLAN

HOMESTAKE MINING COMPANY

GRANTS, NEW MEXICO

License No. SUA-1471

Docket No. 40-8903

Prepared by:

Alan K. Kuhn, Ph.D., P.E.
Consulting Engineer
Albuquerque, New Mexico

and

W. E. Jenkins
Environmental/Hazardous Waste Consultant
Englewood, Colorado

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Homestake Mining Company (HMC) respectfully submits this Tailings Stabilization and Site Reclamation Plan to the Nuclear Regulatory Commission (NRC). The plan was developed to meet the criteria contained in NRC's 10 CFR 40, Appendix A (NRC, 1985 and 1986), for long-term stability and protection for 1,000 years against release of radioactive material from the tailings impoundment and associated mill site. Currently, the tailings impoundment covers approximately 170 acres, is 85 to 90 feet high, and contains approximately 21 million tons of tailings. This plan is based on the ultimate buildout configuration of the tailings impoundment after a five-year period of 2,000 tons per day (tpd) production. This production rate would add an additional 3,650,000 tons of tailings, increasing the impoundment height by 5 to 13 feet and the surface area to approximately 179 acres. The 2,000 tpd production rate is the maximum possible level being used as the basis for relicensing; actual production is expected to be near the present 3,500 tons per month (tpm) rate.

When milling operations are permanently ended, the mill will be decommissioned. The structures and equipment will be demolished and buried in the southeast corner of the stabilized tailings impoundment, as described in Chapter 3.0. The mill area and vicinity around the impoundment will be decontaminated by excavating soils with excessive radium levels, as described in Chapter 3.0, and placing those soils as fill at the toe of the impoundment, which will be protected by a soil cover. The extent of area receiving cleanup has been estimated at 644 acres, based on a gamma survey conducted previously by HMC. Subsequent radiological survey efforts,

described in Chapter 4.0, will include correlations between soil radium contents and gamma meter readings, delineating more precisely those areas requiring soil cleanup.

The major task in this plan is the long-term stabilization of the tailings impoundment. This task, discussed in Chapter 5.0, will begin with the interim stabilization (Section 5.2) required to limit erosion during the closure period. The long-term stabilization will consist of recontouring the impoundment, covering it with soil, and protecting the slopes with vegetation or rock cover (Section 5.3). Soil and rock covers have been designed to satisfy the criteria of 10 CFR 40, Appendix A. As a result of recontouring, the tailings slimes will be covered by sand tailings, effectively reducing the radon flux from the slimes and the resultant required thickness of the soil cover. The soil for this cover will be obtained from on-site clay and sand deposits. Rock to protect the steeper slopes will be limestone obtained from a quarry near the mill. Riprap from this quarry, as well as diversion ditches and rechannelization of San Mateo Creek, will be used to provide the necessary protection against flooding (Section 5.4). The soil cover properties, thickness, and vegetative or rock protection will limit erosion by wind and water to a small fraction of the total cover thickness (Section 5.5).

After the tailings impoundment has been stabilized and the mill site is cleared, the reclamation of the property will be completed by final regrading and revegetation (Chapter 6.0). The site will be recontoured to leave smooth, free-draining surfaces. Revegetation will establish a plant cover of hardy native species.

The only significant non-radiological impact will be elevated levels of some constituents in the ground water. HMC has implemented and will continue to operate a ground water protection program, as described in Chapter 7.0. This program will continue, as presently planned, for up to 15 years after mill closure. The only major difference in the post-closure program will be the construction and use of an evaporation pond for collection well discharge.

Post-closure care and monitoring (Chapter 8.0) will provide continuing surveillance of the stabilized impoundment, as-needed repairs, and operation of the ground water protection system. The stabilization plan is designed to allow remedial care to be performed with minimal manpower and equipment.

The costs for tailings stabilization and site reclamation, described in detail in Chapter 9.0, are based on unit prices obtained from construction industry sources and on quantities derived from the conceptual design. These costs are subject to review annually and will be adjusted to reflect changes in design or in unit prices.

A concept schedule for stabilization and reclamation has been developed (Chapter 10.0). Part of this schedule, the completion of soil cover and subsequent stabilization tasks, is dependent on the rate of consolidation and dewatering of the tailings slimes. The rate of consolidation is impossible to predict with confidence, so some activities can be scheduled only in a relative sense.

2.0 HISTORY AND EXISTING AND FUTURE OPERATIONS

2.1 HISTORY

The Homestake Uranium Mill is located approximately 5.5 miles north of Milan, New Mexico in Section 26, Township 12 North, Range 10 West, in Cibola County. Homestake's Mine Ion Exchange (IX) plant is located in the southeastern part of McKinley County, New Mexico, in the Ambrosia Lake area (Figures 1 and 2). The IX plant is approximately 18 miles northwest of Grants, New Mexico in Section 25, Township 14 North, Range 10 West.

The HMC mill has been a major producer of uranium concentrate since 1958. Homestake's milling facilities were constructed and originally operated as two distinct partnerships, with Homestake Mining Company acting as the managing partner for both. The larger of the two mills was organized as Homestake-Sapin Partners, with a nominal milling capacity of 1,750 tpd. The smaller was organized as Homestake-New Mexico Partners, with a nominal capacity of 750 tpd. Both mills were designed to be alkaline leach-caustic precipitation mills. The combining of these two milling facilities resulted in a mill with a nominal throughput capacity of 3,400 tpd.

The Homestake-New Mexico Partners mill commenced operations in February 1958, while the Homestake-Sapin Partners mill started up in May 1958. Both mills operated independently, each with its own tailings pile, until November 9, 1961 when the partnerships were merged. Homestake-Sapin Partners was the surviving organization.

In January 1962, the former New Mexico Partners mill ceased operations as a complete and independent mill. The Sapin Partners mill continued to utilize a portion of the smaller mill's facilities. In April 1968, through a change in the distribution of ownership, Homestake-Sapin Partners became United Nuclear-Homestake Partners. In March 1981, Homestake then purchased United Nuclear Corporation's interest and the operation became Homestake Mining Company-Grants.

Two tailings impoundments were developed on HMC's property. In December 1956, the U.S. Atomic Energy Commission (AEC) and Homestake-New Mexico Partners signed a contract for the delivery of yellowcake to the federal government. A second contract was signed with the AEC in 1961 for the delivery of additional yellowcake. The first and smaller of the two impoundments resulted from these contracts with the federal government. The total quantity of tailings generated and impounded in this first impoundment was 1.22 million tons. It is located in the SW 1/4 of Section 26, Township 12 North, Range 10 West, N.M.P.M. Tailings material deposited within this impoundment was contained entirely by an embankment composed of natural, compacted soils. The embankment was compacted by heavy equipment and brought to a height of 20 to 25 feet. The crest was a minimum of 10 feet wide, with the base being approximately 40 feet thick. The impoundment covers an area of about 40 acres.

The tailings within this first impoundment are not comingled with any commercial materials. They were all generated under AEC contract. It is Homestake's contention that stabilization and reclamation of this tailings impoundment is the responsibility of the federal government and, as a

result, HMC has brought suit for a legal judgment in this matter (Homestake Mining Company of California, Inc. vs. United States, #580-84C, United States Claims Court). Consequently, Homestake has not addressed this first Homestake-New Mexico Partners tailings impoundment in this plan.

The larger of the two impoundments resulted from production under both federal government and commercial contracts. Homestake-Sapin Partners and the AEC entered into a contract to deliver yellowcake to the federal government in April, 1957. Two other contracts were signed with the AEC in 1960 and 1961. In addition, numerous contracts were placed with electric utilities for nuclear reactor fuel production. The total quantity of tailings generated under AEC contracts was approximately 10 to 11 million tons. In addition, another 10 to 11 million tons of commercial tailings were generated and comingled with the AEC tailings. This impoundment is located in the N 1/2 of Section 26, Township 12 North, Range 10 West, N.M.P.M. and is presently being utilized for tailings disposal at the Homestake mill.

Until 1966, Homestake deposited tailings material into only one cell of the impoundment. Subsequently, Homestake added an additional cell adjacent to and to the west of the existing cell. Since that time, tailings disposal has been alternating between the two cells (east vs. west) whenever necessary to maintain optimal operating conditions.

The starter dike for the larger impoundment was constructed from natural soils excavated within the immediate area. The dike was constructed in six-inch lifts and each lift was compacted by heavy equipment. The material was borrowed from within the tailings area. The dike was constructed to a

height of about 10 feet and a width of about 10 to 15 feet at the top and 25 to 30 feet at the bottom.

2.2 EXISTING OPERATIONS AT THE MILL

The mill employs the alkaline leach-caustic precipitation process for concentrating uranium oxide from ores that have historically averaged from 0.05 to 0.30 percent U_3O_8. The concentrate is a semirefined uranium compound known as yellowcake that averages 90 percent U_3O_8.

The mill has a nominal design throughput capacity of 3,400 tpd of ore. Currently (November 1986), due to contractual requirements, the milling rate has been reduced to approximately 3,500 tpm. In the event there is an increased demand for yellowcake, HMC may increase the throughput to the nominal capacity of 2,000 tpd averaged during each quarterly period for the next five-year time period. This production level is the maximum rate for licensing purposes over the next five years. Therefore, this plan assumes a 2,000 tpd production rate for design purposes.

Current tailings management at the mill site consists of disposal of the waste products from the milling operations in a rectangular impoundment located adjacent to the mill. The impoundment is divided into two cells designated the east and west ponds, contained and surrounded by an embankment (ring dike). The impoundment presently covers approximately 170 acres and is approximately 85 to 90 feet high. The east and west ponds cover approximately 55 acres and 40 acres, respectively, as measured from the crest centerline.

Except for a small clay starter dike around the east pond (now buried by tailings), the entire impoundment is constructed of hydraulically-placed tailings. The mill tailings are transported from the mill to the impoundment in slurry form. The tailings are composed of uranium-depleted fine and coarse sand fractions and slimes (minus No. 200 mesh sieve). The tailings are deposited above ground on the impoundment by means of wet cyclones which separate the material into coarse and fine splits. The coarse material is spigotted along the crest and downstream slope of the embankment of the impoundment, and the fine split is discharged into either the east or west pond. The cyclone travels along the crest of the embankment, building the embankment by the centerline method as it moves. The clarified liquid that is discharged into the ponds (east or west) is recycled through the decant towers back to the mill for reuse in the tailings slurry. At the current reduced milling rate, cyclone separation is not used and the slurry is discharged directly into the tailings pond. The present mode of operation confines disposal to a single pond at a time, with the other pond used for evaporation as needed. To date, the tailings impoundment currently in use has received about 21 million tons of tailings.

The placement and maintenance of tailings is performed in accordance with the Tailings Management Plan (D'Appolonia, 1982). This plan specifies practices which assure compliance with NRC Regulatory Guide 3.11 and 3.11.1, as well as New Mexico State Engineer requirements. At least 5 feet of freeboard and 50 feet of beach are maintained at all times. The piezometric levels and movement monitoring points of the embankment are surveyed on a regular basis. Stability analyses are routinely performed to ensure that

the static and pseudostatic factors of safety of the embankment are at least 1.5 and 1.0, respectively.

In addition to the mill site, HMC operates a small IX plant in the Ambrosia Lake area to recover water-solubilized uranium from the Applicant's mines. All of the IX tail water, without chemical additives, is recirculated back underground for recovery of additional uranium. Until February 1986, some water which was not recirculated was discharged to the Arroyo del Puerto after treatment with barium chloride for the removal of radium-226. A three-acre lined evaporation pond is currently being utilized for evaporating IX back-wash brine solutions.

2.3 PROPOSED CONTINUED OPERATION

HMC plans to continue use of the existing tailings impoundment for the next five-year period. The five-year buildout plan of the tailings impoundment is based on the following considerations:

- Maximum mill production rate for the next five years was estimated to be 2,000 tons of tailings solids per day.
- The structural embankment will be constructed of the coarse-split tailings, which constitute about 40 percent of the solids in the tailings slurry. Fine-split tailings will be placed in the ponds. Coarse split contains less than 10 percent fines, while fine split contains a large percentage of fine sand as well as slimes.
- The crest buildout, or structural embankment, must be sufficient to maintain five feet of freeboard and a 50-foot beach.
- At the present and anticipated rate of production, the required safety factors will be maintained by this disposal method.

Construction of the five-year buildout will be accomplished by centerline method, using the same placement procedures currently in use. The cyclone will travel along the crest, spreading the coarse split ahead and downslope to build the crest and outer slope of the embankment, and discharging the fine split toward the pond across the beach. As the slimes settle out, the clarified liquid is decanted from the center of the pond and is recycled back to the mill for use as process water. The structure will contain all fine tailings and liquid that are discharged into the ponds. At 2,000 tpd, the tailings impoundment would increase in height by about 13 and 5 feet in the east and west ponds, respectively. This increase would be nearly uniform across the slope, crest, beach and pond along any section of the impoundment, enlarging the surface area of the impoundment to about 179 acres.

The tailings impoundment configuration at the end of the five-year period of 2,000 tpd production is illustrated in Figure 3.

3.0 MILL DECOMMISSIONING AND DECONTAMINATION

3.1 MILL DECOMMISSIONING

At closure, HMC will decommission the mill buildings and equipment. HMC does not intend to decontaminate any buildings or material that are contained within the facilities area for salvage purposes. The mill and equipment are considered to be too old to have any reasonable salvage value. All material contained within the facilities area will be torn down and placed at the southeast toe of the tailings impoundment, as shown in Figure 4, and covered with site cleanup soils, as discussed below. Decommissioning will be a phased process rather than a single-step event. For example, conventional ore-processing equipment might be decommissioned before solution extraction circuits. The HMC mill, shown in plan in Figure 4, contains the following processing and miscellaneous structures that will be removed:

- Ore receiving section with receiving scale
- Crushing and sampling section, to include grizzly, impact breaker, rotary dryer and reciprocating sampler
- Fine ore storage section with four ore storage bins and one transfer bin
- Grinding section with ball mill and thickener tanks
- Uranium leaching section with leaching autoclaves, leaching pachuca tanks, solution storage tanks and tailings ion exchange facility
- Precipitation section with pregnant solution tank, precipitation and precipitate thickener tanks
- Vanadium removal section and associated roasting furnace
- Package, storage and shipping section with yellowcake drying, packaging, and drum storage and loadout

- Miscellaneous structures, to include administrative building, shop, laboratory, change house, etc.

All tanks will be removed or cut into pieces and placed in the toe area of the stabilized tailings impoundment. The tanks will be filled with tailings sands or soil material after placement so that void areas will not occur when the final cover material is placed on the tailings impoundment. Building materials, beams, foundations and other flat material will be stacked around or on the tanks. Asphalt from the parking area will be removed and placed in the disposal pile.

Foundations will be removed and the contaminated foundation material will be placed in the same area as mill buildings and equipment. Concrete material will be tested to determine if it can be cleaned for use as riprap in the redesigned drainage channel or for the flood protection of the toe of the impoundment. If it is determined that this material cannot be utilized as riprap, it will be disposed in the same location as the rest of the mill's building materials.

The mill IX plant will continue to operate until ground water restoration is complete, after which it will be demolished and buried in the impoundment toe or the reclaimed evaporation pond.

The demolished mill, placed at the southeastern toe of the tailings impoundment, will be completely covered by contaminated soils excavated from mill and other site areas found to have Ra-226 levels exceeding Criterion 6 limits of 10 CFR 40, Appendix A. Cleanup of contaminated soils and

protected disposal of these materials are discussed in the following sections.

The mine IX plant will continue to operate for an indefinite period. Subsequently, the plant might be sold if not excessively contaminated with radioactive materials. Otherwise, it will be demolished and buried in the tailings impoundment disposal area, or in the reclaimed evaporation pond at the mine.

3.2 FACILITIES SITE CLEANUP

After completion of demolition and removal of all mill buildings and material, the facilities area soil that has been determined to exceed the Ra-226 limits of Criterion 6 will be removed. The facilities area comprises 49 acres and for purposes of cost estimating, it is assumed that approximately one foot of soil material will have to be removed from these 49 acres to meet unrestricted area criteria. Approximately 79,000 cubic yards of contaminated soil material would be removed. On completion of contaminated soil removal, the mill area will be regraded to blend into the contours of the entire reclaimed property. The contaminated soil material will be utilized to fill in and around the mill demolition debris.

3.3 OTHER CONTAMINATED SOIL CLEANUP

HMC conducted a gamma survey to determine areas that may contain elevated concentrations of Ra-226 due to windblown tailings. Site-specific correlations with gamma readings and actual Ra-226 content of the soil were not made, but for this conceptual plan it was assumed that gamma readings above

25 μR/hr correlate with excessive soil radium levels. Excessive levels are concentrations of more than 5 pCi/g radium above background in the upper 15 cm of soil, and more than 15 pCi/g in successively lower 15 cm intervals (Criterion 6, 10 CFR 40, Appendix A). Figure 5 shows the area where HMC gamma readings indicate excessive levels of radium in soil due to windblown tailings. HMC intends to perform an additional gamma survey with Ra-226 correlations to define areas of soil material that have elevated levels of Ra-226 above background. For costing purposes, the area defined in Figure 5, containing 644 acres excluding the tailings impoundments, will require cleanup. Because the windblown tailings are distributed as a thin veneer, it is estimated that only about six inches of soil will require removal. A total of 520,000 cubic yards will be removed and used to cover mill demolition debris and the impoundment toe. Its estimated cost is included in the long-term stabilization costs, addressed in Chapter 9. The soil cleaned up during operations will be placed at or near the impoundment toe, close to its final disposal location.

4.0 RADIOLOGICAL SURVEY

Radiological surveys will be performed in compliance with NRC regulations. The first survey will be conducted prior to closure to delineate the areas in which radium levels exceed allowable limits. Soil in these areas will be removed and disposed as described in Section 3.3. A post-closure radiological survey will be conducted to determine the area around the mill that still has excessive residual radioactive contamination. The radiological survey will be conducted to delineate those areas that exceed the radium concentration limits for the unrestricted environment established by NRC's 10 CFR 40, Appendix A, Criterion 6. The survey will determine the areal extent and depth of soils that contain Ra-226 concentrations above 5 pCi/g average in the first 15 cm of soil and 15 pCi/g in any 15 cm layer of soil below the first 15 cm above established background levels in the proximity of the HMC operations.

4.1 MILL AREA

The radiological survey in the mill area will be conducted using a hand-carried gamma μR/hr meter, or equivalent type of equipment. Approximately 49 acres are contained within the facilities area. Gamma measurements will be made at approximate 10-meter intervals on a rectangular grid within the facilities area. The gamma exposure rates will be correlated with Ra-226 concentrations taken from selected boreholes. Additional soil samples will be taken where the gamma exposure rates exceed the allowable μR/hr-above-background readings, indicating Ra-226 concentrations that exceed Criterion 6 limits.

In addition to the surface gamma survey within the facilities area, where radium concentrations exceed Criterion 6, selected boreholes will be drilled to collect soil samples at 15 cm intervals for analysis of Ra-226 concentrations. Sampling depths will be limited to those in which gamma correlations indicate excessive radium levels. Gamma exposure rates will be measured at 15 cm intervals within the boreholes to assist in determining below-surface concentrations of Ra-226.

Upon completion of the radiological survey within the facilities area, the locations and depths of contaminated soils will be delineated. Residual contaminated soil material will be removed and disposed, allowing the contaminated locations to be upgraded from restricted to unrestricted area classification.

4.2 MINE IX PLANT

A post-closure radiological survey will be conducted in the mine IX plant vicinity. This survey will be conducted in the same manner as that for the facilities area. It is estimated that approximately five acres will need to be surveyed.

4.3 TAILINGS IMPOUNDMENT VICINITY SURVEY

The radiological survey in the vicinity of the tailings impoundment will be directed towards identification of areas that were affected by additional windblown tailings that have accumulated since cleanup during operations. The initial survey will be made using a hand-carried gamma μR/hr meter or meter of equivalent type. A radial grid system will be developed emanating from the center of the tailings disposal area in eight compass directions.

Gamma readings will be taken at 50-meter intervals in each compass direction. Measurements will be taken until consecutive readings indicate exposure rates less than correlated readings associated with Ra-226 concentrations in surface soils greater than 5 pCi/g above background.

Areas containing excessive levels of Ra-226 will be delineated. Within these areas, a rectangular grid system will be used for gamma measurements taken at 50-meter intervals and soil samples collected to a depth of 30 cm at selected locations for analysis of Ra-226. Correlations will be made between radium content and gamma exposure rates. Upon completion of the survey, the volume of soil material that must be removed will be calculated.

4.4 CURRENT RADIOLOGICAL CONTAMINATION ESTIMATES

HMC conducted a gamma survey in 1980 to obtain information on potential areas that may contain elevated levels of radium from windblown tailings. For this reclamation plan and until a new radiological survey is conducted, HMC is using this initial survey to outline the areas where potential excessive radium concentrations may be present. The area is shown in Figure 5 and contains 644 acres (excluding tailings impoundments). For costing it is estimated, due to the nature of windblown tailings, that six inches (15 cm) of soil will have to be removed from this area. Removal of a one-foot layer over the 49 acres within the facilities area will be assumed for costing purposes. Cost estimates for soil removal are contained in Chapter 9 of this plan.

5.0 LONG-TERM STABILIZATION

5.1 GENERAL APPROACH AND RATIONALE

HMC's long-term stabilization plan has been developed to both account for and take advantage of the unique characteristics of the Grants facility, especially the tailings impoundment. The HMC impoundment is enclosed by a full-perimeter embankment constructed of tailings sands. As a result, the amount of outer slope is proportionately much greater than in the typical impoundment with a cross-valley dam. In addition, the latter has to take into account the flood flows from the upstream catchment area; the HMC impoundment has no upstream catchment, but is located within a significant watershed.

These characteristics of the HMC impoundment mean that a large volume of tailings must be relocated to achieve the required maximum slope gradients. The stabilization plan has been designed to use these relocated tailings to promote consolidation of slimes and to suppress radon emanation from the slimes. Lacking any flow-through runoff from upstream catchment, the drainage measures for the top and sides of the impoundment can be relatively modest, accounting only for runoff from direct precipitation. However, the toe of the impoundment must be protected from the San Mateo Creek Probable Maximum Flood (PMF), which would pass directly along the north and west sides of the impoundment.

The foregoing considerations have guided the general approach and underlie the rationale for the stabilization plan. Of course, the fundamental requirements for the plan are those contained in the criteria of Appendix A,

10 CFR 40. While satisfying these regulatory requirements, HMC has sought also to achieve maximum cost effectiveness by realizing multiple benefits from stabilization measures. For example, to satisfy the regulatory requirement for maximum slope gradients of 5:1 (horizontal:vertical), a large volume of sand tailings on the outer embankment slopes must be moved. These tailings will be moved inward across the pond to surcharge the slimes (to accelerate consolidation) and to suppress radon emissions from the slimes, achieving three objectives with one measure. Similarly, the borrow pit for cover soil will be developed in the same location as the channelization and diversion of San Mateo Creek, part of the flood protection measures. The borrow pit will be excavated and reclaimed to leave a broad, shallow water course for control of flood flows. These and other multiple-benefit measures are characteristic of the stabilization plan described in the following sections.

5.2 INTERIM STABILIZATION DURING CLOSURE

After cessation of mill operations and before final stabilization is completed, interim stabilization measures will be used to minimize the erosion of tailings. These measures will provide a transition from interim stabilization during operations (described in a separate submittal) to long-term post-closure stabilization and will include some measures from both programs.

Homestake has found that the tailings that escape from the impoundment as airborne particulates are primarily fines (minus #200 mesh sieve). The principal source of these fines is the beach area around the ponds. Coarser fractions (sands) also become airborne in high winds but stay within a few

feet of ground surface and are redeposited on or close to the impoundment. Wind erosion has the potential for moving tailings more frequently, for longer periods, and consequently in larger volumes than water erosion. The effects of the latter are restricted to the impoundment toe areas. Consequently, the primary objective of interim stabilization during closure is to control wind erosion.

The interim stabilization measures include water spraying, covering of beach areas with sand tailings, and use of snow fences. Pond water (as well as collection well water) will be run through the IX plant to remove recoverable uranium, then returned through a system of movable pipes to impulse sprinklers located on the embankment. The locations of spraying will change as stabilization progresses, but initially water will be sprayed on exposed beaches and sand tailings surfaces not being actively excavated or filled. Spraying will maintain a moist surface that will inhibit wind erosion due to surface tension in the interstitial water. Spraying will also accelerate evaporation of pond water; in fact, the sprinkler system might be started at some time (to be determined) before cessation of mill operations to shorten the post-operational pond dewatering period. Unlike cross-valley impoundments, in which a large portion of the non-evaporated spray water returns to the pond, the infiltrating spray should seep downward and outward away from the ponds. Consequently, dewatering should be relatively rapid. Should additional evaporative capacity be desired or should the process of impoundment regrading overtake dewatering, the pond water will be diverted to the evaporation pond, described in Section 7.4 of this plan.

The period of time during which beaches will be sprayed will be brief because one of the first steps in long-term stabilization will be inward movement of sand tailings from the impoundment crest across the beach. Once covered, the fines on the beach will not again be exposed to wind. As necessary, the sand tailings fill will be sprayed, both for moisture conditioning to enhance compaction and to suppress wind erosion.

Sand tailings surfaces will be stabilized during closure with snow fences until they are covered with compacted soil. Snow fences have been very effective in controlling wind erosion of sand tailings in their extensive use at the Grants facility. They act as obstacles both to break up and reduce ground velocities of wind and to provide wind shadows in which saltating and suspended sands are deposited to form ridges. These ridges then further disrupt surface winds and promote deposition.

The snow fences provide much-needed versatility in interim stabilization. They can be moved around to stay ahead of or follow behind earthmoving equipment. The density, orientation, and pattern of fence placement can be adjusted to the level of protection required at each location.

Use of an interim soil cover is not appropriate for HMC's impoundment. The entire impoundment surface will be altered by excavation and fill; no surfaces developed during impoundment buildout and operations will remain after closure. Therefore, any soil cover placed for interim stabilization would have to be excavated or covered by tailings during regrading to final contours. In addition, any soil cover placed prior to cessation of tailings deposition, during operation, would be covered by tailings added later as

the impoundment is built out by centerline construction. Any soil cover placed at the toe during the operational phase of the impoundment would interrupt the drainage system designed to carry controlled toe seepage and water collected from the pump-back system for recycling back into the milling process. Finally, the outer slopes of the impoundment will be too steep for cover placement until they are cut back to 20% grade, at which time the final stabilization soil cover will be placed, as explained in Section 5.3.

5.3 RECONTOURING AND COVER OF IMPOUNDMENT

5.3.1 Impoundment at End of Operations

This stabilization plan is based on the impoundment configuration expected after five years of buildout at a milling rate of 2,000 tpd. At the time of this submittal, the impoundment contained approximately 21 million tons of tailings solids. The 2,000 tpd production would add an additional 3,650,000 tons of tailings over the next five years. HMC expects that 75% of these tailings will be placed in the east pond, 25% in the west. This distribution will result in about 13 feet and 5 feet of additional impoundment surface height in the east and west cells, respectively, assuming uniform distribution of tailings over those surface areas. The crest elevations of the two parts of the impoundment would differ by an average of 20 feet. The configuration at the end of operations in five years is illustrated in Figure 3.

5.3.2 Radon Emanation

Criterion 6 of Appendix A, 10 CFR 40 requires that a soil cover be used to limit radon release rates to not more than 20 pCi/m^2s. Conservative relationships between radium content and radon flux from tailings, contained in

the GEIS (NRC, 1980), indicate that radon exhalation from uncovered slimes and sands would be 1000 and 100 pCi/m^2s, respectively, assuming radium concentrations of 1000 and 100 pCi/g, respectively. These radium concentrations are conservatively high compared to the values determined from measurements at the HMC impoundment by others (EPA, 1986).

HMC recognized that the excavation required to reduce outer slopes to 5:1 (H:V) could generate a large quantity (up to 3.4 million cubic yards) of sand tailings. Consequently, HMC superimposed various depths of sand tailings on the slimes in successive RAECOM runs to see how effective the sand tailings could be in suppressing radon emissions. Using a density of 104 pcf and moisture content of 11% for the compacted sand tailings fill, the modeling showed that 8-9 feet of sand tailings would reduce radon flux from the slimes to the allowable limit of 20 pCi/m^2s, and 15 feet of this fill would reduce the radon flux from the slimes to 10 pCi/m^2s. RAECOM modeling indicated that the required flux limit from tailings sands over slimes could be achieved with 10 feet of sand tailings fill covered by less than one foot of sandy clay soil, as described in Section 5.3.4, compacted to 90% density, with 37% porosity and an average 12-14% moisture content. The required flux limit from the tailings sands alone can be achieved by less than one foot of this soil cover. However, as discussed in Section 5.3.4, a 2.0 foot cover is planned. This soil is available in the on-site borrow pit described below. The radon emanation modeling is described in more detail in Appendix A.

5.3.3 Recontouring

Criterion 4 of Appendix A, 10 CFR 40, limits final impoundment slopes to 5:1 (H:V). Slopes flatter than 5:1 would require extensive excavation and relocation of large volumes of tailings slimes, as well as outward extension of the impoundment. The outer slopes of the impoundment at the end of operations will range from about 2.5:1 to 3:1 (see Figure 3). Consequently, for final stabilization all slopes will be recontoured to comply with regulatory limits.

If the outer slopes are reduced to 5:1 along the cut line rising from the existing toe, a very large quantity of sand tailings, about 3.4 million cubic yards, would have to be excavated. Distributed across the top of the embankment as fill, additional thicknesses of up to 35 feet and 29 feet would be added to the east and west ponds, respectively. These thicknesses far exceed those useful in suppressing radon emissions (up to 15 feet) from the underlying slimes. Therefore, an alternative recontour surface, defining a 5:1 gradient cutting through the embankment slopes at a higher level, was selected to balance the volume of tailings excavation with the useful volume of tailings fill. This cut slope would start about one-third the slope distance from the toe.

A separate but significant source of contaminated material must also be disposed and stabilized. This material is the soil around the site containing radium levels exceeding the 5 pCi/g to 15 pCi/g limits of 10 CFR 40, Appendix A, Criterion 6, which requires that this soil be covered or otherwise protected to control release of its radiological hazards for 1,000 years, the same protection as that required for the tailings. Rather than cover

the contaminated soils in place, HMC will excavate them and include some or all of them with the tailings for impoundment stabilization. The most efficient means of handling these soils is to use them as fill material at the toe of the impoundment to form a 5:1 fill slope downhill from the 5:1 cut slope in the tailings.

The design selected for recontouring the impoundment combines the toe fill of contaminated soil with the elevated cut slope in the tailings embankment. This design will generate enough excavated sand tailings to make a fill at least 15 feet thick across the pond areas. The sand tailings in the divider dike between the ponds and in the decant tower access ramp in each pond will provide an extra quantity of material needed for compensting for settlement and for grading shallow slopes across the pond fills.

The configuration of the impoundment, recontoured for long-term stabilization, is shown in Figures 6 and 7. All outer slopes will be reduced to 20% (5:1) grade. The lowest portion of the outer slope, about 150 feet wide, will be the contaminated soil fill. This toe will be enlarged and flattened at the southeast corner of the impoundment to provide for burial of the demolished mill (see Chapter 3). The toe fill gradient may be flattened elsewhere as well to accommodate more contaminated soil, if required. The cut slope above the fill will extend up through the former beach, above which the 5:1 slope will be continued in sand tailings fill to the relatively flat tops of these fills above each pond. (On Figure 7, the cross sectional areas of fill in the ponds appear to be much larger than the cut areas in the cross sections. However, the cut areas enclose the entire impoundment, so that when these cross sectional areas are multiplied by the

length of cut, the cut and fill volumes are found to be equal.) The fill in the east pond will be separated from the west pond fill by a 5:1 slope 100 feet long, cut through the divider dike. This cut slope will connect the west pond fill surface, elevations 6670 to 6676, with the east pond fill surface where final elevations will be 6690 to about 6696. Each pond area will be contoured to provide positive, controlled drainage across slopes of 200:1 to 250:1 toward a central swale. The swale in each pond area will channel runoff toward the south and down the outer slope to a diversion ditch leading to San Mateo Creek (Figure 6).

The earthwork for recontouring slopes will probably start at one corner and proceed around the impoundment. Toe fill placement will precede slope excavation, which will be followed by soil cover placement. Filling of pond areas will be initiated by moving the crests inward by dozer. As dewatering and consolidation of slimes permit, coarse tailings will be advanced by dozer and scraper across the pond.

The processes of fill placement and consolidation in the pond could be accelerated by using the pneumatic stowage method. This method uses a high volume, low pressure air pumping system into which solids are fed. Transported by air pressure through pipe to a nozzle, the solids can be blown into place at locations not accessible to men or equipment. If initiated against a firm surface, pneumatic fills can achieve densities of better than 70% Standard Proctor (Maksimovic and Draper, 1982). This method could permit placement of several feet of tailings sands across the ponds early in the reclamation program, accelerating consolidation and providing a stable working surface for heavy equipment. HMC is seriously considering pneumatic

stowage, but for cost estimating purposes the more expensive conventional methods are assumed.

5.3.4 Soil Cover

To comply with the requirements of 10 CFR 40, Appendix A, Criterion 6, HMC will construct a soil cover sufficient to keep radon release rates to acceptable limits and otherwise prevent release of radiological hazards for a period of 1,000 years. The soil will be excavated from a borrow pit located on HMC property northwest and west of the impoundment (Figure 8).

HMC has conducted field and laboratory investigations of the borrow soils. These soils are alluvial sands and clays located in the area shown in Figure 8. At least two distinct clay soils have been identified in the borrow area. These clays are generally medium to low plasticity with lenses of highly plastic clay. The clays range from less than 2 feet to about 10 feet thick and occur within 15 feet of ground surface. The results of field and laboratory studies on these soils are contained in Appendix B. In the area in and adjacent to the borrow pit, as delineated in Figure 8, the volume of available clay is estimated to be about 580,000 cubic yards. Sand soils are at least double the clay volume. Although clays and sands can be excavated separately, HMC intends to excavate both soils and mix them to form a sandy clay to clayey sand soil (USCS classification of SC) which will have good workability and moisture retention characteristics. Laboratory tests show that this mixed soil can be expected to have a maximum dry density of about 115 pcf with 12-14% moisture content. Natural moisture contents of up to 8% in sands and 8-16% in clays indicate that a long-term retained moisture content of about 12% is reasonable. These soil properties

were used as input in RAECOM computer modeling of radon release from the cover impoundment. With 10 to 15 feet of sand tailings covering the slimes, less than one foot of soil, compacted to 90% Standard Proctor density (104 pcf) with about 37% porosity and at least 12% moisture, will satisfy NRC radon release rate limits.

To satisfy regulatory requirements that this soil cover thickness be maintained for 1,000 years, some extra soil thickness is needed to compensate for loss by erosion. Despite rock cover protection on the 5:1 slopes, some soil loss is assumed to occur. Prediction of soil loss by water erosion was made by the Universal Soil Loss Equation (USDA, 1978). This soil loss analysis is included in Appendix C of this plan. The calculated 1,000-year soil losses due to water erosion from top and side slopes are 1.1 inch and 0.7 inch, respectively. Wind erosion soil losses, calculated in accordance with USDA, 1980, are predicted to be 2.1 inches in 1,000 years from the top of the impoundment, where the surface will be revegetated rather than rock-covered. Therefore, the total cover thickness required for protection against radon emanation and erosion is less than 1.5 feet. However, for conceptual design and cost estimating purposes, HMC has selected 2.0 feet of soil cover. This greater-than-required thickness provides extra conservatism and also recognizes the practical constraints of large-scale earthwork; it is not feasible to control the depth and properties of a soil cover thinner than about 1.0 to 1.5 feet.

To construct a soil cover of 2.0 feet over the entire impoundment, a total of about 600,000 cubic yards is required. The borrow pit has been designed to yield enough soil for the impoundment cover, as well as extra for

stripping/grubbing losses and for fill to restore ground surface, to recontour around the mill, and to cover the evaporation pond if soils at that location are not suitable for cover.

The resultant volume of about 800,000 cubic yards will be obtained from the borrow area, illustrated in Figure 8. The borrow area can be enlarged to provide more soil if required. The borrow pit will have an initial upstream face slope of 100:1 and will be reclaimed after impoundment stabilization by grading side slopes to 50:1, followed by revegetation. The floor of the pit will be graded smooth and, because it will already slope downstream at a gradient of less than 1000:1, only revegetation will be required to stabilize the soil. As part of the site recontouring, the San Mateo Creek channel will be diverted through the reclaimed pit, which will subsequently divert all but the most extreme floods away from the impoundment. This recontouring and channelization is illustrated in Figure 9.

The soils will be excavated, hauled, and placed by standard earthwork equipment and methods. The pit will be stripped of vegetation and organic debris, which will be stockpiled for later use in reclamation or burned. Dozers and graders will make initial cuts to delineate clay lenses and sand zones. Scrapers will excavate and haul the soils to the impoundment (average of 0.8 miles one way), where graders will mix soil as necessary. The clay/sand mixtures will be moisture conditioned to wet-of-optimum (usually 14% or higher) and compacted by sheepsfoot rollers to 90% of maximum density.

5.3.5 Rock Cover

In conformance with the requirements of 10 CFR 40, Appendix A, Criterion 4, all relatively steep slopes will be protected against erosion by a cover of broken rock. In this plan, all 5:1 slopes will be covered. In addition, rock will be used at other selected locations to control channel erosion or to armor the toe of the impoundment slopes against Probable Maximum Flood (PMF) erosion. Surfaces flatter than 50:1 will be revegetated. The exception to this will be the drainage swales on the pond covers which, although sloped at about 200:1 (H:V), will be armored with graded rock cover up to one foot thick. Locations of rock cover are shown in Figures 6 and 7.

The rock for this cover is the Todilto Limestone, a Jurassic age formation which outcrops at several locations near the Grants mill (D'Appolonia, 1982, Appendix B). The most likely source is located on private land north of the mill at a haul distance of 7.5 miles one way. Alternate sources of this limestone and of malpais lava might also be considered.

Several rock samples were tested for sodium sulfate soundness, specific gravity, and absorption. The test results, attached to Appendix B of this plan, show that sample Nos. 1, 2, and 5 (all Todilto Limestone) meet the acceptability standards described in Nelson et al., 1986, Table 6.2.

The rock cover will be a minimum of six inches thick, consisting of broken rock up to six inch size. The rock will be quarried by drill-and-blast methods, crushed and screened as necessary, loaded onto bottom-dump trucks, and hauled directly to the placement location. The rock will be spread in a

manner that allows the finer fractions to work to the bottom of the rock layer and form a filter zone in contact with the soil.

5.4 FLOOD PROTECTION

As part of the requirement to provide "reasonable assurance" of control of radiological hazards for 1,000 years (Criterion 4, Appendix A of 10 CFR 40), HMC will protect the stabilized impoundment against disruption by floods. Although no specific recurrence interval or design flood discharge is stated in the regulations, HMC will design against the Probable Maximum Flood (PMF) event.

5.4.1 Hydrologic Setting

The HMC uranium mill site is located east of the Continental Divide in the Rio Grande Drainage System of west-central New Mexico. The mill site is in the San Mateo drainage. North of the mill, the San Mateo is an ephemeral stream and flows only in direct response to large precipitation or snow melt events. There is no distinct channel near the mill, although there may have been one in formerly more pluvial times. A very large precipitation event could result in flow from the San Mateo drainage entering the Rio San Jose drainage. The Rio San Jose is itself ephemeral and flows only in direct response to local rain storms or snow melt. The Rio San Jose discharges to the Rio Puerco, which is a tributary of the Rio Grande.

The U.S. Geological Survey (USGS) has maintained stream flow measurement gages on several streams in this region. From the USGS records it is evident that most flow in this region is ephemeral or intermittent (D'Appolonia, 1982). No definite relationship between the size of the

drainage basins and the mean flow or the maximum recorded flow is evident. Variations in watershed characteristics such as vegetation, slope, soil, channel material and differences in water use apparently are great enough that they cancel or overpower a simple relationship between basin size and flow. These differences indicate that it is difficult to predict flow regimes using regional characteristics and that each watershed must be investigated separately.

The climatic characteristics of the area affect the hydrology of the region in many ways. The low annual precipitation, most of which occurs during brief, intense storms, supports only ephemeral stream flow. Even those drainages in higher elevations with increased precipitation and spring snowmelt are predominantly ephemeral since much of the flow is lost to the alluvium. Flows occur primarily as a result of the fairly common summer thunderstorms. These intense storms cause local flash flooding and erosion. The low precipitation and the high evaporation cause vegetation in some places to be sparse with large amounts of open ground between shrubs or forbs. The open ground, where present, contributes to surface runoff and sheet erosion during the thunderstorms.

The San Mateo drainage basin above the HMC mill site has a drainage area of approximately 291 square miles (Figure 10). Its shape is roughly circular and contains a dendritic (tree-branch style) drainage pattern. Maximum relief is 4,725 feet, with elevations ranging from 6,575 feet at the outlet to 11,300 feet at Mount Taylor, as illustrated in Figure 11.

Channel slopes in the basin range from nearly zero in the valley floor near the site to almost 50 percent at the higher peaks. The slopes on the flanks of the mesas and volcanic cones can vary from 5 to over 100 percent. The steeply sloping upper reaches of the drainage and its tributaries are commonly incised from 10 to 30 feet into the valley alluvium. Where slopes are low, such as near the mill site, flow follows shallow, poorly-defined, braided channels.

5.4.2 PMP and PMF

The peak discharge, velocity, and elevations of the flood produced by a Probable Maximum Precipitation (PMP) event in the San Mateo Creek watershed were determined for that portion of the San Mateo Creek adjacent to HMC's mill and tailings impoundment. This determination required three steps:

- Estimation of the PMP
- Generation of the PMP runoff hydrograph
- Flood routing

Previous surface hydrologic analyses were used as much as possible in these activities, described in detail in the following sections.

PMP Estimation - Hydrometeorological Report No. 55 (Miller et al., 1984) was used to estimate both general (frontal) storm and local (thunderstorm) storm PMP amounts for the San Mateo Creek watershed. Table 1 lists the results of these estimates. The general storm produces larger PMP amounts for the longer (greater than six hour) events.

Runoff Hydrograph - The runoff hydrographs derived from the 6.0 and 24 hour PMP events were estimated with the use of a computerized version of the U.S.

Soil Conservation Service's (SCS) synthetic triangular hydrograph method. This method uses basin soil and vegetative cover characteristics to derive a curve number (CN) that represents the basin's runoff-producing potential. Parameters of basin geometry, such as maximum relief and longest drainage path, are used to calculate a synthetic triangular hydrograph. The computer program distributes precipitation over time according to the graph shown in Figure 21-2 of the U.S. SCS National Engineering Handbook, Section 4, Hydrology (U.S. SCS, 1972). This precipitation distribution is then applied to the synthetic hydrograph to calculate the runoff hydrograph.

Input values for this method, described in the 1982 Environmental Report, include the basin area of 291 square miles, maximum relief of 4,725 feet, longest drainage path of 26.0 miles, and a CN of 70. The 6.0 hour PMP amount of 8.6 inches and the 24 hour PMP amount of 12.2 inches were used in the runoff hydrograph generation.

The results of the hydrograph generation are shown in Table 1. The 6.0 hour PMP produced a peak discharge of 180,250 cubic feet per second (cfs), and the 24 hour PMP produced a peak discharge of 169,800 cfs. The larger peak discharge was used in the flood routing.

Flood Routing - The U.S. Army Corps of Engineers water surface profile computer program, HEC-2, was used to calculate the surface width, elevation and flow velocities of the Probable Maximum Flood (PMF) near the mill site. The HEC-2 program solves backwater curves for both subcritical and supercritical flows. Input requirements include digitized channel and overbank area cross sections, channel and overbank area roughness coefficients, distances

between cross sections, and the stream flow (Hydrologic Engineering Center, 1976). Figure 12 shows the area of the San Mateo floodplain around the HMC mill site. In general, the floodplain is a complex area of berms, abandoned ditches, closed drainage areas and natural flow braids. However, recontouring of the site, especially the borrow area and the vicinity of the impoundment, will remove most irregularities and leave deeper, more uniform flow channels. Expected conditions were represented in the flood routing (HEC-2) model by five cross sections, as shown in Figure 12. Sections A-A', B-B', and C-C' were developed from the expected surfaces after recontouring, shown in Figure 9. Cross sections D-D' and E-E' in Figure 12 depict surfaces upstream of the recontoured area that will have little change. These latter sections were surveyed in October of 1980 and in November of 1981.

The resistance to flow of water provided by channel materials, vegetation, bends and meanders, and channel bottom configuration is characterized by the Manning coefficient "n". An "n" value of 0.05 was chosen for both the overbank and channel areas of cross sections D-D' and E-E' because the channels are quite small compared to, and nearly indiscernible from, the overbank areas. The forbs and shrubs of the overbank areas provide the most resistance to flow. The channel within the soil borrow area was assigned an "n" value of 0.035 because it will be relatively smooth.

The PMF of 180,250 cfs, resulting from the 6.0 hour PMP event, was used in the HEC-2 program to route the flood past the Homestake property. Figure 12 shows the PMF floodplain boundary at the site as calculated by the HEC-2 program. The maximum flow velocity would reach 5.7 feet per second (fps) and the elevation of the water in the overbank areas near the tailings

impoundment could reach 6,592 feet. The flood water elevations are shown in Figure 12 for each of the five sections analyzed. These elevations are high enough to submerge the toe of the impoundment by up to about 10 feet. Therefore, flood protection of the stabilized impoundment is required and will be achieved by placing oversized quarry rock (riprap) of one to two feet diameter along that portion of the toe of the impoundment that will be below PMP peak elevations and adjacent to high velocity flows (not in slack water).

5.4.3 Protection Measures

The crest elevation of the PMF at the tailings impoundment will exceed the elevation of the recontoured, revegetated ground surface around the toe of the impoundment and in some of the reclaimed area of the mill. Consequently, these areas would be inundated during a PMF. Those portions of the embankment toe which might be subject to erosive flow velocities, the north and west sides, will be armored with large rock (riprap) of about 12-24 inches.

In addition to these protective measures, flood flows will be substantially diverted away from the impoundment by the rechannelization of San Mateo Creek through the reclaimed borrow pit. The borrow pit for soil cover materials, described previously in Section 5.3.4, will be initially located and excavated, and later reclaimed, to provide a controlled connection between the ill-defined creek channel north of the impoundment and the broad floodplain to the southwest. The borrow pit will be 600-1300 feet wide and up to eight feet deep. The deeper, wider portion to the north will divert flow away from the impoundment and direct it southwestward. The pit floor will

slope to the southwest and merge with natural ground surface west of the impoundment. This diversion channel should force the higher velocities and most of the discharge volume away from the impoundment, leaving most of the toe areas in relatively slack water conditions.

PMF flood waters will be prevented from flowing around the east and south sides of the impoundment by placing an earthfill levee from the northeast corner of the impoundment to the highway right-of-way to the east. The levee will be constructed of soil excavated from the diversion ditch south of the impoundment and from local soil grading. The levee will keep the east and south impoundment toes in slack water during a PMF.

The toe protection measures and diversion channelization are illustrated in Figures 7 and 9, respectively.

5.5 WATER AND WIND EROSION

5.5.1 Water-Induced Erosion

The water-induced erosion that would occur at the reclaimed tailings impoundment was calculated using the Universal Soil Loss Equation (USLE) (USDA, 1978) for three distinct areas of the tailings impoundment. These areas include:

- Top of the impoundment, with slopes of 200-250:1 (H:V), an average slope length of 1000 feet, and 2.0 feet of cover material.
- East area of impoundment slope, with slopes of 5:1 (H:V), average slope length of 580 feet. Slopes will be covered with 2.0 feet of soil and six inches of rock material.

- West area of impoundment slope, with slopes of 5:1 (H:V), average slope length of 480 feet, 2.0 feet of soil cover and six inches of rock cover.

The soil loss equation is:

$$A = R\ k\ LS\ C\ P$$

where

A = the computed soil loss per unit area, expressed for the units selected for k and the period selected for R. These units selected compute A in tons per acre per year.

R = the rainfall and runoff factor. R = 20

k = the soil erodability factor. This is the soil loss rate per erosion index unit for a specific soil as measured on a unit plot. k = 0.34

L, S = the slope-length factor and slope steepness.

- Impoundment top with average slope length of 1000 feet and 200:1 (H:V) slopes (0.5%); LS factor = 0.152.
- East slope area with 5:1 (H:V) slope (20%) and average slope length of 580 feet; LS factor = 9.82.
- West slope area with 5:1 (H:V) slope (20%) and average slope length of 480 feet; LS factor = 8.93.

C = the cover and management factor. The cover factor for the three areas is as follows:

- Impoundment top with vegetation cover. C = 0.20
- East and West slope areas will be covered with six inches of durable rock cover. C = 0.002

P = Support practice factor. P = 1.0

Calculations for the three areas to determine the tons per acre per year and inches per year of soil loss are contained in Appendix C. For the three areas, the following soil loss can be expected:

- Impoundment top: 0.2067 tons/acre/year
- East pond slope: 0.134 tons/acre/year
- West pond slope: 0.1214 tons/acre/year

Converting these volumes to depths, the amount of soil loss over a 1000-year period will be:

- Impoundment top: 0.0011 in/yr or 1.1 inches in 1000 years
- East pond slope: 0.0007 in/yr or 0.7 inches in 1000 years
- West pond slope: 0.0006 in/yr or 0.6 inches in 1000 years

From the above calculations, the cover as designed will protect against the release of radioactive material for a period in excess of 1,000 years.

5.5.2 Wind-Induced Erosion

Wind-induced erosion at the HMC impoundment is not expected to be a problem because the side slopes of 5:1 (H:V) will be covered with at least six inches of rock material. Over time and with some weathering, there will be the formation of an erosion blanket, and practically no material from these slopes will be wind-transported.

Wind soil loss was determined for the revegetated impoundment top using the following data from USDA Technical Note 27, 1980. Calculations for the Soil Loss Equation are contained in Appendix C. The Soil Loss Equation, where E is potential annual soil loss in tons/acre/year, is:

$$E = f\ (I\ K\ C\ L\ V)$$

where

f = A function of

I = Soil erodability factor. I = 86

K = Soil ridge roughness. K = 0.5

C = Wind erosion climatic factor. C = 50

L = Unsheltered field length, measured to be average of 1,000 feet.

V = Vegetation cover, 1,400 pounds/acre of flat small grain residue.

From Table 5, USDA Technical Note 27, 1980, it is estimated that there will be a loss of 0.4 tons/acre/year, which equates to a soil loss over 1,000 years of 2.1 inches. Adequate soil material will be placed on the impoundment top to prevent the release of radioactive material during the 1,000-year time period, as discussed in previous sections of this chapter.

6.0 REVEGETATION AND FINAL SITE CONFIGURATION

6.1 REVEGETATION

6.1.1 Contour Plan for Affected Areas

Upon completion of mill decommissioning and tailings impoundment stabilization, the site will be graded to the final site configuration, as shown in Figure 9. As explained in Chapter 8 of this plan, the ground water protection system will continue to operate for some time after mill closure. The reclamation of this system (wells, IX plant, and evaporation pond) will occur later (probably 15 years or more) than the reclamation of the rest of the mill site. HMC has taken care to blend the areas that have been affected into the existing landscape contours. The site will be graded to provide natural drainage and to protect against the development of depressions.

As shown in Figures 6 and 7, the tailings disposal area will be contoured with side slopes at 5:1 (H:V) and stabilized with 2.0 feet of soil cover and 0.5 of rock cover. The top of the tailings disposal area has slopes from 200:1 to 250:1 (H:V). A drainage system has also been designed to direct the runoff from the top of the reclaimed tailings, as shown in Figures 6 and 9.

6.1.2 Revegetation

About 1160 acres will require revegetation. The areas to be revegetated include the following:

- Top of tailings impoundment (70 acres)
- Mill area (49 acres)

- Borrow area(s) (139 acres)
- Contaminated soil removal areas (644 acres)
- Mine IX Plant (5 acres)
- Other, including diversions and evaporation pond (250 acres)

The revegetation requirements have been developed based on species currently on-site, on the ability to provide species diversity, and on adaptability of the species to the site. Both sod and bunchgrass species have been selected to help provide soil stability and minimize erosion. The seed mixture will be planted between mid-June and mid-September. This time period has the most favorable moisture and temperature conditions for germination. In some cases, if seedbed preparation is conducted prior to or after this time period, a preparatory crop may be planted. Table 2 provides the permanent seed mixture selected and seeding rates. Table 3 provides the data on rapid-growing preparatory crops, if required.

The soil in the affected areas is of the Penistaja-Prewitt-Moriarty association. This soil is rated good to poor depending on depth (Marker et al., 1974). A new soil survey, just completed by the Soil Conservation Service, has changed the Moriarty Series to the Venadito and the Prewitt Series to the Aparejo (USDA, 1986a). The report on this survey is expected to be published in 1987.

The areas to be revegetated will have seedbeds prepared as follows:

- Mill area -- The mill area will be prepared for revegetation upon completion of demolition and building/equipment removal. Areas where foundations have been cut two to three feet below ground surface will be filled with soil material through grading and recontouring. Contaminated soil will be removed to the depth indicated by radiological survey. The area will be ripped with a bulldozer or equivalent equipment with

ripper shanks which will make parallel cuts on the contour. The area will then be disked or harrowed to provide a surface for drill or broadcast seeding.

- Borrow area(s) and contaminated soil removal area(s) -- Areas that have been compacted through the use of heavy equipment in the removal of soil will be ripped as discussed above. The total area affected will then be disked or harrowed to provide a surface for drill or broadcast seeding. The seedbed preparation will commence as soon as the required amount of soil material has been removed.

- Top of tailings impoundment -- It is anticipated that several years of surcharge with tailings material will be required before the soil cover can safely be placed over the top of the east and west pond areas. Section 5.3.4 discusses the procedures that will be utilized for the placement of the cover material. Upon completion of soil material placement, the area will be disked or harrowed on the contour to provide a surface for drill or broadcast seeding.

- Mine IX Plant -- The foundation area and parking area as well as the evaporation ponds, up to five acres total, will be revegetated.

- Evaporation Pond -- Revegetation will be the same as used for the mill area.

All seeding will follow as closely as possible after seedbed preparation has been accomplished for each area, as discussed above, within the constraints of climatic conditions. As discussed above, optimum seeding is between mid-June and mid-September. Planting in other time periods may be limited to the planting of a preparatory crop.

Two methods of effectively seeding the area to be revegetated include drill and broadcast seeding. For HMC's site, drill seeding will be the primary method of seeding. Broadcast seeding is not considered as effective as drill seeding because of uneven seed distribution and seed desiccation if proper depth placement is not accomplished. Drill seeding offers uniform

placement of seeds, requires fewer seeds per acre seeded, can be drilled directly into preparatory crop stubble, and provides a uniform stand of seeded plants. With seedbed preparation as discussed above, drill seeding will be well suited for HMC's affected areas. All seeding will be conducted along the contour or at a right angle to the prevailing wind.

If broadcast seeding is used, seeding will be accomplished using a cyclone-type broadcaster. After seeding the area will be conditioned by raking, harrowing or other methods to ensure proper seed coverage with soil. Conditioning will be conducted on the contour or at a right angle to the prevailing wind.

It can be anticipated that during some years the revegetation program's success may not achieve desired levels. A yearly evaluation will be made to determine revegetation success. If revegetation is not successful, the area(s) requiring revegetation will be reseeded with the appropriate seed mixture, contained in Table 2. If revegetation is not successful, for whatever reasons, undersize waste rock (minus three inches) will be hauled from the rock quarry (see Section 5.3.5) and mixed with the top lift of soil to raise the volume of 0.84 mm particles to increase wind erosion resistance.

6.2 MULCHING AND FERTILIZATION

Mulch will be applied to all seeded areas to conserve soil moisture and protect against erosion. Application will immediately follow seeding and fertilization. Areas that were seeded as a preparatory crop may not require mulching when perennial species are seeded due to the stubble stand. This will have to be determined on an area-by-area basis. All slopes within the

affected area will be gentle so no special mulch (e.g., cellulose wood fiber, burlap netting, etc.) will be required. Straw or hay mulch will be used, applied at 2,000 pounds per acre. The straw or hay mulch will be anchored with a straw crimper.

A soil investigation will be conducted to determine soil fertility. Results of the analysis will allow determination of the amount of nutrients contained in the plant growth medium. Parameters for determining fertility include nitrate-nitrogen, phosphorus, organic matter and potassium.

6.3 FENCING

Fencing will be used to control access into the revegetated area. The fencing will serve to control livestock grazing on the revegetated areas. The fencing will remain as long as HMC is responsible for monitoring and maintenance. To enclose the property and separate it from public road rights-of-way, about 58,000 feet of three-strand barbed wire will be used.

7.0 NON-RADIOLOGICAL PROTECTION

7.1 CURRENT PROTECTION MEASURES

The only non-radiological hazards identified as resulting from the HMC mill are those related to ground water quality. As the result of a regional ground water survey conducted by the U.S. Environmental Protection Agency in 1975, HMC entered into an agreement with the New Mexico Environmental Improvement Division (EID) to restore water quality outside the restricted area to background concentrations, or better, and to prevent the future migration of tailings seepage from the property. This agreement with the EID was formalized in August, 1976. Fresh water injection wells were installed along the southern border of HMC's property in June, 1977. This system of wells was designed primarily to dilute and disperse elevated concentrations of selenium, uranium and sulfate in ground water located in the subdivision to the south of HMC's operations. Additionally, a mound of water was to be formed by fresh water injection to create, in effect, a hydrologic barrier to prevent the further migration of waters containing elevated concentrations from HMC's property. In 1983, a second series of fresh water injection wells was installed along the southeast border of HMC's property. This system was designed to create a mound, or hydrologic barrier, to prevent the migration of waters containing elevated concentrations beyond the property boundary, as well as to accelerate the process of pushing these waters back towards the pump-back system of collection wells located around the downstream periphery of the tailings impoundment. The fresh water injection rate for each of these systems has averaged approximately 300 gallons per minute for the last several years. The locations of these wells are shown in Figure 13.

In addition to the ground water reclamation programs described above, HMC installed a system of collection wells (pump-back system) on the downstream side of their tailings impoundment. This system was installed in 1978 and was designed to intercept all seepage from the tailings pile. The wells of the collection system are designed to pump at such a rate that an hydraulic gradient toward the wells from both the north and the south is created uniformly along the downstream side of the tailings impoundment. This local change in gradient toward the collection wells not only creates a barrier to future seepage flow (a trough), but pulls back and collects past seepage. The collection rate of this system has averaged slightly greater than 300 gallons per minute over the last several years.

7.2 EFFECTIVENESS OF CURRENT MEASURES

In May, 1984 the NMEID approved HMC's Ground Water Protection Discharge Plan (Hydro-Engineering, 1981), acknowledging that the programs comply with the State's Ground Water Protection Regulations. A comparison of 1976 to 1986 San Mateo alluvial aquifer piezometric information shows that water levels and flow directions have been greatly changed by the remedial measures implemented by HMC. Collection wells around the tailings impoundment are presently intercepting all seepage from the facility and, in fact, are drawing water far out in the aquifer back towards the pump-back system. The injection systems have reversed the direction of flow from southward toward the subdivisions to northward, back toward the collection wells. The injection of fresh water has also greatly reduced the chemical constituent concentrations in ground water to well below background levels in the subdivisions downgradient of HMC's facilities.

Through an extensive monitoring program, HMC has demonstrated that all ground water outside their restricted area has been returned to better water quality than background, or that allowed by the State's Ground Water Protection Standards.

Injection of fresh water has been found to be a very effective solution for the reduction of the elevated chemical concentrations in the alluvial aquifer near Homestake's mill. The hydrologic mound of fresh water at the south property boundary is also a very effective hydrologic barrier which is forcing a reversal of flow direction, driving the elevated constituents between the property boundary and the tailings impoundment northward back to the system of collection wells. Dilution, dispersion and absorption have been very effective in reducing the elevated concentrations observed in the alluvial aquifer without significantly increasing concentrations downgradient. Collection of seepage adjacent to the tailings impoundment and the injection of fresh water have been successful remedial measures to reduce elevated concentrations which had migrated over a large area of the alluvial aquifer.

7.3 POST-CLOSURE PROTECTION MEASURES

In its Ground Water Protection Discharge Plan submitted to the State of New Mexico, HMC has committed to continuing its ground water protection programs until it can be demonstrated that, when the systems are turned off, any future seepage from the tailings facility will not cause the State's Ground Water Protection Standards to be exceeded at the property line. The collection system (which includes the collection wells, IX plant, and evaporation pond) will require operation for a considerable period of time

(possibly 15 years) after the shut-down of the tailings facility. This is because seepage will continue for a time after termination of operation until storage of water in the tailings is down to, or nearly at, its specific retention. However, as the tailings are gradually dewatered, the collection system discharge rate is expected to decline to 200-250 gpm.

This seepage water will be piped through the IX plant for removal of uranium, and the discharged water will be used for interim stabilization during post-closure grading and reclamation of the impoundment. After the impoundment reclamation has been completed and interim stabilization is no longer required, the IX discharge water will be placed in an evaporation pond as discussed below.

7.4 EVAPORATION POND

After mill closure, the tailings impoundment will be dewatered and no longer available for evaporation of water from the collection wells. Consequently, a 66-acre evaporation pond will be constructed to receive collection well discharge during the post-closure period of active ground water protection. This pond will provide storage for about 26 million gallons of water per year in excess of evaporation for about the five years when the collection system will operate at 250 gpm. Subsequently, as discharge declines to 200 gpm and lower, the stored water (about 131 million gallons) will evaporate until the pond is dry.

This pond will be constructed by excavating sufficient soil to create a rectangular retention dike system, then placing a liner across the bottom and sides of the pond. The liner will be Derry Oil Membrane No. 6, a felt

material coated with a thick petroleum rubber compound. The liner will be 250 mils and 125 mils thick on the bottom and sides of the pond, respectively. Leak detection will be provided by existing monitoring wells. The pond, illustrated in Figure 14, will be located as shown in Figure 13 and will incorporate the existing brine pond. It will be reclaimed after cessation of ground water protection measures using the dike soils and clays, excavated previously from the borrow pit before reclamation, to construct a soil cap with the necessary structural and hydrologic properties. This soil cap will be revegetated with the seed mixture discussed in Chapter 6.

8.0 POST-CLOSURE CARE AND MONITORING

Upon completion of the reclamation activities at HMC's site, it is anticipated that a modified ground water and subsidence monitoring program will be required. The following provides a brief description of the monitoring programs that will be implemented.

8.1 GROUND WATER MONITORING PROGRAM

During and after reclamation of the mill and tailings impoundment, HMC will perform ground water monitoring in conjunction with its Ground Water Discharge Plan. Ground water samples will be taken from selected wells downgradient of the reclaimed tailings impoundment and from three wells upgradient. As indicated in Chapter 7, HMC will continue to operate their injection/collection well system to further clean up ground water in the San Mateo alluvium. This system will operate until it can be demonstrated that the ground water will meet New Mexico State standards at HMC's property boundary or the exemptions/alternate concentration limits established by NRC. Monitoring will be conducted on an annual basis for a limited suite of parameters that have shown elevated levels in the past.

8.2 MONITORING AND INSPECTION

HMC will place 15 or more feet of tailings sands over the slimes areas in the west and east ponds. When the sands have been placed and the tailings impoundment graded to final contours, HMC will place two feet of soil over the entire impoundment area. Because the buildout of the impoundment placed only coarse sands in the embankments enclosing the ponds, the only potential for settlement due to consolidation of slimes will be in the pond areas on

top of the tailings impoundment. To determine if settlement has occurred, HMC will install settlement monitoring points at locations similar to those shown in Figure 6.

The monitoring points will be surveyed annually to determine the amount of settlement during the year. The revegetated soil cover over the pond areas will be inspected annually for signs of cracking, depressions, or other deformation which could compromise cover performance. In addition to the embankment top survey and inspection, an annual inspection of the rock cover on the impoundment slopes will be conducted to detect deterioration or erosion of the rock. These inspections and restoration maintenance will continue until transfer of ownership of HMC's interest to the State or federal government upon termination of the license.

8.3 REMEDIAL CARE

The monitor point surveys and inspections described above will detect any conditions requiring maintenance or remediation. The most likely condition will be excessive or non-uniform settlements of the soil cover. During soil cover placement, some extra thickness of soil (included in the nominal two feet thickness) will provide the soil necessary for redistribution and regrading to fill in settlement depressions, reestablish positive gradients, or fill cracks in the cover. Extra soil and rock will be placed at several locations on the stabilized impoundment for these purposes, precluding the need to bring in additional material, a very difficult task after reclamation.

For areas of the site not on the impoundment, remedial measures or maintenance will involve relatively simple repairs using hand tools or light equipment. This work can be accomplished by the staff running the ground water collection system.

9.0 ESTIMATED COSTS

The preceding chapters of this plan have described the conceptual design for long-term stabilization and reclamation of the Homestake-Grants mill site. Some of the stabilization measures (e.g., soil cover placement and contaminated soil cleanup) are based on estimated quantities or dimensions, the accuracy of which can be determined only after additional surveys. Actual mill production in the future will also significantly influence the volumes and dimensions of the impoundment stabilization plan. Consequently, in developing the estimates of costs for stabilization, conservatively high estimates of quantities were used.

The pricing in this estimate is based primarily on independent quotes or unit prices provided by outside sources. The exceptions are those activities or items for which Homestake has cost data from previous requisitions, such as piping and snow fence. The following discussions refer to the items and costs enumerated in Table 4.

9.1 INTERIM STABILIZATION

The items that are specific to interim stabilization are the water spray system and snow fence, and the labor associated with them. Piping already exists to bring water from the mill (slurry line), so the only additional piping needed for the spray system will be that to distribute water along the beach areas. Using one foot of pipe per foot of beach length, a total of 9400 feet of pipe, plus one sprinkler head per 80 feet (or 118 heads) will be required. The unit price of pipe and heads is $1.54 per foot and $12.00 per head, respectively. To maintain pressure and flow, two pumps

(300 gpm at 20 psi) at $1,040 per pump were included in the system. Adding all these costs, the system will cost about $1.91 per foot, or about $18,000 total.

Snow fence will be used on the crests and slopes of the impoundment and will be moved from place to place as required. Using snow fence on half the surface at any time, and placing one line of fence (210 feet) per acre, a total of 11,550 feet of fence at $0.74 per foot will cost about $8,550.

The interim stabilization efforts will gradually give way to long-term stabilization. Consequently, labor will be most intense early in the program and decrease with time. Labor will be required to place and maintain fencing, pipes, sprinklers and pumps over a target period of about three years. Assuming an average of two man-years per year and a total labor cost of $20/man-hour, the estimated total labor cost is $249,600. The total estimated cost of interim stabilization is about $275,000.

9.2 IMPOUNDMENT RECONTOURING

Recontouring of the impoundment will consist of two activities: excavation of the embankment crests and upper slopes to 5:1 (H:V) and placement of this material as fill in the pond areas, and placement of contaminated soil as fill at the embankment toe. Excavation of the crest is expected to be performed first by dozers making relatively short pushes of tailings sands across the beach areas. Once the dozers have cut away the crests and created beaches on the slopes, scrapers will flatten the slopes by longitudinal cuts, hauling the sand tailings up to 1,000 yards to fill locations in the pond areas, where dozers and graders will spread and compact the tailings.

The total volume of 1,850,000 is divided equally between dozers and scrapers for estimating purposes. The entire relocation of tailings (excavate, move, fill, and compact) is a continuous operation and is estimated by a unit price of $1.00 per cubic yard for dozer yardage and $1.62 per cubic yard for scraper yardage, for totals of $925,000 and $1,498,500, respectively.

Fill placed at the toe, consisting of the contaminated soil excavated around the site, is priced as if the soil will be drawn from a stockpile near the fill location, dozed into place, and compacted. Excavation of this soil is priced separately as contaminated soil excavation in Section 9.7. About 310,000 cubic yards are required to create a 5:1 slope toe fill, and about 50,000 cubic yards additional soil will be used to bury the mill debris under a slope of about 10:1. A unit price of $1.80 per cubic yard for dozing and compaction results in a cost of $648,000 for placing the toe fill.

Total costs for recontouring the impoundment are estimated at slightly over $3 million.

9.3 IMPOUNDMENT SOIL COVER

The work items to construct the soil cover on the tailings impoundment consist of borrow pit development (stripping and grubbing); borrow excavation, haulage, and dumping; and spreading and compacting. The borrow area covers about 139 acres. An independent local contractor provided an estimated unit price of $400 per acre, or a total of $55,600 for borrow pit preparation.

The borrow material will be excavated, hauled and dumped by scrapers. The average haul distance, estimated at 0.8 miles, was used to determine the

unit price of $1.62 per cubic yard. Dumped in windrows across the impoundment, the borrow will be spread and compacted by graders, dozers and sheepsfoot rollers after moisture conditioning by water trucks. An estimated unit price of $1.80 per cubic yard covers these activities. With 600,000 cubic yards required for a two-foot cover, the total costs for excavate/haul/dump and spread/compact are $972,000 and $1,080,000, respectively. Combined with borrow area preparation, the total soil cover estimated cost is $2,107,600.

9.4 IMPOUNDMENT ROCK COVER

Rock will be required to cover the impoundment side slopes, to line the drainage swales against all erosion, and to protect the diversion ditches and impoundment toe against flood erosion. The impoundment slope rock cover, 0.5 foot thick, will require about 103,000 cubic yards. Toe protection using oversized rock (one- to two-foot diameter riprap) will require about 16,000 cubic yards. The total for other rock protection is about 5,000 cubic yards, bringing the total to about 124,000 cubic yards.

The cost of rock was separated into six categories. Purchase of rock from the owner was estimated at $0.25 per cubic yard, or $31,000. The rock will be quarried by drill-and-blast methods, crushed and screened, loaded and hauled to dump locations on site, then spread and graded or placed. Each of these tasks has been priced separately based on estimated unit prices supplied by contractors or industry cost data publications. Drill-and-blast is estimated at $1.58 per cubic yard and crushing and screening at $3.50 per cubic yard. To load, haul about 7.5 miles, and dump is priced at $2.00 per cubic yard. Spreading is priced at $1.00 per cubic yard and riprap placement is expected to be $21.00 per cubic yard.

If vegetation cannot dependably protect the top of the impoundment from wind erosion, the undersize waste rock (minus three inches) will be hauled to the site and mixed in the top lift of soil to raise the volume percentage of 0.84 mm particles to increase resistance to wind erosion. No additional costs except load/haul/dump will be involved in this measure, which would call for 25,000 to 30,000 cubic yards of material. The cost of moving this undersize rock to the site has not been included in the estimate in Table 4.

Excluding the undersize rock haulage, the total cost for rock protection is about $1,352,900.

9.5 RADIOLOGICAL SURVEY

The survey to be conducted after site cleanup, to locate residual contamination, has been estimated in two parts, mill area survey and vicinity survey, as lump sum items. Estimates of these costs by an independent contractor are $9,000 and $23,000, respectively, for a total of $32,000.

9.6 MILL DEMOLITION

A detailed estimate of mill demolition costs could not be obtained in the time period available for preparing this plan. Therefore, as a basis for estimating, HMC used the award cost of a contract placed in 1986 for demolition of a uranium mill near Grants. The total estimated cost of mill demolition is $1.5 million, about double the cost of the aforementioned demolition contract.

9.7 CONTAMINATED SOIL EXCAVATION

Cleanup of contaminated soil is expected to be performed in the same manner as borrow pit preparation and excavation, and with comparable haul distances. Therefore, the same unit prices apply. Clearing of 644 acres at $400 per acre will cost $257,600, and excavation of about 80,000 cubic yards in the mill area and 520,000 cubic yards around the site at $1.62 per cubic yard will cost $129,600 and $842,000, respectively. This gives a total cost of $1,229,600 for contaminated soil cleanup. Note that soil disposal is included in impoundment toe fill costs elsewhere in the estimate and that no clearing of the 49-acre mill area is included (included elsewhere as part of demolition).

9.8 SITE RECONTOURING

The earthwork to recontour the site will be accomplished by graders with some minor earthmoving by dozer and scraper. For estimating purposes, the work has been divided into four tasks: general grading (930 acres); borrow pit grading (139 acres); San Mateo diversion (4 acres); and impoundment diversion ditch grading (28 acres). However, the same unit price of $200 per acre applies to all recontouring except the diversion ditch grading, which is estimated by cost per cubic yard ($1.62) to excavate soil and place it in the levee northeast of the impoundment. The estimated cost for recontouring is $360,400.

9.9 REVEGETATION

After recontouring is completed, all site areas not covered by rock will be revegetated. These areas include the top of the impoundment, the contaminated soil removal areas, the mill site, the evaporation pond, and the bor-

row and flood diversion areas. A total of about 1,160 acres will be revegetated. The included tasks, priced separately, are soil preparation/fertilizer/mulch, seeding, and fencing. According to an estimate from an independent revegetation contractor, the costs per acre for the first two are $420 and $80, respectively. Triple-strand barbed wire fencing is priced at $0.89 per foot.

The item totals to revegetate 1,160 acres are $487,200 for soil preparation fertilizer/mulch and $92,800 for seeding. Adding $51,620 for fencing, the total estimated cost is $631,620 for revegetation.

9.10 GROUND WATER RESTORATION AND MONITORING

Two major costs are identified in the ground water protection program. The first--collection, injection, and monitor well operations--is priced at $250,000 per year and includes replacement and repair costs based on actual system operating costs over a 5 to 10 year period. Operating for 15 years, this task will cost $3,750,000.

An evaporation pond, the second major cost item, will be constructed to support the ground water program. The existing five-acre brine pond will be incorporated into this new pond. The cost of the 66-acre pond includes earthwork (excavation of pond area and fill placement to build dikes) at $1.90 per cubic yard, based on costs actually incurred to construct the present brine evaporation ponds. The 85,800 cubic yards of earthwork will cost $163,000. Later earthwork, priced at $1.47 per cubic yard, will be required for reclaiming (filling and covering) this pond. This reclamation earthwork will cost $141,700.

The pond will be lined with Derry Oil Membrane No. 6, the same liner used to create the existing brine evaporation ponds. Homestake paid $4.05 per square yard for this liner. Using the same unit price for the evaporation pond liner, the 306,200 square yards of liner will cost $1,240,110.

The total ground water restoration and monitoring costs are estimated to be about $5,295,000.

9.11 COST ESTIMATE SUMMARY

The total estimated cost for long-term stabilization and reclamation is about $15,855,400. This cost results from conservative estimates of quantities and actual or realistically conservative unit prices based either on independent contractor/vendor estimates, industry cost data, or Homestake procurement records.

These costs will be reviewed annually and revised as necessary.

10.0 SCHEDULE

A schedule for tailings stabilization and site reclamation has been developed on a conceptual basis, relating all activities to the closure date, year 0 in Figure 15. This figure illustrates the schedule and relationship of the activities outlined in this plan. No calendar date for closure of the mill has been set by HMC, so the schedule is based on years from closure, not specific dates.

The ground water protection measures, already in place except for the evaporation pond, start before closure and last for about 15 years after closure, followed by a year of pond reclamation and well plugging. All other activities start at or after closure and will be completed by the end of year six.

At closure, the plan will begin in the first year with interim stabilization, mill demolition, and initial recontouring. In the second year, a radiological survey will define areas for soil cleanup, which will also start that year. Impoundment recontouring will continue through the second year, as well, with sand tailings being pushed progressively farther over the pond areas to fill and surcharge them. The top of the impoundment should be recontoured by the end of the fifth year.

In the third year and through the fourth, the impoundment toe areas will be filled and the side slopes cut to required grade. Site recontouring will be completed, allowing revegetation to start as early as the fourth year.

In the fourth year the soil cover placement will start, followed as closely as possible by rock cover on the outside slopes. Both these activities will continue through the fifth year and should be completed by the end of the sixth year.

This schedule is conceptual only. The actual schedule will be strongly influenced by the rate of dewatering and consolidation of tailings slimes.

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TABLE 1

PMP AND PMF DATA

A. PMP Amounts for San Mateo Creek Watershed

Duration (hrs.)	1/2	1	3	6	24	72
General Storm	NA	3.4	NA	8.6	12.2	15.9
Local Storm	2.2	3.4	5.3	6.7	NA	NA

B. Hydrograph Generation Results

PMP Duration (hrs.)	6	24
PMP Amount (inches)	8.6	12.2
PMF Peak Discharge (cfs)	180,250	169,800
Time to Peak (hrs.)	5.75	5.75
Hydrograph Length (hrs.)	13.5	31.5

TABLE 2

STABILIZATION SEED MIXTURE

SCIENTIFIC NAME	COMMON NAME	SEEDING RATE (DRILL SEEDING)		
		GROWTH HABIT[1]	LBS PURE LIVE SEED/ACRE	NUMBER OF SEEDS/FT^2
Grasses				
Agropyron smithii	Western wheatgrass	NS	4.0	10.1
Bouteloua gracilis	Blue grama	NB	2.0	37.9
Sporobolus cryptandrus	Sand dropseed	NB	0.5	60.8
Oryzopsis hymenoides	Indian ricegrass	NB	3.0	9.7
Sporobolus airoides	Alkali sacaton	NB	0.5	20.2
Shrubs				
Atriplex canescens	Four-wing saltbush	--	0.5	0.6

(1) NB - Native Bunchgrass.
NS - Native Sod.

TABLE 3

PREPARATORY CROP SEEDING RATES

SCIENTIFIC NAME	COMMON NAME	SEEDING RATE[1] LBS PURE LIVE SEED/ACRE
Hordium vulgare	Barley	25.0
or	or	
Triticum aestivum	Wheat	25.0
or	or	
Avena sativa	Oats	25.0

[1] Seeding rate is for drill seeding. If broadcast seeding is used, the rate will be doubled.

TABLE 4

ESTIMATED COSTS
LONG-TERM STABILIZATION AND RECLAMATION
HOMESTAKE MINING COMPANY, GRANTS, NEW MEXICO

CATEGORY OR ITEM/UNITS	UNIT PRICE	QUANTITY	ITEM COST*	CATEGORY COST
1.0 INTERIM STABILIZATION DURING CLOSURE				
1.1 Water Spray System/Ft	$1.91	9,400	$18,000	
1.2 Snow Fence/Ft	$.74	11,550	$8,500	
1.3 Labor/Hr	$20.00	12,480	$249,600	
				$277,100
2.0 IMPOUNDMENT RECONTOURING, TAILINGS EXCAVATION, FILL				
2.1 Dozer (Crest)/Cu Yd	$1.00	925,000	$925,000	
2.2 Scraper (Slope)/Cu Yd	$1.62	925,000	$1,498,500	
2.3 Toe Fill/Cu Yd	$1.80	360,000	$648,000	
				$3,071,500
3.0 IMPOUNDMENT SOIL COVER				
3.1 Borrow Pit Prep./Acre	$400	139	$55,600	
3.2 Excavate, Haul, Dump/Cu Yd	$1.62	600,000	$972,000	
3.3 Spread and Compact/Cu Yd	$1.80	600,000	$1,080,000	
				$2,107,600
4.0 IMPOUNDMENT ROCK COVER				
4.1 Purchase Rock/Cu Yd	$0.25	124,000	$31,000	
4.2 Drill and Blast/Cu Yd	$1.58	124,000	$195,900	
4.3 Crush and Screen/Cu Yd	$3.50	124,000	$434,000	
4.4 Load, Haul, Dump/Cu Yd	$2.00	124,000	$248,000	
4.5 Spread, Grade/Cu Yd	$1.00	108,000	$108,000	
4.6 Place Riprap/Cu Yd	$21.00	16,000	$336,000	
				$1,352,900
5.0 RADIOLOGICAL SURVEY				
5.1 Mill Area Survey, Sampling	L.S.	1	$9,000	
5.2 Vicinity Survey, Sampling	L.S.	1	$23,000	
				$32,000
6.0 MILL DEMOLITION				$1,500,000
7.0 CONTAMINATED SOIL CLEAN-UP				
7.1 Clear Vegetation/Acre	$400	644	$257,600	
7.2 Mill Area/Cu Yd	$1.62	80,000	$129,600	
7.3 Site/Cu Yd	$1.62	520,000	$842,400	
				$1,229,600
8.0 SITE RECONTOURING				
8.1 General Grading/Acre	$200	930	$186,000	
8.2 Borrow Pit Grading/Acre	$200	139	$27,800	
8.3 San Mateo Diversion/Acre	$200	4	$800	
8.4 Impoundment Diversion Ditch/Cu Yd	$1.62	90,000	$145,800	
				$360,400

*Costs rounded to nearest $100.

TABLE 4

ESTIMATED COSTS
LONG-TERM STABILIZATION AND RECLAMATION
HOMESTAKE MINING COMPANY, GRANTS, NEW MEXICO
(Continued)

CATEGORY OR ITEM/UNITS	UNIT PRICE	QUANTITY	ITEM COST*	CATEGORY COST
9.0 REVEGETATION				
9.1 Soil Prep., Fertilizer, Mulch/Acre	$420	1,160	$487,200	
9.2 Seeding/Acre	$80	1,160	$92,800	
9.3 Fencing/Ft	$.89	58,000	$51,600	
				$631,600
10.0 GROUND WATER RESTORATION AND MONITORING				
10.1 Collection, Injection, Monitor Well Opns/Yr	$250,000	15	$3,750,000	
10.2 Evaporation Pond				
10.21 Earthwork/Cu Yd	$1.90	85,800	$163,000	
10.22 Liner/Sq Yd	$4.05	306,200	$1,240,100	
10.23 Reclamation Fill/Cu Yd	$1.47	96,400	$141,700	
				$5,294,800
TOTAL COST				$15,855,400

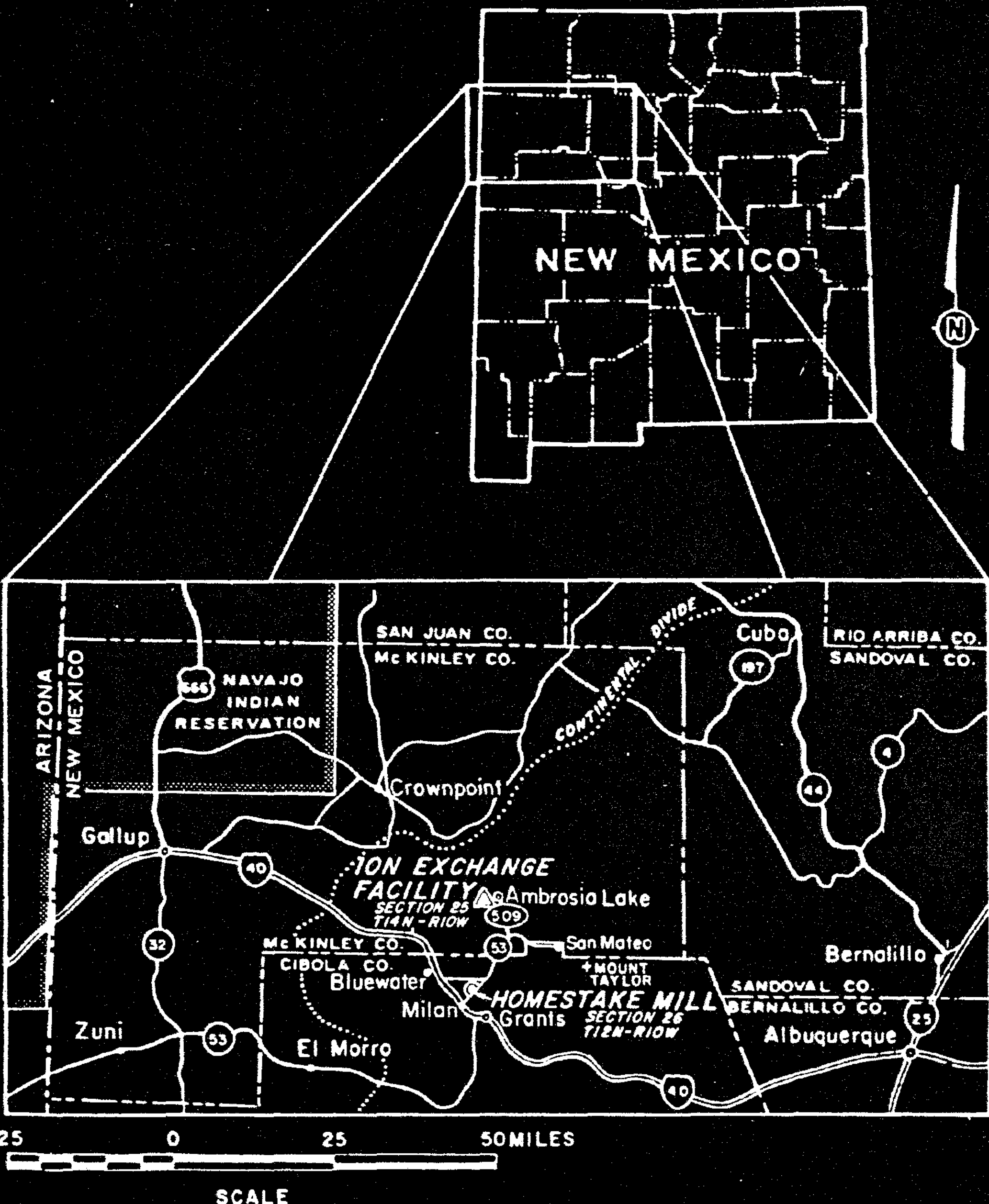


FIGURE I

SITE LOCATION MAP

REFERENCE
STATE OF NEW MEXICO HIGHWAY MAP,
RAND MC NALLY AND COMPANY, 1970,
SCALE : 1" = 25 MILES.

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

HMCSL024643

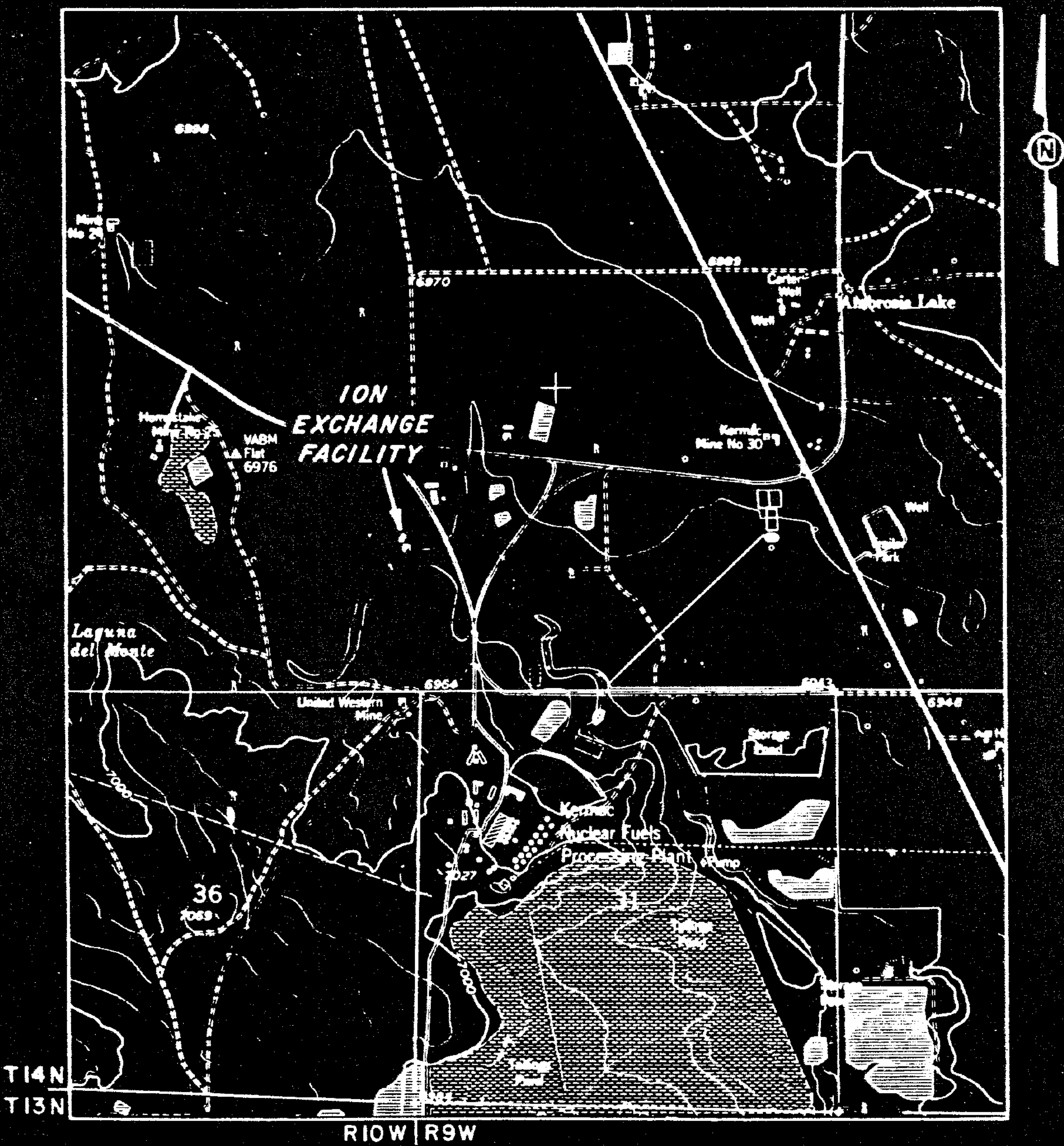


FIGURE 2

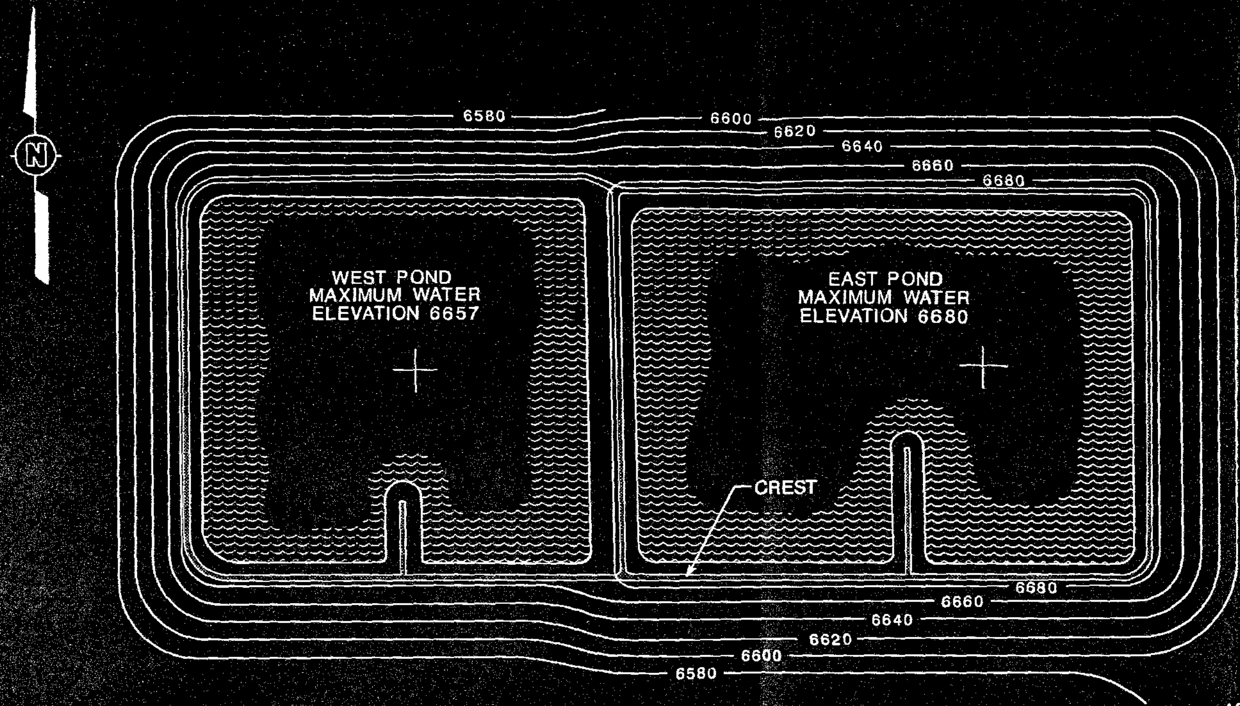
2000 0 2000 4000 FEET

SCALE

SITE LOCATION
MINE WATER DISCHARGE
ION EXCHANGE FACILITY

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

REFERENCE
USGS 7.5 MINUTE TOPOGRAPHIC MAP
OF AMBROSIA LAKE, NEW MEXICO,
DATED 1957, PHOTOREVISED 1980.



NOTES

1. MINIMUM BEACH WIDTH 50 FT.
2. MINIMUM FREEBOARD 5 FT.
3. MAXIMUM CREST ELEVATIONS:
   6687 – EAST POND
   6675 – WEST POND

400 0 400 800 FEET

SCALE

CONTOUR INTERVAL: 20'

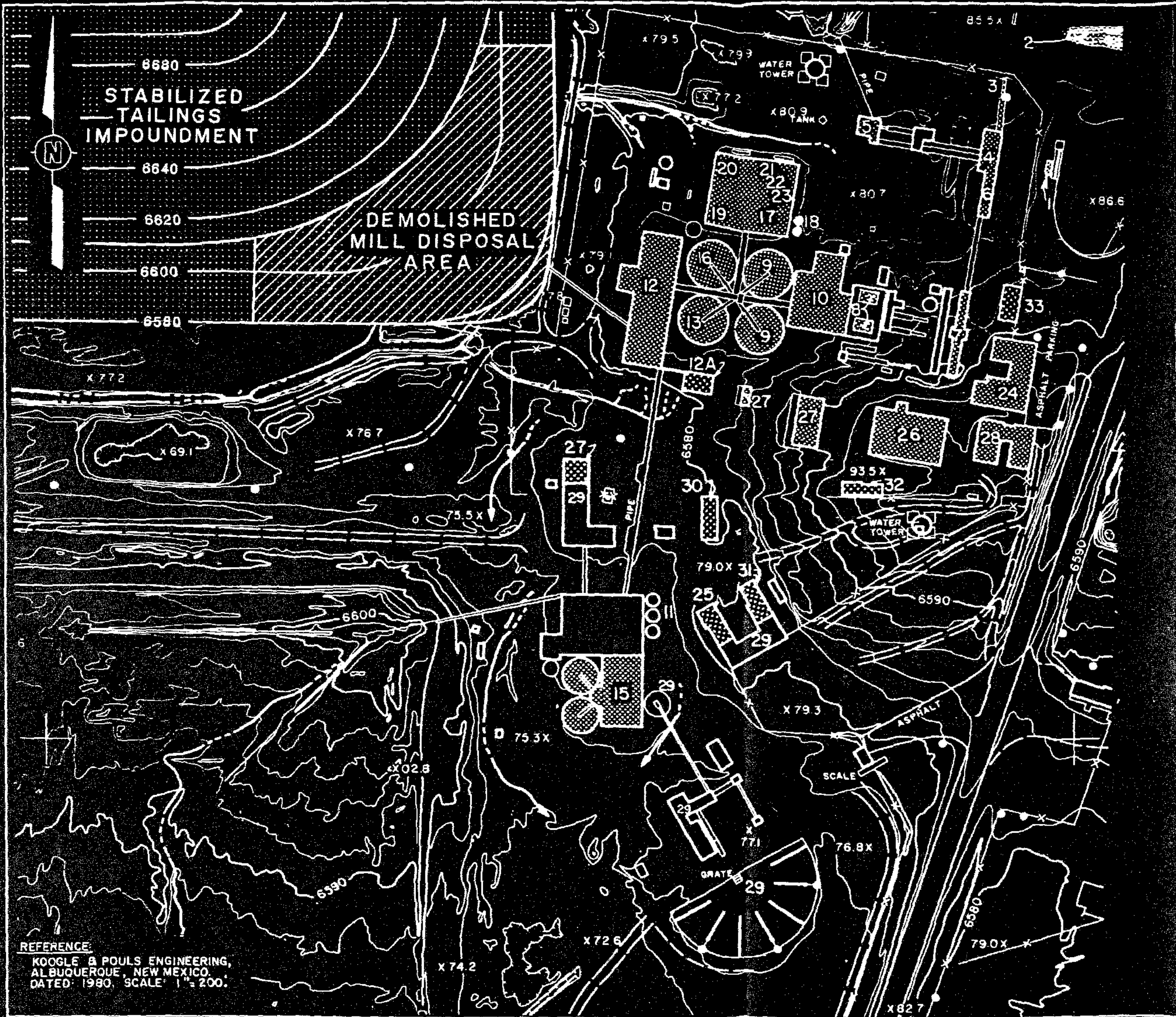
FIGURE 3

TAILINGS IMPOUNDMENT
AT END OF FIVE YEARS
OF 2000 TPD PRODUCTION

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

REV. 0 10/24/88

DESIGNED BY: A.K. KUHN
DRAWN BY: T.M. BOND



CURRENT OPERATING FACILITIES LOCATION IDENTIFICATION

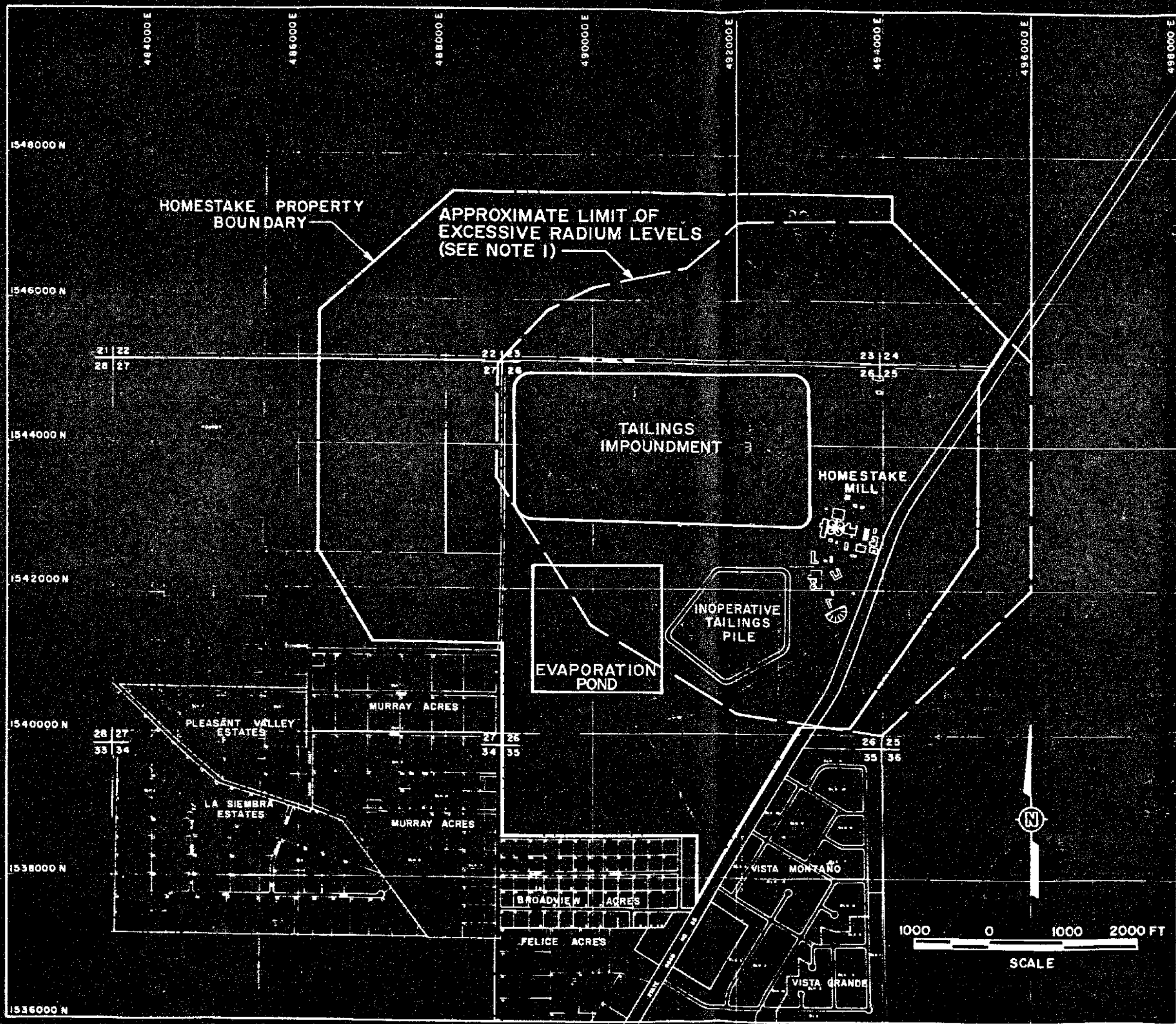
- ORE RECEIVING SECTION
  1. ORE RECEIVING SCALE
  2. ORE STORAGE PAD
- CRUSHING AND SAMPLING SECTION
  3. GRIZZLY
  4. IMPACT BREAKER
  5. ROTARY DRYER
  6. RECIPROCATING SAMPLERS
- FINE ORE STORAGE SECTION
  7. FINE ORE BINS
- GRINDING SECTION
  8. BALL MILL
  9. THICKENER TANKS
- URANIUM LEACHING SECTION
  10. PRESSURE LEACHING AUTOCLAVES
  11. ATMOSPHERIC LEACHING PACHUCA TANKS
  12. FILTERS
      12A. VACUUM PUMPS
  13. SOLUTION STORAGE TANK
  14. TAILINGS DISPOSAL POND
  15. TAILINGS POND ION EXCHANGE
- PRECIPITATION SECTION
  16. PREGNANT SOLUTION
  17. PRECIPITATION TANKS
  18. PRECIPITATION TANKS
  19. PRECIPITATE THICKENER TANK
- VANADIUM REMOVAL SECTION
  20. ROASTING FURNACE
- PACKING - STORAGE AND SHIPPING SECTION
  21. YELLOWCAKE DRYING FURNACE
  22. YELLOWCAKE PACKAGING
  23. YELLOWCAKE DRUM STORAGE AND LOADOUT
- MISCELLANEOUS STRUCTURES
  24. ADMINISTRATIVE BUILDING
  25. GARAGE
  26. SHOP
  27. WAREHOUSES
  28. LABORATORY
  29. OLD FACILITIES (INOPERATIVE SINCE 1961)
  30. ELECTRIC SHOP
  31. INSTRUMENT SHOP
  32. CARPENTER SHOP
  33. CHANGE HOUSE

200 0 200 FEET
SCALE

FIGURE 4

MILL FACILITIES MAP

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO



REFERENCE (BASE MAP)
HOMESTAKE MINING COMPANY, 1981b.

NOTES

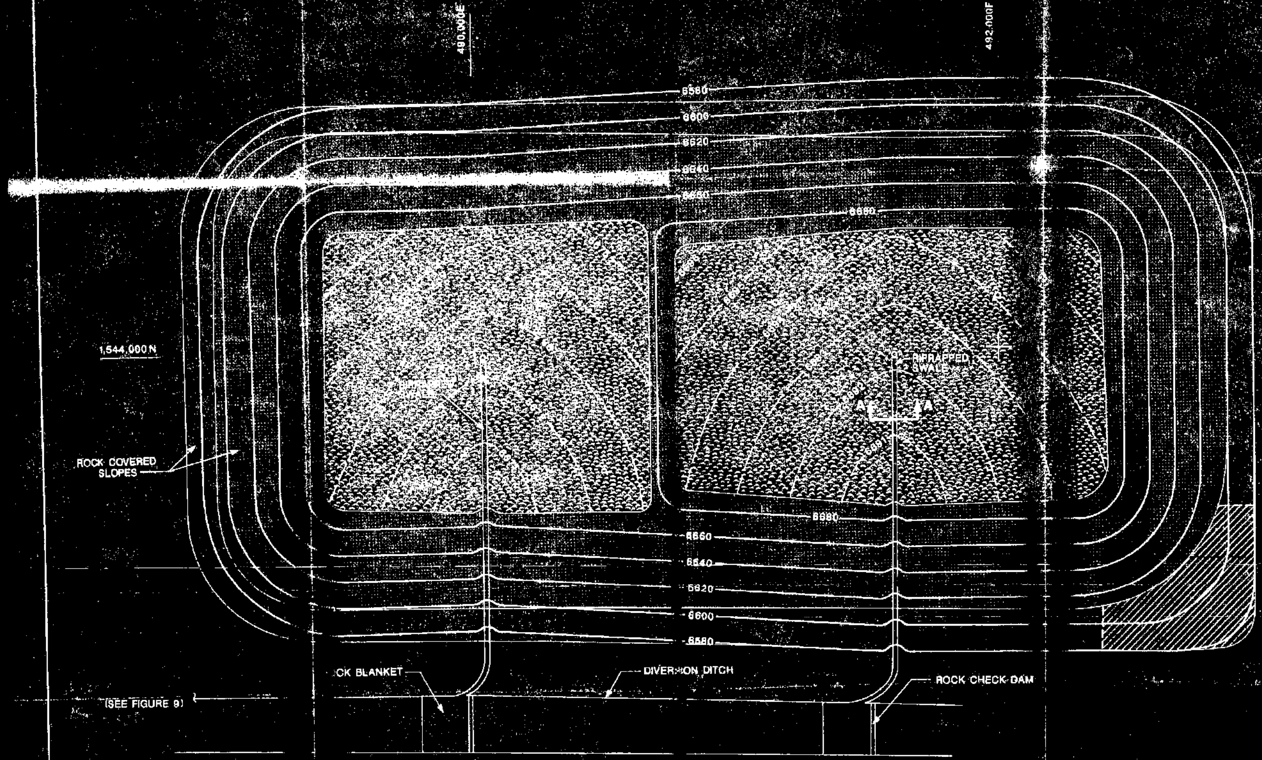
1. APPROXIMATE LIMIT IS OUTER BOUNDARY OF THE AREA OF 25+μR/HR GAMMA READINGS FROM 1980 HMC SURVEY. THE ACTUAL IRREGULAR BOUNDARY HAS BEEN EXTENDED OUTWARD IN SOME PLACES AND SIMPLIFIED ON THIS FIGURE BY STRAIGHT LINE SEGMENTS FOR CONSERVATISM.

2. AREA OF TAILINGS IMPOUNDMENT, 179 ACRES, REPRESENTS CONFIGURATION AT END OF 5-YEAR BUILDOUT.

FIGURE 5

AREA OF SUSPECTED EXCESSIVE RADIUM LEVELS IN SOIL

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

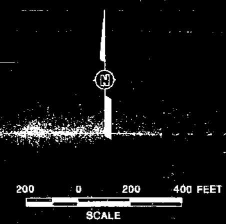


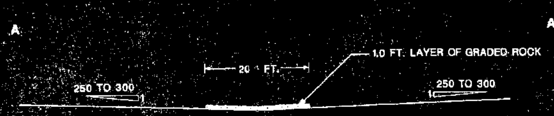
NOTES

1. MAXIMUM GRADIENT ON REVEGETATED SLOPES IS 200:1 (H:V).
2. SWALES ARE ROCK-LINED TO DIVERSION DITCH. ROCK LAYER IS 1.0 FT THICK, GRADED FROM COARSE SAND ON BOTTOM TO 3" TO 6" ROCK ON TOP.
3. DIVERSION DITCH CHECK DAMS AND ROCK BLANKETS CONSTRUCTED OF 3" TO 12" ROCK. SEE FIGURE 9 FOR DETAIL.
4. 6580 CONTOUR IS REPRESENTATIONAL AS SHOWN. ACTUAL CONTOUR WILL DEPEND ON FINAL SITE GRADING.

LEGEND

- REVEGETATED SOIL COVER OVER REGRADED SAND TAILINGS
- ROCK OVER SOIL COVER ON SLOPES EXCAVATED TO 5:1 (H:V)
- ROCK OVER SOIL COVER ON FILL OF CONTAMINATED SOIL
- BURIAL AREA FOR DEMOLISHED MILL
- o SETTLEMENT MONITORING POINT





SECTION A-A'
DRAINAGE SWALE

NOT TO SCALE

REV. 0 10/10/85

DESIGNED BY: A.K. KUHN

DRAWN BY: T.M. BOND

FIGURE 6

PLAN OF TAILINGS IMPOUNDMENT AFTER LONG-TERM STABILIZATION

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

HMCSL024648

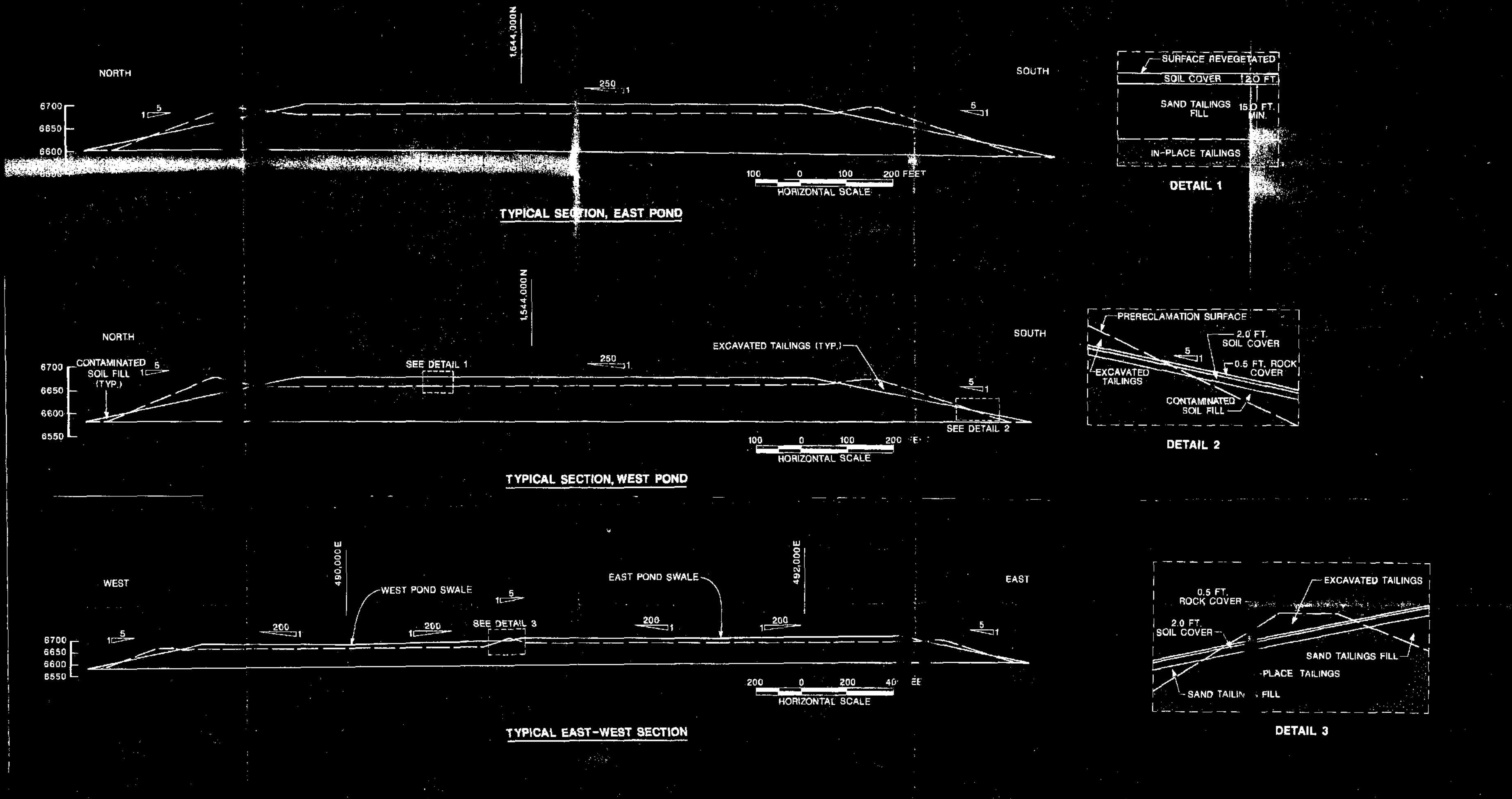


FIGURE 7

CROSS SECTIONS OF TAILINGS IMPOUNDMENT AFTER LONG-TERM STABILIZATION

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

REV 0 10/10/86
DESIGNED BY: A.K. KUHN
DRAWN BY: T.M. BOND

HMCSL024649

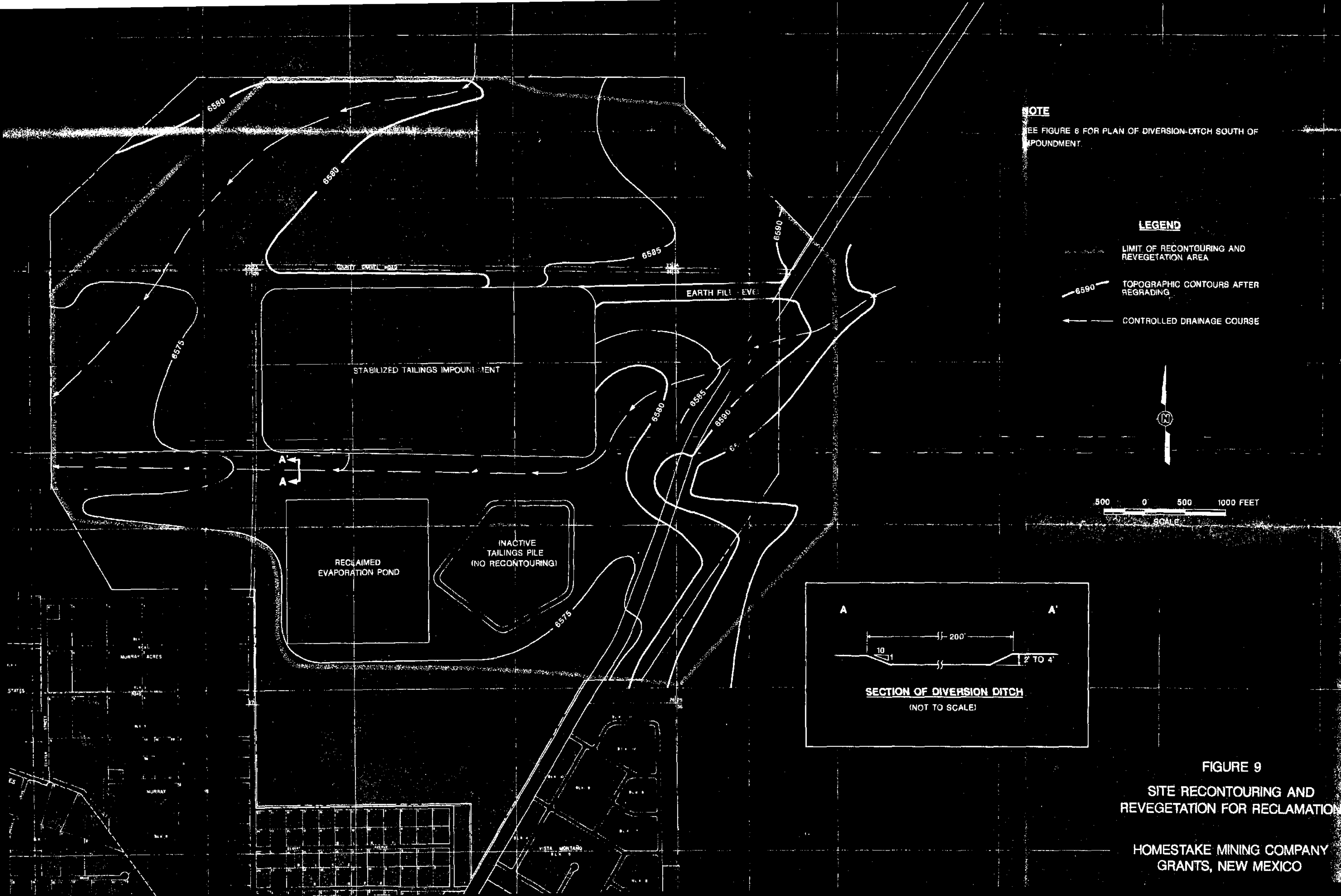


FIGURE 9

SITE RECONTOURING AND REVEGETATION FOR RECLAMATION

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

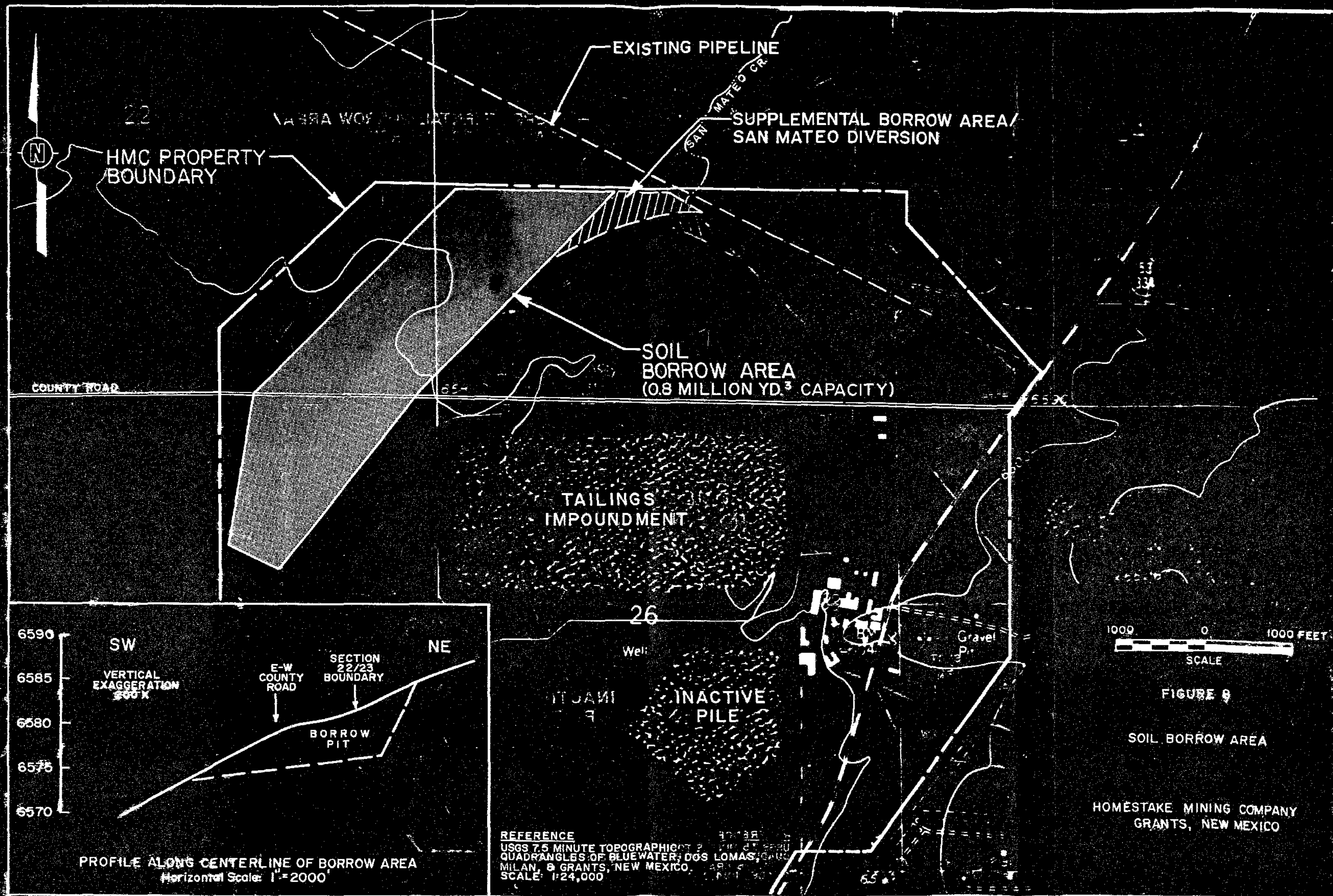


FIGURE 8

SOIL BORROW AREA

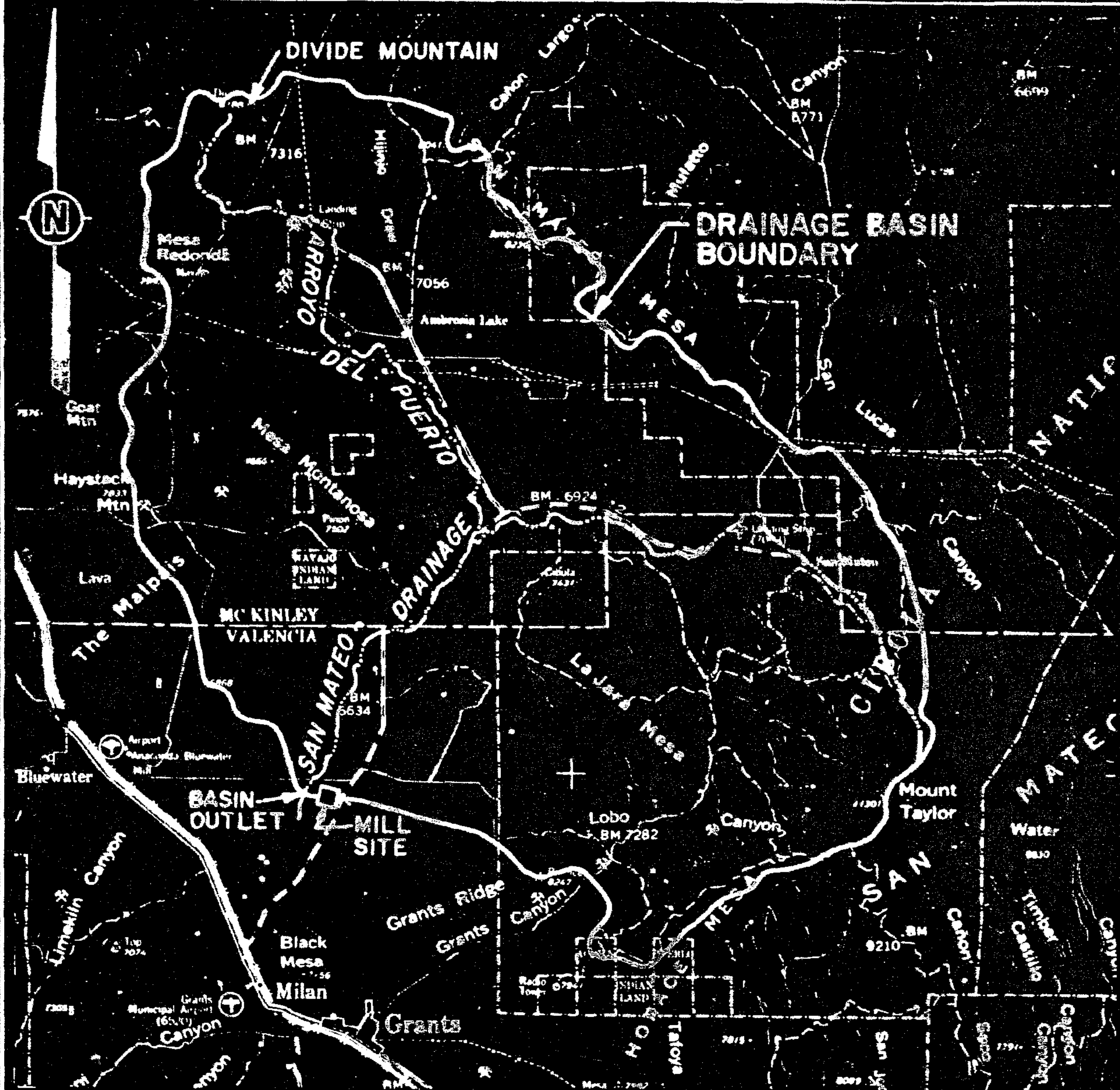


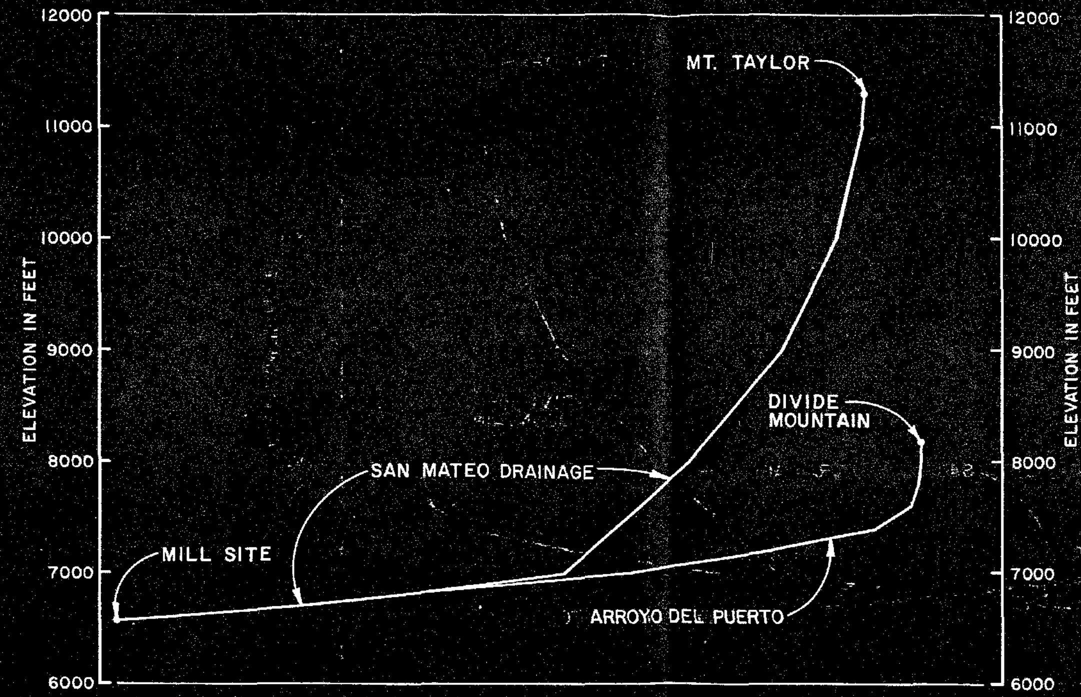
FIGURE 10

SAN MATEO
DRAINAGE BASIN

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

REFERENCE:
U.S.G.S. TOPOGRAPHIC MAP OF
ALBUQUERQUE, NEW MEXICO.
SCALE: 1:250,000 DATED: 1965.

HMCSL024652



SAN MATEO DRAINAGE AND
ARROYO DEL PUERTO PROFILES

NOTE:
FOR PROFILE LOCATIONS SEE FIGURE 10.

1000 0 1000 2000 FEET
VERTICAL SCALE

20000 0 20000 40000 FEET
HORIZONTAL SCALE

FIGURE 11

SAN MATEO DRAINAGE AND ARROYO DEL PUERTO PROFILES

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

HMCSL024653

FIGURE 12

PMF FLOODPLAIN
SAN MATEO DRAINAGE NEAR
HMC MILL SITE

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

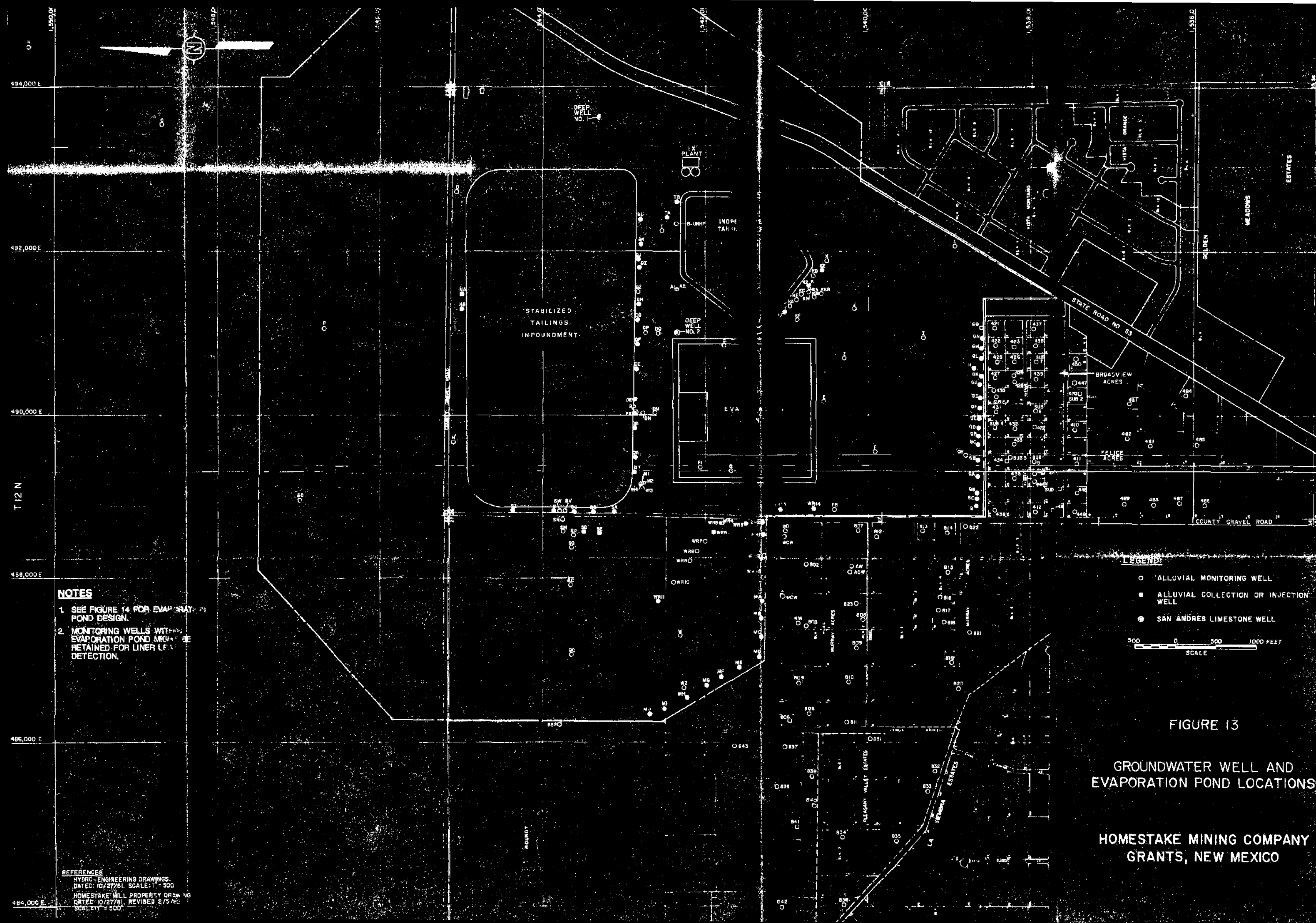
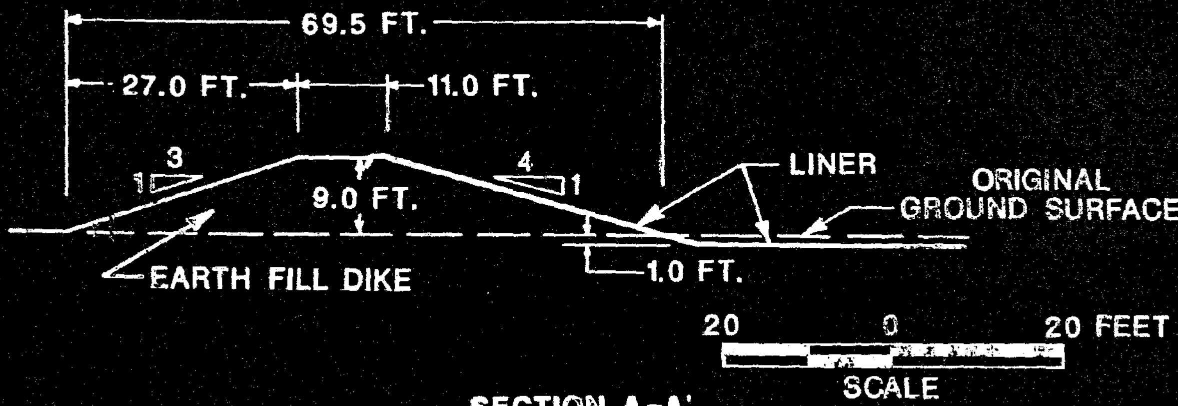


FIGURE 13

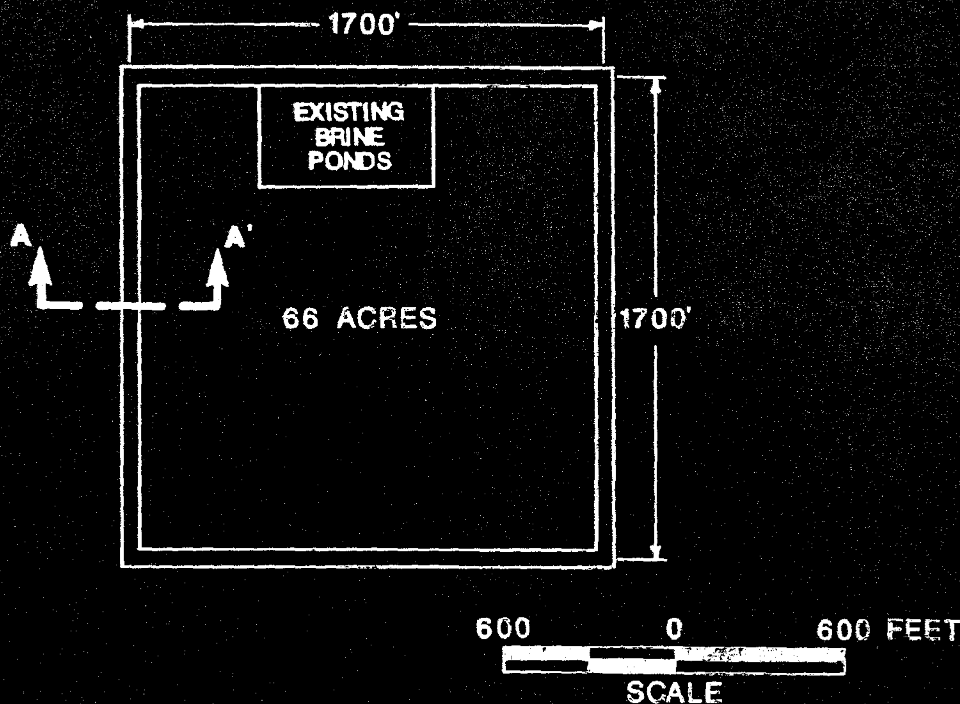
GROUNDWATER WELL AND EVAPORATION POND LOCATIONS

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

HMCSL024655



SECTION A-A'



PLAN VIEW

NOTE

FOR POND LOCATION, SEE FIGURE 13.

FIGURE 14

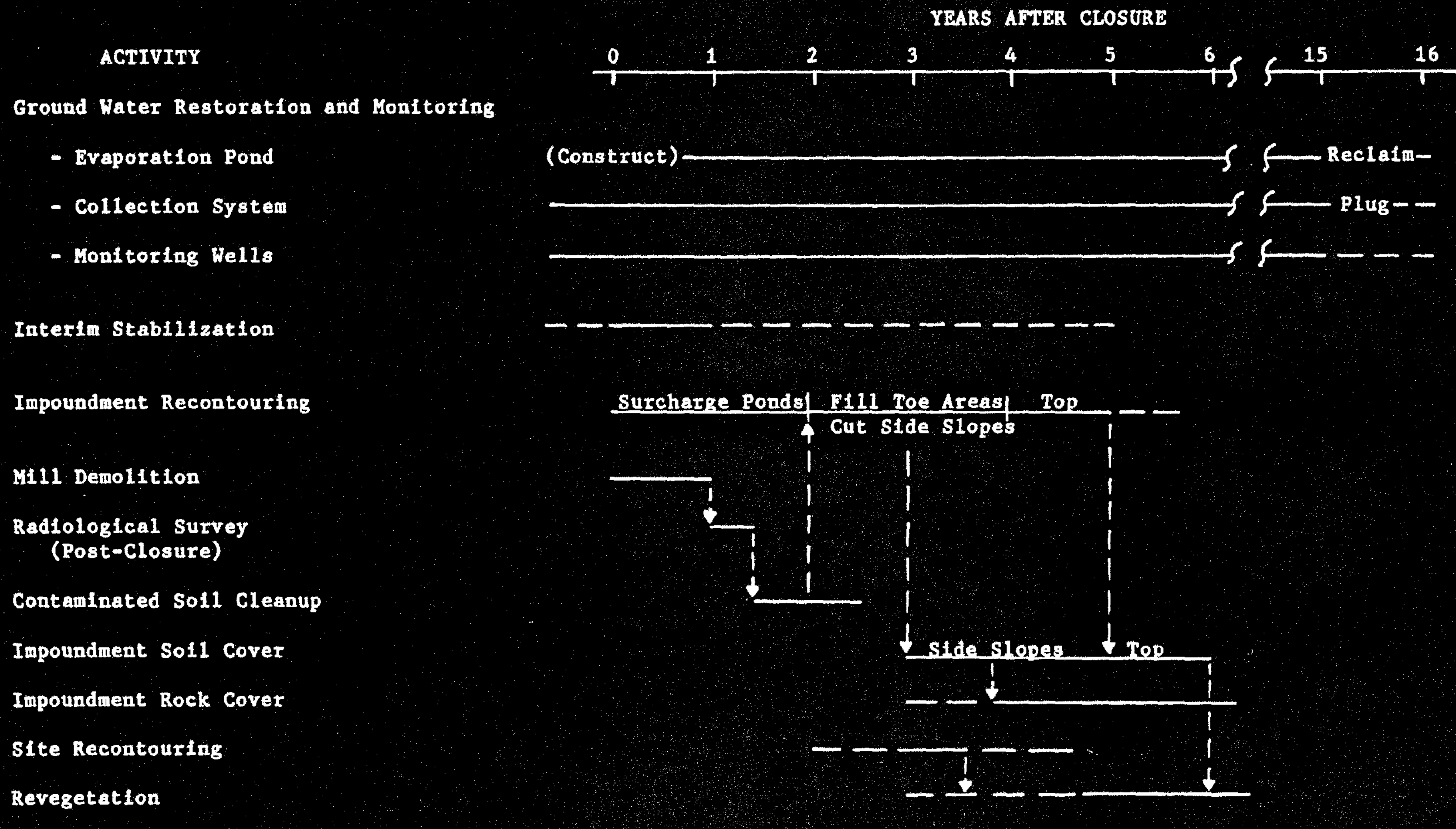
EVAPORATION POND
PLAN AND SECTION

REV. 0 10/23/83

DESIGNED BY: A.K. KUHN
DRAWN BY: T.M. BOND

HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

FIGURE 15. STABILIZATION AND RECLAMATION SCHEDULE



Note: Dashed horizontal line indicates uncertain start or duration time, or intermittent activity.

APPENDIX A

RADON EMANATION MODELING

Condensed from the Report,
"Radon Emanation and Dispersion Modeling"
By Triad Inc., Albuquerque, New Mexico
October 1976
For Homestake Mining Company

APPENDIX A

TABLE OF CONTENTS

ABSTRACT
RADON EMANATION MODELING
OCTOBER 1986

This report is part of the results of work accomplished under Contract Number 152772, conducted for Homestake Mining Company, Grants, New Mexico for the determination of radon emanation and dispersion. The modeling was performed to determine the cover requirements for the Homestake Mill Tailings Pile.

The results show that if the tailings sands are pushed over the slimes, they would reduce the emissions from the slimes. This, in turn, reduces the soil cover requirements to slightly less than one foot of cover required to meet the radon emission requirements of the NRC. This result is conservative.

The computer programs that were used for this work are documented and verified utilizing numeric calculations and comparative analysis. The programs consisted of RAECOM (Ref. 1), an NRC-approved program for determination of cover requirements; HAZMAT (Ref. 2), a proprietary Triad program for statistical analysis and numeric modeling; and AIRDOSE (Ref. 3), a DOE program for the determination of plume dispersion in various meteorological conditions.

RADON EMANATION MODELING

1.0 INTRODUCTION

Homestake Mining Company, Grants, New Mexico came under the regulatory overview of the Nuclear Regulatory Commission (NRC) in 1986. The NRC requested that a plan be developed for the stabilization and reclamation of the facility. This plan includes a soil cover to reduce radon flux to meet the emission requirements in 10 CFR 40, Appendix A.

Triad Inc. (Triad) was contracted to perform the radon emanation modeling. Homestake also requested that Triad review their data, determine its statistical validity, and put it into a useful format. This was done using the program "STA-PRO" (Ref. 4). The initial findings were presented to the NRC at an informal meeting in September 1986. The concensus from the NRC at this meeting was that the methods utilized and results obtained met with their general approval. This report contains only information on the modeling of radon emanation related to soil cover requirements for Homestake's tailings facility.

2.0 COVER REQUIREMENTS

2.1 ASSUMPTIONS

Radon emanation is normally calculated assuming a blend of tailings sands and slimes. The total combined amount of radium is determined using the slimes and sands as percentages of the blend, which is used for calculation of the cover requirements. The Homestake plan for reclamation of the pile does not blend the sands and slimes, but calls for at least 15 feet of

tailings sands to be pushed over the slimes (Ref. 6). This configuration uses the sands to reduce the emission rate from the slimes.

2.1.1 Parameters

The calculations used the following parameters. The sands were assumed to have a radium content of 100 pCi/g and the slimes of 1,000 pCi/g (Ref. 7). The sands were assumed to have a diffusion coefficient of .021 cm^2/s and the slimes of 4.3×10^{-5} cm^2/s (Ref. 8). The radon flux rates for the sands were assumed to be .71 $pCi/m^2/s$ and for the saturated slimes, .032 $pCi/m^2/s$ (Ref. 8). These are conservative numbers. The porosity of the tailings sands is estimated at 37% with a moisture content of 11%. The cover material was assumed to have a porosity of 37% with a moisture content of 12% (Ref. 6).

2.2 COMPUTATIONS OF SANDS OVER SLIMES

It was necessary to determine the optimized amount of tailings sands over slimes to reduce the radon emissions from slimes. The RAECOM code was used with the following assumptions:

1. Sands have no radium.
2. Sands have porosity of 37% with 11% moisture.
3. Slimes have a diffusion coefficient of 4.3×10^{-5} cm^2/s.
4. The flux rate for the saturated slimes is .032 $pCi/m^2/s$.
5. Saturated slimes have a porosity of 37% with a 24.8% moisture content.
6. Slimes have 1,000 pCi/g radium concentration.
7. Slimes are assumed to be infinitely thick.

The results of these computations are:

AMOUNT (feet)	EMISSION RATE ($pCi/m^2/s$)
01	97
02	93
03	82
04	62
05	48
06	36
07	27
08	22
09	17
10	16
11	15
12	14
13	13
14	11
15	10
16	09
17	09
18	08
19	08
20	08

These results indicate that when nine feet of sands are placed on the slimes, radon emissions are reduced to below the required limits of 10 CFR 40, Appendix A.

2.3 SANDS WITH RADIUM

A determination of the cover requirements was then necessary for the tailings sands. The RAECOM code was used with the following assumptions:

1. Sands have 100 pCi/g.
2. Sands have porosity of 37% with 11% moisture.
3. Sands have a diffusion coefficient of .021 cm^2/s.
4. The flux rates for the sands is .71 $pCi/m^2/s$.
5. Cover material has porosity of 37% with 12% moisture.

AMOUNT (feet)	EMISSION RATE ($pCi/m^2/s$)
01	11
02	09
03	08
04	04
05	01

The results indicate that one foot of the soil cover described will meet the 10 CFR 40 requirements for radon emanation limits of 20 $pCi/m^2/s$.

2.4 MODELING OF SLIMES, SANDS, AND COVER SECTION

The models described in 2.2 and 2.3 were combined in a subsequent RAECOM modeling run that combined the slimes, sands, and cover material in one section with all the following assumptions:

1. Slimes have 1,000 pCi/g, sands have 100 pCi/g.
2. Slimes have a porosity of 37% with a 24.8% moisture content.
3. Sands have 100 pCi/g, with a porosity of 37% and a moisture content of 11%.
4. Cover material has a porosity of 37% with a moisture content of 12%.
5. Sands have a diffusion coefficient of .021 cm^2/s, and slimes have 4.3×10^{-5} cm^2/s.
6. Sands have a radon flux rate of .71 $pCi/m^2/s$, and the saturated slimes of .032 $pCi/m^2/s$.
7. Slimes are assumed to be infinitely thick.

AMOUNT (feet)	EMISSION RATE ($pCi/m^2/s$)
01	12
02	10
03	09
04	05
05	02

These results indicate that less than one foot of cover material is required to be placed on the tailings pile to comply with the NRC radon emission release limits.

3.0 CONCLUSION

3.1 COVER REQUIREMENTS

The cover requirements for the Homestake Mill Tailings Pile are based on the results of the radon emanation model (Attachment 1). Input to the model requires at least 15 feet of sands being placed on slimes. The result is that the emissions from the slimes become negligible. The sands have an order of magnitude less radium than the slimes. This allows for a significantly reduced amount of soil cover material thickness. Specifically, less than one foot is required for radon release protection.

3.2 METEOROLOGICAL EFFECTS

Barometric pressure affects the radon emissions from the Homestake facility and influences the area's background significantly. The barometric pressure causes measured changes in background concentrations from 0.98 pCi/l to 6.83 pCi/l Rn-222. All other meteorological conditions combined produce less than a 1% difference in emissions (Ref. 9).

3.3 BACKGROUND RADON

Background radon concentrations for the Ambrosia Lake area are significantly higher than normal. The readings taken at the Homestake facility are greatly influenced by this background. The background radon subtraction

shows that over the past three years there is normally less than 1 pCi/l of Rn-222 present at the mill site (Ref. 9).

3.4 CONSERVATISMS

The following conservatisms are included for information and are not used in any of the calculations:

1. The radium content of the sands is assumed to be 100 pCi/g; the actual amount is approximately 90 pCi/g (Ref. 7).
2. The radium content of the slimes is assumed to be 1,000 pCi/g; the actual amount is approximately 900 pCi/g (Ref. 7).
3. The depth of sands over slimes will be at least 15 feet; there will be more in some locations (Ref. 6).
4. The actual cover requirement is 0.6 feet, whereas 1.0 feet is actually recommended.
5. The small size of the tailings particles is not accurately modeled in RAECOM; consequently, the tortuosity of radon gas flow paths and resultant flow retardation is underestimated by RAECOM.
6. The influence of background is not considered.

These conservatisms clearly indicate with a great deal of certainty that one foot of cover material is adequate with a significant margin of conservatism.

APPENDIX A - REFERENCES

Ref. 1 - "Radiation Attenuation Effectiveness and Cover Optimization with Moisture Effects," RAECOM, The RAECOM Code. NUREG/CR-3533, PNL 4878, RAE-18-5, RU.

Ref. 2 - "HAZMAT", A Proprietary 2-D and 3-D Modeling Code Developed by Triad Incorporated. Prepared by G.S. Mihalovich, December 1985.

Ref. 3 - "AIRDOSE", An airborne release program for determination of plume dispersion integrating meteorological conditions. Resident at the Westinghouse Computing Center, Advanced Systems Technology, Pittsburgh, PA.

Ref. 4 - "STAT-PRO", A Proprietary Statistical and Data Base Management System Developed by Mass. Institute of Computer Technologies. ISBN #0-534-02831-4, September 1984.

Ref. 5 - "Radon Attenuation Handbook for Uranium Mill Tailings Cover Design," NUREG/CR-3533, PNL-4878, RAE-18-5, RU, prepared by V.C. Rogers et al., by Rogers and Associates Engineering Corporation, April 1984.

Ref. 6 - Telecom, Alan K. Kuhn, Consulting Engineer, September 1986, for data input to RAECOM model and other information. Telecom #HMC-86-045.

Ref. 7 - Meeting Minutes, Homestake Mining Company, Edward Kennedy, Meeting Minutes #HMC-86-023. Data obtained for calculations of both forward and backfit model, August 1986.

Ref. 8 - "Radon-222 Emissions and Control Practices for Licensed Uranium Mills and Their Associated Tailings Piles," by PEI Associates, June 1985.

Ref. 9 - "Computer Modeling and Data Analysis of Uranium Mill Tailings Cover," TRIAD:086:HMC:002, prepared by G.S. Mihalovich and S.W. Woolfolk, November 1986.

ATTACHMENT 1
TO APPENDIX A

RUN ONE

********** I N P U T P A R A M E T E R S **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.032 pCi/m2/sec
SURFACE RADON CONCENTRATION : 9.800 pCi/liter

LAYER 1 ADJUSTED TO MEET Jcrit: 20.0 +/- 0.100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 : 0.000 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/sec)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	30.	2.1000E-02	37.0000	0.0000E-01	12.00
2	457.	2.1000E-02	37.0000	4.3100E-02	11.00
3	00.	4.3000E-05	37.0000	7.1000E-02	24.80

*****R E S U L T S O F R A D O N D I F F U S I O N C A L C****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONN. (pCi/liter)	MIC
1	30.	1.2350E+02	2.8734E+01	0.7125

RUN TWO

********** I N P U T P A R A M E T E R S **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.032 pCi/m2/sec
SURFACE RADON CONCENTRATION : 9.800 pCi/liter

LAYER 1 ADJUSTED TO MEET Jcrit: 20.0 +/- 0.100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 : 0.000 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/sec)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	61.	2.1000E-02	37.0000	0.0000E-01	12.00
2	457.	2.1000E-02	37.0000	4.3100E-02	11.00
3	00.	4.3000E-05	37.0000	7.1000E-02	24.80

*****R E S U L T S O F R A D O N D I F F U S I O N C A L C****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONN. (pCi/liter)	MIC
1	61.	1.3121E+02	2.2354E+01	0.7125

ATTACHMENT 1
TO APPENDIX A
(Continued)

RUN THREE

********** I N P U T   P A R A M E T E R S **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.032 pCi/m2/sec
SURFACE RADON CONCENTRATION : 9.800 pCi/liter

LAYER 1 ADJUSTED TO MEET Jcrit: 20.0 +/- 0.100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 : 0.000 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/sec)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	91.	2.1000E-02	37.0000	0.0000E-01	12.00
2	457.	2.1000E-02	37.0000	4.3100E-02	11.00
3	00.	4.3000E-05	37.0000	7.1000E-02	24.80

*****R E S U L T S   O F   R A D O N   D I F F U S I O N   C A L C****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONN. (pCi/liter)	M1C
1	91.	9.7232E+03	1.8635E+01	0.7125

RUN FOUR

********** I N P U T   P A R A M E T E R S **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.032 pCi/m2/sec
SURFACE RADON CONCENTRATION : 9.800 pCi/liter

LAYER 1 ADJUSTED TO MEET Jcrit: 20.0 +/- 0.100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 : 0.000 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/sec)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	122.	2.1000E-02	37.0000	0.0000E-01	12.00
2	457.	2.1000E-02	37.0000	4.3100E-02	11.00
3	00.	4.3000E-05	37.0000	7.1000E-02	24.80

*****R E S U L T S   O F   R A D O N   D I F F U S I O N   C A L C****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONN. (pCi/liter)	M1C
1	122.	5.2873E+03	1.4231E+01	0.7125

TRIAD INCORPORATED

ATTACHMENT 1
TO APPENDIX A
(Continued)

RUN FIVE

********** I N P U T   P A R A M E T E R S **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.032 pCi/m2/sec
SURFACE RADON CONCENTRATION : 9.800 pCi/liter

LAYER 1 ADJUSTED TO MEET Jcrit: 20.0 +/- 0.100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jc) FROM LAYER 1 : 0.000 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/sec)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	152.	2.1000E-02	37.0000	0.0000E-01	12.00
2	457.	2.1000E-02	37.0000	4.3100E-02	11.00
3	90.	4.3000E-05	37.0000	7.1000E-02	14.80

*****R E S U L T S O F R A D O N D I F F U S I O N C A L C*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONN. (pCi/liter)	MIC
1	152.	2.3622E+03	1.0221E+01	0.7125

TRIAD INCORPORATED

APPENDIX B

REPORT OF BORROW SOIL INVESTIGATIONS
HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO

B.1.0 INTRODUCTION

Upon closure of the Grants mill, Homestake Mining Company (HMC) will place a soil cover over the tailings impoundment in accordance with 10 CFR 40, Appendix A, Criterion 6. The reclamation plan developed in 1982 (D'Appolonia, 1982) identified two borrow areas on HMC property from which cover soil could be obtained. However, no detailed investigations had been performed on these areas. In order to determine specifically the properties and quantities of potential borrow materials, information needed in part to support radon emanation modeling and cover design, HMC conducted investigations of the potential borrow areas.

The potential borrow sources are those portions of HMC property to the north and west of the tailings impoundment. Auger test borings and test pits were used to explore these areas and obtain samples for identification and testing. Laboratory tests were conducted on selected samples to determine soil classification and properties important in cover design.

The field and laboratory investigations show that the potential borrow areas contain mostly fine to medium grained alluvial sands. However, significant amounts of clay also exist at shallow depths. When used separately or mixed with the sands, the clays will be easily workable and will provide a suitable cover material for the tailings impoundment. Available quantities of

clay, sand, or a sand/clay mixture are sufficient for the impoundment cover as well as any other possible use in site reclamation.

This report describes the investigations that were performed and the rationale behind them (B.2.0) and the results of the investigations (B.3.0). Supporting data, including logs and test reports, are included as attachments to this report.

B.2.0 METHODS OF INVESTIGATION

The objectives of the investigation were to:

- Identify the types and volumes of soils available in the potential borrow areas.
- Determine those physical properties which would affect placement and performance of the soils as cover on the impoundment.
- Delineate a borrow pit in appropriate soils to be included in the stabilization and reclamation plan.

To accomplish these objectives, a two-phase field exploration program and a laboratory testing program were used. The first phase of the exploration program consisted of drilling and sampling 20 test holes. After initial laboratory testing and evaluation of samples from these test holes, the second exploratory phase was performed. In this second phase, nine test pits were dug at selected locations between test borings. Additional laboratory testing was performed on selected bulk samples of test pit material.

B.2.1 TEST BORINGS AND SAMPLING

In the first phase of exploration during July 15-17, 1986, twenty test

borings were drilled at locations shown in Figure B1. All but three borings were drilled to 21.5 feet. Two, BA17 and BA18, were drilled to 26.5 feet, and BA11 was drilled to 36.5 feet. Each boring was advanced by 4.0 inch I.D. hollow stem auger with Standard Penetration Tests (SPT) performed at five-foot intervals, starting at five feet depth. SPT samples were used for visual soil classification in the field and then preserved in glass jars with airtight lids.

Grab samples of auger cuttings were also obtained at irregular intervals from each boring. A sample of 10 to 20 pounds was usually collected whenever a change of soil was encountered or when clay was penetrated. The mixing of clay and sand soils on the auger flights provided a reasonable analog of the soil mixture that could be used for the impoundment cover.

The locations of the borings were chosen to provide coverage of all HMC property north and west of the impoundment from which borrow soil, if suitable, could be obtained. Other locations on the property were not considered because of proximity to the highway, residences, or mill facilities. The location of each boring was selected by a field engineer and later surveyed by HMC.

All test borings encountered relatively uniform fine to medium sand, and most borings encountered clay as well. Two distinct areas of clay exist, one to the north and west of the impoundment and the other off the northeast corner of the impoundment. The latter occurs at the bottom of BA11 and BA18, below 21 feet, and is the clay of the Chinle shale. The major area of clay, north and west of the impoundment, contains stiff to very stiff

alluvial clays interbedded with sands. The clay which occurs at relatively shallow depth, less than 10 feet, is most accessible and, therefore, of most interest in this investigation. A significant volume of shallow clay, estimated to be about 580,000 cubic yards, was found in the area outlined in Figure B1.

B.2.2 TEST PITS

After the test borings were completed and results were obtained from the initial laboratory tests, nine test pits were dug by backhoe. The test pits were located between borings and beyond the boring pattern to confirm the continuity and extent of the clay deposits. The pits were dug to a maximum depth of 10 feet. Bulk samples were obtained of individual soil strata for additional testing.

The test pits were located by a field engineer relative to the test boring locations and nearby reference points. The locations of the pits were not surveyed.

B.2.3 LABORATORY TESTING

Standard soil testings using ASTM procedures were used to characterize the properties important to the evaluation of the soils for the impoundment cover. In the reduction of radon emanation, the long-term retained moisture and density/porosity of the soil is most important. Grain size distribution and plasticity characteristics affect the workability, compaction characteristics, and erodability of the soil.

Moisture Content - All SPT samples were tested for natural moisture content. Most of this testing was performed by HMC in its mill lab, but Sergent, Hauskins and Beckwith (SHB) tested moisture contents in samples from four borings. The natural moisture ranged from less than 8% in sands to between 8 and 16% in clays.

Grain Size Distribution - Because most soils were clearly either sands or fines (minus No. 200 mesh) based on visual classification, grain size analysis was run only on those 11 bulk samples of mixed soils taken from the augers. These analyses made it possible to relate compaction test results to the grain size distribution.

Atterberg Limits - A total of 22 Atterberg limits (liquid and plastic limits and plasticity index) were run in accordance with ASTD D4318 to properly classify and predict behavior of the fine grained soils. Fifteen of the samples were from SPT tests and provided an initial assessment of the occurrence and distribution of clays. The seven test pit samples tested later confirmed continuity of clays and provided a broader data base for evaluating the properties of the clays.

Compaction Tests - Moisture-density relationships for compacted soils were determined for 18 samples of borrow soil using the Standard Proctor Test Method A of ASTM D698. This test, used to determine the relationship between moisture content and compacted density, yields the optimum values of both. Eleven tests were performed on auger-mixed sand-and-clay grab samples and seven tests were performed on bulk samples of clays taken from the test pits.

Permeability Tests - Four constant-head hydraulic conductivity tests were performed to determine the intrinsic permeability of compacted soil covers. The samples tested were four auger-mixed sand-and-clay samples that represented a reasonable range of cover soil mixtures, based on visual inspections. The samples were first compacted to about 95% maximum dry density at moisture contents slightly wet-of-optimum amounts, similar to the expected field compaction specifications. Each was then saturated and placed under a constant head of 11.5 feet of water, and the amount of flow through time was measured.

B.3.0 RESULTS OF THE INVESTIGATION

B.3.1 DESCRIPTION OF SOILS PRESENT

The designated borrow area contains alluvial soils to depths of at least 21 feet, all above the ground water table. These soils are primarily fine to medium sands, but in the portion of the area west of about departure coordinate 400,000E (see Figure B1), a large amount of clay exists at shallow depth within the alluvium. The natural moisture contents and Atterberg limits of the clays indicate that there may be two distinct clays present in this area. Clay A has medium to low plasticity and natural moisture content below 9%. Clay B is medium to high plasticity with natural moisture content of 10% or higher. The two clays are also distinguishable in Standard Proctor testing, where optimum moisture content of Clay B is higher than Clay A (19 to 22% versus 13 to 18%) and the maximum dry density of B is lower than A (100 to 102 pcf versus 109 to 112 pcf). The distinction between the two clays is readily apparent based on the properties tested but might not be statistically supportable.

The distribution of shallow clay is shown in Figure B1. Deeper clays exist south and east of the clay area shown, but are not being considered at this time for use as borrow material. The area of clay is irregular but appears to be continuous. The A and B clays occur together in this area without apparent spatial separation, although there is some indication that the B clay is concentrated in the deeper, more central parts of the clay deposit, while the A clay is more common toward the edges of the deposit. It is not possible to delineate the separation of A from B clay with confidence at this time.

The sand soils appear to be relatively clean, containing little fines (silts and clays). The size range is narrow and consistently fine to medium sand. Natural moisture contents are usually up to 8% and seem unrelated to depth.

B.3.2 SUITABILITY FOR COVER SOIL

The evaluation of the borrow soil for cover suitability must refer to the performance requirements of the cover. The cover must: (1) reduce radon flux to not more than 20 pCi/m^2s; and (2) resist erosion and infiltration and otherwise remain stable for 1,000 years.

For the first requirement the lowest possible effective porosity and a long-term retained moisture content of at least 10% are desired. For the second requirement, maximum density and cohesion and minimum permeability are desired. The clays soils have more of these desirable properties than the sands. However, sand compacts to higher densities and is generally more

workable than clay. Consequently, a mixture of clay and sand is best for the cover soil, although either the A or B clay alone would be satisfactory.

The mixed soil obtained from the auger, which effectively blended the clay and sand that it penetrated, has been evaluated as the design soil mix for the impoundment cover. This clay/sand mix contains up to 40% clay and is classified as a clayey sand (SC) according to the Unified Soil Classification System. Maximum dry density should be 111 to 117 pcf with optimum moisture contents of 12 to about 15%. Placed at 90-95% density, initial moisture contents can be raised to 14-18% so that long-term retained moisture of about 12% is reasonable. With a mean maximum dry density of about 115 pcf, 90% compaction will produce about 104 pcf dry density and total porosity of about 37%. With a significant clay content, the effective porosity should be significantly less. At 95% compaction, the hydraulic conductivity (intrinsic permeability) of this mixed soil should be 10^{-6} to 10^{-8} cm/sec, while at 90% compaction the value will probably increase about an order of magnitude.

Achieving these properties is well within both the characteristics of the mixed soil and the capabilities of standard earthwork practice. Natural moisture contents of 9 to 15% indicate that it is reasonable to expect 12% retained moisture over the long term if the soil is moisture conditioned to 14-18% during compaction. With that moisture content the soil should be compactable to at least 100 pcf, a dry density sufficient to make the cover durable over a long period of time. Should further analysis indicate that increased clay content (above 40%) would improve cover performance, the soil

mixture can be easily enriched with clay, which will decrease dry density but also increase retained moisture and reduce effective porosity.

B.3.3 DELINEATION OF BORROW PIT

The design cover soil, a sand/clay mixture, can be obtained from relatively shallow excavation in the area in the clay deposit, shown in Figure B1. For a nominal two-foot thick cover, about 570,000 to 600,000 cubic yards of soil will be needed. Conceivably, then, the estimated 580,000 cubic yards of shallow clay could provide all the cover soil needed. However, some borrow soil might be required for site recontouring, evaporation pond reclamation, or other purposes, so a borrow pit of larger capacity is desirable. In addition, because the pit will be located in the San Mateo Creek floodplain, its location, shape, and reclamation should enhance flood diversion and protection to the extent possible.

The location, size, and configuration of the borrow pit delineated in Figure B1 take into account the considerations discussed above. The pit will be located west and north of the areas of suspected excessive radium contamination of soil, so no borrow soils should be contaminated. The borrow pit is defined by straight boundaries, for simplicity in conceptual design, and follows the general pattern of the clay deposit. It starts at the northeast end with a 1% grade sloping to a cut up to 10 feet deep. The pit trends southwestward for about 3,000 feet to the county road, then south-southwestward for another 2,000 feet, becoming progressively more shallow until it merges with existing grade. The width north of the county road is about 1,300 feet, narrowing south of the road to 600 feet at the south end of the pit.

This configuration will yield about 800,000 cubic yards and will require very little reclamation. The capacity includes allowance for losses due to clearing and spoil of soil with too much organic content, for impoundment cover design thickness changes, and for borrow soil requirements elsewhere on site. The layout and gradient of the pit create a large diversion channel which can redirect flood waters around the impoundment. Only small amounts of regrading and then revegetation will be required to reclaim the pit to its post-closure function as a flood channel.

B.4.0 CONCLUSION

This investigation has established that the northwest portion of the HMC property contains clay and sand soils in sufficient quantity and with suitable properties to provide good cover soil for the impoundment and other possible uses. These soils will have the necessary moisture and density to effectively control radon emanation with relatively modest compacted thicknesses (about two feet). Standard earthwork methods and equipment will be adequate to excavate these soils from shallow depths and to place and compact them to required density and moisture. The volumes of available soil are more than enough to satisfy required quantities.

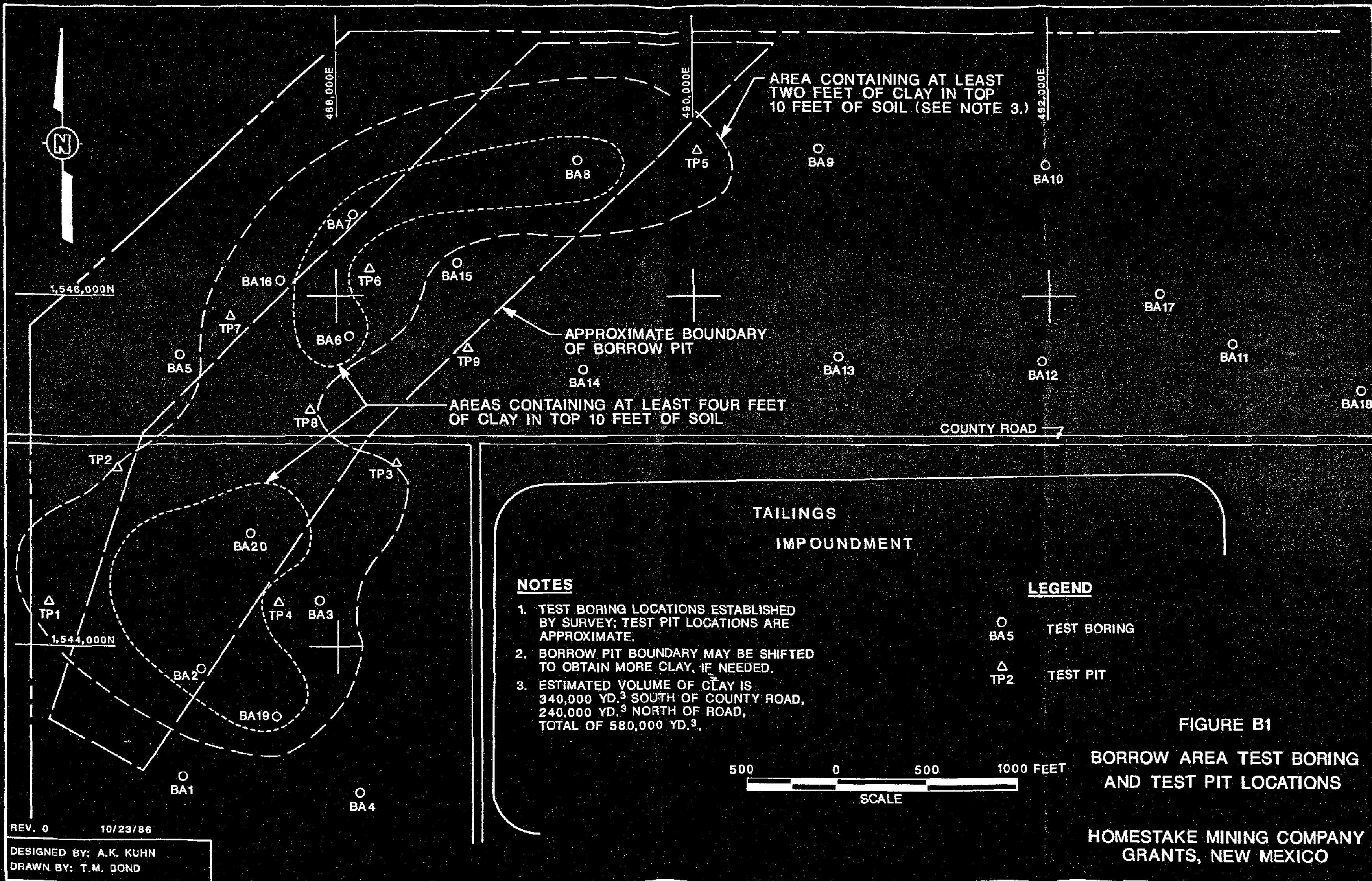


FIGURE B1
BORROW AREA TEST BORING AND TEST PIT LOCATIONS

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS

APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING • HYDROLOGY

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Date July 25, 1986

To: Alan Kuhn PhD., PE
13212 Manitoba Dr. N.E.
Albuquerque, N.M. 87111

SHB Job No. E86-1113

Attn: Alan Kuhn

Re: Contract Drilling & Lab Tests
Homestake Mining Company
Grants, New Mexico

We are sending ☐ As requested ☒ For your use ☐ For comment

☐ Enclosed ☐ Under separate cover via ______

Description Moisture content data & calculations on samples received today from Homestake Mine.

Remarks Homestake added one more sample to determine Atterberg Limits, BA 11-54

By Gregory M. Smith
Title Staff Engineer

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

HMCSL024682

12-21-86

PAN #	Samples		Wet	Dry	Tare
	BA-16				
1	S-1	CL	840	827	665
2	S-2		906	902	636
3	S-3		858	852	630
4	S-4		926	920	674
	BA-17				
5	S-1		962	958	673
6	S-2		881	872	669
7	S-3		909	895	623
8	S-4		926	922	666
9	S-5		905	894	671
	BA-18				
10	S-1		941	921	709
11	S-2		863	857	627
12	S-3		811	799	595
13	S-4(A)		874	857	635
14	S-4(B)	CL	909	876	668
15	S-5		799	789	604
	BA-19				
16	S-1		878	851	679
17	S-2		947	943	665
18	S-3		966	961	683
19	S-4		915	913	604
	BA-20				
20	S-1		851	831	656
21	S-2		933	930	683
22	S-3		936	928	692
23	S-4		890	884	669

7-22-86

Calculations

	Wet	Dry	Diff	% moisture $\frac{Wet-Dry}{Wet} \times 100$
BA-16				
S-1	175	162	13	7.43
S-2	270	266	4	1.48
S-3	228	222	6	2.63
S-4	252	246	6	2.38
BA-17				
S-1	289	285	4	1.38
S-2	212	203	9	4.25
S-3	286	272	14	4.90
S-4	260	256	4	1.54
S-5	234	223	11	4.70
BA-18				
S-1	232	212	20	8.62
S-2	236	230	6	2.54
S-3	216	204	12	5.56
S-4(A)	239	222	17	7.11
S-4(B)	241	208	33	13.69
S-5	195	185	10	5.13
BA-19				
S-1	199	172	27	13.5
S-2	282	278	4	1.42
S-3	283	278	5	1.77
S-4	311	309	2	0.6
BA-20				
S-1	195	175	20	10.26
S-2	250	247	3	1.20

SUMMARY OF NATURAL MOISTURE CONTENTS
OF BORROW SOIL SAMPLES
FROM TESTS BY HMC MILL LAB, 7/17/86

BORING NO., BA-	SAMPLE NO., S-	MOISTURE %	SOIL TYPE
1	1	2.55	
1	2	8.94	CL
1	3	2.22	
1	4	1.67	
2	1	13.27	CH
2	2	13.71	CL
2	3	2.67	
2	4	2.07	
3	1	2.36	
3	2	1.84	
3	3	0.94	
3	4	1.16	
4	1	4.48	
4	2	14.20	CL
4	3	11.03	
4	4	2.02	
5	1	5.57	
5	2	3.10	
5	3	2.21	
5	4	2.09	
6	1	12.04	CL
6	2	2.42	
6	3	2.08	
6	4	2.17	
7	1	9.96	CL
7	2	12.22	CL-CH
7	3	2.34	
7	4	1.67	
8	1	13.81	CH
8	2	2.26	
8	3	1.59	
9	1	4.00	
9	2	1.42	
9	3	0.48	
9	4	1.16	
10	1	2.21	
10	2	3.10	
10	3	1.57	
10	4	1.17	
11	1	3.26	
11	2	6.31	
11	3	3.96	
11	4	14.64	CH
11	5	14.14	CL
11	6	16.93	CH
11	7	4.79	
12	1	0.76	
12	2	3.17	
12	3	0.79	
12	4	2.53	
13	1	2.02	
13	2	5.70	
13	3	1.77	
13	4	0.96	
14	1	1.18	
14	2	1.78	
14	3	0.58	
14	4	0.80	
15	1	3.40	
15	2	2.91	
15	3	0.29	
15	4	1.45	

84-102

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS

APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING • HYDROLOGY

July 28, 1986

Alan K. Kuhn, PhD, P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dr. Kuhn:

The following table lists results of moisture-density relationships, ASTM D698, on samples requested in your letter to this firm dated July 21, 1986. Results of sieve analyses and compaction curves are attached.

Sample	Optimum Moisture Content (%)	Maximum Dry Density (pcf)
BA1-A1	7.8	118.4
BA2-A1	13.6	117.2
BA3-A1	12.1	115.4
BA5-A1	12.3	117.4
BA5-A3	13.6	116.6
BA6-A1	12.4	114.8
BA7-A2	13.4	115.8
BA8-A1	14.8	114.4
BA10-A1	12.0	117.2
BA14-A1	13.3	111.0
BA19-A1	12.8	116.2

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By [signature]
Gregory M. Smith, Staff Engineer

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

PHOENIX (602) 272-6848 ALBUQUERQUE (505) 884-0950 SANTA FE (505) 471-7836 SALT LAKE CITY (801) 266-0720 EL PASO (915) 778-3369

TABULATION OF TEST RESULTS

Job No. E86-1113

Project Contract Drilling & Laboratory Testing

Homestake Mining Company, Grants, NM

Material

Source

HOLE NO.	LOCATION	DEPTH	UNIFIED CLASS.	LL	PI	SIEVE ANALYSIS – ACCUM. % PASSING												LAB. NO.
						200	100	40	10	4	3/8	1/2	3/4	1	1-1/2	3	MOIST.	
	BA1-A1					13	35	98	100								2	13-1
	BA2-A1					32	56	99	100								5	13-2
	BA3-A1					19	55	100									3	13-3
	BA5-A1					25	45	97	100								4	13-4
	BA5-A3					30	50	98	100								2	13-5
	BA6-A1					17	48	99	100								3	13-6
	BA7-A2					36	55	94	100								5	13-7
	BA8-A1					25	50	98	100								6	13-8
	BA10-A1					18	42	96	100								4	13-9
	BA14-A1					14	35	94	100								3	13-10
	BA19-A1					26	61	99	100								5	13-11

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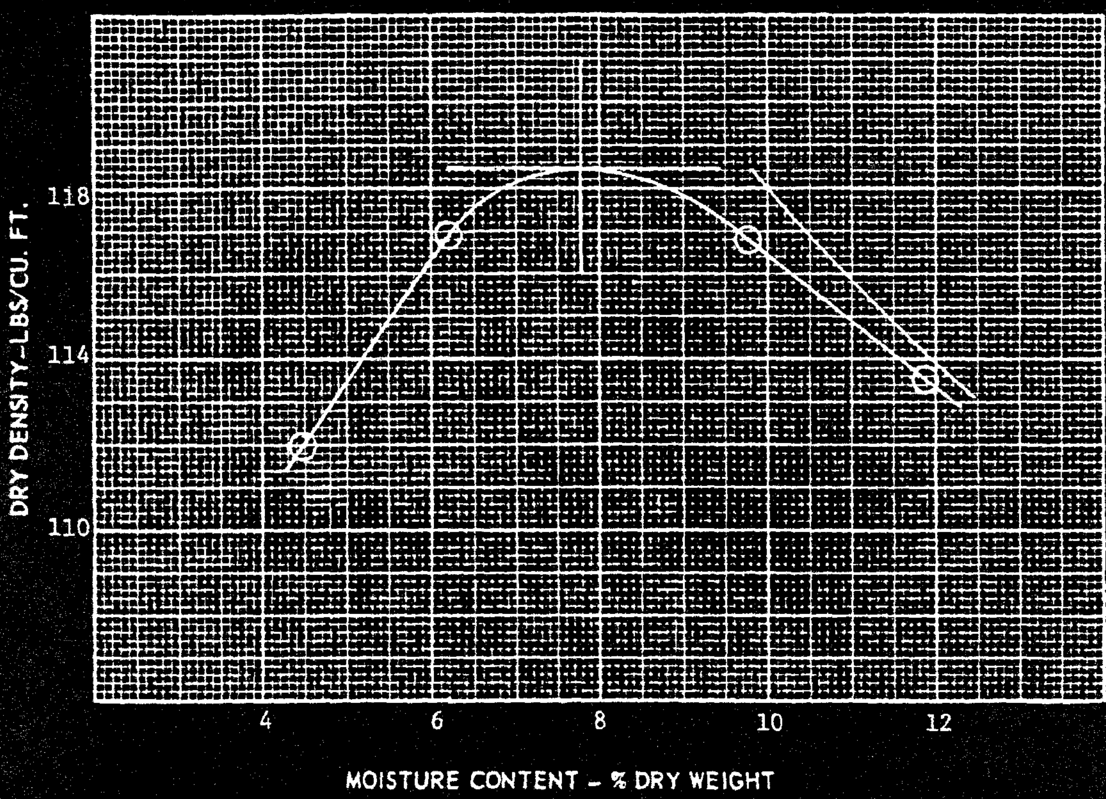
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA1-A1	7.9	118.4	ASTM D698	A	13-1

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	3	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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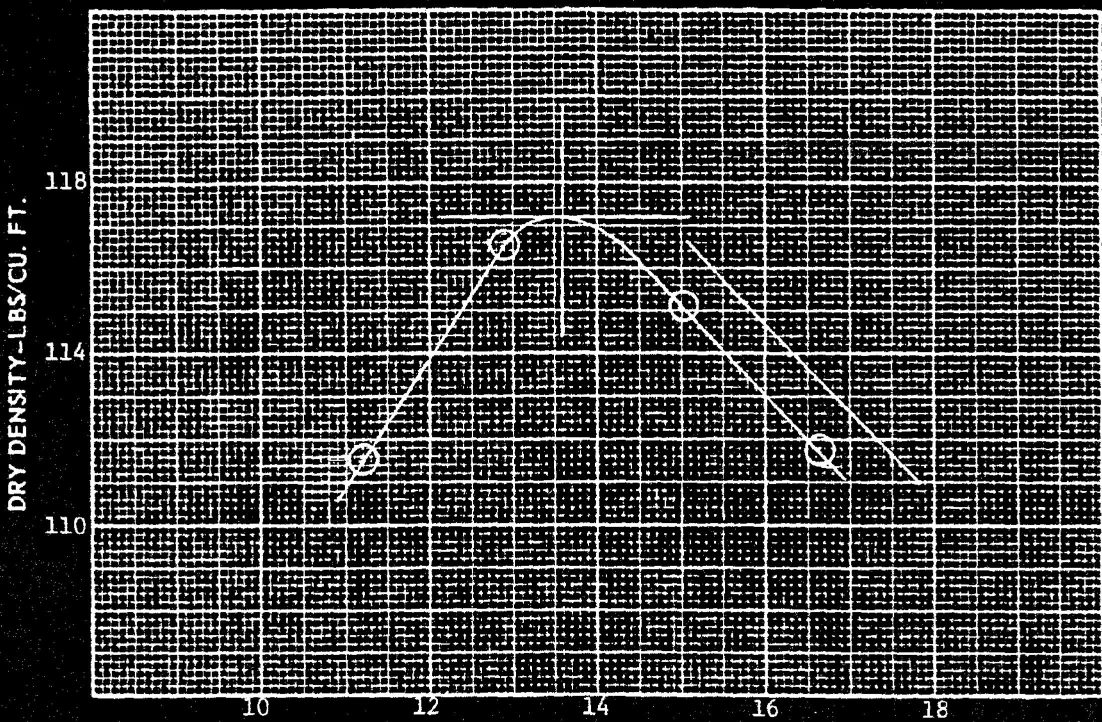
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



MOISTURE CONTENT – % DRY WEIGHT

CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA2-A1	13.6	117.2	ASTM D698	A	13-2

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	3	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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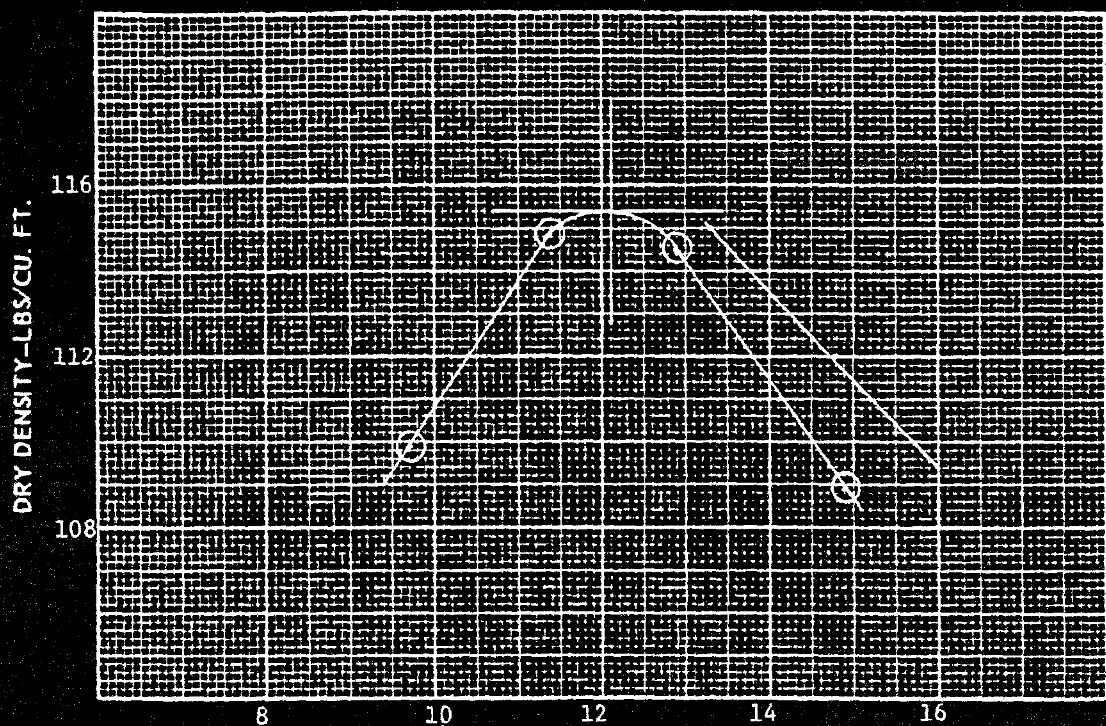
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company JOB NO. E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA3-A1	12.1	115.4	ASTM D698	A	13-3

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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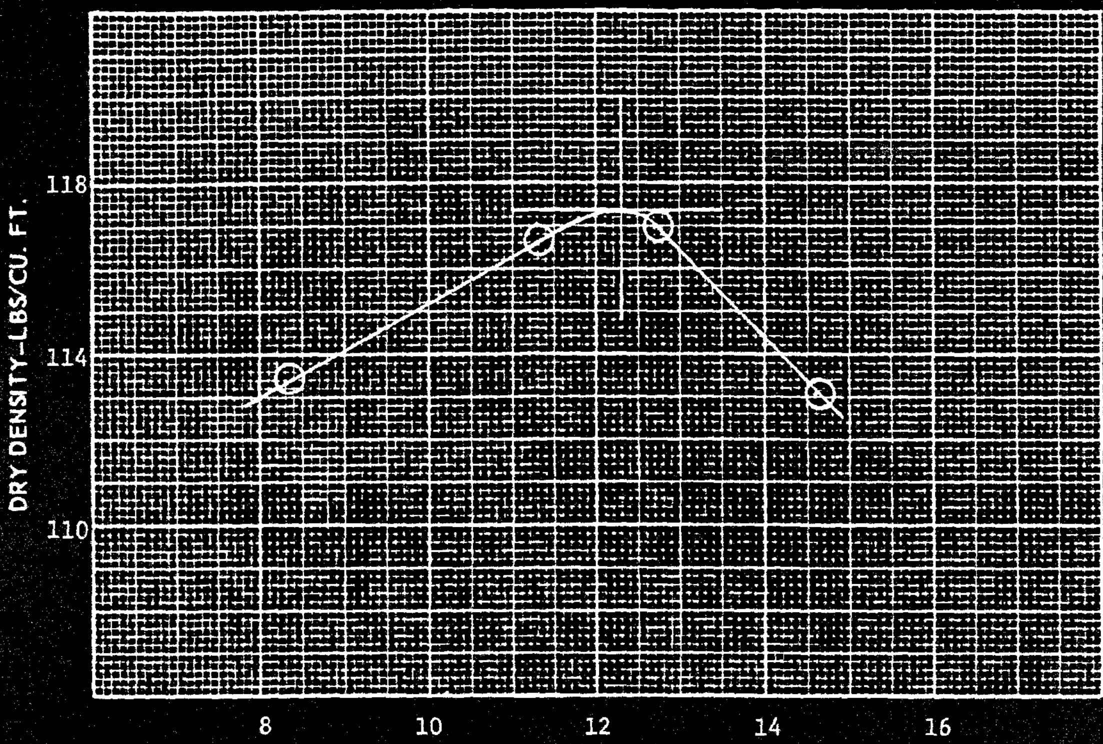
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA5-A1	12.3	117.4	ASTM D698	A	13-4

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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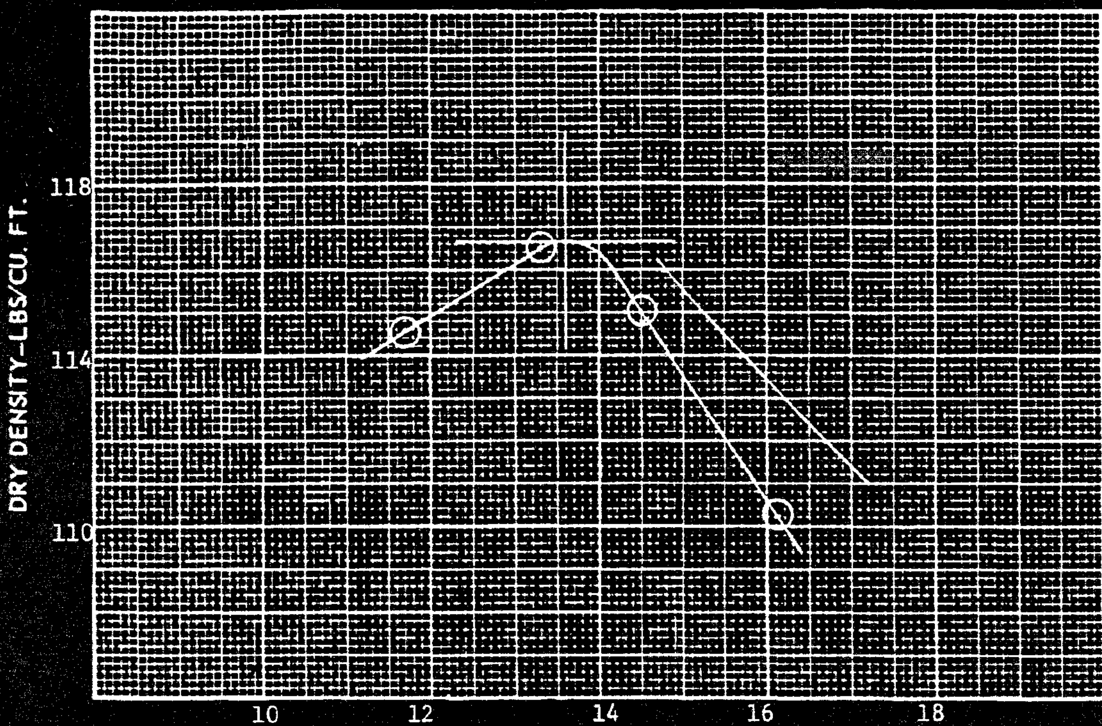
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



MOISTURE CONTENT – % DRY WEIGHT

CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA5-A3	13.6	116.6	ASTM D698	A	13-5

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	5	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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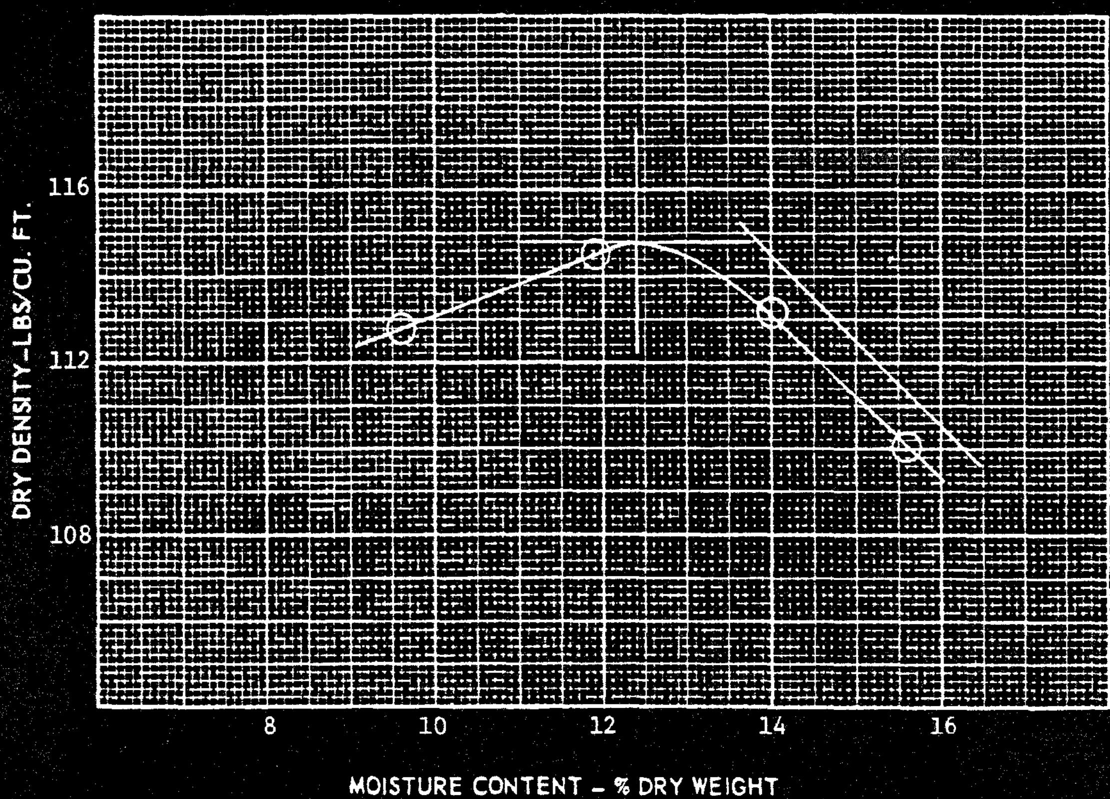
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA6-A1	12.4	114.8	ASTM D698	A	13-6

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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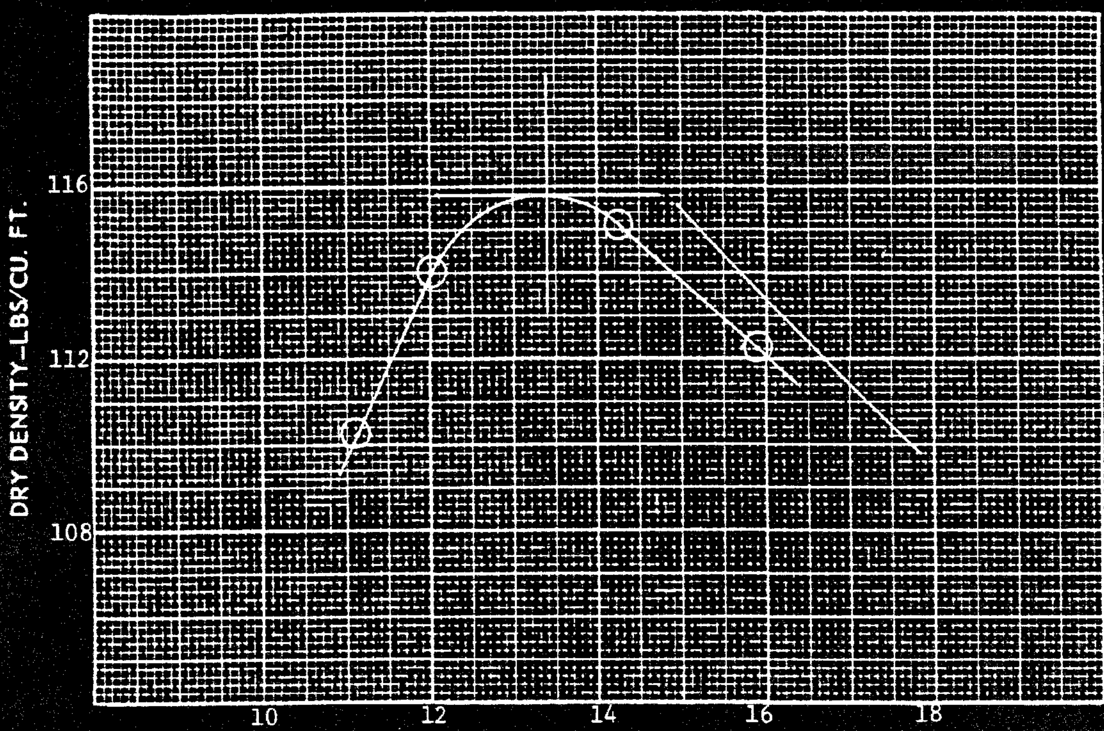
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



MOISTURE CONTENT – % DRY WEIGHT

CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA7-A2	13.4	115.8	ASTM D698	A	13-7

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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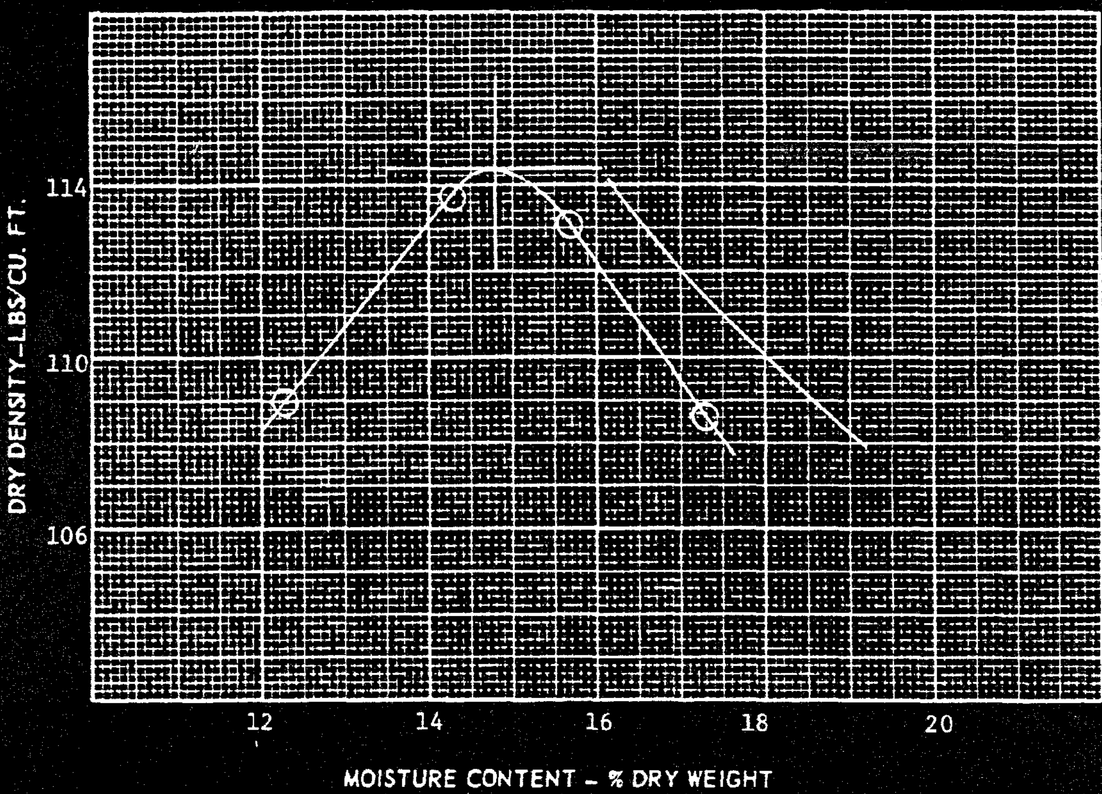
HMCSL024694

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA8-A1	14.8	114.4	ASTM D698	A	13-8

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4''	4.58''	3	25	5.5 LBS.	12''	12,375
B	-#4	6''	4.58''	3	56	5.5 LBS.	12''	12,317
C	+3/4	6''	4.58''	3	56	5.5 LBS.	12''	12,317
D	-3/4	6''	4.58''	3	56	5.5 LBS.	12''	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4''	4.58''	5	25	10.0 LBS.	18''	56,250
B	-#4	6''	4.58''	5	56	10.0 LBS.	18''	55,986
C	-3/4	6''	4.58''	5	56	10.0 LBS.	18''	55,986
D	-3/4	6''	4.58''	5	56	10.0 LBS.	18''	55,986

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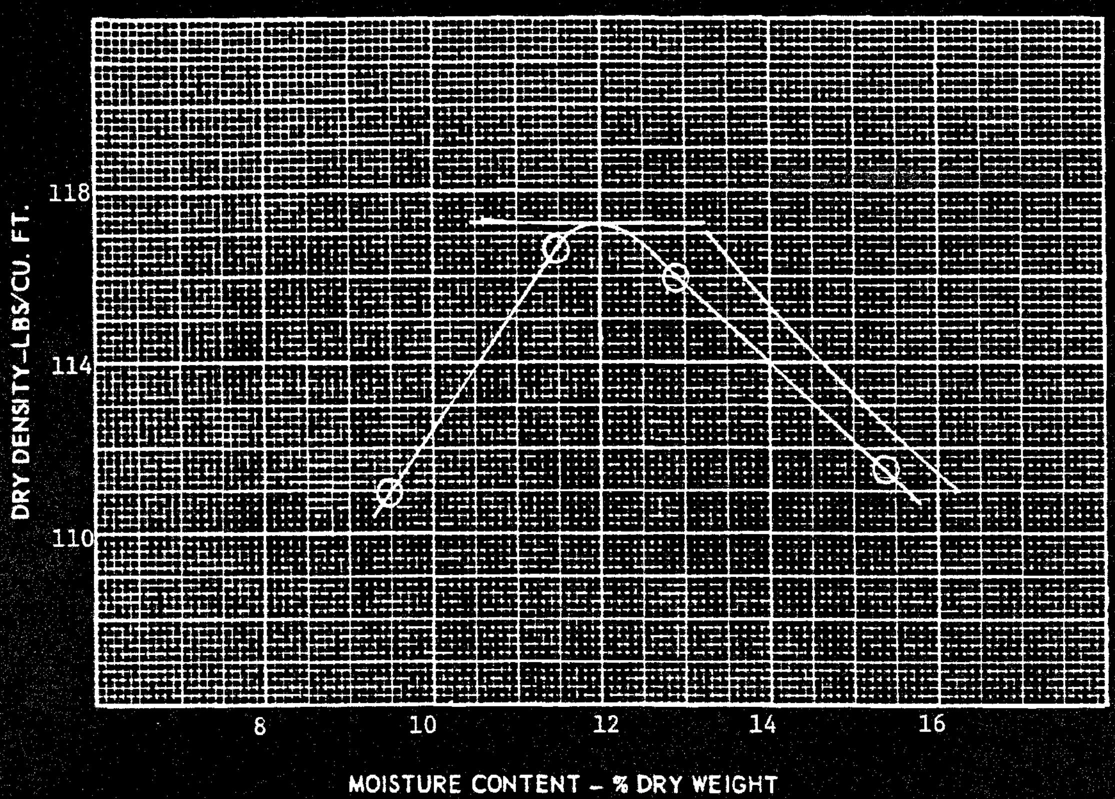
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA10-A1	12.0	117.2	ASTM D698	A	13-9

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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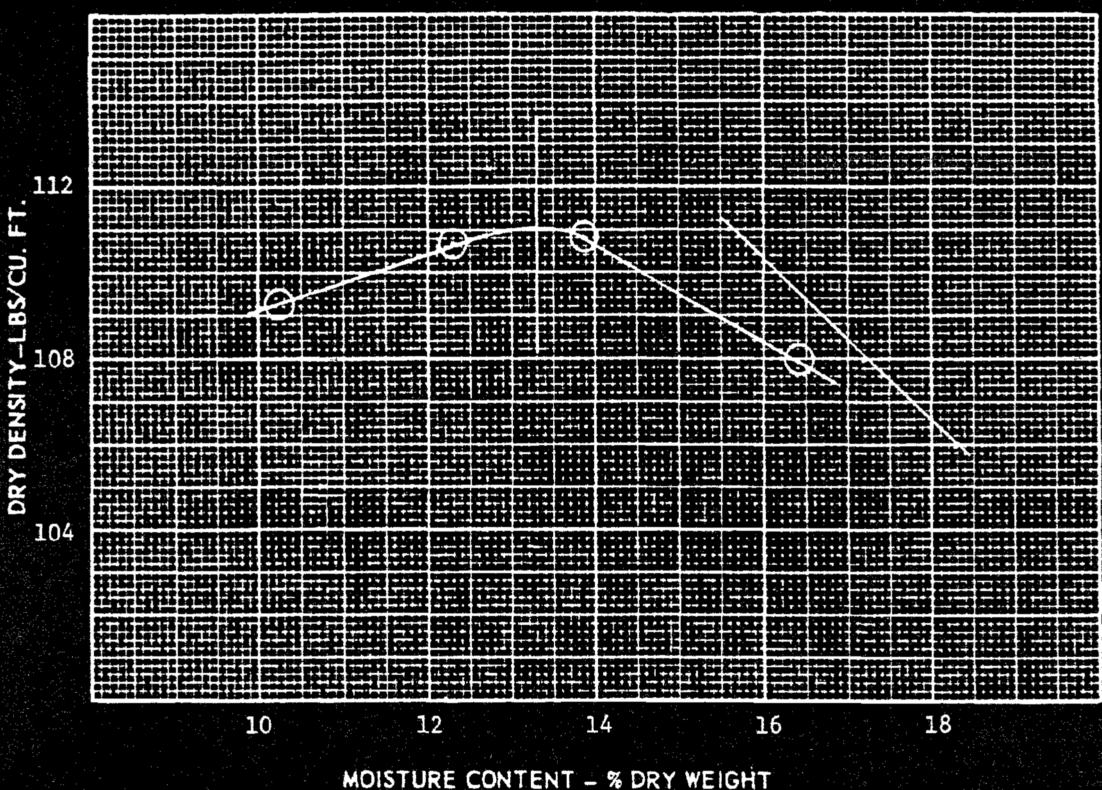
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA14-A1	13.3	111.0	ASTM D698	A	13-10

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
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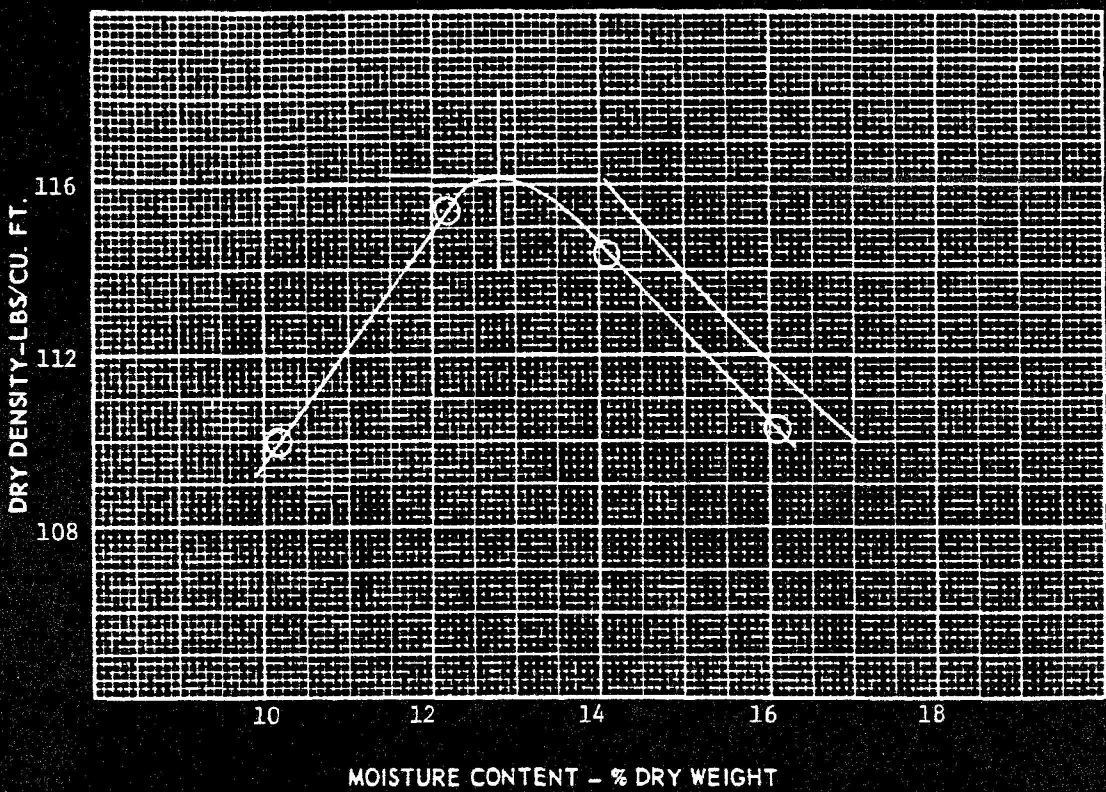
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	BA19-A1	12.8	116.2	ASTM D698	A	13-11

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	55,986
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
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July 31, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

Transmitted herewith is a table listing results of liquid limit and plasticity index tests performed in accordance with ASTM D4318, as requested in your letter of July 21, 1986. Also shown are the soil types of the samples according to the Unified Soil Classification System.

If you have any questions regarding these test results or those transmitted in our letter of July 28, please do not hesitate to contact us.

Respectfully submitted
Sergent, Hauskins & Beckwith Engineers

By [signature]
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

PHOENIX (602) 272-6848
ALBUQUERQUE (505) 884-0950
SANTA FE (505) 471-7836
SALT LAKE CITY (801) 266-0720
EL PASO (915) 778-3369

Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico
SHB Job No. E86-1113

Sample	Depth (feet)	U.S. Class.	Liquid Limit	Plasticity Index
BA1-S2	10-11.5	CL	32	11
BA2-S1	5-6.5	CH	52	31
BA2-S2	10-11.5	CL	48	28
BA4-S2	10-11.5	CL	48	26
BA6-S1	5-6.5	CL	47	27
BA7-S1	5-6.5	CL	42	22
BA7-S2	10-11.5	CL-CH	50	29
BA8-S1	5-6.5	CH	71	52
BA11-S4	20-21.5	CH	56	37
BA11-S5	25-26.5	CL	42	24
BA11-S6	30-31.5	CH	64	45
BA16-S1	5-6.5	CL	30	13
BA18-S4(B)	20-21.5	CL	33	14
BA19-S1	5-6.5	CH	52	32
BA20-S1	5-6.5	CL	39	20

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August 22, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

The table below presents results of moisture-density relationships, as determined by ASTM D698, on samples delivered by you to our lab August 15, 1986. Also listed are results of plastic and liquid limit tests, ASTM D4318. Moisture-density compaction curves are attached.

Sample	Optimum Moisture Content %	Maximum Dry Density (pcf)	Liquid Limit %	Plastic Limit %
TP1, B-1	19	102	40	20
TP2, B-1	13	110.5	23	19
TP4, B-1	16	112	24	19
TP4, B-2	22	102	37	18
TP5, B-1	21	102	45	18
TP7, B-1	16	109	25	18
TP8, B-1	21	100	35	19

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If you have any questions regarding these test results, please do not hesitate to contact us.

Respectfully submitted,

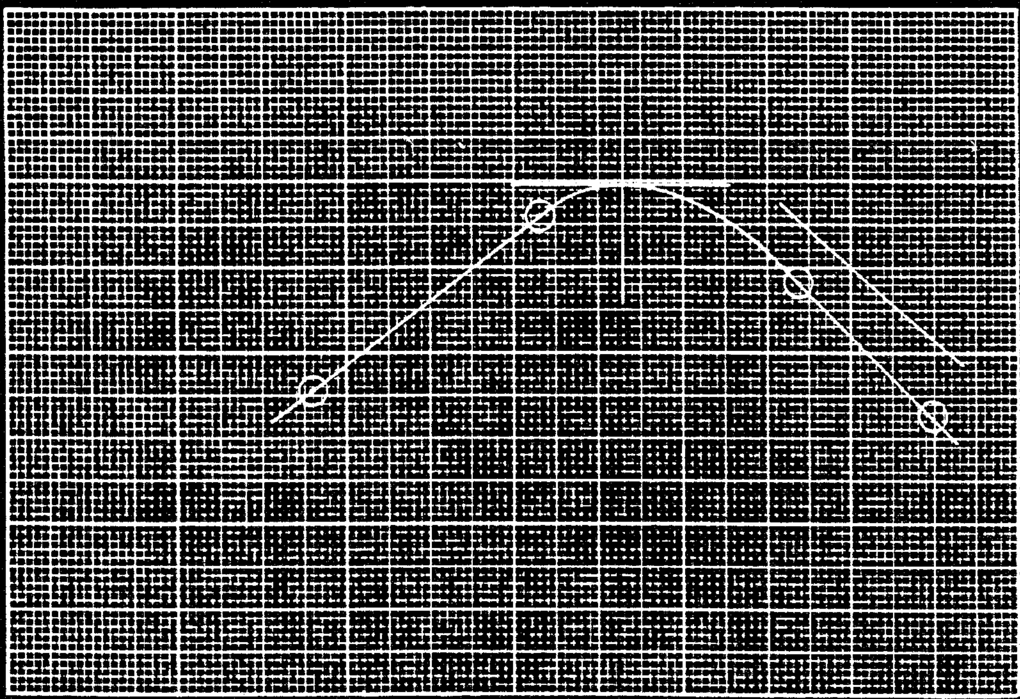
Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP1, B-1	19.3	101.9	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
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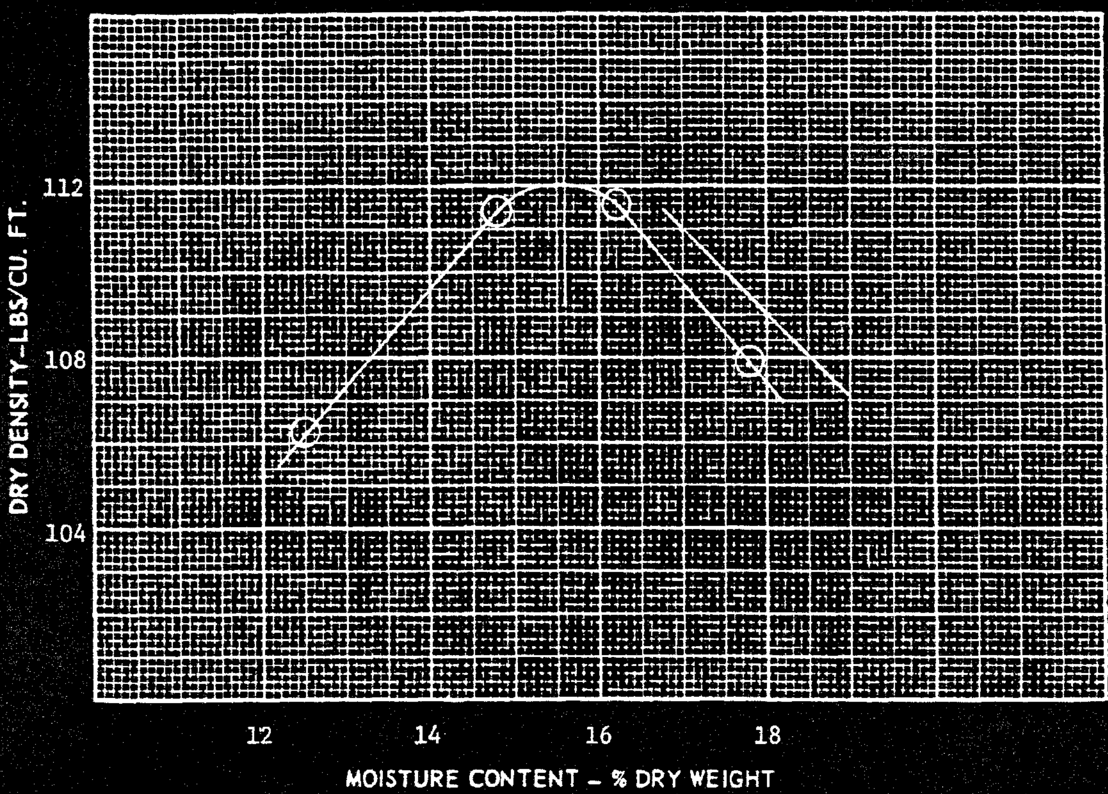
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP4, B-1	15.6	112.0	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
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D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
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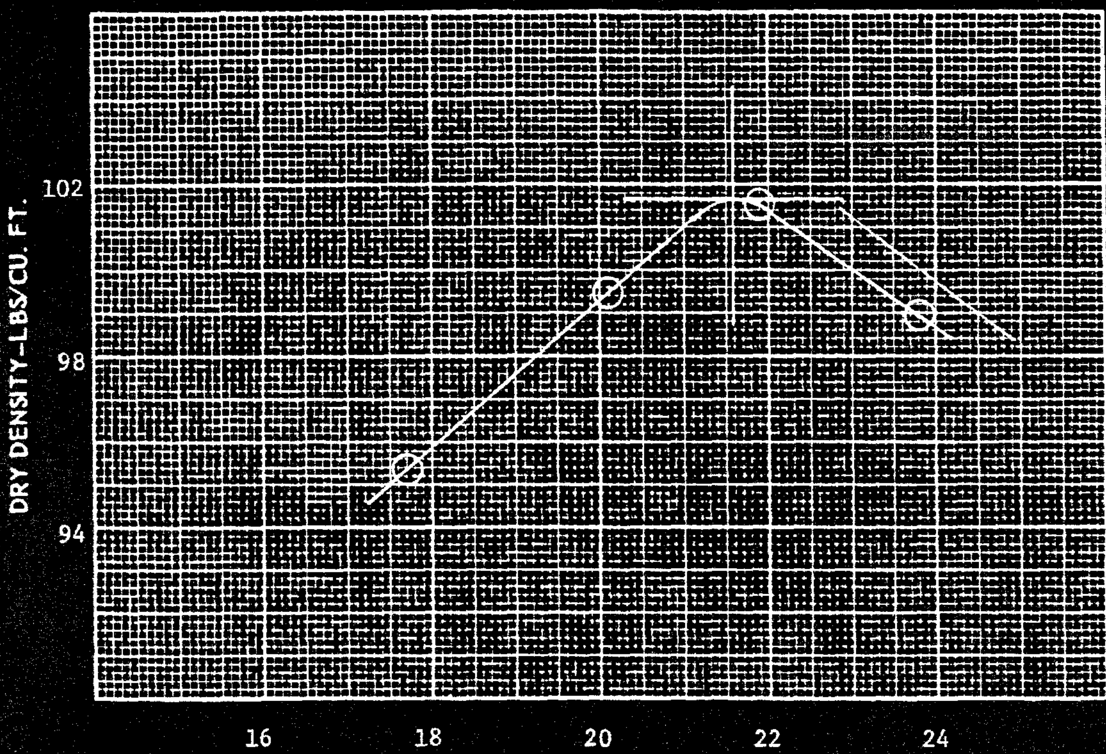
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP4, B-2	21.6	101.7	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
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AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
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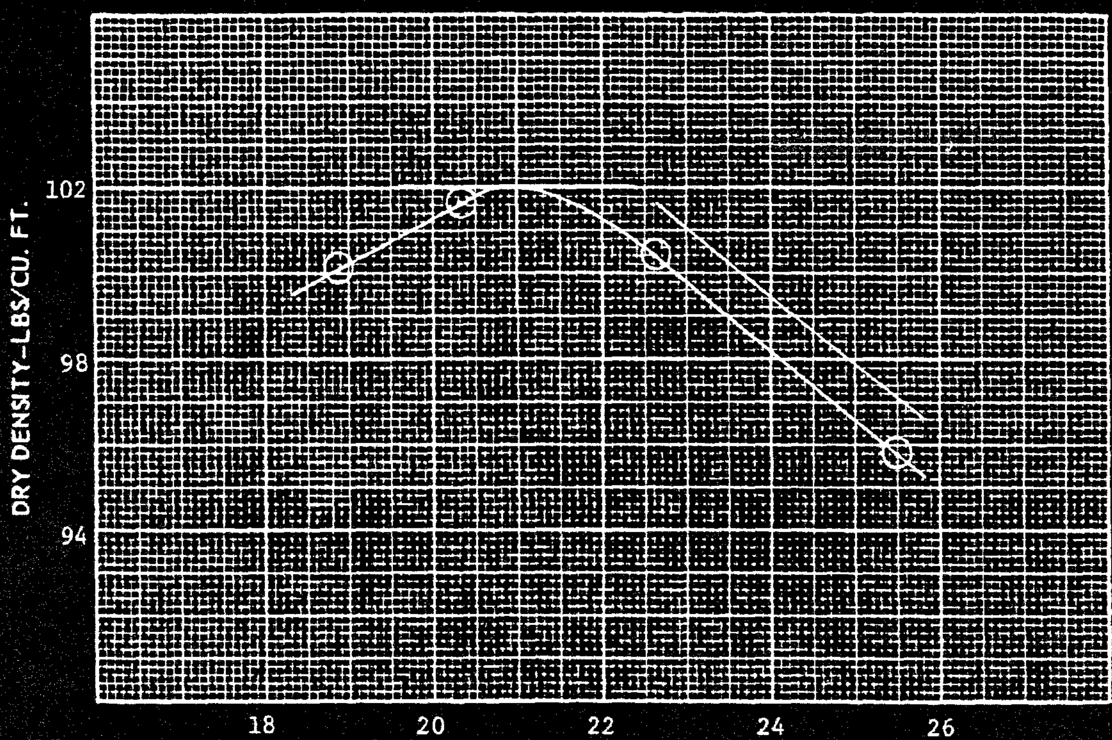
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Homestake Mining Company **JOB NO.** E86-1113



MOISTURE CONTENT – % DRY WEIGHT

CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP5, B-1	21.0	102.0	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
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AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
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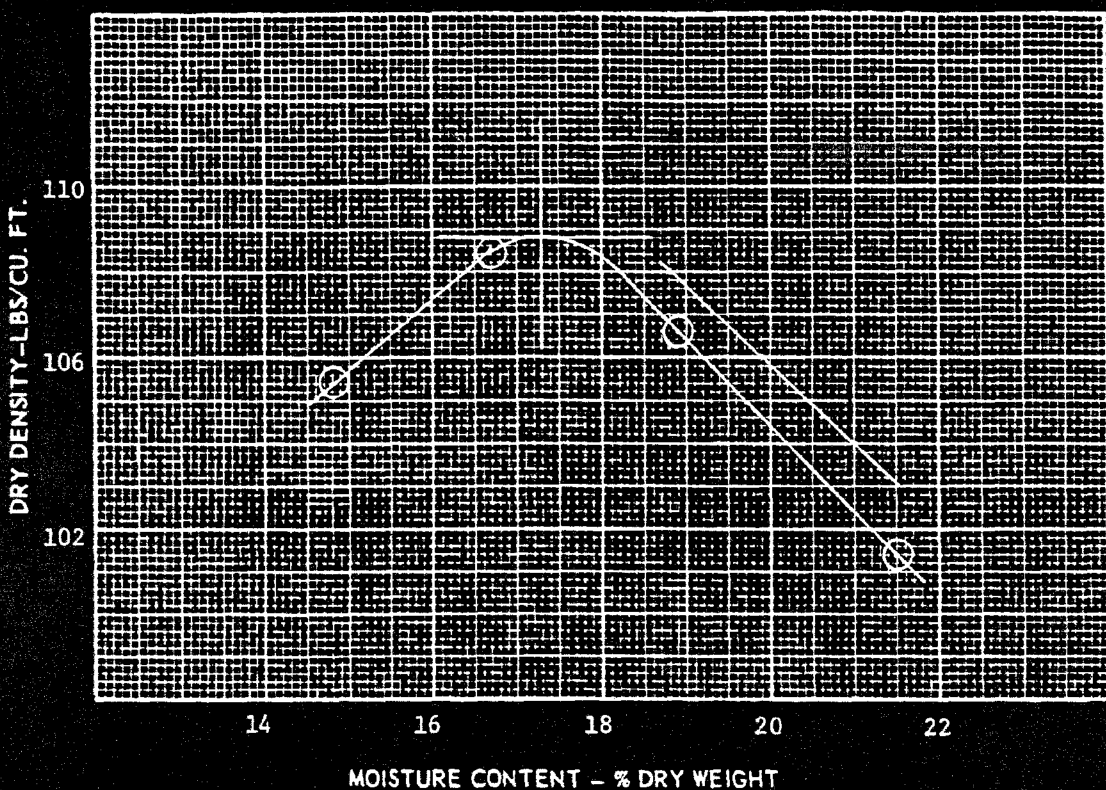
PROJECT Homestake Mining Company **JOB NO.** E86-1113



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP7, B-1	16.3	108.8	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
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AASHTO T180 and ASTM D1557 (Modified Proctor)

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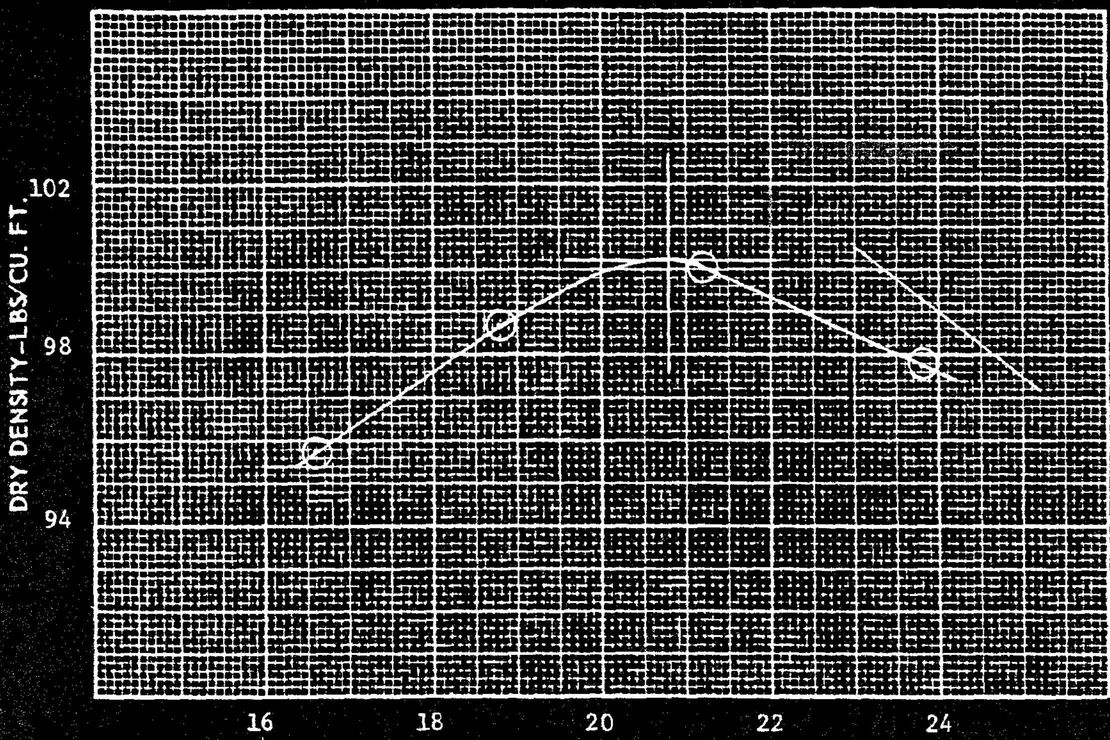

CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	TP8, B-1	20.8	100.2	D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
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AASHTO T180 and ASTM D1557 (Modified Proctor)

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ROBERT L. FREW
ALLON C. OWEN, JR., P.E.

September 3, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Contract Drilling & Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

The table below lists results of constant-head permeability testing performed. A constant water head of 11.5 feet was used to determine the hydraulic conductivities. Also presented are dry densities and water contents achieved prior to testing.

Sample	Dry Density (pcf)	Moisture Content (%)	Compaction* (%)	Hydraulic Conductivity (cm/sec)
BA1-A1	112.5	11.9	95.0	5.4×10^{-5}
BA3-A1	109.0	14.2	94.5	4.4×10^{-6}
BA5-A3	110.8	14.0	95.0	7.6×10^{-6}
BA19-A1	112.5	13.0	96.8	4.7×10^{-8}

* Relative to maximum dry density as determined in accordance with ASTM D698.

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ALBUQUERQUE (505) 884-0950
SANTA FE (505) 471-7836
SALT LAKE CITY (801) 266-0720
EL PASO (915) 778-3369

If you have any questions regarding these results, please do not hesitate to contact us.

Respectfully submitted,

Sergent, Hauskins & Beckwith Engineers

By Gregory M. Smith
Gregory M. Smith, Staff Engineer

Copies: Addressee (2)

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS

APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING • HYDROLOGY

November 6, 1986

Alan K. Kuhn, Ph.D., P.E.
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

SHB Job No. E86-1113

Re: Laboratory Testing
Homestake Mining Company
Grants, New Mexico

Dear Dr. Kuhn:

Test results for specific gravity absorption, and sodium soundness are enclosed. These analysis were performed on the follwoing samples which were submitted on October 10, 1986.

Sample No. 1 - Massive Limestone, Surface
Sample No. 2 - Laminar Limestone, Surface
Sample No. 3 - Bluff Sandstone
Sample No. 4 - Red Sandstone, Recapture
Sample No. 5 - Limestone at 100 feet
Sample No. 6 - Sandstone at 100 feet

ASTM C-127

Specific Gravity & Absorption

Sample No.	Dry Bulk	SSD Bulk	Apparent	Absorption (%)
1	2.68	2.69	2.71	0.4
2	2.69	2.70	2.72	0.4
3	2.04	2.24	2.54	9.9

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ASTM C-127

Specific Gravity & Absorption

Sample No.	Dry Bulk	SSD Bulk	Apparent	Absorption (%)
4	Sample very weathered, decomposed during preparation.			
5	2.64	2.66	2.70	0.9
6	2.11	2.28	2.55	8.1

ASTM C-88

Sodium Soundness (5 cycles)

Sample No.	Sieve Size	Individual Loss (%)	Average Loss (%)
1	-1.5" to +1.0"	0.2	0.2
	-1.0" to +0.75"	0.2	
2	-1.5" to +1.0"	0.1	0.2
	-1.0" to +0.75"	0.3	
3	-1.5" to +1.0"	38.4	44.2
	-1.0" to +0.75"	50.1	
4	Sample very weathered, decomposed during preparation.		
5	-1.5" to +1.0"	1.0	0.6
	-1.0" to +0.75"	0.3	
6	-1.5" to +1.0"	43.8	46.8
	-1.0" to +0.75"	49.8	

Qualitative Examination

Number of Particles

Sample No.	Before Test	Split	Crumbled	Cracked	Flaked	Sound
1	34	---	---	---	4	30
2	34	---	---	---	2	22

Qualitative Examination

Sample No.	Before Test	Number of Particles				
		Split	Crumbled	Cracked	Flaked	Sound
3	31	---	13	3	2	5
4	Sample very weathered, decomposed during preparation.					
5	24	---	---	1	4	19
6	23	---	5	2	4	6

If you have any questions regarding these results, please do not hesitate to contact us.

Respectfully submitted,

Sergent, Hauskins & Beckwith Engineers

By Timothy R. Hyden
Timothy R. Hyden
Assistant Laboratory & Field Supervisor

Copies: Addressee (2)

APPENDIX C
SOIL LOSS BY WATER AND WIND-INDUCED EROSION

Calculations were made to determine the amount of soil loss on the impoundment cover that would occur over time (1,000 years) from both water and wind erosion. Calculations in Section C.1 contain the amount of water erosion soil loss that can be expected from the impoundment top with vegetative cover, gentle slopes (200H:1V) and slope lengths averaging 1,000 feet. In addition, calculations were made for side slopes at 5:1 (H:V), 580 and 480 slope lengths (east and west ponds, respectively) and six inches of rock cover.

Section C.2 contains the estimated amount of soil loss due to wind erosion that can be expected from the impoundment top with gentle slopes (200H:1V), ridge roughness, and vegetative cover converted to pounds of flat small-grain residue or equivalent.

It should be noted that the Universal Soil Loss Equation (USLE) and Wind Erosion Equation were developed for crop land and not range land. However, these are currently the only tools available to estimate soil loss over time.

C.1 WATER SOIL LOSS USING UNIVERSAL SOIL LOSS EQUATION (USLE)

C.1.1 Embankment Top

Soil loss from the top of the embankment was determined by the following:

Average slope = 200:1 (H:V)

Average slope length = 1,000 ft.

Soil Loss Equation: A = R k LS C P

where:

A = Computed soil loss per unit area.

R = Rainfall and runoff factor. For HMC = 20 (Figure 1, USDA Handbook No. 537, 1978).

k = Soil erodability factor. Soil material in the HMC site classified as follows, with assigned k factor:

- Penistaja: k = 0.32
- Prewitt: k = 0.32
- Moriarty: k = 0.37
- Average: k = 0.34

(Marker et al., 1974 and USDA, 1986a) (1)

L, S = Slope length factor and slope steepness factor.

Slope length = 1,000 feet
Slope steepness = 200:1 (H:V) = 0.5% slope

LS = 0.152 (Table 3, USDA Handbook No. 537, 1978).

C = Cover and management factor.
Tall weeds or short brush, 25% cover with 20% ground cover;
C = 0.20 (Table 10, USDA Handbook No. 537, 1978).

P = Support practice factor: P = 1.0
Conservative factor due to slope lengths; slopes will be contoured through disking or harrowing and seeding.

$$A = \underset{R}{20} \times \underset{k}{0.34} \times \underset{LS}{0.152} \times \underset{C}{0.20} \times \underset{P}{1} = 0.2067 \text{ tons/acre/year.}$$

West pond area = 1,250 x 1,080 = 1,350,000 sq ft
= 31 acres.

East pond area = 1,650 x 1,000 = 1,650,000 sq ft
= 38 acres.

---

(1) A recent soil survey has been conducted in the HMC area. The Penistaja series remains Penistaja. Moriarty has been changed to Venadito, and Prewitt changed to Aparejo. k factors remain essentially the same.

Soil Loss From West Pond

31 acres x 0.2067 ton/acre/year = 6.41 tons/year.

Soil Loss From East Pond

38 acres x 0.2067 ton/acre/year = 7.86 tons/year.

C.1.2 Embankment Sides

Soil loss from the sides of the embankment that have side slopes of 5:1 (H:V) and covered with six inches of rock material. Area divided into East area with average slope lengths of 580 feet, and West area with average slope lengths of 480 feet.

Soil Loss Equation: A = R k LS C P

where all factors are defined as in C.1.1, and R and k values are the same as those in C.1.1 above.

L, S = Slope length factor and slope steepness factor.

Slope steepness = 20% for both East and West, 5:1 (H:V).

East slope, 580 feet at 20% slope = 9.82
West slope, 480 feet at 20% slope = 8.93
(Table 3, USDA Handbook No. 537, 1978).

C = Cover and management factor. Six inches rock cover, use Table 11, Handbook No. 537 for 100% cover undisturbed forest.
Factor 0.001 to 0.003; use 0.002.

P, the support practice factor, is not really applicable due to rock cover and no contouring.
A conservative factor of 1.0 is used.

East slope calculations:

```
     R    k     LS      C      P
A = 20 x 0.34 x 9.82 x 0.002 x 1 = 0.134 tons/acre/year
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West slope calculations:

```
     R    k     LS      C      P
A = 20 x 0.34 x 8.93 x 0.002 x 1 = 0.1214 tons/acre/year
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C.1.3 Soil Loss Calculations for 1,000 Years

For depth of soil loss, the following conversion was used:

$$\text{Inches/year} = \frac{\text{tons/acre/year}}{(\text{lbs/ft}^3)\,\frac{(1\text{ ton})}{(2000\text{ lb})}\,\frac{(1\text{ ft})}{(12\text{ in})}\,\frac{(43{,}560\text{ ft}^2)}{(\text{acre})}} \quad (1)$$

Then:

1. Soil Loss, Top of Embankment:

$$\frac{0.2067}{(104)\,\frac{(1)}{(2000)}\,\frac{(1)}{(12)}\,(43{,}560)} = 0.0011 \text{ in/yr or } 1.1 \text{ inches in } 1{,}000 \text{ yrs.}$$

2. East side slope $= \frac{0.134}{188.6847} = 0.0007$ in/yr or 0.7 inches in 1,000 yrs.

3. West side slope $= \frac{0.124}{188.6845} = 0.0006$ in/yr or 0.6 inches in 1,000 yrs.

---

(1) Volume weight, lbs/ft^3 was measured to be 104 lbs/ft^3

C.2 WIND EROSION CALCULATION

C.2.1 Impoundment Top

Reference: U.S. Department of Agriculture, USDA, 1980, Soil Conservation Service, New Mexico, Technical Note No. 27, Re: Wind Erosion-Wind Erosion Equation, Revised February 1986. All tables and figures referenced below and attached hereto are taken from this publication.

The following provides the wind erosion equation and the input parameters used for each parameter.

Wind Erosion Equation: E = f(I k C L V)

where:

E = The potential annual soil loss in tons/acre/year (t/a/y).

f = A function of

I = The erodability of a soil by wind. From Table 1 (attached), a wind erodability index of 86 was selected for a soil cover that best fits WEG-3.

k = The surface roughness factor. When reseeding, will put furrow spacing 8 inches to 12 inches with ridge heights 2.5 inches to 3.5 inches; use a k = 0.5. Furrows will be at right angle to prevailing wind (see Figure 2 for soil ridge roughness).

C = Climatic factor. C value map dated February 1986 (attached); shows a C value of 50.

L = The unsheltered distance across a field along the direction of the most erosive winds. Average slope lengths were measured and are 1,000 feet.

V = Vegetation cover. A seed mixture of western wheatgrass, blue grama, sand dropseed, Indian ricegrass, and alkali sacaton will be seeded. Using Figures 4 and 5 and Table 4 (attached), it is estimated that 1,400+ pounds of flat small-grain residue per acre would remain.

Using Table 5 with C = 50, I = 86, k = 0.5, 1,000-ft slopes, and 1,400-lb residue, soil loss = 0.4 t/a/y.

Data used were confirmed on November 6, 1986 by Ken Walker, SCS, Grants, New Mexico. SCS had just completed a soil survey of the area on the two main series, the Penistaja and Venadito. Ken Walker stated that the Penistaja would fall under WEG-3 or I=86. When the two series were mixed, I=86 was perhaps conservative due to the percentage of clay in the Venadito. K factor and C factor were OK. At initial reseeding with 2,000-lb mulch/acre, here would be no wind erosion. As the vegetation becomes established with the seed mixture to be used, 1,400 lbs/acre residue plus standing crop would be a good figure; again, perhaps conservative.

Using the equation:

$$\text{Inches/year} = \frac{\text{tons/acre/year}}{(\text{lbs/ft}^3)\ \frac{(\text{tons})}{(2000\ \text{lb})}\ \frac{(\text{ft})}{(12\ \text{in})}\ \frac{(43{,}560\ \text{ft}^2)}{(\text{acre})}}$$

$$\text{Inches/year} = \frac{0.4}{(104/\text{ft}^3)\ \frac{(1)}{(2000)}\ \frac{(1)}{(12)}\ (43{,}560)} = 0.0021$$

104 lbs/ft^3 was measured.

Loss during 1,000 years = 2.1 inches.

(from USDA, 1980)

TABLE 1

Wind Erodibility Groups (WEG)

WEG	Predominant Soil Texture Class of Surface Layer	Dry Soil Aggregates Over 0.84 mm Percent 1/	Wind Erodibility Index (I) T/Ac/Yr
1	Very fine sand, fine sand, sand, or coarse sand	1	310 2/ 250 220 180 160
2	Loamy very fine sand, loamy fine sand, loamy sand, loamy coarse sand	10	134
3	Very fine sandy loam, fine sandy loam, sandy loam, or coarse sandy loam	25	86
4	Clay, silty clay, noncalcareous clay loam, or silty clay loam with more than 35 percent clay content	25	86
4L	Calcareous loam and silt loam, or calcareous clay loam and silty clay loam	25	86
5	Noncalcareous loam and silt laom with less than 20 percent clay content, or sandy clay loam, sandy clay	40	56
6	Noncalcareous loam and silt loam with more than 20 percent clay content, or noncalcareous clay loam with less than 35 percent clay content	45	48
7	Silt, noncalcareous silty clay loam with than 35 percent clay content	50	38
8	Soils not suitable for cultivation due to coarse fragments or wetness, wind erosion not a problem	--	--

1/ If sieving shows a different percentage of dry soil aggregates, arrive at "I" from Table 2 on page 5.

2/ The "I" factors for WEG 1 will vary from 160 for the coarse sands to 310 for the very fine sands. Use an I of 220 as an average figure. Use common sense in selecting the factor. If you have a coarse sand with gravel, use a lower figure. If you have no gravel and very fine sand, use a higher figure.

October 1980

(from USDA, 1980)

TABLE 4

Comparability of Range Grasses Used to Locate Data on Conversion to Flat Small Grain Residue Equivalent

DATA ON		NO DATA ON		MOST LIKE
1.	Big bluestem	1.	Indiangrass	1
2.	Switchgrass	2.	Sand bluestem	1
3.	Little bluestem	3.	Silver bluestem	3
4.	Western wheatgrass	4.	Sand dropseed	3
5.	Blue grama	5.	Sand lovegrass	3
6.	Buffalograss	6.	Weeping lovegrass	3
		7.	Plains muhly	3
		8.	Perennial threeawn	5
		9.	Sideoats grama	4
		10.	Hairy grama	5
		11.	Black grama	5
		12.	Needleandthread	3
		13.	Alkali sacaton	3
		14.	Inland saltgrass	6
		15.	Burrograss	6
		16.	Tobosa	4
		17.	Threadleaf sedge	5
		18.	Sacaton	1
		19.	Giant sandreed	1
		20.	Bottlebrush squirreltail	5
		21.	New Mexico feathergrass	3
		22.	Cane bluestem	3

(from USDA, 1980)

TABLE 5 (E) SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR

C = 50
SURFACE - K = 1.
I = 86

(L) UNSHELTERED DISTANCE IN FEET	(V)- FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE 0	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
10000	43.0	38.4	31.4	25.0	17.8	10.6	5.9	3.3	1.7	0.9	0.3			
8000	43.0	38.4	31.4	25.0	17.8	10.6	5.9	3.3	1.7	0.9	0.3			
6000	43.0	38.4	31.4	25.0	17.8	10.6	5.9	3.3	1.7	0.9	0.3			
4000	43.0	38.4	31.4	25.0	17.8	10.6	5.9	3.3	1.7	0.9	0.3			
3000	42.7	38.1	31.2	24.8	17.7	10.5	5.8	3.2	1.6	0.9	0.3			
2000	40.7	36.3	29.6	23.5	16.6	9.8	5.4	2.9	1.5	0.8	0.3			
1000	36.6	32.8	26.3	20.7	14.5	8.4	4.5	2.4	1.2	0.4				
800	35.1	31.2	25.2	19.8	13.8	7.9	4.2	2.2	1.1	0.4				
600	32.2	28.5	23.0	17.9	12.4	7.0	3.7	1.9	0.9	0.3				
400	28.1	24.0	19.8	15.3	10.4	5.7	2.9	1.5	0.5					
300	24.7	[illegible]	17.2	13.2	8.8	4.8	2.4	1.2	0.4					
200	21.2	18.6	14.6	11.1	7.3	3.9	1.9	0.9	0.3					
150	18.0	15.7	12.2	9.1	5.9	3.1	1.4	0.5						
100	14.8	12.6	9.9	7.3	4.6	2.3	1.0	0.4						
80	13.3	11.5	8.8	6.4	4.0	2.0	0.7							
60	10.4	9.0	6.8	4.9	3.0	1.4	0.5							
50	8.7	7.5	5.6	4.0	2.4	1.1	0.4							
40	7.0	6.0	4.4	3.1	1.8	0.7								
30	4.8	4.1	3.0	2.0	1.1	0.5								
20	3.3	2.8	2.0	1.3	0.6									
10	1.5	1.2	0.8	0.4										

(E) SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR

C = 50
SURFACE - K = .75
I = 86

(L) UNSHELTERED DISTANCE IN FEET	(V)- FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE 0	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
10000	32.3	28.6	23.0	17.9	12.4	7.0	3.7	1.9	0.9	0.3				
8000	32.3	28.6	23.0	17.9	12.4	7.0	3.7	1.9	0.9	0.3				
6000	32.3	28.6	23.0	17.9	12.4	7.0	3.7	1.9	0.9	0.3				
4000	31.3	27.7	22.2	17.3	11.9	6.7	3.5	1.8	0.9	0.3				
3000	30.4	26.9	21.6	16.7	11.5	6.4	3.3	1.7	0.8	0.3				
2000	28.8	25.4	20.3	15.7	10.7	6.0	3.1	1.6	0.6					
1000	24.1	21.2	16.8	12.8	8.6	4.6	2.3	1.1	0.4					
800	23.2	20.4	16.1	12.3	8.2	4.4	2.2	1.1	0.4					
600	21.2	18.6	14.6	11.0	7.3	3.9	1.9	0.9	0.3					
400	18.5	16.1	12.6	9.4	6.1	3.2	1.5	0.5						
300	16.2	14.1	10.9	8.1	5.2	2.7	1.2	0.4						
200	13.3	11.5	8.8	6.4	4.0	2.0	0.7							
150	11.0	9.5	7.2	5.2	3.2	1.6	0.6							
100	8.9	[illegible]	[illegible]	4.0	2.4	[illegible]	0.4							
80	7.1	6.1	4.5	3.1	1.8	0.7								
60	4.7	4.0	2.9	2.0	1.1	0.4								
50	4.0	3.4	2.4	1.6	0.8									
40	3.3	2.7	1.9	1.3	0.6									
30	2.0	1.7	1.2	0.5										
20	1.3	1.1	0.7	0.4										
10														

(E) SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR

C = 50
SURFACE - K = .5
I = 86

(L) UNSHELTERED DISTANCE IN FEET	(V)- FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE 0	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
10000	21.5	18.9	14.8	11.2	7.4	4.0	1.9	0.9	0.4					
8000	21.5	18.9	14.8	11.2	7.4	4.0	1.9	0.9	0.4					
6000	21.5	18.9	14.8	11.2	7.4	4.0	1.9	0.9	0.4					
4000	20.4	17.8	14.0	10.5	6.9	3.6	1.7	0.8	0.3					
3000	19.5	17.0	13.3	10.0	6.5	3.4	1.6	0.6						
2000	17.7	15.5	12.0	9.0	5.8	3.0	1.4	0.5						
1000	14.5	12.6	9.7	7.1	4.5	2.3	1.0	0.4						
800	13.5	11.7	8.9	6.5	4.1	2.0	0.9	0.3						
600	11.9	10.3	7.8	5.7	3.5	1.7	0.6							
400	9.7	8.3	6.3	4.5	2.7	1.3	0.5							
300	8.1	6.9	5.1	3.6	2.2	0.9								
200	5.3	4.5	3.3	2.2	1.3	0.5								
150	4.1	3.4	2.5	1.7	0.9	0.4								
100	3.0	2.5	1.8	1.2	0.6									
80	2.2	1.8	1.3	0.8	0.4									
60	1.5	1.3	0.9	0.4										
50	1.2	1.0	0.7	0.3										
40	0.9	0.6	0.2											
30	0.7	0.5	0.2											
20														
10														

NOTE SOIL LOSS OF LESS THAN 0.1 TON/ACRE/YEAR IS NOT RECORDED

FIGURE 2 -SOIL RIDGE ROUGHNESS *

Ridge Height, Inches	Furrow Spacing, Inches: 3	4	6	8	10	12	14	16	18	20	24	30	36	40	42	48	54	60
½	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1	.75	.75	.75	.75	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1½	.5	.75	.75	.75	.75	.75	.75	.75	.75	.75	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	.75	.5	.5	.75	.75	.75	.75	.75	.75	.75	.75	.75	1.0	1.0	1.0	1.0	1.0	1.0
2½	.75	.75	.5	.5	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	1.0
3	1.0	.75	.75	.75	.5	.5	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
3½	1.0	1.0	.75	.75	.75	.5	.5	.5	.5	.75	.75	.75	.75	.75	.75	.75	.75	.75
4	1.0	1.0	1.0	.75	.75	.75	.75	.5	.5	.5	.5	.75	.75	.75	.75	.75	.75	.75
4½	1.0	1.0	1.0	1.0	.75	.75	.75	.75	.75	.5	.5	.5	.75	.75	.75	.75	.75	.75
5	1.0	1.0	1.0	1.0	1.0	.75	.75	.75	.75	.75	.5	.5	.5	.75	.75	.75	.75	.75
5½	1.0	1.0	1.0	1.0	1.0	1.0	.75	.75	.75	.75	.75	.5	.5	.5	.5	.75	.75	.75
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.75	.75	.75	.75	.75	.5	.5	.5	.5	.5	.75
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.75	.75	.75	.75	.75	.5	.5	.5
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.75	.75	.75	.75	.75	.75	.5
9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.75	.75	.75	.75	.75	.75
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.75	.75	.75	.75
11	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.75	.75
12	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.75

* Smooth = 1.0 Semiridged = .75 Ridged = .5

Table for determining whether a field is smooth, semiridged, or ridged.
Developed from Agriculture Handbook No. 346, and Chart 1 on Page 7.

October 1980

(from USDA, 1980)

(from USDA, 1980)

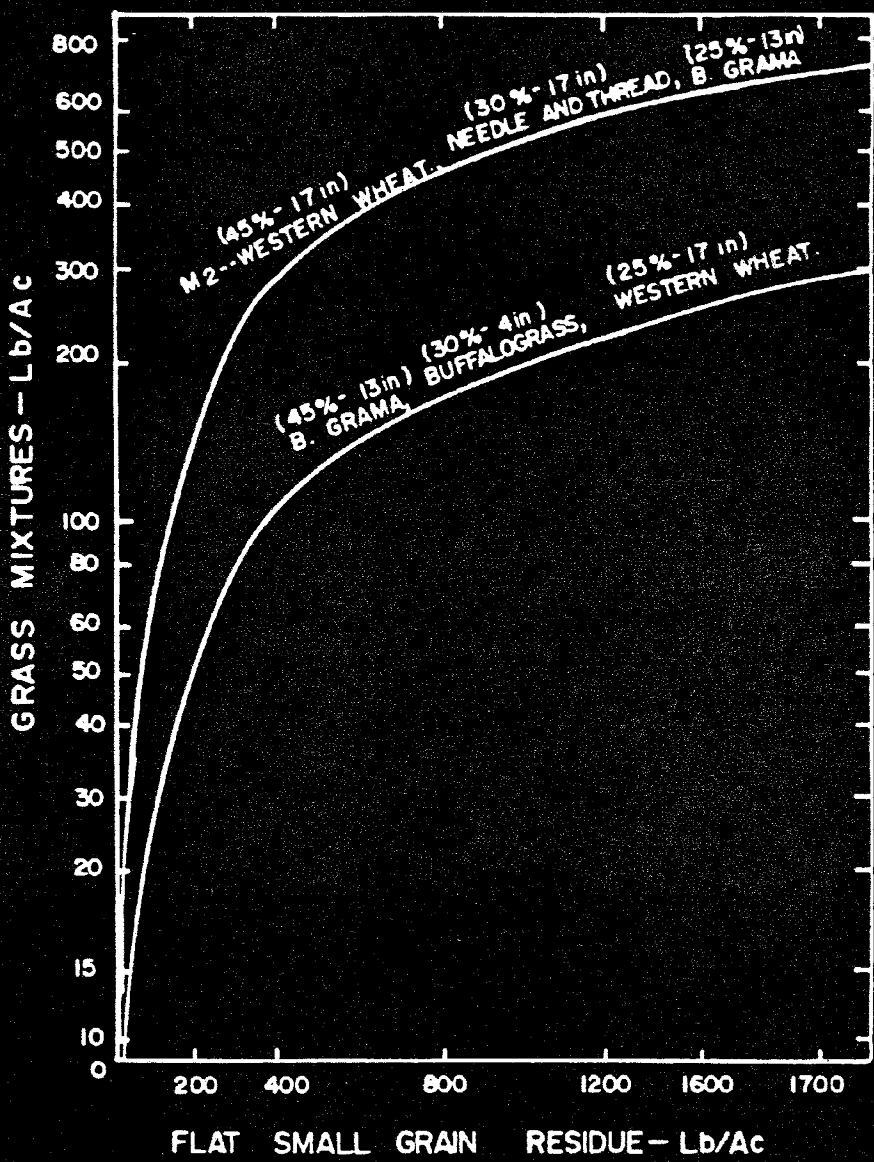


Figure 4. Converting ungrazed range grass mixture to equivalent quantity of flat small grain residue.

(from USDA, 1980)

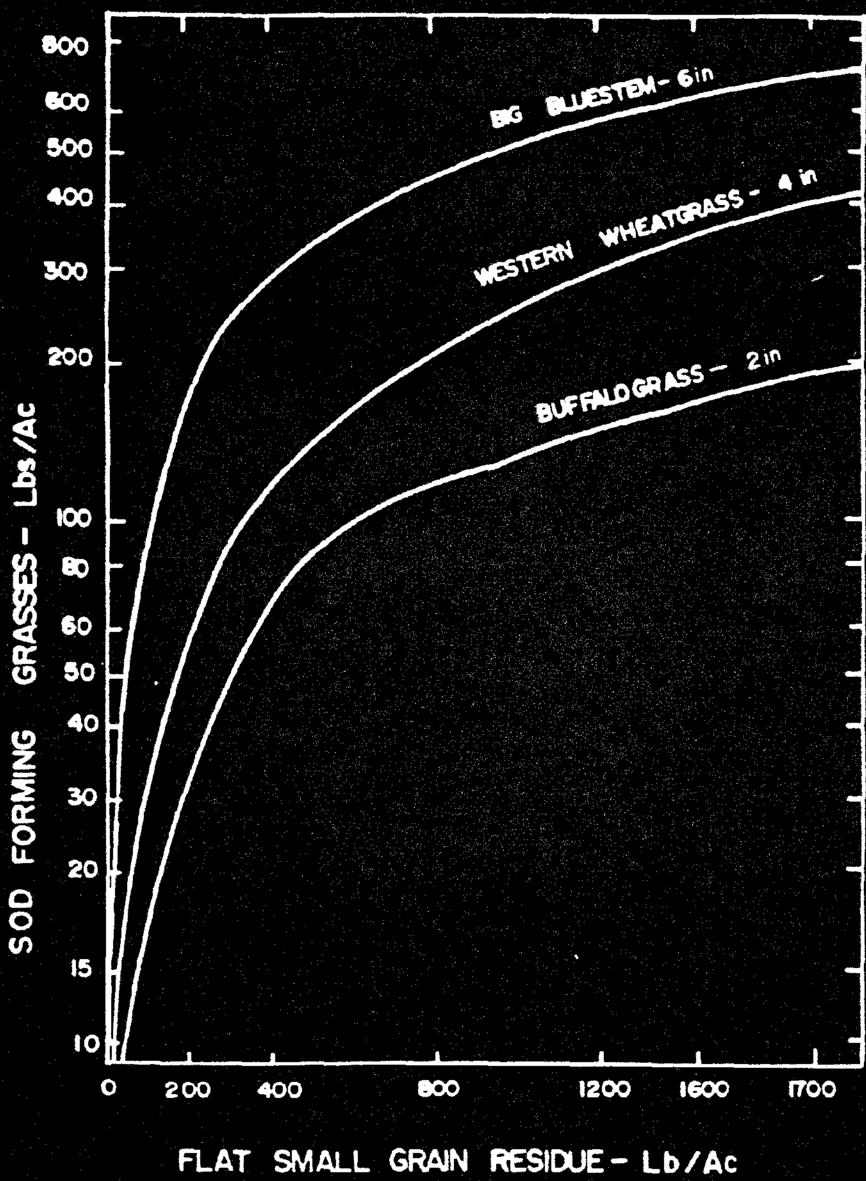
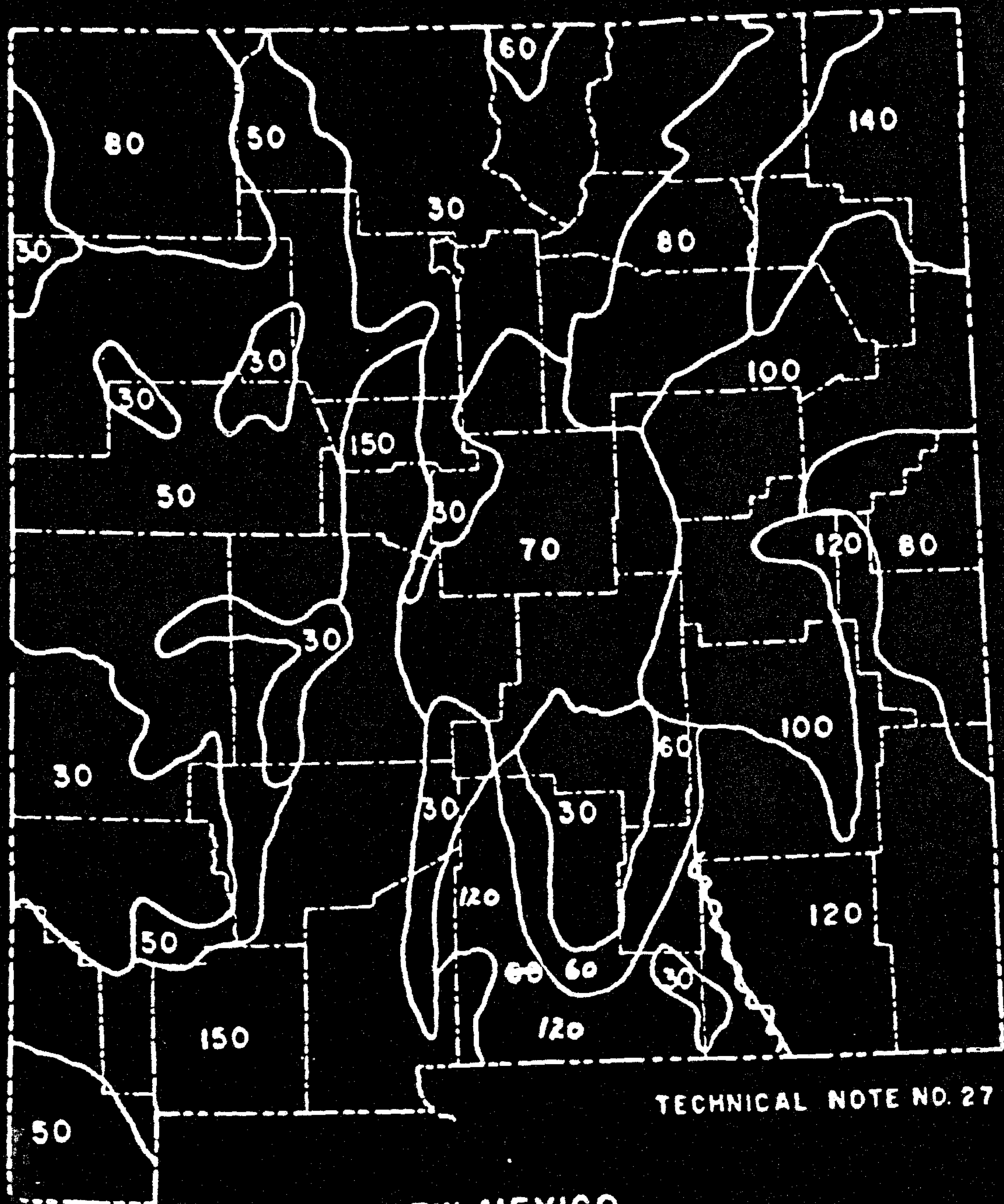


Figure 5. Converting properly grazed big bluestem, wheatgrass, and buffalograss to equivalent quantity of flat small grain residue.

(from USDA, 1980)

C VALUE MAP



TECHNICAL NOTE NO. 27

NEW MEXICO

FEBRUARY, 1986

HMCSL024726

April 28, 1987

CERTIFIED: P475754998

Mr. Harry J. Pettengill, Chief
Licensing Branch 2
Uranium Recovery Field Office
U.S. Nuclear Regulatory Commission
P.O. Box 25325
Denver, Co. 80225

Re: License No. SUA-1471
Docket No. 40-8903

Dear Mr. Pettengill:

This submittal is written in response to your letter of March 9, 1987 concerning Nuclear Regulatory Commission staff comments on Homestake Mining Company's Tailing Stabilization and Site Reclamation Plan.

Attached, please find the requested responses for each specific comment itemized by the NRC. Homestake's responses are not, at this time, being incorporated as revisions to the Reclamation Plan. Homestake proposes to make a single, final revision to the Plan, should it be found necessary, when all of NRC's concerns have been addressed and a general consensus has be reached.

Should you have any other comments or questions concerning the Reclamation Plan or these responses, please don't hesitate to contact me. Also, should it be felt a meeting on these matters may be of benefit, please notify me, and Homestake's contractor can be made available.

Very truly yours,

HOMESTAKE MINING COMPANY-GRANTS

Edward E. Kennedy
Director of Environmental
Affairs

EEK/bgl

xc: T.G. White
D.B. Crouch

HMCSL024727

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

RECEIVED
JUN 19 1987

JUN 17 1987

URFO:PJG
Docket No. 40-8903

Homestake Mining Company
ATTN: Mr. Edward Kennedy
P.O. Box 98
Grants, New Mexico 87020

Gentlemen:

We are in receipt of your letter dated April 28, 1987, providing a response to our March 9, 1987 request for information regarding your proposed reclamation plan. We conclude that the information presented is not adequate to enable us to evaluate the ability of the proposed design to meet the requirements of Criterion 6 of Appendix A to 10 CFR Part 40. We also disagree with statements made regarding the level of detail necessary.

Criterion 9 of Appendix A to 10 CFR Part 40 states that "Financial surety arrangements must be established by each mill operator...to assure that sufficient funds will be available to carry out...the reclamation of any tailings or waste disposal areas. The amount of funds...must be based on Commission-approved cost estimates in a Commission-approved plan for...the reclamation of tailings and/or waste areas in accordance with technical criteria delineated in Section I of the Appendix." Criterion 6 of Section I, in turn, states that a tailings impoundment shall be closed in accordance with a design which provides reasonable assurance of control of radiological hazards for 1000 years, to the extent reasonably achievable but for at least 200 years, and limits releases of radon-222 from uranium byproduct materials to an average release rate of 20 pCi/m^2s to the extent practicable. The proposed design must therefore contain sufficient detail to enable the staff to conclude that the proposed plan, as revised, meets the technical criteria discussed above.

Criterion 9 further states that the surety must be "at least sufficient to cover the costs of decommissioning and reclamation of the areas that are expected to be disturbed before the next license renewal." The projected time of mill closure is not a consideration.

JUN 17 1987

We conclude that the information provided in your April 28, 1987 submittal does not contain the level of detail required for us to make technical judgments regarding the adequacy of the proposed plan or the associated costs. Specifics are provided in the enclosure to this letter.

We have also determined that the inactive tailings pile located south of the main piles although originally designated as a Title III site has since been declared the responsibility of Homestake under it's Title II license. Therefore, the inactive pile must be addressed and included in your reclamation plan. We believe the most environmentally sound and technically feasible plan for long-term stabilization of the inactive pile would involve removing the material from its current location and using it to surcharge slimes areas of the active piles to achieve precover contours.

In the interest of cooperation, we request that you provide a response to this letter by August 1, 1987. Should you have any questions, please contact Mr. Pete Garcia of my staff on (303) 236-2820.

Sincerely,

Harry J. Pettengill, Chief
Licensing Branch 2
Uranium Recovery Field Office
Region IV

Enclosure: As stated

Enclosure

Request for Information

The numbering of the comments below corresponds to that used in your April 28, 1987 response to initial NRC comments.

I. Geotechnical Issues

B. A more detailed settlement monitoring program is necessary to assure that differential settlement does not affect the integrity of the radon barrier. We must, therefore, be able to conclude that the proposed monitoring program is adequate to determine when at least 90 percent of the total settlement in the slimes areas has occurred, so placement of the radon barrier can begin. Information to be submitted must include specific monitoring locations, monitoring methods, and frequencies. In addition, an annual frequency for settlement monitoring is not sufficient to establish the time-settlement curves which will be necessary to determine when 90 percent settlement has occurred. The annual inspection frequency discussed in Criterion 12 of Appendix A to 10 CFR 40, which you reference in your response, has nothing to do with the period of time during which the license is in effect. Criterion 12 discusses post-closure requirements which apply to the governmental entity responsible for long-term surveillance of the site following termination of the license.

D. The composition of the radon barrier layer is extremely critical to estimating long-term moisture contents for the radon barrier which, in turn, are a major factor in determining the thickness of the radon barrier. You state on page 6 that "all clays are candidate soil cover materials, along with the sands overlying them."

The RAECOM analysis performed by Homestake utilized a long-term moisture content of 12 percent for the radon barrier. This value appears to be the average in-situ value for 12 clay samples. Based on in-situ moisture contents for overlying sands, we cannot concur at this time that the 12 percent value is reasonably conservative for a composite radon barrier layer. Half of the soil samples exhibited moisture contents less than 3 percent.

A specific mix for the proposed radon barrier is necessary to enable an accurate determination of the required radon barrier thickness to be made. The information required must include the following:

1. The composition of the radon barrier based on the percentages of clay and sand.

2. Grain size analyses of the typical composite sample as well as the clay and sand fractions.

3. An evaluation of the availability of sufficient clay to achieve the proposed mix.

4. An evaluation of the dispersivity of the clay soils.

E. Specifications for construction and the quality control program are necessary to estimate costs associated with construction such as equipment and personnel requirements and enable us to conclude that the as-placed cover will meet design requirements. Please provide the required specifications for all material types.

II. Surface Water Hydrology

1. Detailed designs are necessary for several features of the proposed plan before we can conclude that the proposed plan will provide reasonable assurance of control of radiological hazards in accordance with Criterion 6 of Appendix A to 10 CFR 40. The features for which specific designs are required are listed below.

   a. the levee at the northeast corner of the impoundment,

   b. the rock cover along the north and west sides of the pile specifically, toe protection designed to prevent scour and undercutting of the riprap,

   e. the rock check dams and blankets located south of the pile.

   f. the diversion ditch on the south and east sides of the impoundment (include all information used in determining the drainage area which will contribute to flows in the ditch).

2. How were the cross-sections used in the HEC-2 PMF analyses developed? Was a topographic map used or were the sections surveyed? If a topographic map was used, please provide it.

EEK Rad.

July 21, 1987

Mr. Pete Garcia
Licensing Branch 2
U.S. Nuclear Regulatory Commission
Uranium Recovery Field Office
Region IV
P.O. Box 25325
Denver, CO 80225

Re: HMC's Discussion of NRC Comments on Tailing
Pile Reclamation Plan.

Dear Mr. Garcia:

Please find attached preliminary draft comments for discussion between Homestake and the NRC at the morning meeting scheduled for July 29, 1987.

If you have any questions in advance of the meeting, please don't hesitate to contact me.

Very truly yours,

HOMESTAKE MINING COMPANY-GRANTS

Edward E. Kennedy
Director of Environmental
Affairs

EEK/bgl

PRELIMINARY DRAFT

RESPONSES TO NRC'S COMMENTS OF JUNE 17, 1987 ON HOMESTAKE'S RECLAMATION PLAN

These responses have been prepared in preliminary draft form for discussion between Homestake and the NRC at a meeting scheduled for 7/29/87. They respond to the letter from NRC to Homestake of June 17 containing comments on Homestake's reclamation plan for its Grants uranium mill. The letter of June 17 contains the second set of NRC comments on the plan -- the first set of NRC comments was transmitted to Homestake on March 9, 1987. Both sets of comments raise questions for Homestake about some technical issues and about the level of detail needed in the plan, considering Homestake's intention to continue operation of the Grants mill. To help resolve its questions, Homestake will meet with NRC on 7/29. In preparation for that meeting, NRC has asked Homestake to prepare these draft responses so that NRC staff can review them and be prepared for more substantive discussion on 7/29.

The following responses are numbered in accordance with the system established in NRC's transmittal of March 9. Some of Homestake's responses of April 28 to those (March 9) NRC comments apparently were satisfactory, because NRC has made no mention of them in the June 17 transmittal. Therefore, the following responses use the original comment numbering system but address only the subjects included again in the June 17 letter from NRC.

DRAFT RESPONSES

I.B. Settlement Monitoring

As stated in the April 28 responses, the predicted total settlement in 90 feet of slimes is up to 3.7 feet. A significant portion has probably already occurred due to downward seepage pressure, and most of the remaining settlement will probably occur during and very soon after sand tailings surcharging. Therefore, we expect that settlements will pose less trouble for the cover than perceived by NRC. Nevertheless, Homestake will install settlement monumuents in each pond area after placement of the tailings surcharge. Each will be a brass cap set in a concrete base, cast in place in the tailings two feet below tailings surface. The caps will be extended to the top of the soil cover when the cover is placed, but eventually must be removed to the base of the cover to eliminate possible release pathways through the cover. Monitoring will be by precision land survey methods tied to control points established near to but off the impoundment. During surcharging and early consolidation the settlement monuments will be surveyed monthly initially, reducing to quarterly when two successive monthly readings show changes of one-third or less of the maximum monthly change previously recorded.

I.D. Soil Cover

NRC's comments do not indicate what data or form of analysis it would consider adequate to support evaluation and selection of a design moisture content of the soil cover. Homestake's first response on this question indicates that testing to specify the cover soil properties has been performed, and that the clay content of the soil can be increased if necessary to achieve the higher long-term moisture or to otherwise satisfy all Criterion 6 requirements. Both sand and clays soils are available in the same borrow pit and with about the same amount of excavation. The approximate soil mix proposed for the cover is described on page B-8 of the plan. This soil is a representative blend of sand and clay obtained from the augers during test drilling. Clearly, more clay than contained in this mix (40%) can be achieved. Section B.3.3, App.B of the plan, states that enough clay is available in the borrow area to construct the cover entirely with clay if necessary, and with no significant cost differential. Knowing this, Homestake has not considered additional testing or analysis to be necessary at this time. Homestake believes that a cover soil of suitable properties can be designed using existing data. To provide NRC with the assurance they seek, the borrow pit will be reconfigured to expose more clay, and the clay content of the cover soil will be increased.

Homestake does not object to specifying material properties, placement methods, and quality control procedures. In fact, this has been done in the plan and April 28 responses to a great extent. Unresolved, however, is the form and degree of specification required. While specifying technical standards within the plan is appropriate, preparing separate formal specifications would be premature at this time.

II. Surface Water Hydrology

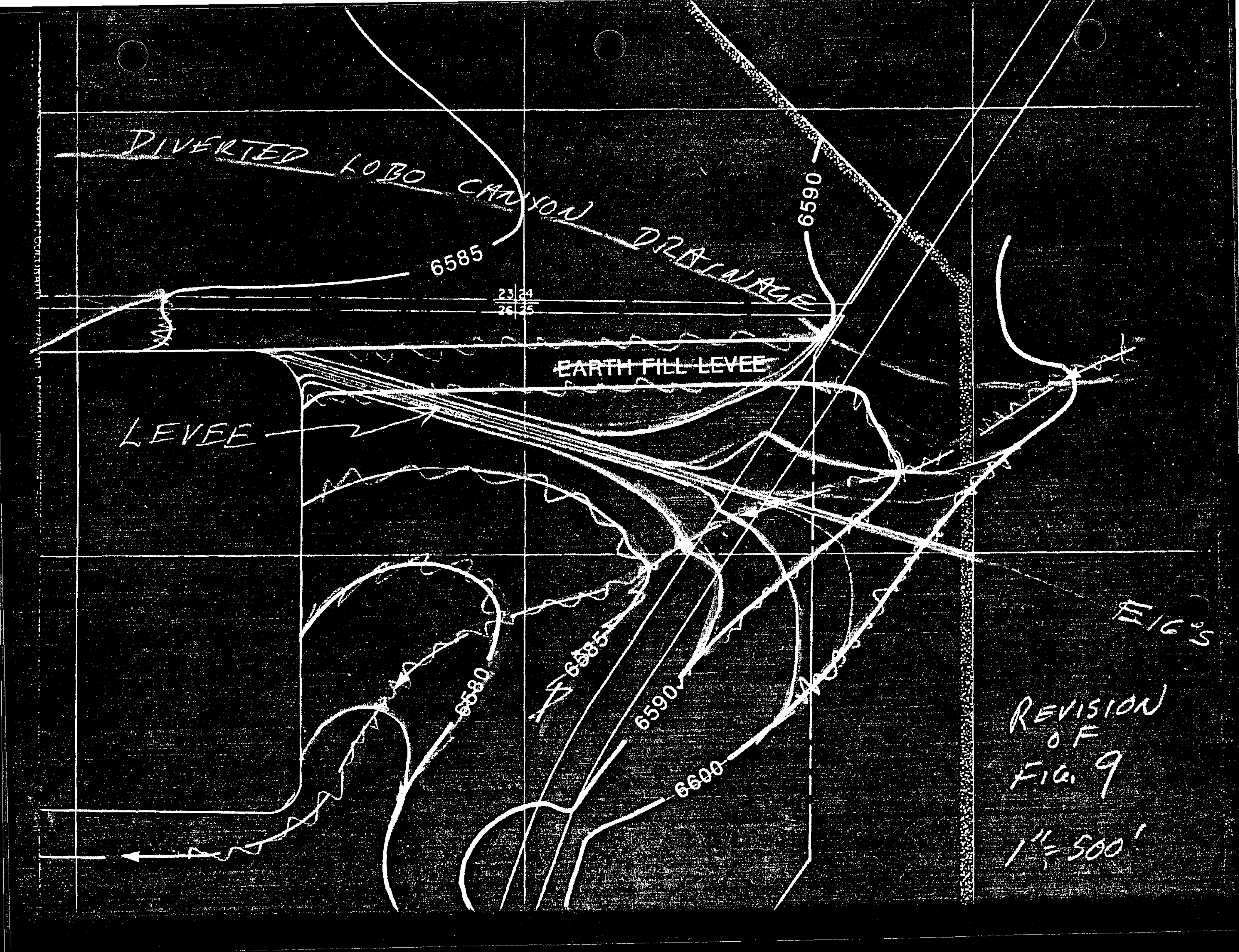
The following responses are numbered in the same way as the surface water hydrology comments of June 17.

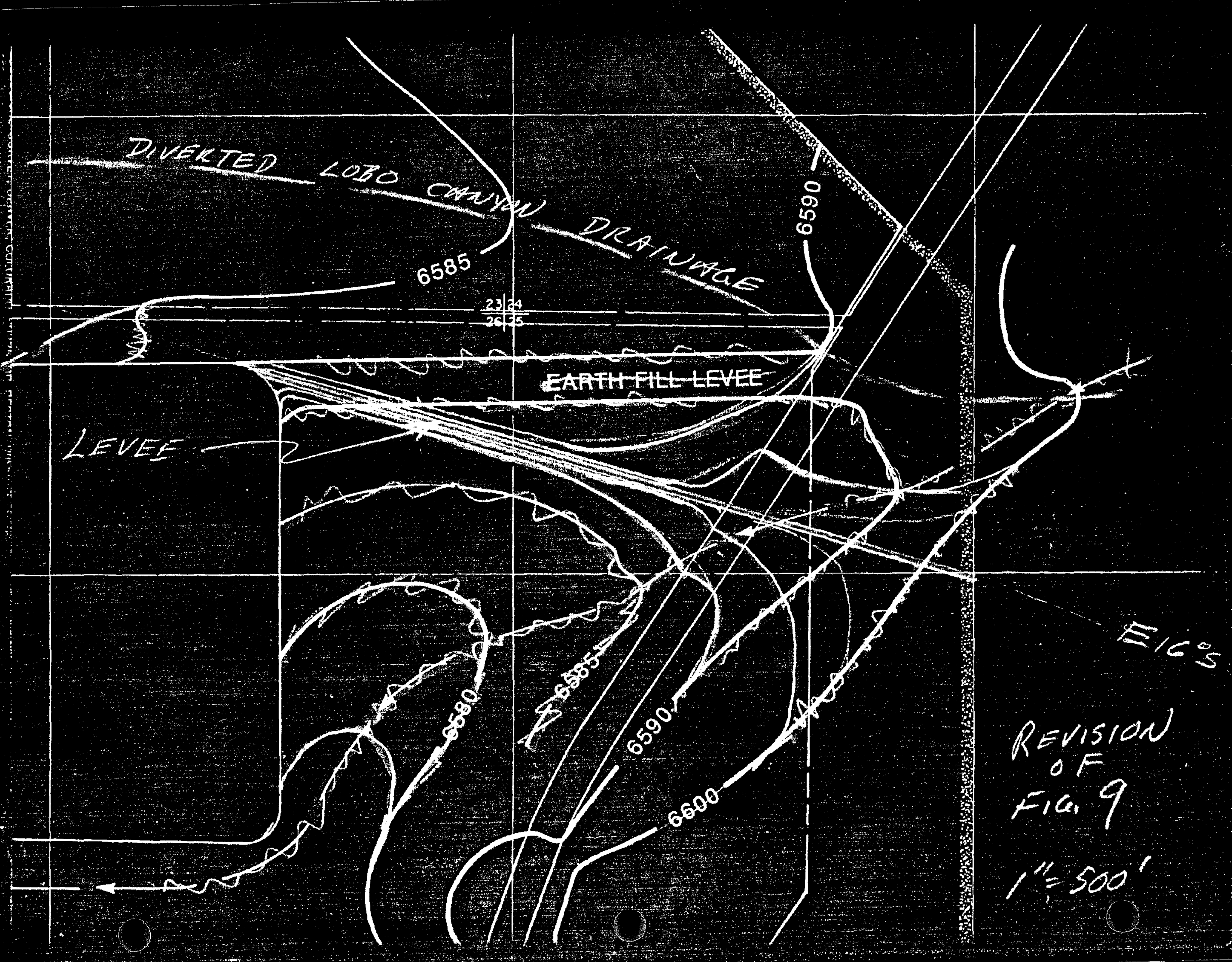
1.a. The levee at the northeast corner of the embankment has been realigned to run E 16 S to take better advantage of existing topography and to minimize or eliminate off-site cut and fill. The poorly defined course of the Lobo Canyon drainage will be rechannelized north of the impoundment. These changes are shown on the attached sketch of the Fig. 9 revision, in which pink highlights the scrub-outs, green the levee crest, and solid blue the revised contours. Figure 12 will also be revised to reflect these changes, as shown on the attached sheet. The flood routing will determine what crest elevation is needed, but at this time the levee is being designed for 3:1 (H:V) slopes and a 20 foot wide crest at elev. 6605. Fill will be sandy soil excavated for Lobo Canyon drainage rechannelization and compacted to at least ~~105 pcf dry density~~.
95% proctor

1.b. Other than drawings showing details, the design of rock cover and riprap has already been addressed in the April 28 responses, including calculations. The drawings to be prepared will show the approximate gradations of rock to be used in the cover (including the filter blanket of crusher fines), a typical section of the slope and toe, and a plan of riprap placement.

1.e. & f. Because of the redesign of the Lobo Canyon drainage diversion and levee, the runoff area tributary to the south diversion has been reduced. As a result, the discharge and velocity of the PMF flow in the south ditch will be lower, and the check dams will not be necessary. Details of the ditch design are being prepared to show the plan and typical cross sections, the confluences with the impoundment drainage channels, erosion protection where needed, and appropriate details. Supporting calculations will include drainage area measurements, Rational Method small basin runoff estimates, velocity and design shear of PMF flow.

2. The attached letter explains the development of the cross sections used in the HEC-2 analyses. The topo maps used are listed and are available from the USGS in Denver.


DIVERTED LOBO CANYON DRAINAGE
6585
6590
23 | 24
26 | 25
EARTH FILL LEVEE
LEVEE
E16°S
6585
6580
6590
6600
REVISION OF FIG. 9
1" = 500'


DIVERTED LOBO CANYON DRAINAGE
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REVISION OF FIG. 9
1" = 500'

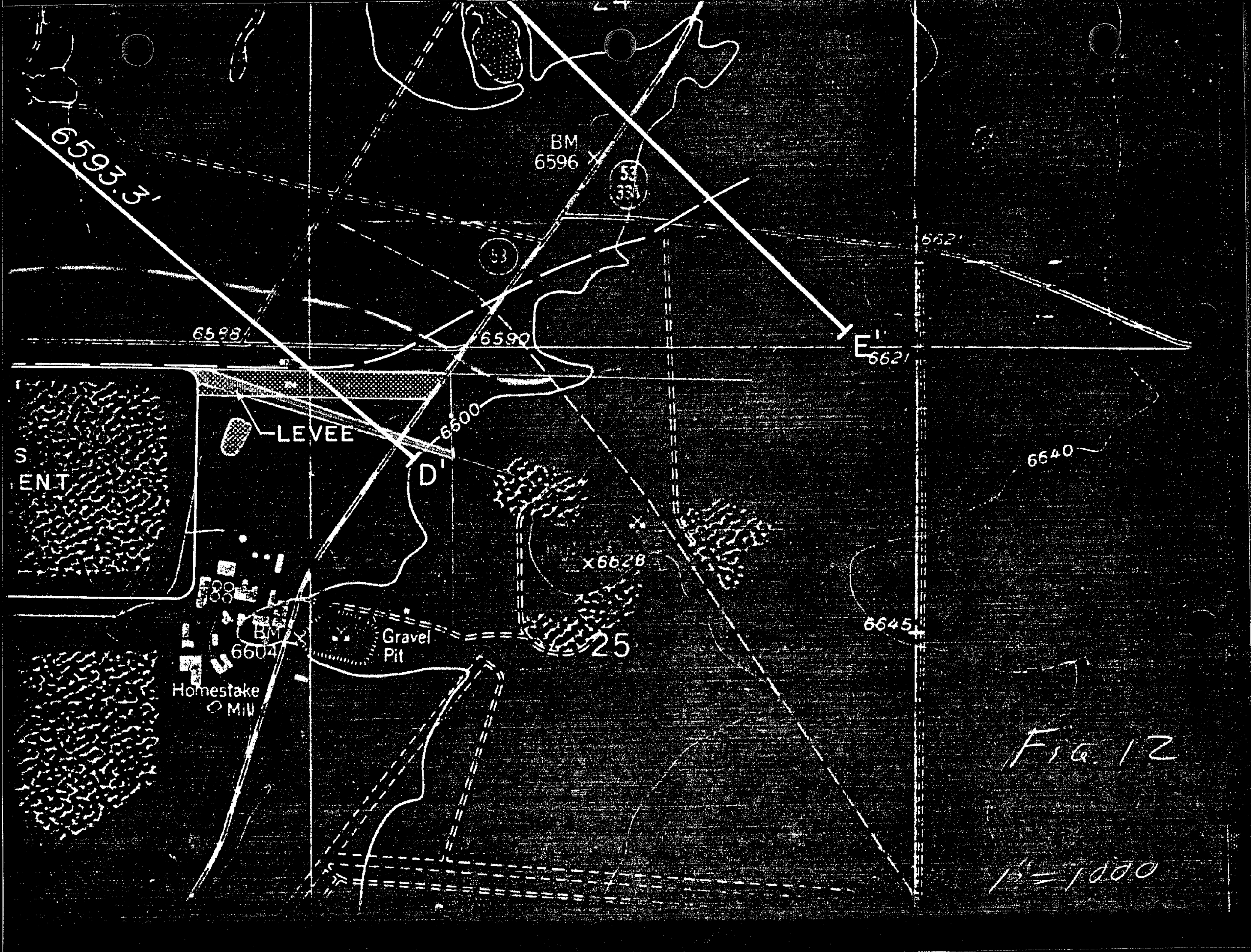
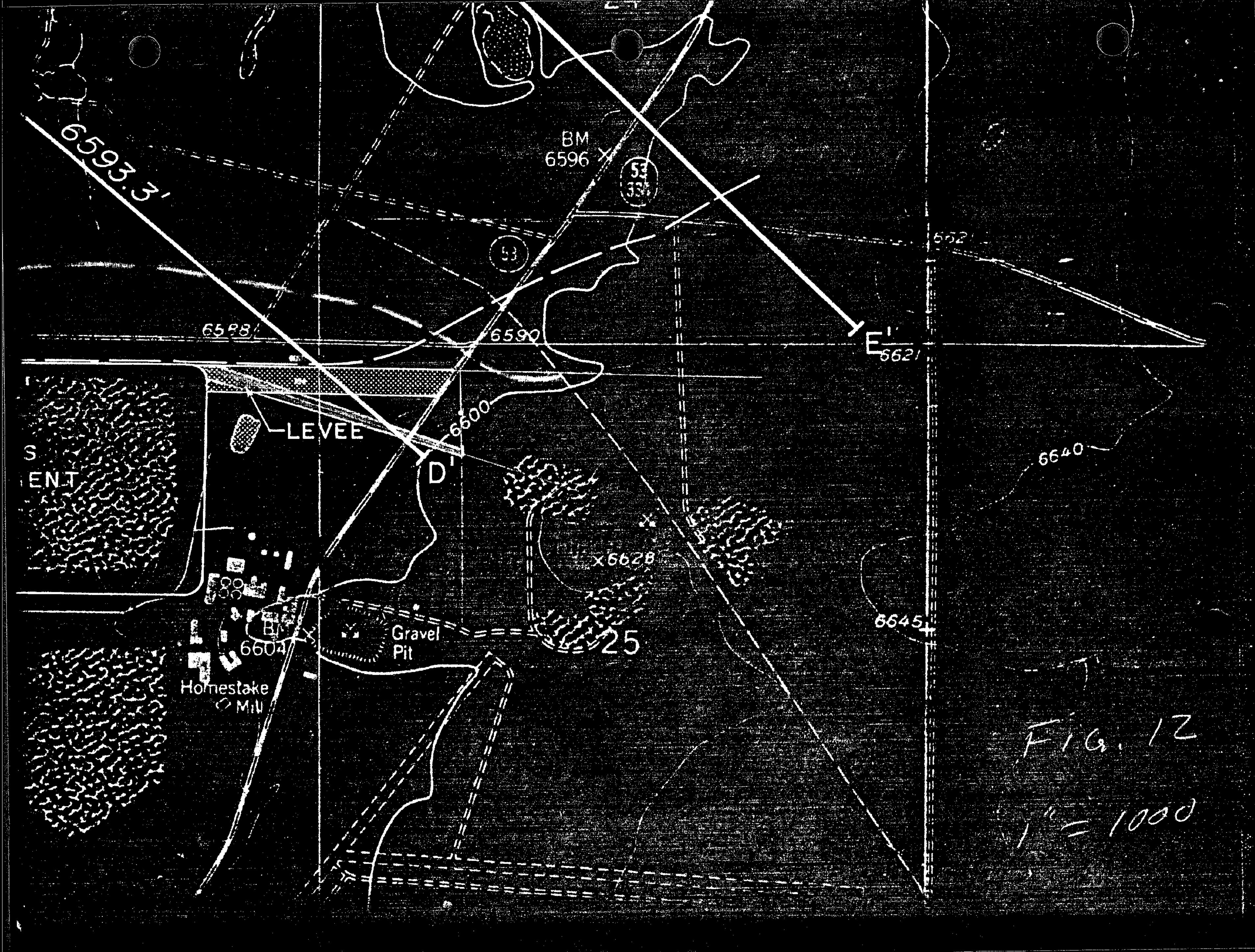

6593.3'
BM
6596
53
334
53
6621'
6588'
6590
E'
6621'
LEVEE
6600
D'
S
ENT
6640
x6628
BM
6604
Gravel
Pit
Homestake
Mill
25
6645

FIG. 12

1" = 1000'


6593.3'
BM
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LEVEE
6600
D'
6640
S
ENT
x6628
BM
6604
Gravel
Pit
25
6645
Homestake
Mill

Fig. 12
1" = 1000

Canonie Environmental

Canonie Environmental [illegible]
6551 South Re[illegible]
Suite 155
Englewood, Colorad[illegible]

Phone 303 79[illegible]

July 6, 1987

RM 86-065

Dr. Alan Kuhn
13212 Manitoba Drive, N.E.
Albuquerque, New Mexico 87111

<u>Cross Section Origination</u>
<u>Homestake Mill</u>
<u>Grants, New Mexico</u>

Dear Al:

I have written a short paragraph explaining the origination of the cross sections used in the PMF floodplain determination for the Homestake Mill near Grants, New Mexico. The paragraph follows:

"Sections Z-Z', A-A', and C-C' were developed from an enlargement of a composite map made from USGS 7.5-minute topographic map sheets of Bluewater, Dos Lomas, Milan, and Grants, New Mexico. This enlarged composite was used as the base map for Figures 8 and 12. Sections B-B', D-D', and E-E' were surveyed in either 1980 or 1981 by Homestake personnel using laser surveying equipment. The sections for B-B' and C-C' were modified to include the reclaimed borrow pit configuration as shown on Figures 8 and 9."

Al, please check Figure 8 to make sure that this figure shows the borrow pit configuration. Gene's copy of the reclamation copy is missing Figure 8.

Please call if you have any questions.

Very truly yours,

Michael J. Timmer

Michael J. Timmer
Project Supervisor

MJT/klg

Rad. 16.

UNITED STATES

NUCLEAR REGULATORY COMMISSION

REGION IV

URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

AUG 20 1987

RECEIVED
AUG 24 1987

URFO:ROG
Docket No. 40-8903

Homestake Mining Company
ATTN: Mr. Edward Kennedy
P.O. Box 98
Grants, New Mexico 87020

Gentlemen:

At the meeting you attended in our office on July 29, 1987, agreement was reached on several issues, and commitments were made for providing additional information needed in our review of the Homestake Reclamation Plan. It was agreed that you would provide us the information when available and at least within 60 days, unless testing results are not available.

Commitments made for providing additional information are as follows:

1. Design details and general construction specifications (QC) for major design features (i.e., radon barrier, rock armor, levee, etc.) will be provided.

2. Soil testing of proposed radon cover (manufactured samples) from the borrow area and a complete set of index testing along with moisture-density relationship determination, permeability and dispersive testing will be submitted. The radon attenuation will be reconsidered using these values and an appropriate long-term moisture to determine the required thickness of cover.

3. The October 1986 Triad Inc. report, "Radon Emanation and Dispersion Modeling" will be submitted. The emanation coefficient will be set at 0.35, unless a differing value is substantiated by test results.

4. The method that will be used to determine when sufficient settlement has occurred so that the radon cover can be placed, will be submitted. Also, the proposal to further reduce surveying to annually will be considered after reviewing several sets of settlement data.

5. In designing riprap, Homestake used a 1-hour PMP = 3.4 inches. (See page 2 of Attachment IIB of 4/28/87, submitted and Table 1 of

Reclamation Plan.) Staff believes PMP should be 11-12 inches. Therefore, Homestake will provide basis for the 3.4-inch PMP value or recalculate using appropriate (defendable) value.

6. Additional drainage will be diverted to the north of the pile. Therefore, a revised PMF analysis is required, and design of riprap on north and west sides of pile has to be reevaluated to assure it is adequate.

7. Design basis for ditch located south of the pile (between the old and new piles) will be provided. Ditch dimensions plus flow depth, discharge and flow velocities will be provided.

8. Swales on top of pile will be armored with rock. Homestake will provide design details of the swales and rock to be used for armoring.

9. Design details of levee to be constructed to divert Lobo Canyon at northeast corner of pile will be provided. A 100-year flood event will be considered to determine potential for scour and erosion of diversion levee during low flow events.

10. Minimum requirements for rock source to be used for riprap will be provided.

11. An evaluation of the potential for scour on the north and west sides of the pile will be made. If there is a potential for undercutting of the toe of the armored slope, the riprap will be extended to the estimated scour depth.

12. A discussion of how the cross-sections along the north side of the pile were determined. (It appears that the 7½-minute quadrangle maps used have a 20-foot contour interval. It is nor clear how these maps were used.)

We also want to remind you that the inactive tailings pile located south of the main pile has to be addressed and included in your reclamation plan. This requirement was previously stated in a letter to you dated June 17, 1987.

Sincerely,

Edward F. Hawkins, Chief
Licensing Branch 1
Uranium Recovery Field Office
Region IV

HMCSL024742

Rad. 1b.

HOMESTAKE MINING COMPANY
P.O. BOX 98
GRANTS, NEW MEXICO
87020

August 28, 1987

Mr. Michael J. Timmer
Canonie Environmental
6551 South Revere Parkway
Suite 155
Englewood, Colorado 80111

Re: Additional Hydrologic/Hydraulic Analysis
Homestake Mining Company

Dear Mr. Timmer:

We are in receipt of your letter of August 25, 1987 concerning the above referenced matter. The referenced items are hereby approved for your analysis as directed by Alan Kuhn. Please bill Homestake as you have in the past for work done (P.O. No. 154037).

If you have any questions or comments concerning the identified tasks, please don't hesitate to contact me or Alan Kuhn.

Very truly yours,

HOMESTAKE MINING COMPANY-GRANTS

Edward E. Kennedy

Edward E. Kennedy
Director of Environmental Affairs

EEK/bgl

xc: Alan Kuhn

CanonieEnvironmental

Canonie Environmental Services Corp.
6551 South Revere Parkway
Suite 155
Englewood, Colorado 80111

Phone: 303-790-1747

86-065

RECEIVED
AUG 28 1987

August 25, 1987

Mr. Edward Kennedy
Homestake Mining Company
P.O. Box 98
Grants, New Mexico 87020

Additional Hydrologic/Hydraulic Analysis
Homestake Mining Company Mill
Grants, New Mexico

Dear Mr. Kennedy:

Mr. Alan Kuhn has indicated the need for additional hydrologic and hydraulic analyses for the reclamation plan for Homestake Mining Company's (Homestake) at Grants, New Mexico. Mr. Kuhn has asked that Canonie Environmental Services Corp. (Canonie) provide the scope and expected costs for this work.

The tasks involved include the following:

1. Determination of revised one-hour and six-hour PMP amounts from the Bureau of Reclamation or NOAA.

2. Recalculation of the PMF for both San Mateo Creek and Lobo Canyon drainage using revised PMP amounts.

3. Routing the PMF through both San Mateo Creek and Lobo Canyon using existing HEC2 input files.

4. Analysis and explanation of effects of converging peak flows on flood heights in Lobo Canyon.

5. Explanation of channel cross section determinations and effects of 20-foot contour intervals on accuracy of flood modeling.

6. Determination of 100-year rainfall amount, 100-year flood hydrograph, and 100-year flood heights and velocities in Lobo Canyon drainage.

7. Determination of PMF and 100-year flood flow velocities along dikes and levees and sizing of riprap, if needed, on Homestake property.

8. Revisions and additions to existing reclamation plan text.

The expected cost for performance of these tasks is $3,800. Canonie has started on Task 1 because of the importance of acquiring the revised PMP amounts.

Please call if you have any questions.

Michael J. Timmer
Project Supervisor

MJT/bk

cc: Alan Kuhn, Albuquerque

Attachment B-2

A Report on Alkaline Carbonate Leaching at Homestake Mining Company

A REPORT

ON

ALKALINE CARBONATE LEACHING AT HOMESTAKE MINING COMPANY

by

Kenneth E. Skiff

and

John P Turner

November 12, 1981

TABLE OF CONTENTS

List of Figures

Introduction

Homestake Mining Company is a major uranium mining and milling operation near Grants, New Mexico.

The Mill, originally built in 1958, had a capacity of 1650 tons per day. With subsequent improvements and the addition of the adjacent Homestake New Mexico Partners mill, the HMC mill is currently rated at about 3500 tons per day.

An alkaline type leach process is utilized by the mill. Milling consists of five basic steps:

A. Ore handling and preparation

B. Extraction

C. Liquid—solid separation

D. Precipitation and purification

E. Product preparation

A. Ore Handling and Preparation

1. Ore

The primary source of ore for the HMC mill is from its four under-ground mines located in the Ambrosia Lake Bed area. Lesser amounts of ore are received from the United Nuclear Corporation and Cobb Nuclear Corporation. These mines are all within thirty miles of the mill site.

Two basic types of ore are processed by the mill. Sandstone accounts for approximately 80% to 85% of the mill feed with the ba1cnce being limestone. The principle mineralization of these ores includes coffinite $[U(SiO_4)_{1-x}(OH)_{4x}]$, uraninite $[U^{+4}_{1-x}, U^{+6}_{x}) 0_{2+x}$, ideally UO_2, tyuyamunite $[Ca (UO_2)_2 (VO_4)_2 5 - 8 H_2O]$, and carnotite $[K_2 (UO_2)_2 (VO_4)_2 3 H_20]$. This mineralization generally occurs as an impregnation,

a pore filling, or as a cement between sand grains. In the ore there is often the presence of carbonaceous materials in association with the uranium mineral, In addition **to** the uranium in the ore, there are trace amounts of molybdenum, selenium, titanium, gold, and silver.

2. Ore Receiving

Trucks hauling 22 to 28 tons of ore deliver their load to the mill from the mines. When a loaded truck arrives at the mill from **the** mines, it is weighed and the ore is sampled for moisture. The moisture determined from the ore in the trucks is used as the basis to calculate the number of dry tons of ore for metallurgical accounting. Each mine’s ore is kept separate in lots for control purposes through crushing and sampling. Lots vary from 200 to 2000 tons each.

The ore grade ranges between 0.04% and 0.30% U_30_8. To minimize fluctuations in the grade of the feed to the mill, the ore lots are selectively crushed.

3. Crushing

An 18 inch grizzly covers a sub—grade hopper on the ore pad. Ore is discharged from this hopper onto an apron feeder. This ore then discharges through an anchor chain curtain onto the crusher iced belt. As the ore discharges from the crusher feed belt onto a rotating wobbler the minus 2 inch fraction is allowed to by—pass the crusher. The crusher discharge and rotating wobbler undersize are combined and sized to plus or minus 3/4 inch by the use of vibrating screens. The 3/4 inch screen oversize is recycled no the crusher and the 3/4 inch undersize is transferred to the sample plant.

4. Drying

Ores containing more than 8 to 9% moisture generally require drying. When required, a 10 foot diameter by 80 foot co-current fired rotary dryer is used. The burner has a capacity of 70 million BTU per hour. Firing can be either natural gas or light fuel oil.

The feed to the dryer is the rotating wobbler undersized (minus 2 inch) and the crusher discharge. Ore discharges the dryer at about 5% moisture. A conveyor belt returns the ore to the vibrating screens in the crusher plant.

5. Sampling

A representative sample of each ore lot is obtained by using four stages of samplers. The first stage operates on the entire crushing plant output and discharges the sample into a small surge bin. A load sensing device is mounted in the surge bin to control the speed of the belts feeding the remaining samplers. This insures a steady stream of falling ore for each sampler. A roll crusher is in the sample stream between the second and third sampler to reduce the particle size to minus 1/4 inch. The fourth and final stage of sampling cuts a quantity equivalent to one pound of sample for each four tons of ore crushed. After the final sample is cut, the ore is continuously dried and crushed to minus 10 mesh. With further sample preparation, chemical and metallurgical testing data is obtained from this sample for metallurgical accounting.

6. Fine Ore Bins

Four concrete silos comprise the fine ore bins, with each being 35 feet in diameter by 50 feet in height. At full capacity tine ore bins contain approximately 6000 tons of ore. Since each lot of ore must retain its identity until the ore reaches the ore bins, there is very

little blending of the ore prior to milling. A conveyor belt transports the ore from the sample plant to the too of the ore bins. A belt tripper in used to discharge the ore into anyone of the four ore bins or into a truck hopper for return to the ore pad.

The ore bins are used **to** segregate different types of ores in order to process the refractory ores such as limestone ore that require a finer grind and a longer retention tire during leaching to maximize the uranium recovery. The mill utilizes two parallel circuits in grinding, thickening, and leaching. These circuits are referred to as the north and south circuits. A majority of the mill’s sandstone ores is processed in the north circuit while the south circuit uses a secondary grind and a longer atmospheric leaching time to process the limestone and other refractory type ores. These ores are directed to the two ore bins that feed the mill’s south circuit.

The feed to the grinding circuit is withdrawn from the ore bins by means of two belt feeders under each ore bin. A collecting belt transfers the discharge from the feeder belts to the ball mill belt feed.

7. Grinding

Each primary grinding circuit consists of a ball mill which **is** operated in closed circuit with a spiral classifier.

The grinding circuits utilize]0 feet by 66 inch Hardinge Conical ball mills. The ball charge in each mill is approximately 22 tons. Equa1 weights of 2 and 2 1/2 inch forged steel balls are used for charge make up. Each ball mill is driven by a 400 hp, 4160 volt, motor geared through a pinon shaft to the ball mill. Operation of the ball mills is maintained at 20 rpm or 83% of critical speed. The ball discharge

density is maintained at 65% solids in **a** sodium carbonate and sodium bicarbonate mill solution containing 37 grams $Na_2\ CO_3$ per liter and 7 grams $Na\ HCO_3$ per liter.

A 72 inch Wemco spiral classifier is operated in closed circuit with the ball mill. Overflow from the classifier is controlled at 20% solids. The overflow product of the classifier is about 10% plus 48 mesh and 35% minus 200 mesh.

The north circuit spiral classifier overf1cx goes directly to the north thickening circuit. As compared to the south circuit containing limestone and other refractory ores the overflow is fed to a 20 inch cyclone which is in closed circuit with a regrind ball mill, this mill is a Denver 6 feet diameter by 6 feet long mill. A 200 hp, 480 volt, motor is connected to a conventional belt drive system that provides the drive to the mill. The mill contains approximately 4 tons of 1 inch forged steel balls.

The regrind cyclone overflow product is about 5% plus 65 inch and 50% minus 200 mesh. This product then goes to the south thickening circuit.

8. Preleach Thickening

The HMC mill has two thickening circuits. Overflow from each grinding circuit is pumped to its respective 20 inch cyclone in the thickening circuit. The cyclone overflow advances **to** the thickener where a polyacrylamide flocculant is used to aid in settling and clarification. Both thickeners overflow by gravity to a common mill solution storage tank for recycle to the grinding circuit. The thickened slurry from the thickener is removed at about 40% solids. The thickener

underflow and the cyclone underflow are recombined in their respective preheat tank **of the** leaching circuit.

B. Extraction

1. Theory

The chemistry of the alkaline leaching system requires the oxidation of tetravalent uranium to the hexavalent state, Oxygen available in the air is the most common oxidant used. The hexavalent uranium dissolves in the presence of carbonate alkalinity to form a uranyl tricarbonate complex ion according to the following reactions.

$$2\ UO_2+O_2 \bullet 2UO_3$$

$$2\ UO_3+6\ Na_2\ CO_3 + 2\ H_2O \bullet 2\ Na_4\ UO_2\ (C0_3)_3 + 4NaOH$$

The uranium will not dissolve in a sodium carbonate solution because the hydroxide alkalinity formed with the complex ion causes the ion to decompose. In a solution containing sodium bicarbonate, the hydroxide alkalinity is neutralized immediately, and the reaction proceeds as follows:

$$U0_3 + Na_2\ CO_3 + 2\ Na\ HCO_3 \bullet Na_4\ UO_2\ (CO_3)_3 + H_2O$$

2. Leaching

The extraction of the uranium from the ore is accomplished in a two stage circuit. The first stage consists of a pressure leach where the pressure is maintained at 60 PSIG and the temperature is maintained a 200°F. Retention time of the slurry **in** the pressure leach is 4.5 hours. The second stage consists of an air agitated atmospheric leach at a temperature of 170°F. The atmospheric leach slurry has a retention tire of 12 hours for the slurry coming from the north leach circuit and of 24

hours for the slurry coming from the south leach circuit.

a. Pressure Leach

Pressure leaching is accomplished **in** two separate circuits each containing eight autoclaves. The autoclaves are 12 feet diameter by 16 feet high, domed, pressure tanks equipped with a top mounted 'Lightnin' mixer. Each tank has two, turbine type, 42 inch diameter impellers mounted on a 14 foot, 4 inch diameter shaft. Oxidation air is fed into the bottom of the autoclaves through a 30 inch bubble-cap diffuser. Pressure in an autoclave circuit is maintained by an automatic bleed—off valve on the Pipe header connected to each autoclave, Heat for leaching is supplied by steam coils. Temperature and pressure in the autoclave circuit is maintained by automatic controls.

Each of the two circuits is operated as a series of eight autoclaves. The ore has a retention time about 4.5 hours in the circuit. The first unit in each leaching circuit is a preheat tank in which the thickener underflow and the cyclone underflow are recombined and heated to 150°F. This preheated slurry at about 55% solids is pumped to the first autoclave leaching tank of its circuit. The flow through the autoclaves is by gravity, and the feed to each autoclave enters the slurry surface and discharges from the bottom through an internal riser. A six inch drop between autoclaves provides the head for flow through the piping in the circuit. The operating volume of each autoclave is approximately 11,000 gallons. The discharge from the last autoclave in each circuit flows into a letdown tank. From the letdown tank, the leached slurry discharges through a concentric tube heat exchanger that cools the slurry from 200°F to 170°F. The pressure of the system provides

the energy to push the partially leached slurry through the heat exchanger to the atmospheric leach.

b. Atmospheric Leach

Atmospheric leaching also consists of **o** separate circuits. The north circuit pressure leach discharges **to** the first of three pachuca tanks with a retention time of 12 hours. The south circuit pressure leach discharge, is split where half the flow goes to the first of another three pachuca tanks and the other half of the flow goes to the first of another three pachuca tanks. Retention time for the south circuit is 24 hours. Each pachuca tank is 19 feet in diameter by 38 feet tall. Four, ten inch air lifts provide agitation for each pachuca. Heat for the circuit is provided through steam jackets on the air lift pipes. Additional air for oxidation and agitation is supplied through five pipes that are suspended from the top of each tank. The air enters the slurry approximately 3 feet from the bottom of the tank.

The slurry from the pressure leach circuit is added to the top of the first pachuca tank of its circuit and f1cxs by gravity through the tanks and discharges into a sump where the slurry is pumped to the liquid—solid separation circuit.

C. Liquid-Solid Separation

1. Filtration

The leached slurries from both atmospheric leach circuits are pumped to the fitter feed tank in the liquid—solid separation circuit. This leached slurry is pumped to each of the first stage of filters, where the soluble uranium values are removed by three codified stages of counter current filtrations. A dilute solution of flocculant is pumped into the tuber feed line where the filter feed and flocculant are mixed. A

thorough mixing takes place as the filter feed slurry and flocculant flow through the pipes, the filter feed valves, and a small mixing chamber on each filter tub.

Each filter stage contains five, 650 square foot and two, 570 square foot rotary drum vacuum filters. The filters are 11 ½ feet in diameter and are equipped with polypropylene grids. A heavy duty nylon filter cloth is used to cover the filters. A 14 gauge stainless **steel** wire is wound on the filters to retain the filter cloth.

The first stage filter cake is washed with a hot filtrate solution from the third stage of filters. The filtrate is sent to clarification, and the first stage filter cake discharges into repulpers for repulping with third stage filtrate. The repulped slurry flows by gravity through an agitated sump and into the second stage of filters. Flocculant is added to the repulper solution to aid in the second stage of filtration. The second and third stage of filters are operated in much the sane manner as the first stage; except that recarbonated barren solution from the precipitation circuit is used as a filter wash and in the repulpers on the second stage, and tailings pond solution or water is used as a wash and in the repulpers on the third stage. The wash solution for each stage of filters is maintained at 100°F, The second stage filtrate is sent to the mill solution circuit, and the third stage filtration is used as a wash and repulper solution on the first stage of filters. The filter cake from the third stage of filters is repulped with recycled tailings pond solution and slurried for tailings disposal.

2. Clarification

The filtrate produced by the first stage of filters is the pregnant

uranium solution for the precipitation circuit. The solution must be clarified before precipitation to remove slimes that have penetrated the filter cloths. Clarification occurs **in** a thickener where a major portion of the silica and shire contaminants settle out. The pregnant solution for precipitation is then pumped from the thickener through heat exchangers to heat the solution from 125°F to 180°F before flowing into the precipitation circuit. The heat is obtained by cooling the pressure leach discharge slurry from 200°F to 170°F.

3. Tailings Disposal

The filter cake from the third stage filters is repulped with recycle solution from the tailings pond ion exchange system and transferred through launders to a tailings slurry tank. Disposal of the tailings slurry is handled by three Ash pumps in series and a cyclone truck. The pumping capacity of these pumps is rated at 1500 gallons per minute.

Tailings disposal encompasses an area of 110 acres. Construction of the pond is done by pumping the tailings slurry at about 40% solids through two, truck mounted, 20 inch cyclones. Underflow from the cyclone is deposited on the dike that surrounds the pond and the cyclone overflow is directed into the pond where the slimes settle out of the tailings solution. Recovery of the tailings solution is through two centrally located decant towers. The reclaimed tailings pond solution flows underground to a pump basin and is returned to the mill where it is processed in an ion exchange circuit for uranium removal.

4. Tailings Pond Ion Exchange

Prior to the reclaimed tailings pond solution being returned to

the third stage filters, the solution is treated **in** a NIMCIX system to remove the soluble uranium.

The NIMCIX plant is rated to treat 1200 gallons per minute of solution yielding a tail of less than 10 ppm U_30_8.

D. Precipitation and Purification

1. Precipitation

The pregnant solution from clarification after being heated to 180°F is pumped to the precipitation circuit. The precipitation is conducted in two stages. First the pregnant solution is mixed in the dissolving tank with recycled yellow cake to increase the soluble uranium content. Second, caustic soda is added to precipitate the uranium. The uranium in the pregnant solution exists as a uranyl tricarbonate complex. When the pH is raised above 12.0 with caustic soda, the complex ion decomposes to form carbonate and sodium diuranate. The latter salt is a yellow precipitate commonly called yellow cake.

$$2\ Na_4\ UO_2\ (CO_3) + 6\ Na\ OH \bullet Na_2\ U2O_7 + 6\ Na_2\ CO_3 + 3H_2O$$

The technique of recycling yellow cake was developed to achieve a more complete precipitation of the uranium in the original pregnant solution. The dissolving tank operates with a yellow cake recycle equivalent to 500% to 700% of the uranium in the incoming pregnant solution. In five hours of contact with the pregnant solution, a portion of the yellow cake dissolves; and the soluble grade of uranium in the solution increases. The precipitation efficiency of the circuit will vary with the level of soluble uranium in the feed. The undissolved yellow cake in circulation does not appreciably effect the precipitation.

The precipitation circuit consists of nine agitated tanks in a

series. The solution has a retention tine of about 12 hours. A solution of 50% caustic soda is metered into the first tank of the precipitation circuit of sufficient quantity to neutralize the sodium bicarbonate and also to maintain an excess of 5 grams per liter caustic soda in the barren solution. The caustic soda may also be added to the pipeline feeding the tank to change the characteristics of the precipitated ye1la cake and the efficiency of precipitation, which are affected by the point of addition.

The yellow cake slurry from the precipitation circuit flows into a 40 foot diameter by 12 foot deep thickener. The thickener is insulated with a floating two inch Styrofoam lid and two inches of Fiberglass insulation on the sides. Because the thickener operates at l70° to 180° F, the cover insulation is necessary to minimize evaporation and heat loss which create thermal currents that hinder settling. The thickener underflow is pumped at about 35 - 40% solids to the vanadium removal section or to the yellow cake dissolving tank for recycle. The thickener overflow is pumped through three plate and frame filter presses for final clarification and then to caustic barren storage.

2. Recarbonation

The caustic barren solution produced in the precipitation circuit contains sodium carbonate and a small quantity of sodium hydroxide. To reuse the barren solution, the caustic must he converted to sodium carbonate and sodium bicarbonate. This conversion is accomplished in two packed towers in which the caustic barren solution is contacted with boiler flue gas. The CO_2 in the flue gas neutralizes the sodium hydroxide and converts some of the carbonate to bicarbonate, the recarbonated

barren solution is pumped to the liquid-solid separation circuit for use as a wash and repulping solution on the second stage of filters.

3. Purification

The primary precipitation of yellow cake produces a product which, when washed and dried, will assay around 75 to 77% $U_3 0_8$, 5 to 6% V_2O_5, 2 to 2.5% CO_3 and 7.5% Na. Although the uranium content is satisfactory, the vanadium, carbonate, and sodium content of the precipitate exceeds contract specifications. Removal of these contaminants is required before the yellow cake is acceptable to the upgrading process plants.

a. Vanadium Removal

The removal of the vanadium and, quite incidentally, carbonate from the yellow cake is accomplished by roasting followed by water leaching. The yellow cake thickener underflow is pumped to a disc filter to dewater the slurry. The filter cake is agitated with a small quantity of sodium carbonate before being fed to the yellow cake roaster.

Yellow cake roasting is accomplished in an 8 foot 6 inch diameter, six hearth, Pacific furnace. The yellow cake is dried at around l600°F. The calcined yellow cake discharges into a water cooled screw conveyor which cools the yellow cake to approximately 200°F before discharging into a ball mill conveyor. Water is used to dissolve the vanadium and carbonate contaminants in the yellow cake. The leached yellow cake slurry is collected in a 16 foot diameter by 10 foot deep thickener. The thickener overflow, containing the vanadium, is filtered and sent to vanadium storage. The vanadium solution is concentrated and cold to a carry vanadium producer.

b. Sodium Removal

Vanadium solution contained in the yellow cake slurry in the sixteen foot yellow cake thickener underflow is removed on a four and one—half foot diameter by six foot long, vacuum, drum filter. Then the yellow cake is washed and repulped with water. This yellow cake containing approximately 7.5% sodium as sodium diuranate is dissolved with sulfuric acid at a pH of around 2.2. Next, ammonia is added to maintain a pH of around 7.4. The uranium reprecipitates as yellow cake, ammonium diruanate and basic sulfate, generally containing less than 0.5% sodium. This product is filtered and washed with ammonium sulfate solution on two six foot diameter by eight-foot long, vacuum, drum filters in series before being dried in a four hearth Pacific roaster and packaged as described under the section on Product Preparation.

E. Product Preparation

The filter cake from the second yellow cake filter discharges into an agitated sump, from where it is pumped to the yellow cake dryer. Yellow cake drying is accomplished by an 8 foot 6 inch diameter, four hearth, Pacific furnace, which is fired to about 1000°F. By the time the yellow cake reaches the bottom of the yellow cake dryer, the moisture and ammonia have been removed. The yellow cake is discharged from the drier through a pulverizer into a hopper, where it is held until packaging.

Yellow cake is packaged in 55 gallon open head drums. A vibrator under toe drum loading station is used to settle the contents or each drum. After the drums are sealed, sampled, and weighed, the drum is cleaned and placed in storage until it is shipped.

Each drum contains a maximum of 1000 pounds of yellow cake and about 45 drums comprise a shipping lot.

F. Acknowledgments

The authors of this report wish to express their thanks to the HMC management for their support and assistance in presenting this paper.

Figure 1

ORE HANDLING AND PREPARATION (A)

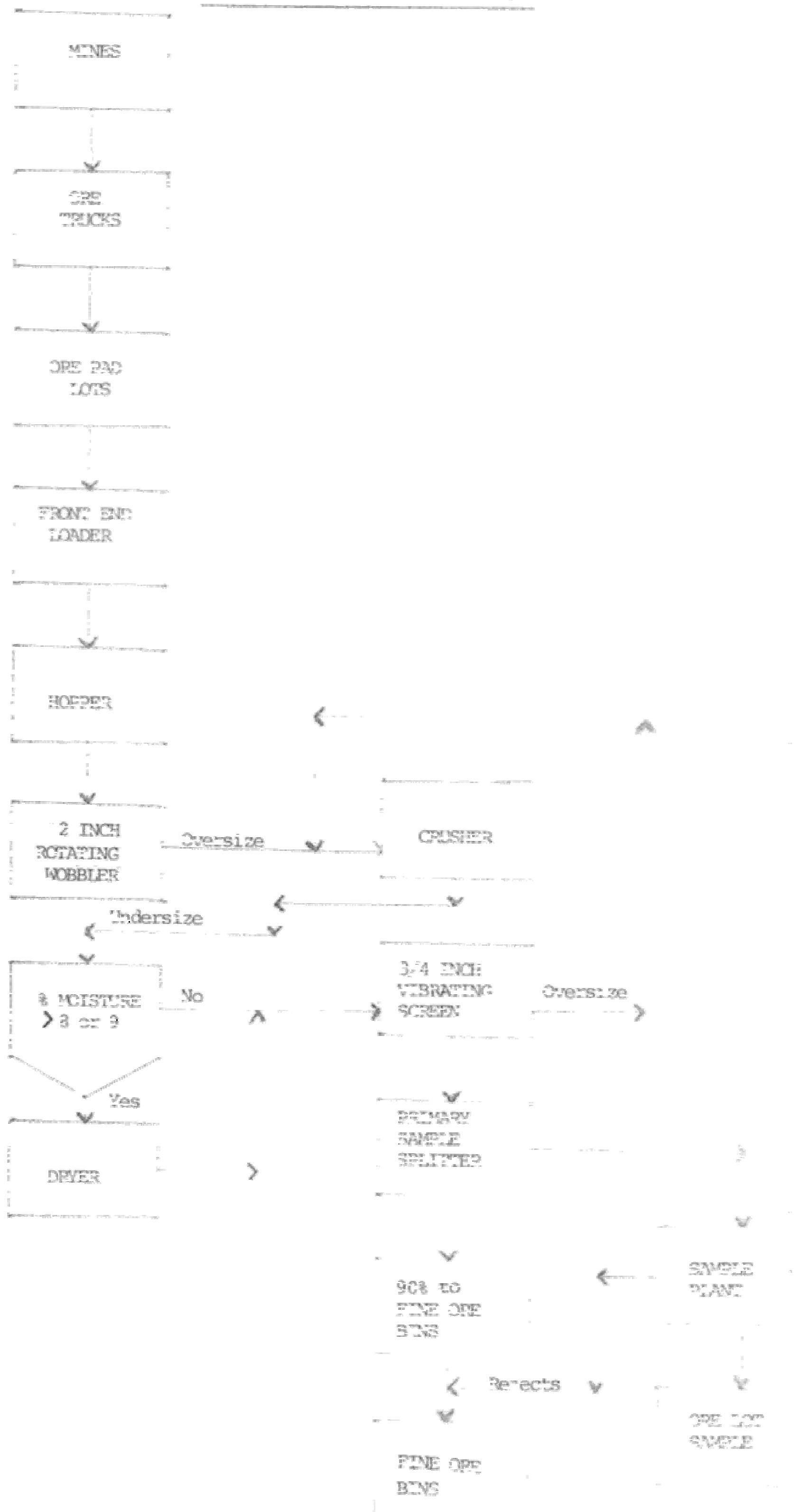


Figure 2
ORE HANDLING AND PREPARATION (B)

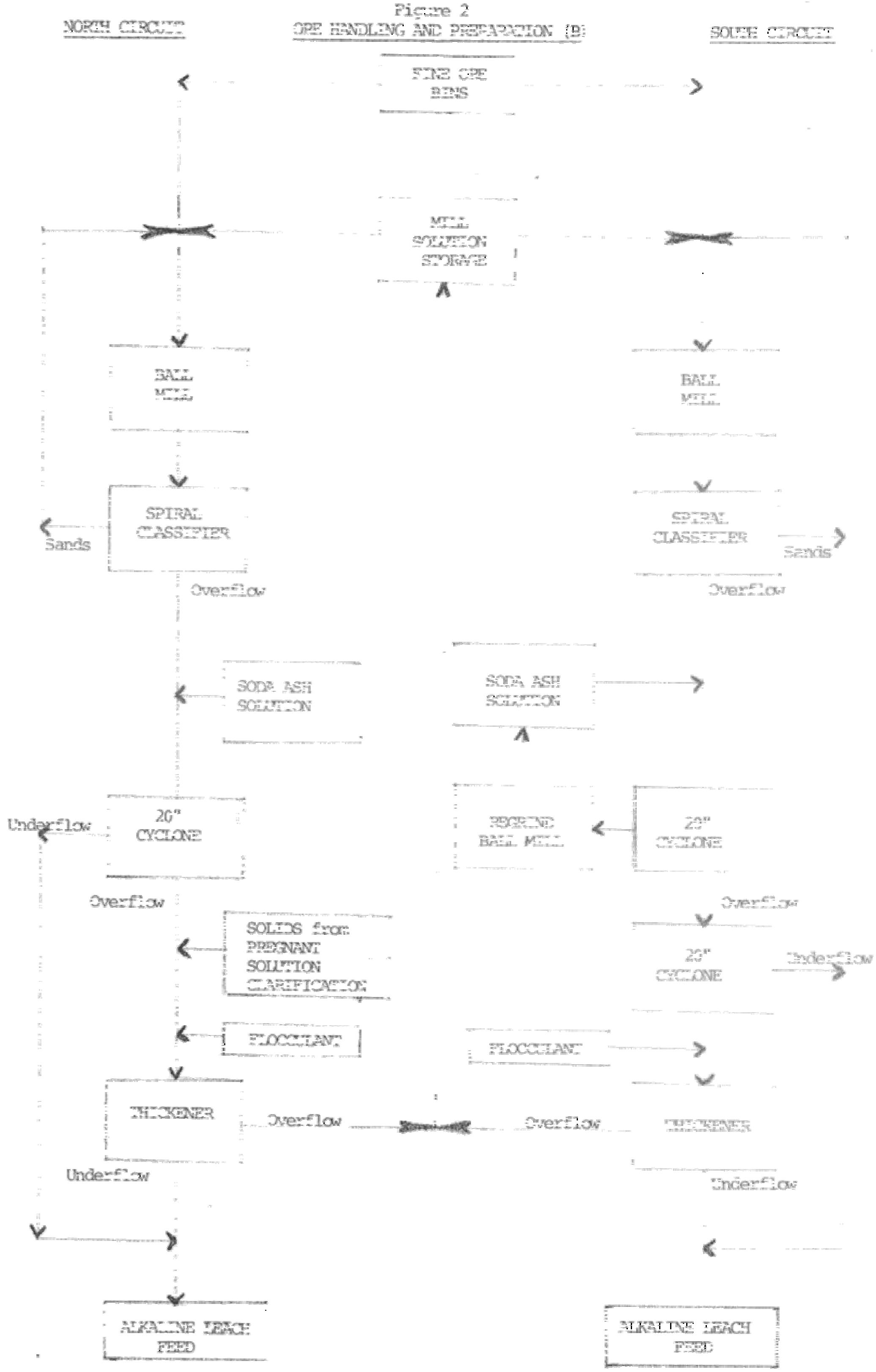


Figure 3

EXTRACTION

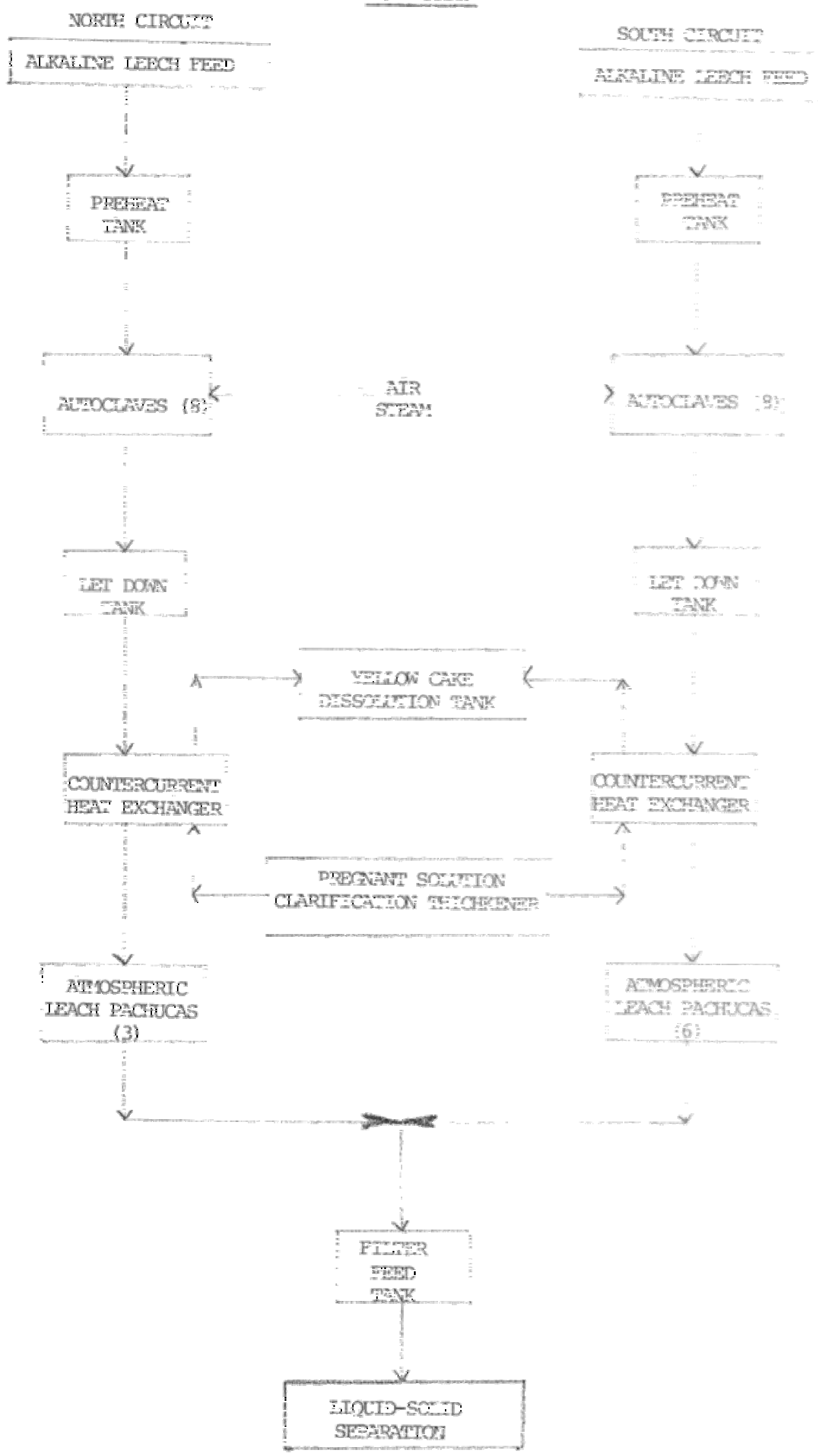


Figure 4

LIQUID-SOLID SEPARATION

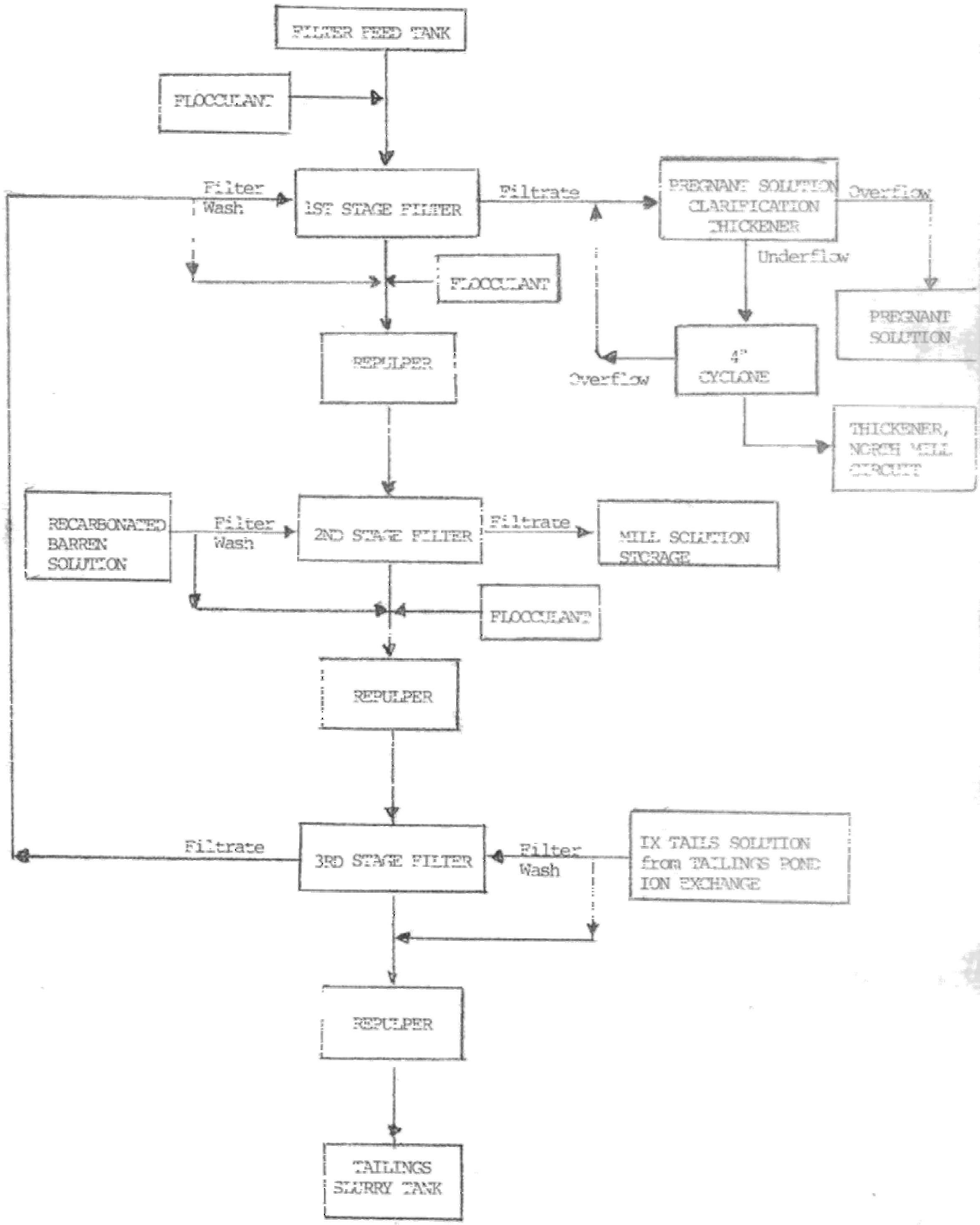


Figure 5

TAILINGS DISPOSAL

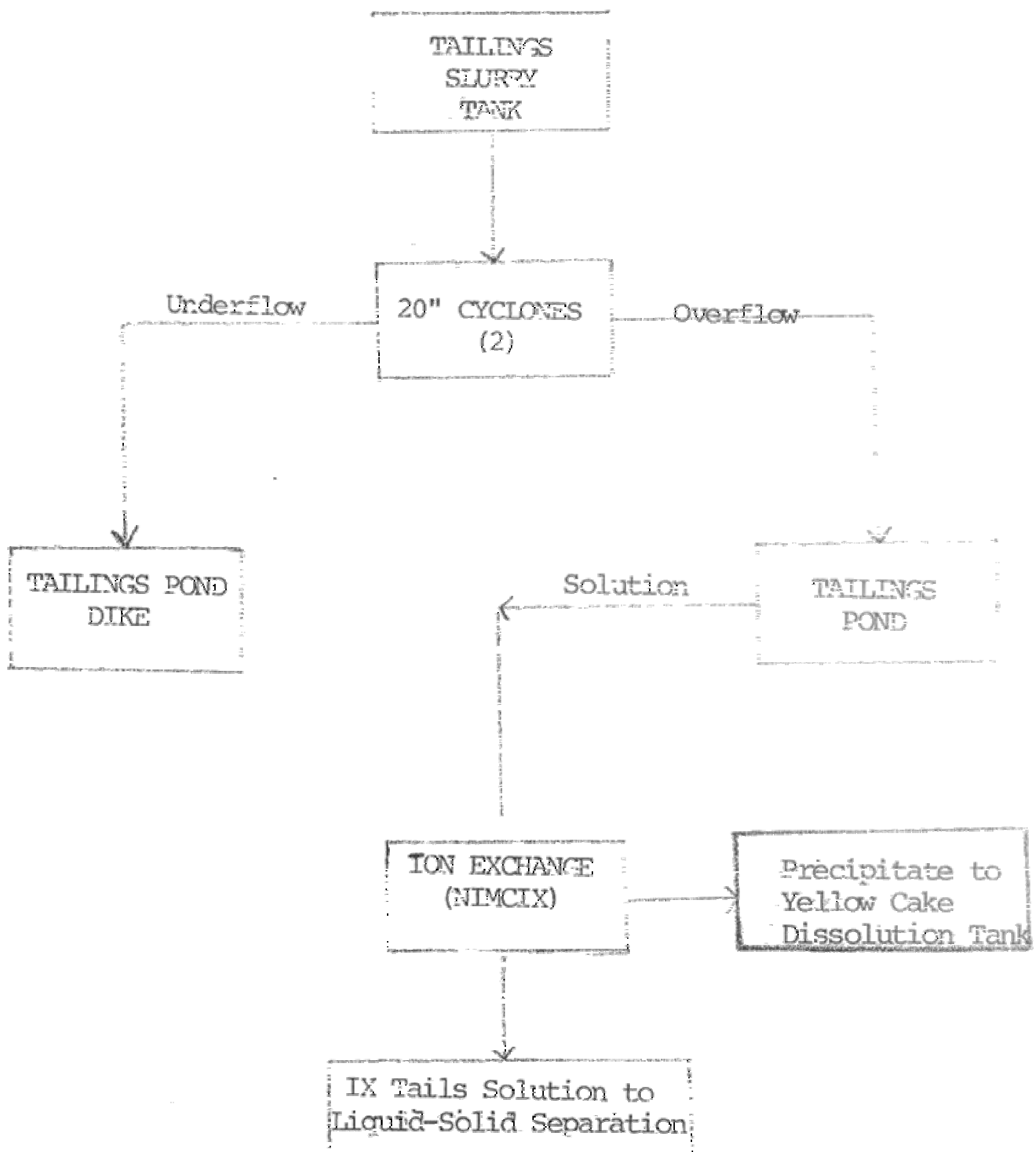


Figure 6 a
PRECIPITATION, PURIFICATION, AND PRODUCT PREPARATION

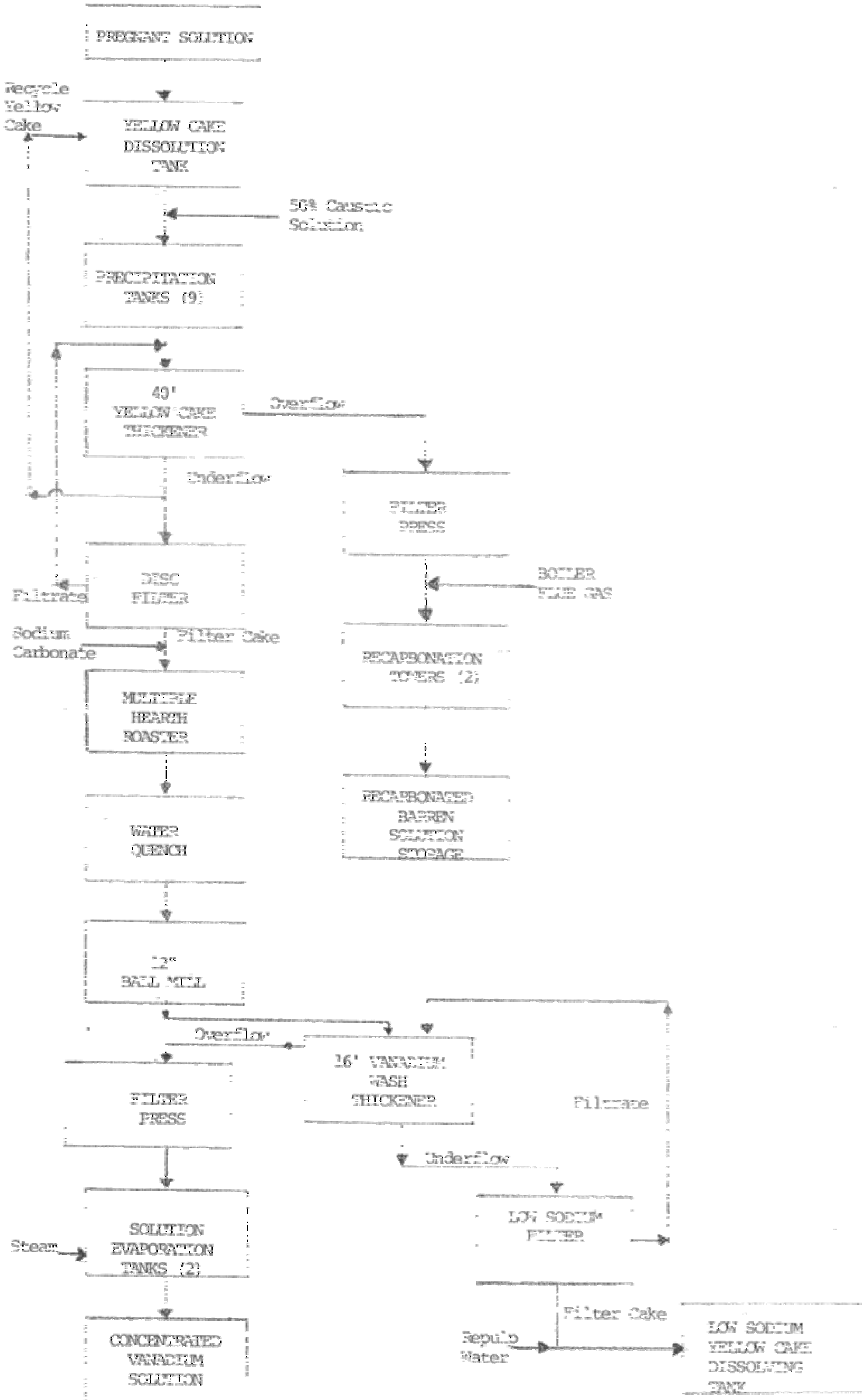
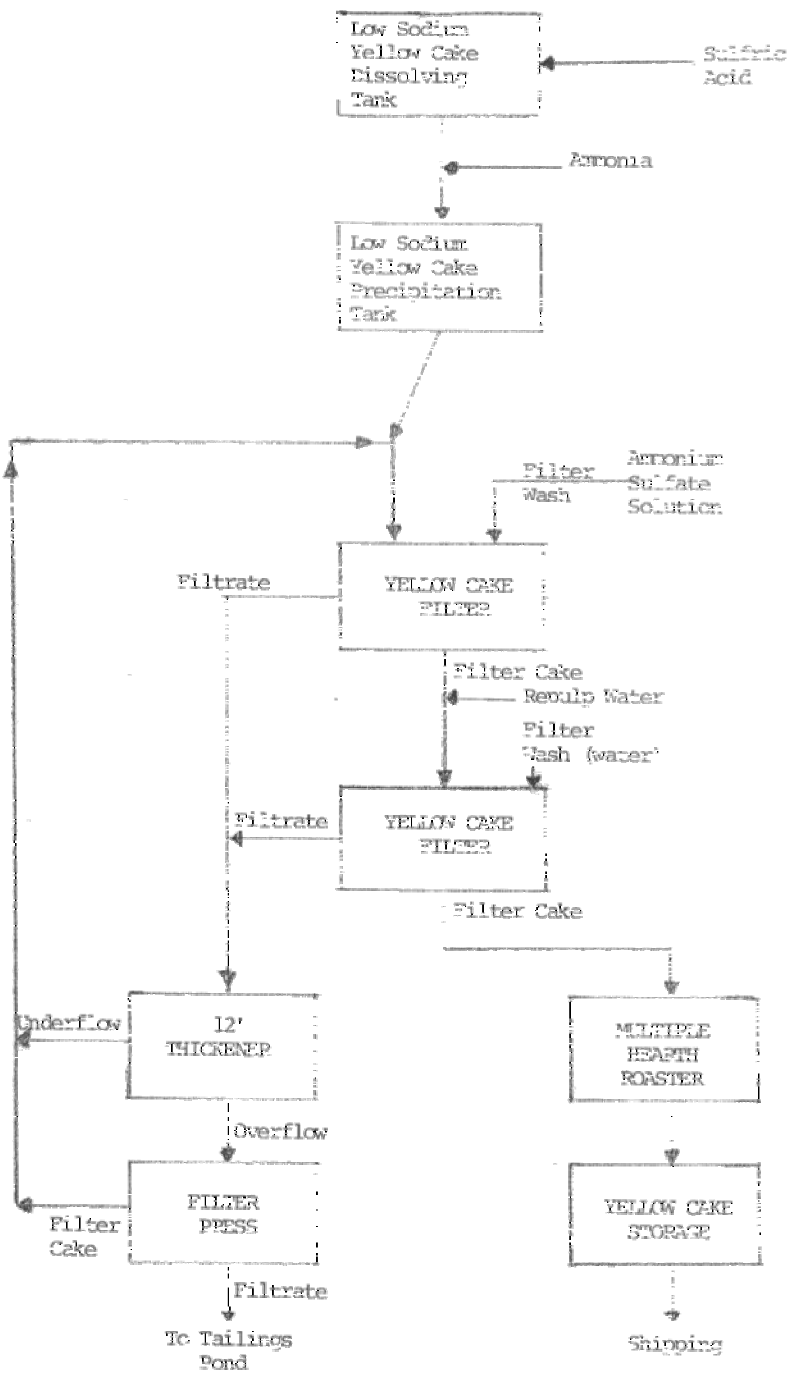


Figure 6 b

PRECIPITATION, PURIFICATION, AND PRODUCT PREPARATION



Appendix B

Well Logs

Well Log Index

#	Log ID	#	Log ID	#	Log ID
1	DD	31	CW24	61	447
2	DD2	32	CW31	62	555
3	HCW	33	WR24	63	816
4	L	34	CW34	64	822
5	M1	35	WR25	65	836
6	N	36	CW35	66	844
7	MY	37	CW37	67	882
8	MX	38	CW40	68	883
9	O	39	CW41	69	L6
10	P	40	643	70	MV
11	P1	41	644	71	L5
12	P2	42	CW50	72	SUB4
13	P3	43	CW52	73	SUB7
14	P4	44	CW55	74	#1 DEEP
15	NA	45	T5	75	929
16	NB	46	T4	76	930
17	NC	47	T11	77	931
18	ND	48	T12	78	932
19	CW2	49	T18	79	934
20	CW3	50	CE6	80	944
21	CW8	51	CE9	81	946
22	CW13	52	CE10	82	948
23	CW14	53	CE11	83	949
24	CW15	54	411	84	954
25	CW21	55	426	85	955
26	CW22	56	430	86	961
27	CW18	57	434	87	962
28	CW17	58	436	88	964
29	CW23	59	437	89	965
30	CW25	60	446	90	982

Well Log DD

HOLE	DATE	TIME	FOOTAGE INTERVAL	COMMENT
DD	4/15/76		6-32'	fine to medium grained, well sorted sand
			33 -45	red clay & coarse sand or gravel (originally thought to be Chinle Clay; however, clay layer is only 10-12' thick. this is probably the same clay layer that was mistakenly identified as Chinle clay in hole AA).
			45-56'	medium grained well sorted, light colored sand
			57-60'	red clay w coarse gravel
			60-65'	medium to fine grained sand
			65-73'	coarse sand & gravel with red clay
			75-83'	coarser sand and gravel w small amounts of chert & limestone fragments Contact w Chinle Clay @ 83'. 80' of 4" PVC casing with lower 40' perforated lowered into hole - same cleanout procedure as on AA.
		1445		well completed
BB	4/21/76	0900	6-10'	fine to medium light colored sand
			10-20'	fine to medium slightly darker sand
			20-23'	medium grained sand
			25-35'	fine grained light colored sand
			35-43'	medium to coarse light colored sand with small amts. of clay
			43-46'	coarse sand mixed w red clay
			46-50'	fine grained sand
		1230	53	hard drilling in black basalt this hole abandoned as was hole CC which required two days of unsuccessful attempts @ drilling thru the basalt

Well Log DD2

STATE ENGINEER OFFICE

WELL RECORD

DD2

Section 1. GENERAL INFORMATION

(A) Owner of well HOMESTAKE MINING CO. Owner's Well No. DD2

Street or Post Office Address

City and State

Well was drilled under Permit No. ______ and is located in the:

a. ___ ¼ ___ ¼ ___ ¼ ___ ¼ of Section ___ Township ___ Range ___ N.M.P.M.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. ___ of Block No. ___ of the ___ Subdivision, recorded in ___ County.

d. X= ___ feet, Y= ___ feet, N.M. Coordinate System ___ Zone in the ___ Grant.

(B) Drilling Contractor COYOTE DRILLING INC. License No. WD -1451

Address

Drilling Began 5-9-08 Completed 5-9-08 Type tools 3 cone bit Size of hole 9 7/8 in.

Elevation of land surface or ___ at well is ___ ft. Total depth of well 90 ft.

Completed well is XXX shallow ☐ artesian. Depth to water upon completion of well 45 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
75	80	5	sand & gravel	2 gpm

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
5"	PVC	none	0.	90	90	PVC CAP	50	90

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

··-· IJ:Jllh lh I •.lI r1cm	To	I hfl. .nn1 h fcH	Color 1111d Type of Ma1t111rl:.ncou._,..ed..
0	10	. 1'10	'qrown,clay
10	20	10	5?-!.D& gravel
20	70	-- 50 ...	red & gray shale
70	80	' 10	samd & gravel
80	90	10	gray shale

Well Log DD2

Revised June 1972

Well Log HCW

STATE ENGINEER OFFICE

WELL RECORD

HCW

Section 1. GENERAL INFORMATION

(A) Owner of well Milton Head Owner's Well No. HCW
Street or Post Office Address P. O. Box 2011
City and State Milan, N.M. 87021

Well was drilled under Permit No. B-677 and is located in the:

a. NE ¼ NE ¼ NE ¼ ____ ¼ of Section 34 Township 12N Range 10W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. 3 of Block No. 1 of the Murray Acres
Subdivision, recorded in Valencia County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Garner Drilling Co. License No. WD-595

Address Box 3146 Milan, N.M. 87021

Drilling Began 8-17-79 Completed 8-27-79 Type tools Rotary Size of hole 8 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 295 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well ____ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
264	287	~~287~~ 23	tan sandstone	30

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
10		weld	0	131	131	open.cemented-0-131		
6 5/8		8	+1	295	296	open	264	295

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
Cemented surface casing in from top to bottom. J.Pierson cementing Co.					

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

State Engineer Representative

STATE ENGINEER OFFICE ALBUQUERQUE, N. MEX. 79 SEP 17 AM 8:12

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received September 17, 1979

Quad ____ FWL ____ FSL ____

File No. B-677 Use Domestic Location No. Lot 3, Blk 1, Marra Acres

Well Log HCW

From	To	in feet	
0	20	20	tan shale
20	40	20	sand & gravel
40	50	10	red shale
50	82	32	sand & gravel
82	240	158	chinle
240	255	15	sandy bleu shale
255	264	9	red shale
264	287	23	tan sandstone
287	295	8	red, blue, purple shale (chinle form)
295	325	30	chinle 5 in. test hole

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Well Log L, M-1, and N

LITHOLOGIC LOGS FOR VARIOUS TEST HOLES (CONT.)

DEPTH INTERVAL (FT)	DESCRIPTION
	WELL L
0-10	Silty Fine Sand
10-20	Silty Fine Sand
20-30	Fine with Medium Sand
30-40	Silty Fine with Medium Sand
40-50	Silty Fine with Medium Sand
50-60	Fine with Medium Sand
	WELL M-1
50-60	Fine with Medium Sand
60-70	Fine with Medium Sand
	WELL N
30-40	Fine with Medium Sand
40-50	Fine with Medium Sand
50-60	Fine with Medium Sand
60-70	Fine with Medium Sand
70-80	Fine with Medium Sand
80-90	Silty Fine with Medium Sand
90-98	Medium with Fine Sandy Silt

Well Log MY and MX

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To.
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # MY Drilled 8/13-14/1996

0	10	tan sand
10	50	tan sandy clay
50	55	tan & purple clay
55	75	tan sandy clay
75	102	sand, gravel & boulders
102	112	purple shale

T.D. 112 ft. 5 in. PVC casing set 0-112 ft. Per. 72-112 ft. 13 sks sand. 6 sks. chips.
Rig Time 1 hr. Dev. Time 3 hrs. 75 gpm.

Hole # MX Drilled 8/14-15/1996

0	15	tan sandy clay
15	20	sand & gravel
20	65	tan sandy clay
65	94	sand, gravel & boulders
94	103	purple shale

T.D. 103 ft. 5 in. PVC casing set 0-103 ft. Per. 63-103 ft. 12 sks sand. 4 sks. chips.
Rig Time 1 hr. Dev. Time 3 hrs. 70 + gpm.

Backhoe Work.. 2 drill pits dug & covered.

TOTAL P.03

Well Log O and P

LITHOLOGIC LOGS FOR VARIOUS TEST HOLES (CONT.)

DEPTH INTERVAL (FT)	DESCRIPTION
	WELL O
30-40	Fine Sandy Silt
40-50	Very Silty Fine Sand
50-60	Fine Sandy Silt
60-70	Fine to Medium Sand
70-80	Medium with Fine Sandy Silt
	WELL P
30-40	Fine with Medium Sand
40-50	Fine Sand
50-60	Fine Sand
60-70	Fine Sand
70-80	Fine with Medium Sand
80-90	Fine with Medium Sand
90-100	Silty Fine with Medium Sand
100-110	Coarse with Medium Sandy Silt
110-115	Medium with Fine Sandy Silt

Well Log P1

Revised June 1972

STATE ENGINEER OFFICE
WELL RECORD

WELL ID. #504

Section 1. GENERAL INFORMATION

(A) Owner of well Homestake Mining Co. Owner's Well No. P-1
Street or Post Office Address Box 3146
City and State Grants, N.M. 87020

Well was drilled under Permit No. B-28-Expl-P1 and is located in the: Mill Site Area

a. ____ ¼ ____ ¼ ____ ¼ ____ ¼ of Section ____ Township ____ Range ____ N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Garner Drilling Co. License No. WD-595

Address Box 3146 Milan, N.M. 87021

Drilling Began 9-8-92 Completed 9-9-92 Type tools Rotary Size of hole 12 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 115 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 55 ft.

Test Well

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
60	105	45	sand & gravel with shale lenses	25 +

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6 sch. 40 PVC			+ 1	115	116	open	60	105
	Well is sand packed.		Dev. time 3 hrs.					

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No. ____

Well Log P1

Depth in Feet		Thickness in Feet	Col[illegible]d Type of Mat[illegible] Encountered
From	To		
0	10	10	sand
10	15	5	red shale
15	25	10	sand & gravel
25	40	15	gravel & shale
40	50	10	XXXXXXXe red shale
50	60	10	tan shale
60	105	45	sand, gravel & shale lenses
105	115	10	red shale

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

[signature]
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Well Log P3, P4, P1, and P2

Garner Drilling Co
Box 3146
Milan, N.M. 87021

To:
Homestake Mining Co. of Ca.
Box 98
Grants,N.M. 87020

Hole # P 3 Drilled 4/22/1998

0	42	tan sandy clay
42	44	red clay
44	56	tan sandy clay
56	65	tan sand & gravel
65	79	yellow sand & gravel
79	85	tan sand & gravel
85	95	purple shale

T.D. 95 ft. 5 in. sch. 40 PVC casing set 0-95 ft. Per. 55-95 ft. Cap on bottom.
23 sks. sand. 18 sks. chips. Air & water Dev.
Rig Time 1 hr. Dev. Time 3 hrs. 30 + gpm.
Backhoe work 1 pit.

Hole # P 4 Drilled 4/23/1998

0	28	tan clay
28	34	red clay
34	38	tan sand & gravel
38	57	tan sandy clay
57	70	tan sand & gravel
70	80	tan sand, gravel & clay
80	84	tan sand & gravel
84	95	red shale

T.D. 92 ft. 5 in. sch.40 PVC casing set 0-92 ft. Per. 52-92 ft. Cap on bottom.
24 sks. sand. 12 sks. chips. Air & water Dev.
Rig Time 1 hr. Dev. Time 3 hrs. 25-30 gpm.
Backhoe work 1 pit.

Well Cleanouts

Hole # P 1 4/27/1998
T.D. 112 ft. 6 in. PVC casing. No cap on bottom.
Black sand, gravel & red shale. Air & water Dev. 50-60 gpm.

Hole # P 2 4/27/1998
T.D. 111 ft. 6 in. PVC casing. No cap on bottom.
Black sand, gravel & red shale. Air & water Dev. 40 gpm.

8 hrs total cleanout time on wells P1 & P2

George,
I need Well ID's plus locations.
Thanks, Joyce

Well Log NA

Revised

STATE ENGINEER OFFICE

WELL RECORD

NA

Section 1. GENERAL INFORMATION

(A) Owner of well United Nuclear-Homestake Partners Owner's Well No. NA
Street or Post Office Address Box 98
City and State Grants, NM

Well was drilled under Permit No. ______ and is located in the: at Mill site

a. NE ¼ NE ¼ NW ¼ ____ ¼ of Section 26 Township 12N Range 10W N.M.P.M.

b. Tract No.____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in Valencia County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant

(B) Drilling Contractor Garner Drilling License No. WD-595
Address Box 3146 Milan, NM

Drilling Began 2-19-81 Completed 2-20-81 Type tools rotary Size of hole 10 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 90 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well ____ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
55	65	10	sand,gravel & shale	25 +

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5 sch. 40 PVC			0	90	91	open	50	90
Hole is sand packed set 40 ft pvc screen								
developement time 4 hrs.								

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

STATE ENGINEER OFFICE ALBUQUERQUE, N. MEX.
81 MAR 23 A 8:25

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. B-28-S-25 Use collectionwell Location No. NE¼NE¼NW¼ 26-12N-10W

Section 6. LOG OF HOLE

Depth in Feet From	To	Thickness in Feet	Color and Type of Material Encountered
0	10	10	sand
10	25	15	yellow shale
25	35	10	red shale
35	55	20	tan shale
55	65	10	sand, gravel & shale
65	75	10 ~~15~~	red shale
75	80	5	red shale & gravel
80	90	10	chinle

Well Log NA

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

[signature]
Driller

INSTRUCTIONS: This form should be execut[ed] in triplicate, preferably ty[pe]written, and submitted to the appropriate district office of the State Engineer. All sections, except S[ecti]on 5, shall be answered [c]ompletely and accurately as possible when any well is drilled, repaired or deepened. Wh[en] ... a plugging record ... [Sect]ion 1(a) and Section 5 need be completed.

Well Log NB

STATE ENGINEER OFFICE

WELL RECORD

NB

Section 1. GENERAL INFORMATION

(A) Owner of well United Nuclear-Homestake Partners Owner's Well No. N B
Street or Post Office Address Box 98
City and State Grants, NM

Well was drilled under Permit No. ______ and is located in the: at Mill site

a. NE ¼ NE ¼ NW ¼ ____ ¼ of Section 26 Township 12N Range 10W N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in Valencia County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor Garner Drilling License No. WD-595

Address Box 3146 Milan, NM

Drilling Began 2-23-81 Completed 2-23-81 Type tools rotary Size of hole 10 in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 90 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well ______ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
55	80	25	sand,gravel & red shale	35+

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5	sch. 40	PVC	0	90	90	open	50	90
hole is sand		packed	Set	40 ft pvc screen				
Developement		time	4 hrs.					

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

STATE ENGINEER OFFICE ALBUQUERQUE, N.MEX.
MAR 23 A 8:25

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ______ FWL ______ FSL ______

File No. B-28-S-26 Use collection well Location No. NE¼NE¼NW¼ 26-12N-10W

Well Log NB

0	15	15	sand
15	35	20	tan shale
35	55	20	red & tan shale
55	80	25	sand,gravel, red shale
80	90	10	chinle

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitt[illegible] to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used [illegible] plugging re[illegible] only Section [illegible] a[illegible] need be completed.

Well Log NC

WELL LOG

NC

General Information

well Identification: Well NC [illegible]

date drilling started: [illegible] date drilling completed: [illegible]

total depth of well: [illegible]

depth to water upon completion of well (static level): [illegible]

Principal Water-Bearing Strata

depth in feet: from [illegible] to [illegible]

thickness in feet: [illegible]

description of water-bearing formation (type of material): [illegible]

[illegible]

Record of Casing

casing diameter: 4" [illegible] solid casing depth in feet from top Surface

to bottom [illegible] perforations from [illegible] to [illegible]

Log of Hole

Depth in Feet		Thickness in Feet	Color and Type of Material
From	To		
Surface	25'	25'	Blue Sand
25'	35'	10'	Yellow sand
35'	50'	15'	Red Sand
50'	60'	10'	Yellow sand
60'	75'	15'	Gravel
75'	85'	10'	Red sand + gravel
85'	95'	10'	Clinker

Well Log ND

WELL LOG

General Information

well identification: DRILLED MONITOR WELL N.D. NORTH FROM TRUCKING

date drilling started: 4-1-82 date drilling completed: 4-3-82

total depth of well: 70 ft.

depth to water upon completeion of well (water level): 50 ft.

Principal Water-Bearing Strata

depth in feet: from 50 ft. to 70 ft.

thickness in feet: 30 ft.

description of water-bearing formation (type of material): Gravel and Sand

---

Record of Casing

casing diameter: 4" inch solid casing depth in feet from top Surface

to bottom 50 ft. perforations from 50 ft. to 70 ft.

Log of Hole

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material
	5-10		Brown Dirt
	15-25		Yellow Sand
	30-35		Brown Sand
	40-45		Yellow Sand
	50-60		Gravel Sand
	65-70		Chinle

Well Log ND

WELL LOG

✓ #0730

General Information

well identification: [illegible] ND [illegible]

date drilling started: 4-1-82 date drilling completed: 4-3-82

total depth of well: 70 ft

depth to water upon completeion of well (water level): 50 ft

Principal Water-Bearing Strata

depth in feet: from 50 ft to 70 ft

thickness in feet: 20 ft

description of water-bearing formation (type of material): Gravel & Sand

Record of Casing

casing diameter: 4" sch solid casing depth in feet from top Surface

to bottom 50 ft perforations from 50 ft to 70 ft

Log of Hole

Depth in Feet		Thickness in Feet	Color and Type of Material
From	To		
Brn Dirt	5-10		
yellow Sand	15-25		
Brn Sand	30-35		
yellow Sand	40-45		
Gravl Sand	50-60		
Clay	65-70		

Well Log CW2

STATE ENGINEER OFFICE

WELL RECORD

CW-2

Section 1. GENERAL INFORMATION

(A) Owner of well Homestake Mining Co. Owner's Well No. # 2 (CW2) Monitor
Street or Post Office Address P.O. Box 98
City and State Grants, N.M. 87020

Well was drilled under Permit No. Applied Form and is located in the: Mill Site at Milan.

a. ____ ¼ SE ¼ SE ¼ SW ¼ of Section 23 Township 12N Range 10W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in Cibola County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Garner Drilling Co. License No. WD-595

Address Box 3146 Milan, N.M. 87021

Drilling Began 12-17-81 Completed 1-16-82 Type tools rotary Size of hole 7 7/8 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 355 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well ____ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
245	255	10	gray sandstone	
303	320	17	white sand	60 + overall
335	354	19	white sand & shale	

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5 in sch.40 PVC			0	353	354	open	243	253
Development time 9 Hrs.							306	316
							343	353

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
Set 8in steel casing 0-136 ft. Cemented from bottom to top					
Setting & cementing casing 7 Hrs.					

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No. ____

Well Log CW2

CW-2

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	40	40	tan shale
40	45	5	red shale
45	55	10	tan shale
55	85	30	sand, shale & gravel — base of Qal
85	245	160	chinle
245	255	10	gray sandstone
255	295	40	chinle
295	303	8	purple & white shale
303	320	17	white sand
320	335	15	gray & white shale
335	354	19	white sand & shale
354	360	6	red shale

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

J Garner
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office ... as possible when any well is

Well Log CW3

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Homestake Mining Co. Owner's Well No. # 3 (CW3) Monitor
Street or Post Office Address P.O. Box 98
City and State Grants, N.M. 87020

Well was drilled under Permit No. Applied Form and is located in the: Mill Site at Milan.

a. ____ ¼ SE ¼ SE ¼ SE ¼ of Section 23 Township 12N Range 10W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in Cibola County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Garner Drilling Co. License No. WD-595

Address Box 3146 Milan, N.M. 87021

Drilling Began 12-19-81 Completed 1-19-82 Type tools Rotary Size of hole 7 7/8 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 235 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well ____ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
210	235	25	gray, white & purple sand	35

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
8in. surface casing			0	92	92			
Cemented from bottom to top								
5 in. PVC with shale catcher. at 208 ft.-								
			- 0	235	236	Open	210	235

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
5 Hrs. rig time setting & cementing surface casing.					
7 Hrs. Development time.					

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No. ____

Well Log CW3

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		
0	25	25	tan sand
25	30	5	red shale
30	35	5	tan sand
35	55	20	sand & gravel
55	70	15	red shale & gravel base of Qal
70	115	45	red shale
115	210	95	purple shale
210	235	25	gray,white & purple sand(5in.test hole 235-415)
235	320	95	purple shale & siltstone
320	335	15	gray sand & shale
335	345	10	purple shale
345	365	20	white sand & shale
365	380	15	gray shale
380	405	25	white sand & shale
405	415	10	red shale

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

J Garner
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office

Well Log CW8

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Homestake Mining Co. Owner's Well No. C W ~~7~~ 8

Street or Post Office Address P.O. Box 98

City and State Grants, N.M 87020

Well was drilled under Permit No. Applied Form and is located in the: Mill Site

a. ____ ¼ ____ ¼ ____ ¼ ____ ¼ of Section ____ Township ____ Range ____ N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in Cibola County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Garner Drilling Co. License No. WD-595

Address Box 3146 Milan, N.M. 87021

Drilling Began 4-13-83 Completed 4-20-83 Type tools Rotary Size of hole 10 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 285.5 ft.

Completed well is ☒ shallow ☐ artesian. Test

Depth to water upon completion of well ____ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
			Test Hole, no water	

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6	13 weld		1	280.5	281.5	open	noneXXXXXXXXX	
4 in. PVC screen set from 275.5-- 285.5 with packer at top.								
Hole cemented from bottom to top.								

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
Used	4½ sks.	Lo-Loss			Cement with mud pump

Section 5. PLUGGING RECORD

Plugging Contractor ____

Address ____

Plugging Method ____

Date Well Plugged ____

Plugging approved by:

____ State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No. ____

Well Log CW8

Section 6. LOG OF HOLE

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered			
From	To					
0	30	30	tan shale			
30	35	5	red shale			
35	60	25	tan sandy shale with gravel lenses			
60	70	10	sand & gravel			
70	75	5	red shale			
75	85	10	sand & gravel			
85	95	10	purple shale			
95	130	35	red shale			
130	155	25	purple shale			
155	160	5	purple shale & white sandstone			
160	245	85	purple shale			
245	252	7	purple shale & sandstone			
252	285.5	33.5	purple shale			
			Cored	Time	Rec.	
			102--104	2 Hrs.	2 ft.	
			220--221.3	2.5 Hrs.	1.1 ft.	
			277- 279.8	3 Hrs.	2.8 ft.	
			Total	7.5 Hrs.		7.5 Hrs
			Set casing & cement to 280.5 ft.			8 Hrs.
			Drill out cement plug,drill hole from			
			280.5 to 285.5 ft.Set 10 ft. 4in. screen			
			with packer at top as liner from 275.5 to			
			285.5 ft. Circulate hole with clear water.			
			Jet hole with air to remove water.			3.5 Hrs.

Section 7. REMARKS AND ADDITIONAL INFORMATION

Total Rig Time 19 Hrs.

Total Drilling large hole 280.5 ft.

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

J Gor[illegible]

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office

Well Log CW13

Garner Drilling Co.
Box 3146
Milan, N.M. 87021
12-28-1994

To;
Homestake Mining Co.
P.O. Box 98
Grants, N.M. 87020

Hole # C W13 12 N 10W S35

0	55	tan sandy shale
55	65	sand
65	70	tan shale
70	220	red,gray & purple shale
220	250	gray shale & white sand
250	255	white sand
255	360	red, gray & purple shale
360	370	white shale
370	425	red shale

T.D. 425 ft. Well was logged. Circu. loss at 250 ft 14 sks. lo-loss
20 sks. sand , set 5 sks. chips from 265-275 ft. 5 in hole from 275-425 ft. closed with bentonite chips. 45 gal. pellets.
8 in. steel casing set 0-78 ft.
6 in. sch. 40 set 0-225 ft. screen set from 225- 265 ft.
Rig Time 11 Hrs.
Dev. Time 5 Hrs.
Drilling Time 12-15-94 to 12-28-1994

Well Log CW14 and CW15

Garner Drilling Co.
Box 3146
Milan, N.M, 87021
1-19-1995

To:
Homestake Mining CO.
Grants, N.M. 87020

Hole # CW 14

0	35	tan shale
35	50	red shale
50	55	sand
55	65	red shale
65	215	purple & gray shale
215	230	gray shale
230	270	red & purple shale
270	280	white sand
280	310	red shale
310	338	white sand & shale
338	365	red shale

T D 365 Well was logged
73 ft 10 3/4 in steel casing 0 - 73 ft.
6 in. sch. 40 PVC casing set 0 - 365 ft.
screen set from 278 to 358 ft
80 sks. sand 15 bucketts pellets 34 sks. chips
100 + gpm Rig time 14 hrs. Dev. time 7 hrs.
Drilling time. Dec. 28,1994 to Jan. 11-1995

Hole # CW-15

0	35	tan sandy shale
35	50	sand
50	63	red shale
63	80	white sand & shale
80	90	purple shale
90	110	white shale
110	125	white sand
125	130	red shale
130	150	purple shale
150	170	white sand & shale
170	320	red, gray & purple shale
320	385	red & gray shale & sand lenses

T D 385 ft. Well was logged
63 ft 8 in. steel casing 0-63 ft.
133 ft 5 in. sch. 40 PVC casing set 0-133 ft.
screen set from 73 to 133 ft.
40 sks. sand 4 5 gal. pails pellets
7.5 gpm Rig time 11 hrs. Dev. time 4 hrs.
Drilling time Jan. 11 to Jan. 19-1995

Well Log CW21, CW22, CW18, and CW17

Garner Drilling Co.
Box 3146
Milan, N.M. 87021
2-11-1995

To;
Homestake Mining Co.
P.O. Box 98
Grants, N.M. 87020

Hole # C W 21 Drilled 1-30-31-1995 Test Hole

0	60	tan sandy shale
60	80	red shale
80	120	gray shale
120	130	white shale
130	158	red shale

T.D. 158 ft. Well was logged.
Hole is plugged with bentonite chips
Rig Time 1 hr.

Hole # CW 22 Drilled 2-1-1995 Test hole

0	35	tan sandy shale
35	83	white & gray sand
83	95	purple shale
95	120	purple & gray sandstone
120	160	gray & purple shale

T.D. 160 ft. Well is logged.
Hole is plugged with bentonite chips.

Hole # CW 18 Drilled 2-2 to 2-8-1995 Test Well Hole was logged.

0	15	tan sand & shale
15	45	sand, shale & gravel
45	70	red sand & gravel
70	92	sand, gravel & boulders
92	155	red shale
155	187	purple shale & sand
187	220	gray sand & shale
220	290	gray & purple shale
290	340	red shale
340	400	white & purple shale
400	425	red shale

T.D. 425 ft. Set 8 in. steel casing 0-100 ft. Set 5 in. sch. 40 PVC 0-232 ft.
Screen set from 177 ft. to 232 ft. 5 in hole from 232 - 425 ft. plugged.
40 sks. sand. 5 buckets pellets. 15 sks. bentonite chips. 15 sks. Lo-Loss
Lost Circu. at 190 & 210 ft.
Rig Time 8 hrs. Dev. Time 3.5 hrs. Well making 75 + gpm

Hole # 17 CW Drilled 2-9 to 2-11-1995 Test Well Hole is logged.

0	75	tan sand & shale
75	85	purple & gray shale
85	100	white sandstone & shale
100	125	red shale

T.D. 125 ft.Well is logged. Set 105 ft 5 in. sch 40 PVC casing from 0-105 ft.
Screen set 83 to 103 ft. 10 sks. sand, 5 buckets pellets, 14 sks, bentonite chips
Lost Circu. at 90 ft. 4 sks Lo-Loss
Rig Time 2 hrs. Dev. Time 2 hrs. 2 gpm

TOTAL P.01

Well Log CW23, CW25, and CW24

GARNER DRILLING COMPANY
PO BOX 3146
MILAN, NM 87021

TO: HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO 87020

6562
55
6507

Hole # CW 23 Drilled 2/13/95

0	55	Tan sandy shale
55	70	Red shale
70	80	Gray shale
80	105	Red shale & sand lenses
105	112	Gray sandy shale
112	120	Purple sandy shale
T.d.	120 Ft	Test Hole. Hole is Logged.

RIG TIME 1 Hour

Hole # CW 25 Drilled 2/14/95 to 2/15/95

0	55	tan sandy shale
55	60	gray shale
60	85	red shale & sand lenses
85	92	gray shale
92	120	purple sandy shale

T.D. 120 ft. Casing set o to 102 ft. Per from 62 - 102 ft.
5 in PVC casing. 16 sks. sand. 5 buckets. pellets. 16 sks. bentonite chips.
Well is logged. 8 gpm Rig time 1 hr. Dev. time 3 hrs.

Hole # CW 24 Drilled 2/16 to 18/1995

0	65	tan sand & shale
65	95	white sand & shale
95	108	purple shale
108	112	white frac. sandstone. lost circu.
112	118	red & purple shale
118	147	red shale

T.D. 147 ft. 5 in. casing set 0-118 ft. Per. 78 to 113 ft.
15 sks. sand, 6 buckets pellets, 21 sks. chips. 17 gpm
Well is logged. Rig time 2 hrs. Dev. time 3.5hrs.

B & B Drilling Co., Inc.

GRAND JUNCTION, COLORADO 81502
P.O. Box 2866 (303) 242-3918

LEFT OFFICE 6:00 A.M. — ARRIVED RIG 6:15 A.M.

LEFT RIG 10:45 P.M. — ARRIVED TOWN 11:05 P.M.

WEATHER — UNIT NO. 11 — DATE 9/13/95 — AREA HOMESTAKE — RIG TIME 16½

CONTRACT NO. — COUNTY — STATE

Well Log CW31

HOLE NO.	DEPTH From	DEPTH To	FORMATION	REMARKS		
CW-32			DEVELOP WELL			
			<2 HRS>			
CW-31	0	360	5¼" Hole - STANDBY LOGGING			
			GEOLOGY: 1 HR			
		0-6	TAN SAND			
		6-13	TAN SANDY CLAY			
		13-38	Grey to BLACK BASALT			
		38-50	RED SAND			
		50-111	RED to tan CLAY & GRAVEL	54 @	75-78	
		111-156	RED Chinle			
		156-158	Grey SANDSTONE			
		158-252	RED to Purple Chinle			
		252-313	RED to Grey SS - HIGHLY FRACT	298-308		
		313-318	Grey CLAY @ SS Ledges			
		318-360	Grey to Purple CLAY			
	0	200	REAM to 9⅞"			

BIT INFORMATION

Size	5¼	5¼
Manufactured By	Smith	Rockmaster
Type or No.	[illegible] 04	Blade
New		✓
Rebit	USED	
Footage	9	360
Total		

Driller: J. WALKER	Time: 17
Truck Driver: B. COOK	Time: 17
Drill Helper: L. WORKMAN	Time: 17
Back Hoe: B. JONES	Time:

Loads Water: 3

Loads Water:

MUD — BRAN

OTHER: 2 Lo Loss

Total Footage

09/21/95 13:33 TX/RX NO.2142 P.002

Well Log WR24 and CW34

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To:
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # WR 24 Drilled 10/5/1995

0	45	tan sandy clay
45	65	purple clay & sand
65	82	sand & gravel
82	90	purple shale

T.D. 90 ft. 5 in casing set. 0-90 ft. Per. 50-90 ft. 24 sks. sand. 3 sks. chips.
Rig Time 1 hr. Dev. Time 2 hrs. 20 gpm.

Hole # CW 34 Drilled 10/7/1995

0	5	sand
5	20	gray & green sandy shale
20	40	gray & pink sandstone & shale
40	54	white frac. sandstone
54	100	red shale
100	120	purple shale

T.D. 63 ft. 5 in. casing set. 0-63 ft. Per. 33-63 ft. 15 sks. sand. 2 sks chips.
5 in hole 63-120 ft. hole is Logged. 5 in hole Bent. plugged 63-120 ft. 6 sks. chips.

Rig Time 2 hrs. Dev. Time 2 hrs. Seepage.

TOTAL P.02

Well Log WR25, CW35, and CW37

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To;
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # WR 25 Drilled 10/9-10/1995 Hole is Logged 12N 10W S22

0	50	tan sandy clay
50	68	purple,tan clay & sand lenses
68	100	white & purple shale & sandstone lenses
100	110	gray shale
110	115	red shale

T.D. 115 ft. 5 in. casing set 0-111 ft. Per. 71-111 ft. 15 sks. sand set 64-111 ft.
2 cans pellets, 6 sks. chips set 0-64 ft.
Rig Time 2 hrs. Dev. Time 2 hrs. Water Seepage.

Hole # CW 35 Drilled 10/10-12-/1995 Hole is Logged 12N 10W S22

0	25	sand
25	30	sand & gravel
30	40	purple sandy clay
40	45	sand & gravel
45	60	purple sandy clay
60	83	sand & gravel
83	92	gray sandy shale
92	100	white sand--- lost circu.
100	110	pink & white sandstone
110	125	purple shale
125	130	gray & purple shale

T.D. 130 ft. 5 in casing set 0-118 ft. Per. 93-118 ft. 10 sks. sand set 91-118 ft.
1 can pellets, 6 sks. chips set 0-91 ft.
Rig Time 2 hrs. Dev. Time 2 hrs. 11 gpm.

Hole # CW 37 Drilled 10/12-16/1995 Hole is Logged 12N 10W S34

0	55	tan sandy shale
55	67	gray clay
67	100	red sandy shale
100	125	white sandstone
125	145	red sandstone & shale lenses
145	160	gray sandy shale

T.D. 160 ft. 5 in. casing set 0-150 ft. Per. 100-150 ft. 23 sks. sand. 5 sks. chips.
Rig Time 4 hrs. Dev. Time 2 hrs. 50 gpm.

TOTAL P.05

Well Log CW4

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Homestake Mining Co. of Ca. Owner's Well No. CW 40
Street or Post Office Address Box 98
City and State Grants, N.M. 87020

Well was drilled under Permit No. Monitor Well and is located in the: Mill Site Area

a. ____ ¼ ____ ¼ ____ ¼ ____ ¼ of Section 35 Township 12 N Range 10 W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in Cibola County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in
the ____ Grant.

(B) Drilling Contractor Garner Drilling Co. License No. WD 595

Address Box 3146 Milan, N.M. 87021

Drilling Began 3/7/1996 Completed 3/14/1996 Type tools Rotary Size of hole 8 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 264 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 78 ft.

Test Well

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
222	240	18	hard red sandy shale	
240	255	15	gray & purple sandy shale	20

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
8 steel	casing		0	84	84	open		
5 sch.	40 PVC		+ 3	264	264	cap	224	264
25 sks	sand. 29	sks. chips.						

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No. ____

Well Log CW40

From	To	In Feet	
0	25	25	tan clay
25	30	5	gravel
30	65	35	tan clay
65	75	10	tan clay & gravel
75	190	115	red & purple shale
190	222	32	gray & purple shale
222	240	18	hard red sandy shale
240	255	15	gray & purple sand & shale
255	305	50	gray & purple shale. 5 in. test hole 264-305 ft. Plugged.

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Well Log CW41, 643, and 644

Garner Drilling Co
Box 3146
Milan, N.M. 87020

To:
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # CW 41 Drilled 10/9-16/1996

0	5	red clay
5	25	sand, gravel & boulders
25	30	red clay
30	61	tan sand
61	70	purple shale
70	100	gray shale
100	115	hard red shale
115	140	hard gray shale
140	155	hard red shale
155	165	hard gray & red shale
165	170	white sandstone
170	192	hard gray shale
192	210	hard gray & red shale
210	235	red shale

T.D. 206 ft. 6 in. PVC casing set 0-206 ft. Per. 146-206 ft.
10 in hole drilled. 5 in. test hole 206 ft. to 235 ft. Test hole plugged.
42 100 lb. sks. sand. 27 sks. chips. 8 sks. Lo- Loss.
Well is logged.
Rig Time 2 hrs. Dev. Time 4 hrs. 12 + gpm.

Hole # 643 Drilled 10/16-17/1996

0	35	tan sandy clay
35	40	sand & gravel
40	57	tan sand & gravel
57	93	purple clay
93	101	sand & gravel
101	108	purple & gray shale

T.D. 108 ft. 5 in. PVC casing set 0-108 ft. Per. 58-108 ft. 39 50 lb.sks. sand.
3 sks. chips.
Rig Time 1 hr. Dev. Time 3 hrs. 17 + gpm.

Hole # 644 Drilled 10/17-18/1996

0	40	tan sand
40	45	sand & gravel
45	55	tan sand
55	102	sand & gravel
102	110	gray & red shale

T.D. 110 ft. 5 in. PVC casing set 0-110 ft. Per.55-110 ft. 33 sks. sand. 4 sks. chips
Rig Time 1 hr. Dev. Time 3 hrs. 20 + gpm.

Well Log CW50

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To:
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # C W 50 Completed 5/27/2003

0	5	Tan sand
5	35	Tan clay & sand
35	40	Red clay
40	50	Tan & red clay
50	75	Tan clay & wash
75	85	Tan clay
85	100	Purple shale
100	130	Red shale
130	142	Hard gray shale
142	153	Hard red & purple shale
153	160	Hard frac. gray shale
160	170	Gray shale

T.D. 170 ft. Set 5 in. PVC casing 0-170 ft. Perf. 130 -170 ft.Cap on bottom.
Flush hole, Sand pack & Dev.
Sand pack from 120 to 170 ft Chip pack from 95 to 120 ft.
25 sks. sand. 8 sks. chips.

T.D. 170 ft. RIG Time 2 hrs. Dev. Time 3 hrs. 60 gpm.

5 in. test hole was logged before reaming.

Well Log CW52

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To:
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # C W 52   Completed 6/10/2003

0	6	Tan & purple clay
6	35	Tan clay & wash
35	50	Red clay
50	95	Tan sand & wash
95	102	Red clay
102	140	Red shale
140	175	Hard gray & purple shale
175	265	Purple & gray shale
265	280	Gray & white sand
280	305	Gray & purple shale
305	330	Hard white sand
330	335	Hard purple & gray shale
335	360	Hard white sand
360	370	Gray shale
370	380	Red shale

T.D. of 5in. test 380 ft. Hole was logged.
Reamed test hole 0-180 ft. Set 5 in. PVC casing o-180 ft. Perf.140-180 ft.
Cap on bottom.

5 in. hole had caved at 195 ft.Beat bit on down to 215ft and it plugged solid.
Put 10 sks. chips in from 185 to 215 ft.
Wash casing, sand pack from 130 to 180 ft. Chip pack 105 to 130 ft.
25 sks. sand. 8 sks. chips.
5 in. hole lost circu. at 157. 265 & 320 ft.

Used 29 lds. water and 17 sks. Lo-Loss.

T.D. of Well 180 ft. 200 ft of test hole.

Rig Time 3 hrs. Dev. Time 3 hrs. gpm 20

Well Log CW55

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To.
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # C W ~~54~~ 55   5 in. Test Well   Completed 6/3/2004

0	45	Tan clay
45	55	Purple shale
55	95	Gray & purple shale
95	135	Purple shale
135	165	Gray & purple shale
165	175	Gray & white shale
175	223	Gray & purple shale
223	240	Hard & soft layers of white sandstone
240	265	Red & purple shale

T.D. 265 ft.

Changed Well ID per Al

Well Log T5, T4, and T11

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To:
Homestake Mining Co. of Cal.
Box 98
Grants, N.M. 87020

Hole # T 5 — Drilled 5/6-7/2002

0	20	Tan fill
20	85	Gray sandy fill
85	105	White & tan sandy clay
105	115	Red & tan clay
115	130	Tan sand
130	145	Tan & red clay
145	151	Tan sand & clay
151	178	Hard purple shale
178	182	Gray & red shale

Set 5 in. PVC casing 0-182 ft. Perf. 122-182 ft. Cap on bottom.
Chip pack 0-25 ft. Sand pack 25-100 ft. Chip pack 100- 110 ft. Sand pack 110-182 ft.
71 sks. sand. 10 sks. chips. Washed hole with water & air.

T.D. 182 ft. Rig Time 1 hr. Dev. Time 3 hrs. 18 gpm.

Hole # T 4 — Drilled 5/8-10/2002

0	15	Tan fill
15	85	Gray sandy fill
85	110	Tan clay
110	160	Tan sand & clay
160	175	Tan sand & gravel
175	180	Purple shale
180	205	Gray & purple shale

Set 5 in. PVC casing 0-205 Perf. 145-205 ft. Cap on bottom.
Chip pack 0-30 ft. Sand pack 30-125 ft. Chip pack 125-135 ft. Sand pack 135-205 ft.
83 sks. sand. 13 sks. chips. Washed hole with water & air.

T.D. 205 ft. Rig Time 1 hr. Dev. Time 3 hrs. 25-30 gpm.

Hole # T 11 — Drilled 5/13-17/2002

0	10	Tan fill
10	80	Gray sandy fill
80	110	Tan sandy clay
110	130	Tan clay
130	145	Tan & red sandy clay
145	160	Tan sand, gravel, rocks & clay
160	168	Gray shale
168	193	Purple & red shale

Set 5 in PVC casing 0-193 ft. Perf. 113-193 ft. Cap on bottom.
Chip pack 0-30 ft. Sand pack 30-98 ft. Chip pack 98- 108 ft. Sand pack 108-193 ft.
76 sks. sand. 12 sks. chips. Washed hole with water & air.

T.D. 193 ft. Rig Time 1 hr. Dev. Time 3 hrs. 30 + gpm.

Well Log T12 and T18

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To:
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # T 12 Drilled 5/22-29/2002

0	10	Tan fill
10	78	Gray sandy fill
78	90	Tan clay
90	100	Tan & orange sand
100	135	Tan sand & clay
135	170	Tan sand, gravel & rocks — Base Qal
170	180	Red & purple shale
180	200	Purple & gray shale

Set 5 in. PVC casing 0-200 ft. Perf. 120-200 ft. Cap on bottom.
Chip pack 0-30 ft. Sand pack 30- 100 ft. Chip pack 100-115 ft. Sand pack 115-200 ft.
85 sks. sand. 15 sks. chips. Washed hole with water & air.

T.D. 200 ft. Rig Time 1 hr. Dev. Time 3 hrs. 45-50 gpm.

Hole # T 18 Drilled 5/30- 6/4/2002

0	25	Tan fill
25	90	Black fill
90	105	Tan clay & sand
105	125	Tan sand
125	135	Tan sandy clay
135	145	Red & tan clay
145	162	Tan sand, gravel & rocks
162	180	Hard purple shale
180	185	Red shale
185	195	Purple & gravel shale

Set 5 in. PVC casing 0-195 ft. Perf. 115-195 ft. Cap on bottom.
Chip pack 0-30 ft. Sand pack 30-100 ft. Chip pack 100-110 ft. Sand pack 110-195 ft.
102 sks. sand. 20 sks. chips. Washed hole with water & air.
Drilled 10 in. hole 0-90 ft. 8 ½ in. hole 90- 195 ft.

T.D. 195 ft. Rig Time 1 hr. Dev. Time 3 hrs. 20-25 gpm.

RECEIVED SEP 0 8 2006

Well Log CE6

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well HOMESTAKE MINING CO. Owner's Well No. CE 6

Street or Post Office Address P.O. BOX 98

City and State GRANTS, NM 87020

Well was drilled under Permit No. ______ and is located in the:

a. ____ ¼ ____ ¼ ____ ¼ ____ ¼ of Section ______ Township ______ Range ______ N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______ Subdivision, recorded in ______ County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor COYOTE DRILLING INC. License No. WD-1451

Address P.O. BOX 3467 MILAN, NM 87021

Drilling Began 6-27-06 Completed 6-27-06 Type tools ROTARY Size of hole 9 7/8 in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 140' ft.

Completed well is [XX] shallow [ ] artesian. Depth to water upon completion of well ______ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
90	120	30	GRAY WHITE & PURPLE SAND	18 gpm

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
6"	PVC		0	140	140	PVC	100	140

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ______

Address ______

Plugging Method ______

Date Well Plugged ______

Plugging approved by:

______ State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ______ FWL ______ FSL ______

File No. ______ Use ______ Location No. ______

Depth in Feet From	To	Thickness in Feet	Color and Type of Material Encountered
0	10	10	TAN SAND
10	20	10	SAND & RED SHALE
20	50	30	RED SHALE
50	75	25	SAND & GRAVEL
75	140	65	WHITE GRAY PURPLE SAND

Well Log CE6

Well CE6

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Clifford Lopez
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Well Log CE9

Section 1. GENERAL INFORMATION

(A) Owner of well HOMESTAKE MINING CO. Owner's Well No. CE 9
Street or Post Office Address P.O. BOX 98
City and State GRANTS, NM 87020

Well was drilled under Permit No. ______ and is located in the:

a. ___ ¼ ___ ¼ ___ ¼ ___ ¼ of Section ___ Township ___ Range ___ N.M.P.M.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. ___ of Block No. ___ of the ___
Subdivision, recorded in ___ County.

d. X= ___ feet, Y= ___ feet, N.M. Coordinate System ___ Zone in the ___ Grant.

(B) Drilling Contractor COYOTE DRILLING INC. License No. WD- 1451

Address P.O. BOX 3467 MILAN, NM 87021

Drilling Began 8-21-06 Completed 821-06 Type tools ROTARY Size of hole 9 7/8 in.

Elevation of land surface or ___ at well is ___ ft. Total depth of well 130' ft.

Completed well is XX shallow ☐ artesian. Depth to water upon completion of well ___ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
40	80	40	SAND & GRAVEL	10-20

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
6"	PVC		0	130	130	PVC	90	130

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ___
Address ___
Plugging Method ___
Date Well Plugged ___
Plugging approved by:

___
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ___ FWL ___ FSL ___

File No. ___ Use ___ Location No. ___

Depth in Feet From	To	Thickness in Feet	Color and Type of Material Encountered.
0	10	10	BROWN CLAY
10	40	30	TAN SAND
40	80	40	SAND & GRAVEL
80	100	20	PURPLE SHALE
100	130	30	WHITE & PURPLE SAND

Well Log CE9

Well CE9

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Cliffie Lopez
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

RECEIVED SEP 0 8 2006

STATE ENGINEER OFFICE

WELL RECORD

Well Log CE10

Section 1. GENERAL INFORMATION

(A) Owner of well HOMESTAKE MINING CO. Owner's Well No. CE 10
Street or Post Office Address P.O. BOX 98
City and State GRANTS, NM 87020

Well was drilled under Permit No. ____ and is located in the:

a. ____ ¼ ____ ¼ ____ ¼ ____ ¼ of Section ____ Township ____ Range ____ N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor COYOTE DRILLING INC. License No. WD-1451

Address P.O. BOX 3467 MILAN, NM 87021

Drilling Began 8-14-06 Completed 8-14-06 Type tools ROTARY Size of hole 9 7/8 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 130" ft.

Completed well is xxx shallow ☐ artesian. Depth to water upon completion of well ____ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
95	120	30	GRAY WHITE & PURPLE SAND	10gpm

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
6"	PVC		0	130	130	PVC	90	130

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No. ____

Depth in Feet From	To	Thickness in Feet	Color and Type of Material Encountered
0	10	10	TAN SAND
10	20	10	SAND & RED SHALE
20	50	30	RED SHALE
50	75	25	SAND & GRAVEL
75	130	55	WHITE GRAY & PURPLE SAND

Well Log CE10

Well CE10

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Cliffw Lopez
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

RECEIVED SEP 0 8 2006

STATE ENGINEER OFFICE

WELL RECORD

Well Log CE11

Section 1. GENERAL INFORMATION

(A) Owner of well HOMESTAKE MINING CO. Owner's Well No. CE 11
Street or Post Office Address P.O. BOX 98
City and State GRANTS, NM 87020

Well was drilled under Permit No. ______ and is located in the:

a. ___ ¼ ___ ¼ ___ ¼ ___ ¼ of Section ______ Township ______ Range ______ N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in ______ County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor COYOTE DRILLING INC. License No. WD-1451

Address P.O. BOX 3467 MILAN, NM 87021

Drilling Began 8-11-06 Completed 8-12-06 Type tools ROTARY Size of hole 9 7/8 in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 140' ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well ______ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
100	130	30	PURPLE RED & WHITE SAND	35+

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
6"	PVC		0	140	140	PVC	100	140

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ______ FWL ______ FSL ______

File No. ______ Use ______ Location No. ______

Well Log CE11

Depth in Feet From	To	Thickness in Feet	Color and Type of Material Encountered
0	10	10	TAN SAND
10	30	20	RED SHALE
30	55	25	SAND & GRAVEL
55	65	10	RED & PURPLE SHALE
65	75	10	PURPLE SAND & GRAVEL
75	90	15	PURPLE SHALE
90	130	40	PURPLE RED & WHITE SAND
130	140	10	PURPLE SHALE

well CE11

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Cliffie Lopez
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Form WR 23 STATE ENGINEER OFFICE

Well Log 411

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

411

Section 1

(Plat of 640 acres)

(A) Owner of well Nina R. Umie

Street and Number R. L. R. Ste Box 4024

City Grants State New Mex

Well was drilled under Permit No. B-277 and is located in the

____ ¼ ____ ¼ ____ ¼ of Section ____ Twp. ____ Rge. ____

(B) Drilling Contractor Leroy Wilson License No. WD 173

Street and Number 4207 San Mateo Road

City Grants State New Mex

Drilling was commenced 9-22 1971

Drilling was completed 9-26 1971

Elevation at top of casing in feet above sea level about 6520 Total depth of well 72

State whether well is shallow or artesian shallow Depth to water upon completion 51

Section 2

PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	64	68	4	sand & gravel
2				
3				
4				
5				

Section 3

RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
6 5/8	.188		0	72		STRAP around	56	72

Section 4

RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used
					NONE

Section 5

PLUGGING RECORD

Name of Plugging Contractor NONE License No. ____

Street and Number ____ City ____ State ____

Tons of Clay used ____ Tons of Roughage used ____ Type of roughage ____

Plugging method used ____ Date Plugged ____ 19 ____

Plugging approved by:

____ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used
			411

FOR USE OF STATE ENGINEER ONLY

Date Received STATE ENGINEER OFFICE 1971 NOV 30 AM 11:09

File No. B-277 Use dom Location No. Cat-4 ...

ction 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	3	3	Brown	topsoil
3-	54	51	light Brown	sandy Clay
[illegible]	64	10	Brown clay	very sticky clay.
[illegible]	68	4	Light Brown	sharp sand & Small gravel
[illegible]	72	4	Red clay	Red clay

e undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and cor-
ct record of the above described well.

Leroy Wilson

Well Driller

Form W[redacted]

STATE ENGINEER OFFICE

Well Log 426

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Freeman Lusk

426

Section 1

(Plat of 640 acres)

(A) Owner of well Warren J. Bell

Street and Number General Delivery, Milan Station

City Grants, XXXXXXX State New Mexico

Well was drilled under Permit No. B-148 and is located in the Broadview Acres Addn of Section Lot 6 Twp. Blk. 1 Rge.

(B) Drilling Contractor O. L. Ray License No. WD-302

Street and Number Box 536

City Grants, XXXXXXXXX State New Mexico

Drilling was commenced July 23, 1960

Drilling was completed July 23, 1960

Elevation at top of casing in feet above sea level ______ Total depth of well 100 feet

State whether well is shallow or artesian Shallow Depth to water upon completion 60 ft.

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	60	100	40	sand & gravel, red shale
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
			0	100	100		80	100

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor ______ License No. ______

Street and Number ______ City ______ State ______

Tons of Clay used ______ Tons of Roughage used ______ Type of roughage ______

Plugging method used ______ Date Plugged ______ 19____

Plugging approved by:

______
Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

426

FOR USE OF STATE ENGINEER ONLY

Date Received 8/2/60

File No. B-148 Use domestic Location No. Broadview Acres (Grant Lot 6, Blk. 1

Well Log 426

Depth in Feet		Thickness in Feet	Color	Type of Material Encountered
From	To			
0	12	12	brownish	soil
12	60	48	yellow	clay
60	65	5	white	sandstone stringers
65	80	15	brownish	sand & gravel
80	100	20	red	shale

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Well Driller

Form [illegible]3 STATE ENGINEER OFFICE

Well Log 430

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well Gordon [illegible] 430

Street and Number [illegible] Box [illegible]

City Grants State N. [illegible]

Well was drilled under Permit No. B-195 and is located in the Lot No. 9, Block No. 1, Broadview Acres [illegible] ¼ ¼ ¼ of Section Twp. Rge.

(B) Drilling Contractor Boyd [illegible] License No. [illegible]

Street and Number [illegible]

City Grants State [illegible]

Drilling was commenced 5-10 19

Drilling was completed 5-2[illegible] 19

Elevation at top of casing in feet above sea level about [illegible] Total depth of well [illegible]

State whether well is shallow or artesian shallow Depth to water upon completion [illegible]

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	5[illegible]	72	1[illegible]	sand and gravel
2	135	145	10	porous sandstone
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
12	3	welded	[illegible]	10[illegible]	[illegible]	none	60	[illegible]

Section 4 none RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 none PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received [illegible]

File No. B-195 Use dom Location No. Lot 9, Blk. 1 Broadview Acres

Well Log 430

Section 6

LOG OF WELL

Depth in Feet		Thickness in Feet	Color	Type of Material Encountered
From	To			
0	5[illegible]	5[illegible]	tan	Sand and adobe
5[illegible]	72	14	grey	Sand and gravel
72	1[illegible]0	4[illegible]	red	Clay and mudstone
120	1[illegible]5	15	red	Mud and sandstone
13[illegible]	145	10	grey	Sandstone
1[illegible]	150	5	red	Mud

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Well Driller

Form WR-23

Well Log 434

STATE ENGINEER OFFICE

WELL RECORD

434

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

434

(A) Owner of well Clint Worthen

Street and Number PO Box 2191

City Milan State New Mex

Well was drilled under Permit No. RG 35688 and is located in the Lot 18 ¼ Block 2 ¼ Broadview Acres ¼ of Section ____ Twp. ____ Rge. ____

(B) Drilling Contractor LeRoy Wilson License No. WD 473

Street and Number 4207 San Mateo Road

City Grants State New Mex

Drilling was commenced July 19 75

Drilling was completed Sept 19 75

(Plat of 640 acres)

Elevation at top of casing in feet above sea level 6500 Total depth of well 280

State whether well is shallow or artesian Shallow Depth to water upon completion 70

Section 2

PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	65	78		sand and gravel (dry gravel)
2	263	275		sandstone
3				
4				
5				

Section 3

RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
6 5/8 OD	18 weld				267'	Driven	none	

Section 4

RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5

PLUGGING RECORD

Name of Plugging Contractor ____ License No. ____

Street and Number ____ City ____ State ____

Tons of Clay used ____ Tons of Roughage used ____ Type of roughage ____

Plugging method used ____ Date Plugged ____ 19 ____

Plugging approved by:

STATE ENGINEER OFFICE ALBUQUERQUE, N. MEX.

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

434

FOR USE OF STATE ENGINEER ONLY

Date Received 1975 OCT 7 AM 11:38

File No. B-253 Use Domestic Location No. Lot 18 B1 2 Broadview Ac VALENCIA

Well Log 434

Section 6 LOG OF WELL

Depth in Feet		Thickness in Feet	Color	Type of Material Encountered
From	To			
0	5		Brown	Top soil
5	38		Lt Brown	Sandy silt
38	65		red	red clay
65	75		Lt Brown	loose sand + gravel
75	243		[illegible]	clay shale
243	260		red	sandy clay
260	265		Blue gray	clay
[illegible]	275		Lt Brown	[illegible]
275	280		Blue gray	Clay
Bottom				

#434 [illegible]

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Robert L Wilson
Well Driller

Form WR-23 **Well Log 436**

STATE ENGINEER OFFICE

WELL RECORD

436

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well Jack Freeland / John W. Pitman [illegible]

Street and Number P. O. Box 2451

City Milan State New Mexico

Well was drilled under Permit No. B-238 and is located in the Lot 23 Block #1 [illegible] ¼ of Section [illegible] Twp. Rge.

(B) Drilling Contractor SANFORD H. COLE License No. [illegible]

Street and Number 400 GAVILAN PL., N. W.

City ALBUQUERQUE, NEW MEXICO State

Drilling was commenced Sept 16 19 [illegible]

Drilling was completed Sept 28 19 [illegible]

Elevation at top of casing in feet above sea level Total depth of well 295'

State whether well is shallow or artesian Shallow Depth to water upon completion [illegible]

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	280'	295'	15	Sandstone
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
5 ½ [illegible]	15	Plain			295'	None	280	295

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used
			436

FOR USE OF STATE ENGINEER ONLY

Date Received STATE ENGINEER OFFICE 1958 OCT 15 AM 10:17

File No. B-238 Use [illegible] Location No.

[illegible] BLK 1 LOT 23

Section 6

No. 436

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	10	10	Dark	Topsoil
10	45	35	Brown	Sandy Shale
45	55	10	Yellow	Sandstone
55	90	35	Brown	Conglomerate & Shale
90	120	30	Gray	Shale & Sand Lenses
120	280	160	Red	Shale
280	295	15	Gray	Sandstone

436

6560
280
6280

6560
6470

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Well Driller

Well Log 437

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Floyd Maestas Owner's Well No. 1 437

Street or Post Office Address General Delivery

City and State San Mateo, NM 87050

Well was drilled under Permit No. B-502 and is located in the:

a. ___ ¼ ___ ¼ ___ ¼ NE ¼ of Section 35 Township 12N Range 10W N.M.P.M.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. 1 of Block No. 2 of the Broadview Acres Subdivision, recorded in Valencia County.

d. X= ___ feet, Y= ___ feet, N.M. Coordinate System ___ Zone in the ___ Grant.

(B) Drilling Contractor Alldredge Drilling License No. WD 566

Address ___

Drilling Began k 11/13 Completed 11/19 Type tools Rotary Size of hole 8 3/4 in.

Elevation of land surface or ___ at well is ___ ft. Total depth of well 340 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 110 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
280	290	10	Grey sand	75gpm

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
5"	156 wall	--	+2	-300	302	---------	240	300

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				
0	340		15 Quick Gel		Pump

Section 5. PLUGGING RECORD

Plugging Contractor ___

Address ___

Plugging Method ___

Date Well Plugged ___

Plugging approved by: ___

State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

1977 NOV 30 PM
STATE ENGINEER OFFICE
ALBUQUERQUE, N. MEX.

FOR USE OF STATE ENGINEER ONLY

437

Date Received November 30, 1977

Quad ___ FWL ___ FSL ___

File No. B-502 Use domestic Location No. BROADVIEW ACRES Lot 1 Bk 2 (Valencia)

Section 6. LOG OF HOLE

Depth in From	To	Thickness in Feet	Color and Type of Material Encountered
0	60	60	Sand
60	80	20	Gravel
80	90	10	Quicksand — Qal
90	180	90	Red clay
180	220	40	Shale & sand
220	280	60	Clay
280	290	10	Grey sand
290	340	50	Clay
			#437
			upper
			6572 6572
			280 180
			6292 lower 6392

Well Log 437

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Jim [signature]
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1 and Section 5 need be completed.

Form WR-23

STATE ENGINEER OFFICE

Well Log 446

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed. Edward Allan

Section 1

(Plat of 640 acres)

(A) Owner of well GEORGE FITZGERALD
Street and Number P.O. Box 1205
City GRANTS State
Well was drilled under Permit No. [illegible] and is located in the
[illegible] ¼ [illegible] ¼ ¼ of Section Twp. [illegible] Rge.
(B) Drilling Contractor [illegible] License No. [illegible]
Street and Number [illegible]7
City [illegible] State [illegible]
Drilling was commenced 1-1-7[illegible] 19
Drilling was completed 1[illegible]-1[illegible]-7[illegible] 19

Elevation at top of casing in feet above sea level [illegible]' Total depth of well ~~11[illegible]'~~ 110'
State whether well is shallow or artesian [illegible] Depth to water upon completion 45'

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	To	Thickness in Feet	Description of Water-Bearing Formation
1	[illegible]0'	[illegible]'	[illegible]'	[illegible]
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
[illegible]	13	[illegible]	0	110'	11[illegible]'	[illegible]	60'	~~5[illegible]~~ 95

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.
Street and Number City State
Tons of Clay used Tons of Roughage used Type of roughage
Plugging method used Date Plugged 19
Plugging approved by: Cement Plugs were placed as follows:

Basin Supervisor

No.	Depth of Plug From	To	No. of Sacks Used
			446

FOR USE OF STATE ENGINEER ONLY

Date Received [illegible]

File No. B-265 Use Domestic Location No. Lot 24 Blk 3-A

Broadview A

No. 446

Section 6

LOG OF WELL

Depth in Feet		Thickness in Feet	Color	Type of Material Encountered
From	To			
0	10'	10	Tan	Sandy top soil
10'	30'	20'	Tan	Sand shale
30'	45'	15'	Pink	Shale
45'	55'	10'	Pink	Sandy Shale
55'	60'	5	Tan	Sand/quick sand
[illegible]'	95'	35'	Purple	Sand stone in layers w/shale-water
95'	110'	15'	Purple	Sandy shale
		Bailed tested at 10 gpm		

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Victor Quesnelle (signature)
Well Driller

Form WR-23

STATE ENGINEER OFFICE

Well Log 447

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Dwight Martin

447

Section 1

(Plat of 640 acres)

(A) Owner of well [illegible] E. ALFORD

Street and Number 2300 [illegible] 56

City CHAMA, NEW MEXICO State 87520

Well was drilled under Permit No. HC-48504-B-296 and is located in the LOT 1 ¼ BLOCK 3-A ¼ ¼ of Section [illegible] Twp. [illegible] Rge. [illegible]

(B) Drilling Contractor [illegible] License No. WD 445

Street and Number P. O. Box 2576

City [illegible] State [illegible]

Drilling was commenced 12-1-72 19

Drilling was completed 12-30-72 19

Elevation at top of casing in feet above sea level 0' Total depth of well 142'

State whether well is shallow or artesian SHALLOW Depth to water upon completion [illegible] 50'

Section 2 — PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	38'	142'	104'	SANDSTONE
2				
3				
4				
5				

Section 3 — RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
6 5/8"		WELDED	0'	142'	142'	none	120'	142'

Section 4 — RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 — PLUGGING RECORD

Name of Plugging Contractor ____ License No. ____

Street and Number ____ City ____ State ____

Tons of Clay used ____ Tons of Roughage used ____ Type of roughage ____

Plugging method used ____ Date Plugged ____ 19 ____

Plugging approved by:

____ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used
			447

FOR USE OF STATE ENGINEER ONLY

1973 JAN 12 AM 11:34

Date Received

File No. B-296 Use Dom Location No. Broadview [illegible]

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0'	5'	5'	TA[illegible]	SANDY SHALE
5'	80'	75'	YELLOW	SHALE
[illegible]'	138'	58'	[illegible]	[illegible]LE
138'	142'	4'	TAN	SANDSTONE
[illegible]	STANDS [illegible]	50'	[illegible] SURFACE	
[illegible]	[illegible]	40 SPM		

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Lee Pickett
Well Driller

5052879289 HOMESTAKE MINING CO 02:06:16 p.m. 02-20-2010

Well Log 555

STATE ENGINEER O

RECEIVED FEB 11 2010

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well HOMESTAKE MINING CO. Owner's Well No. 555
Street or Post Office Address
City and State

Well was drilled under Permit No. ______ and is located in the:

a. ___ ¼ ___ ¼ ___ ¼ ___ ¼ of Section ___ Township ___ Range ___ N.M.P.M.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. ___ of Block No. ___ of the ___
Subdivision, recorded in ___ County. N 35°13.736 W 107° 53.805

d. X= ___ feet, Y= ___ feet, N.M. Coordinate System ___ Zone in the ___ Grant.

(B) Drilling Contractor COYOTE DRILLING INC. License No. WD -1451

Address

Drilling Began 2-1-10 Completed 2-2-10 Type tools 3 cone bit Size of hole 9" in.

Elevation of land surface or ___ at well is ___ ft. Total depth of well 100' ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 51' ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
70	80	10	gray & purple sand	5 gpm

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5"	PVC		0	100'	103'	PVC cap	60	90

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

Section 5. PLUGGING RECORD

Plugging Contractor
Address
Plugging Method
Date Well Plugged
Plugging approved by:

State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ___ FWL ___ FSL ___

File No. ___ Use ___ Location No. ___

5052879289 HOMESTAKE MINING CO

555

Well Log 555

From	To	Thickness in Feet	Color and Type of Material Encountered
0	48	48	alluvium
48	70	22	purple shale
70	100	30	sand & purple shale
100	110	10	purple shale

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Form WR-23

STATE ENGINEER OFFICE

Well Log 816

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well [illegible]

Street and Number P.O. Box 521

City Grants State N.M.

Well was drilled under Permit No. BC 30693 and is located in the

___ ¼ ___ ¼ ___ ¼ of Section 7 & 3 Twp. 12N Rge. 10W

(B) Drilling Contractor Lee Pickett License No. WD 445

Street and Number P.O. Box 2576

City Milan State N.M.

Drilling was commenced May 2 19__

Drilling was completed May 10 19 56

Elevation at top of casing in feet above sea level ______ Total depth of well 255'

State whether well is shallow or artesian Shallow Depth to water upon completion [illegible]

Section 2

PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	240'	250'	10'	White Sand---Water Bearing
2				
3				
4				
5				

Section 3

RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
6 5/8"		Welded	0'	255'	255'	Tapered	[illegible]	250'

Section 4

RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5

PLUGGING RECORD

Name of Plugging Contractor ______ License No. ______

Street and Number ______ City ______ State ______

Tons of Clay used ______ Tons of Roughage used ______ Type of roughage ______

Plugging method used ______ Date Plugged ______ 19____

Plugging approved by:

______
Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

816

FOR USE OF STATE ENGINEER ONLY

Date Received [illegible stamp]

File No. B-225 Use Dom Location No. 12.N.10W.34

Murray Acres

Section 6

LOG OF WELL

Depth in Feet From	To	Thickness in Feet	Color	Type of Material Encountered
0	35'	35'	Tan	Sandy Top Soil
35'	160'	125'	Dk Red	Sandy Shale
160'	240'	80'	Purple/Red	Shale
240'	250'	10'	White	Water Bearing Sand

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Lee Puckett

Well Driller

Well Log 822

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(A) Owner of well Robert L. Siemens 822

Street and Number P. O. Box 521

City Grants State New Mexico

Well was drilled under Permit No. ______ and is located in the ____ ¼ ____ ¼ ____ ¼ of Section ____ Twp. ____ Rge. ____

(B) Drilling Contractor Prewitt Drilling Co. License No. ______

Street and Number 405 Julie Drive

City Gallup State New Mexico

Drilling was commenced June 19 64

Drilling was completed July 19 64

(Plat of 640 acres)

Elevation at top of casing in feet above sea level ______ Total depth of well 980 feet

State whether well is shallow or artesian Shallow Depth to water upon completion ______

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	790	845	55 ft.	San Andres Soft Sandstone
2	860	975	65 ft.	San Andres Med. Red Sandstone
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
7"O.D.	20	10-V	560	980	420	Larkin	790	845
							860	875
	This was	a deepening	contract	from	600 ft.	to 980 ft.	with 7" O. D.	Liner.

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor ______ License No. ______

Street and Number ______ City ______ State ______

Tons of Clay used ______ Tons of Roughage used ______ Type of roughage ______

Plugging method used ______ Date Plugged ______ 19 ____

Plugging approved by:

______
Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received April 12, 1965

File No. B-5-F Use irrigation Location N0N.10W.27 431

MURRAY BLK 5 LOT 1

6567
790
5777

≈6560
790
5770 top of Ps

Section 6

LOG OF WELL

Well Log 822

Depth in Feet From	To	Thickness in Feet	Color	Type of Material Encountered
600'	700'	100	Red	Chinle Shale
700	790	90	Multi-colored	Chinle Shale
790	845	55	Pink	San Andres S. S.
845	860	15	White	Hard Sandstone
860	975	65	Pink	Soft Sandstone
975	980	5	Red	Hard Sandstone

Kd base geologic Map 8310
5770
Dif 2540

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

P. F. Hubbell
Well Driller

Well Log 836

WELL RECORD

Mike Stovall

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well: Boyd C. Sfintz
Street and Number: Box 411
City: Grants State: N. M.
Well was drilled under Permit No. B-163 and is located in the ¼ SE ¼ NW ¼ of Section 35 Twp. 12N Rge. 10W
(B) Drilling Contractor: W. H. Steele License No. WD-307
Street and Number: Box 832
City: Grants State: N. M.
Drilling was commenced: 7-6- 19 61
Drilling was completed: 8-22- 19 61

Elevation at top of casing in feet above sea level: 6568 Total depth of well: 90'
State whether well is shallow or artesian: Shallow Depth to water upon completion: 35'

Section 2

PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	65	80	15	Coarse Sand + Gravel
2				
3				
4				
5				

Section 3

RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
4	5	welded	0	90	90	None	65	80

Section 4 None

RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 None

PLUGGING RECORD

Name of Plugging Contractor ____ License No. ____
Street and Number ____ City ____ State ____
Tons of Clay used ____ Tons of Roughage used ____ Type of roughage ____
Plugging method used ____ Date Plugged ____ 19____
Plugging approved by: Cement Plugs were placed as follows:

____
Basin Supervisor

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received: STATE ENGINEER OFFICE DISTRICT I ALBUQUERQUE, N. MEX. 1961 AUG 30 AM 8:10

836

File No. B-170 Use domestic Location No. Pleasant Valley Estat Lot 5, Blk. 2 (Grants)

Well Log 836

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	15	15	Brown	B. Gravel - Sand
15	25	10	Light tan	Fine Sand
25	60	35	Pink	Sand + ~~Gravel~~ Clay
60	80	20	Grey	Coarse Sand + Gravel
80	90	10	Red	Mud + Clay

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Wallace Hubert Steele
Well Driller

Well Log 844

General Information

844

well identification: MONITOR WELL #1 AT ROBERT L. SIMMONS-SOUTH OF PROPERTY

date drilling started: 6-14-82 date drilling completed: 6-16-82

total depth of well: 75 ft.

depth to water upon completeion of well (water level): 33 ft.

Principal Water-Bearing Strata

depth in feet: from 35 ft. to 65 ft.

thickness in feet: 30 ft.

description of water-bearing formation (type of material): Gravel & Sand

Record of Casing

casing diameter: 4" inch solid casing depth in feet from top Surface

to bottom 35 ft. perforations from 35 ft. to 75 ft.

Log of Hole

Depth in Feet		Thickness in Feet	Color and Type of Material
From	To		
	5-10		Brown Dirt
	25-40		Yellow Sand
	45-65		Gravel
	70-75		Chinle

Well Log 882, 883, L6, MV, and L5

Garner Drilling Co.
Box 3146
Milan, N.M. 87021

To;
Homestake Mining Co. of Ca.
Box 98
Grants, N.M. 87020

Hole # 882 ✓ Drilled 8/4-7-95 12N 10W

0	12	sand
12	72	Basalt
72	80	sand & gravel
80	86	tan shale
86	98	sand
98	110	purple shale

T.D. 110 ft. 4½ PVC casing set 0-110 ft. Per. 70-110 ft.
8 in steel casing set 0-15 ft. 25 sks. sand.Dev. time 2 hrs. 25 gpm +
Drill Rig time 22 hrs. at $ 130.00 per. hr.

Hole # 883 Drilled 8/7-8/95 12 N 10W

0	15	sand
15	35	Basalt
35	45	red sandy shale
45	96	sand, shale & fine gravel
96	100	gray & purple shale

T.D. 100 ft. 5 in. casing set 0-100 ft. Per. 50-100 ft.30 sks. sand. 2 sks. chips.
Rig time 1 hr. Dev. time 2 hrs. 20 gpm +

Hole # L-6 Drilled 8/9/95 12 N 10 W

0	20	tan sandy shale
20	45	sand & gravel
45	50	tan shale
50	65	red shale

T.D. 65 ft. 5 in. casing set 0-55 ft. per. 25-55 ft. 15 sks. sand. 4 sks. chips.
Rig time 1 hr. Dev. time 1 hr. no water.

Hole # M V Drilled 8/9-11/95 12 N 10 W

0	20	sand
20	87	Basalt
87	91	frac. Basalt
91	95	sand
95	105	red shale

T.D. 105 ft. 4½ in casing set 0-105 ft. Per. 75-105 ft. 25 sks. sand.
8 in. steel casing set 0-23 ft. Dev. time 2 hrs. 25 gpm +
Drill Rig time 19 hrs. at $ 130.00 per. hr.

Hole # L-5 Drilled 8/11-14/95 12 N 10 W

0	25	tan sandy shale
25	50	red shale & sand
50	65	red shale

T.D. 65 ft. 5 in casing set 0-55 ft. Per. 25-55 ft. 18 sks. sand.2 sks. chips.
Rig time 1 hr. Dev. time 2 hrs. 3 + gpm.

Well Log SUB4

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

William Chamberlain

SUB 4

(A) Owner of well William H. Brownholtz
Street and Number P.O. Box 2002
City Milan Station, Grants State New Mexico
Well was drilled under Permit No. B-165 and is located in the
Lot 13 ¼ E. SE ¼ NW ¼ NW ¼ of Section 35 Twp. 12N Rge. 10W
(B) Drilling Contractor Wallace M. Steele Box 832 License No. WD-307
Street and Number Box 832
City Grants State New Mexico
Drilling was commenced 4-13 19 61
Drilling was completed 4-18 19 61

(Plat of 640 acres)

Elevation at top of casing in feet above sea level 6554 Total depth of well 100'
State whether well is shallow or artesian shallow Depth to water upon completion 63

Section 2

PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	63	78	15	Coarse sand and gravel
2				
3				
4				
5				

Section 3

RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
4"	3.5	welded	0	100	100	None	60	85

Section 4

RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used
		NONE			

1961 APR 25 AM 8:13 STATE ENGINEER OFFICE

Section 5

PLUGGING RECORD

Name of Plugging Contractor NONE License No.
Street and Number City State
Tons of Clay used Tons of Roughage used Type of roughage
Plugging method used Date Plugged 19
Plugging approved by: Cement Plugs were placed as follows:

Basin Supervisor

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used
			SUB 4

FOR USE OF STATE ENGINEER ONLY

Date Received 4/25/61

File No. B-165 Use domestic Location No. Broadview Acres Addn. Lot 13, Blk. 1

LOG OF WELL

Well Log SUB4

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	15	15	Light Brown	Blow sand and sandy loam
15	25	10	Light Tan	Fine Sand
25	30	5	Grey	Course Sand
30	63	33	Pink	Adobe mixed with coarse sand
63	70	7	Grey	Course sand
70	78	8	Grey	Coarse sand and gravel
78	100	22	Red	Red clay mudstone with sand stone layers

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Hubert Steele
Well Driller

Well Log SUB7

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

Phyllis Reese

(A) Owner of well Mrs. Irene Kibbe

Street and Number Box 261

City Grants, State New Mexico

Well was drilled under Permit No. B-150 and is located in the SE ¼ NE ¼ ¼ of Section 35 Twp. 12 N Rge. 10W

(B) Drilling Contractor O.L.Ray License No. WD- 302

Street and Number Box 536

City Grants, State New Mexico

Drilling was commenced August 20, 19 60

Drilling was completed August 20, 19 60

(Plat of 640 acres)

Elevation at top of casing in feet above sea level ______ Total depth of well 98 feet

State whether well is shallow or artesian shallow Depth to water upon completion 60 feet

Section 2

PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	To	Thickness in Feet	Description of Water-Bearing Formation
1	60	98	38	sandstone stringers, sand & gravel, red shale
2				
3				
4				
5				

Section 3

RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
4"			0	98	98		78	98

Section 4

RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5

PLUGGING RECORD

Name of Plugging Contractor ______ License No. ______

Street and Number ______ City ______ State ______

Tons of Clay used ______ Tons of Roughage used ______ Type of roughage ______

Plugging method used ______ Date Plugged ______ 19____

Plugging approved by:

______ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	To	No. of Sacks Used

prob Boardwalk could be Montano

SUB 7

FOR USE OF STATE ENGINEER ONLY

Date Received 9/7/60

File No. B-150 Use domestic Location No. 12.10.35.240

BLK 2 LOT 5

Well Log SUB7

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	12	12	Brownish	tpp XX soil
12	60	48	Yellow	clay
60	65	5	White	sandstone stringers
65	85	20	Brownish	sand & gravel
85	98	13	Red	shale

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Well Driller

Well Log #1 DEEP

WELL RECORD

#1 Deep

Section 1. GENERAL INFORMATION

(A) Owner of well United Nuclear-Homestake Partners — Owner's Well No. B-28-A (Expl

Street or Post Office Address P.O. Box 98

City and State Grants, New Mexico

Well was drilled under Permit No. B-28-A (Explor.) and is located in the:

a. ____ ¼ ~~NW~~ ¼ ~~NE~~ ¼ ~~SE~~ ¼ of Section 26 Township 12N Range 10W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor United Nuclear-Homestake Partners License No. WD-704

Address P.O. Box 98, Grants, NM 87020

Drilling Began 1-14-79 Completed 1-27-79 Type tools ____ Size of hole ____ in.

Elevation of land surface or ____ at well is ≅6575 ft. Total depth of well 1000 ft.

Completed well is ☐ shallow ☒ artesian. Depth to water upon completion of well 137 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
955	999	44	San Andres limestone	850

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
16" OD	62.58	Welded	0	300	300			
9 5/8 OD	35	Welded	300	999	699		919	999
24"	corrigated culvert pipe	Welded	0	50	50			

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				
0	50	30"		88	Pump
0	300	20"		284	Pump thru center of casing with plug at 929 ft thru 10 ft. of
300	929	12 3/4"		240	perforations until cement came to surface (drilled out plug)

Section 5. PLUGGING RECORD

Plugging Contractor ____

Address ____

Plugging Method ____

Date Well Plugged ____

Plugging approved by: 79 JUN 8 PM 12:44

State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received 6-8-79

Quad ____ FWL ____ FSL ____

File No. B-28-A-Expl. Use expl. Location No. NW SE NE 26-12N

Section 6. [illegible] OF HOLE

Well Log #1 DEEP

Depth From	Depth To	Thickness in Feet	Color and Type of Material Encountered
0	120	120	Clay and Sand
120	284	164	Shale
284	307	23	Shale and Sandstone
307	319	12	Sandstone
319	347	28	Shale and Sandstone
347	377	30	Shale
377	395	18	Shale and Sandstone
395	414	19	Sandstone
414	433	19	Shale
433	450	17	Sandstone
450	459	9	Shale
459	476	17	Sandstone
476	596	120	Shale
596	615	19	Sandstone
615	708	93	Shale
708	723	15	Sandstone
723	788	65	Shale and Sandstone
788	812	24	Shale
812	829	17	Sandstone
829	870	41	Shale
870	955	85	Sandstone and Shale
955	999	44	San Andres limestone

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Well Log 929

Reg'ional Well 929

929

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Freddy W. Holley Owner's Well No. 1
Street or Post Office Address P.O. Box 143
City and State Bluewater, New Mexico 87005

Well was drilled under Permit No. B-554 and is located in the:

a. NW ¼ ____ ¼ ____ ¼ ____ ¼ of Section 25 Township 12N Range 10W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Kell Drilling, Inc. License No. WD-718

Address P.O. Box 1177 Grants, New Mexico 87020

Drilling Began June 5, 1978 Completed June 5, 1978 Type tools Rotary Size of hole 6¼ in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 320 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 290 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
290	320	30	San Andres Limestone	15 G.P.M. Test

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
5"	Plastic		Surface	320	320	----	290	320

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				
320	290	6¼	3/8 Gravel	Pack	By Hand
290	Surface	Lean	Cement	12 Sacks	By Hand

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____ State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

STATE ENGINEER OFFICE
DISTRICT I
ALBUQUERQUE, N. MEX.
78 JUN 8 PM 12 28

FOR USE OF STATE ENGINEER ONLY

Date Received June 8, 1978

Quad ____ FWL ____ FSL ____

File No. B-554 Use dom/san Location No. 12N.10W.25.100 ~~(Valencia)~~

Well Log 929

Section 6. LOG OF HOLE

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		
0	160	160	Red Sand
160	290	130	Volcanic Ash
290	320	30	Cray San Andres Limestone

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

Form WR-23

Well Log 930

STATE ENGINEER OFFICE

WELL RECORD

930

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well: Elmer Reed

Street and Number: 673 Sargent St

City: Grants State: [illegible]

Well was drilled under Permit No. [illegible] and is located in the ___ ¼ ___ ¼ [illegible] ¼ of Section 25 Twp. 12 N Rge. 10 W

(B) Drilling Contractor: [illegible] License No. [illegible]-537

Street and Number: [illegible]

City: Grants State: New Mexico

Drilling was commenced: [illegible] 19 72

Drilling was completed: April [illegible] 19 72

Elevation at top of casing in feet above sea level: [illegible] Total depth of well: 410' ft.

State whether well is shallow or artesian: shallow Depth to water upon completion: 106' ft.

Section 2

PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	335	395	60	Hard sand containing fine gravel and shale
2				
3				
4				
5				

Section 3

RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
10	21	welded	surface		40			
6	13	welded			410	none	330	400

Section 4

RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5

PLUGGING RECORD

Name of Plugging Contractor ______ License No. ______

Street and Number ______ City ______ State ______

Tons of Clay used ______ Tons of Roughage used ______ Type of roughage ______

Plugging method used ______ Date Plugged ______ 19___

Plugging approved by:

______ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received: STATE ENGINEER OFFICE 1972 NOV 12 PM 12:19

File No. B-286 Use dom Location No. 25 12N 10W

Section 6

LOG OF WELL

Well Log 930

Depth in Feet		Thickness in Feet	Color	Type of Material Encountered
From	To			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] gravel & [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

J. Gosner
Well Driller

Well Log 931

READ INSTRUCTIONS ON BACK

Revised March 1972

APPLICATION TO APPROPRIATE UNDERGROUND WATERS
IN ACCORDANCE WITH SECTION 75-11-1 NEW MEXICO STATUTES

931

HC 45314 - $1.00

1. Name and Address of Applicant: File No. B-294

Bill D. Bell
6100 San Mateo Rd.
Grants, N Mex.

2. Describe well location under one of the following subheadings:

a. ___ ¼ ___ ¼ W ½ Sec. 25 Twp. 12N Rge. 10W N. M. P. M., in Valencia County.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. ___ of Block No. ___ of the ___ Subdivision, recorded in ___ County.

d. X = ___ feet, Y = ___ feet, N. M. Coordinate System ___ Zone in the ___ Grant.

e. Give street address or route and box No. of property upon which well is to be located, or location by direction and distance from known landmarks ___

3. Approximate depth (if known) 450 feet; outside diameter of casing 6 inches.

Name of driller (if known) Hubbell Drilling Co

4. Use of water (check appropriate box or boxes):

- [x] Household, non-commercial trees, lawn and garden not to exceed 1 acre.
- [x] Livestock watering.
- [x] Drinking and sanitary purposes and the irrigation of non-commercial trees, shrubs and lawns in conjunction with a commercial operation.
- [ ] Prospecting, mining or drilling operations to discover or develop natural resources.
- [ ] Construction of public works, highways and roads.

If any of the last three were marked, give name and nature of business under Remarks. (Item 5)

5. Remarks: Rent spaces for 8 Mobile homes own care home livestock (cow, 2 goats, chickens, horse and [illegible] [illegible] [illegible] consultation with applicants wife

I, Bill Bell, affirm that the foregoing statements are true to the best of my knowledge and belief and that development shall not commence until approval of the permit has been obtained.

Bill Bell, Applicant

By: ___ Date: 6/26/72

ACTION OF STATE ENGINEER

This application is approved for the use indicated, subject to all general conditions and to the specific conditions numbered 3(5) on the reverse side hereof. This permit will automatically expire unless this well is drilled or driven and the well record filed on or before June 15, 1973

S. E. Reynolds, State Engineer

By: [signature]
D. N. Stone, District I

Date: June 29, 1972

File No. B-294

Well Log 932

STATE ENGINEER OFFICE

WELL RECORD

25-334-2

932

Section 1. GENERAL INFORMATION

(A) Owner of well JAMES HAMILTON CONSTRUCTION CO INC Owner's Well No. ______
Street or Post Office Address P.O BOX 249
City and State GRANTS NEW MEXICO 87020

Well was drilled under Permit No. B-770 and is located in the:

a. SW ¼ SE ¼ SW ¼ SW ¼ of Section 25 Township 12N Range 10W N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in VALENCIA County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor JAMES HAMILTON CONSTRUCTION CO. INC. License No. WD765

Address P.O. BOX 249, GRNTS NEW MEXICO 87020

Drilling Began 1-28-80 Completed 1-31-80 Type tools ROTARY DRILL Size of hole 6 in.

Elevation of land surface or 6540' at well is 6540' ft. Total depth of well 490 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 290 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
490'	209'	20'	SANDSTONE	110 gpm

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6	80	N/A	437	490	490	SAND POINT	490	450

STATE ENGINEER OFFICE
DISTRICT I
ALBUQUERQUE, N.MEX.
80 SEP 11 P 1:59

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
N/A					

Section 5. PLUGGING RECORD

Plugging Contractor N A
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ______ FWL ______ FSL ______

File No. B-770 Use Dom/San Location No. 12N.10W.25.334 Valencia County

Well Log 932

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in [illegible]plicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section [illegible] shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is [illegible] plugging rec[illegible] Section [illegible] a) and Section 5 need be completed.

Well Log 934

934

READ INSTRUCTIONS ON BACK

Revised March 1977

APPLICATION TO APPROPRIATE UNDERGROUND WATERS
IN ACCORDANCE WITH SECTION 75-11-1 NEW MEXICO STATUTES

76 DEC 8 P2:26

STATE ENGINEER OFFICE
DISTRICT I
ALBUQUERQUE, N. MEX.

File No. B-409

1. Name and Address of Applicant:
A-1 Industries INC
2712 Coors S.W.
Albuq. N.M. 87105

2. Describe well location under one of the following subheadings:

a. SE ¼ ___ ¼ ___ ¼ of Sec. 26 Twp. 12N Rge. 10 W N. M. P. M., in Valencia County.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. ___ of Block No. ___ of the ___ Subdivision, recorded in ___ County.

d. X = ___ feet, Y = ___ feet, N. M. Coordinate System ___ Zone in the ___ Grant.

e. Give street address or route and box No. of property upon which well is to be located, or location by direction and distance from known landmarks. 5800 San Mateo Hiway Grants, N.M. 87020
4.2 miles North of old Hiway 66 across from UNF Mill

3. Approximate depth (if known) 250' feet; outside diameter of casing 5½" inches.

Name of driller (if known) Coffey Drilling 2720 Coors S.W. Albq.

4. Use of water (check appropriate box or boxes):

☑ Household, non-commercial trees, lawn and garden not to exceed 1 acre.

☐ Livestock watering.

☑ Drinking and sanitary purposes and the irrigation of non-commercial trees, shrubs and lawns in conjunction with a commercial operation.

☐ Prospecting, mining or drilling operations to discover or develop natural resources.

☐ Construction of public works, highways and roads.

If any of the last three were marked, give name and nature of business under Remarks. (Item 5)

5. Remarks: Plastic Pipe & Tank Supply house with employees living quarters Mobile Home Spaces Sell wholesale & Retail

I, Paul D. Powers affirm that the foregoing statements are true to the best of my knowledge and belief and that development shall not commence until approval of the permit has been obtained.

A-1 Industries INC Applicant

By Paul D. Powers

Date: 12-1-76

ACTION OF STATE ENGINEER

This application is approved for the use indicated, subject to all general conditions and to the specific conditions numbered ___ on the reverse side hereof. This permit will automatically expire unless this well is ___ and the well record filed on or before December 15, 1977.

S. E. Reynolds, State Engineer

By [signature]
J. T. Everheart, District 1

December 8, 1976

METER REQUIRED
SEE CONDITION 5 B OF
APPROVAL # ___

File No. B-409

Well Log 934

GENERAL CONDITIONS OF APPROVAL

A. The maximum amount of water that may be appropriated under this permit is 3 acre feet in any calendar year.

B. The well shall be drilled only by a driller licensed in the State of New Mexico in accordance with Section 75-11-13 New Mexico Statutes Annotated. A licensed driller shall not be required for the construction of a driven well; provided, that the casing shall not exceed two and three-eighths (2 3/8) inches outside diameter (Section 75-11-13).

C. Driller's log must be filed in the office of the State Engineer within 10 days after the well is drilled or driven. Failure to file the log within that time shall result in automatic cancellation of the permit. Log forms will be provided by the State Engineer upon request.

D. The casing shall not exceed 7 inches outside diameter except under specific conditions in which reasons satisfactory to the State Engineer are shown.

E. If the well under this permit is used at any time to serve more than one household, livestock in a commercial feed lot operation, or any other commercial purpose, the permittee shall comply with Specific Conditon of Approval number 5(b).

F. In the event this well is combined with other wells permitted under Section 75-11-1 New Mexico Statutes Annotated, the total outdoor use shall not exceed the irrigation of one acre of non-commercial trees, lawn, and garden, or the equivalent outside consumptive use, and the total appropriation for household and outdoor use from the entire water distribution system shall not exceed 3 acre feet per annum.

SPECIFIC CONDITIONS OF APPROVAL

(Applicable only when so indicated on the other side of this form.)

1. Depth of the well shall not exceed the thickness of the (a) the valley fill or (b) Ogallala formation.
2. The well shall be constructed to artesian well specifications and the State Engineer Office shall be notified before casing is landed or cemented.
3. Appropriation and use of water under this permit shall not exceed a period of one year from the date of approval.
4. Use shall be limited to household, non-commercial trees, lawn and garden not to exceed one acre and/or stock use.
5. A totalizing meter shall be installed before the first branch of the discharge line from the well and the installation shall be acceptable to the State Engineer; the State Engineer shall be advised of the make, model, serial number, date of installation, and initial reading of the meter prior to appropriation of water and pumping records shall be submitted to the District Supervisor (a) for each calendar month, on or before the 30th day of the following month (b) on or before the 10th of January, April, July and October of each year for the three preceding calendar months (c) for each calendar year on or before the 30th day of January of the following year.
6. The well shall be plugged upon completion of the permitted use and a plugging report shall be filed in the office of the State Engineer within 10 days.
7. Final approval for the use of the well shall be dependent upon a leakage test made by the State Engineer Office.
8. shall be limited strictly to household and/or drinking and sanitary purposes; water shall be conveyed from the well to the place of use in closed conduit and the effluent returned to the underground so that it will not appear on the surface. No irrigation of lawns, garden, trees or use in any type of pool or pond is authorized under this permit.

INSTRUCTIONS

The application shall be made in the name of the actual user of the well for the purpose specified in the application.

The application shall be executed in triplicate and forwarded with a $1.00 filing fee to the appropriate office of the State Engineer.

A separate application must be filed for each well to be drilled or used.

If well to be used is an existing well, an explanation (and file number, if possible) should be given under Remarks. (Item 5.)

Applications for appropriation, well logs and request for information in the following basins should be addressed to the State Engineer at the office indicated:

✓ Bluewater, Estancia, Rio Grande, and Sandia Basins
District No. 1, 505 Marquette NW, Room 1015, Albuquerque, New Mexico 87101

Capitan, Carlsbad, Fort Sumner, Hondo, Jal, Lea, Penasco, Portales, Roswell, and Upper Pecos Basins
District No. 2, Box 1717, Roswell, New Mexico 88201

Animas, Gila-San Francisco, Hot Springs, Las Animas Creek, Lordsburg, Mimbres, Nutt-Hockett, Playas, San Simon, and Virden Valley Basins
District No. 3, Box 844, Deming, New Mexico 88030

Canadian River Basin
State Engineer Office, State Capitol, Bataan Memorial Bldg., Santa Fe, New Mexico 87501

APPLICATION TO APPROPRIATE UNDERGROUND WATERS
IN ACCORDANCE WITH SECTION 75-11-1 NEW MEXICO STATUTES

76 DEC 8 P2: 26

Well Log 934

STATE ENGINEER OFFICE
DISTRICT I
ALBUQUERQUE, N. MEX.

File No. B-409

1. Name and Address of Applicant:
A-1 Industries INC
2712 Coors S.W.
Albuq. N.M. 87105

2. Describe well location under one of the following subheadings:

a. SE ¼ ____ ¼ ____ ¼ of Sec. 26 Twp. 12N Rge. 10W N. M. P. M., in Valencia County.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X = ____ feet, Y = ____ feet, N. M. Coordinate System ____ Zone
in the ____ Grant.

e. Give street address or route and box No. of property upon which well is to be located, or location by direction and distance from known landmarks 5800 San Mateo Hiway
Grants, N.M. 87020
4.2 miles North of old Hiway 66 across from UNK Mill

3. Approximate depth (if known) 250' feet; outside diameter of casing 5½" inches.

Name of driller (if known) Coffey Drilling 2720 Coors S.W. albq.

4. Use of water (check appropriate box or boxes):

☑ Household, non-commercial trees, lawn and garden not to exceed 1 acre.

☐ Livestock watering.

☑ Drinking and sanitary purposes and the irrigation of non-commercial trees, shrubs and lawns in conjunction with a commercial operation.

☐ Prospecting, mining or drilling operations to discover or develop natural resources.

☐ Construction of public works, highways and roads.

If any of the last three were marked, give name and nature of business under Remarks. (Item 5)

5. Remarks: Plastic Pipe & Tank Supply house with employees living quarters. Mobile Home spaces. Sell wholesale & Retail

I, Paul D. Powers, affirm that the foregoing statements are true to the best of my knowledge and belief and that development shall not commence until approval of the permit has been obtained.

A-1 Industries INC Applicant

By: Paul D. Powers Date: 12-1-76

ACTION OF STATE ENGINEER

This application is approved for the use indicated, subject to all general conditions and to the specific conditions numbered 5 b on the reverse side hereof. This permit will automatically expire unless the well is drilled or driven and the well record filed on or before December 15, 1977

S. E. Reynolds, State Engineer

By: J. T. Everheart, District 1

Date: December 3, 1976

METER REQUIRED
SEE CONDITION 5 b OF
APPROVAL #
File No. B-409

Well Log 934

GENERAL CONDITIONS OF APPROVAL

A. The maximum amount of water that may be appropriated under this permit is 3 acre feet in any calendar year.

B. The well shall be drilled only by a driller licensed in the State of New Mexico in accordance with Section 75-11-13 New Mexico Statutes Annotated. A licensed driller shall not be required for the construction of a driven well; provided, that the casing shall not exceed two and three-eighths (2 3/8) inches outside diameter (Section 75-11-13).

C. Driller's log must be filed in the office of the State Engineer within 10 days after the well is drilled or driven. Failure to file the log within that time shall result in automatic cancellation of the permit. Log forms will be provided by the State Engineer upon request.

D. The casing shall not exceed 7 inches outside diameter except under specific conditions in which reasons satisfactory to the State Engineer are shown.

E. If the well under this permit is used at any time to serve more than one household, livestock in a commercial feed lot operation, or any other commercial purpose, the permittee shall comply with Specific Conditon of Approval number 5(b).

F. In the event this well is combined with other wells permitted under Section 75-11-1 New Mexico Statutes Annotated, the total outdoor use shall not exceed the irrigation of one acre of non-commercial trees, lawn, and garden, or the equivalent outside consumptive use, and the total appropriation for household and outdoor use from the entire water distribution system shall not exceed 3 acre feet per annum.

SPECIFIC CONDITIONS OF APPROVAL

(Applicable only when so indicated on the other side of this form.)

1. Depth of the well shall not exceed the thickness of the (a) the valley fill or (b) Ogallala formation.
2. The well shall be constructed to artesian well specifications and the State Engineer Office shall be notified before casing is landed or cemented.
3. Appropriation and use of water under this permit shall not exceed a period of one year from the date of approval.
4. Use shall be limited to household, non-commercial trees, lawn and garden not to exceed one acre and/or stock use.
5. A totalizing meter shall be installed before the first branch of the discharge line from the well and the installation shall be acceptable to the State Engineer; the State Engineer shall be advised of the make, model, serial number, date of installation, and initial reading of the meter prior to appropriation of water and pumping records shall be submitted to the District Supervisor (a) for each calendar month, on or before the 30th day of the following month (b) on or before the 10th of January, April, July and October of each year for the three preceding calendar months (c) for each calendar year on or before the 30th day of January of the following year.
6. The well shall be plugged upon completion of the permitted use and a plugging report shall be filed in the office of the State Engineer within 10 days.
7. Final approval for the use of the well shall be dependent upon a leakage test made by the State Engineer Office.
8. Use shall be limited strictly to household and/or drinking and sanitary purposes; water shall be conveyed from the well to the place of use in closed conduit and the effluent returned to the underground so that it will not appear on the surface. No irrigation of lawns, garden, trees or use in any type of pool or pond is authorized under this permit.

INSTRUCTIONS

The application shall be made in the name of the actual user of the well for the purpose specified in the application.

The application shall be executed in triplicate and forwarded with a $1.00 filing fee to the appropriate office of the State Engineer.

A separate application must be filed for each well to be drilled or used.

If well to be used is an existing well, an explanation (and file number, if possible) should be given under Remarks. (Item 5.)

Applications for appropriation, well logs and request for information in the following basins should be addressed to the State Engineer at the office indicated;

Bluewater, Estancia, Rio Grande, and Sandia Basins
District No. 1, 505 Marquette NW, Room 1023, Albuquerque, New Mexico 87101

Capitan, Carlsbad, Fort Sumner, Hondo, Jal, Lea, Penasco, Portales, Roswell, and Upper Pecos Basins
District No. 2, Box 1717, Roswell, New Mexico 88201

Animas, Gila-San Francisco, Hot Springs, Las Animas Creek, Lordsburg, Mimbres, Nutt-Hockett, Playas, San Simon, and Virden Valley Basins
District No. 3, Box 844, Deming, New Mexico 88030

Canadian River Basin
State Engineer Office, State Capitol, Bataan Memorial Bldg., Santa Fe, New Mexico 87501

HC #72287
$1.00 BF

CHANGE OF OWNERSHIP OF WATER RIGHT

Well Log 934

1. NAME OF WATER RIGHT OWNER OF RECORD United Nuclear Corporation
Mailing Address Post Office Box 3951
City and State Albuquerque, New Mexico 87110
the owner and holder of a water right set forth in file number B 409
of record in the office of the State Engineer has conveyed All (all or part) of said right to:

Name United Nuclear - Homestake Partners
Mailing Address Post Office Box 98
City and State Grants, New Mexico 87020

2. IRRIGATION: The conveyed water right is appurtenant to lands described as follows (describe only lands with actual water right and diversion as that amount of water measured at the well and/or farm headgate):

SUBDIVISION (District or Hydrographic Survey)	SECTION	TOWNSHIP (Map No.)	RANGE (Tract No.)	ACREAGE	DIVERSION (Acre Feet Per Annum)	PRIORITY
			TOTAL			

77 NOV 14 A 8:48
STATE ENGINEER OFFICE ALBUQUERQUE, N. MEX.

1977 NOV 10 AM 11:0_
STATE ENGINEER OFFICE

OTHER: Purpose ; Amount (acre feet per annum of diversion); Priority

3. DESIGNATE WELLS TO ACCOMPANY THE CONVEYED RIGHT: (To be executed if conveyance involves only a part of a ground water right):

WELL FILE NO.	SUBDIVISION (District or Hydrographic Survey)	SECTION	TOWNSHIP (Map No.)	RANGE (Tract No.)
B 409	SE 1/4	26	12 N	10W

(Domestic Use - drinking and sanitary purposes)

4. I HEREBY CONSENT TO A LAWFUL CHANGE IN THE PLACE AND/OR PURPOSE OF USE OF THE ABOVE-DESCRIBED WATER RIGHT: (To be executed if water right described above is a right for irrigation purposes and has been conveyed separate from the land to which it is appurtenant.)

The undersigned, being first duly sworn upon oath, deposes and says that he has read the foregoing statements and that the same are true to the best of his knowledge and belief.

UNITED NUCLEAR CORPORATION

BY [signature]
D. D. TURBERVILLE, V. PRES.

Subscribed and sworn to before me this 7th day of [illegible], A.D., 19 77

My commission expires: 6-1-80 [signature] Notary Public

INSTRUCTIONS

Change of ownership shall be filed in triplicate ... [illegible] ... fee of $1.00. If executed by the ... [illegible] ... instrument of conveyance.

FOR STATE ENGINEER USE ONLY

A (warranty deed, other) from to
was found by me to be recorded on the day of , A. D., 19 on page
of Book No. of record of County,
By: Date:
Date Received November 14, 1977 File No. B-409

Well Log 934

1.

R

No. 69009

STATE ENGINEER OFFICE
SANTA FE, NEW MEXICO

OFFICIAL RECEIPT

CONTROL NUMBER			
DATE	December 8, 1976		
AMOUNT RECEIVED	GW	SW	TOTAL
CASH			
CHECK	X		$1.00

FILE NO. B-409

POWER'S WELL INFO

BANK
ALBUQUERQUE NATIONAL BANK Check #4306 for one dollar only.

FOR PAYMENT AS INDICATED BELOW
Application for domestic and sanitation permit.

NAME AND ADDRESS
A-1 Industries
2712 Coors SW
Albuquerque, New Mexico 87105

FOR USE BY ADMINISTRATIVE DIVISION

FOR USE BY SANTA FE OFFICE ONLY

WATER RIGHTS

DATE	EARNED GW	EARNED SW	REFUND	TRANSCRIPT EXP.	BALANCE

Well Log 934

REPORT NO ____

COFFEY DRILLING & SUPPLY
ALBUQUERQUE, NEW MEXICO
DAILY LOG — DRILLER REPORT

RIG Pik-e-Drill
TOUR Day (Specify Morning or Evening)
DATE 17 Jan 77
START ____ TIME ____ END ____ TIME

WELL OWNER A-1 Industries
WELL NAME ____
ADDRESS 2713 Coors SW Alb, NM 87105
TOOL PUSHER Fod Coffey
SIZE & TYPE BIT ____ MUD ____ VIS ____ WT ____
SERIAL NO ____

DEPTH TO	DEPTH	REMARKS — FORMATION OR DESCRIPTION OF CUTTINGS	DRILL PIPE & COLLARS NO.	LENGTH	TOTAL IN HOLE	CONNECTION TIME
0	5'	Surface Silt & Sand				
5	10'	Silt & Silty Shale				
10	15'	Red Sand				
15	20'	Light Tan Sand				
20	30'	Grey Sand & Gravel				
30	50'	Red Sand/ Some Gravel				
50	200	Red Shale & Clay				
200	270	Dark Red Shale & Clay				
270	275	Red Shale / Streaks Grey Shale				
275	285	Light Grey Sandstone				
285	300	Sandstone & Fractured Limestone				
		Pump Set @ 210'				
		Water @ 100' in Casing or higher				

	EMPLOYEES ON THIS TOUR	HOURS	INITIAL
DRILLER	Fod Coffey		
DERRICK			
FLOOR	Terry Shoemaker		
FLOOR			
TRUCK DRIVER			
OTHER			

FOR OFFICE USE ONLY

RIG OPERATING HOURS	RATE	AMOUNT
STANDBY HOURS	RATE	AMOUNT
	RATE	AMOUNT
	RATE	AMOUNT
REPORT TOTAL →		

OFFICE COPY

Well Log 944

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

944

(A) Owner of well B & W Construction Owner's Well No. ______
Street or Post Office Address 6100 4th, N. W.
City and State Albuquerque, New Mexico

Well was drilled under Permit No. B-802 and is located in the:

a. ____ ¼ ____ ¼ ____ ¼ ____ ¼ of Section 35 Township 12N Range 10W N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. 1 of Block No. 12 of the Vista Montano Subdivision
Subdivision, recorded in Valencia County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor Alldredge Drilling Co., Inc. License No. WD-566

Address P. O. Box 1630; Grants, N. M. 87020

Drilling Began 5/9/80 Completed 5/9/80 Type tools Rock Bit Size of hole 8 3/4 in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 300 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 160 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
250	265	15	Red Sand	40

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
5"	SCH 40	PVC	0	300	20	None	220	280

JUN 11 '80 ... 14

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

944

Quad ______ FWL ______ FSL ______

File No. B-802 Use Dom.San. Location No. Lt.1Blk.12 Vista Monta Valencia Co

From	To	in Feet	
0	20	20	Sand & Gravel
20	250	230	Red Shale
250	265	15	Red Sand
265	300	35	Red Shale

Well Log 944

6594
250
6354

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Ron E. Gray
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and s mitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely a accurately as possible when any well is drilled, repaired or deepened. When this form i sed as a plugging record, only Section 1(Section 5 need be completed.

Well Log 946

STATE ENGINEER OFFICE

WELL RECORD

35-233 946

Section 1. GENERAL INFORMATION

(A) Owner of well Residential Heating & Air Owner's Well No. ______

Street or Post Office Address 7801 Coors Blvd. SW

City and State Albuquerque, NM

Well was drilled under Permit No. B-658 and is located in the:

a. SE ¼ SW ¼ SW ¼ 35 ¼ of Section 35 Township 12N Range 10W N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in Valencia County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor Rotary Drilling License No. WD-643

Address P.O. Box 129 - Grants, NM 87020

Drilling Began 4-11-79 Completed 4-15-79 Type tools Rotary Size of hole 6¼ in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 260 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 130 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
220	260	20	Sandstone	451

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
4	Sch 40	PVC	0	260	260		230	260

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
3	15	6¼		1 sack	Poured

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY 35-233

Date Received 4-26-79

Quad ______ FWL ______ FSL ______

File No. B-658 Use ______ Location No. 12 N. 10 W. 35 4

946

From	To	in Feet	
0	85	85	Sand
85	118	33	Gravel
118	220	102	Red Shale
220	260	40	Sandstone

Well Log 946

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

STATE ENGINEER OFFICE

WELL RECORD

Well Log 948

948

Section 1. GENERAL INFORMATION

(A) Owner of well Rams Construction Owner's Well No. HC-68894
Street or Post Office Address P.O.Box 2150
City and State Grants, N.M. 87020

Well was drilled under Permit No. ~~XXX XX-XXX~~ B-396 and is located in the:

a. N.W. ¼ N.W. ¼ S.W. ¼ ¼ of Section 25 Township 12 N Range 10W N.M.P.M.

b. Tract No. of Map No. of the

c. Lot No. of Block No. of the
Subdivision, recorded in Valencia County.

d. X= feet, Y= feet, N.M. Coordinate System Zone in the Grant.

(B) Drilling Contractor ~~Jerry Odom Drilling Co~~ License No. ~~XXX~~ WD 701

Address P.O.Box 1270 Grants, N.M. 87020

Drilling Began 11/30/76 Completed 12/23/ 76 Type tools Rotary Rig Size of hole 9 " in.

Elevation of land surface or at well is 6600 ft. Total depth of well 255 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 100 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
200	255	55	Lime Stone	30

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5	6	weld Casing	0	255	255		200	255

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
0	255	9("	8		Gravel Pack

Section 5. PLUGGING RECORD

Plugging Contractor
Address
Plugging Method
Date Well Plugged
Plugging approved by:

State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received 1/5/77 948

Quad FWL FSL

File No. B-396 Use dom 4 san Location No. 12N.10W.25 31
35.3

From	To		
0	170	170	Grey Shale
170	200	30	Red Shale or Clay
200	255	55	Lime Stone

Well Log 948

L959

L959

L959

77 JAN 5 P12:47
STATE ENGINEER OFFICE
ALBUQUERQUE, N. MEX.

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

JERRY ODOM DRLG. CO.
P. O. BOX 1270 PH. 287-4974
GRANTS, NEW MEXICO 87020

Colleen Odom

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Completed Feb. 19, 1950. 949 - (by EDG - Apr. 19, 53)

Well Log 949

12.10.27.333 - Log. from AR Card files

	0-18	Soil and clay
	18-20	Sand
Qvf	20-75	Brown clay
	75-112	Clay and sand
	112-140	Hard red clay
	140-155	Red shale — prob. Top of Rcl
	155-250	Conglomerate — 6562 / 155 / 6407
	250-264	Limestone
	264-268	Limestone and clay
	268-271	Brown shale
	271-282	Lime rock and clay
	282-288	Blue clay
	288-360	Blue clay with other colors
	360-370	Red clay
	370-380	Blue clay with other colors
	380-385	Hard pan
	385-388	Sandstone
	388-411	Sandstone and clay
	411-425	Red sandstone and red shale
	425-445	Shale, sandstone and clay
	445-460	Clay and sandstone
	460-470	Limestone
Psa	470-476	Sandstone
	476-480	Crevice in sandstone
	480-491	[illegible]s, hard and soft sandstone
	491-502	Sandstone.

(Cont. [illegible])

12.10.27.333

Well Log 949

12.10.27.333 (Continued)

502-510 Soft sandstone

510-534 Sandstone

534-540 Soft sandstone

540-545 Sandstone

545-551 Hard sandstone.

Set 20" pipe to 390'. (392' of 8-ga. csg)

Set 16" pipe to 505'. (218' of 10-ga. csg)

Lap in larger casing - 103'.

Used Mills perforator:

Perforations 1/2" dia, 3 to 4" long.

Perforated: 260-290 / 400-493 } 7 holes per 10'.

Depth wtr. first encountered: 75'.

Standing level before perforating - 85'

Standing level after perforating - 84'

Test: 48 hrs.

Wtr. level prior to test 88'.

Draw down from standing level - 45'.

No. gpm when test first started - 1200

" " " " completed - 1850

Drawdown at completion of test - 16'.

Well Log 954

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

954

Section 1. GENERAL INFORMATION

(A) Owner of well: Wesley Marquez — Owner's Well No.:
Street or Post Office Address: 804 E. First St.
City and State: Grants, N.M. 87020

Well was drilled under Permit No. B-1004 - Verbal and is located in the:

a. NW ¼ NW ¼ NW ¼ ___ ¼ of Section 3 Township 11 N Range 10 W N.M.P.M.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. ___ of Block No. ___ of the ___
Subdivision, recorded in Cibola County.

d. X= ___ feet, Y= ___ feet, N.M. Coordinate System ___ Zone in the ___ Grant.

(B) Drilling Contractor: Garner Drilling Co. License No. WD- 595

Address: Milan, N.M.

Drilling Began 11-5-84 Completed 11-19-84 Type tools Rotary Size of hole 8 in.

Elevation of land surface or ___ at well is ___ ft. Total depth of well 307 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 76 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
285	295	10	white sandstone	30
295	307	12	yellow free, sandstone	50 +

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
5 sch.	40 PVC		+ 1	307	308	open	285	307
gravel	packed							

STATE ENGINEER OFFICE DISTRICT 1 ALBUQUERQUE, N.M. — DEC 12 AM 10 18

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ___
Address ___
Plugging Method ___
Date Well Plugged ___
Plugging approved by: ___
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ___ FWL ___ FSL ___

File No. B-1004 ___ Use ___ Location No. 11n10w3.111 (Cibola)

954

11 N 10W Sec 3 NW NW NW

Sec■ LOG OF HOLE

Well Log 954

Depth in Feet From	To	Thickness in Feet	Color and Type of Material Encountered
0	20	20	silt & sand
20	35	15	tan shale
35	48	13	malapia
48	70	22	tan shale
70	75	5	coarse sand
75	85	10	tan shale
85	96	11	loose coarse sand & silt
96	225	129	blue & purple shale
225	230	5	white sandstone
230	250	20	gray shale & sandstone
250	270	20	red sandstone
270	285	15	grey & purple shale, frac. & caving
285	295	10	white sandstone
295	307	12	frac. yellow sandstone

Section 7. REMARKS AND ADDITIONAL INFORMATION

6545
225
6320

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

J. G[illegible]
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

TOTAL P.02

Well Log 955

STATE ENGINEER OFFICE

WELL RECORD

Prob 955

location of this well

La Sientra 955

Section 1. GENERAL INFORMATION

(A) Owner of well M. C. Guthrie BLK 1 LOT 21 Owner's Well No. ______
Street or Post Office Address Box 3499
City and State Milan, N.M. 87021

Well was drilled under Permit No. B-510 and is located in the:

a. ______ ¼ ______ ¼ SW ¼ SW ¼ of Section 34 Township 12N Range 10W N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in Valencia County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor Garner Drilling Co. License No. W D 595

Address Box 3146 Milan, N.M. 87021

Drilling Began 1-3-78 Completed 3-31-78 Type tools Rotary Size of hole 7 7/8 in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 498 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 97 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
420	498	78	yellow sandstone with fracs.	200+

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5 9/16	.188 wall	weld.	0	498	499	open	385	498

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

78 APR 12 PM 12:55

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received 4/12/78

Quad ______ FWL ______ FSL ______

File No. B-510 Use domestic Location No. 12N.10W.34.440(VAlencia

955 also 954 [illegible]

Well Log 955

Section 6. LOG OF HOLE

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		
0	40	40	tan shale & gravel mixed
40	80	40	red shale
80	120	40	blue limestone
120	230	110	re d shale
230	360	130	purple shale
360	380	20	blue lime
380	395	15	hard white sandstone
395	420	25	sandy yellow shale
420	498	78	hard yellow sandstone with fracs.
			6550

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office

Well Log 961

STATE ENGINEER OFFICE

WELL RECORD

961

Section 1. GENERAL INFORMATION

(A) Owner of well Charles Voight Owner's Well No. 1
Street or Post Office Address 720 Jefferson
City and State Grants, NM 87020

Well was drilled under Permit No. B-468 and is located in the:

a. ___ ¼ ___ ¼ NW ¼ NW ¼ of Section 2 Township 11N Range 10W N.M.P.M.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. ___ of Block No. ___ of the ___
Subdivision, recorded in ___ County.

d. X= ___ feet, Y= ___ feet, N.M. Coordinate System ___ Zone in
the ___ Grant.

(B) Drilling Contractor Rotary Drilling Inc. License No. WD-643

Address Box 129 Grants, NM 87020

Drilling Began 3-14-78 Completed 3-15-78 Type tools Rotary Size of hole 5 5/8 in.

Elevation of land surface or ___ at well is ___ ft. Total depth of well 240 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 90 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
200	240	40	Sandstone	30 gpm

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
4	160psi	PVC	0	240	240		200	240

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
	This was an existing well. Applicant wished to repair and deepen well.				

Section 5. PLUGGING RECORD

Plugging Contractor ___
Address ___
Plugging Method ___
Date Well Plugged ___
Plugging approved by:

___
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received March 29, 1978

Quad ___ FWL ___ FSL ___

File No. B-468 Use domestic Location No. 11N.10W.2.110(Valenc

961

Well Log 961

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
130	200	70	Shale
200	240	40	Sandstone

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplic preferably typew ten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, sh e answered as c pletely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a p g record, onl on 1) and Section 5 need be completed.

Form WR-23 STATE ENGINEER OFFICE

Region not listed

Well Log 962

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

962

Section 1

(Plat of 640 acres)

(A) Owner of well Winfred J. Grider

Street and Number Box 4075

City Grants State New Mexico

Well was drilled under Permit No. B-263 and is located in the ¼ ¼ SW ¼ of Section 2 Twp. 11N Rge. 10W

(B) Drilling Contractor Leroy Wilson License No. 473

Street and Number 4207 San Mateo Road

City Grants State New Mexico

Drilling was commenced 19

Drilling was completed 19

Elevation at top of casing in feet above sea level Total depth of well 238

State whether well is shallow or artesian shallow Depth to water upon completion 98

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	To	Thickness in Feet	Description of Water-Bearing Formation
1				
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received

File No. B-263 Use Dom. [illegible] Location No. 11N [illegible]

962

Well Log 962

Water well for Winifred J. [illegible]
Top soil 0 - 5 feet
layers of hard pan about 2 to 3' [illegible] to about 70'
some sand, gravel mixed in to 70. top soil
about 50% sand & gravel 70 to 78 with clay.
Water at 78 feet. about 1 gallon to 1 gallon & 1 quart per min.
Shen Lee 78 to 115
Gray clay & rock 115 - 138
Brown clay - 138 to 145
Gray clay 145 - 175
Brown clay & shale 175 - 195
shen lee to 195 - 225
sand stone ledge 225 - 230
Gray clay-shale 230 - 238
water at 225 - raized to 98 feet from top.
bailed about 40 gallons per min. drawn down about
40 feet. bailed for about 1 1/2 hour and no sand noticed
Well is cased to about 220 with 6 5/8 O.D. new Pipe
.188 wall

Gary Wilson - Driller

Well Log 964

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

964

Section 1. GENERAL INFORMATION

(A) Owner of well WILSONS DOBBS JR. Owner's Well No. ______
Street or Post Office Address 6060 SAN MATEO RD
City and State GRANTS, N M 87020

Well was drilled under Permit No. B - 772 and is located in the:

a. ____ ¼ SE ¼ NW ¼ SE ¼ of Section 3 Township 11N Range 10 W N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in ______ County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor ROTARY Drilling License No. WD-463

Address Box 129 Grants, NM 87020

Drilling Began 2-25-80 Completed 2-26-80 Type tools ROTARY Size of hole 6½ in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 200 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 121 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
170	195	5	BROKEN SANDSTONE	8

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
4	160 PSI	PVC # 2						
			+2	200	202		170	200

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
10	20	6		SACK	POURED

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

964

Date Received 2/25/80

Quad ______ FWL ______ FSL ______

File No. B-772 Use domestic Location No. SE¼NW¼SE¼ 3-11N-10W

From	To	in Feet	
0	10	10	
10	103		
103	145		
145	168		

Well Log 964

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, sh[illegible] be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as [illegible]ing record, only Section 1(a) and Section 5 need be completed.

Well Log 965

STATE ENGINEER OFFICE

WELL RECORD

965

Section 1. GENERAL INFORMATION

(A) Owner of well Wilbert Wharton Owner's Well No. 1
Street or Post Office Address Box 2735
City and State Milan, New Mexico

Well was drilled under Permit No. B-359 and is located in the:

a. ____ ¼ ____ ¼ E½ ¼ ____ ¼ of Section 3 Township 11N Range 10W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Carl Webster License No. WD 654

Address Gen. Del. Milan, New Mexico 87021

Drilling Began May 7-1977 Completed May 8, 1977 Type tools Rock bit & Reamer Size of hole 7 3/8 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 200' ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 70' ~~150'~~ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
0	20'	20'	Topsoil	0
20'	100'	80'	Clay	0
100'	130'	30'	Limestone	0
130'	200'	70'	Gravel	15 GPM

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
6"	24	welded	0'	140'	140	Steel	120'	140'
4"	½ lb	Joined	0'	200'	200	Set	130	200'

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				
0'	200'	7 3/8	0	0	Air & Soap.

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received June 22, 1977

965

Quad ____ FWL ____ FSL ____

File No. B-359 Use Domestic Location No. 11N10W.3.000

Section LOG ...

Well Log 965

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Carl Webster
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Well Log 982

Welsch

STATE ENGINEER OFFICE

WELL RECORD

982
1

Section 1. GENERAL INFORMATION

(A) Owner of well: Michael O'Leary   Owner's Well No. 1

Street or Post Office Address: 329 W. Santa Fe

City and State: Grants N. M. 87020

Well was drilled under Permit No. B 701 and is located in the:

a. ___ ¼ ___ ¼ ___ ¼ ___ ¼ of Section ___ Township ___ Range ___ N.M.P.M.

b. Tract No. ___ of Map No. ___ of the ___

c. Lot No. 1 of Block No. 3 of the Walle Verde Estates Subdivision, recorded in Valencia County.

d. X= ___ feet, Y= ___ feet, N.M. Coordinate System ___ Zone in the ___ Grant.

(B) Drilling Contractor: Jimmie Saunders   License No. WD 804

Address: P.O. Box 3081 Milan N.M 87021

Drilling Began 7-20-79 Completed 7-20-79 Type tools Rotory Size of hole 8 in.

Elevation of land surface or ___ at well is ___ ft. Total depth of well 110' ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 60' ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
90	105	15	Sand + Gravel	60

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
5 9/16	Plastic		0	110	110		90	105

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ___

Address ___

Plugging Method ___

Date Well Plugged ___

Plugging approved by: ___

79 JUL 23 AM 8:48

State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received July 23, 1979

982

Quad ___ FWL ___ FSL ___

File No. B-701 Use Domestic Location No. Lot 1, Bk 3, ~~Valle Verde~~

Well Log 982

Section 6. LOG OF HOLE

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		
0	60	60	Shale + SAND
60	85	25	SAND + Gravel
85	90	5	shale
95	105	15	SAND + Gravel
105	110	5	Red shale

Section 7. REMARKS AND ADDITIONAL INFORMATION

Well was Gravel Packed

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

J. R. Saunders
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office

Appendix C

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill

APPENDIX C1
REPORT TEXT

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill

Grants Operation

License No. SUA-1471

November 1995

Prepared for:

Homestake Mining Company of California
Grants Operations
P. O. Box 98
Grants, NM 87020

Prepared By:

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, NM 87111

W/OVERSIZED

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill

Grants Operation

License No. SUA-1471

November 1995

Prepared for:

Homestake Mining Company of California
Grants Operations
P. O. Box 98
Grants, NM 87020

Prepared By:

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, NM 87111

Completion Report for Reclamation of Off-Pile Areas
at the Homestake Mining Company Uranium Mill

Grants Operation

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company Uranium Mill

Grants Operation

1. Introduction

Homestake Mining Company of California (HMC), owner of the uranium mill near Grants, New Mexico, has completed the reclamation of the off-pile areas in compliance with the NRC-approved Reclamation Plan (HMC, 1993a) and the Radioactive Materials License Conditions (SUA-1471). The uranium mill facilities were decommissioned in 1994 and 1995 according to the Decommissioning Plan, as approved by the NRC as License Condition No. 29. Byproduct contaminated asbestos containing material was placed in the Large Tailings Pile. Mill debris containing process residues or yellowcake contamination was placed in the Large Tailings Pile. Structures and other less contaminated debris were placed in pits on the east and south side of the Large Tailings Pile. Mill site surface soils containing the majority of the radiological source term were removed and placed on the tailings pile. A clean soil cover was then placed over the entire 50-acre mill site. A report on the decommissioning of the mill and reclamation of the mill site is currently being prepared for submittal to the NRC (HMC, 1995a).

The cleanup of the windblown contaminated soils began early in 1988. A February 16, 1989 plan approved by the NRC as License Condition No. 19 committed HMC to remediate certain areas near the tailings piles that exceeded the 10.5 pCi/g cleanup criteria for Ra-226. After the mill decommissioning was complete, cleanup of the windblown contamination and other off-pile contaminated materials resumed in 1993 using cleanup criteria and verification procedures specified in License Condition 29C. Areas that were to be covered with clean materials were verified according to the NRC-approved procedure applicable at the time. Cleanup continued throughout 1994 and 1995 with the final verification completed on September 20, 1995. A new verification plan was approved by the NRC on March 1, 1995 and used for the verification of cleanup for the major portion of the decontaminated areas.

Figure 1-1 shows the Mill Site and Tailings Features as they currently exist. The Large Tailings Pile currently has radon barrier and an erosion protection layer placed on the side slopes according to the NRC-approved reclamation plan. The top of the pile currently has an interim cover and is awaiting final settlement before radon barrier placement. Evaporation Pond No. 1 was built on the small tailings pile. The new Evaporation Pond No. 2 was constructed in the spring of 1995.

Areas of the site currently used for activities associated with the groundwater restoration project include the collection ponds and evaporation ponds. Evaporation Pond No. 2 was placed on an area that had been decontaminated to meet the cleanup criteria. This pond along with the older collection ponds and Evaporation No. 1 will be decommissioned after the groundwater restoration project has been completed. All liners and contaminated residues and soils will be placed in Evaporation Pond No. 1 on the small tailings pile. Upon decommissioning, these off-

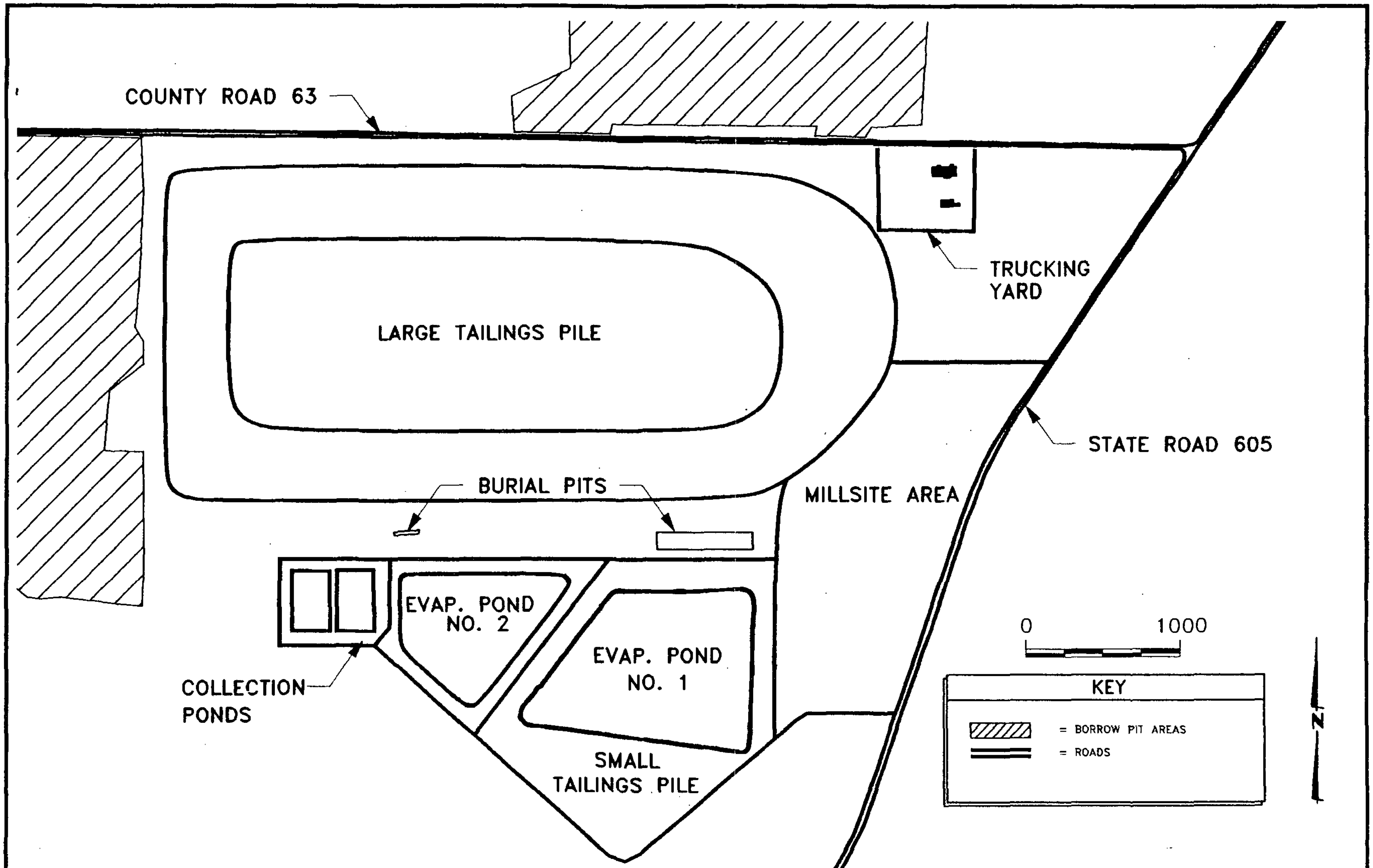


Figure 1-1 Homestake Mining Company Millsite-Current Grants Operations Site Facility

Prepared By:
Anderson Engineering Co., Inc.
10-19-95 FIG1-1B.DWG

pile areas will be resurveyed and verified as meeting the soil cleanup criteria. The Small Tailings Pile will then be reclaimed according to 10 CFR Part 40, Appendix A.

Other areas shown on the map that do not require verification are the borrow areas where several feet of borrow material have recently been removed. Prior to removal, some decontamination of the surface layer occurred by removal and placement on the top of the tailings pile. Surface soil samples were taken to assure that the area was suitable as a borrow source for radon barrier material. The characterization data are presented in Section 5.0. Additional confirmation that the borrow material was not contaminated with windblown tailings was presented in Table 3-1 of the report, Final Radon Barrier Design for the Large Tailings Pile (HMC, 1995b).

This report consolidates all data taken over the three-year reclamation period to demonstrate that the areas have been decontaminated to the 10 CFR Part 40, Appendix A criteria. During the reclamation period, new technology became available that enabled site characterization and verification data to be obtained in a much more accurate and less costly manner than had been used previously. Verification plans were developed based on this technology and approved by the NRC. For work completed prior to the new technology, the areas were verified using the plan that was approved at that time. Therefore this report includes data for areas verified using the two different verification methods.

2. Cleanup Criteria

The soil cleanup criteria for the site are specified in 10 CFR Part 40, Appendix A, Criterion 6. The Ra-226 cleanup for land, averaged over 100 m^2, may not exceed the background concentrations by more than 5 pCi/g in the top 15-cm layer beneath the surface. For 15-cm layers more than 15 cm below the surface, the average Ra-226 concentration is limited to 15 pCi/g above natural background levels. For areas not meeting the soil cleanup limits, the radon emissions must be limited to 20 pCi/m^2s and the area must meet the criterion for longevity of stabilization.

The NRC-approved Ra-226 background concentration for the site is 5.5 pCi/g which was incorporated in the cleanup criteria in Amendment No. 15 of License SUA-1471. Therefore the cleanup criteria for the HMC site limits the Ra-226 concentration to 10.5 pCi/g and 20.5 pCi/g for the surface and subsurface 15-cm thick layers, respectively.

3. Verification Procedures

3.1 Verification Procedure Based on Soil Samples and Gamma Measurements at Grid Intersection Points

The verification procedure used in the initial verification activities was based on License Condition No. 39 of License Amendment No 15 (NRC, 1993). Two areas were identified as shown in Figure 3-1. Within the line shown in the figure, the verification plan called for soil samples to be collected at a minimum of every 50-meter grid point and gamma-ray measurements made at ground level at every 10-meter grid point. Outside the boundary, soil samples were to be collected at every 100-meter grid point with the gamma measurements made at every 10-meter grid point. This procedure was implemented for those areas verified prior to March 1, 1995 at which time the NRC approved a new procedure (NRC, 1995) based on the use of the Global Positioning System (GPS)-based radiological surveys and soil samples as discussed below. This was approved in License Amendment No. 20.

A slight modification to the procedure approved as License Amendment No. 15 was implemented for the road ways. The modification was necessary since the roadways were long narrow strips of land which did not lend themselves to the 50-meter grid for soil sampling. This modified procedure was approved for use in the roadways as a part of License Amendment No. 20.

The License Amendments and Procedures for verifying the off-pile areas are included as Appendix A.

3.2 Verification Procedure Using Global Positioning System-Based Gamma Surveys and Soil Samples

The Global Positioning System(GPS)-based radiological surveys generate high density gamma survey data with relative ease since the gamma data are recorded automatically every two seconds along with the corresponding location coordinates. Studies were done to correlate the gamma-ray count rate data to the Ra-226 concentration in soil. Action levels were developed based on the gamma data to indicate where additional cleanup was required. After all cleanup was completed, the area was resurveyed according to the following procedure approved for use by the NRC (NRC, 1995).

Two zones were considered for soil verification purposes with different approaches taken for each zone. The inner zone encompasses the area in the immediate vicinity of the large and small tailings piles and mill site as shown in Figure 3-2. All surface soil within the inner zone excluding the tailings piles, the two debris disposal pits, and the mill site are included in the inner zone. All areas noted as excluded have or will be covered with fill or radon barrier as indicated in the NRC-approved Reclamation Plan. This inner zone has a higher probability of the existence of localized contaminated areas and is also influenced by gamma-ray shine from the small tailings pile. The outer zone includes all of the area outside of the inner zone that has

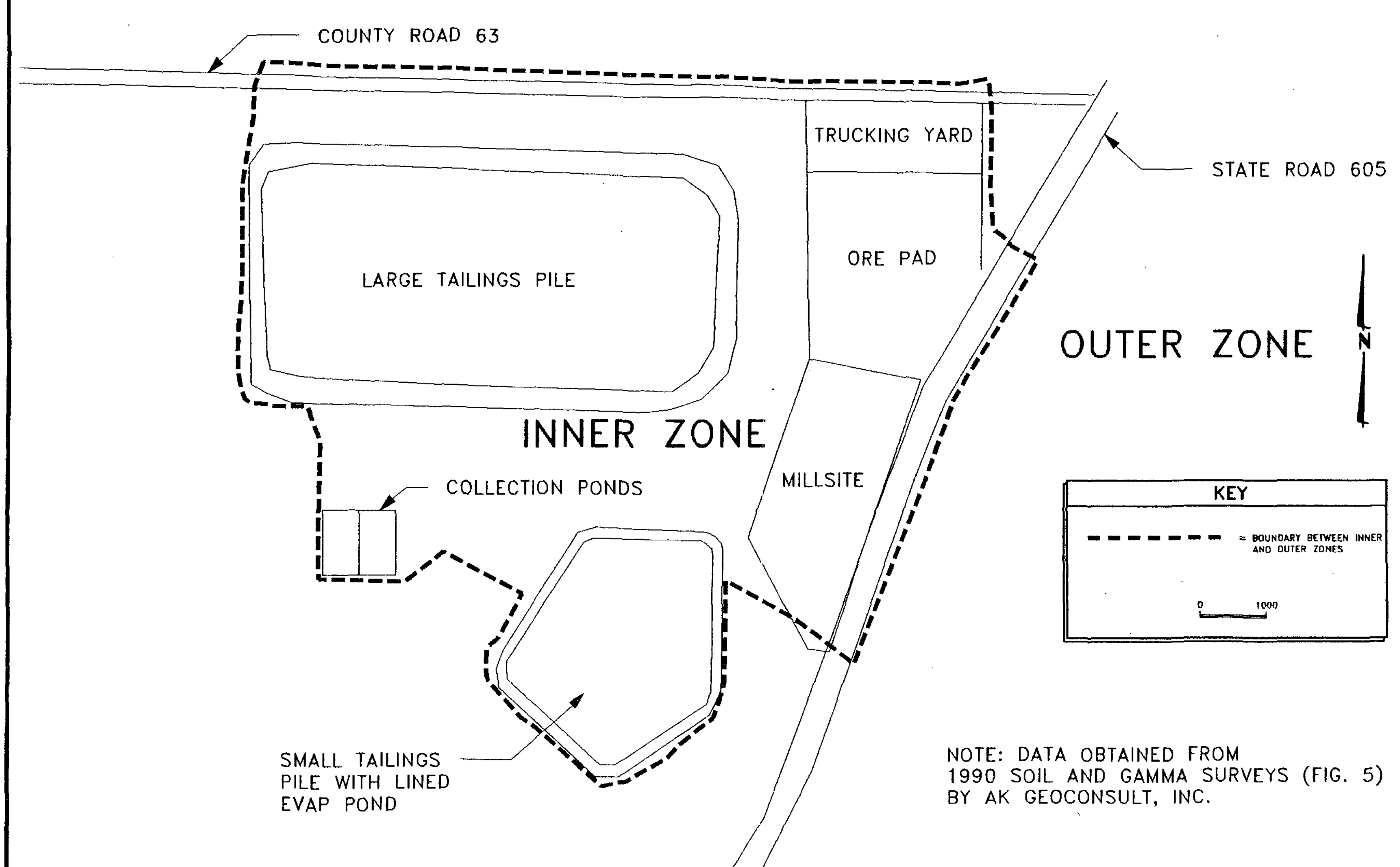


Figure 3-1 Site Map Showing Inner And Outer Zones For Verification Done Prior To March 1, 1995

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG3-1B.DWG

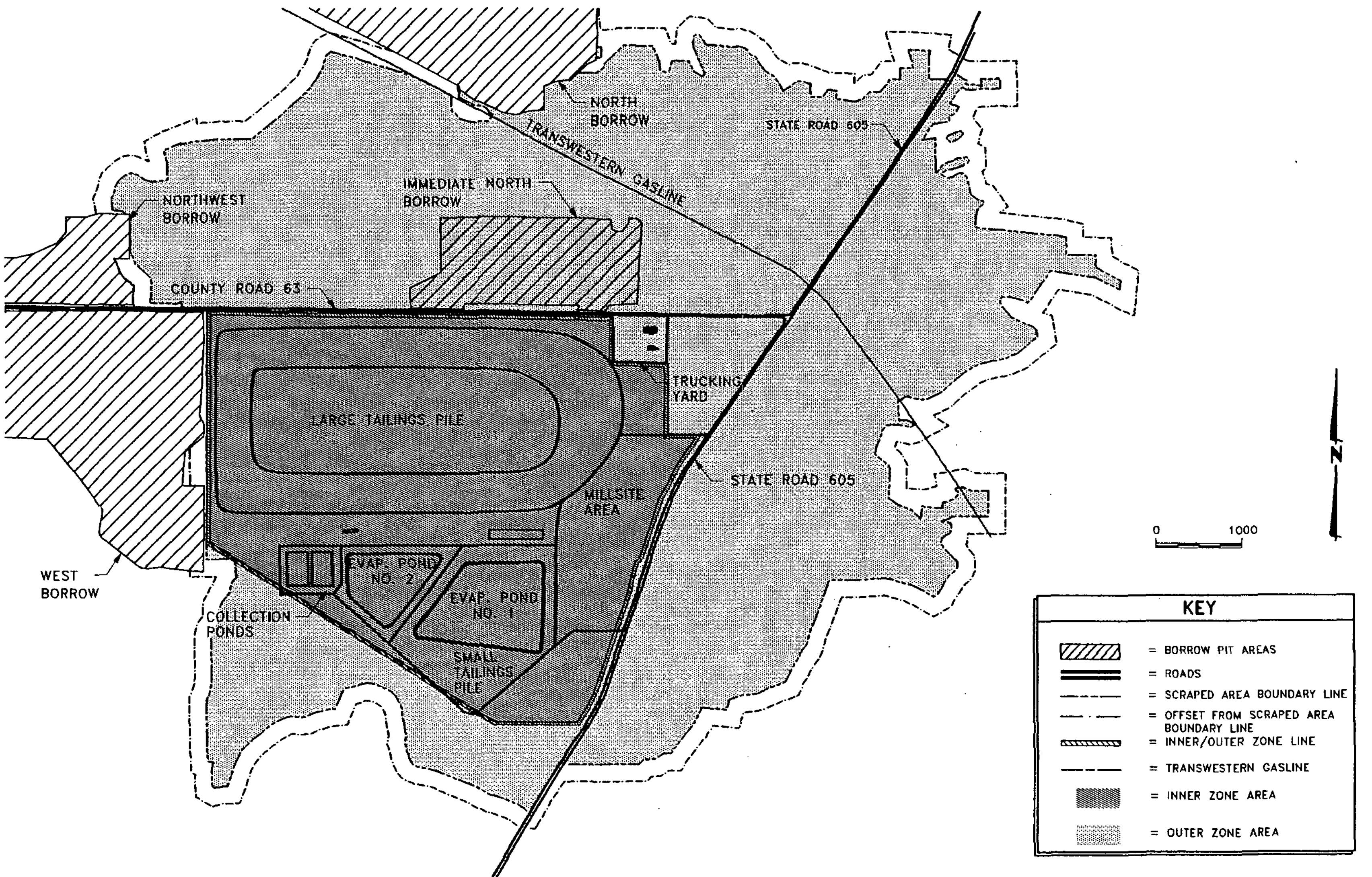


Figure 3-2 Site Map Showing The Inner And Outer Zones For Verification Done After March 1, 1995

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG3-2.DWG

been affected by windblown tailings or ore dust. The outer zone is more homogeneous in that the characteristic size of contaminated areas was normally hundreds of meters across. Because of the difference in the two zones, individual verification plans were prepared for each zone.

For the inner zone, a GPS-based gamma survey was conducted to assure that all 100-m^2 areas had an average count rate of less than 28,000 cpm. If gamma shine from the uncovered small tailings pile did not allow removal to the 28,000 cpm action level to be achieved, the entire area above 28,000 cpm was divided into 100-m^2 grids and sampled using a five point composite sample and analyzed for Ra-226. All other areas were divided into 500-ft grids. The gamma survey map was used to identify the 100-m^2 grid block within each 500-ft by 500-ft grid having the highest average gamma count rate. A five point composite sample was prepared for each grid block by taking 6-inch deep surface samples. The NRC-approved procedure provided for areas exceeding the 10.5 pCi/g Ra-226 cleanup criterion to be further excavated and a new gamma survey done. If any sampled area required additional decontamination, the second highest area within the grid block was to have been sampled and evaluated. This procedure was to have been followed until it was evident that the entire 500-ft grid block meets the cleanup criterion of 10.5 pCi/g.

For the outer zone, beginning at the closest point near the northwest corner of the Large Tailings Pile (but within the outer zone), 500-ft grids were established in an easterly direction extending to the State Highway 605. All areas had been cleaned so that the average gamma reading for any area of 100-m^2 size was 21,000 cpm or less. The 100-m^2 grid block within each 500-ft by 500-ft grid block having the highest average gamma reading was sampled and analyzed for Ra-226. A five-point composite sample was prepared from each of 30 five hundred-ft grids from the north side of the Large Tailings Pile. An additional 10 grids were sampled in a similar manner from each of the areas in the southerly direction and easterly direction at the boundary of the inner zone and outer zone.

A statistical test was specified to determine whether the mean concentration of the 50 grid blocks is 10.5 pCi/g or less at the 95 per cent confidence level using equation 8-13 of NUREG/CR-5849. Since this represents the mean of a set of 50 biased samples (selected from the grid that has the highest gamma exposure rate), the passing of this test provides assurance that the error rate is very low for the entire sample set made up of all the possible grids that could have been sampled.

If any sample was found to exceed the 10.5 pCi/g limit, the area was to have been recleaned and a new gamma survey done. For any grid block that failed the 10.5 pCi/g criterion, the 100 m^2 grid block with the second highest average gamma reading was to have been sampled and analyzed in a similar manner. This procedure was to have been followed until it was evident that there is a high probability that all portions of the grid block meets the cleanup criteria.

If the data passed the statistical test (equation 8-13 of NUREG/CR-5849), HMC was allowed to establish 1000-ft grids for the remaining portion of the outer zone. The 100-m^2 grid block having the highest average count rate within each 1000-ft grid was then sampled and analyzed

for Ra-226 in a manner as described above. Equation 8-13 of NUREG/CR-5849 was used for this set of samples to demonstrate compliance with the desire to clean all grid blocks to meet the 10.5 pCi/g cleanup criterion with a low error rate.

The test provided for the situation where if the mean of the samples is less than the 10.5 pCi/g criterion but the data fails the statistical test, HMC would follow procedures similar to those recommended in Section 8.6 of NUREG/CR-5849. The number of samples would have been increased to include the grids with the second highest average gamma levels and again perform the statistical test. This could have been done until the statistical test is met. In any case, all grid blocks that were sampled and measured to exceed the 10.5 pCi/g were to have been recleaned and resurveyed.

If the statistical test for the samples from the highest samples within the 1000-ft grid blocks would have failed, HMC would have established 500-ft grids over the entire outer area and sampled the 100-m^2 grid block lying to the northeast of each 500-ft grid line intersection. The northeast grid was proposed to assure that no bias was factored into the sampling strategy.

The gamma-ray count rate from the GPS-based radiological survey equipment is recorded once every 2 seconds and represents an average count rate over the field of view of the detector (placed 18 inches above the ground surface). The fact that the detector is moving slowly along the traverses also indicates that the count rate is influenced by the count rate behind the moving system. Therefore, each number represents an average over an area with dimensions of approximately 3 meters by 2 meters, or approximately 6 square meters. In order to obtain a good estimate of the mean gamma count rate for a large area, fewer measurements are required compared to point measurements since each number represents an average over a rather large area.

The density of measurements within any 100 m^2 grid block averaged between 8 and 9. However the uniformity of data depends on operator skill and topography. In some cases, areas on maps may have as few as 5 or 6 records. Homestake reviewed all data maps and where the density was considered too low to assure a good average gamma level, additional data were obtained and added to the data base. For the outer zone where gamma levels are uniform and slowly varying, as few as 5 records were considered adequate; for the inner zone where the characteristic size of contaminated areas may be smaller, a minimum of 7 records per 100 m^2 was considered adequate.

The verification procedure has been included in Appendix A.

4.0 Site Coordinate Systems

The major coordinate system used by HMC for the site is expressed in State Plane Coordinates. However, in the expression of sampling points and grids it is normally desirable to adopt naming conventions for points and grid blocks. During the initial cleanups and verification where the verification plan was based on the soil samples taken at grid intersection points as described in Section 3.1, the nomenclature shown in Figure 4-1 was used to reference points. Three points were established, A, B, and C as shown. The numerical increments to the north, south, east, and west represent 300 feet. A point directly north of point "C" at a distance of 300 ft is labeled CN1.0. Each 300 feet segment is divided into 100 feet segments. A point 100 feet north of point CN1.0 is CN1.1, a point 200 feet north of CN1.0 is CN1.2, and a point 300 feet north of CN1.0 is CN2.0. Similarly, points in the three other directions are similarly referenced and may be referenced relative to point A, B, and C. The only exception to this is CW7.0, CW8.0, and CW9.0 which lie on even increments of 100 feet from point C as shown in Figure 4-1 but do not follow the 300-ft unit convention described above. The only place that these references were used, however, is in the cleanup of the mill site which is not addressed in this report. Points off the principal axes are referenced using the conventional (x,y) coordinate nomenclature, where x and y are defined above.

The coordinate labeling convention described above was not used for the areas where the GPS radiological surveys were performed. For ease in computerized data management, the state plane coordinates were used for all gamma data recorded. All grid blocks were referenced by the coordinates of the northwest corner, regardless of size. Grid blocks were named according to the convention shown in Figure 4-2. Major grid lines one thousand feet apart were created from north to south and east to west across the site corresponding to thousand feet increments of state plane coordinate system grid spacing. The East-West rows were labeled from A to L while the North-South columns were labeled from 1 to 15. Each 1000-ft by 1000-ft grid block is named by its row and column position such as E02. If the major grid block as shown in Figure 4-2 is E02, then it can be seen that E02 is divided into four 500-ft square grid blocks, E021, E022, E023, and E024. These 500-ft grid blocks are further divided into 100-ft square grid blocks as seen in the figure. Reference to these 100-ft grid blocks shown in the figure would be E02401, E02402,... E02425. Further subdividing into the 33.3-ft square grid blocks would be done by adding the respective number of the 33.3-ft square grid block as given in the figure. The use of 33.3-ft grid blocks for verification was used since the area is approximately 100 m^2 which relates to the cleanup criteria which averages the Ra-226 and gamma count rate over areas of 100 m^2.

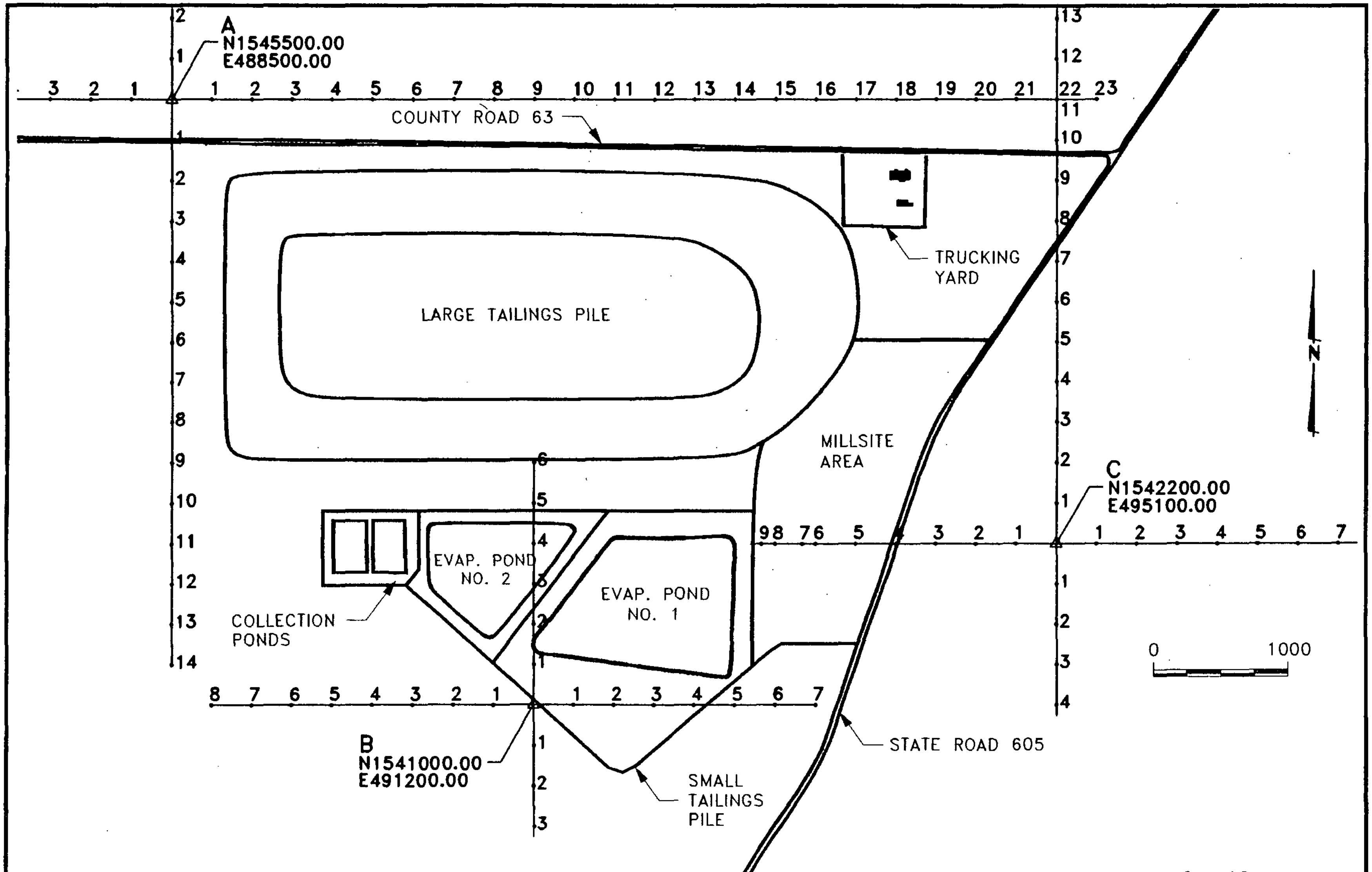


Figure 4–1 Point Nomenclature For Verification Measurements Made Prior To March 1, 1995

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG4-1.DWG

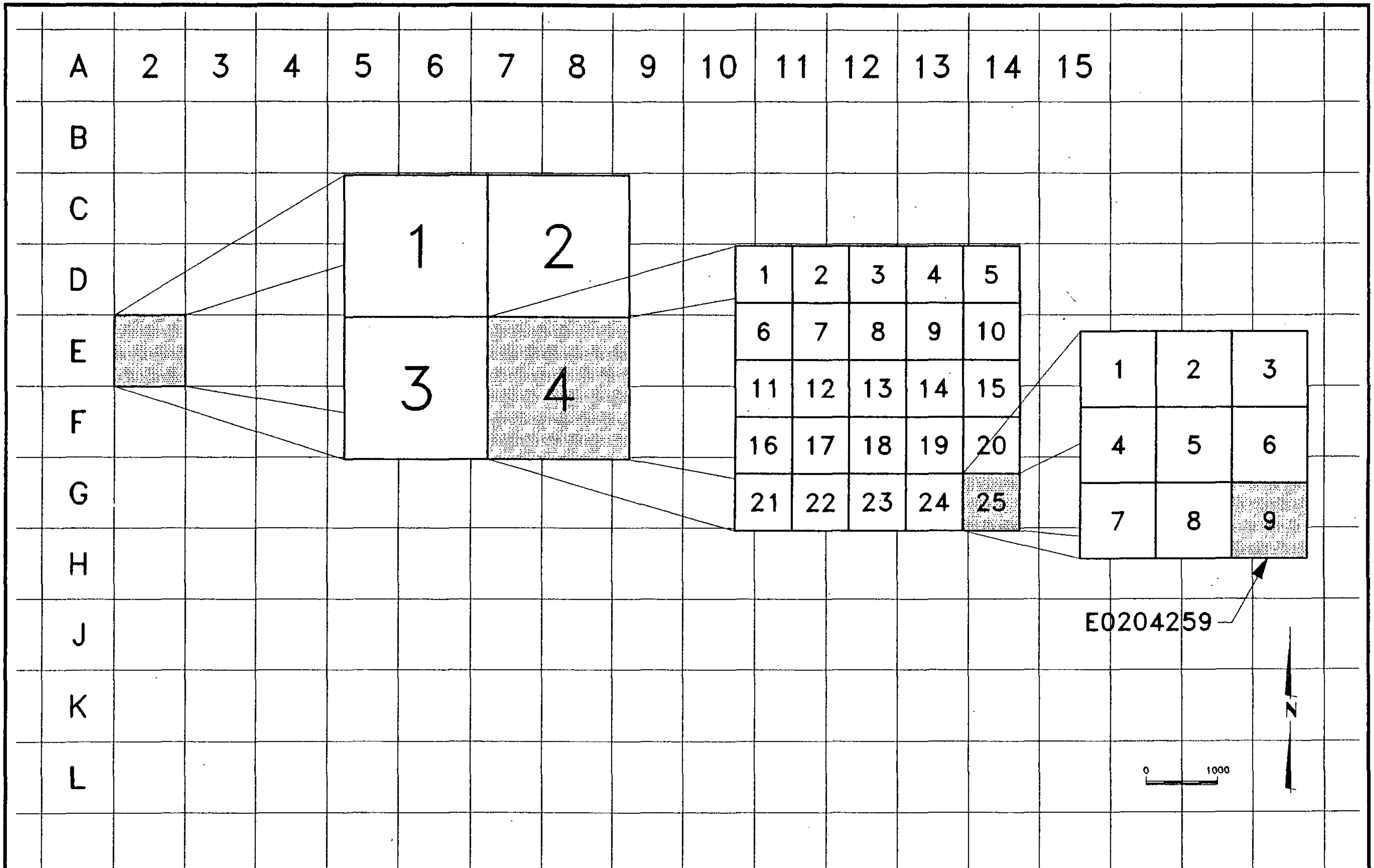


Figure 4-2 Grid Block Nomenclature For Areas Sampled After March 1, 1995

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG4-2.DWG

5.0 Characterization of Areas to be Used for Material Borrow

The areas used for borrow material are shown in Figure 3-2. The North, Northwest, and West Borrow Areas are located primarily out of the influence of windblown tailings from the pile as can be observed from the contamination zone boundary also shown in Figure 3-2. A comprehensive borrow area study was conducted to identify borrow sources near the site (HMC, 1994). Twenty-one soil samples randomly selected from the North Borrow Area showed near or below normal background values for the site. The Northwest Borrow Area was sampled on February 21, February 23, and March 8-9, 1994 by taking 0-6 inch deep and 6-12 inch deep samples at 34 locations on a grid of 300 feet. All results were at background levels. The data and sampling locations are provided in Appendix B.

The West Borrow Area was sampled on March 5, 1993, February 17, 1994, and March 8-9, 1994 by taking 110 samples up to depths of six feet. All samples taken met the cleanup criteria with the highest sample having 6.28 pCi/g Ra-226. The data and a map showing the sampling locations are provided in Appendix D.

The development of the Immediate North Borrow Area was done in May-June 1994. Prior to the use of the area, the top surface layer was removed and placed on the large tailings pile. Soil samples were taken to confirm that the area had been decontaminated. The results of 86 soil samples were taken which averaged 3.6 pCi/g. In reviewing the data, a few samples were reported as above the 10.5 pCi/g criterion for unrestricted release. While HMC staff believe that these areas were further remediated, no documentation could be found. The material was then used as radon barrier on the West and North Side Slope of the Large Tailings Pile. Characterization data for the Immediate North Borrow Area is provided in Appendix B.

As indicated in earlier, the borrow material from all of these areas, with the exception of the North Borrow Area, was used as interim cover on the top and side slopes of the Large Tailings Pile and for radon barrier on the North, West, and South side slopes. These materials were sampled after placement on the Large Tailings Pile (see Table 3-1 of HMC, 1995) and found to have background levels of Ra-226. The North Borrow material has been used for the radon barrier on the east side slope, aprons of the north and south side slope, and will be used for radon barrier on the top of the Large Tailings Pile.

Since the tailings on the Large Tailings Pile have been covered, there is no potential for the areas used for borrow to have become contaminated by windblown tailings. Therefore no verification measurements were required for the borrow areas.

6.0 Verification of Soil Cleanup

The verification measurements were done under two different sets of NRC-approved procedures using the two different conventions for labeling sampling points. The verification procedures and grid-naming and point-location conventions have been discussed in Section 3 and Section 4.

6.1 Areas Verified Using Procedures Based on Grid Intersection Sampling and Gamma Measurements

Areas verified using this procedure consist of a few areas that were verified prior to the revision to the Verification Plan approved by the NRC on March 1, 1995. These areas include the Trucking Yard, areas immediately adjacent to the toe of the large tailings pile, county road removal, State Road 605 right-of-way, and other areas where it was desirable to decontaminate and verify early in the reclamation period. The data for these areas are presented below.

6.1.1 Trucking Yard Area

The area known as the Trucking Yard Area shown in Figure 1-1 was decontaminated and verified in preparation for further use in managing the decommissioning of the site. After the contaminated soil was removed, thirty-one soil samples were taken and analyzed. All sample results were below the Ra-226 cleanup criterion with the maximum measured value of 6.9 pCi/g. Because of the high shine from the large tailings pile, no gamma readings were recorded. The data are presented in Appendix C along with a map showing the location of the Trucking Yard Area. In reviewing the data, no soil samples were taken from an small area near the southwest corner of the parcel. This was the location of the fuel area which was later excavated to a significant depth to remove fuel contaminated soils.

While no additional soil samples were taken, a radiological survey was done on all accessible areas of the Trucking Yard area using the GPS-based radiological survey equipment. This survey was done after the Large Tailings Pile had been covered and therefore was not influenced by gamma shine from the pile. An isocontour map is included as Figure C-1 in Appendix C which shows that the gamma-ray count rates in the area that was not sampled meets the gamma-ray action levels for the outer perimeter. The gamma map indicates elevated gamma count rates in other portions of the Trucking Yard. These levels were due to the shine from water processing equipment that was stored on the site. The soil sample results along with the gamma survey date provide reasonable assurance that the area meets the cleanup criteria. Clean soil was applied to the area which was then used for management of the remedial construction activities.

6.1.2 North Toe Area

The north toe of the Large Tailings Pile lies within a few yards of the County Road

63 right of way. To assure that this narrow strip of land meets the cleanup criteria, a line along the strip was sampled at 100-ft intervals, with the sampling points identified by the site control point "A". A total of 44 samples were taken on February 24, 1994 and analyzed for Ra-226. None of the samples exceeded the 10.5 pCi/g Ra-226 criterion with the exception of samples No. 4634 and No. 4646. These samples were reported to have Ra-226 concentrations of 27.65 and 11.5 pCi/g, respectively. All samples were sent to a vendor laboratory for Ra-226 analysis and U-nat analysis. The Ra-226 analyses agreed well with the analyses of the HMC on-site laboratory. The uranium concentrations on the samples taken near the northeastern corner of the Large Tailings Pile were elevated in uranium, probably as a result of precipitate from water seepage from the Large tailings Pile. The aprons were added to the pile in part to cover this contamination that extended to several feet beneath the surface. The data for the North Toe area is included in Appendix D.

6.1.3 West Toe Area

One hundred ten samples were taken on February 17, 1994, March 5, 1993, and March 8-9, 1994 to demonstrate that the area west of the Large Tailings Pile was free of contamination, including the area later to be known as the West Borrow Area. Locations of these samples were identified using Control Point A of the site coordinate system. The data are presented in Appendix D.

Soil samples were taken at depths up to six feet deep in the area to be used as borrow. Samples were taken down to 12 inches near the West Toe of the Large Tailings Pile. All samples taken met the cleanup criteria with the highest measured concentration being 6.28 pCi/g Ra-226. Because of the high gamma shine from the pile, no gamma measurements were documented.

6.1.4 Ore Spillage Area Near the North Ore Storage Pad

During the cleanup of the north ore storage pad, the area contiguous to the ore pad had become contaminated with ore and windblown tailings. As a part of decommissioning the ore pad, the surface soils were removed and consolidated with the tailings. This area lies north of mill site between the mill site and the Trucking Yard Area.

Confirmation 6-inch deep soil samples were taken using the site control point coordinate system using control point "C". The soil samples were taken on March 8-9, 1994, February 21, 1994, and February 23, 1994. The laboratory results are included in Appendix E where the sampling locations are shown on a map that is enclosed. Thirty five sampling locations representing a grid spacing of 100 feet are shown on the map. Forty-seven soil sample results are provided in the table, with 12 being duplicate samples. Only one sample was measured above 10.5 pCi/g (13.52 pCi/g). However, another sample reportedly taken at the same location was reported

as 3.33 pCi/g. This may have been a second sampling after the area had additional material removed. Five QA samples submitted to Eberline Laboratory indicated agreement that the Ra-226 concentrations were below 10.5 pCi/g. The U-nat concentrations were also measured and were below 35 pCi/g, a value normally accepted for unrestricted release of property. Splits of these samples were also analyzed by Energy Laboratory with similar results for Ra-226. However, the U-nat concentration for one of the samples was measured at 69 pCi/g.

After the area was verified as clean, approximately two feet of clean borrow material was placed on the area to restore it to the initial grade. Because of the gamma shine from the Large Tailings Pile, no gamma measurements were documented.

6.2 Verification of Road Right of Ways

The cleanup of the State and County roads was done under agreements where backfilling excavated areas was required prior to obtaining the final radiological assay results. Soils on both sides of State Highway 605 were removed where the contamination could or was known to have arisen from site operations. This included the impact from windblown tailings as well as the two ore storage pads. However, a decision was made to limit the distance from the mill site at which the cleanup would be done since most of the roads in this region have uranium ore spillage from the transport of ore. Characterization data are presented that demonstrate that the contamination along State Highway 605 north of the mill site arises from ore spillage and therefore is not the responsibility of HMC. All data for the road ways is included in Appendix F.

6.2.1 Verification of State Highway 605 Right of Way along Mill Site

The verification of the State Highway 605 right of way along the mill site was done using the NRC-approved verification procedure included in Appendix A. Stations were surveyed at 25-ft intervals along each side of the road extending from the County Road 63 intersection to the entrance to Hamilton Construction south of mill site. The width of the right of way was variable, extending to the fence line in both directions. Gamma-ray measurements were made by walking within the 25-ft interval along each side of the road and recording the readings for each interval. After being convinced that the area met the gamma-ray action levels, soil samples were collected at approximately one-half the excavation width along each side of the road at 150-ft intervals. These samples were analyzed for Ra-226 using gamma-ray spectroscopy.

The excavation of tailings contaminated soils was done under an agreement with the State of New Mexico whereby HMC agreed to backfill the excavated area at the end of each day. This made it impossible to obtain soil sample results prior to placing backfill.

Two different gamma measurement instruments were used to guide the excavation and

to take the required gamma measurements. A Ludlum 2221 ratemeter/scaler and a Ludlum 44-10 NaI detector with a lead collimating shield was used with an action level of 10 kcpm. The second instrument was a Ludlum Model 3 ratemeter coupled to a shielded 44-2 NaI detector. The action level for this instrument was 10-12 μR/h. In both cases, an allowance for higher levels was made to correct for better geometry conditions when surveying deep excavations where side-wall shine increases the count rate significantly. The NRC reviewed and approved this procedure (NRC, 1995).

The gamma measurements are given in Table F-1 and show that all values were below the action levels of the instruments with the exception of a few. When levels exceeded the action levels, grab soil samples were taken and analyzed immediately using the HMC spectrometer. A safety factor of 1.5 was normally used to account for the disequilibrium of radon and its daughters with Ra-226. The elevated readings were normally attributable to geometry effects. If the soil samples showed levels that approached the cleanup limits, additional soil was removed.

A total of 78 soil samples were taken on July 28, August 1, 2, 8 and 11, 1994. The results of the soil samples are presented in Table F-2. The samples at stations 270, 446, and 547 were found to exceed 10.5 pCi/g. However the depth of excavation at these points was 3.1, 4.7, and 2.8 feet where the cleanup criterion is 20.5 pCi/g. Only the sample at station 446 exceeded the cleanup criterion (29.27 pCi/g). A review of the data suggest that the spectrometer operator made an error in recording a number by recording only 4 digits of a 5 digit number for a region of interest attributable to Th-232 decay. This results in an erroneously high Ra-226 concentration result rather that a result of approximately 6 pCi/g which is believed to be the actual value. The low gamma value for that area support the conclusion that the soil sample result is an anomaly.

The results of the Highway 605 right-of-way verification are presented in Appendix F.

6.2.2 Characterization of State Highway 605 Right of Way South of Hamilton Construction Company Entrance.

The area south of the entrance to Hamilton Construction Company entrance was done to assure that all contamination south of the mill site had been removed. Soil samples were taken from an additional 1600 feet of right of way. Stations were located by survey at 25-ft intervals and soil samples taken according in the same manner as specified in the verification plan.

The results of the soil sample analyses show that all samples were below the Ra-226 cleanup criterion of 10.5 pCi/g. Gamma readings were not documented. The Ra-226 concentration data are presented in Table F-3 of Appendix F.

6.2.3 Verification of County Road 63 Road Base

In June 1994, the rock and upper road base material was removed from County Road 63 along with right-of-way surface soils. The excavation began approximately 1000 feet west of the west end of the Large Tailings Pile and extended 7700 feet to State Highway 605. Soil samples (0-6 inch and 6-12 inch) were taken from the center of the road base at 100-ft intervals. Approximately two feet of road base material was then placed and the road immediately reconstructed prior to obtaining the sample results. Seven of the 154 soil samples exceeded the 10.5 pCi/g cleanup criterion for surface soils. Five of the elevated samples were taken from the excavated surface (0-6 inches) exceeded the 10.5 pCi/g cleanup criterion for the surface layer with a maximum Ra-226 concentration of 15.14 pCi/g. Only one sample exceeded the 20.5 pCi/g cleanup criterion for subsurface soils. The sample was taken at 6-12 inches beneath the excavated surface and was analyzed to have a Ra-226 concentration of 23.8 pCi/g and a U-nat concentration of 14.3 pCi/g. Since the 0-6 inch sample at that location had very low radioactivity, the 23.8 pCi/g probably represents the activity of a sample of the original road base material which commonly has a high uranium content in the area. The data are presented in Table F-4 of Appendix F.

HMC contends that the cleanup of the County Road 63 meets the intent of the standards since the 0-6 inch samples were taken below grade where the criterion is 20.5 pCi/g. The 23.8 pCi/g sample, because of the high uranium content, probably was taken from the original road base material.

No gamma exposure rate measurements were documented since the high gamma-ray shine from the uncovered north side slope of the Large Tailings Pile masked any radiation emitted from the road base at the time.

6.2.4 Characterization of Ore Spillage on State Highway 605 Right of Way North of County Road 93 Intersection.

Highway 605 was used to haul ore to the Homestake Mill and other mills in the area. Because the ore was hauled in open trucks, ore and ore dust is present in the soils along the roads throughout the region. This contamination has been found at significant depths due to regrading and ditching activities.

HMC decided to characterize the right of way north of the County Road 63 intersection to determine the character and depth of contamination. Samples were taken north of the intersection on both sides of the highway at approximately 150-feet intervals for approximately 2500 feet. Six-inch deep samples were taken to a total depth of 2 feet. The data showed that contaminated soils exceeding the Ra-226 cleanup criterion extended to 2 feet or more for much of the 2500 feet. No correlation with proximity to the HMC mill site is apparent.

The quality control samples that were split and sent to an outside laboratory were analyzed for Ra-226 and U-nat. As anticipated, the results of these twelve quality control samples showed that most of the Ra-226 activity in the samples could be attributed to uranium ore rather than tailings, especially since much of uranium would have been solubilized and transported away over the long period of time. Table F-5 and a map are included in Appendix F which provide the radiological data and sample locations.

HMC concluded that it was not their responsibility to decontaminate the right of way since the contamination did not result from HMC site operations.

6.3 Verification of Areas Using GPS-Based Radiological Survey Data and Soil Sampling Data

The GPS-based radiological survey data was down loaded into the AutoCADD computer application where site features, isocontours, and the state plane reference coordinates were shown on 24-in by 36-in maps. A set of 83 maps displaying this information is included as Appendix J. Isocontour lines at the action level of 21,000 cpm for the outer zone and 28,000 cpm for the inner zone are shown. Areas exceeding the action levels were either further decontaminated or the area was sampled to demonstrate compliance with the standard.

In order to implement the NRC-approved verification plan, it was necessary to evaluate each 33.3-ft by 33.3-ft grid block in order to determine that there were the required minimum number of gamma data points within the grid block, to determine the average gamma count rate within the grid block, and to identify those 33.3-ft by 33.3-ft grid blocks that exceeded the gamma action level of 21,000 cpm for the outer zone and 28,000 cpm for the inner zone. In addition, the location of the 33.3-ft by 33.3-ft grid blocks with the highest average count rates within the 500-ft by 500-ft (inner zone) and 1000-ft by 1000-ft (outer zone) were required for sampling purposes. This was accomplished by importing the data into a data base manager and sorting the data into the 33.3-ft by 33.3-ft grids. Note that each 500-ft by 500-ft grid block has 225 of the 33.3-ft by 33.3-ft grid blocks. For each 500-ft by 500-ft grid block, a summary sheet was created where the 33.3-ft grid block with the maximum average gamma was identified by name and location, the average gamma value, and the number of points that were available in calculating the average gamma count rate. In addition, those grid blocks having fewer than five data points for outer zone and fewer than seven data points for the inner zone were identified. Also all grids having average gamma count rates higher than the action level are listed. These GPS Data Sort Summary Sheets are included in Appendix I.

6.3.1 Verification of the Inner Zone

The verification of the portions of the inner zone (Figure 3-2) that were not previously discussed in Section 6-1 and Section 6-2 consist of areas to the south and east of the Large Tailings Piles. In some instances, there is overlap in the data due to the disturbance of an area from construction activities and the area was reverified or it

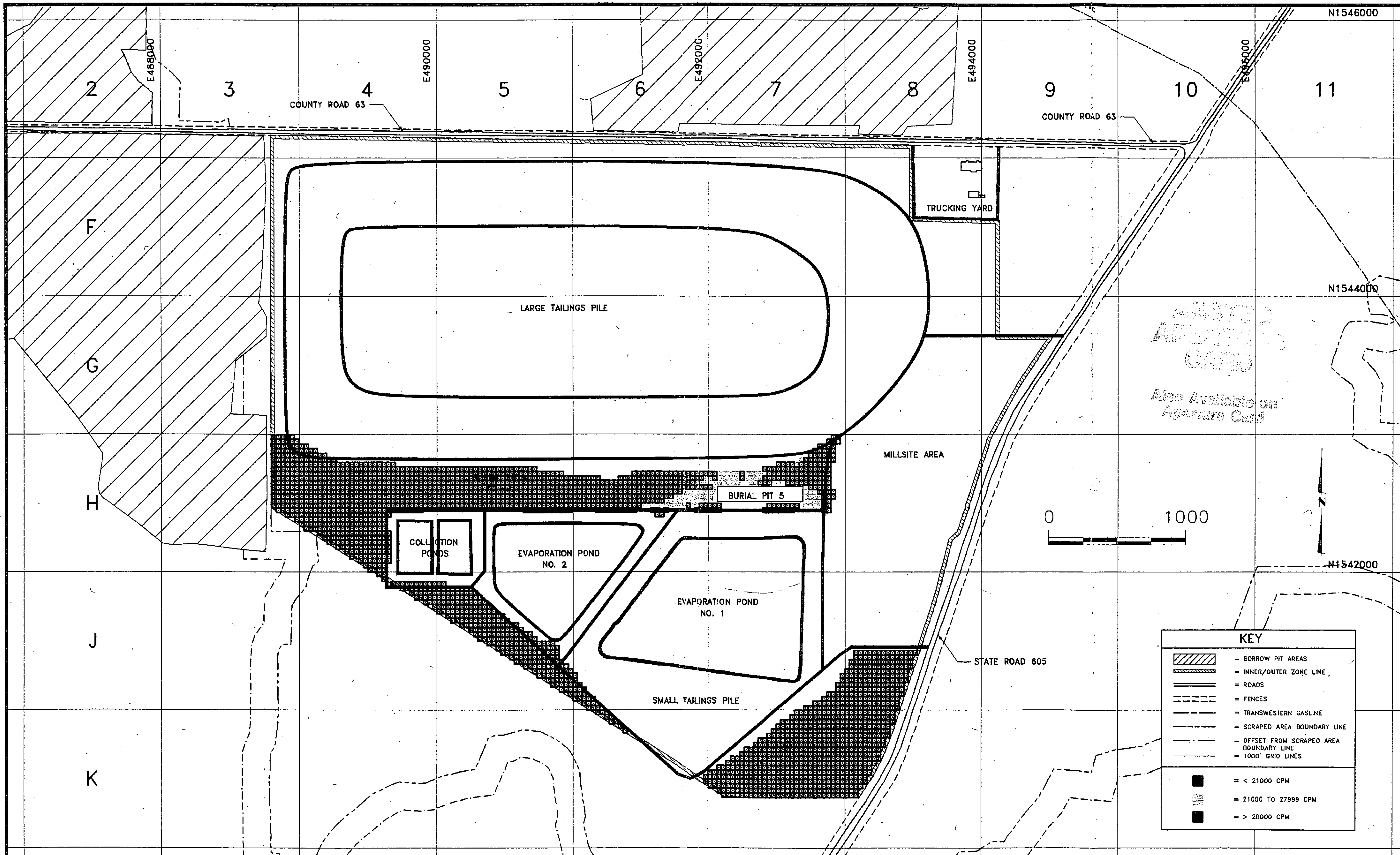


Figure 6-1 Average Gamma Count Rate For Grids In The Inner Zone

9512210244-01

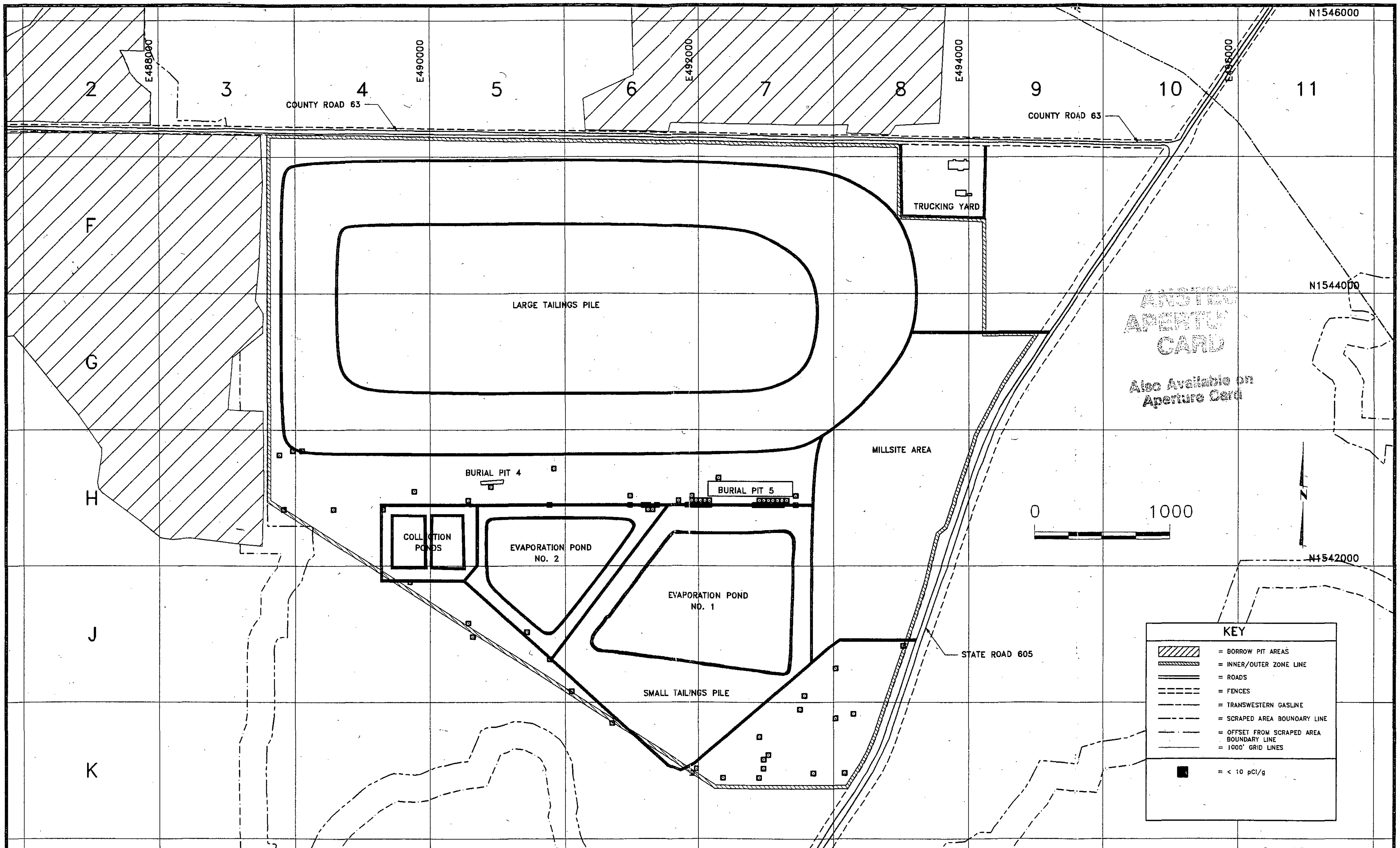


Figure 6-2 Ra-226 Concentration From Soil Samples Taken In The Inner Zone

9512210244-02

was unknown to the verification field crew that the area had already been verified using the previously approved verification method.

Areas within the Inner Zone that will not be verified at this time are the tailings piles, the areas where the evaporation ponds and collection ponds are placed, the Mill Site Area, and the two Debris Disposal Pits. The reclamation of the Mill Site and two Debris Disposal Pits is addressed in the Uranium Mill Decommissioning Report. Evaporation Pond No. 2 was constructed during the summer of 1995. The area on which the pond was constructed was decontaminated and verified. However, since the license condition requires that, upon decommissioning of the facility, the pond will be removed and the underlying area verified, these data are not presented in this report.

The gamma-ray data resulting from averaging the gamma-ray count rates for each 33.3-ft by 33.3-ft grid block is represented in Figure 6-1, where the colors indicate areas where the average gamma-ray count rate is above 28,000 cpm, between 21,000 cpm and 28,000 cpm, and below 21,000. All areas above 28,000 required soil samples since the shine from the area prevented verification based on gamma-ray count rate. For 500-ft by 500-ft grid blocks having no areas higher than 28,000 cpm, the 33.3-ft by 33.3-ft grid block having the highest gamma count rate was sampled and analyzed for Ra-226. Also any grid than did not meet the minimum number of data records was either sampled or additional data obtained and added to the data base.

The grid blocks that were sampled are shown in Figure 6-2. The results of the Ra-226 analyses are presented in Table H-1 of Appendix H. The results show that this approach has been very conservative since no soil samples exceeded the 10.5 pCi/g cleanup criterion. In fact, no sample exceeded 5 pCi/g. The mean of the 72 samples is 1.11 pCi/g with a standard deviation of 1.05 pCi/g. This clearly indicates that the area has been remediated to meet the unrestricted release criteria.

The data in Figures 6-1 and 6-2 do not always align with the site features. In most cases, the exact boundary of the site feature had not been determined. In others, an overlap is shown where a portion of a grid block was sampled whereby the resolution of each point on the maps is 33.3-ft by 33.3-ft. Near the Large Tailings Pile, aprons had been constructed to cover the area where no radiological data are shown. The only area known to not have verification data is the area immediately north of Evaporation Pond No. 1 between the pond and Burial Pit No. 5. The soil from this area was removed to a large depth leaving a hole where water collected. Since the area will be disturbed during the reclamation of the Small Tailings Pile, it was decided to verify the area at that time.

6.3.2 Verification of Outer Zone

6.3.2.1 Statistical Test for Study Area within the Innermost Portion of the Outer Zone

A statistical test was developed in accordance with the verification plan to assure that the use of the 21,000 cpm gamma action level resulted in a high probability that each 100 m^2 (33.3-ft by 33.3-ft) grid block meets the cleanup criterion of 5 pCi/g above background, or 10.5 pCi/g. The test was applied to the 33.3-ft by 33.3-ft grid blocks within each 500-ft by 500-ft grid block that has the highest average gamma reading in the innermost portion of the outer zone. The verification plan indicated that if the mean concentration of this set of measurements met the soil concentration cleanup criterion at the 95 percent confidence level, then the soil sampling strategy would be to sample only the grid block within each 1000' by 1000' grid block that has the highest average gamma-ray count rate.

Fifty-two 500-ft by 500-ft grid blocks were evaluated for this test. The grid blocks were chosen according to the NRC-approved verification procedure and are highlighted in Figure 6-3. Data sorts were done to establish the 33.3-ft by 33.3-ft grid block having the highest average gamma-ray count rate. These data sort sheets are provided in Appendix G. Table 6-1 presents the data for each 33.3-ft by 33.3-ft grid block representing the average highest gamma count rate within each of the 52 larger grid blocks. The table shows that the average count rate is 16,629 cpm with a standard deviation of 2,460 cpm. The average Ra-226 concentration is 2.51 pCi/g with a standard deviation of 0.52 pCi/g.

The EPA recommended procedure for testing data for compliance with a guideline value at a desired level of confidence (NUREG/CR-5849, Equation 8-13) was applied to this set of data. The test is to calculate the mean plus the standard error corresponding to the desired level of confidence and compare that value to the cleanup criterion of 10.5 pCi/g. In equation form,

$$\mu_\alpha = \overline{X} + t_{1-\alpha,df}\frac{s}{\sqrt{n}}$$

where $t_{1-\alpha,df}$ is the "t" statistic for the 95% level for the degrees of freedom, df, taken from statistical tables, $\overline{X}$ is the arithmetic mean, s is the standard deviation, and n is the number of data points.

From the "student t" tables, the "t" statistic is 1.68 for 51 degrees of freedom at the 95 percent confidence (one sided) level. Substituting the numbers in the above equation gives 2.6 pCi/g. This value of 2.6 pCi/g must be less than the 10.5 pCi/g

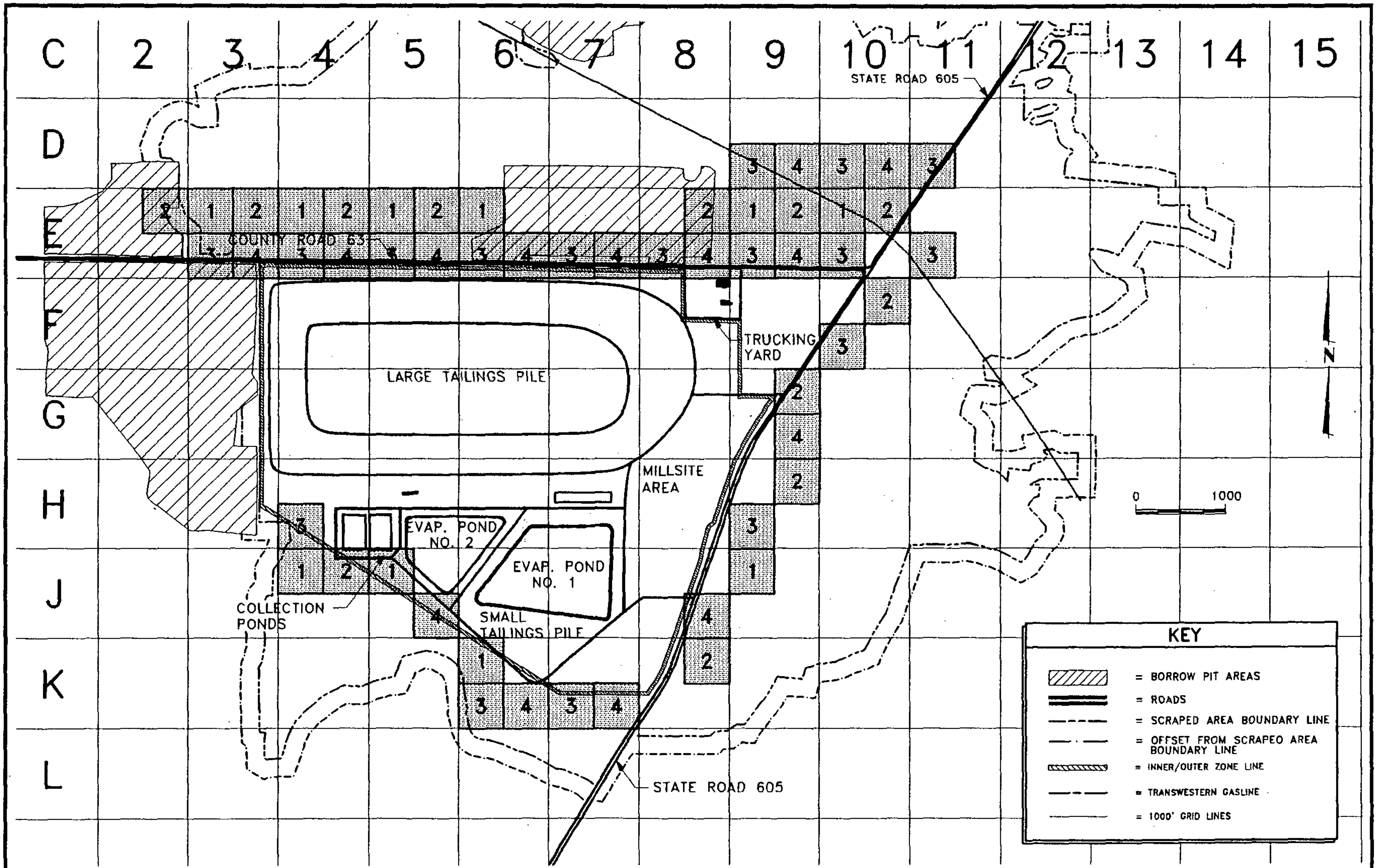


Figure 6-3 Grid Blocks Sampled For Statistical Test

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG6-3.DWG

Table 6-1 Ra-226 and Gamma Count Rate Data for the Outer Zone Statistical Test

Grid Number	HMC Laboratory (pCi/g)	Gamma (avg cpm)
E031222	3.54	15818
E032142	1.21	14898
E033049	1.65	12839
E034114	2.24	12936
E041056	1.77	13051
E042169	0.10	16630
E043111	1.00	13085
E044145	1.46	13569
E051195	2.72	13934
E052153	2.64	16153
E053151	1.75	15472
E054059	1.28	15365
E061067	2.22	15732
E063127	3.27	15801
E064147	3.29	15539
E073127	1.15	15075
E074147	2.45	15433
E082251	4.18	17779
E083203	1.12	16087
E084171	1.25	18796
E091155	5.86	19093
E092248	4.24	20767
E093135	5.47	19030
E094059	4.89	19882
E101114	5.49	21766
E102084	3.17	20674
E103101	4.86	20059
E113166	4.10	17927

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Grants Operations

Table 6-1 Ra-226 and Gamma Count Rate Data for the Outer Zone Statistical Test

Grid Number	HMC Laboratory (pCi/g)	Gamma (avg cpm)
D093206	2.02	15253
D094229	2.79	17648
D103249	2.38	20918
D104176	4.02	21964
D113084	2.04	20785
F102237	1.74	18906
F103039	3.19	15298
G092096	2.38	13361
G094067	1.67	12833
H092225	1.37	17007
H093095	0.79	18226
J091041	2.10	17219
J084225	2.34	15199
K082076	3.38	16690
K073084	3.46	13934
K074174	0.47	15601
K061142	1.58	18007
K063196	3.07	17974
K064177	1.22	16043
J051164	2.26	14390
J054255	1.15	18230
J041053	2.27	15650
J042218	1.71	15408
H043239	2.79	14980
Mean	2.51	16629.12
Std. Deviation	1.33	2460.06
Number	52	52
Standard Error	0.03	47.31

cleanup criterion in order to pass the test, which obviously passes with ease. The data in Table 6-1 confirm the conservatism of the 21,000 cpm action level in that of the 52 grids tested, eight of the grids actually exceeded 20,000 cpm with two slightly above 21,000 cpm. However the maximum Ra-226 concentration was 5.9 pCi/g, much lower than the 10.5 pCi/g cleanup criterion.

Since the data passed the statistical test, the verification plan specifies that the 33.3-ft by 33.3-ft grid block having the highest average gamma count rate within each 1000-ft by 1000-ft grid block will be sampled. A similar statistical test will be done on the set of data from the grids sampled from the 1000-ft by 1000-ft grids.

6.3.2.2 Verification Data for Outer Zone

Upon passing the statistical test addressed in Section 6.3.2.1, the GPS-radiological survey maps were examined visually and by the data sort technique to assure that the minimum number of gamma data records existed for each grid block. In some grid blocks requiring additional data, more data were obtained and added to the data base; in others, a soil sample was taken from the grid block to demonstrate compliance with the 10.5 pCi/g cleanup criterion. The data sort provided the name of the 33.3-ft by 33.3-ft grid block having the highest average gamma count rate within each 500-ft grid block. These grid blocks made up the four possible grid blocks to be sampled for each 1000-ft by 1000-ft grid.

The Ra-226 concentration values for the grid blocks having the highest gamma-ray count rate within each 1000-ft by 1000-ft grid block are provided in Table H-2 of Appendix H. No samples were found to exceed the cleanup criterion and therefore no further decontamination was required. All samples were less than 8 pCi/g.

The set of Ra-226 concentration data for the 78 samples taken in the outer zone (not including the statistical test data presented in Section 6.3.2.1) has a mean of 2.95 pCi/g and a standard deviation of 1.89 pCi/g. Applying the statistical test as described in Section 5.3.2.1, the mean plus the standard error at the 95 percent confidence level is equal to 3.5 pCi/g. This clearly passes the statistical test and confirms the verification of the outer zone.

7.0 Quality Control

Condition 29C of License SUA-1471 requires that a minimum of 15 percent of soil verification samples be recounted by an off-site vendor laboratory using gamma-ray spectroscopy or chemical analysis. The condition also specifies that a minimum of 5 percent of the samples must be analyzed by chemical analysis. This has been interpreted and implemented by HMC as a minimum of 10 percent of the samples will be analyzed by gamma-ray spectroscopy and a minimum of one half of those ten percent will also be analyzed by chemical analysis.

The verification data presented in the tables shows the results of all analyses done on the samples. For example, Appendix H consists of the verification soil sample results using the verification procedure based on sampling the grid blocks with the highest gamma-ray count rate (post March 1, 1995 procedure). This procedure was applied to more than 90 percent of the area. The data in Appendix H shows that 150 verification soil samples were taken and analyzed by the on-site HMC laboratory. Of those 150 samples, 15 samples were analyzed by an off-site laboratory using gamma-ray spectroscopy. An additional 21 samples were analyzed at off-site laboratories using chemical analyses. Additional QC data are presented in the remaining appendices.

The results of the QC program were evaluated by the Radiation Protection Administrator at least monthly. Agreement was within normal analytical accuracy and precision.

8.0 Summary

The data presented in this report indicate that the cleanup of the off-pile windblown contaminated areas within the HMC site has been accomplished using procedures approved by the NRC. The extensive gamma-ray data as presented on the maps provide a high degree of assurance that every 100 m^2 grid block is either below the action level or has been sampled and demonstrated to be below the cleanup criteria. The statistical tests have also demonstrated that the action levels used were very conservative in that the set of samples representing 100 m^2 area grid blocks having the highest average gamma-ray count rates all were beneath the cleanup criteria. The statistical test showed that the means of these data sets for the inner zone, the outer zone, and the special statistical test within the outer zone were all below the cleanup criteria at the 95 percent level. In fact, the mean Ra-226 concentration of these samples was 1.1 pCi/g and 2.5 pCi/g for the inner zone and outer zone, respectively.

The cleanup of the road right of ways was done under somewhat more difficult conditions in that immediate backfilling was required by the state and local government agencies. However it was demonstrated that this was accomplished with a high degree of certainty that the cleanup criteria were met.

The application of the verification plan approved prior to March 15, 1995 was applied for the Trucking Yard Area, the area around the North Ore Storage Pad, and at the north and west toe of the Large Tailings Pile. These areas were verified using the soil sampling procedure in the NRC-approved verification plan. However, at the time of the cleanup, the north and west side slopes of the Large Tailings Pile had not been covered and thus the gamma-shine from the pile was the major contributor to the exposure rate. Therefore while the exposure rate measurements were used to guide the excavation, the levels were not documented. These areas were then backfilled to the original grade. The fact that the soil samples demonstrated that the surface cleanup criteria (10.5 pCi/g) had been met and that the area required extensive backfill to bring it back to grade provides additional assurance that these areas meet the cleanup criteria. This area constitutes a very small fraction of the total remediated area.

9. Bibliography

HMC, 1993a Reclamation Plan, Revision October 1993, Homestake Mining Company of California, Grants Operation, P. O. Box 98, Grants, New Mexico 87020. Prepared by AK Geoconsult., Inc. with Jenkins Environmental, Inc.

NRC, 1993 License Amendment No. 15 to Radioactive Materials License SUA-1471, August 25, 1993, U. S. Nuclear Regulatory Commission, Washington D. C.

HMC, 1994 Borrow Investigation, Homestake Mining Company, Grants Operation, P. O. Box 98, Grants, New Mexico 87020. Prepared by Knight Piesold and Company, Denver, Colorado.

HMC, 1995a Uranium Mill Decommissioning Report, Homestake Mining Company of California, Grants Operation, P. O. Box 98, Grants, New Mexico 871020.

HMC, 1995b Final Radon Barrier Design for the Large Tailings Pile, June 1995, Homestake Mining Company of California, Grants Operation, P. O. Box 98, Grants, New Mexico 87020

NRC, 1995 License Amendment No. 20 to Radioactive Materials License SUA-1471, March 1, 1995, U. S. Nuclear Regulatory Commission, Washington D. C.

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill

Grants Operation

License No. SUA-1471

Appendices A-G

November 1995

Prepared for:

Homestake Mining Company of California
Grants Operations
P. O. Box 98
Grants, NM 87020

Prepared By:

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, NM 87111

Appendix A

Verification Procedures and License Amendments Related to Verification of the Cleanup of Windblown Tailings

UNITED STATES

NUCLEAR REGULATORY COMMISSION

REGION IV

URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

AUG 25 1993

RECEIVED
AUG 27 1993
EHSGA DEPT.

Docket No. 40-8903
SUA-1471, Amendment No. 15

Homestake Mining Company
ATTN: Harold Barnes
650 California Street
San Francisco, California 94108-2788

Dear Mr. Barnes:

Pursuant to Title 10, Code of Federal Regulations, Part 40, and in accordance with your submittals by letters dated December 31, 1990; August 28, 1991; and April 3, 1992; as modified by the staff, Source Material License SUA-1471 is hereby amended to incorporate a mill decommissioning plan by revising Condition No. 29 to read as follows:

29. The licensee shall decommission the Homestake Uranium Mill in accordance with Section 2 of the reclamation plan dated January 1991; the licensee's August 28, 1991, response to comments 1-10 of the NRC's August 2, 1991, letter; and Technical Specifications B1 and B2 of the reclamation plan as revised on April 3, 1992. In addition, the licensee shall perform a soil cleanup verification survey and sampling program as specified below.

   A. Soil samples shall be collected for determination of Ra-226 content as a minimum at every 50-meter gridpoint and the results of gamma surveys conducted at ground level documented at every 10-meter gridpoint in areas designated as requiring soil cleanup on Figure 5 of the reclamation plan (shown within dotted green line on Figure 5).

   B. Soil samples shall be collected for determination of Ra-226 content as a minimum at every 100-meter gridpoint and the results of gamma surveys conducted at ground level documented at every 10-meter gridpoint in areas outside of that specified in (A) above until results indicate background levels of Ra-226 in soil.

   C. The licensee shall establish a gamma action level which results in investigation and/or remediation. This action level shall be based on a correlation of gamma levels to Ra-226 concentrations in soil established after the main tailings pile has been covered, and shall provide at least a 95 percent probability of identifying a Ra-226 concentration of 10.5 pCi/g. The action and correlation shall be based on surface gamma readings conducted using appropriately sensitive and shielded survey instruments and soil samples collected at a minimum of 15 locations where expected

Ra-226 concentrations are 20 pCi/g or less. The action level, as well as the methodology and all data used in determining the action level and the gamma:Ra-226 correlation, shall be submitted to NRC for review and approval at least 90 days prior to beginning the survey program described in (A) or (B) above.

D. The licensee shall use only soils obtained from borrow areas outside the restricted area which have not been impacted by site operations to cover the mill disposal area. The location of these borrow areas shall be documented.

E. The licensee shall implement a quality control (QC) program for the soil cleanup verification program which consists of recounting using offsite gamma spectroscopy equipment or chemical analysis by a vendor laboratory of at least 15 percent of all soil samples collected. In addition, a minimum of 5 percent of the QC samples shall be chemically analyzed. Results of the QC program shall be evaluated by the Radiation Protection Administrator and the evaluation documented at least monthly during the verification sampling program.

F. All decommissioning activities shall be documented. Within 90 days following the completion of mill demolition and disposal activities, the licensee shall submit to the NRC a report documenting the activities and providing summaries of all data generated as part of the radiation safety program for mill decommissioning. In addition, within 90 days following the completion of the soil cleanup and verification program, the licensee shall submit to the NRC a report documenting the cleanup activities and providing the results of all soil sampling and gamma surveys conducted to verify the adequacy of cleanup.

[Applicable Amendments: 15]

All other conditions of this license shall remain the same. The license is being reissued to incorporate the above revision.

An environmental assessment regarding the proposed decommissioning plan was completed by the staff on May 12, 1993. Based on the environmental assessment, a Finding of No Significant Impact and Notice of Intent to Amend License was published in the Federal Register on June 11, 1993 (58 FR 32734).

The issuance of this amendment was discussed via telecon between Mr. Fred Craft of Homestake and Mr. Pete Garcia of my staff on August 16, 1993.

Sincerely,

Ramon E. Hall
Director

Enclosure:
Source Material License SUA-1471

cc:
H. Barnes, HMC
B. Garcia, RCPD, NM
E. Montoya, NMED

NRC Form 374
(5-84)

U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter 1, Parts 30, 31, 32, 33, 34, 35, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee

1. Homestake Mining Company

2. P.O. Box 98
Grants, New Mexico 87020

3. License number: SUA-1471, Amendment No. 15

4. Expiration date: Until NRC determines site reclamation is adequate. [Applicable Amendments: 12]

5. Docket or Reference No.: 40-8903

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
Uranium	Any	Unlimited

9. Authorized Place of Use: The licensee's uranium mill located in Cibola County, New Mexico, and the licensee's auxiliary ion exchange facility located in McKinley County, New Mexico. [Applicable Amendments: 12]

10. This license authorizes only the possession of residual uranium and byproduct material in the form of uranium waste tailings and other byproduct waste generated by the licensee's past milling operations in accordance with the programs listed below:

    A. "ALARA-Radiation Protection Program," submitted on February 28, 1990.

    B. "Quality Assurance Program for Radiological Monitoring," submitted on February 28, 1990.

    C. "Mill Respiratory Protection," submitted on February 28, 1990.

    D. "Occupational and Environmental Monitoring and Surveillance Program," submitted on April 6, 1990.

    E. "Emission Control Device Program," submitted on June 19, 1987.

    F. "Uranium Mill Bioassay Program," submitted on June 19, 1987.

    Anywhere the word "will" is used, it shall denote a requirement.

    [Applicable Amendments: 2, 6, 12]

License number SUA-1471, Amendment No. 15

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Docket or Reference number 40-8903

AUG 2 5 1993

11. The licensee shall determine that employees leaving work are not contaminated with radioactive materials. When an employee has showered and changed clothes prior to leaving work, he may be assumed to be free of contamination.

12. The licensee shall implement an embankment inspection program as specified in the submittal dated September 21, 1987, with the exception that quarterly dam evaluations need no longer be performed. The annual training of site personnel responsible for dam inspections shall be conducted by a registered professional engineer.

    An annual technical evaluation report of the large and small tailings impoundments shall be prepared under the direction of a registered professional engineer experienced in dam design and construction. The evaluation should include an inspection of the large and small tailings impoundments, a review and assessment of all associated monitoring data and inspection reports, and an overall judgement of the effectiveness of the inspection program. A copy of the report shall be submitted to the NRC, Uranium Recovery Field Office, within 1 month of completion of the report.

    [Applicable Amendments: 2, 12, 14]

13. The licensee is hereby authorized to possess byproduct material in the form of uranium waste tailings and other byproduct wastes generated by the licensee's milling operations.

14. Release of equipment or packages from the restricted area shall be in accordance with the attachment to SUA-1471 entitled, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984.

15. The results of all effluent and environmental monitoring required by this license shall be reported in accordance with 10 CFR 40, Section 40.65, with copies of the report sent to the NRC, Uranium Recovery Field Office. Monitoring data shall be reported in the format shown in the attachment to SUA-1471 entitled, "Sample Format for Reporting Monitoring Data." All ground-water monitoring data shall be reported as described in License Condition No. 35. [Applicable Amendments: 5]

16. Before engaging in any activity not previously assessed by the NRC, the licensee shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not previously assessed or that is greater than that previously assessed, the licensee shall provide a written evaluation of such activities and obtain prior approval of the NRC in the form of a license amendment.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number
SUA-1471, Amendment No. 15
Docket or Reference number
40-8903

AUG 25 1993

17. Prior to termination of this license, the licensee shall provide for transfer of title to byproduct material and land, including any interests therein (other than land owned by the United States or the State of New Mexico), which is used for the disposal of such byproduct material or is essential to ensure the long-term stability of such disposal site to the United States or the State of New Mexico, at the State's option.

18. The licensee shall not make any changes to the approved tailings retention system without specific prior approval of the NRC, Uranium Recovery Field Office, in the form of a license amendment.

19. The licensee shall implement an interim stabilization program for all tailings not covered by standing water as specified in the submittal dated February 16, 1989, with the following additional requirements:

A. Application of chemical stabilizer shall be performed and the application documented at least annually.

B. Detailed quarterly inspections of the effectiveness of measures implemented to control blowing of tailings shall be performed and documented by the Radiation Protection Administrator (RPA).

C. An annual technical evaluation of the effectiveness of measures implemented to control blowing of tailings shall be performed by a team which includes at a minimum the RPA and the Resident Manager. The evaluation shall specifically address the effectiveness of the erosion control blanket in light of the continuing deposition of windblown material, the need for additional application of chemical stabilizer, and the need for modification of the sprinkler system in response to changes in available beach area. A report documenting the evaluation shall be prepared and a copy submitted to the NRC by October 1 of each year.

D. An annual soil sampling and gamma survey program shall be performed to verify the effectiveness of measures used to control blowing of tailings. The results of the sampling and survey program as well as proposals for corrective actions for areas exceeding 10.5 pCi/g Ra-226 shall be submitted to the NRC by October 1 of each year. The results of the program shall specifically be considered as part of the evaluation required by 19(C) above.

[Applicable Amendments: 2, 6]

20. The licensee is hereby exempted from the requirements of Section 20.203(e)(2) of 10 CFR 20 for areas within the mill provided that all entrances to the mill are conspicuously posted in accordance with Section 20.203(e)(2) and with the words, "Any area within this mill may contain radioactive material."

21. The mill Radiation Protection Administrator (RPA), who is responsible for conducting the mill radiation safety program, shall possess the minimum qualifications as specified in Section 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As is Reasonably Achievable."

22. The results of sampling, analyses, surveys and monitoring; the results of calibration of equipment, reports on audits and inspections; all meetings and training courses required by this license and any subsequent reviews, investigations, and corrective actions, shall be documented. Unless otherwise specified in the NRC regulations, all such documentation shall be maintained for a period of at least 5 years.

23. Standard operating procedures (SOPs) shall be established for all operational process activities involving radioactive materials that are handled, processed, or stored. Standard operating procedures for operational activities shall enumerate pertinent radiation safety practices to be followed. Additionally, written procedures shall be established for nonoperational activities to include in-plant and environmental monitoring, bioassay analyses, and instrument calibrations. An up-to-date copy of each written procedure shall be kept in the mill area to which it applies.

    All written procedures for both operational and nonoperational activities shall be reviewed and approved in writing by the RPA before implementation and whenever a change in procedure is proposed to ensure that proper radiation protection principles are being applied. In addition, the RPA shall perform a documented review of all existing operating procedures at least annually.

24. The licensee shall be required to use a Radiation Work Permit (RWP) for all work or nonroutine maintenance jobs where the potential for significant exposure to radioactive material exists and for which no standard written procedure already exists. The RWP shall be approved by the RPA or his designee, qualified by way of specialized radiation protection training, and shall at least describe the following:

    A. The scope of work to be performed.

    B. Any precautions necessary to reduce exposure to uranium and its daughters.

    C. The supplemental radiological monitoring and sampling necessary prior to, during, and following completion of the work.

25. Occupational exposure calculations shall be performed and documented within 1 week of the end of each regulatory compliance period as specified in 10 CFR 20.103(a)(2) and 10 CFR 20.103(b)(2). Routine airborne ore dust and yellowcake samples shall be analyzed in a timely manner to allow exposure

MATERIALS LICENSE
SUPPLEMENTARY SHEET

calculations to be performed in accordance with this condition. Required nonroutine monitoring for ore dust and yellowcake exposure shall be analyzed and the results reviewed by the RPA within 2 working days after sample collection.

26. Mill tailings, other than small samples for purposes such as research or analysis, shall not be transferred from the site without specific prior approval of the NRC in the form of a license amendment. The licensee shall maintain a permanent record of all transfers made under the provisions of this condition.

27. All liquid effluents from mill process buildings, with the exception of sanitary wastes, shall be discharged to the tailings impoundment.

28. The licensee shall maintain an NRC-approved financial surety arrangement consistent with 10 CFR 40, Criteria 9 and 10, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination of the mill and mill site, reclamation of tailings or waste disposal areas, ground-water restoration, and the long-term surveillance fee. Within 3 months of NRC approval of a revised reclamation plan, the licensee shall submit for NRC review and approval a proposed revision to the financial surety arrangement if estimated costs for the newly approved plan exceed the amount covered in the existing financial surety. The revised surety arrangement shall then be in effect within 3 months of written NRC approval. Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of costs and the basis for the cost estimate. The attachment to the license entitled, "Recommended Outline for Site Specific Reclamation and Stabilization Cost Estimates," outlines the minimum considerations used by the NRC in the review of site closure cost estimates.

The licensee's currently approved surety, a Parent Company Guarantee issued by Homestake Mining Company, shall be continuously maintained in an amount no less than $20,000,000 for the purpose of complying with 10 CFR 40, Criteria 9 and 10, until a replacement is authorized by the NRC. The use of a parent company guarantee necessitates an evaluation of the corporate parent as part of the annual surety update. In addition to the cost information required above, the annual submittal must include updated documentation of the (1) letter from the chief financial officer of the parent company, (2) auditor's special report confirmation of chief financial officer's letter, (3) schedule reconciling amounts in chief financial officer's letter to amounts in financial statements, and (4) parent company guarantee if any changes are appropriate.

[Applicable Amendments: 9, 12]

29. The licensee shall decommission the Homestake Uranium Mill in accordance with Section 2 of the reclamation plan dated January 1991; the licensee's August 28, 1991, response to comments 1-10 of the NRC's August 2, 1991, letter; and Technical

License number
SUA-1471, Amendment No. 15

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Docket or Reference number
40-8903

AUG 25 1993

Specifications B1 and B2 of the reclamation plan as revised on April 3, 1992. In addition, the licensee shall perform a soil cleanup verification survey and sampling program as specified below.

A. Soil samples shall be collected for determination of Ra-226 content as a minimum at every 50-meter gridpoint and the results of gamma surveys conducted at ground level documented at every 10-meter gridpoint in areas designated as requiring soil cleanup on Figure 5 of the reclamation plan (shown within dotted green line on Figure 5).

B. Soil samples shall be collected for determination of Ra-226 content as a minimum at every 100-meter gridpoint and the results of gamma surveys conducted at ground level documented at every 10-meter gridpoint in areas outside of that specified in (A) above until results indicate background levels of Ra-226 in soil.

C. The licensee shall establish a gamma action level which results in investigation and/or remediation. This action level shall be based on a correlation of gamma levels to Ra-226 concentrations in soil established after the main tailings pile has been covered, and shall provide at least a 95 percent probability of identifying a Ra-226 concentration of 10.5 pCi/g. The action and correlation shall be based on surface gamma readings conducted using appropriately sensitive and shielded survey instruments and soil samples collected at a minimum of 15 locations where expected Ra-226 concentrations are 20 pCi/g or less. The action level, as well as the methodology and all data used in determining the action level and the gamma:Ra-226 correlation, shall be submitted to NRC for review and approval at least 90 days prior to beginning the survey program described in (A) or (B) above.

D. The licensee shall use only soils obtained from borrow areas outside the restricted area which have not been impacted by site operations to cover the mill disposal area. The location of these borrow areas shall be documented.

E. The licensee shall implement a quality control (QC) program for the soil cleanup verification program which consists of recounting using offsite gamma spectroscopy equipment or chemical analysis by a vendor laboratory of at least 15 percent of all soil samples collected. In addition, a minimum of 5 percent of the QC samples shall be chemically analyzed. Results of the QC program shall be evaluated by the Radiation Protection Administrator and the evaluation documented at least monthly during the verification sampling program.

F. All decommissioning activities shall be documented. Within 90 days following the completion of mill demolition and disposal activities, the licensee shall submit to the NRC a report documenting the activities and providing summaries

of all data generated as part of the radiation safety program for mill decommissioning. In addition, within 90 days following the completion of the soil cleanup and verification program, the licensee shall submit to the NRC a report documenting the cleanup activities and providing the results of all soil sampling and gamma surveys conducted to verify the adequacy of cleanup.

[Applicable Amendments: 15]

30. The licensee shall implement a program to minimize dispersal of dust from the ore stockpile area(s). This program shall include written operating procedures. The effectiveness of the control method used shall be evaluated weekly by means of a documented inspection.

31. The licensee is authorized to construct and operate a lined brine evaporation pond in accordance with plans, conditions, revisions, and commitments made in conjunction with Ground Water Discharge Plan DP-339, approved by the Ground Water/Hazardous Bureau of the State of New Mexico by a letter dated January 17, 1986, signed by Ernest Rebuck. Such plans, conditions, revisions, and commitments are contained in submittals and correspondence from Homestake Mining Company dated March 22, 1984, April 9, 1984, and April 17, 1986; and includes a commitment by letter dated April 11, 1986, to reclaim the pond area in accordance with applicable reclamation standards after the cessation of operations.
[Applicable Amendments: 5, 8]

32. The licensee shall comply with the following:

    A. The quantity of air sampled and the method of analysis shall result in a lower limit of detection (LLD) for all in-plant air sampling of at least 10 percent of the respective maximum permissible concentration for restricted areas.

    B. Analysis of urine samples shall utilize an LLD of at least 5 ug/l uranium.

    C. A copy of the report documenting the annual ALARA audit shall be submitted to the NRC, Uranium Recovery Field Office, for review within 30 days of completion of the audit.

[Applicable Amendments: 2]

33. All eating areas and change rooms located in mill process areas shall be spot-checked weekly for removable surface contamination. Areas shall be promptly cleaned if surface contamination levels exceed the values listed in Table 1 of Regulatory Guide 8.30. In addition, all laboratory surfaces used for preparation

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number: SUA-1471, Amendment No. 15
Docket or Reference number: 40-8903
AUG 25 1993

of bioassay samples shall be spot-checked prior to sample analysis and decontaminated if removable contamination levels exceed 200 dpm alpha/100 cm^2. The results of all surveys and spot checks shall be documented. [Applicable Amendments: 2]

34. DELETED by Amendment No. 4.

35. The licensee shall implement a compliance monitoring program containing the following:

    A. Implement the monitoring program shown in Table 5-1 of the September 15, 1989, submittal. Additionally, the volumes of water injected and recovered as part of the corrective action program shall be monitored and documented quarterly.

    B. Comply with the following ground-water protection standards at brine evaporation pond point-of-compliance Wells D1 and BP, at the inactive tailings impoundment point-of-compliance Wells Y and X, and at the active tailings impoundment point-of-compliance Wells S4, S3, M5, and DQ with background being recognized in Well P:

       chromium = 0.06 mg/l, molybdenum = 0.03 mg/l, selenium = 0.10 mg/l, vanadium = 0.02 mg/l, uranium = 0.04 mg/l, radium-226 and -228 = 5.0 pCi/l, and thorium-230 = 0.30 pCi/l.

    C. Implement the corrective action program described in the September 15, 1989, submittal due to exceeding ground-water protection standards, with the objective of returning the concentrations of chromium, molybdenum, selenium, thorium-230, uranium, and vanadium to the concentration limits specified in 35(B) above.

    D. Operate the lined evaporation pond and enhanced evaporation system as described in the June 8 and 28, 1990, submittals.

    E. Submit a semiannual ground-water monitoring report in accordance with the reporting requirements of 10 CFR 40.65. Also, submit, by February 28 of each year, a performance review of the corrective action program that details the progress towards attaining ground-water protection standards.

    [Applicable Amendments: 3, 4, 5, 7, 8, 10, 11]

36. The licensee shall complete site reclamation in accordance with an approved reclamation plan. The ground-water corrective action plan shall be conducted as authorized by License Condition No. 35. All activities shall be completed in accordance with the following schedules.

License number
SUA-1471, Amendment No. 15

Docket or Reference number
40-8903

AUG 25 1993

MATERIALS LICENSE
SUPPLEMENTARY SHEET

A. To ensure timely compliance with target completion dates established in the Memorandum of Understanding with the Environmental Protection Agency (56 FR 55432, October 25, 1991), the licensee shall complete reclamation to control radon emissions as expeditiously as practicable, considering technological feasibility, in accordance with the following schedule:

(1) Windblown tailings retrieval and placement on the pile:

For the Large Impoundment - December 31, 1996.

For the Small Impoundment - May 31, 1997.

(2) Placement of the interim cover to decrease the potential for tailings dispersal and erosion:

For the Large Impoundment - December 31, 1996.

For the Small Impoundment - May 31, 1997.

(3) Placement of final radon barrier designed and constructed to limit radon emissions to an average flux of no more than 20 $pCi/m^2/s$ above background:

For the Large Impoundment which has no evaporation ponds - December 31, 1996.

For the Small Impoundment, tailings pile surface areas are essentially covered by evaporation ponds constructed as part of the ground-water corrective action program. Prior to December 31, 2001, the areas not covered by the evaporation ponds shall have final radon barrier in place. Final radon barrier placement over the entire pile shall be completed within 2 years of completion of ground-water corrective actions.

B. Reclamation, to ensure required longevity of the covered tailings and ground-water protection, shall be complete as expeditiously as is reasonably achievable, in accordance with the following target dates for completion:

(1) Placement of erosion protection as part of reclamation to comply with Criterion 6 of Appendix A of 10 CFR Part 40:

For the Large Impoundment - September 30, 1999.

For the Small Impoundment - July 1, 2014.

(2) Projected completion of ground-water corrective actions to meet performance objectives specified in the ground-water corrective action plan - May 1, 2010.

C. Any license amendment request to revise the completion dates specified in Section A must demonstrate that compliance was not technologically feasible (including inclement weather, litigation which compels delay to reclamation, or other factors beyond the control of the licensee).

D. Any license amendment request to change the target dates in Section B above, must address added risk to the public health and safety and the environment, with due consideration to the economic costs involved and other factors justifying the request such as delays caused by inclement weather, regulatory delays, litigation, and other factor beyond the control of the licensee.

[Applicable Amendments: 13]

37. The licensee shall reclaim the large and small tailings impoundments as stated in their January 31, 1991, Reclamation Plan, as revised by submittals dated August 28, 1991, April 3, April 30, and December 21, 1992, and June 30, 1993, submittals, with the following additional requirements.

A. The cover system for the large tailings impoundment shall be as defined on Figure 3.4 of Attachment #5 to the licensee's June 30, 1993, submittal except the clayey sand radon barrier shall be 8 feet thick and shall consist of minus 3/4-inch material, containing at least 25 percent passing the No. 200 sieve, Atterberg limits plotting above the "A" line; and shall be compacted in 6-inch lifts to at least 95 percent of Standard Proctor density within minus 2 to plus 2 percent of the optimum moisture content.

B. The radon barrier for the small impoundment shall be 14 feet thick and shall consist of minus 3/4-inch material, containing at least 25 percent passing the No. 200 sieve, Atterberg limits plotting above the "A" line; and shall be compacted in 6-inch lifts to at least 95 percent of Standard Proctor density within minus 2 to plus 2 percent of the optimum moisture content.

C. The licensee shall submit a construction quality control program for NRC review and approval prior to placing any portion of the radon barrier that will ensure that the specification which limits the activity of the radon barrier material to 5 pCi/g above background is not exceeded.

D. The construction quality assurance and control program shall be as defined in the Staff Technical Position On Testing and Inspection (NRC, 1989). The acceptable correlation between ASTM D 2922 and ASTM D 1556 shall be as defined in the licensee's April 30, 1992, submittal.

License number
SUA-1471, Amendment No. 15

Docket or Reference number
40-8903

AUG 25 1993

MATERIALS LICENSE
SUPPLEMENTARY SHEET

F. The radon barrier shall not be placed on the top surface of the large tailings impoundment until the settlement has been demonstrated to be at least 90 percent of expected settlement, and the results of this determination have been reviewed and accepted by the NRC. The radon barrier may be placed on the large impoundment side slopes following final grading of the impoundment. Care shall be taken to preclude the possibility of ponding. Before the erosion protection is placed, it shall be verified that the radon barrier material meets the specifications.

G. The adequacy of the erosion protection proposed for the side slopes of both the large and small impoundments shall be reevaluated considering any increases in impoundment heights due to the revised radon attenuation cover design.

H. All reclamation plan requirements shall be incorporated into a single comprehensive document by October 31, 1993. This may be accomplished by providing appropriate revisions to the January 31, 1991, reclamation plan drawings and technical specifications, or by providing new drawings and technical specifications.

I. A completion report shall be provided within 6 months of the completion of construction. This report, including as-built drawings, shall verify that reclamation of the site has been performed according to the approved plan. The report shall also include summaries of results of the quality assurance and control testing to demonstrate that approved specifications were met.

[Applicable Amendments: 14]

FOR THE NUCLEAR REGULATORY COMMISSION

Date AUG 25 1993

Ramon E. Hall, Director
Uranium Recovery Field Office
Region IV

RECEIVED MAR - 7 1995

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 1, 1995

Mr. F. R. Craft, Resident Manager
Homestake Mining Company
P.O. Box 98
Grants, New Mexico 87020

SUBJECT: SOIL CLEANUP VERIFICATION SURVEY AND SAMPLING PLAN

Dear Mr. Craft:

The U.S. Nuclear Regulatory Commission staff has completed its review of your amendment request submitted in your letter dated September 15, 1994. The review found the proposed "Soil Cleanup Verification Survey and Sampling Plan for Use at the Grants Uranium Mill Tailing Site," dated September 1994, acceptable, and the amendment is approved.

Therefore, pursuant to Title 10 of the Code of Federal Regulations, Part 40, Source Material License SUA-1471 is hereby amended by revising License Condition No. 29. All other conditions of this license shall remain the same. A copy of the staff's Technical Evaluation Report for the license amendment is Enclosure 1. The license is being revised to incorporate the above modification (Enclosure 2).

If you have any questions regarding this letter or the enclosures, please contact Ken Hooks at (301) 415-7777.

Sincerely,

Joseph J. Holonich, Chief
High-Level Waste and Uranium
Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 40-8903
SUA-1471, Amendment No. 20

Enclosures: As stated

cc: Shawn Ghose, USEPA, Region 6
Kerrie Neet, NMED Superfund Section
Diana Malone, Navajo Superfund Project

TECHNICAL EVALUATION REPORT

E: January 11, 1995

DOCKET NO. 40-8903 LICENSE NO. SUA-1471

LICENSEE: Homestake Mining Company of California

FACILITY: Homestake (Grants Uranium Mill)

PROJECT MANAGER: Kenneth Hooks

TECHNICAL REVIEWER: Elaine Brummett

SUMMARY AND CONCLUSIONS:

By letter dated September 15, 1994, Homestake Mining Company (Homestake) requested that License Condition 29 be amended to approve its "Soil Cleanup Verification Survey and Sampling Plan." After discussions with the Nuclear Regulatory Commission staff, Homestake provided additional data by letter dated October 31, 1994, and a revised plan by letter dated December 13, 1994. The plan relies on an improved gamma survey procedure and a conservative gamma action (cleanup) level. The plan places greater reliance on gamma levels by requiring fewer soil sample analyses, to demonstrate cleanup to the radium (Ra-226) surface soil standard of 5 pCi/g above background. The NRC staff has determined that the revised plan (verification procedure) should provide adequate data to demonstrate compliance with the soil cleanup standard.

KGROUND:

The soil cleanup standards in Criterion 6 of Appendix A to Title 10 Code of Federal Regulations (CFR) Part 40, require that the concentration of Ra-226 in land, averaged over areas of 100 square meters (m^2), which as a result of uranium byproduct material, does not exceed the background level by more than 5 pCi/g averaged over the first 15 cm below the surface, and 15 pCi/g averaged over 15-cm thick layers more than 15 cm below the surface.

License Conditions 29A, 29B, and 29C require Homestake, in part, to:

1) collect soil samples for Ra-226 analysis as a minimum at every 50 meters and document the ground level gamma reading every 10 meters for the area around the tailings piles (inner zone, see Attachment A);

2) collect soils samples as a minimum at every 100 meters and document the ground level gamma reading every 100 meters for the windblown areas (outer zone) until results indicate background levels of Ra-226 in soil; and

3) the gamma action level shall be based on a correlation with Ra-226 concentration that provides at least a 95 percent probability of identifying a Ra-226 concentration of 10.5 pCi/g.

Enclosure 1

Homestake proposes to use a new gamma survey procedure and a conservative gamma action level. In addition, the site is to be cleaned to the surface soil Ra-226 concentration standard of 5 pCi/g plus background (5.5 pCi/g is the approved background value for this site), even though some areas are to be backfilled. Homestake proposes to demonstrate compliance with the soil cleanup standard utilizing a verification procedure that includes specifications to:

1) collect five soil samples to composite from the 100 m^2 area with the highest gamma values in every 152 by 152-meter (500 by 500-foot) area of the inner zone (see Attachment A), and document a minimum of 7 gamma measurements for each 100 m^2 area;

2) collect five soil samples to composite from the 100 m^2 area with the highest gamma values in every 305 by 305-meter (1000 by 1000-foot) area in the outer zone, except for 50 blocks next to the inner zone, and document a minimum of 5 gamma measurements for each 100 m^2 area; and

3) demonstrate that the mean Ra-226 concentration of the sampled grids is 10.5 pCi/g or less at the 95 percent confidence level.

AMENDMENT REQUEST:

Homestake requests that License Condition 29 be amended to approve the "Soil Cleanup Verification Survey and Sampling Plan" of September 15, 1994, as modified by the submittal of December 13, 1994. This would replace the verification survey and sampling program specified by License Conditions 29A, 29B, and 29C. In addition, Homestake requested (page 12, September 15, 1994) acceptance of the slight modification to the verification procedure that was used along the highway right-of-way.

TECHNICAL EVALUATION:

Gamma Survey Procedure

Homestake proposes (September 15, 1994) to use a Global Positioning System (GPS) land surveyor and computer mapping system coupled to radiological survey data. This gamma-mapping system consists of digital gamma-ray monitoring equipment using a 2 by 2-inch sodium iodide detector. This provides a gamma count rate every 2 seconds to the survey system that tags the data with the coordinates. The data is loaded into AutoCAD software for mapping and developing isocontours. Apparently, the accuracy of the coordinates is better than 1 meter. Homestake indicates that the proposed verification plan utilizing this high-density gamma survey provides greater assurance of compliance with the cleanup standards than that originally proposed.

For the survey, the gamma detector is placed 18 inches above the ground surface and is moved slowly so that each reading (count rate) represents approximately 3 meters by 2 meters. Generally there are 8 or 9 count rates recorded for each 100 m^2, and the average distance between data points is less than 20 feet. NRC staff determined that this method provides a better approximation of the average gamma field than the ground level measurement every 10 meters required by License Condition 29 A.

Gamma Action Levels

The gamma action level for the outer zone is based on data provided October 31, 1994. Homestake took composite soil samples from 20 10-m by 10-m grids for Ra-226 analysis. The Ra-226 values were correlated to gamma count rates obtained using the GPS

equipment. Ra-226 values ranged from 6.6 to 14.0 pCi/g. At these low levels, the correlation coefficient was understandably low. Homestake chose what it considered to be a conservative gamma action of 21,000 counts/minute (cpm). Background values for the site are about 15,000 to 18,000 cpm. The 11 grids that exceeded the 10.5 pCi/g Ra-226 level and 2 grids that met the Ra-226 standard had average count rates above 21,000 cpm. The proposed gamma survey for the inner zone will assure that all areas are below 28,000 cpm. This value is based on the September 15, 1994, data and takes into consideration the shine from the uncovered portions of the small tailings pile and that the area will be covered by more than 1 foot of fill. NRC staff determined that the gamma action levels are acceptable, considering the limitations of the correlation method.

Soil Sampling Plan

Homestake proposes to composite 5 soil samples from 100 m^2 areas (verification grids) to determine the Ra-226 concentration. This is a standard method and meets the regulation by providing an average value. Homestake's rationale for sampling fewer grids in the outer zone is that the contamination level is less, is all surficial, and is more uniform than the contamination in the inner zone. NRC staff determined that this sampling approach is acceptable.

If any Ra-226 analysis exceeds the criterion, Homestake proposes to clean the grid and resurvey it. Then the grid within that same block that has the highest gamma levels would be sampled. Also, Homestake proposes to perform a statistical test to demonstrate that the mean Ra-226 concentration meets the surface soil criterion at the 95 percent confidence level. Passing this test provides assurance that the error rate is very low, since the samples are from the grids most likely to have the highest Ra-226 concentration.

Homestake estimated (December 28, 1994, telephone communication) that the area undergoing soil cleanup is approximately 1700 acres. The proposed sampling plan would substantially reduce costs for this large area, because fewer soil samples (approximately 10 percent of the number specified in the license condition) would be taken and analyzed for Ra-226. NRC staff determined that, considering the cost savings and the revised gamma verification system, the proposed soil sampling plan and statistical analysis should provide adequate assurance that the soil cleanup standard has been met.

Highway Right-of-Way Verification

Homestake modified the NRC-approved cleanup verification procedure for the right-of-way along State Highway 605 (September 15, 1994). Since the excavated areas required immediate backfill to protect the public health and safety, a gamma action level for use with the shielded microR meter was used. An integrated count was taken while walking over the excavated area and recorded at 7.6-meter (25-foot) intervals. Soil samples were taken at 45.7-meter (150-foot) intervals. NRC staff determined that the modifications result in a higher density of gamma and Ra-226 data than originally proposed, and the gamma action level is adequate. Therefore, this verification procedure for the highway right-of-way is acceptable.

CONCLUSION:

The staff finds the proposed changes to Source Material License SUA-1471, License

Condition 29, to reflect: 1) the new gamma survey procedure to be used for soil cleanup verification (September 15, 1994); and 2) the proposed gamma action levels and the soil sampling plan (December 13, 1994) acceptable. In addition, the staff finds : proposed deletion of Parts A, B, and C of License Condition 29 that provided the :vious soil cleanup program acceptable.

ENVIRONMENTAL IMPACT EVALUATION:

In accordance with the categorical exclusion contained in paragraph (c)(11) of 10 CFR 51.22, an environmental assessment is not required for this licensing action. That paragraph states that the categorical exclusion applies to the issuance of amendments to licenses for uranium mills provided that: (1) there is no significant change in the types or significant increase in the amounts of any effluents that may be released off site; (2) there is no significant increase in individual or cumulative occupational radiation exposure; (3) there is no significant construction impact; and (4) there is no significant increase in the potential for or consequences from radiological accidents.

The licensing action discussed in this memorandum modifies the radon barrier design in accordance with Criterion 6 of 10 CFR Part 40, Appendix A. An environmental report is not required from the licensee since the amendment does not meet the criteria of 10 CFR 51.60 (b)(2).

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, C[illegible] Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 39, 40 and 70, and in reliance on statements and representations heretofore m[illegible] the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuc[illegible] material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Homestake Mining Company	3. License number SUA-1471, Amendment No. 20
2. P.O. Box 98 Grants, New Mexico 87020	4. Expiration date: Until NRC determines site reclamation is adequate. [Applicable Amendment: 12]
	5. Docket or Reference No: 40-8903

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
Uranium	Any	Unlimited

9. Authorized Place of Use: The licensee's uranium mill located in Cibola County, New Mexico, and the licensee's auxiliary ion exchange facility located in McKinley County, New Mexico. [Applicable Amendment: 12]

10. This license authorizes only the possession of residual uranium and byproduct material in the form of uranium waste tailings and other byproduct waste generated by the licensee's past milling operations in accordance with Tables 1 and 3 and the procedures submitted by letter dated September 2, 1993.

    Anywhere the word "will" is used, it shall denote a requirement.

    [Applicable Amendments: 2, 6, 12, 16]

11. The licensee shall determine that employees leaving work are not contaminated with radioactive materials. When an employee has showered and changed clothes prior to leaving work, he may be assumed to be free of contamination.

12. The licensee shall implement an embankment inspection program as specified in the submittal dated September 21, 1987, with the exception that quarterly dam evaluations need no longer be performed. The annual training of site personnel responsible for dam inspections shall be conducted by a registered professional engineer.

    An annual technical evaluation report of the large and small tailings impoundments shall be prepared under the direction of a registered professional engineer experienced in dam design and construction. The evaluation should include an inspection of the large and small tailings impoundments, a review and assessment

License number
SUA-1471, Amendment No. 20

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Docket or Reference number
40-8903

of all associated monitoring data and inspection reports, and an overall judgement of the effectiveness of the inspection program. A copy of the report shall be submitted to the NRC, within 1 month of completion of the report.

[Applicable Amendments: 2, 12, 14]

13. The licensee is hereby authorized to possess byproduct material in the form of uranium waste tailings and other byproduct wastes generated by the licensee's milling operations.

14. Release of equipment or packages from the restricted area shall be in accordance with the attachment to SUA-1471 entitled, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984.

15. The results of all effluent and environmental monitoring required by this license shall be reported in accordance with 10 CFR 40, Section 40.65, with copies of the report sent to the NRC. Monitoring data shall be reported in the format shown in the attachment to SUA-1471 entitled, "Sample Format for Reporting Monitoring Data." All ground-water monitoring data shall be reported as described in License Condition No. 35. [Applicable Amendments: 5]

1ᶜ Before engaging in any activity not previously assessed by the NRC, the licensee shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not previously assessed or that is greater than that previously assessed, the licensee shall provide a written evaluation of such activities and obtain prior approval of the NRC in the form of a license amendment.

17. Prior to termination of this license, the licensee shall provide for transfer of title to byproduct material and land, including any interests therein (other than land owned by the United States or the State of New Mexico), which is used for the disposal of such byproduct material or is essential to ensure the long-term stability of such disposal site, to the United States or the State of New Mexico, at the State's option.

18. The licensee shall not make any changes to the approved tailings retention system without specific prior approval of the NRC, in the form of a license amendment.

19. DELETED by Amendment No. 17.

20. The licensee is hereby exempted from the requirements of Section 20.203(e)(2) of 10 CFR 20 for areas within the mill provided that all entrances to the mill are conspicuously posted in accordance with Section 20.203(e)(2) and with the words, "Any area within this mill may contain radioactive material."

The mill Radiation Protection Administrator (RPA), who is responsible for conducting the mill radiation safety program, shall possess the minimum

qualifications as specified in Section 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As is Reasonably Achievable."

22. The results of sampling, analyses, surveys and monitoring; the results of calibration of equipment, reports on audits and inspections; all meetings and training courses required by this license and any subsequent reviews, investigations, and corrective actions, shall be documented. Unless otherwise specified in the NRC regulations, all such documentation shall be maintained for a period of at least 5 years.

23. Standard operating procedures (SOPs) shall be established for all operational process activities involving radioactive materials that are handled, processed, or stored. Standard operating procedures for operational activities shall enumerate pertinent radiation safety practices to be followed. Additionally, written procedures shall be established for nonoperational activities to include in-plant and environmental monitoring, bioassay analyses, and instrument calibrations. An up-to-date copy of each written procedure shall be kept in the mill area to which it applies.

All written procedures for both operational and nonoperational activities shall be reviewed and approved in writing by the RPA before implementation and whenever a change in procedure is proposed to ensure that proper radiation protection principles are being applied. In addition, the RPA shall perform a documented review of all existing operating procedures at least annually.

24. The licensee shall be required to use a Radiation Work Permit (RWP) for all work or nonroutine maintenance jobs where the potential for significant exposure to radioactive material exists and for which no standard written procedure already exists. The RWP shall be approved by the RPA or his designee, qualified by way of specialized radiation protection training, and shall at least describe the following:

A. The scope of work to be performed.

B. Any precautions necessary to reduce exposure to uranium and its daughters.

C. The supplemental radiological monitoring and sampling necessary prior to, during, and following completion of the work.

25. Occupational exposure calculations shall be performed and documented within 1 week of the end of each regulatory compliance period as specified in 10 CFR 20.103(a)(2) and 10 CFR 20.103(b)(2). Routine airborne ore dust and yellowcake samples shall be analyzed in a timely manner to allow exposure calculations to be performed in accordance with this condition. Required nonroutine monitoring for ore dust and yellowcake exposure shall be analyzed and the results reviewed by the RPA within 2 working days after sample collection.

License number
SUA-1471, Amendment No. 20

Docket or Reference number
40-8903

MATERIALS LICENSE
SUPPLEMENTARY SHEET

26. Mill tailings, other than small samples for purposes such as research or analysis, shall not be transferred from the site without specific prior approval of the NRC in the form of a license amendment. The licensee shall maintain a permanent record of all transfers made under the provisions of this condition.

27. All liquid effluents from mill process buildings, with the exception of sanitary wastes, shall be discharged to the tailings impoundment.

28. The licensee shall maintain an NRC-approved financial surety arrangement consistent with 10 CFR 40, Criteria 9 and 10, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination of the mill and mill site, reclamation of tailings or waste disposal areas, ground-water restoration, and the long-term surveillance fee. Within 3 months of NRC approval of a revised reclamation plan, the licensee shall submit for NRC review and approval a proposed revision to the financial surety arrangement if estimated costs for the newly approved plan exceed the amount covered in the existing financial surety. The revised surety arrangement shall then be in effect within 3 months of written NRC approval. Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of costs and the basis for the cost estimate. The attachment to the license entitled, "Recommended Outline for Site Specific Reclamation and Stabilization Cost Estimates," outlines the minimum considerations used by the NRC in the review of site closure cost estimates.

    The licensee's currently approved surety, a Parent Company Guarantee issued by Homestake Mining Company, shall be continuously maintained in an amount no less than $20,000,000 for the purpose of complying with 10 CFR 40, Criteria 9 and 10, until a replacement is authorized by the NRC. The use of a parent company guarantee necessitates an evaluation of the corporate parent as part of the annual surety update. In addition to the cost information required above, the annual submittal must include updated documentation of the (1) letter from the chief financial officer of the parent company, (2) auditor's special report confirmation of chief financial officer's letter, (3) schedule reconciling amounts in chief financial officer's letter to amounts in financial statements, and (4) parent company guarantee if any changes are appropriate.

    [Applicable Amendments: 9, 12]

29. The licensee shall decommission the Homestake Uranium Mill in accordance with Section 2 of the reclamation plan dated January 1991; the licensee's August 28, 1991, response to comments 1-10 of the NRC's August 2, 1991, letter; and Technical Specifications B1 and B2 of the reclamation plan as revised on April 3, 1992. In addition, the licensee shall perform a soil cleanup verification gamma survey and soil sampling program as specified in the submittal of September 15, 1994, and as modified by the submittal of December 13, 1994.

    [Applicable Amendment: 20]

    A. Deleted by Amendment No. 20

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number: SUA-1471, Amendment No. 20
Docket or Reference number: 40-8903

B. Deleted by Amendment No. 20

C. Deleted by Amendment No. 20

D. The licensee shall use only soils obtained from borrow areas outside the restricted area which have not been impacted by site operations to cover the mill disposal area. The location of these borrow areas shall be documented.

E. The licensee shall implement a quality control (QC) program for the soil cleanup verification program which consists of recounting using offsite gamma spectroscopy equipment or chemical analysis by a vendor laboratory of at least 15 percent of all soil samples collected. In addition, a minimum of 5 percent of the QC samples shall be chemically analyzed. Results of the QC program shall be evaluated by the Radiation Protection Administrator and the evaluation documented at least monthly during the verification sampling program.

F. All decommissioning activities shall be documented. Within 90 days following the completion of mill demolition and disposal activities, the licensee shall submit to the NRC a report documenting the activities and providing summaries of all data generated as part of the radiation safety program for mill decommissioning. In addition, within 90 days following the completion of the soil cleanup and verification program, the licensee shall submit to the NRC a report documenting the cleanup activities and providing the results of all soil sampling and gamma surveys conducted to verify the adequacy of cleanup.

[Applicable Amendment: 15]

30. The licensee shall implement a program to minimize dispersal of dust from the ore stockpile area(s). This program shall include written operating procedures. The effectiveness of the control method used shall be evaluated weekly by means of a documented inspection.

31. The licensee is authorized to construct and operate a lined brine evaporation pond in accordance with plans, conditions, revisions, and commitments made in conjunction with Ground Water Discharge Plan DP-339, approved by the Ground Water/Hazardous Bureau of the State of New Mexico by a letter dated January 17, 1986, signed by Ernest Rebuck. Such plans, conditions, revisions, and commitments are contained in submittals and correspondence from Homestake Mining Company dated March 22, 1984, April 9, 1984, and April 17, 1986; and includes a commitment by letter dated April 11, 1986, to reclaim the pond area in accordance with applicable reclamation standards after the cessation of operations.

[Applicable Amendments: 5, 8]

32. The licensee shall comply with the following:

MATERIALS LICENSE
SUPPLEMENTARY SHEET

A. The quantity of air sampled and the method of analysis shall result in a lower limit of detection (LLD) for all in-plant air sampling of at least 10 percent of the respective maximum permissible concentration for restricted areas.

B. Analysis of urine samples shall utilize an LLD of at least 5 ug/l uranium.

C. A copy of the report documenting the annual ALARA audit shall be submitted to the NRC, review within 30 days of completion of the audit.

[Applicable Amendment: 2]

33. All eating areas and change rooms located in mill process areas shall be spot-checked weekly for removable surface contamination. Areas shall be promptly cleaned if surface contamination levels exceed the values listed in Table 1 of Regulatory Guide 8.30. In addition, all laboratory surfaces used for preparation of bioassay samples shall be spot-checked prior to sample analysis and decontaminated if removable contamination levels exceed 200 dpm alpha/100 cm^2. The results of all surveys and spot checks shall be documented.

[Applicable Amendment: 2]

34. DELETED by Amendment No. 4.

35. The licensee shall implement a compliance monitoring program containing the following:

A. Implement the monitoring program shown in Table 2 of the licensee's September 2, 1993 submittal.

B. Comply with the following ground-water protection standards at brine evaporation pond point-of-compliance Wells D1 and BP, at the inactive tailings impoundment point-of-compliance Wells Y and X, and at the active tailings impoundment point-of-compliance Wells S4, S3, M5, and DQ with background being recognized in Well P:

chromium = 0.06 mg/l, molybdenum = 0.03 mg/l, selenium = 0.10 mg/l, vanadium = 0.02 mg/l, uranium = 0.04 mg/l, radium-226 and -228 = 5.0 pCi/l, and thorium-230 = 0.30 pCi/l.

C. Implement the corrective action program described in the September 15, 1989, submittal due to exceeding ground-water protection standards, with the objective of returning the concentrations of chromium, molybdenum, selenium, thorium-230, uranium, and vanadium to the concentration limits specified in 35(B) above.

D. Operate the lined evaporation pond and enhanced evaporation system as described in the June 8 and 28, 1990, submittals.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number
SUA-1471, Amendment No. 20

Docket or Reference number
40-8903

E. Submit a semiannual ground-water monitoring report in accordance with the reporting requirements of 10 CFR 40.65. Also, submit, by February 28 of each year, a performance review of the corrective action program that details the progress towards attaining ground-water protection standards.

[Applicable Amendments: 3, 4, 5, 7, 8, 10, 11, 16]

36. The licensee shall complete site reclamation in accordance with an approved reclamation plan. The ground-water corrective action plan shall be conducted as authorized by License Condition No. 35. All activities shall be completed in accordance with the following schedules.

A. To ensure timely compliance with target completion dates established in the Memorandum of Understanding with the Environmental Protection Agency (56 FR 55432, October 25, 1991), the licensee shall complete reclamation to control radon emissions as expeditiously as practicable, considering technological feasibility, in accordance with the following schedule:

(1) Windblown tailings retrieval and placement on the pile:

For the Large Impoundment - December 31, 1996.

For the Small Impoundment - May 31, 1997.

(2) Placement of the interim cover to decrease the potential for tailings dispersal and erosion:

For the Large Impoundment - December 31, 1996.

For the Small Impoundment - May 31, 1997.

(3) Placement of final radon barrier designed and constructed to limit radon emissions to an average flux of no more than 20 $pCi/m^2/s$ above background:

For the Large Impoundment which has no evaporation ponds - December 31, 1996.

For the Small Impoundment, tailings pile surface areas are essentially covered by evaporation ponds constructed as part of the ground-water corrective action program. Prior to December 31, 2001, the areas not covered by the evaporation ponds shall have final radon barrier in place. Final radon barrier placement over the entire pile shall be completed within 2 years of completion of ground-water corrective actions.

B. Reclamation, to ensure required longevity of the covered tailings and ground-water protection, shall be complete as expeditiously as is reasonably achievable, in accordance with the following target dates for completion:

MATERIALS LICENSE
SUPPLEMENTARY SHEET

(1) Placement of erosion protection as part of reclamation to comply with Criterion 6 of Appendix A of 10 CFR Part 40:

For the Large Impoundment - September 30, 1999.

For the Small Impoundment - July 1, 2014.

(2) Projected completion of ground-water corrective actions to meet performance objectives specified in the ground-water corrective action plan - May 1, 2010.

C. Any license amendment request to revise the completion dates specified in Section A must demonstrate that compliance was not technologically feasible (including inclement weather, litigation which compels delay to reclamation, or other factors beyond the control of the licensee).

D. Any license amendment request to change the target dates in Section B above, must address added risk to the public health and safety and the environment, with due consideration to the economic costs involved and other factors justifying the request such as delays caused by inclement weather, regulatory delays, litigation, and other factor beyond the control of the licensee.

[Applicable Amendment: 13]

37. The licensee shall reclaim the large and small tailings impoundments as stated in their January 31, 1991, Reclamation Plan, as revised by submittals dated August 28, 1991, April 3, April 30, and December 21, 1992, and June 30, 1993, submittals, with the following additional requirements.

A. The cover system for the large tailings impoundment shall be as defined on Figure 3.4 of Attachment #5 to the licensee's June 30, 1993, submittal except the clayey sand radon barrier shall be 8 feet thick and shall consist of minus 3/4-inch material, containing at least 25 percent passing the No. 200 sieve, Atterberg limits plotting above the "A" line; and shall be compacted in 6-inch lifts to at least 95 percent of Standard Proctor density within minus 2 to plus 2 percent of the optimum moisture content.

B. The radon barrier for the small impoundment shall be 14 feet thick and shall consist of minus 3/4-inch material, containing at least 25 percent passing the No. 200 sieve, Atterberg limits plotting above the "A" line; and shall be compacted in 6-inch lifts to at least 95 percent of Standard Proctor density within minus 2 to plus 2 percent of the optimum moisture content.

C. The licensee shall submit a construction quality control program for NRC review and approval prior to placing any portion of the radon barrier that will ensure that the specification which limits the activity of the radon barrier material to 5 pCi/g above background is not exceeded.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

D. The construction quality assurance and control program shall be as defined in the Staff Technical Position On Testing and Inspection (NRC, 1989). The acceptable correlation between ASTM D 2922 and ASTM D 1556 shall be as defined in the licensee's April 30, 1992, submittal.

F. The radon barrier shall not be placed on the top surface of the large tailings impoundment until the settlement has been demonstrated to be at least 90 percent of expected settlement, and the results of this determination have been reviewed and accepted by the NRC. The radon barrier may be placed on the large impoundment side slopes following final grading of the impoundment. Care shall be taken to preclude the possibility of ponding. Before the erosion protection is placed, it shall be verified that the radon barrier material meets the specifications.

G. The adequacy of the erosion protection proposed for the side slopes of both the large and small impoundments shall be reevaluated considering any increases in impoundment heights due to the revised radon attenuation cover design.

H. All reclamation plan requirements shall be incorporated into a single comprehensive document by October 31, 1993. This may be accomplished by providing appropriate revisions to the January 31, 1991, reclamation plan drawings and technical specifications, or by providing new drawings and technical specifications.

I. A completion report shall be provided within 6 months of the completion of construction. This report, including as-built drawings, shall verify that reclamation of the site has been performed according to the approved plan. The report shall also include summaries of results of the quality assurance and control testing to demonstrate that approved specifications were met.

[Applicable Amendments: 14]

38. The licensee is authorized to use water collected as part of the site ground-water corrective action program for conditioning soils during placement of the interim cover or the radon barrier on the tailings impoundments. The licensee shall also analyze samples of the collection water being used for this purpose for radium-226 and 228 content semiannually. If sample results exceed 30 pCi/l combined radium, the licensee shall perform an evaluation of the potential impacts of using this water on the required design of the radon barrier and submit the evaluation for NRC review within 30 days of receipt of sample results.

[Applicable Amendment: 18]

39. The licensee is authorized to construct and operate a lined evaporation pond, located between the existing evaporation pond (#1) and the existing brine ponds, in accordance with plans and commitments contained in submittals and correspondence from Homestake Mining Company dated July 26, 1994; August 16, 1994; August 19, 1994; and September 2, 1994; and September 15, 1994. The NRC shall be

License number
SUA-1471, Amendment No. 20

Docket or Reference number
40-8903

MATERIALS LICENSE
SUPPLEMENTARY SHEET

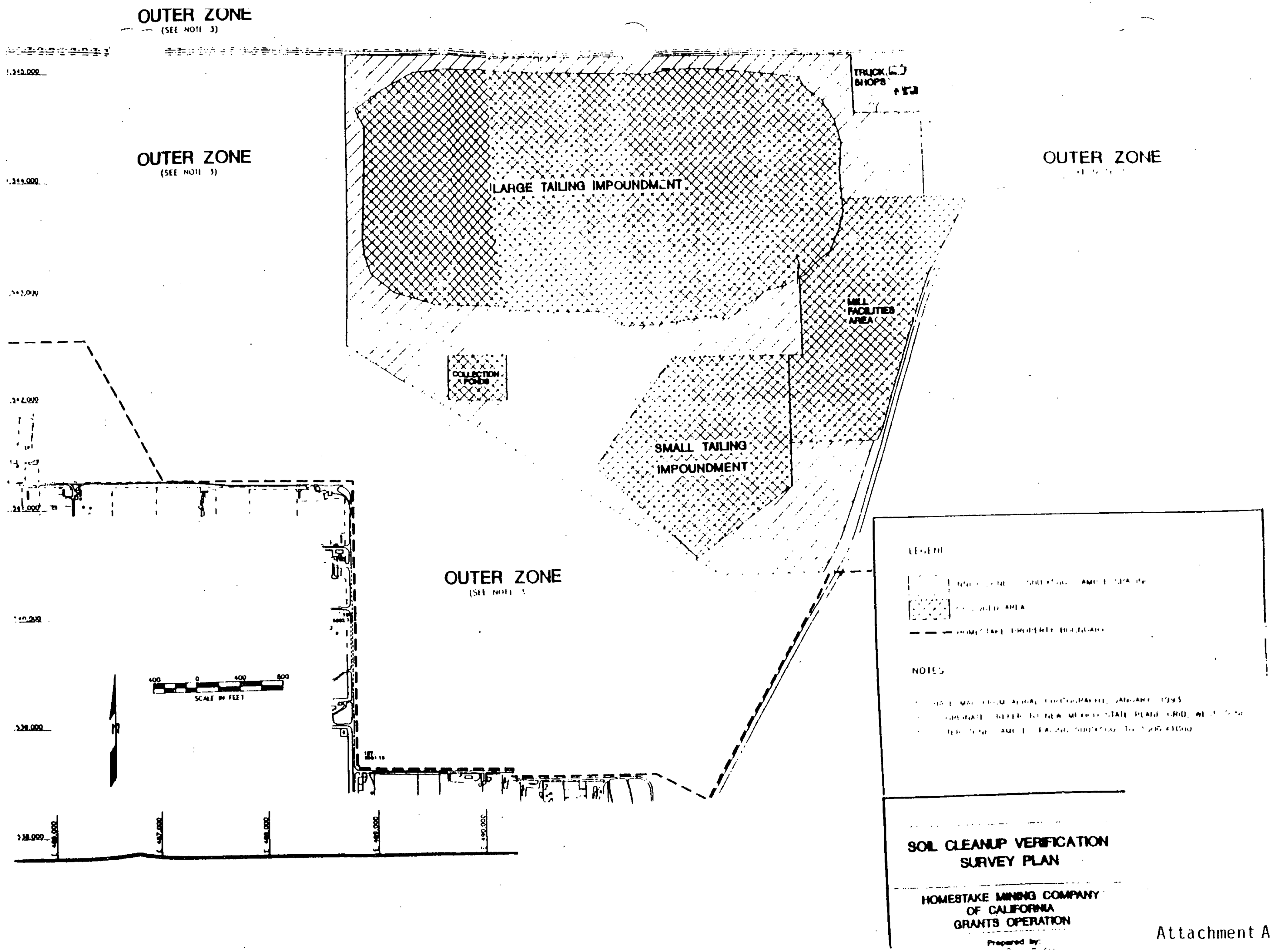
notified by the licensee of any changes or revisions to the design. The licensee shall notify the NRC 30 days prior to start of filling the pond, at which time the NRC may choose to inspect the pond and construction records. Final reclamation shall consist of movement of liner and dike material to the small tailings impoundment. Underlying soils will be sampled for radium-226 content, and if above site standard of 5.5 pCi/gram, soils will be excavated and placed on the small impoundment.

[Applicable Amendment: 19]

FOR THE NUCLEAR REGULATORY COMMISSION

Date Mar 1, 1995

Joseph J. Holonich, Chief
High-Level Waste and Uranium Recovery
Projects Branch
Division of Waste Management, NMSS



Attachment A

December 13, 1994

NEXT DAY UPS TRACKING NO.: 1078 5569 431

U.S. Nuclear Regulatory Commission
Division of Waste Management, MS5E2
Attn. Mr. Joseph J. Holonich, Chief
High Level Waste and Uranium
Recovery Projects Branch
11555 Rockville Pike
Rockville, MD 20850

Re: License SUA-1471 - Docket No. 40-8903

Dear Mr. Holonich:

On September 15, 1994, Homestake Mining Company of California (HMC), owner of the Grants Uranium Mill, submitted a report, "Soil Cleanup Verification Survey and Sampling Plan for Use at the Grants Uranium mill Tailings Site" which was to be used as a basis for a license amendment for verifying the cleanup of windblown tailings and other off-pile contaminated areas. After informal discussions with Ms. Elaine Brummett and Mr. Ken Hooks, HMC conducted an additional study to support a gamma-ray action level for the windblown contaminated areas. A revision to the original action level was evident from the study. The study results were presented in our October 31, 1994 submittal to you.

Informal comments on these submittals on November 8, 1994 in a telephone conversation between myself and NRC staff resulted in the following discussions and revised verification plan.

A. Verification Plan

A.1 Two zones will be considered for soil verification purposes with different approaches taken for each zone. The inner zone encompasses the area in the immediate vicinity of the large and small tailings piles and mill site as shown on the enclosed drawing. All surface soil within the inner zone excluding the tailings piles, the two debris disposal pits, and the mill site are included in the inner zone. All areas noted as excluded have or will be covered with fill or radon barrier as indicated in the NRC-approved Reclamation Plan. This inner zone has a higher probability of localized contaminated areas and is also influenced by gamma-ray shine from the small tailings pile.

The outer zone includes all of the area outside of the inner zone that has been affected by windblown tailings or ore dust. The outer zone is more homogeneous in that the characteristic size of contaminated area is expected to be hundreds of meters across. Because of the difference in the two zones, individual verification plans have been prepared for each zone. This results in an allocation of resources which provide a high probability of compliance with the Ra-226 cleanup criteria.

A.2 For the inner zone, a GPS-based gamma survey will be conducted to assure all areas are below 28,000 cpm. If gamma shine, from the uncovered small tailings pile, does not allow the 28,000 cpm action level to be achieved, the entire area above 28,000 cpm will be gridded into 100 m^2 grids and sampled using a five point composite sample and analyzed for Ra-226. All other areas will be divided into 500 ft grids. The gamma survey map will be used to identify the 100 m^2 grid block within each 500-ft by 500-ft grid having the highest average gamma count rate. A five point composite sample will be prepared for each grid block by taking 6-inch deep surface samples. Each area exceeding the 10.5 pCi/g Ra-226 cleanup criterion will be further excavated and a new gamma survey done. If any sampled area requires additional decontamination, the second highest area within the grid block will be sampled and evaluated. This procedure will be followed until it is evident that the entire 500-ft grid block will meet the cleanup criterion of 10.5 pCi/g.

A.3 For the outer zone, beginning at the closest point near the northwest corner of the Large Tailings Pile (but within the outer zone), 500-ft grids will be established in an easterly direction extending to the State Highway 605. All areas will have been cleaned so that the average gamma reading for any area of 100 m^2 size will be 21,000 cpm or less. The hundred m^2 grid block within each 500-ft by 500-ft grid block having the highest average gamma reading will be sampled and analyzed for Ra-226. A five-point composite sample will be prepared from each of 30 five hundred-ft grids from the north side of the Large Tailings Pile. An additional 10 grids will be sampled in a similar manner from each of the areas in the southerly direction and easterly direction at the boundary of the inner zone and outer zone.

A statistical test will be done to determine whether the mean concentration of the 50 grid blocks is 10.5 pCi/g or less at the 95 per cent confidence level using formula 8-13 of NUREG/CR-5849. Since this represents the mean of a set of 50 biased samples (selected from the grid that has the highest gamma exposure rate), the passing of this test provides assurance that the error rate is very low for the entire sample set made up of all the possible grids that could have been sampled.

If any sample exceeds the 10.5 pCi/g limit, the area will be recleaned and a new gamma survey done. For any grid block that failed the 10.5 pCi/g criterion, the 100 m^2 grid block with the second highest average gamma reading will also be sampled and analyzed in a similar manner. This procedure will be followed until it is evident that there is a high probability that all portions of the grid block meets the cleanup criteria.

A.4 If the statistical test (equation 8-13) is satisfied, HMC will establish 1000-ft grids for the remaining portion of the outer zone. When this occurs, the 100 m^2 grid block having the highest average count rate within each 1000-ft grid will be sampled and analyzed for Ra-226 in a manner as described in No. A.3 above. Equation 8-13 of NUREG/CR-5849 will be used for this set of samples to demonstrate compliance with the desire to clean all grid blocks to meet the 10.5 pCi/g cleanup criterion with a low error rate.

If the mean of the samples is less than the 10.5 pCi/g criterion but the data fails the statistical test, HMC will follow procedures similar to those recommended in Section 8.6 of NUREG/CR-5849. The number of samples will be increased to include the grids with the second highest average gamma levels and again perform the statistical test. This will be done until the statistical test is met. In any case, all grid blocks that were sampled and measured to exceed the 10.5 pCi/g will be recleaned and resurveyed.

If the statistical test in A.3 above fails, HMC will establish 500-ft grids over the entire outer area and sample the 100-m^2 grid block lying to the northeast of each 500-ft grid line intersection. The northeast grid is proposed to assure that no bias is factored into the sampling strategy.

B. Excavation Control Monitoring

Excavation control monitoring is done by a combination of two methods. The GPS-based radiological survey results in a plot of gamma count rates over large areas. Isocontour lines corresponding to action levels are used to delineate the excavation boundaries for scrapers or other large equipment to use while removing the contaminated material. The action level is determined from the correlation studies included in the October 31, 1994 submittal, currently 21,000 cpm.

For small areas such as near utility lines, roads, and areas where contamination may be found at considerable depth, ground control technicians using shielded NaI detectors conduct radiological surveys and guide the excavation effort. This real-time monitoring information

provides a high level of confidence that once the removal is complete, the area will meet the cleanup criteria. Correlation studies for the shielded detectors were performed at the same time as those for the unshielded detectors. The data were provided in the original September 15, 1994 submittal, "Soil Cleanup Survey and Sampling Plan for Use at the Grants Uranium Mill Tailings Site." With the detector placed at a height of six inches above the surface, an action level of 10,000 cpm is used. Experience has shown that normally an area of 100 m^2 size averages less than 9,000 cpm using an action level of 10,000 cpm.

C. Density of Gamma-Ray Measurements

The gamma-ray count rate from the GPS-based radiological survey equipment is recorded once every 2 seconds and represents an average count rate over the field of view of the detector (placed 18 inches above the ground surface). The fact that the detector is moving slowly along the traverses also indicates that the count rate is influenced by the count rate behind the moving system. Therefore, each number represents an average over an area with dimensions of approximately 3 meters by 2 meters, or approximately 6 square meters. In order to obtain a good estimate of the mean gamma count rate for a large area, fewer measurements are required compared to point measurements since each number represents an average over a rather large area.

The density of measurements within any 100 will be considered m^2 grid block averages between 8 and 9. However the uniformity of data depends on operator skill and topography. In some cases, areas on maps may have as few as 5 or 6 records. Homestake reviews all data maps and where the density is considered too low to assure a good average gamma level, additional data are obtained and added to the data base. For outlying areas where gamma levels are consistent and slowly varying, as few as 5 records will be considered adequate; for near-pile areas where the characteristic size of contaminated areas may be smaller, HMC will insist on a minimum of 7 records per 100 m^2.

D. External Influences on Gamma Measurements

NRC staff has raised questions regarding the effects of soil moisture and topography on gamma measurements. It is true that high moisture content retards radon diffusion and thus limits the release of radon from surficially contaminated soils. The maximum effect would be a percentage reduction equal to the emanating fraction. This of course assumes that under dry conditions (or conditions which the calibration studies were done) all of the radon released into the pore space was released to the atmosphere while under wet conditions, none of the radon was released to the atmosphere. Naturally this is not the case and influences as high as 10 percent are difficult to find. For areas where large amounts of rainfall exist, the ground may become moist to great depths preventing the normal diffusion of radon to the surface. This will result in a decrease

in the gamma exposure rate of up to approximately ten percent. Similarly, snow has been shown to decrease the count rates up to ten percent. The semiarid conditions at HMC seldom result in deep penetration of soil moisture. Also, the area near the HMC site does not receive a large amount of snow which stays for a few days at most. Therefore weather conditions (a light rain) at HMC would more likely result in a short-term increase in gamma exposure rate. Since the gamma surveys are not conducted when the soil is wet or snow is on the ground, HMC considers that the effect of soil moisture on the gamma count rate is minimal.

Local topography can be a factor with the greatest influences being on top of ridges (lower levels) and in valleys (higher levels). Experience has shown that these influences are normally less than a few percent. Monitoring in deep trenches however can increase the count rate by up to 2000 cpm on a bare NaI (2-in by 2-in) detector under near background conditions. While these are real influences, most situations tend to increase the count rates rather than decrease the count rates.

The action levels were developed using measurements made while the surface soils were dry and in areas that were relatively flat. Therefore the only influences discussed above that would be nonconservative are the measurements made on sharp ridges. The Grants Uranium Mill Site topography is generally flat near the piles and mill yard and west of Highway 605. The area east of the highway is in some areas generally rolling terrain with elevation changes over a few hundred yards of less than 30 feet. It is not considered a significant source of error for this site.

We believe that this verification plan takes advantage of the very comprehensive gamma data available at the site. The soil sampling strategy, based on a biased sampling of the areas having the highest gamma count rates, provides additional assurance that the site will be meet the cleanup criteria. Please advise me if we can provide additional information.

Sincerely,

HOMESTAKE MINING COMPANY

F. R. Craft
Resident Manager

Enclosure (3 drawings)
xc: H. Barnes
S. Collins - NRC

Standard Operating Procedure
Homestake Mining Company

Verification of Highway Right-of-Way

1. Purpose

To describe the radiological measurements necessary for assuring that the highway right-of-way has been cleaned up to meet the cleanup criteria.

2. Discussion

The highway right-of-way that divides the HMC property is known to be contaminated by windblown tailings. Because of public safety concerns, HMC plans to backfill the excavated areas contiguous to both sides of the pavement prior to obtaining the verification data from soil sample results. Gamma-ray count rate action levels will be developed for detectors that have known correlations between the gamma-ray count rate and Ra-226 concentrations in soil. These action levels will be conservatively chosen in order to minimize the probability for error (estimated 95 % confidence interval).

3. Gamma-Ray Count Rates for Use in Determining Adequacy of Cleanup

Two separate studies were conducted to develop correlations between radiation detector readings and Ra-226 concentrations in soil. The first study focussed on areas south of the Large Tailings Pile where windblown and tailings liquids had contaminated the area. The area is representative of contamination where the uranium content is higher than that that exists in tailings.

A procedure was developed whereby detectors were held at a fixed height and one or more measurements recorded. A five-plug composite sample was taken from the top six-inch soil layer within an area having a radius of approximately 18 inches. Locations where the Ra-226 concentrations ranged from near background to approximately 30 pCi/g were used to develop the correlations shown in the attached figures.

Action Levels were chosen as follows:

Detector	Height	Action Level
Ludlum 3/44-2	36 in	10-12 microR/h*
Ludlum 44-10 (shielded)	6 in	10 kcpm*

* May be higher when geometry conditions increase gamma exposure levels

4. Procedure

4.1 Land survey stakes or other markers will be placed adjacent to the area to be excavated on both sides of the highway at intervals of 25 feet. Each stake will have a unique identifier with at least one stake referenced to the site coordinate system.

4.2 Scrapers will excavate to the prescribed depth, based on prior soil sample results.

4.3 The excavation control technician will the scan the area. Areas exceeding the action level will be marked with pin flags for additional excavation. This will be done until it appears that all contamination above the cleanup criterion has been removed.

4.4 The width of the excavation on each side of the highway will range from 15 to 50 feet. A gamma-ray measurement representing each 25-ft long segment (parallel to the highway) will be recorded on the attached form according to the following procedure.

4.4.1 Follow the HMC procedure for function checking the meter at the beginning of each work shift.

4.4.2 Walk within the excavated area at a fast pace while observing the meter reading, assuring that time is spent in all areas. Record the average reading on the line corresponding to the number on the land survey marker on the northernmost part of the area.

Mark any area that exceeds the action level and immediately advise the field supervisor.

4.5 After areas have been shown to be below the gamma-ray action level, take a 6-inch deep soil sample at approximately one-half the excavation width along each side of the road at 150-ft intervals.

Homestake Mining Company
Gamma-Ray Verification Measuremnts
Cleanup of Highway Right-of-Way

Scaler/Rate Meter Ser. No.________________
Detector Ser. No.______________
Shield Used (Y or N) __________
Action Level __________________microR/h

Stake Number	microR/h	Stake Number	microR/h

Homestake Mining Company
Gamma-Ray Verification Measuremnts
Cleanup of Highway Right-of-Way

Scaler/Rate Meter Ser. No.________________
Detector Ser. No.______________
Shield Used (Y or N) __________
Action Level __________________(cpm or cphm)

Stake Number	counts/min	Stake Number	counts/min

Appendix B

Radiological Characterization Data for Areas Used as Material Borrow Areas

Homestake Mining Company - Grants Operation

Table B-1	Soil Sample Results For North Borrow Pit
Table B-2	Soil Sample Results Taken From The Northwest Borrow Pit
Table B-3	Soil Sample Results Taken From The Near North Borrow Pit

Homestake Mining Company - Grants Operation
Table B-1 Soil Sample Results For North Borrow Pit

HMC Lab ID	HMC Sample ID	Energy Lab ID	Ra-226 Chem. pCi/g	Ra-226 Prec. pCi/g
3421	AN-12-AE-12	94-32126	1.5	0.3
3422	AN-9-AE-12	94-32127	2.0	0.3
3423	AN-10-AE-14	94-32128	0.5	0.2
3424	AN-13-AE-10	94-32129	1.7	0.3
3425	AN-11-AE-12	94-32130	1.0	0.2
3426	AN-14-AE-9	94-32131	1.8	0.3
3427	AN-14-AE-14	94-32132	1.4	0.3
3428	AN-13-AE-13	94-32133	1.1	0.2
3429	AN-12-AE-10	94-32134	0.1	0.1
3430	AN-9-AE-14	94-32135	1.4	0.3
3431	AN-14-AE-15	94-32136	1.7	0.3
3432	AN-12-AE-14	94-32137	1.3	0.3
3433	AN-12-AE-8	94-32138	1.7	0.3
3434	AN-14-AE-8	94-32139	1.2	0.2
3435	AN-8-AE-12	94-32140	2.5	0.3
3436	AN-12-AE-14	94-32141	1.3	0.3
3437	AN-9-AE-9	94-32142	1.5	0.3

HMC Lab ID	HMC Sample ID	Energy Lab ID	Ra-226 Chem. pCi/g	Ra-226 Prec. pCi/g
3438	AN-11-AE-14	94-32143	1.7	0.3
3439	AN-10-AE-12	94-32144	0.7	0.2
3440	AN-14-AE-11	94-32145	1.2	0.2
3441	AN-14-AE-17	94-32146	0.5	0.2

Homestake Mining Company - Grants Operation

Table B-2 Soil Samples Taken From The Northwest Borrow Pit

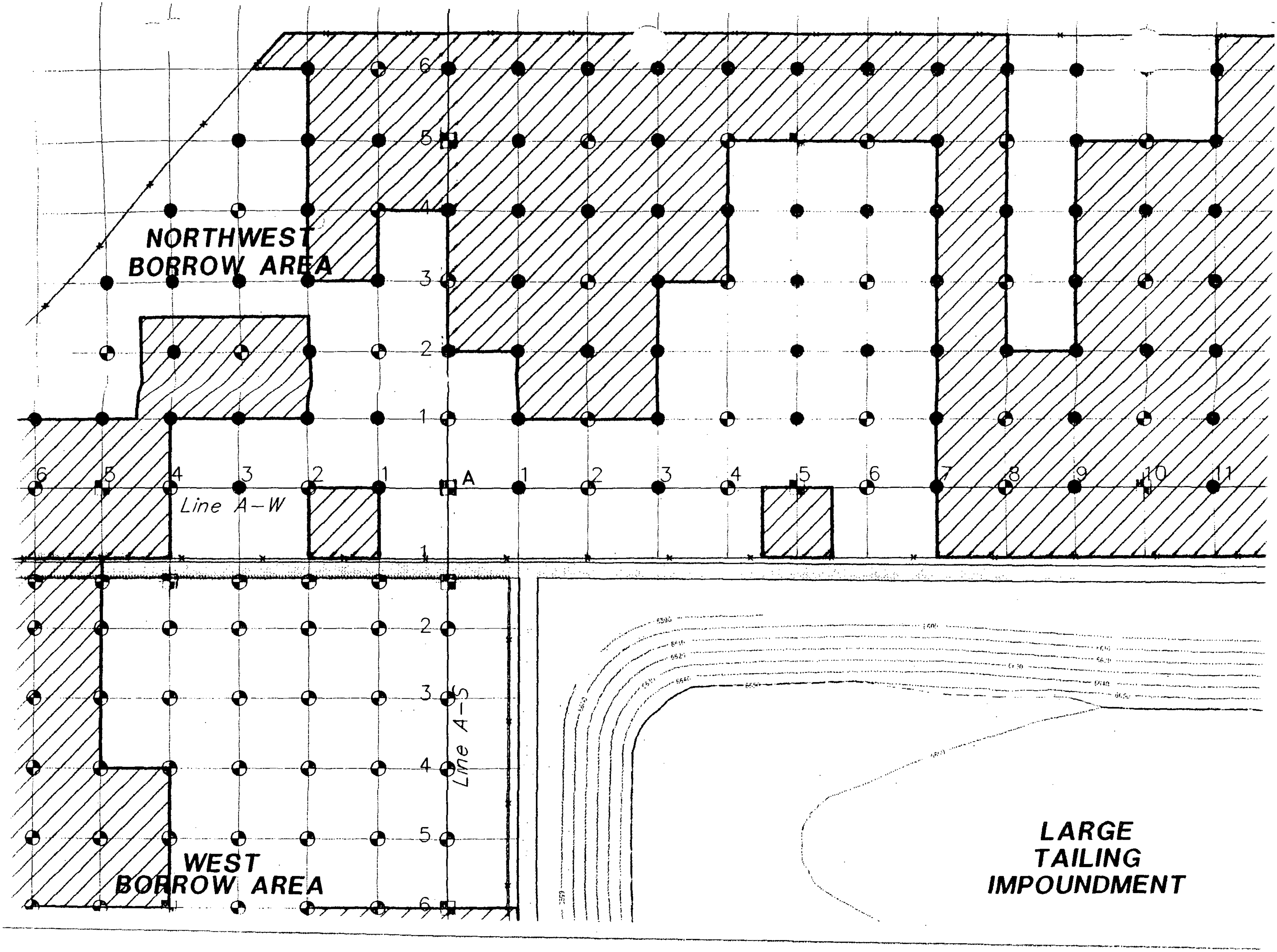
LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
755	AW - 1 - 6"	4.40					
756	AW - 1 - 12"	-0.40					
757	AW - 2 - 6"	1.05					
758	AW - 2 - 12"	-0.42					
759	AW - 3 - 6"	1.82					
760	AW - 3 - 12"	0.41					
761	AW - 4 - 6"	1.17					
762	AW - 4 - 12"	-0.23					
763	AW - 5 - 6"	0.94	1.68	5.00		<1.7	
764	AW - 5 - 12"	-0.19					
765	AW - 6 - 6"	0.58					
766	AW - 6 - 12"	-0.29					
767	AW - 7 - 6"	2.44					
768	AW - 7 - 12"	-0.03					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
769	AN1, AW 1, 6"	4.12					
770	AN1, AW 1, 12"	0.11					
771	AN1, AW 2, 6"	1.16					
772	AN1, AW 2, 12"	0.14					
773	AN1, AW 3, 6"	1.11	1.57	3.40	1.80	<1.7	0.90
774	AN1, AW 3, 12"	-0.42					
775	AN1, AW 4, 6"	-0.03					
776	AN1, AW 4, 12"	-0.36					
777	AN1, AW 5, 6"	0.64					
778	AN1, AW 5, 12"	-0.54					
779	AN1, AW 6, 6"	-0.01					
780	AN1, AW 6, 12"	-0.48					
781	AN1, AW 7, 6"	1.49					
782	AN1, AW 7, 12"	-0.29					
783	AN2, AW 1, 6"	5.96	6.22	8.80		<2.1	
784	AN2, AW 1, 12"	0.20					
785	AN2, AW 2, 6"	2.11					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
786	AN2, AW 2, 12"	-0.09					
787	AN2, AW 3, 6"	2.73					
788	AN2, AW 3, 12"	-0.37					
789	AN2, AW 4, 6"	2.29					
790	AN2, AW 4, 12"	-0.32					
791	AN2, AW 5, 6"	0.88					
792	AN2, AW 5, 12"	-0.79					
793	AN2, AW 6, 6"	0.06	1.10	4.90	1.20	<0.90	3.30
794	AN2, AW 6, 12"	-0.38					
795	AN3, AW 1, 6"	3.95					
796	AN3, AW 1, 12"	-0.28					
797	AN3, AW 2, 6"	3.50					
798	AN3, AW 2, 12"	-0.41					
799	AN3, AW 3, 6"	1.17					
800	AN3, AW 3, 12"	-0.17					
801	AN3, AW 4, 6"	0.74					
802	AN3, AW 4, 12"	-0.19					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
803	AN3, AW 5, 6"	0.16	1.33	1.90		<1.5	
804	AN3, AW 5, 12"	-0.55					
805	AN4, AW 2, 6"	-0.55					
806	AN4, AW 2, 12"	0.46					
807	AN4, AW 3, 6"	0.54					
808	AN4, AW 3, 12"	-0.50					
809	AN4, AW 4, 6"	1.17					
810	AN4, AW 4, 12"	-0.80					
811	AN 4 , AW 1 6"	1.85					
812	AN 4 , AW 1 12"	-0.55					
813	AN 5 , AW 1 6"	4.87	5.43	7.90	5.90	3.90	4.30
814	AN 5 , AW 1 12"	0.43					
815	AN 5 , AW 2 6"	4.66					
816	AN 5 , AW 2 12"	0.06					
817	AN 5 , AW 3 6"	3.78					
818	AN 5 , AW 3 12"	-0.35					
819	AN 6 , AW 1 6"	7.07					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
820	AN 6 , AW 1 12"	0.08					
821	AN 6 , AW 2 6"	5.19					
822	AN 6 , AW 2 12"	1.01					


NORTHWEST
BORROW AREA
Line A–W
Line A–S
WEST
BORROW AREA
LARGE
TAILING
IMPOUNDMENT
A

Homestake Mining Company - Grants Operation
Table B-3 Soil Sample Results Taken From The Near North Barrow Area

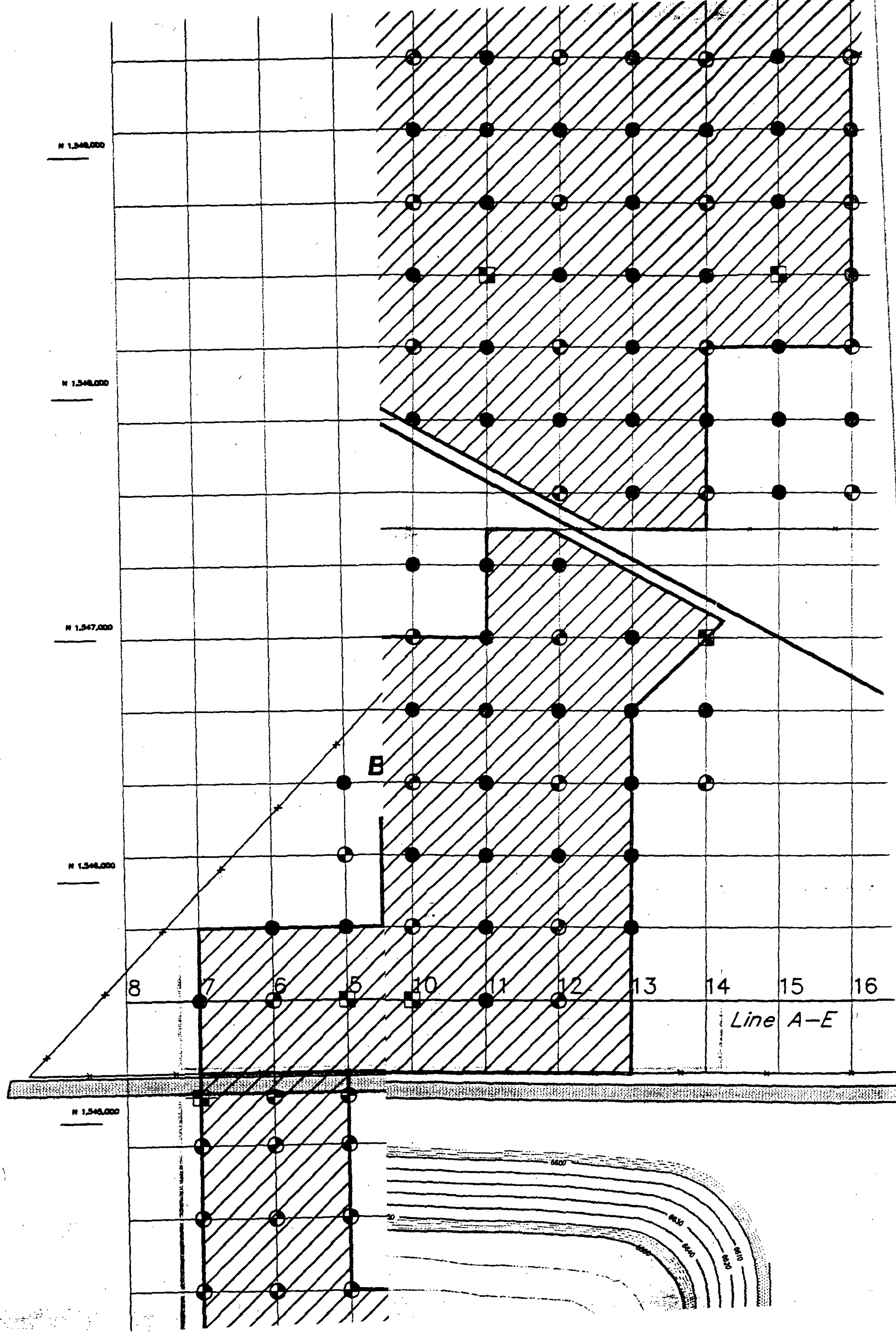
HMC Lab ID	HMC Sample ID	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	TMA Eberline Ra 238 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Unat pCi/g
662	AN - 1, AE-7, 6"	3.08				
663	AN - 1, AE-7, 12"	-0.39	0.87	<1.10		
664	AN - 1, AE-8, 6"	6.90				
665	AN - 1, AE-8, 12"	1.25				
666	AN - 1, AE-9, 6"	9.77				
667	AN - 1, AE-9, 12"	1.06				
668	AN - 1, AE-10, 6"	1.82				
669	AN - 1, AE-10, 12"	-0.37				
670	AN - 1, AE-11, 6"	-0.20				
671	AN - 1, AE-11, 12"	-1.30				
672	AN - 1, AE-12, 6"	4.01				
673	AN - 1, AE-12, 12"	0.15	2.64	<2.00	2.4	1.9
674	AN - 1, AE-13, 6"	2.92				
675	AN - 1, AE-13, 12"	-0.81				
729	AN - 2, AE-7, 6"	0.16				
730	AN - 2, AE-7, 12"	-0.91				

HMC Lab ID	HMC Sample ID	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	TMA Eberline Ra 238 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Unat pCi/g
731	AN - 2, AE-8, 6"	0.31				
732	AN - 2, AE-8, 12"	-0.61				
733	AN - 2, AE-9, 6"	0.86	2.13	2.70	2.7	7.2
734	AN - 2, AE-9, 12"	-0.23				
735	AN - 2, AE-10, 6"	0.79				
736	AN - 2, AE-10, 12"	-0.79				
737	AN - 2, AE-11, 6"	-0.86				
738	AN - 2, AE-11, 12"	-0.64				
739	AN - 2, AE-12, 6"	2.31				
740	AN - 2, AE-12, 12"	-0.93				
741	AN - 2, AE-13, 6"	0.19				
742	AN - 2, AE-13, 12"	-0.31				
837	AN - 3, AE-7, 6"	9.26				
838	AN - 3, AE-7, 12"	0.10				
839	AN - 3, AE-8, 6"	1.68				
840	AN - 3, AE-8, 12"	-0.98				
841	AN - 3, AE-9, 6"	29.66				
842	AN - 3, AE-9, 12"	3.86				
843	AN - 3, AE-10, 6"	7.07	8.71	<3.40		

HMC Lab ID	HMC Sample ID	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	TMA Eberline Ra 238 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Unat pCi/g
844	AN - 3, AE-10, 12"	3.55				
845	AN - 3, AE-11, 6"	22.12				
846	AN - 3, AE-11, 12"	7.07				
847	AN - 3, AE-12, 6"	-0.22				
848	AN - 3, AE-12, 12"	-0.60				
849	AN - 3, AE-13, 6"	0.96				
850	AN - 3, AE-13, 12"	-1.00				
877	AN - 4, AE-7, 6"	1.56				
878	AN - 4, AE-7, 12"	-0.82				
879	AN - 4, AE-8, 6"	2.56				
880	AN - 4, AE-8, 12"	1.22				
881	AN - 4, AE-9, 6"	15.27				
882	AN - 4, AE-9, 12"	-0.28				
883	AN - 4, AE-10, 6"	11.05	11.81	<5.20		
884	AN - 4, AE-10, 12"	0.21				
885	AN - 4, AE-11, 6"	11.50				
886	AN - 4, AE-11, 12"	4.77				
887	AN - 4, AE-12, 6"	8.24				
888	AN - 4, AE-12, 12"	-0.83				

HMC Lab ID	HMC Sample ID	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	TMA Eberline Ra 238 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Unat pCi/g
889	AN - 4, AE-13, 6"	19.58				
890	AN - 4, AE-13, 12"	-0.78				
917	AN - 5, AE-7, 6"	4.21				
918	AN - 5, AE-7, 12"	-1.34				
919	AN - 5, AE-8, 6"	23.34				
920	AN - 5, AE-8, 12"	-0.26				
921	AN - 5, AE-9, 6"	4.54				
922	AN - 5, AE-9, 12"	-0.93				
923	AN - 5, AE-10, 6"	4.84	6.08	<2.20		
924	AN - 5, AE-10, 12"	-1.26				
925	AN - 5, AE-11, 6"	16.25				
926	AN - 5, AE-11, 12"	-0.62				
927	AN - 5, AE-12, 6"	7.05				
928	AN - 5, AE-12, 12"	2.77				
929	AN - 5, AE-13, 6"	9.70				
930	AN - 5, AE-13, 12"	9.86				
931	AN - 5, AE-14, 6"	10.18				
932	AN - 5, AE-14, 12"	-1.05				
957	AN - 6, AE-7, 6"	4.22				

HMC Lab ID	HMC Sample ID	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	TMA Eberline Ra 238 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Unat pCi/g
958	AN - 6, AE-7, 12"	-0.79				
959	AN - 6, AE-8, 6"	3.73				
960	AN - 6, AE-8, 12"	-1.04				
961	AN - 6, AE-9, 6"	1.21				
962	AN - 6, AE-9, 12"	-1.05				
963	AN - 6, AE-10, 6"	2.74	3.81	<1.70		
964	AN - 6, AE-10, 12"	-0.58				
965	AN - 6, AE-11, 6"	1.95				
966	AN - 6, AE-11, 12"	-0.89				
967	AN - 6, AE-12, 6"	1.94				
968	AN - 6, AE-12, 12"	-0.44				
969	AN - 6, AE-13, 6"	1.20				
970	AN - 6, AE-13, 12"	-0.25				


N 1,547,000
B
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Line A–E

Appendix C

Verification Data-Trucking Yard Area

Homestake Mining Company - Grants Operation

Table C-1 Soil Sample Results Taken in The Trucking Yard

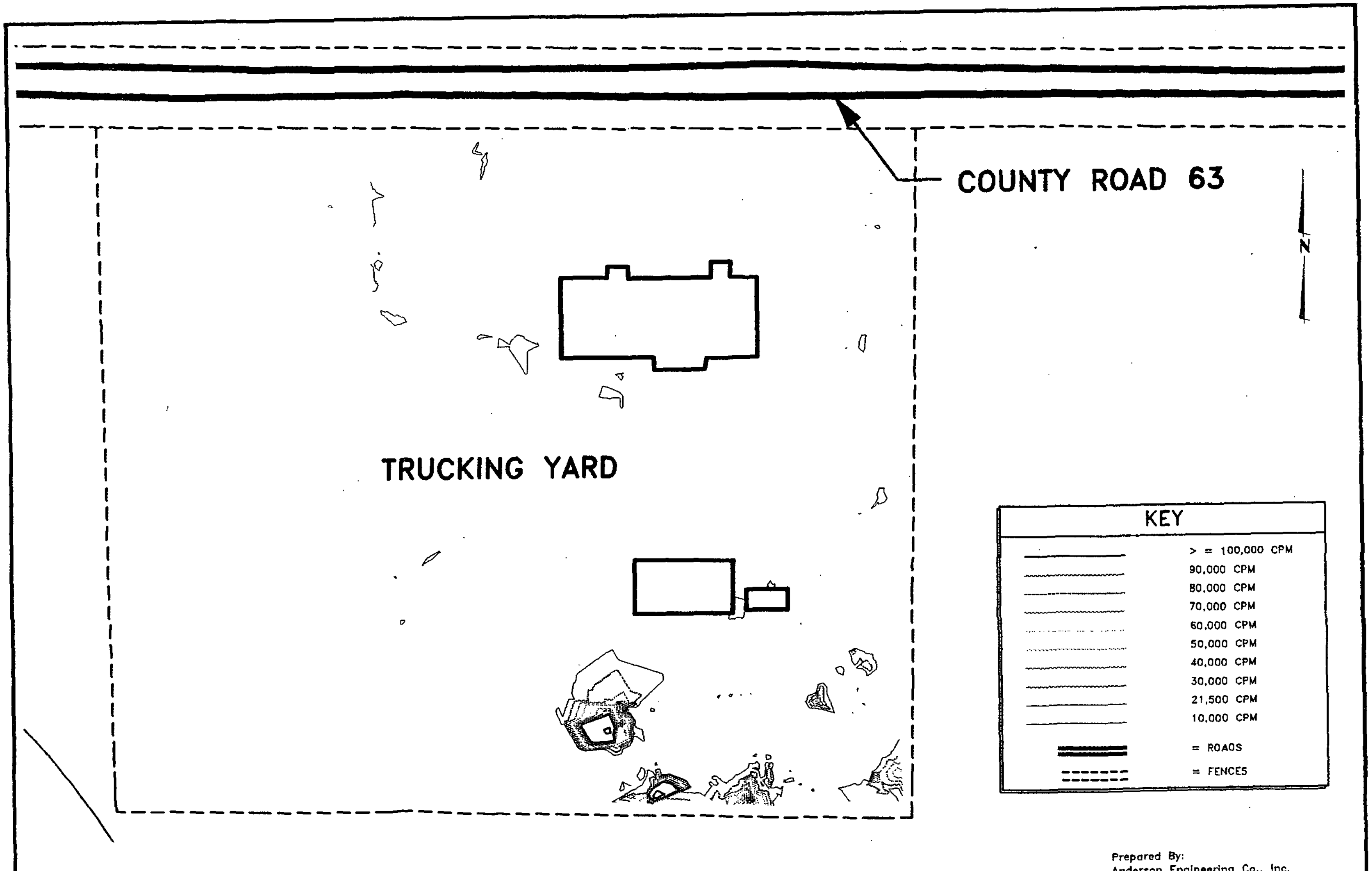


Figure C-1 GPS RADIOLOGICAL SURVEY INSIDE TRUCKING YARD

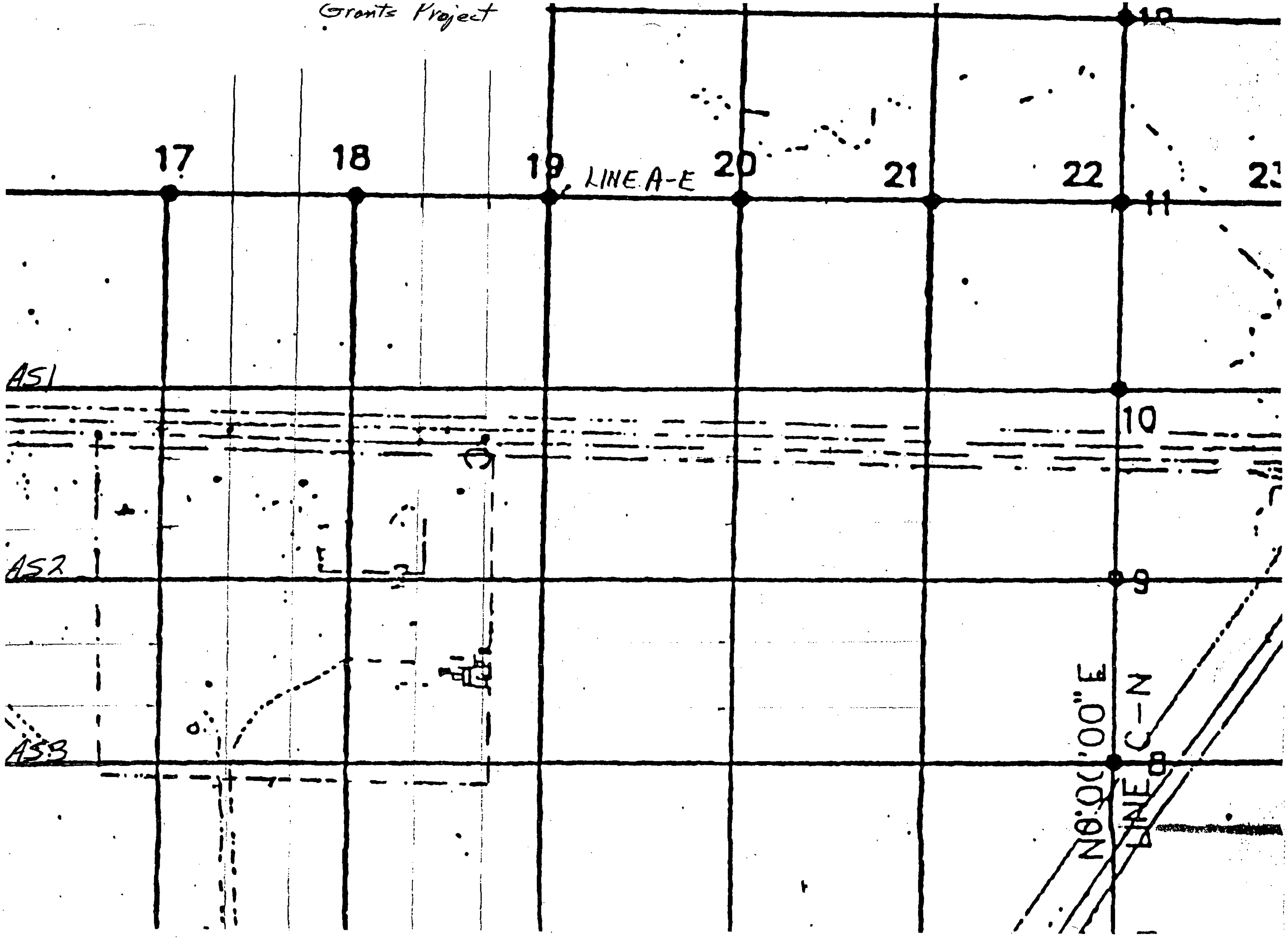
Homestake Mining Company - Grants Operation

Table C-1 Soil Sample Results Taken in The Trucking Yard

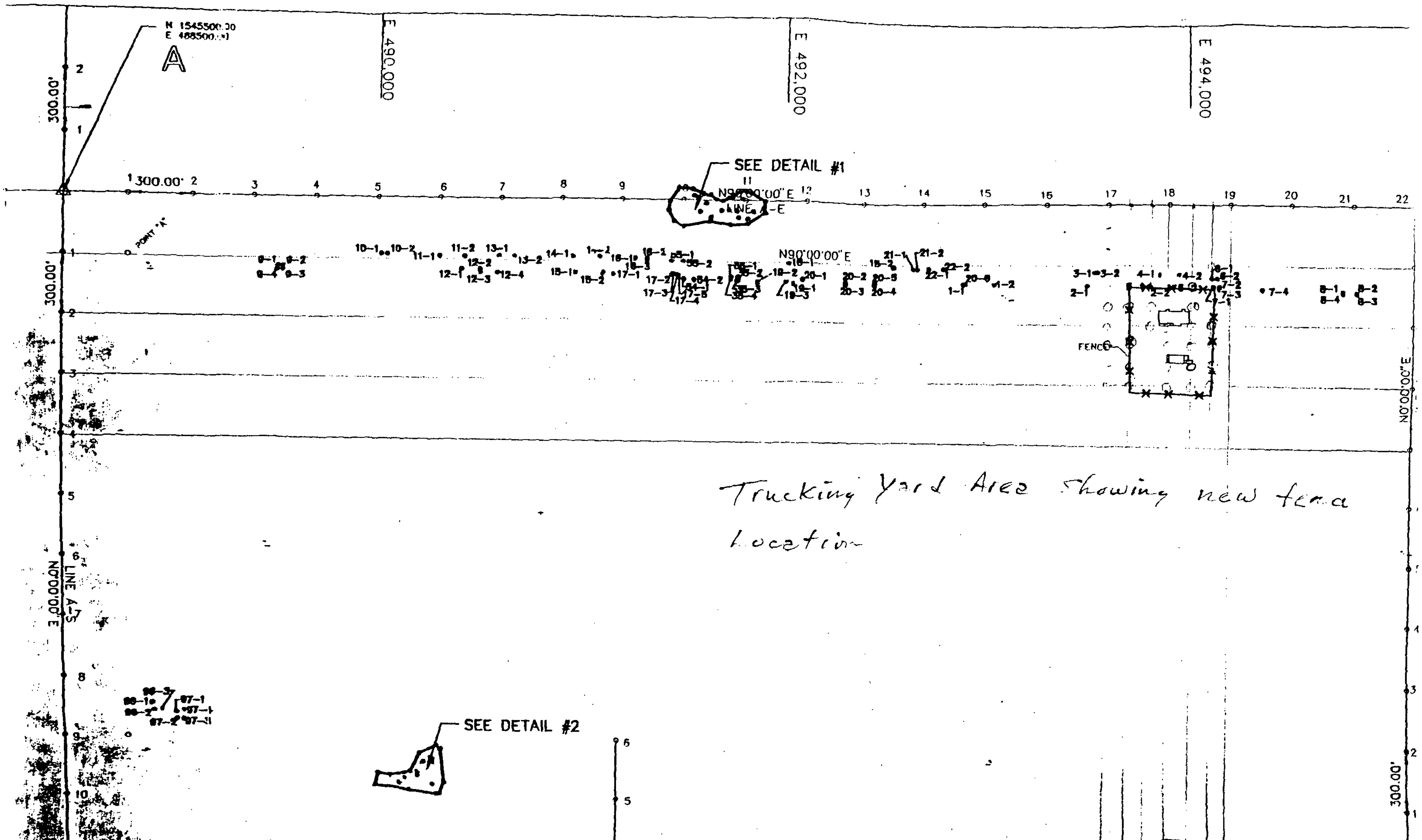
LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3930	STA. # AE-17 - AS-3	1.66					
3931	STA. # AE-18 - AS-2.1	0.61					
3932	STA. # AE-18.2 - AS-3	4.18					
3933	STA. # AE-18.2 - AS-2.2	5.07					
3934	STA. # AE-18.1 - AS-3	0.44					
3935	STA. # AE-18.1- AS-1.2	0.62					
3936	ST.# AE-18.1-AS-1.2 30'	0.70					
3937	STA. # AE-17.1- AS-2.1	3.16					
3938	STA. # AE-18- AS-2.2	0.59	0.58		0.50	1.88	3.00
3939	STA. # AE-18.1- AS-1.1	1.60					
3940	STA. # AE-17.1 - AS-3	1.62					
3941	STA. # AE-18.1- AS-2.2	0.63					
3942	STA. # AE-18 - AS-2	1.58					
3943	STA. # AE-17.1- AS-2.2	-3.23					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3944	STA. # AE-17.1-	1.64					
3945	STA. # AE-18 - AS-3	6.91					
3946	STA. # AE-17 - AS-2	1.58					
3947	STA. # AE-18.2- AS-2.1	0.47					
3948	STA. # AE-18.1- AS-2	1.56	2.34			2.80	
3949	STA. # AE-18.1- AS-1.2	1.21					
3950	STA. # AE-17.2 - AS-2	0.84					
3951	STA. # AE-17.2 - AS-1.2	2.28					
3952	STA. # AE-18.1- AS-2	1.90					
3953	STA. # AE-17 - AS-1.2	0.72					
3954	STA. # AE-17.1 - AS-1.2	1.60					
3955	STA. # AE-17 - AS-2.1	2.14					
3956	STA. # AE-17.1 - AS-2.1	3.06					
3957	STA. # AE-17 - AS-2	1.41					
3958	STA. # AE-17.1 - AS-2	6.93	6.52		5.20	4.02	7.40
3959	STA. # AE-18.2- AS-1	1.14					
3960	STA. # AE-18.2- AS-2	0.92					

Grants Project



		88970.000000	RS 23-2		90147.000000	RS 29-3	41142.000000	90
00	90408.000000	RS 12-1	40982.000000	88933.000000	RS 23	40819.000000	90112.000000	RS 29-4	160.000000	90
						40655.000000	90043.000000	RS 30-1	385.000000	90



Appendix D

Verification Data for Toe of Large Tailings Pile and Characterization Data for the West Borrow Area

Homestake Mining Company - Grants Operation

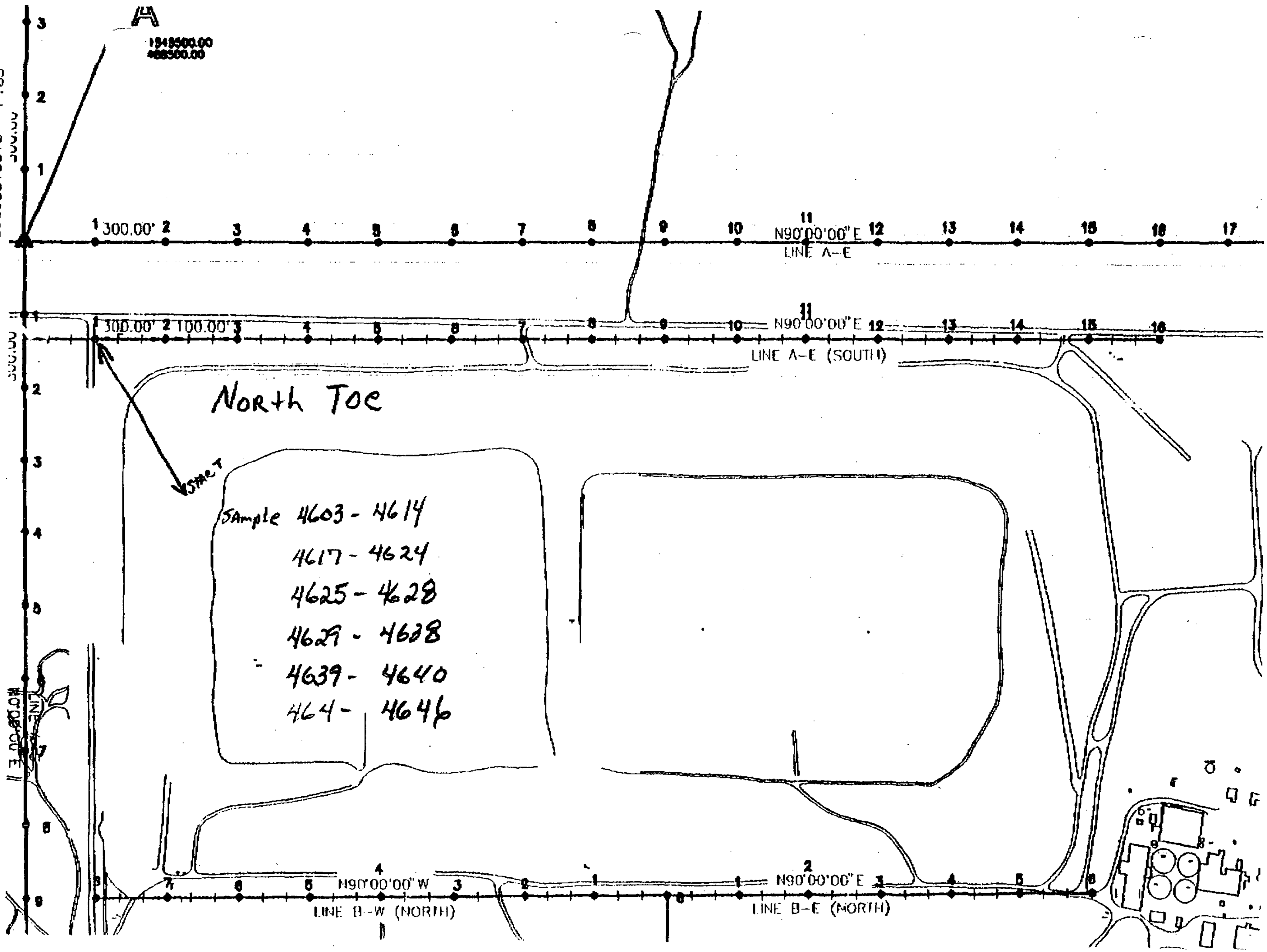
Homestake Mining Company - Grants Operation

Table D-1 Soil Sample Results For The North Toe of The Large Tailings Pile

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4603	AS1.1-E1	4.20			3.80		8.80
4604	AS1.1-E1.1	1.77			1.90		16.50
4605	AS1.1-E1.2	2.44			2.50		10.60
4606	AS1.1-E2	1.42			1.90		17.40
4607	AS1.1-E2.1	1.00			0.90		3.30
4608	AS1.1-E2.2	1.18	0.58		0.60	<1.5	1.20
4609	AS1.1-E3	1.25			0.60		1.00
4610	AS1.1-E3.1	1.63			0.90		2.10
4611	AS1.1-E3.2	2.18			1.50		3.80
4612	AS1.1-E4	1.68			1.30		3.50
4613	AS1.1-E4.1	2.36			2.50		11.70
4614	AS1.1-E4.2	0.92			0.50		0.50
4617	AS1.1 E5	0.38			0.30		0.50
4618	AS1.1 E5.1	0.51	0.86		0.90	2.00	4.00
4619	AS1.1 E5.2	0.70			0.40		0.40
4620	AS1.1 E6	0.49			0.70		0.90

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4621	AS1.1 E6.1	0.70			0.60		0.80
4622	AS1.1 E6.2	1.34			1.20		1.50
4623	AS1.1 E7	1.26			1.20		1.30
4624	AS1.1 E7.1	1.14			1.10		11.90
4625	AS1.1 E7.2	1.96			1.70		14.60
4626	AS1.1 E8	2.02			1.70		5.70
4627	AS1.1 E8.1	1.57			1.20		1.50
4628	AS1.1 E8.2	1.20	0.81		0.80	2.40	4.20
4629	AS1.1 E9	0.68			0.50		2.00
4630	AS1.1 E9.1	1.74			2.30		4.90
4631	AS1.1 E9.2	2.05			2.90		10.30
4632	AS1.1 E10	6.34			9.00		13.50
4633	AS1.1 E10.1	0.91			1.30		1.80
4634	AS1.1 E10.2	27.65			39.10		13.20
4635	AS1.1 E11	1.09			0.90		12.90
4636	AS1.1+50 E11.2	0.42			0.60		0.70
4637	AS1+50 E11.2	1.22			0.90		11.00
4638	AS1+50 E12	1.91	1.60		2.10	7.20	22.30
4639	AS1.1+50 E12.1	0.82			0.60		10.70

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4640	AS1.1+50 E12.2	0.83			1.30		22.60
4641	AS1.1+50 E13	1.00			0.70		11.80
4642	AS1.1+50 E13.1	2.76			3.60		24.60
4643	AS1.1+50 E13.2	7.14			7.60		69.60
4644	AS1.1+50 E14	1.21			1.30		60.00
4645	AS1.1+50 E14.1	0.44			0.60		40.30
4646	AS1.1+50 E14.2	11.50			14.80		35.50


A
300.00'
N90°00'00"E
LINE A-E
300.00' 100.00'
N90°00'00"E
LINE A-E (SOUTH)
North Toe
Start
Sample 4603 - 4614
4617 - 4624
4625 - 4628
4629 - 4638
4639 - 4640
464- 4646
N90°00'00"W
LINE B-W (NORTH)
N90°00'00"E
LINE B-E (NORTH)

Homestake Mining Company - Grants Operation

Table D-2 Soil Sample Results For The West Toe of The Large Tailings Pile And West Barrow Area

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
316	AS-1+50'S (0'-2')	-1.22					
317	AS-1+50'S (2'-4')	-1.11					
318	AS-1+50'S (4'-6')	-1.66					
319	AS-6 (0'-2')	-1.32					
320	AS-6 (2'-4')	-1.48					
321	AS-6 (4'-6')	-1.06					
322	AS-11 (0'-2')	-1.45					
323	AS-11 (2'-4')	-1.05					
324	AS-11 (4'-6')	-1.26	0.53			< 0.95	
325	AW-4,AS1,100'S0'-2'	-1.31					
326	AW-4,AS1,100'S 2'-4'	-0.78					
327	AW-4,AS1,100'S 4'-6'	-0.80					
328	AW-4,AS-6 0'-2'	-1.20					
329	AW4-,AS-6 2'-4'	-1.50					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
330	AW-4,AS-6 4'-6'	-1.09					
331	AW4,AS11 0'-2'	-1.57					
332	AW-4,AS-11 2'-4'	-1.63	0.47		3.20	< 1.0	0.30
333	AW-4,AS-11 4'-6'	-0.77					
534	NW - 1 N	-0.79					
535	NW - 1 S	-0.47					
536	NW - 2 N	-0.76					
537	NW - 2 S	1.84					
538	NW - 3 N	-0.65					
539	NW - 3 S	-0.88					
540	AE-1,AS-1, 6"	4.67					
541	AE-1,AS-1, 12"	0.75					
542	AE-1.1, AS-1.1, 6"	-1.15					
543	AE-1.1, AS-1.1,12"	-0.62	0.33			<0.67	
544	AE-1.2, AS-1.2, 6"	-0.59					
545	AE-1.2, AS-1.2,12"	-1.10					
546	AE-1, AS-2, 6"	-0.82					

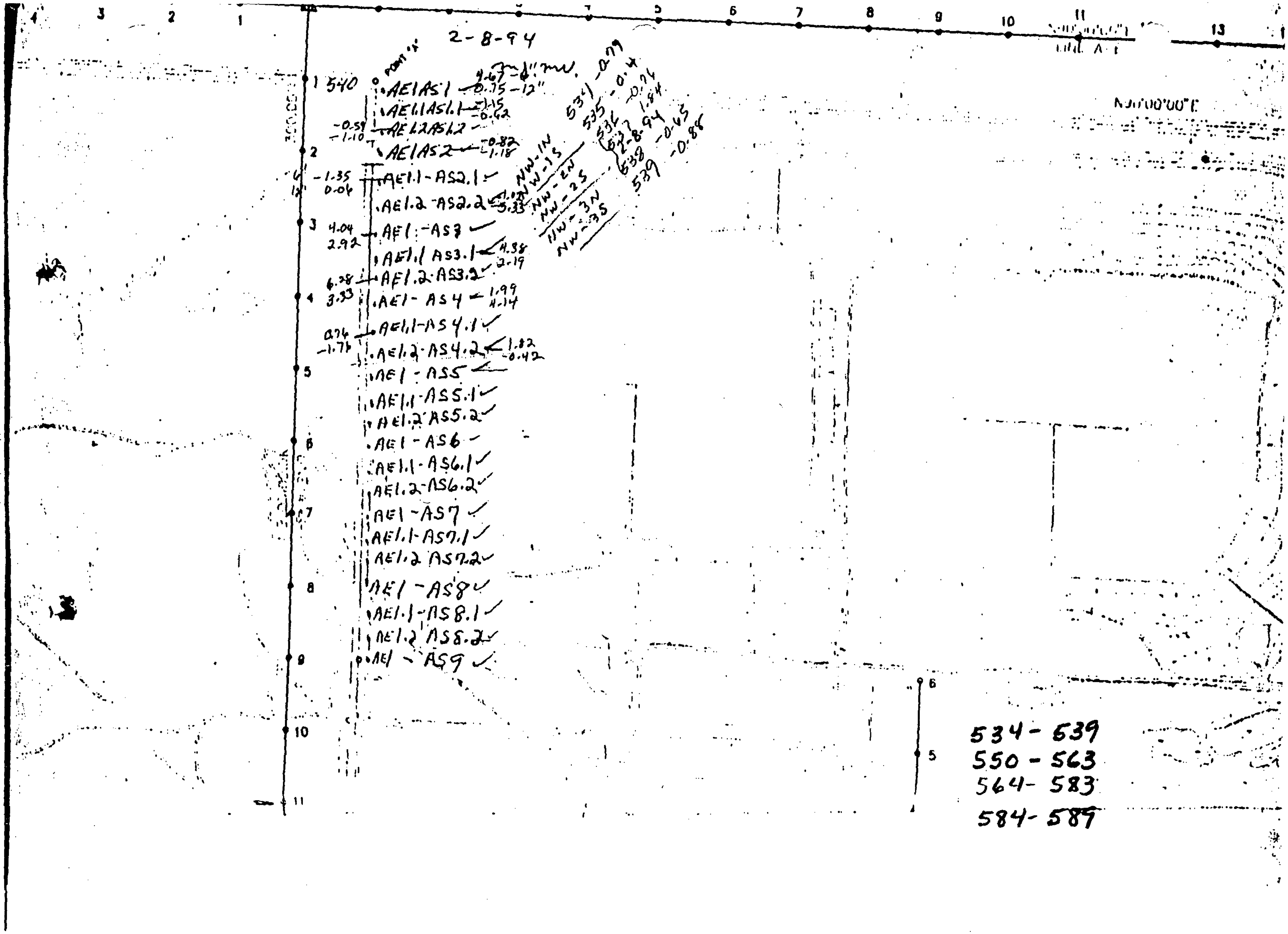
LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
547	AE-1, AS-2, 12"	-1.18					
548	AE-1.1, AS-2.1, 6"	-1.35					
549	AE-1.1, AS-2.1, 12"	0.06					
550	AE-1.2, AS-2.2, 6"	-1.02					
551	AE-1.2, AS-2.2, 12"	-5.33					
552	AE-1, AS-3, 6"	4.04					
553	AE-1, AS-3, 12"	2.92	0.65		0.60	<1.3	1.10
554	AE-1.1, AS-3.1, 6"	4.38					
555	AE-1.1, AS-3.1, 12"	2.19					
556	AE-1.2, AS-3.2, 6"	6.28					
557	AE-1.2, AS-3.2, 12"	3.33					
558	AE-1, AS-4, 6"	1.99					
559	AE-1, AS-4, 12"	4.14					
560	AE-1.1, AS-4.1, 6"	0.76					
561	AE-1.1, AS-4.1, 12"	-1.76					
562	AE-1.2, AS-4.2, 6"	1.82					
563	AE-1.2, AS-4.2, 12"	-0.44	2.04			1.40	

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
564	AE-1,AS-5, 6"	1.18					
565	AE-1,AS-5, 12"	-0.11					
566	AE-1.1,AS-5.1, 6"	3.63					
567	AE-1.1,AS-5.1, 12"	0.11					
568	AE-1.2,AS-5.2, 6"	3.19					
569	AE-1.2,AS-5.2, 12"	1.98					
570	AE-1,AS-6, 6"	1.74					
571	AE-1,AS-6, 12"	0.32					
572	AE-1.1,AS-6.1, 6"	0.76					
573	AE-1.1,AS-6.1, 12"	1.02	2.67		2.90	<1.6	2.10
574	AE-1.2,AS-6.2, 6"	-0.59					
575	AE-1.2,AS-6.2, 12"	-0.68					
576	AE-1,AS-7, 6"	0.40					
577	AE-1,AS-7, 12"	0.37					
578	AE-1.1,AS-7.1, 6"	0.21					
579	AE-1.1,AS-7.1, 12"	-0.33					
580	AE-1.2,AS-7.2, 6"	0.40					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
581	AE-1.2,AS-7.2, 12"	0.25					
582	AE-1,AS-8, 6"	1.33					
583	AE-1,AS-8, 12"	0.52	1.85			<2.4	
584	AE-1.1,AS-8.1, 6"	0.70					
585	AE-1.1,AS-8.1, 12"	0.57					
586	AE-1.2,AS-8.2, 6"	0.67					
587	AE-1.2,AS-8.2, 12"	-0.13					
588	AE-1,AS-9, 6"	0.64					
589	AE-1,AS-9, 12"	0.57					
590	N.W-H.L.POLE,1-6"	-0.72					
591	N.W-H.L.POLE,1-12"	-0.85					
592	N.W-H.L.POLE,2-6"	-0.84					
593	N.W-H.L.POLE,2-12"	-0.82	0.56		0.60	1.30	3.80
594	N.W-H.L.POLE,3-6"	0.18					
595	N.W-H.L.POLE,3-12"	0.39					
596	N.W-H.L.POLE,4-6"	-0.39					
597	N.W-H.L.POLE,4-12"	-0.65					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
598	N.W-H.L.POLE,6-6"	-0.65					
599	N.W-H.L.POLE,6-12"	-0.81					
600	AW7,AS-1+100 0'-2'	-0.52					
601	AW-7,AS-1+100 0'-4'	-0.49					
602	AW-7,AS-1+100 4'-6'	-0.84					
603	AW-7,AS-6 (0'-2')	-0.47	0.84			<1.4	
604	AW-7,AS-6 (2'-'4)	-0.78					
605	AW-7,AS-6 (4'-'6)	-0.84					
606	AW-7,AS-10(4'-'6)	-0.67					
607	AW-7,AS-10(2'-'4)	-0.52					
608	AW-7,AS-10(0'-'2)	-0.95					
625	Point A - 0'- 2'	-0.84					
626	Point A - 2'- 4'	-0.58					
627	Point A - 4'- 6'	-0.80					
628	NWPP 5 - 6"	-0.02					
629	NWPP 5 - 12"	-0.88					
630	NWPPI 3 - 6"	-0.83					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
631	NWPPI 3 - 12"	-0.85					
632	NE I- 4 - 6"	-1.04					
633	NE I- 4 - 12"	-0.93	0.53	2.70	0.50	<1.5	0.60
634	NE I- 5 - 6"	-0.94					
635	NE I- 5 - 12"	-1.07					
636	S W S P - 6"	-0.56					
637	S W S P - 12"	-1.11					
638	NE 7 - 6"	-0.83					
639	NE 7 - 12"	-0.86					
640	NE 8 - 6"	-0.62					
641	NE 8 - 12"	-0.69					


2-8-94
AE1AS1
AE1.1AS1.1
AE1.2AS1.2
AE1AS2
AE1.1-AS2.1
AE1.2-AS2.2
AE1-AS3
AE1.1 AS3.1
AE1.2-AS3.2
AE1-AS4
AE1.1-AS4.1
AE1.2-AS4.2
AE1-AS5
AE1.1-AS5.1
AE1.2-AS5.2
AE1-AS6
AE1.1-AS6.1
AE1.2-AS6.2
AE1-AS7
AE1.1-AS7.1
AE1.2 AS7.2
AE1-AS8
AE1.1-AS8.1
AE1.2 AS8.2
AE1-AS9
NW-1N
NW-1S
NW-2N
NW-2S
NW-3N
NW-3S
534-539
550-563
564-583
584-589

Appendix E

Verification Data-Area Near North Ore Pad

Homestake Mining Company - Grants Operation

Table E-1 Soil Sample Results For Area Near North Ore Pad

Homestake Mining Company - Grants Operation

Table E-1 Soil Sample Results For Area Near North Ore Pad

LAB ID	Wind Blown Sample ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3878	C N 5 2/ W 4 6 "	-0.69					
3879	C N 5 2/ W 4 1/ 6 "	-0.92					
3880	C N 5 2/ W 3 1/ 6 "	-2.59					
3881	C N 5 2/ W 3 2/ 6 "	-2.40					
3882	C N 5 1/ W 2 1/ 6 "	-1.59	0.45		0.30	3.25	4.00
3883	C N 5 1/ W 2 2/ 6 "	-1.57					
3884	C N 5 1/ W 3 6 "	-0.38					
3885	C N 5 1/ W 3 1/ 6 "	-3.55					
3886	C N 5 1/ W 3 2/ 6 "	-3.74					
3887	C N 5 1/ W 4 6 "	2.30					
3888	C N 5 1/ W 4 1/ 6 "	3.63					
3889	C N 5 W 4 6 "	-3.15					
3890	C N 5 W 2 1/ 6 "	-3.45					
3891	C N 5 W 2 2/ 6 "	-4.55					

LAB ID	Wind Blown Sample ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3892	C N 5 W 3 6 "	-4.43	0.77			3.25	
3893	C N 5 W 3 1/ 6 "	-4.48					
3894	C N 5 W 3 2/ 6 "	-4.06					
3895	C N 4 2/ W 2 1/ 6 "	-3.72					
3896	C N 4 2/ W 2 2/ 6 "	-5.44					
3897	C N 4 2/ W 3 6 "	-4.75					
3898	C N 4 2/ W 3 1/ 6 "	-4.72					
3899	C N 4 2/ W 3 2/ 6 "	-5.01					
3900	C N 4 2/ W 4 6 "	9.05					
3901	C N 4 1/ W 2 2/ 6 "	13.52					
3902	C N 4 1/ W 3 6 "	-3.27	1.12		1.00	30.00	69.10
3903	C N 4 1/ W 3 1/ 6 "	-3.96					
3904	C N 4 - W 3 6 "	1.78					
3905	C N 4 - W 3 1/ 6 "	2.65					
3906	C N 4 - W 3 2/ 6 "	5.44					
3907	C N 3 - W 3 1/ 6 "	2.21					
3908	C N 3 - W 3 2/ 6 "	2.64					

LAB ID	Wind Blown Sample ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3909	C N 3 1/ W 3 1/ 6 "	5.61					
3910	C N 3 2/ W 3 6 "	1.70					
3911	C N 3 2/ W 3 1/ 6 "	8.35					
4234	CN3-W 3.1	0.41					
4235	CN 3.1- W3.1	0.63					
4236	CN 3.2- W3	0.63					
4237	CN 3.2- W3.1	0.76					
4238	CN-4 W3.1	0.59	0.35		0.40	5.30	15.40
4239	CN-4 W 3.1	0.96					
4240	CN-4.1 W2.2	3.33					
4241	CN-4.1 W-3	0.89					
4242	CN-4.1-W3.1	1.20					
4243	CN-4.2-W2.1	1.64					
4244	CN-4.2-W2.2	2.69					
4245	CN-4.2-W3	1.82					
4246	CN-4.2-W3.1	1.38					

LAB ID	Wind Blown Sample ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g

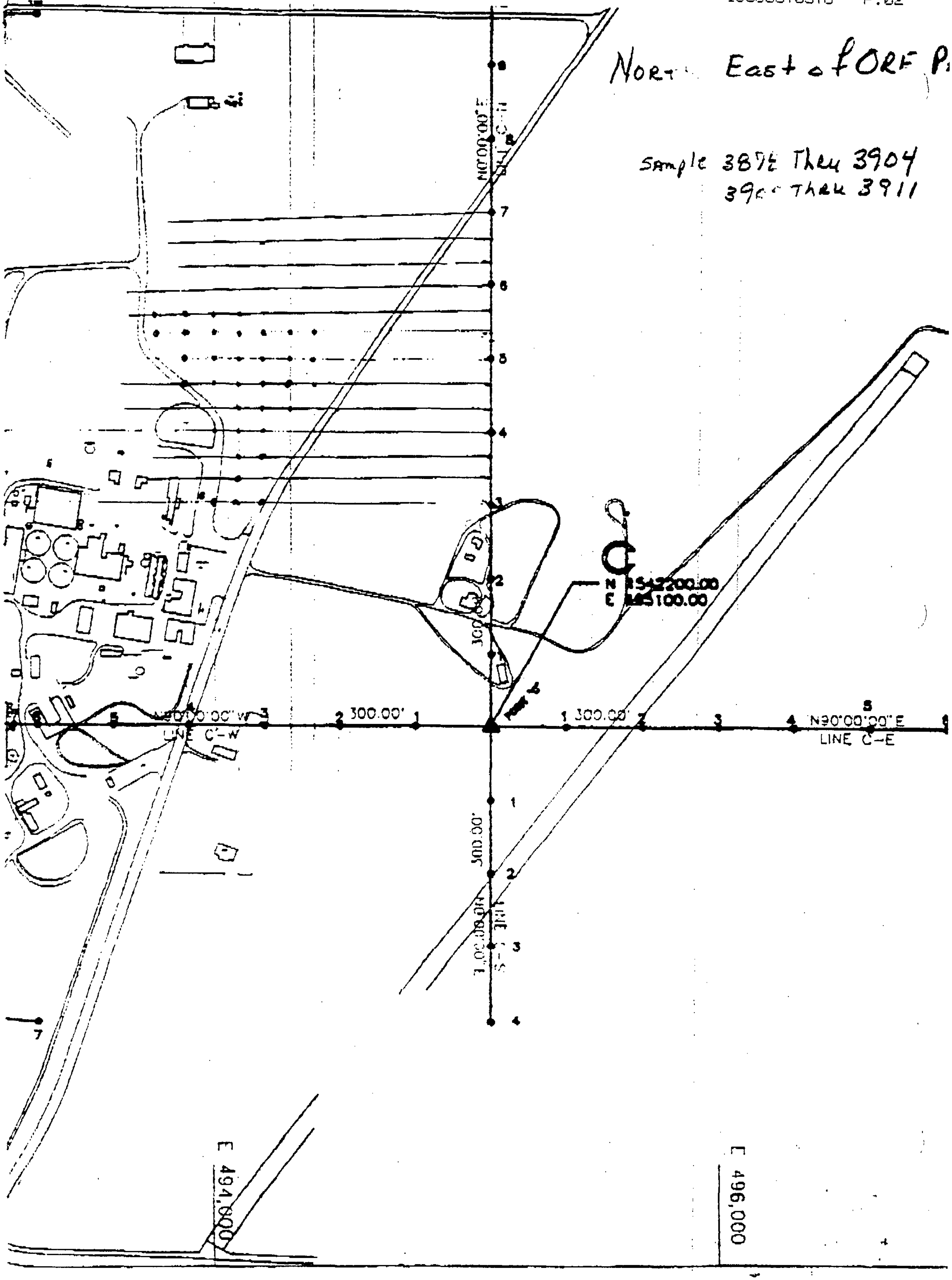
HMC Average= **1.30**

Stand. Deviation= **0.88**

08-09-1995 03:31PM FROM HOMESTAKE GRANTS TO 15058370378 P.02

North East of ORF P

Sample 38?? Thru 3904
39?? Thru 3911



Appendix F

Characterization and Verification Data
State High Way 605 Right of Way and County Road 63 Road Bed

Homestake Mining Company - Grants Operation

Homestake Mining Company - Grants Operation
Table F-1 Gamma Readings For State Hwy. 605 Right-of-Way Along Mill Site

Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr
100	5236		122	3507		144	3525	
101	3600		123	3269		145	3236	
102	3367		124	3114		146	3070	
103	3398		125	3206		147	2987	
104	3334		126	3079		148	2918	
105	3486		127	3133		149	3065	
106	3486		128	3146		150	3108	
107	3154		129	3102		151	3203	
108	3167		130	3049		152	2892	
109	3255		131	3238		153	2899	
110	3623		132	3238		154	2781	
111	3622		133	2992		155	3043	
112	3836		134	3318		156	2939	
113	3549		135	3523		157	2987	
114	3540		136	3416		158	2833	
115	3366		137	3443		159	3078	
116	3514		138	3145		160	3541	
117	2532		139	2965		161	3570	

Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr
118	2753		140	3514		162	3453	
119	2960		141	3561		163	3626	
120	3971		142	3422		164	3214	
121	2805		143	3544		165	2972	
166	3444		188	3031		210	3891	
167	2784		189	3457		211	4198	
168	3845		190	3717		212	3669	
169	3497		191	4087		213	3324	
170	3562		192	3806		214	3108	
171	3406		193	3287		215	3179	
172	3696		194	2968		216	3029	
173	3738		195	3012		217	3162	
174	3403		196	3283		218	3234	
175	4096		197	3111		219	3272	
176	3071		198	3290		220	4462	
177	2983		199	3548		221	4875	
178	2791		200	4997		222	5242	
179	3023		201	3631		223	4527	
180	2873		202	3285		224	4678	
181	2926		203	3382		225	4243	

Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr
182	2797		204	3593		226	4276	
183	2747		205	4063		227	4006	
184	2659		206	4508		228	4496	
185	2677		207	4677		229	4968	
186	2557		208	4247		230	4832	
187	2971		209	4111		231	3995	
232	3627		254	3547		276	3076	
233	3869		255	3105		277	4192	
234	3932		256	4067		278	3128	
235	3986		257	2288		279	3566	
236	4542		258	3422		280	3469	
237	3967		259	3297		281	4010	
238	3947		260	4509		282	3206	
239	3937		261	3421		283	4070	
240	3840		262	3525		284	3700	
241	3523		263	4025		285	3827	
242	3560		264	3426		286		10-11
243	4596		265	3250		287		10-11
244	4200		266	3540		288		9-11
245	3493		267	4314		289		10-11

Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr
246	3181		268	3606		290		9-11
247	3303		269	4384		291		9-11
248	4362		270	4496		292		9-10
249	3396		271	4528		293		9-10
250	3215		272	5046		294		8-9
251	2617		273	4792		295		9-10
252	2807		274	4154		296		9-10
253	3231		275	2980		297		8-9
298		8-9	320		9-10	342	3724	
299		8-9	321		10-11	343	2896	
300		7-8	322		10-11	344	2636	
301		7-8	323		10-11	345	2544	
302		7-8	324		9-10	346	2631	
303		8-10	325		9-10	347	2564	
304		8-10	326		7-8	348	3110	
305		7-11	327		9-10	349	3155	
306		7-11	328		9-10	350		9-10
309	4301	* n/a	331		9-10	353		9-10
310	4301	* n/a	332		8-9	354		9-10

* Averaged over more than one 25 ft interval.

Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr
311	3803	* n/a	333		9-10	355		9-10
312	3803	* n/a	334		9-10	356		9-10
313	3803	* n/a	335		9-10	357		10-13
314	4038	* n/a	336		9-10	358		11-13
315	4038	* n/a	337		9-10	359		12-14
316	3577	* n/a	338		6-7	360		12-14
317	3577	* n/a	339		9-10	361		12-14
318	3577	* n/a	340	3640		362		15-16
319	4324	* n/a	341	3126		363		15-16
364		15-16	386	3691		408	2895	
365		15-16	387	3691		409	3133	
366		15-16	388	3365		410	3001	
367		15-16	389	3054		411	3808	
368		13-14	390	3011		412	4489	
369		13-15	391	3913		413	4308	
370		12-14	392	4013		414	3749	
371		13-15	393	4551		415	3564	
372		14-16	394	3837		416	3382	
373		14-16	395	3315		417	4704	

* Averaged over more than one 25 ft interval.

Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr
374		14-16	396	3573		418	3892	
375	3256		397	2930		419	4485	
376	3426		398	3109		420	4811	
377	3735		399	3471		421	4665	
378	3128		400	3107		422	2687	
379	3215		401	3118		423	2765	
380	2744		402	3354		424	3311	
381	2797		403	2851		425	2954	
382	3124		404	2812		426	3203	
383	3346		405	2691		427	3051	
384	3340		406	2721		428	2874	
385	3560		407	3114		429	2939	
430	3707		452	3724		474	3653	
431	2634		453	3040		475	2816	
432	3031		454	3615		476	2400	
433	4204		455	4413		477	2462	
434	3812		456	4611		478	2974	
435	4363		457	4017		479	2437	
436	4610		458	3659		480	2719	
437	3966		459	4088		481	2668	

Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in μR/hr
438	3263		460	2531		482	3170	
439	3991		461	3637		483	2920	
440	3782		462	3786		484	2827	
441	3677		463	3694		485	3326	
442	3436		464	3489		486	5845	
443	2860		465	4032		487	2953	
444	2936		466	3291		488	2936	
445	3876		467	3437		489	3033	
446	3960		468	3774		490	2642	
447	3448		469	4523		491	2616	
448	3427		470	3542		492	2805	
449	3811		471	3926		493	2641	
450	4103		472	3876		494	3682	
451	4337		473	3462		495	3082	
496	2905		518	3484		540	7590	
497	3688		519	3341		541	8004	
498	3392		520	4935		542	7484	
499	3258		521	4615		543	7062	
500	3138		522	7475		544	7144	
501	3151		523	7876		545	6409	

Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr	Station Number	Gamma Reading in cphm	Gamma Reading in µR/hr
502	3381		524	7484		546	6609	
503	3172		525	6372		547	7145	
504	3943		526	6470				
505	3633		527	6484				
506	3188		528	9962				
507	2901		529	8062				
508	3094		530	5888				
509	2842		531	6558				
510	3394		532	6796				
511	3531		533	8598				
512	2865		534	6894				
513	2812		535	7164				
514	2839		536	7876				
515	2910		537	7608				
516	3012		538	6680				
517	2880		539	7180				

Homestake Mining Company - Grants Operation

Table F-2 Soil Sample Results For State Hwy. 605 Right-of-Way Along Mill Site

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3457	STA. #326 0 "-6 "	0.30					
3458	STA. #332 0 "-6 "	0.74					
3459	STA. #338 0 "-6 "	0.38					
3460	STA. #350 0 "-6 "	0.30					
3461	STA. #356 0 "-6 "	0.24	0.83		0.8	<3.5	
3462	STA. #362 0 "-6 "	0.49					
3463	STA. #368 0 "-6 "	0.20					
3464	STA. #374 0 "-6 "	0.48					
3465	STA. #286 0 "-6 "	4.24					
3466	STA. #292 0 "-6 "	5.67					
3718	STA. #523 0 "-6 "	0.25					
3719	STA. #529 0 "-6 "	-0.92					
3720	STA. #535 0 "-6 "	3.08					
3721	STA. #541 0 "-6 "	-0.13					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3722	STA. #547 0 "-6 "	13.48					
3723	STA. #201 0 "-6 "	-2.19	0.42		0.40	<3.6	6.20
3724	STA. #206 0 "-6 "	-0.88					
3725	STA. #212 0 "-6 "	-1.41					
3726	STA. #218 0 "-6 "	-1.33					
3727	STA. #224 0 "-6 "	6.20					
3728	STA. #298 0 "-6 "	7.09					
3729	STA. #304 0 "-6 "	6.59					
3730	STA. #230 0 "-6 "	7.66					
3731	STA. #234 0 "-6 "	-0.84					
3732	STA. #240 0 "-6 "	4.12	3.70		4.60	<4.44	7.00
3733	STA. #246 0 "-6 "	7.80					
3734	STA. #252 0 "-6 "	6.38					
3735	STA. #258 0 "-6 "	2.54					
3736	STA. # 264 0 "-6 "	1.82					
3737	STA. # 270 0 "-6 "	16.33					
3738	STA. # 276 0 "-6 "	4.34					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3739	STA. # 282 0 "-6 "	0.27					
3740	STA. # 288 0 "-6 "	4.83					
3741	STA. # 434 0 "-6 "	7.20					
3742	STA. # 440 0 "-6 "	2.91	3.93		3.90	<2.27	2.80
3743	STA. # 446 0 "-6 "	29.27					
3744	STA. # 452 0 "-6 "	0.16					
3745	STA. # 469 0 "-6 "	1.26					
3746	STA. # 464 0 "-6 "	6.76					
3747	STA. # 475 0 "-6 "	-0.98					
3748	STA. # 481 0 "-6 "	7.18					
3749	STA. # 487 0 "-6 "	-2.71					
3750	STA. # 493 0 "-6 "	-1.35					
3751	STA. # 499 0 "-6 "	-1.53					
3752	STA. # 505 0 "-6 "	-0.85	0.98		1.20	<3.6	5.20
3753	STA. # 511 0 "-6 "	-2.26					
3754	STA. # 517 0 "-6 "	8.76					
3755	STA. # 458 0 "-6 "	-2.51					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3756	STA. # 106 0 "-6 "	2.14					
3757	STA. # 112 0 "-6 "	1.07					
3819	STA. # 122 0 "-6 "	1.01					
3820	STA. # 128 0 "-6 "	0.71					
3821	STA. # 134 0 "-6 "	0.72					
3822	STA. # 140 0 "-6 "	0.30	0.65		0.50	2.92	6.50
3823	STA. # 144 0 "-6 "	0.69					
3824	STA. # 148 0 "-6 "	0.88					
3825	STA. # 150 0 "-6 "	5.18					
3826	STA. # 156 0 "-6 "	0.98					
3827	STA. # 162 0 "-6 "	2.54					
3828	STA. # 168 0 "-6 "	0.47					
3829	STA. # 174 0 "-6 "	0.36					
3830	STA. # 180 0 "-6 "	0.10					
3831	STA. # 186 0 "-6 "	0.14					
3832	STA. # 192 0 "-6 "	4.81	4.28		4.20	15.60	31.60
3833	STA. # 198 0 "-6 "	0.18					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3834	STA. # 344 0 "-6 "	0.83					
3918	STA. # 392	4.91	3.54		3.80	7.51	13.90
3919	STA. # 410	1.80					
3920	STA. # 416	5.99					
3921	STA. # 428	1.90					
3922	STA. # 386	1.34					
3923	STA. # 422	2.37					
3924	STA. # 380	2.11					
3925	STA. # 398	1.37					
3926	STA. # 404	1.62					
3927	STA. # 100	1.40					
3928	STA. # 320	3.79	2.94			<2.34	
3929	STA. # 118	2.05					

Homestake Mining Company - Grants Operation

Table F-3 Soil Sample Results For State Hwy 605 South of Hamilton Construction Company Entrance

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4271	#1 SR-605 S. EXT.	6.17					
4272	#2 SR-605 S. EXT.	5.40					
4273	#3 SR-605 S. EXT.	8.89					
4274	#4 SR-605 S. EXT.	5.50					
4275	#5 SR-605 S. EXT.	4.82					
4276	#6 SR-605 S. EXT.	9.14					
4277	#7 SR-605 S. EXT.	4.05					
4278	#8 SR-605 S. EXT.	7.56	7.20		7.60	2.60	3.70
4279	#9 SR-605 S. EXT.	7.48					
4280	#10 SR-605 S. EXT.	7.46					
4281	#11 SR-605 S. EXT.	9.41					
4282	#12 SR-605 S. EXT.	6.93					
4283	#13 SR-605 S. EXT.	8.40					
4284	#14 SR-605 S. EXT.	3.47					
4285	#15 SR-605 S. EXT.	3.88					
4286	#16 SR-605 S. EXT.	3.73					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4287	#17 SR-605 S. EXT.	8.09					
4288	#18 SR-605 S. EXT.	8.05	7.70			<3.0	
4289	#19 SR-605 S. EXT.	1.99					
4290	#20 SR-605 S. EXT.	2.63					
4291	#21 SR-605 S. EXT.	5.14					
4292	#22 SR-605 S. EXT.	3.74					
4293	#23 SR-605 S. EXT.	1.58					
4294	#24 SR-605 S. EXT.	3.16					
4295	#25 SR-605 S. EXT.	5.00					
4296	#26 SR-605 S. EXT.	3.79					
4297	#27 SR-605 S. EXT.	2.28					
4298	#28 SR-605 S. EXT.	1.28	1.50		1.60	<2.3	1.40
4299	#29 SR-605 S. EXT.	1.46					
4300	#30 SR-605 S. EXT.	9.57					
4301	#31 SR-605 S. EXT.	7.31					
4302	#32 SR-605 S. EXT.	6.11					
4303	#33 SR-605 S. EXT.	10.07					
4304	#34 SR-605 S. EXT.	5.86					
4305	#35 SR-605 S. EXT.	9.64					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4306	#36 SR-605 S. EXT.	3.12					
4307	#37 SR-605 S. EXT.	1.61					
4308	#38 SR-605 S. EXT.	1.34	1.50			<1.8	
4309	#39 SR-605 S. EXT.	2.44					
4310	#40 SR-605 S. EXT.	3.15					
4319	#41 SR-605 S. EXT.	3.45					
4320	#42 SR-605 S. EXT.	2.07					
4321	#43 SR-605 S. EXT.	3.44					
4322	#44 SR-605 S. EXT.	2.09					
4323	#45 SR-605 S. EXT.	3.55					
4324	#46 SR-605 S. EXT.	3.69					
4325	#47 SR-605 S. EXT.	1.58					
4326	#48 SR-605 S. EXT.	4.38					
4327	#49 SR-605 S. EXT.	0.94					
4328	#50 SR-605 S. EXT.	3.28	3.50			<2.2	
4329	#51 SR-605 S. EXT.	1.48					
4330	#52 SR-605 S. EXT.	1.25					
4331	#53 SR-605 S. EXT.	4.19					
4332	#54 SR-605 S. EXT.	2.00					

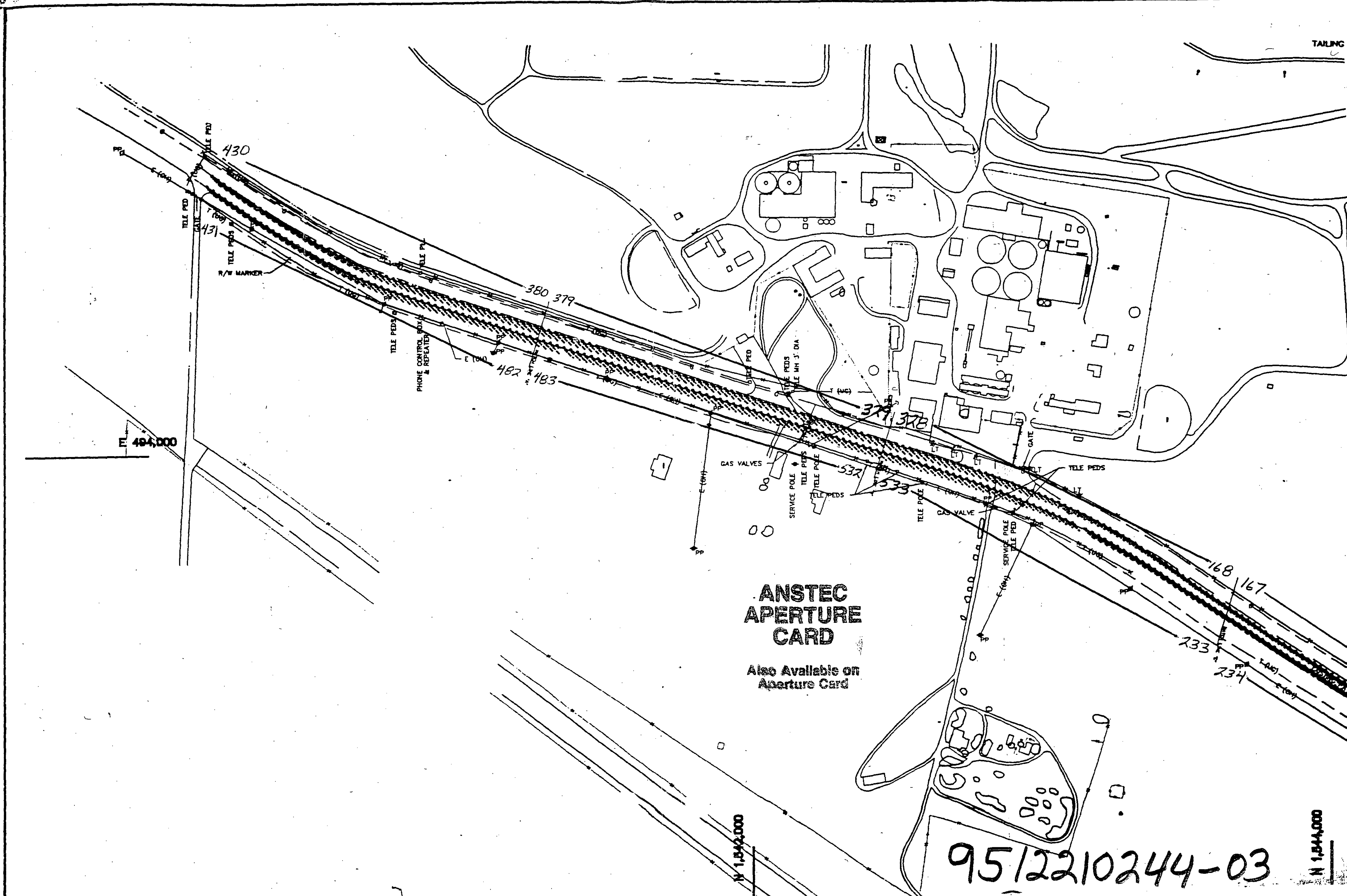
LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4333	#55 SR-605 S. EXT.	1.45					
4334	#56 SR-605 S. EXT.	0.18					
4335	#57 SR-605 S. EXT.	1.47					
4336	#58 SR-605 S. EXT.	2.58					
4337	#59 SR-605 S. EXT.	1.78					
4338	#60 SR-605 S. EXT.	3.96	3.70		4.50	<2.6	3.30
4339	#61 SR-605 S. EXT.	9.40					
4340	#62 SR-605 S. EXT.	4.26					
4341	#63 SR-605 S. EXT.	1.98					
4342	#64 SR-605 S. EXT.	2.02					
4343	#65 SR-605 S. EXT.	1.53					
4344	#66 SR-605 S. EXT.	3.33					
4345	#67 SR-605 S. EXT.	1.79					
4346	#68 SR-605 S. EXT.	2.65					
4347	#69 SR-605 S. EXT.	1.59					
4348	#70 SR-605 S. EXT.	1.84	2.00			<2.1	
4349	#71 SR-605 S. EXT.	2.04					
4350	#72 SR-605 S. EXT.	2.06					
4351	#73 SR-605 S. EXT.	1.23					

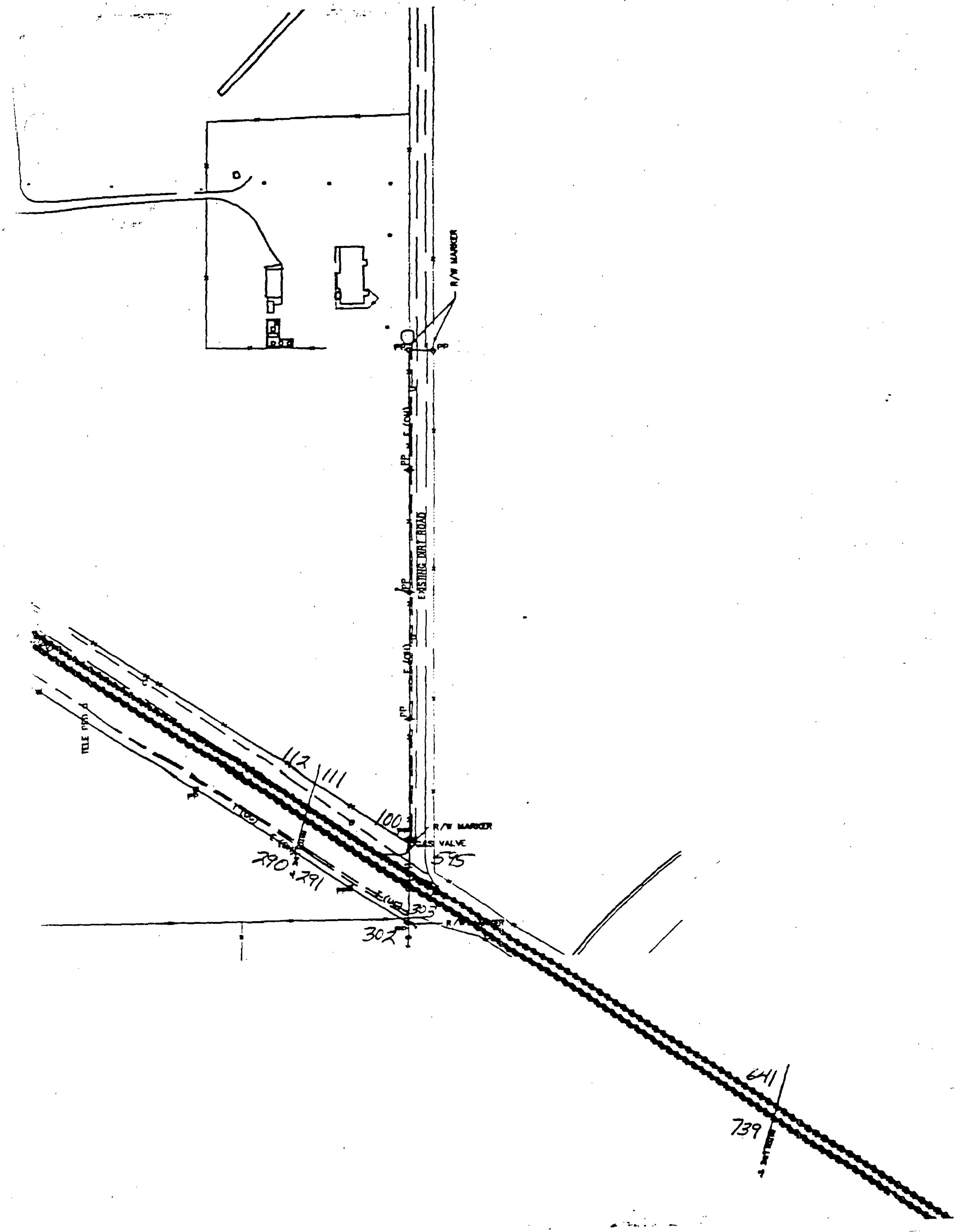
LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4352	#74 SR-605 S. EXT.	1.22					
4353	#75 SR-605 S. EXT.	2.22					
4354	#76 SR-605 S. EXT.	2.41					
4355	#77 SR-605 S. EXT.	2.30					
4356	#78 SR-605 S. EXT.	3.84					
4357	#79 SR-605 S. EXT.	2.14					
4358	#80 SR-605 S. EXT.	2.59	2.60		2.80	<1.9	3.60
4359	#81 SR-605 S. EXT.	2.88					
4360	#82 SR-605 S. EXT.	3.88					
4361	#83 SR-605 S. EXT.	1.80					
4362	# 84 SR-605 S. EXT.	3.36					
4363	#85 SR-605 S. EXT.	4.48					
4364	#86 SR-605 S. EXT.	1.76					
4365	#87 SR-605 S. EXT.	6.06					
4366	# 88 SR-605 S. EXT.	2.77					
4367	#89 SR-605 S. EXT.	3.92					
4368	#90 SR-605 S. EXT.	6.45	5.70			3.80	
4369	#91 SR-605 S. EXT.	5.61					
4370	#92 SR-605 S. EXT.	2.69					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4371	#93 SR-605 S. EXT.	2.46					
4372	#94 SR-605 S. EXT.	3.96					
4373	#95 SR-605 S. EXT.	2.25					
4374	#96 SR-605 S. EXT.	4.60					
4375	#97 SR-605 S. EXT.	1.81					
4376	#98 SR-605 S. EXT.	6.31					
4377	#99 SR-605 S. EXT.	4.61					
4378	#100 SR-605 S. EXT.	2.65	2.90		2.60	<2.4	2.80
4379	#101 SR-605 S. EXT.	4.98					
4380	#102 SR-605 S. EXT.	1.88					
4381	#103 SR-605 S. EXT.	2.40					
4382	#104 SR-605 S. EXT.	2.53					
4383	#105 SR-605 S. EXT.	2.75					
4384	#106 SR-605 S. EXT.	1.98					
4385	#107 SR-605 S. EXT.	3.68					
4386	#108 SR-605 S. EXT.	2.30					
4387	#109 SR-605 S. EXT.	1.80					
4388	#110 SR-605 S. EXT.	2.53	2.70			<2.0	
4389	#111 SR-605 S. EXT.	9.25					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4390	#112 SR-605 S. EXT.	7.75					
4391	#113 SR-605 S. EXT.	9.55					
4392	#114 SR-605 S. EXT.	2.86					
4393	#115 SR-605 S. EXT.	4.49					
4394	#116 SR-605 S. EXT.	5.39					
4395	# 117 SR-605 S. EXT.	5.98					
4396	#118 SR-605 S. EXT.	3.78					
4397	#119 SR-605 S. EXT.	4.71					
4398	#120 SR-605 S. EXT.	4.22	4.00		4.60	<2.3	3.10
4563	S.R 605 SOUTH EXT. 121	1.85			2.40		2.30
4564	S.R 605 SOUTH EXT. 122	1.41			1.70		1.40
4565	S.R 605 SOUTH EXT. 123	1.17			1.80		1.80
4566	S.R 605 SOUTH EXT. 124	3.33			3.30		2.50
4567	S.R 605 SOUTH EXT. 125	2.41			3.10		3.50
4568	S.R 605 SOUTH EXT. 126	2.14	2.20		2.60	<3.0	2.70
4569	S.R 605 SOUTH EXT. 127	2.66			2.90		2.90
4570	S.R 605 SOUTH EXT. 128	2.87			3.80		3.80
4571	S.R 605 SOUTH EXT. 129	2.59			3.20		3.10
4572	S.R 605 SOUTH EXT. 130	2.67			2.80		4.30

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4573	S.R 605 SOUTH EXT. 131	1.60			1.80		2.20


TAILING
430
431
TELE PED
GATE
TELE PEDS
R/W MARKER
380 379
TELE PEDS
PHONE CONTROL BOX & REPEATER
E (OH)
482 483
TELE PED
TELE PEDS
377 378
GAS VALVES
SERVICE POLE
TELE POLE
TELE PEDS
532
533
TELE POLE
GAS VALVE
SERVICE POLE
TELE PED
TELE PEDS
GATE
168 167
233
234
PP
E 494,000
N 1,842,000
N 1,844,000


R/W MARKER
PP
PP
EXISTING DIRT ROAD
R/W MARKER
VALVE
112
111
100
595
290 + 291
302
641
739

Homestake Mining Company - Grants Operation

Table F-4 Soil Sample Results For County Road 63 Right-of-Way

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2760	C R - 1 6"	1.77					
2761	C R - 1 12"	-0.43					
2762	C R - 2 6"	0.33	0.87	1.00	1.00	2.80	1.20
2763	C R - 2 12"	0.21					
2764	C R - 3 6"	0.66					
2765	C R - 3 12"	-0.52					
2766	C R - 4 6"	0.29					
2767	C R - 4 12"	-0.42					
2768	C R - 5 6"	-0.24					
2769	C R - 5 12"	-0.29					
2770	C R - 6 6"	-0.85					
2771	C R - 6 12"	-0.71					
2772	C R - 7 6"	1.02	1.51	1.60		<2.8	
2773	C R - 7 6"	-0.63					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2774	C R - 8 6"	2.77					
2775	C R - 8 12"	-0.07					
2776	C R - 9 6"	3.88					
2777	C R - 9 12"	-0.60					
2778	C R - 10 6"	2.51					
2779	C R - 10 12"	0.18					
2780	C R - 11 6"	5.76					
2781	C R - 11 12"	-0.30					
2782	C R - 12 6"	-0.51	0.51	<1.0	0.50	<1.1	1.50
2783	C R - 12 12"	-0.23					
2784	C R - 13 6"	-0.32					
2785	C R - 13 12"	-0.52					
2786	C R - 14 6"	0.19					
2787	C R - 14 12"	-0.67					
2788	C R - 15 6"	-0.50					
2789	C R - 15 12"	-1.35					
2790	C R - 16 6"	-0.29					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2791	C R - 16 12"	-0.59					
2792	C R - 17 6"	-0.11	0.88	1.90		<2.1	
2793	C R - 17 12"	-0.79					
2794	C R - 18 6"	0.41					
2795	C R - 18 12"	-0.26					
2796	C R - 19 6"	12.76			9.20		9.20
2797	C R - 19 12"	1.25					
2798	C R - 20 6"	6.07					
2799	C R - 20 12"	-0.35					
2800	C R - 21 6"	8.29					
2801	C R - 21 12"	13.61			16.90		7.40
2802	C R - 22 6"	9.78	8.11	10.30	10.80	3.70	10.50
2803	C R - 22 12"	2.18					
2804	C R - 23 6"	1.18					
2805	C R - 23 12"	-0.12					
2806	C R - 24 6"	10.19			9.70		7.40
2807	C R - 24 12"	0.70					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2808	C R - 25 6"	0.59					
2809	C R - 25 12"	0.23					
2810	C R - 26 6"	5.29					
2811	C R - 26 12"	0.67					
2812	C R - 27 6"	2.36	2.94	3.60		3.40	
2813	C R - 27 12"	-0.02					
2814	C R - 28 6"	9.56					
2815	C R - 28 12"	0.75					
2816	C R - 29 6"	0.33					
2817	C R - 29 12"	0.02					
2818	C R - 30 6"	1.16					
2819	C R - 30 12"	-0.52					
2820	C R - 31 6"	0.68					
2821	C R - 31 12"	-0.14					
2822	C R - 32 6"	0.45	1.46	1.40	1.40	<2.2	2.30
2823	C R - 32 12"	-0.37					
2824	C R - 33 6"	2.52					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2825	CR - 33 12"	0.67					
2826	CR - 34 6"	0.93					
2827	CR - 34 12"	0.03					
2828	CR - 35 6"	8.38					
2829	CR - 35 12"	-0.05					
2830	CR - 36 6"	0.10					
2831	CR - 36 12"	0.17					
2832	CR - 37 6"	-0.12	1.64	2.50		<3.6	
2833	CR - 37 12"	0.05					
2834	CR - 38 6"	2.69					
2835	CR - 38 12"	-0.53					
2836	CR - 39 6"	0.08					
2837	CR - 39 12"	-0.57					
2838	CR - 40 6"	-0.31					
2839	CR - 40 12"	-0.09					
2926	CR 41, 6 "	-0.26					
2927	CR 41, 12 "	0.15					

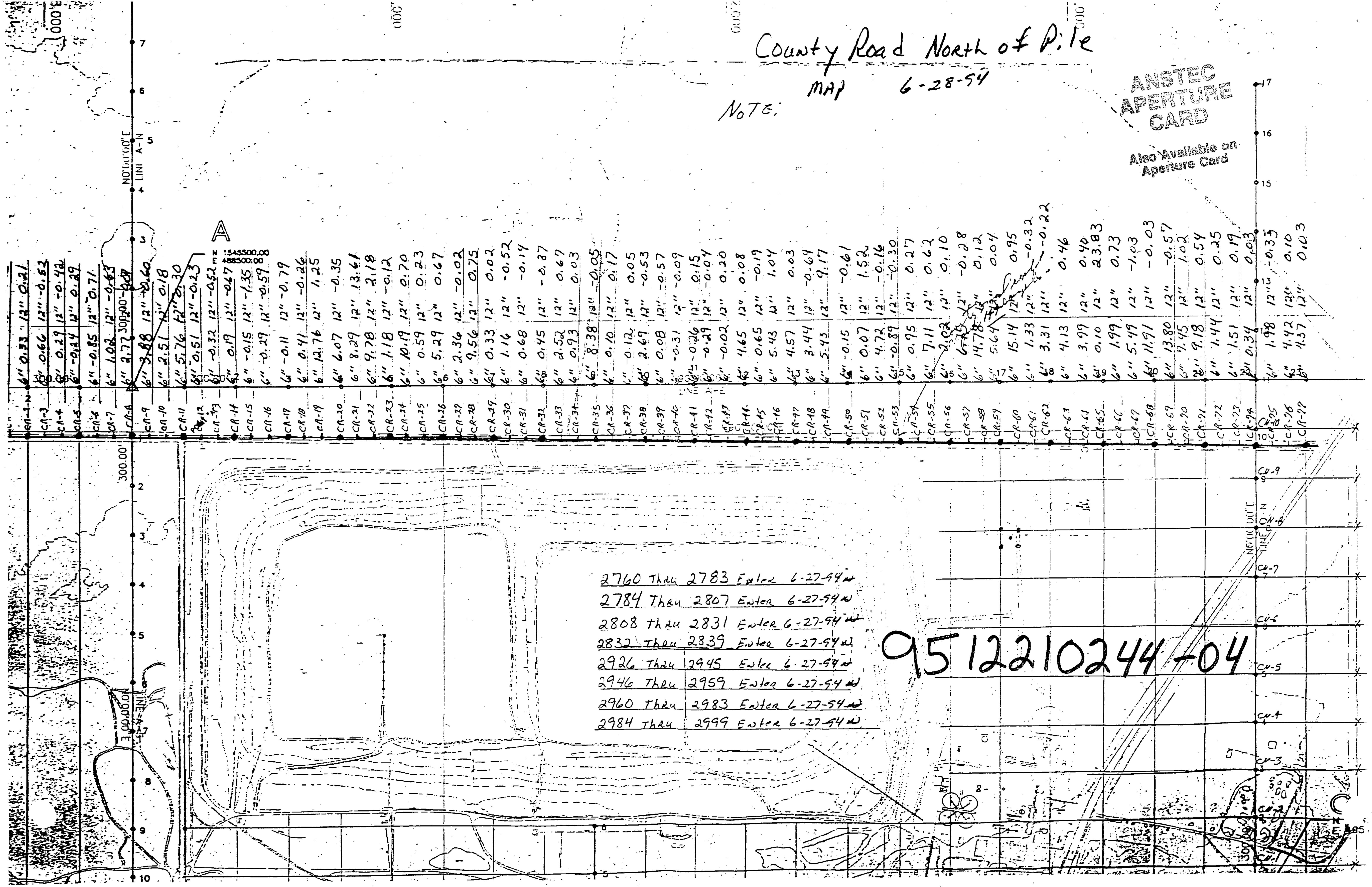
LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2928	C R 42, 6 "	-0.29					
2929	C R 42, 12 "	-0.04					
2930	C R 43, 6 "	-0.02					
2931	C R 43, 12 "	0.20					
2932	C R 44, 6 "	4.65	5.19	6.80	5.40	<2.6	3.40
2933	C R 44, 12 "	0.08					
2934	C R 45, 6 "	0.65					
2935	C R 45, 12 "	-0.19					
2936	C R 46, 6 "	5.43					
2937	C R 46, 12 "	1.04					
2938	C R 47, 6 "	4.57					
2939	C R 47, 12 "	0.03					
2940	C R 48, 6 "	3.44					
2941	C R 48, 12 "	-0.69					
2942	C R 49, 6 "	5.43	5.31	7.80		5.70	
2943	C R 49, 12 "	9.17					
2944	C R 50, 6 "	-0.15					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2945	C R 50, 12 "	-0.61					
2946	C R 51, 6 "	0.07					
2947	C R 51, 12 "	1.52					
2948	C R 52, 6 "	4.72					
2949	C R 52, 12 "	-0.16					
2950	C R 53, 6 "	-0.89					
2951	C R 53, 12 "	-0.30					
2952	C R 54, 6 "	0.95		3.30	1.70		1.20
2953	C R 54, 12 "	0.27					
2954	C R 55, 6 "	7.11					
2955	C R 55, 12 "	0.62					
2956	C R 56, 6 "	2.02					
2957	C R 56, 12 "	0.10					
2958	C R 57, 6 "	6.15					
2959	C R 57, 12 "	-0.28					
2960	C R 58, 6 "	14.78			11.40		8.70
2961	C R 58, 12 "	0.12					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2962	C R 59, 6 "	5.64	6.54	8.10		<4.4	
2963	C R 59, 12 "	0.04					
2964	C R 60, 6 "	15.14			14.30		11.90
2965	C R 60, 12 "	0.95					
2966	C R 61, 6 "	1.33					
2967	C R 61, 12 "	-0.32					
2968	C R 62, 6 "	3.31					
2969	C R 62, 12 "	-0.22					
2970	C R 63, 6 "	4.13					
2971	C R 63, 12 "	0.46					
2972	C R 64, 6 "	3.99	4.96	7.90	4.00	<1.8	3.60
2973	C R 64, 12 "	0.40					
2974	C R 65, 6 "	0.10					
2975	C R 65, 12 "	23.83			19.40		14.30
2976	C R 66, 6 "	1.99					
2977	C R 66, 12 "	0.73					
2978	C R 67, 6 "	5.49					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2979	C R 67, 12 "	-1.03					
2980	C R 68, 6 "	11.91			17.60		30.60
2981	C R 68, 12 "	-0.03					
2982	C R 69, 6 "	13.80	11.72	13.50	0.60	5.70	0.70
2983	C R 69, 12 "	-0.57					
2984	C R 70, 6 "	7.45					
2985	C R 70, 12 "	1.02					
2986	C R 71, 6 "	9.18					
2987	C R 71, 12 "	0.54					
2988	C R 72, 6 "	1.44					
2989	C R 72, 12 "	0.25					
2990	C R 73, 6 "	1.51					
2991	C R 73, 12 "	0.19					
2992	C R 74, 6 "	0.34	1.51	3.20	1.20	<1.5	1.80
2993	C R 74, 12 "	0.03					
2994	C R 75, 6 "	1.98					
2995	C R 75, 12 "	-0.33					

LAB ID	Wind Blown ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2996	C R 76, 6 "	4.42					
2997	C R 76, 12 "	0.10					
2998	C R 77, 6 "	4.37					
2999	C R 77, 12 "	0.03					


County Road North of Pile
MAP 6-28-94
NOTE:
ANSTEC APERTURE CARD
Also Available on Aperture Card
A
1545500.00
488500.00
N01°00'00"E
LINE A-N
300.00'
2760 Thru 2783 Enter 6-27-94
2784 Thru 2807 Enter 6-27-94
2808 Thru 2831 Enter 6-27-94
2832 Thru 2839 Enter 6-27-94
2926 Thru 2945 Enter 6-27-94
2946 Thru 2959 Enter 6-27-94
2960 Thru 2983 Enter 6-27-94
2984 Thru 2999 Enter 6-27-94
9512210244-04

Homestake Mining Company - Grants Operation

Table F-5 Soil Sample Characterization Data For State Road 605 Right-of-Way North of County Road 63

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2170	SR-2 A-N 6"	10.70					
2171	SR-2 A-N 12"	17.73					
2172	SR-2 B-N 6"	25.63	30.20	34.60	17.10	7.90	17.10
2173	SR-2 B-N 12"	18.27					
2174	SR-3 A-N 6"	15.52					
2175	SR-3 A-N 12"	19.23					
2176	SR-3 B-N 6"	35.65					
2177	SR-3 B-N 12"	8.67					
2178	SR-4 A-N 6"	20.45					
2179	SR-4 A-N 12"	2.15					
2180	SR-4 B-N 6"	13.16					
2181	SR-4 B-N 12"	2.10					
2182	SR-5 A-N 6"	18.07	19.68	23.60	17.70	6.00	11.30
2183	SR-5 A-N 12"	6.61					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2184	S R - 5 N. B - 6"	24.34					
2185	S R - 5 N. B - 12"	14.06					
2186	S R - 1 N. C - 6"	34.58					
2187	S R - 1 N. C - 12"	4.22					
2188	S R - 1 N. D - 6"	11.60					
2189	S R - 1 N. D - 12"	0.43					
2190	S R - 2 N. C - 6"	6.10					
2191	S R - 2 N. C - 12"	1.34					
2192	S R - 2 N. D - 6"	24.68	28.26	33.50		<5.1	
2193	S R - 2 N. D - 12"	0.91					
2194	S R - 3 N. C - 6"	45.70					
2195	S R - 3 N. C - 12"	6.81					
2196	S R - 3 N. D - 6"	13.76					
2197	S R - 3 N. D - 12"	0.50					
2198	S R - 4 N. C - 6"	32.55					
2199	S R - 4 N. C - 12"	6.85					
2200	S R - 4 N. D - 6"	10.27					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
2201	S R - 4 N. D - 12 "	20.84					
2202	S R - 5 N. C - 6 "	31.62	33.79	37.90	30.60	8.40	25.00
2203	S R - 5 N. C - 12 "	30.07					
2204	S R - 5 N. D - 6 "	16.77					
2205	S R - 5 N. D - 12 "	40.94					
3102	S-R-N-P-, 1 B 6 "	12.41	12.33	15.10		14.40	
3103	S-R-N-P- ,1 B 12 "	46.86					
3104	S-R-N-P-, 1B -1'.5 "	4.03					
3105	S-R-N-P-, 1 B - 2 '	-6.49					
3106	S-R-N-P-, 2 B -6 "	34.11					
3107	S-R-N-P-, 2 B - 12"	12.94					
3108	S-R-N-P- , 2B -1'.5"	12.92					
3109	S-R-N-P-, 2 B - 2 '	64.91					
3110	S-R-N-P-, 3 B -6 "	18.48			18.10		14.50
3111	S-R-N-P-, 3 B - 12"	3.42					
3112	S-R-N-P- ,3 B -1'.5"	7.84	6.91	9.00	11.10	3.50	10.20
3113	S-R-N-P-, 3 B - 2 '	46.64					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3114	S-R-N-P-, 4 B -6 "	64.07					
3115	S-R-N-P-, 4 B - 12"	6.87					
3116	S-R-N-P- ,4 B -1'.5"	10.11					
3117	S-R-N-P-, 4 B - 2 '	36.49					
3118	S-R-N-P-, 5 B -6 "	49.70					
3119	S-R-N-P-, 5 B - 12"	12.03					
3120	S-R-N-P- ,5 B -1'.5"	5.33					
3121	S-R-N-P-, 5 B - 2 '	25.30					
3122	S-R-N-P-, 6 B -6 "	71.19	63.13	80.10		19.40	
3123	S-R-N-P-, 6 B - 12"	1.20					
3124	S-R-N-P- ,6 B -1'.5"	20.34					
3125	S-R-N-P-, 6 B - 2 '	62.49					
3126	S-R-N-P-, 7 B -6 "	30.14					
3127	S-R-N-P-, 7 B - 12"	4.39					
3128	S-R-N-P- ,7 B -1'.5"	22.84					
3129	S-R-N-P-, 7 B - 2 '	44.20					
3130	S-R-N-P-, 8 B -6 "	35.34					

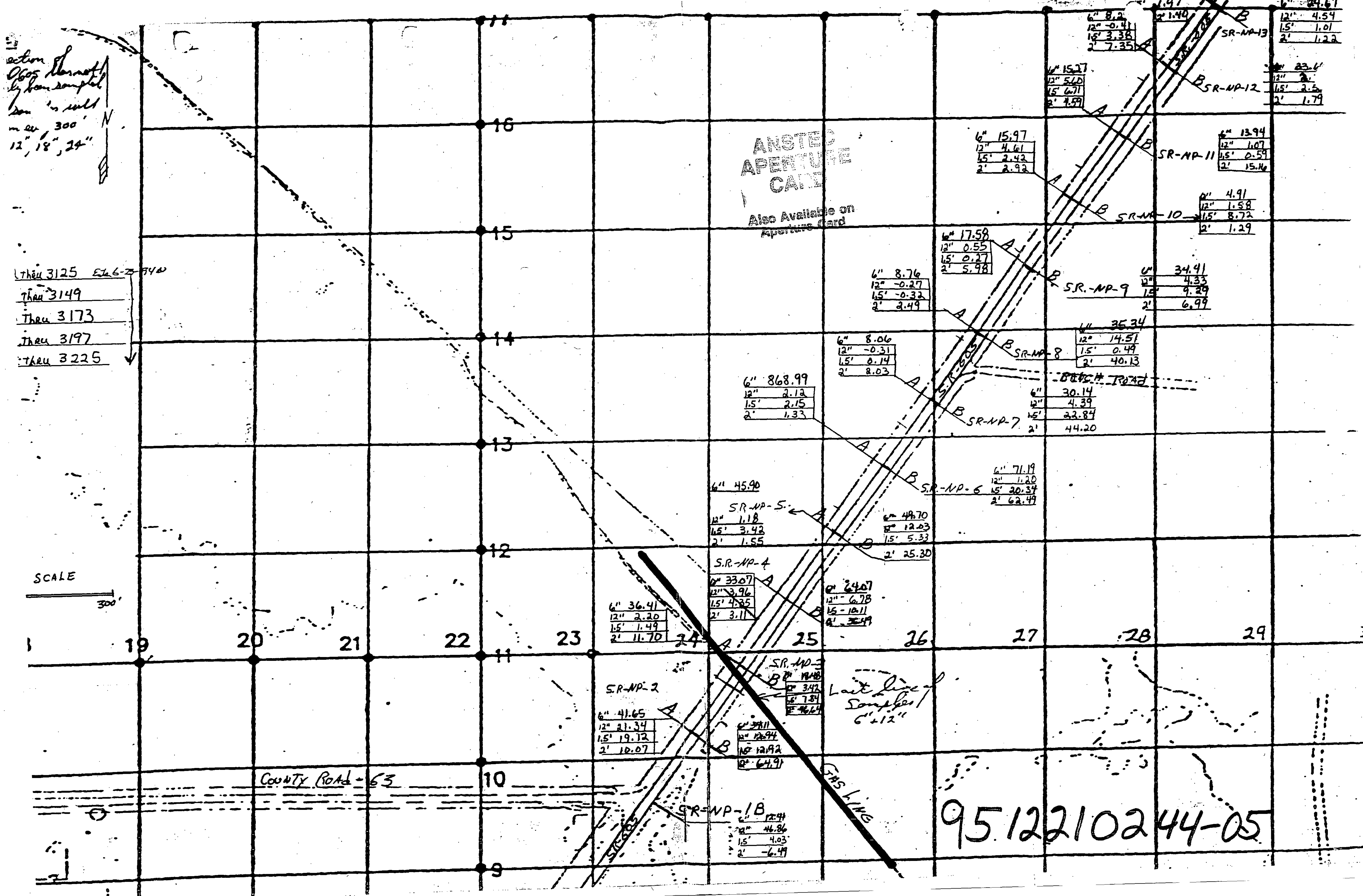
LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3131	S-R-N-P-, 8 B - 12"	14.51					
3132	S-R-N-P- ,8 B -1'.5"	0.49	1.77	2.50	2.30	7.60	1.70
3133	S-R-N-P-, 8 B - 2 '	40.13					
3134	S-R-N-P-, 9 B -6 "	34.41			34.60		23.40
3135	S-R-N-P-, 9 B - 12"	4.33					
3136	S-R-N-P- ,9 B -1'.5"	9.29					
3137	S-R-N-P-, 9 B - 2 '	6.99					
3138	S-R-N-P-, 10 B -6 "	4.91					
3139	S-R-N-P-, 10 B 12"	1.58					
3140	S-R-N-P- ,10 B 1'.5"	8.72					
3141	S-R-N-P-, 10 B 2 '	1.29					
3142	S-R-N-P-, 11 B -6 "	13.94	14.01	5.50		5.90	
3143	S-R-N-P-, 11 B 12"	1.07					
3144	S-R-N-P- ,11 B 1'.5"	0.59					
3145	S-R-N-P-, 11 B 2 '	15.16					
3146	S-R-N-P-, 12 B -6 "	33.66					
3147	S-R-N-P-, 12 B 12"	2.77					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3148	S-R-N-P- ,12 B 1'.5"	2.50					
3149	S-R-N-P-, 12 B 2'	1.79					
3150	S-R-N-P-, 13 B -6"	24.67			25.40		33.50
3151	S-R-N-P-, 13 B 12"	4.54					
3152	S-R-N-P- ,13 B 1'.5"	1.01	2.29	3.25	3.20	4.10	9.00
3153	S-R-N-P-, 13 B 2'	1.22					
3154	S-R-N-P , 2 A 6"	41.65					
3155	S-R-N-P , 2 A 12"	21.34					
3156	S-R-N-P , 2 A 1'.5"	19.12					
3157	S-R-N-P , 2 A 2'	10.07					
3158	S-R-N-P , 3 A 6"	36.41			32.20		28.70
3159	S-R-N-P , 3 A 12"	2.20					
3160	S-R-N-P , 3 A 1'.5"	1.49					
3161	S-R-N-P , 3 A 2'	11.70					
3162	S-R-N-P , 4 A 6"	33.07	28.33	28.40		12.30	
3163	S-R-N-P , 4 A 12"	3.96					
3164	S-R-N-P , 4 A 1'.5"	4.35					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3165	S-R-N-P , 4 A 2 '	3.11					
3166	S-R-N-P , 5 A 6 "	45.89					
3167	S-R-N-P , 5 A 12 "	1.18					
3168	S-R-N-P , 5 A 1'.5 "	3.42					
3169	S-R-N-P , 5 A 2 '	1.55					
3170	S-R-N-P , 6 A 6 "	868.98					
3171	S-R-N-P , 6 A 12 "	2.12					
3172	S-R-N-P , 6 A 1'.5 "	2.15	2.68	4.10	2.90	4.90	8.70
3173	S-R-N-P , 6 A 2 '	1.33					
3174	S-R-N-P , 7 A 6 "	8.06					
3175	S-R-N-P , 7 A 12 "	-0.31					
3176	S-R-N-P , 7 A 1'.5 "	0.14					
3177	S-R-N-P , 7 A 2 '	2.03					
3178	S-R-N-P , 8 A 6 "	8.76					
3179	S-R-N-P , 8 A 12 "	-0.27					
3180	S-R-N-P , 8 A 1'.5 "	-0.32					
3181	S-R-N-P , 8 A 2 '	2.49					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3182	S-R-N-P , 9 A 6 "	17.58	13.00	16.60	13.90	7.80	13.80
3183	S-R-N-P , 9 A 12 "	0.55					
3184	S-R-N-P , 9 A 1'.5 "	0.27					
3185	S-R-N-P , 9 A 2 '	5.98					
3186	S-R-N-P , 10 A 6 "	15.97					
3187	S-R-N-P , 10 A 12 "	4.61					
3188	S-R-N-P , 10 A 1'.5 "	2.42					
3189	S-R-N-P , 10 A 2 '	2.92					
3190	S-R-N-P , 11 A 6 "	15.27					
3191	S-R-N-P , 11 A 12 "	5.60					
3192	S-R-N-P , 11 A 1'.5 "	6.71	7.29	7.50	7.90	5.30	10.70
3193	S-R-N-P , 11 A 2 '	4.59					
3194	S-R-N-P , 12 A 6 "	8.23					
3195	S-R-N-P , 12 A 12 "	-0.41					
3196	S-R-N-P , 12 A 1'.5 "	3.38					
3197	S-R-N-P , 12 A 2 '	7.35					
3222	S R - N P 13 A 6 "	13.25	12.34	15.10	13.20	8.80	11.60

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
3223	SR-NP 13A 12"	5.15					
3224	SR-NP 13A 1.5'	1.97					
3225	SR-NP 13A 2'	1.40					



9512210244-05

Date Collected: 19,23,24,1995

Date Sealed: May 25,1995

Date Read : JUNE 12,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH661-CH961	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	EKG
4933	PT-20	4008	1296	1299	1053	3.81	1.23	1.23	1661.50	2.20	4.28	3.58
4934	PT-26	2715	1307	1347	1145	2.37	1.14	1.18	1337.00	0.61	1.49	1.43
4935	PT-27	2598	1280	1214	1018	2.55	1.26	1.19	1321.90	0.58	1.44	1.87
4936	JO44238	3866	1550	1377	1001	3.86	1.55	1.36	1381.20	1.60	3.79	4.14
4937	JO34101	2878	1457	1305	1142	2.52	1.28	1.14	1480.40	0.49	1.09	1.49
4938	JO42092	3173	1493	1244	1027	3.09	1.45	1.21	1576.40	0.82	1.70	2.40
4939	HO43239	3130	1284	1218	1002	3.12	1.26	1.21	1501.70	1.29	2.79	2.28
4940	JO52237	1975	1014	926	1057	1.87	0.96	0.88	1491.00	0.33	0.73	1.24

Appendix G

Data Sort Sheets for Statistical Study in Outer Zone

Date Collected: May ?? 23,24,1995

Date Sealed: May 25, 1995

Date Read : JUNE 12,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH656	TH(ROI)911KEV CH661-CH961	K(ROI)1406KEV CH1338-CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH961	K 1460 KEV CH1336-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RATE	HMC Ra 226 pCi/g	EKG
4933	PT-20	4006	1296	1299	1053	3.61	1.23	1.23	1661.50	2.20	4.26	3.56
4934	PT-26	2715	1307	1347	1145	2.37	1.14	1.16	1337.00	0.61	1.49	1.43
4935	PT-27	2596	1260	1214	1016	2.55	1.26	1.19	1321.90	0.58	1.44	1.67
4936	JO44238	3666	1550	1377	1001	3.66	1.55	1.36	1381.20	1.60	3.79	4.14
4937	JO34101	2676	1457	1305	1142	2.52	1.26	1.14	1460.40	0.49	1.09	1.49
4938	JO42092	3173	1493	1244	1027	3.09	1.45	1.21	1576.40	0.82	1.70	2.40
4939	HO43239	3130	1264	1216	1002	3.12	1.26	1.21	1501.70	1.29	2.79	2.26
4940	JO52237	1975	1014	926	1057	1.67	0.96	0.86	1491.00	0.33	0.73	1.24

Homestake Mining Company - Grants, New Mexico Project 9:36:12 AM, 5/2/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E031 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E031222
Ave. Gamma : 15,818.27
No. of Points : 15
North Limits : >1545566.67,<1545600
East Limits : >488133.33,<488166.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: [illegible] 1995

Date Sealed: MAY [illegible] 1995

Date Read : MAY 22,1995

SAMPLED BY MJ and LJ. PREP SAMPLES HG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549–CH658	TH(ROI)911KEV CH881–CH961	K(ROI)1406KEV CH1330–CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549–CH658	TH 911 KEV CH661–CH961	K 1460 KEV CH1338–CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra226 pCi/kg
4670	E031222	3493	1223	1350	1106	3.16	1.11	1.22	1549.80	1.67	3.54	2.66
4671	C064193	3148	1324	1346	1053	2.99	1.28	1.28	1470.40	1.14	2.54	2.16
4672	D074013	6926	2015	1852	1202	5.40	1.57	1.44	1510.80	3.47	7.55	5.83
4673	E141169	3732	1883	1705	1305	2.86	1.20	1.31	1395.10	0.91	2.15	2.47
4674	H061259	2556	1358	1477	1730	1.48	0.76	0.65	1622.70	0.23	0.46	0.61
4675	H052157	3639	1461	1373	1045	3.48	1.40	1.31	1702.70	1.45	2.79	2.61
4676	E074147	2863	1155	1153	1010	2.63	1.14	1.14	1569.00	1.17	2.45	2.15
4677	E083127	3665	1418	1339	1044	3.51	1.36	1.28	1570.90	1.56	3.27	3.00

Homestake Mining Company - Grants, New Mexico Project 7:30:43 AM, 4/4/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E032 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E032142
Ave. Gamma : 14,898.91
No. of Points : 23.00
North Limits : >1545766.67,<1545800
East Limits : >488833.33,<488866.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0.00

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: MARCH 24,1995

Date Sealed: Mar. ,1995

Date Read : April 12,1995

SAMPLED BY IV AND MJ. PREP SAMPLES HO. 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS HA(HOI) 609KEV CH549 CH658	HI(HOI)911KEV CH861-CH961	K(HOI)1460KEV CH1338-CH1458	COUNT TIME SECONDS	CPS HA 609 KEV CH549-CH658	TH 911 KEV CH861-CH981	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG
4738	E022157	3665	1394	1366	1006	3.64	1.39	1.36	1565.50	1.50	3.30	3.05
4739	E031117	2933	1219	1320	1133	2.59	1.08	1.17	1519.60	0.90	1.96	2.05
4740	D024014	3821	1328	1379	1016	3.76	1.31	1.36	1426.10	1.86	4.37	3.87
4741	D023053	4842	1785	1807	1391	3.34	1.27	1.30	1432.50	1.43	3.30	3.13
4742	D021259	4631	1617	1589	1147	4.04	1.41	1.39	1425.50	2.00	4.65	3.64
4743	D033032	16471	5040	4853	3365	4.89	1.50	1.44	1507.60	2.66	6.33	5.63
4744	D022109	8609	2463	2125	1200	7.17	2.05	1.77	1354.90	4.54	11.12	6.64
4745	D031079	6718	2028	1895	1247	5.39	1.63	1.52	1395.90	3.22	7.64	6.37
4746	D032024	2838	1495	1588	1398	2.03	1.07	1.14	1392.40	0.21	0.51	1.29
4747	E032142	2902	1372	1300	1174	2.47	1.17	1.11	1476.40	0.54	1.21	1.71
4748	D034026	9083	3333	3397	2726	3.33	1.22	1.25	1506.90	1.51	3.32	3.00
4749	D043064	5361	1959	1961	1510	3.55	1.30	1.30	1436.40	1.83	3.75	3.75

Homestake Mining Company - Grants, New Mexico Project 4:15:58 PM, 4/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E033 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E033049
Ave. Gamma : 12,839.25
No. of Points : 20
North Limits : >1545400,<1545433.33
East Limits : >488366.67,<488400

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Jur[illegible]995

Date Sealed: June 7, 1995

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.60	0.75	1.65	1.56
4971	E034114	2605	1056	1065	1015	2.57	1.04	1.07	1526.60	1.05	2.24	1.69
4972	E044145	2236	1015	999	1001	2.23	1.01	1.00	1517.60	0.66	1.46	1.52
4973	E053151	2665	1201	1099	1002	2.66	1.20	1.10	1527.20	0.62	1.75	2.09
4974	E041056	2449	1035	961	1007	2.43	1.03	0.95	1636.70	0.89	1.77	1.66
4975	D104176	3967	1526	1374	1001	3.96	1.52	1.37	1457.60	1.79	4.02	4.26
4976	D103249	3334	1461	1319	1049	3.18	1.39	1.26	1460.60	1.06	2.38	2.50
4977	D093206	2674	1128	1035	1002	2.67	1.13	1.03	1581.40	0.96	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project 5:52:32 PM, 4/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E034 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E034114
Ave. Gamma : 12,936.13
No. of Points : 16
North Limits : >1545233.33,<1545266.67
East Limits : >488500,<488533.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Ju[illegible] 1995

Date Sealed: June [illegible]995

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 **SOIL SAMPLES**

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH661-CH961	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCI/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.60	0.75	1.65	1.56
4971	E034114	2605	1056	1065	1015	2.57	1.04	1.07	1528.60	1.05	2.24	1.69
4972	E044145	2236	1015	999	1001	2.23	1.01	1.00	1517.60	0.66	1.46	1.52
4973	E053151	2665	1201	1099	1002	2.66	1.20	1.10	1527.20	0.62	1.75	2.09
4974	E041056	2449	1035	961	1007	2.43	1.03	0.95	1636.70	0.69	1.77	1.66
4975	D104176	3967	1526	1374	1001	3.96	1.52	1.37	1457.60	1.79	4.02	4.26
4976	D103249	3334	1461	1319	1049	3.16	1.39	1.26	1460.60	1.06	2.38	2.50
4977	D093206	2674	1126	1035	1002	2.67	1.13	1.03	1581.40	0.96	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project 3:29:14 PM, 4/4/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E041 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E041056
Ave. Gamma : 13,051.29
No. of Points : 14.00
North Limits : >1545933.33,<1545966.67
East Limits : >489466.67,<489500

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0.00

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Jur[illegible]995

Date Sealed: June 7, 1995

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549–CH658	TH(ROI)911KEV CH681–CH961	K(ROI)1406KEV CH1336–CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549–CH658	TH 911 KEV CH861–CH981	K 1480 KEV CH1336–CH1458	SAMPLE WT.	TRUE SAMPLE CT. RATE	HMC Ra 226 pCi/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.80	0.75	1.65	1.56
4971	E034114	2805	1056	1085	1015	2.57	1.04	1.07	1528.60	1.05	2.24	1.69
4972	E044145	2236	1015	999	1001	2.23	1.01	1.00	1517.80	0.66	1.46	1.52
4973	E053151	2665	1201	1099	1002	2.86	1.20	1.10	1527.20	0.62	1.75	2.09
4974	E041056	2449	1035	961	1007	2.43	1.03	0.95	1638.70	0.89	1.77	1.68
4975	D104176	3967	1528	1374	1001	3.98	1.52	1.37	1457.60	1.79	4.02	4.28
4978	D103249	3334	1461	1319	1049	3.18	1.39	1.26	1460.60	1.06	2.36	2.50
4977	D093206	2674	1126	1035	1002	2.67	1.13	1.03	1581.40	0.96	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

11:19:12 AM, 3/31/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: Outer

GRID E042

The Grid with the Max. Gamma

Grid :	E042169
Ave. Gamma :	16,630.14
No. of Points :	14.00
North Limits :	>1545700,<1545733.33
East Limits :	>489566.67,<489600

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	East Limits	North Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0.00

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Dale Collected: March 26,1995

Dale Sealed: Marc ,995

Dale Read : April 17,1995

SAMPLED BY LJ. PREP SAMPLES RG. 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS IIA(IIOI) 609KEV CI1549 - CI1858	I(IIOI)911KEV CI1681 - CI1961	K(IIOI)1400KEV CI1338 - CI1456	COUNT TIME SECONDS	CPS IIA 609 KEV CI1549 - CI1658	TII 911 KEV CI1861 - CI1961	K 1460 KEV CI1338 - CI1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra-226 Ri/g
4760	E042169	2349	1287	1327	1559	1.51	0.83	0.85	1681.30	0.05	0.10	0.61
4761	E041056	3031	1147	1034	1009	3.00	1.14	1.02	1812.98	1.25	2.58	2.46
4762	D042216	7938	2231	1871	1334	5.95	1.67	1.40	1599.20	3.79	7.67	6.41
4763	D044254	4910	1620	1583	1566	3.14	1.03	1.01	1840.00	1.64	3.31	2.63
4764	E051195	3508	1411	1178	1035	3.39	1.36	1.14	1529.80	1.25	2.72	3.80
4765	D053193	2848	1259	1157	1065	2.67	1.16	1.09	1394.40	0.76	1.60	2.40
4766	E052153	3858	1568	1461	1187	3.25	1.34	1.25	1447.50	1.15	2.64	3.43
4767	E061067	3169	1378	1298	1036	3.08	1.33	1.25	1441.60	0.97	2.22	2.43
4768	D054255	7204	2231	1040	1280	5.63	1.74	1.44	1387.90	3.25	7.76	7.38
4769	D083095	3848	1489	1289	1030	3.73	1.45	1.25	1366.60	1.52	3.63	3.91
4770	D083095	1528	785	840	1019	1.50	0.77	0.82	1724.10	0.18	0.30	0.84

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E043 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E043111
Ave. Gamma : 13,085.40
No. of Points : 25
North Limits : >1545266.67,<1545300
East Limits : >489000,<489033.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: JUNE 13, 1995

Date Sealed: JUN 95

Date Read: JUNE 30, 1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609 KEV CH549 – CH658	TH(ROI) 911 KE CH881 – CH981	K(ROI) 1406 KEV CH 1338 – CH 1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549 – CH65	TH 911 KEV CH881 – CH981	K 1460 KEV CH1338 – CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem Unat pCi/g
5021	H043239	3848	1528	1570	1230	3.13	1.24	1.28	1575.70	1.34	2.77					
5022	G103133	2790	1436	1566	1799	1.55	0.80	0.87	1810.90	0.28	0.56					
5023	E043111	2306	1064	1042	1235	1.87	0.86	0.84	1819.00	0.50	1.00					
5024	L061015	4639	1828	1944	1888	2.46	0.97	1.03	1812.90	1.06	2.16					
5025	J053041	2643	1387	1299	1827	1.82	0.85	0.80	1464.40	0.24	0.54					

Homestake Mining Company - Grants, New Mexico Project 8:36:21 AM, 4/21/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E044 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E044145
Ave. Gamma : 13,569.93
No. of Points : 27
North Limits : >1545233.33,<1545266.67
East Limits : >489833.33,<489866.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

[illegible]

Date Collected: Jur 95

Date Sealed: June 7,1995

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH858	TH(ROI)911KEV CH881-CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH858	TH 911 KEV CH881-CH981	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RATE	HMC Ra 226 pCi/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.80	0.75	1.85	1.58
4971	E034114	2605	1058	1085	1015	2.57	1.04	1.07	1528.60	1.05	2.24	1.69
4972	E044145	2238	1015	999	1001	2.23	1.01	1.00	1517.60	0.66	1.46	1.52
4973	E053151	2685	1201	1099	1002	2.68	1.20	1.10	1527.20	0.82	1.75	2.09
4974	E041056	2449	1035	981	1007	2.43	1.03	0.95	1638.70	0.89	1.77	1.88
4975	D104178	3987	1528	1374	1001	3.98	1.52	1.37	1457.60	1.79	4.02	4.28
4976	D103249	3334	1461	1319	1049	3.18	1.39	1.26	1480.60	1.08	2.38	2.50
4977	D093206	2674	1128	1035	1002	2.67	1.13	1.03	1581.40	0.98	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

11:23:45 AM, 3/31/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: Outer

GRID E051

The Grid with the Max. Gamma

Grid : E051195
Ave. Gamma : 13,934.80
No. of Points : 5.00
North Limits : >1545633.33,<1545666.67
East Limits : >490333.33,<490366.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	East Limits	North Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0.00

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: M[illegible] 26,1995

Date Sealed: March 31,1995

Date Read : April 17,1995

SAMPLED BY LJ. PREP SAMPLES NO. 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(HOI) 609KEV CH549 - CH658	TH(HOI)911KEV CH881 - CH961	K(HOI)1406KEV CH1338 - CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549 - CH658	TH 911 KEV CH861 - CH961	K 1460 KEV CH1336 - CH1450	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCl/g	ERG Ra-226 Rci/g
4760	E042169	2349	1287	1327	1559	1.51	0.83	0.85	1661.30	0.85	0.10	0.61
4761	E041056	3031	1147	1034	1009	3.00	1.14	1.02	1612.98	1.25	2.56	2.46
4762	D042216	7936	2231	1871	1334	5.95	1.67	1.40	1599.20	3.79	7.67	6.41
4763	D044254	4910	1620	1583	1568	3.14	1.03	1.01	1640.00	1.64	3.31	2.63
4764	E051195	3506	1411	1176	1035	3.39	1.36	1.14	1529.60	1.25	2.72	3.60
4765	D053193	2848	1259	1157	1065	2.67	1.16	1.09	1394.40	0.76	1.80	2.40
4766	E052153	3858	1566	1481	1187	3.25	1.34	1.25	1447.50	1.15	2.64	3.43
4767	E061067	3189	1376	1298	1036	3.08	1.33	1.25	1441.60	0.97	2.22	2.43
4768	D054255	7204	2231	1848	1280	5.63	1.74	1.44	1387.90	3.25	7.76	7.36
4769	D063095	3848	1469	1289	1038	3.73	1.45	1.25	1386.60	1.52	3.03	3.91
4770	D063095	1528	765	640	1019	1.50	0.77	0.82	1724.10	0.16	0.30	0.64

Homestake Mining Company - Grants, New Mexico Project 1:19:36 PM, 4/24/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E052 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E052153
Ave. Gamma : 16,153.66
No. of Points : 34
North Limits : >1545766.67,<1545800
East Limits : >490966.67,<491000

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Mar---9,1995

Date Sealed: March ..,1995

Date Read : April 17,1995

SAMPLED BY LJ. PREP SAMPLES HQ. 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549 - CH658	TH(ROI)911KEV CH861 - CH961	K(ROI)1406KEV CH1338 – CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549 – CH658	TH 911 KEV CH861 – CH961	K 1460 KEV CH1338 – CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra-226 Rci/g
4760	E042169	2349	1207	1327	1559	1.51	0.83	0.85	1661.30	0.05	0.10	0.61
4761	E041058	3031	1147	1034	1009	3.00	1.14	1.02	1612.96	1.25	2.56	2.46
4762	D042216	7938	2231	1871	1334	5.95	1.67	1.40	1599.20	3.79	7.67	6.41
4763	D044254	4910	1620	1563	1566	3.14	1.03	1.01	1640.00	1.64	3.31	2.63
4764	E051195	3506	1411	1176	1035	3.39	1.36	1.14	1529.60	1.25	2.72	3.60
4765	D053193	2848	1259	1157	1065	2.87	1.18	1.09	1394.40	0.76	1.60	2.40
4766	E052153	3850	1566	1481	1187	3.25	1.34	1.25	1447.50	1.15	2.64	3.43
4767	E061067	3189	1376	1298	1036	3.08	1.33	1.25	1441.60	0.97	2.22	2.43
4768	D054255	7204	2231	1840	1280	5.63	1.74	1.44	1387.90	3.25	7.76	7.38
4769	D063095	3846	1489	1289	1030	3.73	1.45	1.25	1366.60	1.52	3.83	3.91
4770	D083095	1528	785	840	1019	1.50	0.77	0.62	1724.10	0.16	0.30	0.84

Homestake Mining Company - Grants, New Mexico Project 11:39:54 AM, 4/21/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E053 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E053151
Ave. Gamma : 15,472.44
No. of Points : 9
North Limits : >1545266.67,<1545300
East Limits : >490400,<490433.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Jun[illegible]995

Date Sealed: June 7, [illegible]

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI) 911KEV CH661-CH961	K(ROI) 1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.60	0.75	1.65	1.56
4971	E034114	2605	1056	1085	1015	2.57	1.04	1.07	1526.60	1.05	2.24	1.69
4972	E044145	2236	1015	999	1001	2.23	1.01	1.00	1517.60	0.66	1.46	1.52
4973	E053151	2665	1201	1099	1002	2.66	1.20	1.10	1527.20	0.62	1.75	2.09
4974	E041056	2449	1035	961	1007	2.43	1.03	0.95	1638.70	0.69	1.77	1.66
4975	D104176	3967	1526	1374	1001	3.98	1.52	1.37	1457.60	1.79	4.02	4.28
4976	D103249	3334	1461	1319	1049	3.16	1.39	1.26	1460.60	1.06	2.36	2.50
4977	D093206	2674	1126	1035	1002	2.67	1.13	1.03	1581.40	0.98	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project 12:08:07 PM, 4/21/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E054 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E054059
Ave. Gamma : 15,365.73
No. of Points : 11
North Limits : >1545400,<1545433.33
East Limits : >490966.67,<491000

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: June 7 1995

Date Sealed: June

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TI1(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TI1 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4978	D113195	5487	1890	1505	1127	4.87	1.86	1.34	1514.30	2.55	5.51	5.20
4979	E073127	2361	1145	1017	1016	2.32	1.13	1.00	1550.20	0.54	1.15	1.56
4980	E054059	3918	1868	1715	1704	2.30	1.10	1.01	1490.50	0.58	1.28	1.90
4981	E083203	2284	1117	966	1004	2.27	1.11	0.96	1477.30	0.51	1.12	1.21
4982	E093135	4879	1687	1414	1066	4.57	1.58	1.32	1428.10	2.39	5.47	4.99
4983	E082251	5173	1837	1568	1356	3.81	1.35	1.18	1502.40	1.92	4.18	3.70
4984	E091155	5016	1872	1394	1055	4.76	1.58	1.32	1458.90	2.81	5.88	5.49
4985	E101114	24170	8121	6563	5010	4.82	1.82	1.31	1372.60	2.81	8.23	5.75

Homestake Mining Company - Grants, New Mexico Project 3:12:37 PM, 4/24/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E061 Zone: Outer

The Grid with the Max. Gamma

Grid : E061067
Ave. Gamma : 15,732.32
No. of Points : 25
North Limits : >1545800,<1545833.33
East Limits : >491000,<491033.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Mar[illegible] 1995

Date Sealed: March [illegible], 1995

Date Read : April 17, 1995

SAMPLED BY LJ. PREP SAMPLES RG. 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(HOI) 609KEV CH549 - CH658	TH(HOI) 911KEV CH881 - CH961	K(HOI) 1406KEV CH1338 - CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549 - CH658	TH 911 KEV CH861 - CH961	K 1460 KEV CH1338 - CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra-226 Rci/g
4760	E042169	2349	1287	1327	1559	1.51	0.83	0.85	1661.30	0.05	0.10	0.81
4761	E041056	3031	1147	1034	1009	3.00	1.14	1.02	1812.98	1.25	2.58	2.46
4762	D642216	7936	2231	1871	1334	5.95	1.67	1.40	1599.20	3.79	7.87	6.41
4763	D044254	4910	1620	1583	1566	3.14	1.03	1.01	1640.00	1.64	3.31	2.63
4764	E051195	3508	1411	1178	1035	3.39	1.36	1.14	1529.80	1.25	2.72	3.80
4765	D053193	2848	1259	1157	1065	2.67	1.18	1.09	1394.40	0.78	1.80	2.40
4766	E052153	3858	1588	1481	1187	3.25	1.34	1.25	1447.50	1.15	2.64	3.43
4767	E061067	3189	1376	1296	1036	3.06	1.33	1.25	1441.80	0.97	2.22	2.43
4768	D054255	7204	2231	1840	1280	5.63	1.74	1.44	1387.90	3.25	7.76	7.38
4769	D083695	3846	1489	1289	1030	3.73	1.45	1.25	1388.60	1.52	3.83	3.91
4770	D083095	1526	785	840	1019	1.50	0.77	0.82	1724.10	0.16	0.36	0.84

Homestake Mining Company - Grants, New Mexico Project 5:44:17 PM, 4/24/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E063 Zone: Outer

The Grid with the Max. Gamma

Grid : E063127
Ave. Gamma : 15,801.64
No. of Points : 14
North Limits : >1545200,<1545233.33
East Limits : >491100,<491133.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: MAY 3,1995

Date Sealed: M. 995

Date Read : MAY 22,1995

SAMPLED BY MJ and LJ. PREP SAMPLES HG . 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG RA226 pCi/g
4870	E031222	3493	1223	1350	1106	3.16	1.11	1.22	1549.80	1.87	3.54	2.86
4871	C064193	3148	1324	1346	1053	2.99	1.28	1.28	1470.40	1.14	2.54	2.18
4872	D074013	6926	2015	1052	1282	5.40	1.57	1.44	1510.80	3.47	7.55	5.83
4873	E141169	3732	1683	1705	1305	2.86	1.29	1.31	1395.10	0.91	2.15	2.47
4874	H081259	2556	1358	1477	1730	1.48	0.78	0.85	1622.70	0.23	0.46	0.61
4875	H052157	3639	1461	1373	1045	3.48	1.40	1.31	1702.70	1.45	2.79	2.61
4876	E074147	2063	1155	1153	1010	2.83	1.14	1.14	1589.00	1.17	2.45	2.15
4877	E083127	3665	1418	1339	1044	3.51	1.36	1.28	1570.90	1.56	3.27	3.00

Homestake Mining Company - Grants, New Mexico Project 5:35:41 PM, 4/24/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E064 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E064147
Ave. Gamma : 15,539.26
No. of Points : 19
North Limits : >1545200,<1545233.33
East Limits : >491800,<491833.33

Min(No. of Points) : 19

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: [illegible],1995

Date Sealed: JU[illegible] 1995

Date Read : JUNE 28,1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609 KEV CH549 – CH658	TH(ROI)911KE CH861 – CH961	K(ROI)1406KEV CH1338 – CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549 – CH65	TH 911 KEV CH861 – CH961	K 1460 KEV CH1338 – CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem Unat pCi/g
5002	ED64 147	4142	1599	1332	1231	3.36	1.30	1.08	1463.50	1.47	3.29					
5003	KD64 177	2347	1157	1120	1033	2.27	1.12	1.08	1359.30	0.51	1.22					
5004	KD63 196	3623	1496	1349	1095	3.31	1.37	1.23	1361.20	1.28	3.07					
5005	KD73084	4152	1512	1295	1220	3.40	1.24	1.08	1555.50	1.65	3.48					

Homestake Mining Company - Grants, New Mexico Project 5:03:17 PM, 4/27/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E073 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E073127
Ave. Gamma : 15,075.47
No. of Points : 19
North Limits : >1545200,<1545233.33
East Limits : >492100,<492133.33

Min(No. of Points) : 15

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Ju[illegible] 1995

Date Sealed: June 9, 1995

Date Read: JUNE 27, 1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH881-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4978	D113195	5487	1890	1505	1127	4.87	1.68	1.34	1514.30	2.55	5.51	5.20
4979	E073127	2361	1145	1017	1018	2.32	1.13	1.00	1550.20	0.54	1.15	1.58
4980	E054059	3918	1868	1715	1704	2.30	1.10	1.01	1490.50	0.58	1.28	1.90
4981	E083203	2264	1117	988	1004	2.27	1.11	0.96	1477.30	0.51	1.12	1.21
4982	E093135	4879	1667	1414	1068	4.57	1.56	1.32	1428.10	2.39	5.47	4.99
4983	E082251	5173	1837	1586	1358	3.81	1.35	1.18	1502.40	1.92	4.18	3.70
4984	E091155	5018	1672	1394	1055	4.78	1.58	1.32	1456.90	2.61	5.88	5.49
4985	E101114	24170	8121	6583	5010	4.82	1.62	1.31	1372.60	2.61	6.23	5.75

Homestake Mining Company - Grants, New Mexico Project 5:23:02 PM, 4/27/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E074 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E074147
Ave. Gamma : 15,433.00
No. of Points : 15
North Limits : >1545200,<1545233.33
East Limits : >492800,<492833.33

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: MAY 3,1995

Date Sealed: MA .995

Date Read : MAY 22,1995

SAMPLED BY MJ and LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH881-CH961	K(ROI)1406KEV CH1330-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra226 pCi/g
4870	E031222	3493	1223	1350	1106	3.16	1.11	1.22	1549.80	1.87	3.54	2.66
4871	C064193	3148	1324	1346	1053	2.99	1.26	1.28	1470.40	1.14	2.54	2.16
4872	D074013	6926	2015	1052	1282	5.40	1.57	1.44	1510.80	3.47	7.55	5.83
4873	E141169	3732	1683	1705	1305	2.86	1.29	1.31	1305.10	0.91	2.15	2.47
4874	H081259	2556	1358	1477	1730	1.48	0.78	0.85	1622.70	0.23	0.48	0.61
4875	H052157	3639	1461	1373	1045	3.48	1.40	1.31	1702.70	1.45	2.79	2.61
4876	E074147	2863	1155	1153	1010	2.83	1.14	1.14	1589.00	1.17	2.45	2.15
4877	E083127	3665	1418	1339	1044	3.51	1.36	1.28	1570.90	1.56	3.27	3.00

Homestake Mining Company - Grants, New Mexico Project 11:16:44 AM, 4/26/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E082 Zone: Outer

The Grid with the Max. Gamma

Grid : E082251
Ave. Gamma : 17,779.50
No. of Points : 10
North Limits : >1545566.67,<1545600
East Limits : >493900,<493933.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: J[illegible].1995

Date Sealed: June [illegible], 1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES NO. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TII(ROI)911KEV CH861-CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TII 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4976	D113195	5487	1690	1505	1127	4.87	1.66	1.34	1514.30	2.55	5.51	5.20
4979	E073127	2361	1145	1017	1016	2.32	1.13	1.00	1550.20	0.54	1.15	1.58
4980	E054059	3918	1866	1715	1704	2.30	1.10	1.01	1490.50	0.56	1.26	1.90
4981	E083203	2284	1117	968	1004	2.27	1.11	0.98	1477.30	0.51	1.12	1.21
4982	E093135	4879	1667	1414	1068	4.57	1.58	1.32	1426.10	2.39	5.47	4.99
4983	E062251	5173	1837	1568	1356	3.81	1.35	1.18	1502.40	1.92	4.16	3.70
4984	E091155	5018	1672	1394	1055	4.76	1.58	1.32	1456.90	2.61	5.88	5.49
4985	E101114	24170	8121	6563	5010	4.82	1.62	1.31	1372.60	2.81	6.23	5.75

Homestake Mining Company - Grants, New Mexico Project 5:42:00 PM, 4/27/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E083 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E083203
Ave. Gamma : 16,087.95
No. of Points : 39
North Limits : >1545166.67,<1545200
East Limits : >493466.67,<493500

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: Jun[illegible] 1995

Date Sealed: June [illegible]95

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID.	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH656	TH(ROI)911KEV CH661-CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH656	TH 911 KEV CH661-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4978	D113195	5467	1690	1505	1127	4.67	1.68	1.34	1514.30	2.55	5.51	5.20
4979	E073127	2361	1145	1017	1016	2.32	1.13	1.00	1550.20	0.54	1.15	1.58
4980	E054059	3916	1866	1715	1704	2.30	1.10	1.01	1490.50	0.58	1.26	1.90
4981	E083203	2284	1117	968	1004	2.27	1.11	0.96	1477.30	0.51	1.12	1.21
4982	E093135	4879	1687	1414	1068	4.57	1.58	1.32	1426.10	2.39	5.47	4.99
4983	E062251	5173	1637	1586	1358	3.81	1.35	1.16	1502.40	1.92	4.16	3.70
4984	E091155	5016	1672	1394	1055	4.76	1.58	1.32	1456.90	2.61	5.66	5.49
4985	E101114	24170	8121	8563	5010	4.82	1.62	1.31	1372.60	2.61	6.23	5.75

Homestake Mining Company - Grants, New Mexico Project 6:20:12 PM, 4/27/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E084 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E084171
Ave. Gamma : 18,796.20
No. of Points : 10
North Limits : >1545166.67,<1545200
East Limits : >493600,<493633.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: MAY 95

Date Sealed: MAY 8, 1995

Date Read : MAY 23, 1995

SAMPLED BY MJ and LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(HOI) 609KEV CH549 CH658	TH(HOI)911KEV CH861-CH961	K(HOI)1406KEV CH1338-CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1456	SAMPLE WT.	TRUE SAMPLE CT. RATE	HMC Ra 226 pCi/g	ERG Ra226 pCi/g
4878	D113195	34231	10026	6560	4817	7.11	2.08	1.78	1475.70	4.52	10.07	8.49
4879	C114239	2947	1461	1402	1153	2.56	1.27	1.22	1390.10	0.57	1.34	2.28
4880	E084171	2633	1282	1272	1098	2.40	1.17	1.16	1531.30	0.58	1.25	1.91
4881	C122142	3720	1542	1459	1342	2.77	1.15	1.09	1493.60	1.07	2.36	3.01

Homestake Mining Company - Grants, New Mexico Project 11:44:11 AM, 5/5/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E091 Zone: Outer

The Grid with the Max. Gamma

Grid : E091155
Ave. Gamma : 19,093.67
No. of Points : 12
North Limits : >1545733.33,<1545766.67
East Limits : >494433.33,<494466.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: June [illegible] 1995

Date Sealed: June 9, 1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549 - CH658	TH(ROI) 911KEV CH861 - CH961	K(ROI) 1406KEV CH1336 - CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549 - CH658	TH 911 KEV CH861 - CH961	K 1460 KEV CH1336 - CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4978	D113195	5467	1890	1505	1127	4.87	1.68	1.34	1514.30	2.55	5.51	5.20
4979	E073127	2361	1145	1017	1016	2.32	1.13	1.00	1550.20	0.54	1.15	1.58
4980	E054059	3918	1868	1715	1704	2.30	1.10	1.01	1490.50	0.56	1.26	1.90
4981	E083203	2284	1117	966	1004	2.27	1.11	0.96	1477.30	0.51	1.12	1.21
4982	E093135	4879	1687	1414	1068	4.57	1.58	1.32	1426.10	2.39	5.47	4.99
4983	E082251	5173	1837	1586	1356	3.81	1.35	1.16	1502.40	1.92	4.16	3.70
4984	E091155	5016	1672	1394	1055	4.76	1.58	1.32	1456.90	2.81	5.86	5.49
4985	E101114	24170	8121	6563	5010	4.82	1.62	1.31	1372.60	2.81	6.23	5.75

Homestake Mining Company - Grants, New Mexico Project 11:47:01 AM, 5/5/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E092 Zone: Outer

The Grid with the Max. Gamma

Grid : E092248
Ave. Gamma : 20,767.55
No. of Points : 11
North Limits : >1545500,<1545533.33
East Limits : >494833.33,<494866.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: June 1,1995

Date Sealed: June ,5

Date Read : JUNE 20,1995

SAMPLED BY LJ. PREP SAMPLES NO. *15 DAY READING SEALED* *1995* *SOIL SAMPLES*

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549 CH656	TH(ROI)911KEV CH861- CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549- CH656	TH 911 KEV CH861- CH981	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG
4954	H064259	2444	1194	1163	1075	2.27	1.11	1.08	1645.20	0.54	1.07	1.36
4955	E092248	5322	2009	1790	1324	4.02	1.52	1.35	1429.20	1.66	4.24	4.00
4956	E101114	13809	4782	4068	2893	4.70	1.85	1.41	1437.50	2.42	5.49	5.25
4957	F091026	10344	4434	4288	4082	2.53	1.09	1.05	1607.60	0.91	1.85	1.82
4958	C073222	2387	1282	1348	1400	1.69	0.92	0.98	1561.40	0.22	0.47	0.70
4959	K073028	3485	1395	1284	1257	2.77	1.11	1.02	1597.10	1.15	2.35	2.32
4960	J082059	2547	1091	1075	1002	2.54	1.09	1.07	1556.80	0.92	1.93	2.38
4961	K083219	3381	1351	1330	1275	2.65	1.06	1.04	1599.70	1.11	2.27	2.15

Homestake Mining Company - Grants, New Mexico Project 4:14:55 PM, 5/30/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E093 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E093135
Ave. Gamma : 19,030.12
No. of Points : 17
North Limits : >1545233.33,<1545266.67
East Limits : >494233.33,<494266.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: June [illegible] 1995

Date Sealed: June 9, 1995

Date Read : JUNE 27, 1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TI(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1336-CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TI 911 KEV CH861-CH961	K 1460 KEV CH1336-CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4978	D113195	5487	1690	1505	1127	4.87	1.88	1.34	1514.30	2.55	5.51	5.20
4979	E073127	2361	1145	1017	1018	2.32	1.13	1.00	1550.20	0.54	1.15	1.58
4980	E054059	3918	1888	1715	1704	2.30	1.10	1.01	1490.50	0.58	1.28	1.90
4981	E083203	2284	1117	988	1004	2.27	1.11	0.98	1477.30	0.51	1.12	1.21
4982	E093135	4879	1687	1414	1068	4.57	1.58	1.32	1428.10	2.39	5.47	4.99
4983	E082251	5173	1837	1588	1358	3.81	1.35	1.18	1502.40	1.92	4.18	3.70
4984	E091155	5018	1872	1394	1055	4.78	1.58	1.32	1456.90	2.81	5.88	5.49
4985	E101114	24170	8121	8563	5010	4.82	1.82	1.31	1372.60	2.81	6.23	5.75

Homestake Mining Company - Grants, New Mexico Project 4:16:39 PM. 5/30/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E094 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E094059
Ave. Gamma : 19,882.62
No. of Points : 13
North Limits : >1545400,<1545433.33
East Limits : >494966.67,<495000

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33 x33 PLOT,

Date Collected: Jur 95

Date Sealed: June 9,1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH656	TH(ROI)911KEV CH661-CH961	K(ROI)1406KEV CH1338-CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH656	TH 911 KEV CH661-CH961	K 1460 KEV CH1338-CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pci/g
4986	E102064	6075	2465	2103	1739	3.49	1.42	1.21	1438.80	1.39	3.17	3.29
4987	H092225	2897	1258	1154	1309	2.21	0.96	0.88	1765.00	0.75	1.37	1.59
4988	H093095	2686	1331	1223	1339	2.01	0.99	0.91	1760.20	0.43	0.79	0.88
4989	E103101	12663	4533	3788	2956	4.29	1.53	1.28	1434.10	2.14	4.86	4.75
4990	E094059	4846	1748	1410	1122	4.32	1.56	1.26	1419.90	2.12	4.89	4.78
4991	E092248	4424	1483	1254	1003	4.41	1.48	1.25	1456.70	2.40	5.39	4.83
4992	E113166	3554	1119	1009	1006	3.53	1.11	1.00	1653.90	2.07	4.10	3.84
4993	F102237	3065	1280	1137	1351	2.26	0.95	0.84	1617.30	0.86	1.74	1.50

Homestake Mining Company - Grants, New Mexico Project 12:47:04 PM, 5/5/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E101 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E101114
Ave. Gamma : 21,765.74
No. of Points : 19
North Limits : >1545733.33,<1545766.67
East Limits : >495000,<495033.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 2

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
E101114	21,765.74	19	>1545733.33,<1545766.67	>495000,<495033.33
E101118	21,704.08	12	>1545700,<1545733.33	>495033.33,<495066.67

Date Collected: June 1,1995

Date Sealed: Jun. ,995

Date Read : JUNE 20,1995

SAMPLED BY LJ. PREP SAMPLES RO. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549 CH658	TH(ROI)911KEV CH861–CH981	K(ROI)1460KEV CH1338–CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549–CH658	TH 911 KEV CH861–CH961	K 1460 KEV CH1338–CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG
4954	H084259	2444	1194	1163	1075	2.27	1.11	1.08	1645.20	0.54	1.07	1.36
4955	E092246	5322	2069	1790	1324	4.02	1.52	1.35	1429.20	1.68	4.24	4.00
4956	E101114	13609	4762	4068	2893	4.70	1.65	1.41	1437.50	2.42	5.49	5.25
4957	F091028	10344	4434	4288	4082	2.53	1.09	1.05	1607.60	0.91	1.65	1.62
4958	C073222	2387	1282	1346	1400	1.89	0.92	0.98	1561.40	0.22	0.47	0.70
4959	K073028	3485	1395	1284	1257	2.77	1.11	1.02	1597.10	1.15	2.35	2.32
4960	J082059	2547	1091	1075	1002	2.54	1.09	1.07	1558.60	0.92	1.93	2.36
4961	K083219	3381	1351	1330	1275	2.65	1.06	1.04	1599.70	1.11	2.27	2.15

Homestake Mining Company - Grants, New Mexico Project 2:19:38 PM, 5/8/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E102084
Ave. Gamma : 20,674.50
No. of Points : 16
North Limits : >1545833.33,<1545866.67
East Limits : >495700,<495733.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33'x33' PLOT,

Date Collected: Jun 95

Date Sealed: June 9,1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

	Wind Blown	TOTAL COUNTS				CPS				TRUE	HMC	ERC
LAB ID	Samples ID.	RA(ROI) 609KEV CII549-CII658	TH(ROI)911KEV CII861-CII981	K(ROI)1406KEV CII1338-CII1458	COUNT TIME SECONDS	RA 609 KEV CII549-CII658	TH 911 KEV CII661-CII961	K 1460 KEV CII1338-CII1458	SAMPLE WT.	SAMPLE CT. RAT	Ra 226 pCi/g	Ra 226 pCi/g
4986	E102084	6075	2465	2103	1739	3.49	1.42	1.21	1436.60	1.39	3.17	3.29
4987	H092225	2697	1258	1154	1309	2.21	0.96	0.66	1765.00	0.75	1.37	1.59
4988	H093095	2688	1331	1223	1339	2.01	0.99	0.91	1760.20	0.43	0.79	0.66
4989	E103101	12683	4533	3768	2956	4.29	1.53	1.28	1434.10	2.14	4.88	4.75
4990	E094059	4848	1748	1410	1122	4.32	1.56	1.26	1419.90	2.12	4.89	4.78
4991	E092248	4424	1483	1254	1003	4.41	1.48	1.25	1458.70	2.40	5.39	4.83
4992	E113166	3554	1119	1009	1006	3.53	1.11	1.00	1853.90	2.07	4.10	3.64
4993	F102237	3085	1280	1137	1351	2.26	0.95	0.84	1817.30	0.88	1.74	1.50

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E103

Zone: Outer

The Grid with the Max. Gamma

Grid : E103101
Ave. Gamma : 20,059.41
No. of Points : 37
North Limits : >1545366.67,<1545400
East Limits : >495400,<495433.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33'x33' PLOT.

Date Collected: Jul 995

Date Sealed: June 9, 1995

Date Read : JUNE 27, 1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH661-CH981	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH981	K 1460 KEV CH1336-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pci/g
4986	E102064	6075	2465	2103	1739	3.49	1.42	1.21	1436.60	1.39	3.17	3.29
4987	H092225	2897	1256	1154	1309	2.21	0.96	0.88	1765.00	0.75	1.37	1.59
4988	H093095	2688	1331	1223	1339	2.01	0.99	0.91	1760.20	0.43	0.79	0.68
4989	E103101	12683	4533	3788	2956	4.29	1.53	1.28	1434.10	2.14	4.88	4.75
4990	E094059	4848	1748	1410	1122	4.32	1.56	1.26	1419.90	2.12	4.89	4.76
4991	E092246	4424	1463	1254	1003	4.41	1.46	1.25	1456.70	2.40	5.39	4.63
4992	E113166	3554	1119	1009	1006	3.53	1.11	1.00	1653.90	2.07	4.10	3.64
4993	F102237	3085	1260	1137	1351	2.28	0.95	0.84	1617.30	0.86	1.74	1.50

Homestake Mining Company - Grants, New Mexico Project 3:12:00 PM, 5/5/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E113 Zone: Outer

The Grid with the Max. Gamma

Grid : E113166
Ave. Gamma : 17,927.31
No. of Points : 13
North Limits : >1545133.33,<1545166.67
East Limits : >496066.67,<496100

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33'x33' PLOT,

Date Collected: 7,1995

Date Sealed: June 9,1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549–CH656	TH(ROI)911KEV CH661–CH961	K(ROI)1406KEV CH1338–CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549–CH656	TH 911 KEV CH661–CH961	K 1460 KEV CH1338–CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4986	E102084	6075	2465	2103	1739	3.49	1.42	1.21	1436.80	1.39	3.17	3.29
4987	H092225	2697	1256	1154	1309	2.21	0.96	0.86	1765.00	0.75	1.37	1.59
4988	H093095	2688	1331	1223	1339	2.01	0.99	0.91	1780.20	0.43	0.79	0.88
4989	E103101	12683	4533	3766	2956	4.29	1.53	1.28	1434.10	2.14	4.88	4.75
4990	E094059	4846	1746	1410	1122	4.32	1.56	1.26	1419.90	2.12	4.89	4.78
4991	E092246	4424	1463	1254	1003	4.41	1.46	1.25	1456.70	2.40	5.39	4.83
4992	E113166	3554	1119	1009	1006	3.53	1.11	1.00	1653.90	2.07	4.10	3.84
4993	F102237	3085	1280	1137	1351	2.28	0.95	0.84	1617.30	0.86	1.74	1.50

Homestake Mining Company - Grants, New Mexico Project 9:31:13 AM, 5/5/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D093 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D093206
Ave. Gamma : 15,253.13
No. of Points : 8
North Limits : >1546133.33,<1546166.67
East Limits : >494466.67,<494500

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: 6,1995

Date Sealed: June 7,1995

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

	Wind Blown	TOTAL COUNTS				CPS						
										TRUE	HMC	
LAB	Samples	RA(ROI) 609KEV	TH(ROI)911KEV	K(ROI)1406KEV	COUNT TIME	RA 609 KEV	TH 911 KEV	K 1460 KEV	SAMPLE	SAMPLE	Ra 226	
ID	ID.	CH549-CH658	CH861-CH961	CH1336-CH1458	SECONDS	CH549-CH658	CH861-CH961	CH1338-CH1458	WT.	CT. RAT	pCi/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.60	0.75	1.65	1.56
4971	E034114	2605	1056	1085	1015	2.57	1.04	1.07	1526.60	1.05	2.24	1.69
4972	E044145	2236	1015	999	1001	2.23	1.01	1.00	1517.60	0.66	1.46	1.52
4973	E053151	2665	1201	1099	1002	2.66	1.20	1.10	1527.20	0.62	1.75	2.09
4974	E041056	2449	1035	961	1007	2.43	1.03	0.95	1636.70	0.69	1.77	1.66
4975	D104176	3967	1526	1374	1001	3.96	1.52	1.37	1457.60	1.79	4.02	4.26
4976	D103249	3334	1461	1319	1049	3.16	1.39	1.26	1460.60	1.06	2.38	2.50
4977	D093206	2674	1126	1035	1002	2.67	1.13	1.03	1581.40	0.96	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project 9:33:50 AM, 5/5/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID DC94 Zone: Outer

The Grid with the Max. Gamma

Grid : DC94229
Ave. Gamma : 17,648.42
No. of Points : 19
North Limits : >1546000,<1546033.33
East Limits : >494666.67,<494700

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: M^^ 9,1995

Date Sealed: MAY .., 1995

Date Read : MAY 25,1995

SAMPLED BY MJ and LJ. PREP SAMPLES NO. 15 DAY READING SEALED 1995 SOIL SAMPLES

	Wind Blown	TOTAL COUNTS				CPS				TRUE	IMC	ERG
LAB	Samples	RA(ROI) 609KEV	TH(ROI)911KEV	K(ROI)1406KEV	COUNT TIME	RA 609 KEV	TH 911 KEV	K 1460 KEV	SAMPLE	SAMPLE	Ra 226	Ra 226
ID	ID.	CH549 - CH658	CH661 - CH961	CH1336 - CH1458	SECONDS	CH549 - CH658	CH661 - CH961	CH1338 - CH1458	WT.	CT. RAT	pCi/g	pCi/g
4882	E111012	8026	3971	3462	3059	2.62	1.30	1.13	1393.70	0.57	1.34	1.92
4883	E123124	2503	1279	1366	1612	1.55	0.79	0.86	1717.70	0.30	0.56	0.59
4884	E132185	6992	2650	2606	1931	3.62	1.46	1.35	1433.10	1.45	3.33	3.54
4885	D094229	3187	1200	1249	1137	2.60	1.06	1.10	1555.70	1.32	2.79	2.08

Homestake Mining Company - Grants, New Mexico Project 8:36:50 AM, 4/25/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D103 Zone: Outer

The Grid with the Max. Gamma

Grid : D103249
Ave. Gamma : 20,918.38
No. of Points : 13
North Limits : >1546000,<1546033.33
East Limits : >495366.67,<495400

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: [illegible] 6,1995

Date Sealed: June 7,1995

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH661-CH961	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH961	K 1460 KEV CH1336-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.60	0.75	1.65	1.56
4971	E034114	2605	1056	1065	1015	2.57	1.04	1.07	1526.60	1.05	2.24	1.69
4972	E044145	2236	1015	999	1001	2.23	1.01	1.00	1517.60	0.66	1.48	1.52
4973	E053151	2665	1201	1099	1002	2.66	1.20	1.10	1527.20	0.82	1.75	2.09
4974	E041056	2449	1035	961	1007	2.43	1.03	0.95	1638.70	0.69	1.77	1.66
4975	D104178	3987	1528	1374	1001	3.98	1.52	1.37	1457.80	1.79	4.02	4.26
4976	D103249	3334	1481	1319	1049	3.18	1.39	1.26	1480.80	1.06	2.36	2.50
4977	D093206	2674	1128	1035	1002	2.67	1.13	1.03	1581.40	0.96	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project
9:15:27 AM, 4/25/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D104 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D104176
Ave. Gamma : 21,963.93
No. of Points : 14
North Limits : >1546133.33,<1546166.67
East Limits : >495666.67,<495700

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 6

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
D104172	21,535.50	14	>1546166.67,<1546200	>495633.33,<495666.67
D104173	21,827.60	15	>1546166.67,<1546200	>495666.67,<495700
D104175	21,661.31	16	>1546133.33,<1546166.67	>495633.33,<495666.67
D104176	21,963.93	14	>1546133.33,<1546166.67	>495666.67,<495700
D104181	21,650.55	11	>1546166.67,<1546200	>495700,<495733.33
D104236	21,642.27	15	>1546033.33,<1546066.67	>495766.67,<495800

Location: SOIL VERIFICATION SURVEY 33 X33 PLOT,

Date Collected: [illegible] 6,1995

Date Sealed: June 7,1995

Date Read : JUNE 22,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1336-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RATE	HMC Ra 226 pCi/g	ERG
4970	E033049	2344	1040	1071	1023	2.29	1.02	1.05	1495.60	0.75	1.65	1.56
4971	E034114	2605	1056	1085	1015	2.57	1.04	1.07	1526.60	1.05	2.24	1.69
4972	E044145	2236	1015	999	1001	2.23	1.01	1.00	1517.60	0.66	1.46	1.52
4973	E053151	2665	1201	1099	1002	2.66	1.20	1.10	1527.20	0.62	1.75	2.09
4974	E041056	2449	1035	961	1007	2.43	1.03	0.95	1636.70	0.69	1.77	1.66
4975	D104176	3967	1526	1374	1001	3.96	1.52	1.37	1457.80	1.79	4.02	4.28
4976	D103249	3334	1461	1319	1049	3.16	1.39	1.26	1460.60	1.06	2.36	2.50
4977	D093206	2674	1128	1035	1002	2.67	1.13	1.03	1581.40	0.96	2.02	1.79

Homestake Mining Company - Grants, New Mexico Project 9:23:29 AM, 5/11/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D113 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D113084
Ave. Gamma : 20,785.50
No. of Points : 25
North Limits : >1546333.33,<1546366.67
East Limits : >496200,<496233.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: MAY 16,1995

Date Sealed: MA 1995

Date Read : JUNE 2,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4900	K042055	4204	1666	1450	1077	3.90	1.57	1.35	1469.80	1.61	3.59	4.07
4901	K051179	13887	4688	3962	2643	5.25	1.77	1.50	1523.10	2.85	8.15	5.25
4902	LO41117	3408	1810	1334	1077	3.16	1.49	1.24	1409.80	0.82	1.92	2.41
4903	L081048	3110	1590	1410	1225	2.54	1.30	1.15	1410.00	0.47	1.09	2.30
4904	D113084	2889	1308	1151	1022	2.63	1.28	1.13	1382.00	0.88	2.04	1.93

Homestake Mining Company - Grants, New Mexico Project 1:32:30 PM, 5/30/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: Outer

GRID F102

The Grid with the Max. Gamma

Grid : F102237
Ave. Gamma : 18,905.90
No. of Points : 10
North Limits : >1544500,<1544533.33
East Limits : >495700,<495733.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33'x33' PLOT.

Date Collected: J 1995

Date Sealed: June 9,1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH661-CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH981	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	ERG Ra 226 pCi/g
4986	E102084	6075	2465	2103	1739	3.49	1.42	1.21	1436.80	1.39	3.17	3.29
4987	H092225	2697	1258	1154	1309	2.21	0.96	0.88	1785.00	0.75	1.37	1.59
4988	H093095	2688	1331	1223	1339	2.01	0.99	0.91	1780.20	0.43	0.79	0.88
4989	E103101	12683	4533	3766	2956	4.29	1.53	1.28	1434.10	2.14	4.88	4.75
4990	E094059	4846	1748	1410	1122	4.32	1.56	1.26	1419.90	2.12	4.89	4.78
4991	E092248	4424	1483	1254	1003	4.41	1.48	1.25	1458.70	2.40	5.39	4.83
4992	E113166	3554	1119	1009	1006	3.53	1.11	1.00	1853.90	2.07	4.10	3.84
4993	F102237	3085	1280	1137	1351	2.28	0.95	0.84	1817.30	0.86	1.74	1.50

Homestake Mining Company - Grants, New Mexico Project 11:43:34 AM, 5/17/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: **Outer**

GRID F103

The Grid with the Max. Gamma

Grid : F103039
Ave. Gamma : 15,298.69
No. of Points : 26
North Limits : >1544400,<1544433.33
East Limits : >495266.67,<495300

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: [illegible] 7,1995

Date Sealed: June 12,1995

Date Read: JUNE 28,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED **1995** **SOIL SAMPLES**

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4994	G092096	3155	1176	1072	1169	2.65	0.99	0.90	1691.90	1.23	2.36	2.29
4995	F103039	6120	2026	1569	1418	3.81	1.43	1.12	1536.00	1.50	3.19	3.31
4996	J091041	2947	1250	1090	1060	2.78	1.16	1.03	1555.70	1.00	2.10	2.13
4997	G094087	3607	1476	1419	1553	2.32	0.95	0.91	1591.40	0.91	1.67	1.69
4998	J094225	2909	1169	1033	1020	2.85	1.17	1.01	1560.80	1.11	2.34	2.44
4999	K082078	13660	4990	4440	3930	3.48	1.27	1.13	1626.30	1.66	3.36	3.24
5000	K072035	3370	1683	1674	1795	1.88	0.94	0.93	1555.80	0.39	0.83	1.44
5001	K074174	1732	926	923	1056	1.64	0.66	0.67	1547.00	0.22	0.47	0.59

Homestake Mining Company - Grants, New Mexico Project 8:44:19 AM, 5/17/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G092 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G092096
Ave. Gamma : 13,361.20
No. of Points : 15
North Limits : >1543833.33,<1543866.67
East Limits : >494866.67,<494900

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: J[illegible],1995

Date Sealed: June 12,1995

Date Read : JUNE 28,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4994	G092096	3155	1178	1072	1169	2.85	0.99	0.90	1691.90	1.23	2.38	2.29
4995	F103039	5120	2028	1589	1418	3.81	1.43	1.12	1538.00	1.80	3.19	3.31
4996	J081041	2947	1250	1090	1060	2.78	1.18	1.03	1555.70	1.00	2.10	2.13
4997	G084087	3607	1478	1419	1553	2.32	0.95	0.91	1691.40	0.91	1.87	1.89
4998	J084225	2909	1189	1033	1020	2.85	1.17	1.01	1560.80	1.11	2.34	2.44
4999	K082076	13680	4990	4440	3930	3.48	1.27	1.13	1628.30	1.88	3.38	3.24
5000	K072035	3370	1683	1674	1795	1.88	0.94	0.93	1655.80	0.39	0.83	1.44
5001	K074174	1732	926	923	1058	1.84	0.88	0.87	1547.00	0.22	0.47	0.69

Homestake Mining Company - Grants, New Mexico Project 11:13:07 AM, 5/30/95
GPS Radiological Surveys

By ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G094 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : G094067
Ave. Gamma : 12,833.20
No. of Points : 35
North Limits : >1543300,<1543333.33
East Limits : >494500,<494533.33

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33 X33' PLOT,

Date Collected: 7,1995

Date Sealed: June 12,1995

Date Read: JUNE 26,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1336-CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1336-CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	ERG Ra 226 pCi/g
4994	G092096	3155	1176	1072	1169	2.65	0.99	0.90	1691.90	1.23	2.36	2.29
4995	F103039	5120	2026	1569	1418	3.61	1.43	1.12	1536.00	1.50	3.19	3.31
4996	J091041	2947	1250	1090	1060	2.76	1.16	1.03	1555.70	1.00	2.10	2.13
4997	G084067	3607	1476	1419	1553	2.32	0.95	0.91	1591.40	0.91	1.67	1.69
4998	J084225	2909	1169	1033	1020	2.85	1.17	1.01	1560.80	1.11	2.34	2.44
4999	K082076	13660	4990	4440	3930	3.48	1.27	1.13	1626.30	1.66	3.36	3.24
5000	K072035	3370	1683	1674	1795	1.88	0.94	0.93	1555.80	0.39	0.83	1.44
5001	K074174	1732	926	923	1058	1.64	0.88	0.87	1547.00	0.22	0.47	0.59

Homestake Mining Company - Grants, New Mexico Project 10:16:27 AM, 5/30/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H092 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : H092225
Ave. Gamma : 17,007.17
No. of Points : 23
North Limits : >1542533.33,<1542566.67
East Limits : >494633.33,<494666.67

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33'X33' PLOT,

Date Collected: Ju 1995

Date Sealed: June 9,1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1338-CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4986	E102084	6075	2465	2103	1739	3.49	1.42	1.21	1436.80	1.39	3.17	3.29
4987	H092225	2897	1256	1154	1309	2.21	0.96	0.88	1785.00	0.75	1.37	1.59
4988	H093095	2686	1331	1223	1339	2.01	0.99	0.91	1760.20	0.43	0.79	0.66
4989	E103101	12683	4533	3788	2958	4.29	1.53	1.28	1434.10	2.14	4.88	4.75
4990	E094059	4846	1746	1410	1122	4.32	1.56	1.26	1419.90	2.12	4.69	4.78
4991	E092246	4424	1463	1254	1003	4.41	1.46	1.25	1456.70	2.40	5.39	4.63
4992	E113166	3554	1119	1009	1008	3.53	1.11	1.00	1653.90	2.07	4.10	3.84
4993	F102237	3085	1280	1137	1351	2.28	0.95	0.84	1617.30	0.86	1.74	1.50

Homestake Mining Company - Grants, New Mexico Project 10:18:21 AM, 5/30/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H093 Zone: Outer

The Grid with the Max. Gamma

Grid : H033095
Ave. Gamma : 18,226.17
No. of Points : 18
North Limits : >1542333.33,<1542366.67
East Limits : >494333.33,<494366.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33'x33' PLOT.

Date Collected: J ,1995

Date Sealed: June 9,1995

Date Read : JUNE 27,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH661-CH961	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH661-CH961	K 1460 KEV CH1336-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4986	E102084	6075	2465	2103	1739	3.49	1.42	1.21	1436.60	1.39	3.17	3.29
4987	H092225	2897	1258	1154	1309	2.21	0.96	0.88	1765.00	0.75	1.37	1.59
4988	H093095	2686	1331	1223	1339	2.01	0.99	0.91	1780.20	0.43	0.79	0.88
4989	E103101	12683	4533	3766	2956	4.29	1.53	1.28	1434.10	2.14	4.88	4.75
4990	E094059	4846	1748	1410	1122	4.32	1.56	1.26	1419.90	2.12	4.89	4.78
4991	E092246	4424	1483	1254	1003	4.41	1.48	1.25	1456.70	2.40	5.39	4.83
4992	E113166	3554	1119	1009	1006	3.53	1.11	1.00	1653.90	2.07	4.10	3.64
4993	F102237	3085	1280	1137	1351	2.28	0.95	0.84	1617.30	0.88	1.74	1.50

Homestake Mining Company - Grants, New Mexico Project 4:27:04 PM, 5/8/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J091 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J091041
Ave. Gamma : 17,219.20
No. of Points : 10
North Limits : >1541966.67,<1542000
East Limits : >494300,<494333.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: J[illegible] 7,1995

Date Sealed: June [illegible],1995

Date Read : JUNE 28,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1336-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1336-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4994	G092096	3155	1176	1072	1169	2.65	0.99	0.90	1691.90	1.23	2.38	2.29
4995	F103039	5120	2026	1569	1416	3.61	1.43	1.12	1536.00	1.50	3.19	3.31
4996	J091041	2947	1250	1090	1060	2.76	1.16	1.03	1555.70	1.00	2.10	2.13
4997	G094067	3607	1476	1419	1553	2.32	0.95	0.91	1591.40	0.91	1.67	1.69
4998	J094225	2909	1189	1033	1020	2.65	1.17	1.01	1560.80	1.11	2.34	2.44
4999	K082076	13660	4990	4440	3930	3.46	1.27	1.13	1626.30	1.66	3.38	3.24
5000	K072035	3370	1683	1674	1795	1.66	0.94	0.93	1555.80	0.39	0.63	1.44
5001	K074174	1732	926	923	1056	1.64	0.66	0.87	1547.00	0.22	0.47	0.59

Homestake Mining Company - Grants, New Mexico Project 4:01:54 PM, 5/26/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J084 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J084225
Ave. Gamma : 15,199.92
No. of Points : 13
North Limits : >1541033.33,<1541066.67
East Limits : >493633.33,<493666.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY 33 X33 PLOT,

Date Collected: [illegible],1995

Date Sealed: June 12,1995

Date Read: JUNE 28,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4994	G092096	3155	1178	1072	1189	2.85	0.99	0.90	1891.90	1.23	2.38	2.29
4995	F103039	8120	2028	1589	1418	3.81	1.43	1.12	1538.00	1.50	3.19	3.31
4996	J091041	2947	1250	1090	1060	2.78	1.18	1.03	1555.70	1.00	2.10	2.13
4997	G094067	3607	1478	1419	1553	2.32	0.95	0.91	1591.40	0.91	1.87	1.89
4998	J084225	2909	1169	1033	1020	2.85	1.17	1.01	1560.80	1.11	2.34	2.44
4999	K082078	13680	4990	4440	3930	3.48	1.27	1.13	1828.30	1.66	3.38	3.24
5000	K072035	3370	1683	1674	1795	1.88	0.94	0.93	1555.80	0.39	0.83	1.44
5001	K074174	1732	926	923	1058	1.84	0.88	0.87	1547.00	0.22	0.47	0.59

Homestake Mining Company - Grants, New Mexico Project 2:42:32 PM, 5/26/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K082 Zone: Outer

The Grid with the Max. Gamma

Grid : K082C76
Ave. Gamma : 16,690.50
No. of Points : 24
North Limits : >1540833.33,<1540866.67
East Limits : >493666.67,<493700

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: 7,1995

Date Sealed: June 12,1995

Date Read : JUNE 28,1995

SAMPLED BY LJ. PREP SAMPLES RG. — 15 DAY READING SEALED — 1995 — SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549 - CH658	TH(ROI)911KEV CH881 - CH961	K(ROI)1406KEV CH1338 - CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549 - CH658	TH 911 KEV CH881 - CH961	K 1460 KEV CH1338 - CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	ERG Ra 226 pCi/g
4994	G092096	3155	1176	1072	1189	2.65	0.99	0.90	1691.90	1.23	2.38	2.29
4995	F103039	5120	2028	1589	1418	3.61	1.43	1.12	1536.00	1.50	3.19	3.31
4996	J091041	2947	1250	1090	1060	2.78	1.18	1.03	1555.70	1.00	2.10	2.13
4997	G094087	3607	1478	1419	1553	2.32	0.95	0.91	1591.40	0.91	1.87	1.89
4998	J084225	2909	1189	1033	1020	2.85	1.17	1.01	1560.60	1.11	2.34	2.44
4999	K082076	13660	4990	4440	3930	3.48	1.27	1.13	1626.30	1.66	3.36	3.24
5000	K072035	3370	1683	1674	1795	1.88	0.94	0.93	1555.80	0.39	0.83	1.44
5001	K074174	1732	926	923	1058	1.64	0.86	0.87	1547.00	0.22	0.47	0.59

Homestake Mining Company - Grants, New Mexico Project 10:39:05 AM, 5/31/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K073 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : K073084
Ave. Gamma : 13,934.36
No. of Points : 11
North Limits : >1540333.33,<1540366.67
East Limits : >492200,<492233.33

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collect... NE 8,1995

Date Sealed. ...E 13,1995

Date Read : JUNE 28,1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609 KEV CI1549 – CI1658	TH(ROI) 911 KE CI1861 – CI1961	K(ROI) 1406 KEV CI11338 – CI11458	COUNT TIME SECONDS	CPS RA 609 KEV CI1549 – CI165	TH 911 KEV CI1861 – CI1961	K 1460 KEV CI11338 – CI11456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem Unat pCi/g
5002	E064 147	4142	1599	1332	1231	3.36	1.30	1.08	1463.50	1.47	3.29					
5003	K064 177	2347	1157	1120	1033	2.27	1.12	1.08	1359.30	0.51	1.22					
5004	K063 196	3623	1496	1349	1095	3.31	1.37	1.23	1361.20	1.28	3.07					
5005	K073064	4152	1512	1295	1220	3.40	1.24	1.06	1555.50	1.65	3.46					

Homestake Mining Company - Grants, New Mexico Project 10:41:46 AM, 5/31/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K074 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K074174
Ave. Gamma : 15,601.27
No. of Points : 15
North Limits : >1540133.33,<1540166.67
East Limits : >492600,<492633.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: 7,1995

Date Sealed: June 12,1995

Date Read: JUNE 26,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549-CH658	TH(ROI)911KEV CH861-CH961	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH658	TH 911 KEV CH861-CH961	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	ERG Ra 226 pCi/g
4994	G092096	3155	1176	1072	1189	2.65	0.99	0.90	1691.90	1.23	2.38	2.29
4995	F103039	5120	2026	1589	1418	3.61	1.43	1.12	1536.00	1.50	3.19	3.31
4996	J091041	2947	1250	1090	1060	2.78	1.18	1.03	1555.70	1.00	2.10	2.13
4997	G094087	3607	1476	1419	1553	2.32	0.95	0.91	1591.40	0.91	1.87	1.69
4998	J094225	2909	1189	1033	1020	2.85	1.17	1.01	1560.80	1.11	2.34	2.44
4999	K082076	13660	4990	4440	3930	3.48	1.27	1.13	1626.30	1.66	3.38	3.24
5000	K072035	3370	1683	1674	1795	1.88	0.94	0.93	1555.80	0.39	0.83	1.44
5001	K074174	1732	926	923	1056	1.64	0.88	0.87	1547.00	0.22	0.47	0.59

Homestake Mining Company - Grants, New Mexico Project 4:17:25 PM, 5/12/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K061 Zone: Outer

The Grid with the Max. Gamma

Grid : K061142
Ave. Gamma : 18,007.95
No. of Points : 19
North Limits : >1540766.67,<1540800
East Limits : >491333.33,<491366.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: May 23,1995

Date Sealed: Ma, [illegible]95

Date Read : JUNE 13,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

	Wind Blown	TOTAL COUNTS				CPS				TRUE	HMC	
LAB	Samples	RA(ROI) 609KEV	TH(ROI)911KEV	K(ROI)1406KEV	COUNT TIME	RA 609 KEV	TH 911 KEV	K 1460 KEV	SAMPLE	SAMPLE	Ra 226	
ID	ID.	CH549–CH856	CH861–CH961	CH1338–CH1450	SECONDS	CH549–CH656	CH861–CH961	CH1338–CH1458	WT.	CT. RAT	pCi/g	
4941	J051233	2643	1321	1179	1195	2.21	1.11	0.99	1467.60	0.46	1.00	1.35
4912	J054255	2560	1251	1216	1088	2.35	1.15	1.12	1569.70	0.56	1.15	1.32
4943	J054099	2330	1040	1073	1086	2.15	0.96	0.99	1616.10	0.70	1.42	1.70
4944	J063212	2501	1220	1132	1001	2.50	1.22	1.13	1596.00	0.59	1.21	1.63
4945	J063218	2820	1419	1406	1295	2.18	1.10	1.09	1621.90	0.46	0.92	1.40
4946	K061142	3347	1613	1369	1164	2.88	1.39	1.18	1445.70	0.70	1.58	2.72
4947	K061095	2614	1245	1163	1005	2.60	1.24	1.16	1561.00	0.68	1.42	1.78
4948	K082258	1662	952	983	1038	1.61	0.92	0.95	1543.80	0.37	0.76	1.04
4949	K064052	2051	1044	986	1115	1.64	0.94	0.66	1585.00	0.35	0.72	0.67

Homestake Mining Company - Grants, New Mexico Project 9:03:58 AM, 5/15/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K063 Zone: Outer

The Grid with the Max. Gamma

Grid :	K063196
Ave. Gamma :	17,374.38
No. of Points :	15
North Limits :	>1540133.33,<1540166.67
East Limits :	>491366.67,<491400

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFACTION SURVEY 33'X33' PLOTS

Date Collected: [illegible]NE 8,1995

Date Sealed: [illegible]E 13,1995

Date Read: JUNE 28,1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609 KEV CH549 - CH658	TL(ROI)911KE CH861 - CH961	K(ROI)1406KEV CH1336 - CH1456	COUNT TIME SECONDS	CPS RA 609 KEV CH549 - CH65	TH 911 KEV CH861 - CH961	K 1460 KEV CH1336 - CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	RMO Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem Unat pCi/g
5002	E064 147	4142	1599	1332	1231	3.36	1.30	1.08	1463.50	1.47	3.29					
5003	K064 177	2347	1157	1120	1033	2.27	1.12	1.08	1359.30	0.51	1.22					
5004	K063 196	3623	1496	1349	1095	3.31	1.37	1.23	1361.20	1.26	3.07					
5005	K073064	4152	1512	1295	1220	3.40	1.24	1.06	1555.50	1.65	3.46					

Homestake Mining Company - Grants, New Mexico Project 9:06:26 AM, 5/15/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K064 Zone: Outer

The Grid with the Max. Gamma

Grid : K064177
Ave. Gamma : 16,043.72
No. of Points : 18
North Limits : >1540100,<1540133.33
East Limits : >491600,<491633.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Location: SOIL VERIFICATION SURVEY [illegible] PLOTS

Date Collected: [illegible]E 8,1995

Date Sealed: J[illegible] 13,1995

Date Read : JUNE 28,1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

		TOTAL COUNTS				CPS						TMA	Energy	Energy	TMA	Energy
LAB ID	Wind Blown Samples ID.	RA(ROI) 609 KEV CH549 - CH658	TI(ROI)911KE CH861 - CH961	K(ROI)1406KEV CH1338 - CH1458	COUNT TIME SECONDS	RA 609 KEV CH549 - CH65	TH 911 KEV CH861 - CH961	K 1460 KEV CH1338 - CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	Eberline Ra 226 pCi/g	Gamma Ra 226 pCi/g	Wet Chem Ra 226 pCi/g	Eberline U 238 pCi/g	Wet Chem Unat pCi/g
5002	ED64 147	4 142	1599	1332	1231	3.36	1.30	1.08	1463.50	1.47	3.29					
5003	KD64 177	2347	1157	1120	1033	2.27	1.12	1.08	1359.30	0.81	1.22					
5004	KD63 196	3623	1496	1349	1095	3.31	1.37	1.23	1361.20	1.26	3.07					
5005	KD73064	4 152	1512	1295	1220	3.46	1.24	1.08	1555.50	1.65	3.46					

Homestake Mining Company - Grants, New Mexico Project
10:10:37 AM, 5/16/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J051

Zone: Outer

The Grid with the Max. Gamma

Grid : J051164
Ave. Gamma : 14,390.43
No. of Points : 21
North Limits : >1541633.33,<1541666.67
East Limits : >490000,<490033.33

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: MAY 13, 1995

Date Sealed: JU[illegible], 1995

Date Read: JUNE 29, 1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

		TOTAL COUNTS				CPS										
LAB ID	Wind Blown Samples ID.	RA(ROI) 609 KEV CH546 – CH658	TH(ROI)911KE CH861 – CH961	K(ROI)1406KEV CH1338 – CH1456	COUNT TIME SECONDS	RA 609 KEV CH546 – CH65	TH 911 KEV CH861 – CH961	K 1460 KEV CH1336 – CH1456	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem Unat pCi/g
5013	K071253	1666	904	1047	1005	1.66	0.90	1.04	1566.50	0.23	0.48					
5014	K072167	1707	901	640	1006	1.66	0.66	0.93	1597.00	0.26	0.54					
5015	K071259	7301	4122	3996	4460	1.63	0.62	0.66	1560.00	0.12	0.24					
5016	K073055	1647	1013	1046	1196	1.54	0.65	0.66	1480.10	0.17	0.38					
5017	K061026	1566	666	696	1026	1.54	0.66	0.67	1634.20	0.13	0.27					
5016	J051164	2962	1260	1205	1006	2.96	1.27	1.20	1506.40	1.05	2.26					
5016	J042218	2724	1254	1233	1002	2.72	1.25	1.23	1527.30	0.60	1.71					
5020	J041053	3794	1666	1500	1205	3.15	1.40	1.24	1451.40	1.01	2.27					

Homestake Mining Company - Grants, New Mexico Project 10:51:03 AM, 5/14/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J054 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J054255
Ave. Gamma : 18,230.27
No. of Points : 11
North Limits : >1541033.33,<1541066.67
East Limits : >490933.33,<490966.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collected: M[illegible]3,1995

Date Sealed: May [illegible], 1995

Date Read : JUNE 13,1995

SAMPLED BY LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609KEV CH549- CH658	TH(ROI)911KEV CH861- CH981	K(ROI)1406KEV CH1338- CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549- CH658	TH 911 KEV CH861- CH981	K 1460 KEV CH1338- CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	
4941	J051233	2643	1321	1179	1195	2.21	1.11	0.99	1487.80	0.48	1.00	1.35
4942	J054255	2560	1251	1216	1086	2.35	1.15	1.12	1589.70	0.56	1.15	1.32
4943	J054099	2330	1040	1073	1086	2.15	0.98	0.99	1618.10	0.70	1.42	1.70
4944	J063212	2501	1220	1132	1001	2.50	1.22	1.13	1596.00	0.59	1.21	1.63
4945	J063218	2820	1419	1408	1295	2.18	1.10	1.09	1621.90	0.46	0.92	1.40
4946	K081142	3347	1813	1389	1184	2.88	1.39	1.18	1445.70	0.70	1.56	2.72
4947	K081095	2614	1245	1183	1005	2.80	1.24	1.16	1561.00	0.68	1.42	1.76
4948	K082258	1862	952	983	1038	1.81	0.92	0.95	1543.60	0.37	0.76	1.04
4949	K084052	2051	1044	986	1115	1.84	0.94	0.88	1585.00	0.35	0.72	0.87

Homestake Mining Company - Grants, New Mexico Project 4:44:52 PM, 5/15/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J041 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : J041053
Ave. Gamma : 15,650.17
No. of Points : 18
North Limits : >1541966.67,<1542000
East Limits : >489466.67,<489500

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collect... Y 13,1995

Date Sealed: ... 14,1995

Date Read: JUNE 29,1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

LAB ID	Wind Blown Samples ID.	TOTAL COUNTS RA(ROI) 609 KEV CH549-CH658	TH(ROI)911KE CH881-CH981	K(ROI)1406KEV CH1338-CH1458	COUNT TIME SECONDS	CPS RA 609 KEV CH549-CH65	TH 911 KEV CH881-CH981	K 1460 KEV CH1338-CH1458	SAMPLE WT.	TRUE SAMPLE CT. RAT	HMO Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem Unat pCi/g
5013	K071253	1669	904	1047	1005	1.66	0.90	1.04	1566.50	0.23	0.48					
5014	K072187	1707	901	940	1008	1.69	0.89	0.93	1597.00	0.28	0.54					
5015	K071259	7301	4122	3996	4480	1.63	0.92	0.89	1580.00	0.12	0.24					
5016	K073055	1847	1013	1049	1198	1.54	0.85	0.88	1480.10	0.17	0.38					
5017	K081028	1589	888	896	1029	1.54	0.86	0.87	1834.20	0.13	0.27					
5018	J051164	2982	1280	1205	1008	2.96	1.27	1.20	1508.40	1.05	2.26					
5019	J042218	2724	1254	1233	1002	2.72	1.25	1.23	1527.30	0.80	1.71					
5020	J041053	3794	1686	1500	1205	3.15	1.40	1.24	1451.40	1.01	2.27					

Homestake Mining Company - Grants, New Mexico Project 4:50:56 PM, 5/15/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J042 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : J042218
Ave. Gamma : 15,408.93
No. of Points : 15
North Limits : >1541500,<1541533.33
East Limits : >489533.33,<489566.67

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Date Collect Y 13,1995

Date Sealed: J. . 14,1995

Date Read: JUNE 29,1995

SAMPLED BY MJ AND LJ. PREP SAMPLES RG. 15 DAY READING SEALED 1995 SOIL SAMPLES

	Wind Blown	TOTAL COUNTS				CPS						TMA	Energy	Energy	TMA	Energy
										TRUE	HMO	Eberline	Gamma	Wet Chem	Eberline	Wet Chem
LAB	Samples	RA(ROI) 809 KEV	TI(ROI)911KE	K(ROI)1406KEV	COUNT TIME	RA 809 KEV	TI 911 KEV	K 1460 KEV	SAMPLE	SAMPLE	Ra 226	Ra 226	Ra 226	Ra 226	U 238	Unat
ID	ID.	CI1549-CI1658	CI1861-CI1981	CI11338-CI11458	SECONDS	CI1549-CI165	CI1991-CI1981	CI11339-CI11458	WT.	CT. RAT	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
5013	K071253	1809	904	1047	1005	1.68	0.90	1.04	1568.50	0.23	0.48					
5014	K072187	1707	901	940	1008	1.09	0.89	0.93	1597.00	0.26	0.54					
5015	K071259	7301	4122	3998	4490	1.93	0.92	0.89	1580.00	0.12	0.24					
5016	K073055	1647	1013	1049	1199	1.54	0.95	0.88	1480.10	0.17	0.38					
5017	K081028	1589	899	896	1029	1.54	0.98	0.87	1934.20	0.13	0.27					
5018	J051164	2992	1280	1205	1009	2.96	1.27	1.20	1508.40	1.05	2.28					
5019	J042216	2724	1254	1233	1002	2.72	1.25	1.23	1527.30	0.80	1.71					
5020	J041053	3794	1998	1500	1205	3.15	1.40	1.24	1451.40	1.01	2.27					

Homestake Mining Company - Grants, New Mexico Project 10:06:15 AM, 5/15/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H043 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H043239
Ave. Gamma : 14,980.82
No. of Points : 11
North Limits : >1542000,<1542033.33
East Limits : >489266.67,<489300

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,500: Count(Grid) : 0

List of grids with Gamma greater than 21,500:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill

Grants Operation

License No. SUA-1471

Appendices H-I

November 1995

Prepared for:

Homestake Mining Company of California
Grants Operations
P. O. Box 98
Grants, NM 87020

Prepared By:

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, NM 87111

Completion Report for Reclamation of Off-Pile Areas
at the Homestake Mining Company of California Uranium Mill

Grants Operation

License No. SUA-1471

Appendices H-I

November 1995

Prepared for:

Homestake Mining Company of California
Grants Operations
P. O. Box 98
Grants, NM 87020

Prepared By:

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, NM 87111

Appendix H

Verification Data-Soil Sample Ra-226 Results for Inner and Outer Zones

Homestake Mining Company - Grants Operation

Homestake Mining Company - Grants Operation

Table H-1 Soil Sample Results of Inner Zone Surveyed by GPS

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4801	H034057	2.86					
4803	H043039	2.56					
4804	H032106	4.56					
4805	H041065	2.62					
4806	H042246	1.09					
4807	H051252	2.80	2.70			4.20	
4808	H063056	0.48					
4809	H064026	3.02					
4810	H062258	0.41					
4811	H074034	0.67					
4812	H072237	1.15					
4813	H074011	0.90					
4814	H073053	3.43	3.10			<3.1	
4815	H071175	0.30					
4816	H061259	1.18					
4817	H054046	0.98					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4818	H053033	0.73			1.40		2.40
4819	H074022	0.93					
4820	H074021	0.67					
4821	H074024	0.35	0.61		0.60	7.40	23.00
4822	H074016	0.45					
4823	H074013	0.64					
4824	H074012	0.30					
4825	H074015	0.74					
4826	H074014	0.31					
4827	H064028	3.68					
4828	H064027	4.14	3.70		4.70	6.20	12.60
4829	H064024	3.40					
4830	H064016	2.30					
4831	H073056	0.53					
4832	H073055	0.16					
4833	H073052	0.77					
4834	H073054	0.26					
4835	H073016	1.01	0.91			15.00	
4836	H073015	0.64					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4837	H073014	0.31					
4838	H064056	0.37			0.40		5.50
4839	H065055	0.35					
4840	H064054	0.16					
4841	H073013	0.39					
4842	H073012	0.59	0.74			7.60	
4843	H073011	1.52					
4844	H064053	0.62					
4845	H064052	0.19					
4846	H064042	0.23					
4847	H044028	1.01					
4874	H061259	0.46					
4875	H052157	2.79					
4938	JO42092	1.70			1.20		2.40
4940	JO52237	0.73					
4941	J051233	1.00					
4943	J054099	1.42					
4944	J063212	1.21					
4947	K061095	1.42					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4948	K062258	0.78					
4949	K064052	0.72					
4959	K073026	2.35					
4963	J084017	0.40					
4964	J083114	0.13					
4965	J074236	0.94					
4966	K071155	0.55					
4967	K081061	0.13					
4968	K083013	0.40					
4969	K074042	0.77					
5000	K072035	0.83					
5013	K071253	0.48					
5014	K072167	0.54					
5015	k071259	0.24					
5016	K073055	0.38					
5017	K081028	0.27					
5025	J053041	0.54					
5026	H032099	1.69					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
	HMC Average=	**1.11**					
	Stand. Deviation=	**1.05**					

Homestake Mining Company - Grants Operation

Table H-2 Soil Sample Results of Outer Zone Surveyed by GPS

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4738	E022157	3.30	3.80		4.70	2.50	9.40
4739	E031117	1.96					
4740	D024014	4.37					
4741	D023053	3.30					
4742	D021259	4.65					
4743	D033032	6.33					
4744	D022109	11.12	8.50		10.40	<3.1	6.20
4745	D031079	7.64					
4746	D032024	0.51					
4747	E032142	1.21					
4748	D034028	3.32					
4749	D043064	3.75					
4760	E042169	0.10					
4761	E041058	2.58					
4762	D042218	7.87					
4763	D044254	3.31					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4764	E051195	2.72			3.90		5.00
4765	D053193	1.80	2.30			3.10	
4766	E052153	2.64					
4767	E061067	2.22					
4768	D054255	7.76					
4769	D063095	3.63					
4770	D063095	0.30					
4771	D022153	6.95					
4772	D041081	3.59	2.70			<1.4	
4773	D051244	1.87					
4774	D061218	3.16					
4775	D052059	2.86					
4776	D062253	6.18					
4777	D071189	1.81					
4778	D072043	2.99			3.90		2.80
4779	D081078	0.35	0.48			<1.8	
4780	D082234	7.93					
4781	D091189	6.04					
4782	D092233	0.31					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4783	C093077	1.73					
4784	C091022	4.83					
4785	C044251	4.57					
4786	C042185	3.74	2.90			<2.3	
4787	C044014	4.23					
4788	C034186	3.75					
4789	C033247	4.25					
4790	D024073	2.60					
4791	E022051	1.28					
4792	D031114	5.79			9.10		3.10
4802	H034099	3.54					
4848	B123228	0.60					
4849	B114209	0.39	0.53			<2.0	
4850	B103215	0.77					
4851	B094205	0.50					
4852	B084231	3.40					
4853	B074231	3.16					
4854	B053256	1.58					
4857	D102223	5.07					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4858	C092059	1.40			1.10		0.80
4859	C101015	0.71					
4860	D124068	3.29					
4861	D134217	1.39					
4862	C072084	3.60					
4863	C082161	5.28	4.70			<4.4	
4864	C051135	3.09					
4865	E022108	1.45					
4866	D024094	0.68					
4867	D031118	5.31					
4868	C033248	0.84					
4869	D044162	3.19					
4870	E031222	3.54	2.50			<2.8	
4871	C064193	2.54					
4872	D074013	7.55					
4873	E141169	2.15					
4876	E074147	2.45					
4877	E063127	3.27	2.70			<2.7	
4878	D113195	10.07			10.10		9.70

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4879	C114239	1.34					
4880	E084171	1.25					
4881	C122142	2.36					
4882	E111012	1.34					
4883	E123124	0.58					
4884	E132185	3.33	3.30			8.20	
4885	D094229	2.79					
4886	F121087	3.67					
4887	F131118	1.47					
4888	G124239	0.98					
4889	G111021	2.08					
4890	H113041	3.26					
4891	H101052	3.59	2.50			<2.7	
4892	J101221	1.37					
4893	K102014	1.00					
4894	J121036	1.72					
4895	H123099	0.88					
4896	J093178	2.12					
4897	K091089	2.11					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4898	L033043	2.48	2.30			8.30	
4899	K032193	2.90					
4900	K042055	3.59					
4901	K051179	6.15					
4902	LO41117	1.92					
4903	L061048	1.09					
4904	D113084	2.04					
4936	JO44238	3.79					
4937	JO34101	1.09					
4939	HO43239	2.79	2.10			<3.4	
4942	J054255	1.15					
4945	J063218	0.92					
4946	K061142	1.58	1.70			<2.0	
4950	F112085	3.04					
4951	F104031	2.22					
4952	G092096	2.65					
4953	H091138	0.49					
4954	H084259	1.07					
4955	E092248	4.24					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4956	E101114	5.49					
4957	F091028	1.85					
4958	C073222	0.47					
4960	J082059	1.93					
4961	K083219	2.27					
4962	F112085	1.45					
4970	E033049	1.65					
4971	E034114	2.24					
4972	E044145	1.46					
4973	E053151	1.75					
4974	E041056	1.77					
4975	D104176	4.02					
4976	D103249	2.38					
4977	D093206	2.02					
4978	D113195	5.51					
4979	E073127	1.15					
4980	E054059	1.28					
4981	E083203	1.12	1.30			<2.3	
4982	E093135	5.47					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
4983	E082251	4.18					
4984	E091155	5.86					
4985	E101114	6.23					
4986	E102084	3.17					
4987	H092225	1.37					
4988	H093095	0.79	0.57			<1.1	
4989	E103101	4.88					
4990	E094059	4.89					
4991	E092248	5.39					
4992	E113166	4.10					
4993	F102237	1.74					
4994	G092096	2.38					
4995	F103039	3.19	2.80			<3.3	
4996	J091041	2.10					
4997	G094067	1.87					
4998	J084225	2.34					
4999	K082076	3.38					
5001	K074174	0.47					
5002	E064147	3.29	3.30			<3.7	

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
5003	K064177	1.22					
5004	K063196	3.07					
5005	K073084	3.46					
5013	K071253	0.48					
5018	J051164	2.28					
5019	J042218	1.71					
5020	J041053	2.27					
5021	H043239	2.77					
5022	G103133	0.58					
5023	E043111	1.00					
5024	L081015	2.16					
5027	C044105	3.02					
5028	D101189	3.81					
5029	D102147	3.74					
5030	D102183	4.34					
5031	D102187	2.80					
5032	D102235	3.99					
5033	D102236	4.63					
5034	D104175	4.40					

LAB ID	Wind Blown Samples ID.	HMC Ra 226 pCi/g	TMA Eberline Ra 226 pCi/g	Energy Gamma Ra 226 pCi/g	Energy Wet Chem. Ra 226 pCi/g	TMA Eberline U 238 pCi/g	Energy Wet Chem. Unat pCi/g
5035	D104172	4.05					
5036	D104173	2.95					
5037	D104181	3.22					
5038	D104184	2.85					
5039	D104185	3.43					
5040	D104222	2.80					
5041	D104223	2.98					
5042	D104226	3.02					
5043	D104231	3.02					
5044	D104234	2.44					
5045	D104237	2.13					
5046	D104236	6.72					
5047	E101115	2.89					
5048	E101118	5.46					
5049	C073166	2.13					

HMC Average= 2.95

Stand. Deviation= 1.89

Appendix I

Data Sort Results Identifying the Grid Blocks with Highest Gamma Count Rate, Grid Blocks Exceeding Action Levels, and Grid Blocks not Meeting Data Point Requirements for Inner and Outer Zones

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **BO5**

Highest Average 33' Grid for each 500' Grid:

***BO53	13,940.62
BO54	13,482.25

***Highest average 33" grid within the 1000" grid

Coordinates for:	B053256
North limits:	>1548033.33,<1548066.67
East limits:	>490466.67,<490500

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B053 **Zone:** Outer

The Grid with the Max. Gamma

Grid : B053256
Ave. Gamma : 13,940.62
No. of Points : 13
North Limits : >1548033.33,<1548066.67
East Limits : >490466.67,<490500

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B054 **Zone: Outer**

The Grid with the Max. Gamma

Grid : B054214
Ave. Gamma : 13,482.25
No. of Points : 16
North Limits : >1548033.33,<1548066.67
East Limits : >490500,<490533.33

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 28, 1995

Grid: **B08 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

B083	15,650.21
***B084	17,338.00

***Highest average 33" grid within the 1000" grid

Coordinates for: B084231
North limits: >1548066.67,<1548100.00
East limits: >493700.00,<493733.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B083 **Zone: Outer**

The Grid with the Max. Gamma

Grid : B083192
Ave. Gamma : 15,650.21
No. of Points : 29
North Limits : >1548166.67,<1548200
East Limits : >493333.33,<493366.67

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B084 **Zone: Outer**

The Grid with the Max. Gamma

Grid : B084231
Ave. Gamma : 17,338.00
No. of Points : 17
North Limits : >1548066.67,<1548100
East Limits : >493700,<493733.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **B09**

Highest Average 33' Grid for each 500' Grid:

B093	16,852.29
***B094	19,662.00

***Highest average 33" grid within the 1000" grid

Coordinates for:	B094205
North limits:	>1548133.33,<1548166.67
East limits:	>494933.33,<494966.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B093 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : B093237
Ave. Gamma : 16,852.29
No. of Points : 17
North Limits : >1548000,<1548033.33
East Limits : >494200,<494233.33

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B094 **Zone: Outer**

The Grid with the Max. Gamma

Grid : B094205
Ave. Gamma : 19,662.00
No. of Points : 10
North Limits : >1548133.33,<1548166.67
East Limits : >494933.33,<494966.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **B10**

Highest Average 33' Grid for each 500' Grid:

***B103 20,531.25

***Highest average 33" grid within the 1000" grid

Coordinates for: B103215
North limits: >1548033.33,<1548066.67
East limits: >495033.33,<495066.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B103 **Zone: Outer**

The Grid with the Max. Gamma

Grid : B103215
Ave. Gamma : 20,531.25
No. of Points : 8
North Limits : >1548033.33,<1548066.67
East Limits : >495033.33,<495066.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **B11**

Highest Average 33' Grid for each 500' Grid:

***B114 12,524.71

***Highest average 33" grid within the 1000" grid

Coordinates for: B114209
North limits: >1548100.00,<1548133.33
East limits: >496966.67,<497000.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B114 **Zone: Outer**

The Grid with the Max. Gamma

Grid : B114209
Ave. Gamma : 12,524.71
No. of Points : 14
North Limits : >1548100,<1548133.33
East Limits : >496966.67,<497000

Min(No. of Points) : 14

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **B12**

Highest Average 33' Grid for each 500' Grid:

***B123 14,406.57

***Highest average 33" grid within the 1000" grid

Coordinates for:	B123228
North limits:	>1548000.00,<1548033.33
East limits:	>497133.33,<497166.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID B123 **Zone: Outer**

The Grid with the Max. Gamma

Grid : B123228
Ave. Gamma : 14,406.57
No. of Points : 13
North Limits : >1548000,<1548033.33
East Limits : >497133.33,<497166.67

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 2, 1995

Grid: **C03**

Highest Average 33' Grid for each 500' Grid:

***C033	14,613.30
C034	13,596.77

***Highest average 33" grid within the 1000" grid

Coordinates for: C033248
North limits: >1547000.00,<1547033.33
East limits: >488333.33,<488366.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C033 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C033248
Ave. Gamma : 14,613.30
No. of Points : 10
North Limits : >1547000,<1547033.33
East Limits : >488333.33,<488366.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C034 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C034187
Ave. Gamma : 13,596.77
No. of Points : 13
North Limits : >1547100,<1547133.33
East Limits : >488700,<488733.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 2, 1995

Grid: **C04**

Highest Average 33' Grid for each 500' Grid:

C042	9,933.50
C043	13,005.07
***C044	13,899.67

***Highest average 33" grid within the 1000" grid

Coordinates for:	C044251
North limits:	>1547066.67,<1547100.00
East limits:	>489900.00,<489933.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C042 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C042203
Ave. Gamma : 9,933.50
No. of Points : 8
North Limits : >1547666.67,<1547700
East Limits : >489966.67,<490000

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C043 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C043187
Ave. Gamma : 13,005.07
No. of Points : 14
North Limits : >1547100,<1547133.33
East Limits : >489200,<489233.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C044 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C044251
Ave. Gamma : 13,899.67
No. of Points : 9
North Limits : >1547066.67,<1547100
East Limits : >489900,<489933.33

Min(No. of Points) : 3

Number of grids with fewer than 5 data points: Count(Grid) :1

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
C044105	9,566.00	3	>1547333.33,<1547366.67	>489933.33,<489966.67

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27 1995

Grid: **CO5**

Highest Average 33' Grid for each 500' Grid:

***CO51	15,412.61
CO52	13,793.82
CO53	12,800.00
CO54	12,945.06

***Highest average 33" grid within the 1000" grid

Coordinates for:	CO51135
North limits:	>1547733.33,<1547766.67
East limits:	>490233.33,<490266.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C051 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C051135
Ave. Gamma : 15,412.61
No. of Points : 28
North Limits : >1547733.33,<1547766.67
East Limits : >490233.33,<490266.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C052 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C052029
Ave. Gamma : 13,793.82
No. of Points : 11
North Limits : >1547900,<1547933.33
East Limits : >490666.67,<490700

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C053 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C053062
Ave. Gamma : 12,800.00
No. of Points : 12
North Limits : >1547366.67,<1547400
East Limits : >490033.33,<490066.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C054 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C054205
Ave. Gamma : 12,945.06
No. of Points : 16
North Limits : >1547133.33,<1547166.67
East Limits : >490933.33,<490966.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 28, 1995

Grid: **C06 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

C061	13,129.13
C062	15,464.42
C063	14,566.28
***C064	17,991.09

***Highest average 33" grid within the 1000" grid

Coordinates for: C064193
North limits: >1547166.67,<1547200.00
East limits: >491866.67,<491900.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C061 Zone: Outer

The Grid with the Max. Gamma

Grid : C061246
Ave. Gamma : 13,129.13
No. of Points : 15
North Limits : >1547533.33,<1547566.67
East Limits : >491366.67,<491400

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C062 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C062189
Ave. Gamma : 15,464.42
No. of Points : 19
North Limits : >1547600,<1547633.33
East Limits : >491766.67,<491800

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C063 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C063052
Ave. Gamma : 14,566.28
No. of Points : 25
North Limits : >1547466.67,<1547500
East Limits : >491433.33,<491466.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C064 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C064193
Ave. Gamma : 17,991.09
No. of Points : 11
North Limits : >1547166.67,<1547200
East Limits : >491866.67,<491900

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 28, 1995

Grid: **C07 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

C072	14,964.40
***C073	18,861.81
C074	17,106.21

***Highest average 33" grid within the 1000" grid

Coordinates for:	C073166
North limits:	>1547133.33,<1547166.67
East limits:	>492066.67,<492100.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C072 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C072259
Ave. Gamma : 14,964.40
No. of Points : 15
North Limits : >1547500,<1547533.33
East Limits : >492966.67,<493000

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C073 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C073166
Ave. Gamma : 18,861.81
No. of Points : 16
North Limits : >1547133.33,<1547166.67
East Limits : >492066.67,<492100

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C074 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C074059
Ave. Gamma : 17,106.21
No. of Points : 28
North Limits : >1547400,<1547433.33
East Limits : >492966.67,<493000

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 28, 1995

Grid: **C08 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

C081	16,291.13
***C082	17,369.70
C083	16,895.67
C084	15,469.92

***Highest average 33" grid within the 1000" grid

Coordinates for:	C082161
North limits:	>1547666.67,<1547700.00
East limits:	>493500.00,<493533.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C081 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C081163
Ave. Gamma : 16,291.13
No. of Points : 15
North Limits : >1547666.67,<1547700
East Limits : >493066.67,<493100

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C082 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C082161
Ave. Gamma : 17,369.70
No. of Points : 10
North Limits : >1547666.67,<1547700
East Limits : >493500,<493533.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C083 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C083171
Ave. Gamma : 16,895.67
No. of Points : 12
North Limits : >1547166.67,<1547200
East Limits : >493100,<493133.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C084 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C084014
Ave. Gamma : 15,469.92
No. of Points : 12
North Limits : >1547433.33,<1547466.67
East Limits : >493500,<493533.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 29, 1995

Grid: **C09 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

C091	16,147.29
***C092	18,767.89
C093	15,195.75
C094	14,888.54

***Highest average 33" grid within the 1000" grid

Coordinates for:	C092056
North limits:	>1547933.33,<1547966.67
East limits:	>494966.67,<495000.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C091 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C091031
Ave. Gamma : 16,147.29
No. of Points : 14
North Limits : >1547966.67,<1548000
East Limits : >494200,<494233.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C092 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C092056
Ave. Gamma : 18,767.89
No. of Points : 9
North Limits : >1547933.33,<1547966.67
East Limits : >494966.67,<495000

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C093 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C093077
Ave. Gamma : 15,195.75
No. of Points : 12
North Limits : >1547300,<1547333.33
East Limits : >494100,<494133.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C094 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C094098
Ave. Gamma : 14,888.54
No. of Points : 13
North Limits : >1547300,<1547333.33
East Limits : >494833.33,<494866.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **C10**

Highest Average 33' Grid for each 500' Grid:

***C101	19,737.00
C102	17,551.62
C103	17,192.00
C104	16,524.85

***Highest average 33" grid within the 1000" grid

Coordinates for:	C101015
North limits:	>1547933.33,<1547966.67
East limits:	>495033.33,<495066.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C101 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C101015
Ave. Gamma : 19,737.00
No. of Points : 10
North Limits : >1547933.33,<1547966.67
East Limits : >495033.33,<495066.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C102258
Ave. Gamma : 17,551.62
No. of Points : 13
North Limits : >1547500,<1547533.33
East Limits : >495933.33,<495966.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C103 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C103204
Ave. Gamma : 17,192.00
No. of Points : 14
North Limits : >1547133.33,<1547166.67
East Limits : >495400,<495433.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C104 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C104145
Ave. Gamma : 16,524.85
No. of Points : 13
North Limits : >1547233.33,<1547266.67
East Limits : >495833.33,<495866.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico

GPS Radiological Surveys

By: Environmental Restoration Group, Inc.

Anderson Engineering Company, Inc.

Date: May 4, 1995

Grid: **C11**

Highest Average 33' Grid for each 500' Grid:

C111	17,141.55
C112	17,043.83
C113	17,767.86
***C114	18,056.00

***Highest average 33" grid within the 1000" grid

Coordinates for:	C114239
North limits:	>1547000.00,<1547033.33
East limits:	>496766.67,<496800.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C111 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C111252
Ave. Gamma : 17,141.55
No. of Points : 11
North Limits : >1547566.67,<1547600
East Limits : >496433.33,<496466.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C112 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : C112221
Ave. Gamma : 17,043.83
No. of Points : 12
North Limits : >1547566.67,<1547600
East Limits : >496600,<496633.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C113 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C113153
Ave. Gamma : 17,767.86
No. of Points : 14
North Limits : >1547266.67,<1547300
East Limits : >496466.67,<496500

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C114 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C114239
Ave. Gamma : 18,056.00
No. of Points : 8
North Limits : >1547000,<1547033.33
East Limits : >496766.67,<496800

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 4, 1995

Grid: **C12**

Highest Average 33' Grid for each 500' Grid:

C121	16,356.65
***C122	16,478.80
C123	16,308.57

***Highest average 33" grid within the 1000" grid

Coordinates for:	C122142
North limits:	>1547766.67,<1547800.00
East limits:	>497833.33,<497866.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C121 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C121075
Ave. Gamma : 16,356.65
No. of Points : 17
North Limits : >1547833.33,<1547866.67
East Limits : >497133.33,<497166.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID C122 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C122142
Ave. Gamma : 16,478.80
No. of Points : 15
North Limits : >1547766.67,<1547800
East Limits : >497833.33,<497866.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID C123 **Zone: Outer**

The Grid with the Max. Gamma

Grid : C123218
Ave. Gamma : 16,308.57
No. of Points : 14
North Limits : >1547000,<1547033.33
East Limits : >497033.33,<497066.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 1, 1995

Grid: **DO2**

Highest Average 33' Grid for each 500' Grid:

D022	15,720.18
***D024	15,846.31

***Highest average 33" grid within the 1000" grid

Coordinates for:	D024094
North limits:	>1546333.33,<1546366.67
East limits:	>487800.00,<487833.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D022 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D022159
Ave. Gamma : 15,720.18
No. of Points : 17
North Limits : >1546700,<1546733.33
East Limits : >487966.67,<488000

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D024 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D024094
Ave. Gamma : 15,846.31
No. of Points : 13
North Limits : >1546333.33,<1546366.67
East Limits : >487800,<487833.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: July 11, 1995

Grid: **D03**

Highest Average 33' Grid for each 500' Grid:

D031	16,872.50
D032	12,737.88
***D033	17,117.77
D034	15,929.33

***Highest average 33" grid within the 1000" grid

Coordinates for:	D033032
North limits:	>1546466.67,<1546500.00
East limits:	>488233.33,<488266.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D031 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D031142
Ave. Gamma : 16,872.50
No. of Points : 14
North Limits : >1546766.67,<1546800
East Limits : >488333.33,<488366.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D032 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D032024
Ave. Gamma : 12,737.88
No. of Points : 8
North Limits : >1546933.33,<1546966.67
East Limits : >488600,<488633.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D033 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D033032
Ave. Gamma : 17,117.77
No. of Points : 13
North Limits : >1546466.67,<1546500
East Limits : >488233.33,<488266.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D034 **Zone:** Outer

The Grid with the Max. Gamma

Grid : D034208
Ave. Gamma : 15,929.33
No. of Points : 24
North Limits : >1546100,<1546133.33
East Limits : >488933.33,<488966.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27 1995

Grid: **D04**

Highest Average 33' Grid for each 500' Grid:

D041	12,865.00
D042	15,015.92
DO43	13,869.14
***DO44	15,997.95

***Highest average 33" grid within the 1000" grid

Coordinates for:	D044162
North limits:	>1546166.67,<1546200.00
East limits:	>489533.33,<489566.67

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D041 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D041081
Ave. Gamma : 12,865.00
No. of Points : 10
North Limits : >1546866.67,<1546900
East Limits : >489200,<489233.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D042 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D042218
Ave. Gamma : 15,015.92
No. of Points : 13
North Limits : >1546500,<1546533.33
East Limits : >489533.33,<489566.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D043 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D043064
Ave. Gamma : 13,869.14
No. of Points : 7
North Limits : >1546333.33,<1546366.67
East Limits : >489000,<489033.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D044 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D044162
Ave. Gamma : 15,997.95
No. of Points : 19
North Limits : >1546166.67,<1546200
East Limits : >489533.33,<489566.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27 1995

Grid: **D05**

Highest Average 33' Grid for each 500' Grid:

D051	11,469.00
D052	15,850.82
D053	12,691.13
***D054	17,460.17

***Highest average 33" grid within the 1000" grid

Coordinates for:	D054255
North limits:	>1546033.33,<1546066.67
East limits:	>490933.33,<490966.67

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GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D051 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D051244
Ave. Gamma : 11,469.00
No. of Points : 9
North Limits : >1546533.33,<1546566.67
East Limits : >490300,<490333.33

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D052 **Zone:** Outer

The Grid with the Max. Gamma

Grid : D052059
Ave. Gamma : 15,850.82
No. of Points : 11
North Limits : >1546900,<1546933.33
East Limits : >490966.67,<491000

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D053 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D053193
Ave. Gamma : 12,691.13
No. of Points : 8
North Limits : >1546166.67,<1546200
East Limits : >490366.67,<490400

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D054 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D054255
Ave. Gamma : 17,460.17
No. of Points : 12
North Limits : >1546033.33,<1546066.67
East Limits : >490933.33,<490966.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27 1995

Grid: **D06**

Highest Average 33' Grid for each 500' Grid:

D061	15,905.45
***D062	18,470.40
D063	17,784.92
D064	17,831.27

***Highest average 33" grid within the 1000" grid

Coordinates for:	D062253
North limits:	>1546566.67,<1546600.00
East limits:	>491966.67,<492000.00

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D061 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D061218
Ave. Gamma : 15,905.45
No. of Points : 11
North Limits : >1546500,<1546533.33
East Limits : >491033.33,<491066.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

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GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D062 **Zone:** Outer

The Grid with the Max. Gamma

Grid : D062253
Ave. Gamma : 18,470.40
No. of Points : 10
North Limits : >1546566.67,<1546600
East Limits : >491966.67,<492000

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D063 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D063095
Ave. Gamma : 17,784.92
No. of Points : 12
North Limits : >1546333.33,<1546366.67
East Limits : >491333.33,<491366.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D064 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D064039
Ave. Gamma : 17,831.27
No. of Points : 11
North Limits : >1546400,<1546433.33
East Limits : >491766.67,<491800

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27 1995

Grid: **D07**

Highest Average 33' Grid for each 500' Grid:

D071	16,870.50
D072	17,548.45
D073	13,544.00
***D074	18,451.75

***Highest average 33" grid within the 1000" grid

Coordinates for:	D074013
North limits:	>1546466.67,<1546500.00
East limits:	>492566.67,<492600.00

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D071 **Zone:** Outer

The Grid with the Max. Gamma

Grid : D071189
Ave. Gamma : 16,870.50
No. of Points : 10
North Limits : >1546600,<1546633.33
East Limits : >492266.67,<492300

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D072 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D072043
Ave. Gamma : 17,548.45
No. of Points : 11
North Limits : >1546966.67,<1547000
East Limits : >492866.67,<492900

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D073 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D073038
Ave. Gamma : 13,544.00
No. of Points : 13
North Limits : >1546400,<1546433.33
East Limits : >492233.33,<492266.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D074 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D074013
Ave. Gamma : 18,451.75
No. of Points : 8
North Limits : >1546466.67,<1546500
East Limits : >492566.67,<492600

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27 1995

Grid: **D08**

Highest Average 33' Grid for each 500' Grid:

D081	20,069.08
***D082	20,353.36
D083	13,483.44
D084	14,908.67

***Highest average 33" grid within the 1000" grid

Coordinates for:	D082234
North limits:	>1546533.33,<1546566.67
East limits:	>493700.00,<493733.33

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D081 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D081078
Ave. Gamma : 20,069.08
No. of Points : 12
North Limits : >1546800,<1546833.33
East Limits : >493133.33,<493166.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D082 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D082234
Ave. Gamma : 20,353.36
No. of Points : 11
North Limits : >1546533.33,<1546566.67
East Limits : >493700,<493733.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID D083 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D083052
Ave. Gamma : 13,483.44
No. of Points : 9
North Limits : >1546466.67,<1546500
East Limits : >493433.33,<493466.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D084 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D084163
Ave. Gamma : 14,908.67
No. of Points : 9
North Limits : >1546166.67,<1546200
East Limits : >493566.67,<493600

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **D09**

Highest Average 33' Grid for each 500' Grid:

D091	16,127.90
D092	14,306.45
D093	15,253.19
***D094	17,648.42

***Highest average 33" grid within the 1000" grid

Coordinates for:	D094229
North limits:	>1546000.00,<1546033.33
East limits:	>494666.67,<494700.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D091 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D091189
Ave. Gamma : 16,127.90
No. of Points : 10
North Limits : >1546600,<1546633.33
East Limits : >494266.67,<494300

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D092 **Zone:** Outer

The Grid with the Max. Gamma

Grid : D092233
Ave. Gamma : 14,306.45
No. of Points : 11
North Limits : >1546566.67,<1546600
East Limits : >494766.67,<494800

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D093 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D093206
Ave. Gamma : 15,253.13
No. of Points : 8
North Limits : >1546133.33,<1546166.67
East Limits : >494466.67,<494500

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D094 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D094229
Ave. Gamma : 17,648.42
No. of Points : 19
North Limits : >1546000,<1546033.33
East Limits : >494666.67,<494700

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **D10**

Highest Average 33' Grid for each 500' Grid:

D101	21,036.33
***D102	22,370.91
D103	20,918.38
D104	21,963.93

***Highest average 33" grid within the 1000" grid

Coordinates for:	D102223
North limits:	>1546566.67,<1546600.00
East limits:	>495666.67,<495700.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D101 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : D101189
Ave. Gamma : 21,036.33
No. of Points : 15
North Limits : >1546600,<1546633.33
East Limits : >495266.67,<495300

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 1

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
D101189	21,036.33	15	>1546600,<1546633.33	>495266.67,<495300

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D102223
Ave. Gamma : 22,370.91
No. of Points : 11
North Limits : >1546566.67,<1546600
East Limits : >495666.67,<495700

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 6

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
D102147	22,335.92	12	>1546700,<1546733.33	>495800,<495833.33
D102183	21,453.13	16	>1546666.67,<1546700	>495766.67,<495800
D102187	21,428.50	16	>1546600,<1546633.33	>495700,<495733.33
D102223	22,370.91	11	>1546566.67,<1546600	>495666.67,<495700
D102235	21,944.44	16	>1546533.33,<1546566.67	>495733.33,<495766.67
D102236	21,691.64	14	>1546533.33,<1546566.67	>495766.67,<495800

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D103 **Zone:** Outer

The Grid with the Max. Gamma

Grid : D103249
Ave. Gamma : 20,918.38
No. of Points : 13
North Limits : >1546000,<1546033.33
East Limits : >495366.67,<495400

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D104 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D104176
Ave. Gamma : 21,963.93
No. of Points : 14
North Limits : >1546133.33,<1546166.67
East Limits : >495666.67,<495700

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 14

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
D104172	21,535.50	14	>1546166.67,<1546200	>495633.33,<495666.67
D104173	21,827.60	15	>1546166.67,<1546200	>495666.67,<495700
D104175	21,661.31	16	>1546133.33,<1546166.67	>495633.33,<495666.67
D104176	21,963.93	14	>1546133.33,<1546166.67	>495666.67,<495700
D104181	21,650.55	11	>1546166.67,<1546200	>495700,<495733.33
D104184	21,251.40	15	>1546133.33,<1546166.67	>495700,<495733.33
D104185	21,233.50	14	>1546133.33,<1546166.67	>495733.33,<495766.67
D104222	21,054.50	14	>1546066.67,<1546100	>495633.33,<495666.67
D104223	21,256.45	22	>1546066.67,<1546100	>495666.67,<495700
D104226	21,205.62	21	>1546033.33,<1546066.67	>495666.67,<495700
D104231	21,255.48	21	>1546066.67,<1546100	>495700,<495733.33
D104234	21,203.63	16	>1546033.33,<1546066.67	>495700,<495733.33
D104236	21,642.27	15	>1546033.33,<1546066.67	>495766.67,<495800
D104237	21,018.50	14	>1546000,<1546033.33	>495700,<495733.33

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 11, 1995

Grid: **D11**

Highest Average 33' Grid for each 500' Grid:

D111	20,508.13
D112	17,421.43
***D113	20,785.50
D114	17,917.50

***Highest average 33" grid within the 1000" grid

Coordinates for: D113084
North limits: >1546333.33,<1546366.67
East limits: >496200.00,<496233.33

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D111 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D111162
Ave. Gamma : 20,508.13
No. of Points : 8
North Limits : >1546666.67,<1546700
East Limits : >496033.33,<496066.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D112 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D112064
Ave. Gamma : 17,421.43
No. of Points : 14
North Limits : >1546833.33,<1546866.67
East Limits : >496500,<496533.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D113 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D113084
Ave. Gamma : 20,785.50
No. of Points : 25
North Limits : >1546333.33,<1546366.67
East Limits : >496200,<496233.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D114 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D114104
Ave. Gamma : 17,917.50
No. of Points : 12
North Limits : >1546333.33,<1546366.67
East Limits : >496900,<496933.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **D12**

Highest Average 33' Grid for each 500' Grid:

D121	16,639.78
D122	16,625.60
D123	16,788.77
***D124	17,006.17

***Highest average 33" grid within the 1000" grid

Coordinates for:	D124068
North limits:	>1546300.00,<1546333.33
East limits:	>497533.33,<497566.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D121 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D121245
Ave. Gamma : 16,639.78
No. of Points : 9
North Limits : >1546533.33,<1546566.67
East Limits : >497333.33,<497366.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D122 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D122162
Ave. Gamma : 16,625.60
No. of Points : 10
North Limits : >1546666.67,<1546700
East Limits : >497533.33,<497566.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D123 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D123136
Ave. Gamma : 16,788.77
No. of Points : 13
North Limits : >1546233.33,<1546266.67
East Limits : >497266.67,<497300

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D124 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D124068
Ave. Gamma : 17,006.17
No. of Points : 12
North Limits : >1546300,<1546333.33
East Limits : >497533.33,<497566.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **D13**

Highest Average 33' Grid for each 500' Grid:

D133	14,159.13
***D134	14,390.29

***Highest average 33" grid within the 1000" grid

Coordinates for:	D134217
North limits:	>1546000.00,<1546033.33
East limits:	>498500.00,<498533.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D133 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D133258
Ave. Gamma : 14,159.13
No. of Points : 15
North Limits : >1546000,<1546033.33
East Limits : >498433.33,<498466.67

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID D134 **Zone: Outer**

The Grid with the Max. Gamma

Grid : D134217
Ave. Gamma : 14,390.29
No. of Points : 17
North Limits : >1546000,<1546033.33
East Limits : >498500,<498533.33

Min(No. of Points) : 17

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 24, 1995

Grid: **EO2**

Highest Average 33' Grid for each 500' Grid:

***EO22 14,683.92

***Highest average 33" grid within the 1000" grid

Coordinates for: E022108
North limits: >1545800.00,<1545833.33
East limits: >487933.33,<487966.67

Homestake Mining Company - Grants, New Mexico Project

7/19/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E022 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E022108
Ave. Gamma : 14,683.92
No. of Points : 13
North Limits : >1545800,<1545833.33
East Limits : >487933.33,<487966.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 2, 1995

Grid: **E03**

Highest Average 33' Grid for each 500' Grid:

***E031	15,818.27
E032	14,898.91
E033	12,839.25
E034	12,936.13

***Highest average 33" grid within the 1000" grid

Coordinates for:	E031222
North limits:	>1545566.67,<1545600.00
East limits:	>488133.33,<488166.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E031 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E031222
Ave. Gamma : 15,818.27
No. of Points : 15
North Limits : >1545566.67,<1545600
East Limits : >488133.33,<488166.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E032 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E032142
Ave. Gamma : 14,898.91
No. of Points : 23
North Limits : >1545766.67,<1545800
East Limits : >488833.33,<488866.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E033 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E033049
Ave. Gamma : 12,839.25
No. of Points : 20
North Limits : >1545400,<1545433.33
East Limits : >488366.67,<488400

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E034 **Zone:** Outer

The Grid with the Max. Gamma

Grid : E034114
Ave. Gamma : 12,936.13
No. of Points : 16
North Limits : >1545233.33,<1545266.67
East Limits : >488500,<488533.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 28, 1995

Grid: **E04 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

E041	13,356.46
***E042	16,630.14
E043	13,085.40
E044	13,569.93

***Highest average 33" grid within the 1000" grid

Coordinates for:	E042169
North limits:	>1545700.00,<1545733.33
East limits:	>489566.67,<489600.00

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E041 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E041233
Ave. Gamma : 13,356.46
No. of Points : 13
North Limits : >1545566.67,<1545600
East Limits : >489266.67,<489300

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E042 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E042169
Ave. Gamma : 16,630.14
No. of Points : 14
North Limits : >1545700,<1545733.33
East Limits : >489566.67,<489600

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E043 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E043111
Ave. Gamma : 13,085.40
No. of Points : 25
North Limits : >1545266.67,<1545300
East Limits : >489000,<489033.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
7/19/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E044 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E044145
Ave. Gamma : 13,569.93
No. of Points : 27
North Limits : >1545233.33,<1545266.67
East Limits : >489833.33,<489866.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27, 1995

Grid: **EO5**

Highest Average 33' Grid for each 500' Grid:

E051	13,934.80
***E052	16,153.66
E053	15,472.44
E054	15,365.73

***Highest average 33" grid within the 1000" grid

Coordinates for: E052153
North limits: >1545766.67,<1545800.00
East limits: >490966.67,<491000.00

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E051 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E051195
Ave. Gamma : 13,934.80
No. of Points : 5
North Limits : >1545633.33,<1545666.67
East Limits : >490333.33,<490366.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
7/19/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E052 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E052153
Ave. Gamma : 16,153.66
No. of Points : 34
North Limits : >1545766.67,<1545800
East Limits : >490966.67,<491000

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project

7/19/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E053 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E053151
Ave. Gamma : 15,472.44
No. of Points : 9
North Limits : >1545266.67,<1545300
East Limits : >490400,<490433.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E054 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E054059
Ave. Gamma : 15,365.73
No. of Points : 11
North Limits : >1545400,<1545433.33
East Limits : >490966.67,<491000

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27, 1995

Grid: **EO6**

Highest Average 33' Grid for each 500' Grid:

E061	15,732.32
***E063	15,801.64
E064	15,539.26

***Highest average 33" grid within the 1000" grid

Coordinates for: E063127
North limits: >1545200.00,<1545233.33
East limits: >491100.00,<491133.33

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E061 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E061067
Ave. Gamma : 15,732.32
No. of Points : 25
North Limits : >1545800,<1545833.33
East Limits : >491000,<491033.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E063 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E063127
Ave. Gamma : 15,801.64
No. of Points : 14
North Limits : >1545200,<1545233.33
East Limits : >491100,<491133.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E064 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E064147
Ave. Gamma : 15,539.26
No. of Points : 19
North Limits : >1545200,<1545233.33
East Limits : >491800,<491833.33

Min(No. of Points) : 19

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 28, 1995

Grid: **E07**

Highest Average 33' Grid for each 500' Grid:

E073	15,075.47
***E074	15,433.00

***Highest average 33" grid within the 1000" grid

Coordinates for:	E074147
North limits:	>1545200.00,<1545233.33
East limits:	>492800.00,<492833.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E073 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E073127
Ave. Gamma : 15,075.47
No. of Points : 19
North Limits : >1545200,<1545233.33
East Limits : >492100,<492133.33

Min(No. of Points) : 15

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E074 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E074147
Ave. Gamma : 15,433.00
No. of Points : 15
North Limits : >1545200,<1545233.33
East Limits : >492800,<492833.33

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27, 1995

Grid: **EO8**

Highest Average 33' Grid for each 500' Grid:

E082	17,779.50
E083	16,087.95
***E084	18,796.20

***Highest average 33" grid within the 1000" grid

Coordinates for:	E084171
North limits:	>1545166.67,<1545200.00
East limits:	>493600.00,<493633.33

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E082 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E082251
Ave. Gamma : 17,779.50
No. of Points : 10
North Limits : >1545566.67,<1545600
East Limits : >493900,<493933.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E083 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E083203
Ave. Gamma : 16,087.95
No. of Points : 39
North Limits : >1545166.67,<1545200
East Limits : >493466.67,<493500

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E084 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E084171
Ave. Gamma : 18,796.20
No. of Points : 10
North Limits : >1545166.67,<1545200
East Limits : >493600,<493633.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **E09**

Highest Average 33' Grid for each 500' Grid:

E091	19,093.67
***E092	20,767.55
E093	19,030.12
E094	19,882.62

***Highest average 33" grid within the 1000" grid

Coordinates for:	E092248
North limits:	>1545500.00,<1545533.33
East limits:	>494833.33,<494866.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E091 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E091155
Ave. Gamma : 19,093.67
No. of Points : 12
North Limits : >1545733.33,<1545766.67
East Limits : >494433.33,<494466.67

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E092 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E092248
Ave. Gamma : 20,767.55
No. of Points : 11
North Limits : >1545500,<1545533.33
East Limits : >494833.33,<494866.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E093 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E093135
Ave. Gamma : 19,030.12
No. of Points : 17
North Limits : >1545233.33,<1545266.67
East Limits : >494233.33,<494266.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

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GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID E094   **Zone: Outer**

The Grid with the Max. Gamma

Grid : E094059
Ave. Gamma : 19,882.62
No. of Points : 13
North Limits : >1545400,<1545433.33
East Limits : >494966.67,<495000

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000:   Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **E10**

Highest Average 33' Grid for each 500' Grid:

***E101	21,765.74
E102	20,674.50
E103	20,059.41
E104	20,088.14

***Highest average 33" grid within the 1000" grid

Coordinates for:	E101114
North limits:	>1545733.33,<1545766.67
East limits:	>495000.00,<495033.33

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E101 **Zone:** Outer

The Grid with the Max. Gamma

Grid : E101114
Ave. Gamma : 21,765.74
No. of Points : 19
North Limits : >1545733.33,<1545766.67
East Limits : >495000,<495033.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 3

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
E101114	21,765.74	19	>1545733.33,<1545766.67	>495000,<495033.33
E101115	21,280.10	10	>1545733.33,<1545766.67	>495033.33,<495066.67
E101118	21,704.08	12	>1545700,<1545733.33	>495033.33,<495066.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E102084
Ave. Gamma : 20,674.50
No. of Points : 16
North Limits : >1545833.33,<1545866.67
East Limits : >495700,<495733.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E102084
Ave. Gamma : 20,674.50
No. of Points : 16
North Limits : >1545833.33,<1545866.67
East Limits : >495700,<495733.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E103 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E103101
Ave. Gamma : 20,059.41
No. of Points : 37
North Limits : >1545366.67,<1545400
East Limits : >495400,<495433.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E104 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E104156
Ave. Gamma : 20,088.14
No. of Points : 14
North Limits : >1545233.33,<1545266.67
East Limits : >495966.67,<496000

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 11, 1995

Grid: **E11**

Highest Average 33' Grid for each 500' Grid:

***E111	19,135.90
E112	18,111.08
E113	17,927.31
E114	18,951.40

***Highest average 33" grid within the 1000" grid

Coordinates for: E111012
North limits: >1545966.67,<1546000.00
East limits: >496033.33,<496066.67

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E111 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E111012
Ave. Gamma : 19,135.90
No. of Points : 10
North Limits : >1545966.67,<1546000
East Limits : >496033.33,<496066.67

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E112 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E112231
Ave. Gamma : 18,111.08
No. of Points : 13
North Limits : >1545566.67,<1545600
East Limits : >496700,<496733.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E113 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E113166
Ave. Gamma : 17,927.31
No. of Points : 13
North Limits : >1545133.33,<1545166.67
East Limits : >496066.67,<496100

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E114 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E114077
Ave. Gamma : 18,951.40
No. of Points : 10
North Limits : >1545300,<1545333.33
East Limits : >496600,<496633.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **E12**

Highest Average 33' Grid for each 500' Grid:

E121	17,622.00
E122	16,608.36
***E123	20,258.00
E124	18,661.40

***Highest average 33" grid within the 1000" grid

Coordinates for:	E123124
North limits:	>1545233.33,<1545266.67
East limits:	>497100.00,<497133.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E121 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E121138
Ave. Gamma : 17,622.00
No. of Points : 20
North Limits : >1545700,<1545733.33
East Limits : >497233.33,<497266.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E122 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E122214
Ave. Gamma : 16,608.36
No. of Points : 14
North Limits : >1545533.33,<1545566.67
East Limits : >497500,<497533.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E123 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E123124
Ave. Gamma : 20,258.00
No. of Points : 13
North Limits : >1545233.33,<1545266.67
East Limits : >497100,<497133.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E124 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : E124018
Ave. Gamma : 18,661.40
No. of Points : 15
North Limits : >1545400,<1545433.33
East Limits : >497533.33,<497566.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **E13**

Highest Average 33' Grid for each 500' Grid:

E131	16,192.60
***E132	17,191.00
E133	16,395.72

***Highest average 33" grid within the 1000" grid

Coordinates for: E132185
North limits: >1545633.33,<1545666.67
East limits: >498733.33,<498766.67

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E131 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E131098
Ave. Gamma : 16,192.60
No. of Points : 15
North Limits : >1545800,<1545833.33
East Limits : >498333.33,<498366.67

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E132 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E132185
Ave. Gamma : 17,191.00
No. of Points : 23
North Limits : >1545633.33,<1545666.67
East Limits : >498733.33,<498766.67

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E133 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E133066
Ave. Gamma : 16,395.72
No. of Points : 43
North Limits : >1545333.33,<1545366.67
East Limits : >498066.67,<498100

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: April 27, 1995

Grid: **E14**

Highest Average 33' Grid for each 500' Grid:

***E141	15,578.00
E143	15,429.50

***Highest average 33" grid within the 1000" grid

Coordinates for:	E141169
North limits:	>1545600.00,<1545633.33
East limits:	>499066.67,<499100.00

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E141 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E141169
Ave. Gamma : 15,578.00
No. of Points : 20
North Limits : >1545600,<1545633.33
East Limits : >499066.67,<499100

Min(No. of Points) : 17

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID E143 **Zone: Outer**

The Grid with the Max. Gamma

Grid : E143041
Ave. Gamma : 15,429.50
No. of Points : 20
North Limits : >1545466.67,<1545500
East Limits : >499300,<499333.33

Min(No. of Points) : 16

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 31, 1995

Grid: **F09 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***F091	19,167.09
F092	17,357.42
F094	15,412.59

***Highest average 33" grid within the 1000" grid

Coordinates for:	F091028
North limits:	>1544900.00,<1544933.33
East limits:	>494133.33,<494166.67

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: Outer

GRID F091

The Grid with the Max. Gamma

Grid : F091028
Ave. Gamma : 19,167.09
No. of Points : 22
North Limits : >1544900,<1544933.33
East Limits : >494133.33,<494166.67

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F092 **Zone: Outer**

The Grid with the Max. Gamma

Grid : F092132
Ave. Gamma : 17,357.42
No. of Points : 19
North Limits : >1544766.67,<1544800
East Limits : >494733.33,<494766.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: Outer

GRID F094

The Grid with the Max. Gamma

Grid : F094015
Ave. Gamma : 15,412.59
No. of Points : 17
North Limits : >1544433.33,<1544466.67
East Limits : >494533.33,<494566.67

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **F10**

Highest Average 33' Grid for each 500' Grid:

F101	16,326.73
F102	18,905.90
F103	15,298.69
***F104	20,056.00

***Highest average 33" grid within the 1000" grid

Coordinates for: F104031
North limits: >1544466.67,<1544500.00
East limits: >495700.00,<495733.33

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F101 **Zone: Outer**

The Grid with the Max. Gamma

Grid : F101205
Ave. Gamma : 16,326.73
No. of Points : 26
North Limits : >1544633.33,<1544666.67
East Limits : >495433.33,<495466.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : F102237
Ave. Gamma : 18,905.90
No. of Points : 10
North Limits : >1544500,<1544533.33
East Limits : >495700,<495733.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/19/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F103

Zone: Outer

The Grid with the Max. Gamma

Grid : F103039
Ave. Gamma : 15,298.69
No. of Points : 26
North Limits : >1544400,<1544433.33
East Limits : >495266.67,<495300

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
7/19/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: **Outer**

GRID F104

The Grid with the Max. Gamma

Grid : F104031
Ave. Gamma : 20,056.00
No. of Points : 11
North Limits : >1544466.67,<1544500
East Limits : >495700,<495733.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 26, 1995

Grid: **F11**

Highest Average 33' Grid for each 500' Grid:

F111	19,724.80
***F112	20,054.69
F113	19,163.73
F114	16,798.25

***Highest average 33" grid within the 1000" grid

Coordinates for:	F112085
North limits:	>1544833.33,<1544866.67
East limits:	>496733.33,<496766.67

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F111

Zone: Outer

The Grid with the Max. Gamma

Grid : F111181
Ave. Gamma : 19,724.80
No. of Points : 15
North Limits : >1544666.67,<1544700
East Limits : >496200,<496233.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F112 **Zone: Outer**

The Grid with the Max. Gamma

Grid : F112085
Ave. Gamma : 20,054.69
No. of Points : 13
North Limits : >1544833.33,<1544866.67
East Limits : >496733.33,<496766.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F113 **Zone: Outer**

The Grid with the Max. Gamma

Grid : F113012
Ave. Gamma : 19,163.73
No. of Points : 11
North Limits : >1544466.67,<1544500
East Limits : >496033.33,<496066.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

Zone: Outer

GRID F114

The Grid with the Max. Gamma

Grid :	F114036
Ave. Gamma :	16,798.25
No. of Points :	16
North Limits :	>1544433.33,<1544466.67
East Limits :	>496766.67,<496800

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **F12**

Highest Average 33' Grid for each 500' Grid:

***F121	19,637.50
F122	16,000.88
F123	12,614.33
F124	13,431.88

***Highest average 33" grid within the 1000" grid

Coordinates for: F121087
North limits: >1544800.00,<1544833.33
East limits: >497200.00,<497233.33

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F121

Zone: **Outer**

The Grid with the Max. Gamma

Grid : F121087
Ave. Gamma : 19,637.50
No. of Points : 12
North Limits : >1544800,<1544833.33
East Limits : >497200,<497233.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F122 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : F122016
Ave. Gamma : 16,000.88
No. of Points : 16
North Limits : >1544933.33,<1544966.67
East Limits : >497566.67,<497600

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F123 **Zone: Outer**

The Grid with the Max. Gamma

Grid : F123053
Ave. Gamma : 12,614.33
No. of Points : 15
North Limits : >1544466.67,<1544500
East Limits : >497466.67,<497500

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F124 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : F124011
Ave. Gamma : 13,431.88
No. of Points : 16
North Limits : >1544466.67,<1544500
East Limits : >497500,<497533.33

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **F13**

Highest Average 33' Grid for each 500' Grid:

***F131 16,081.50

***Highest average 33" grid within the 1000" grid

Coordinates for: F131118
North limits: >1544700.00,<1544733.33
East limits: >498033.33,<498066.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID F131 **Zone: Outer**

The Grid with the Max. Gamma

Grid : F131118
Ave. Gamma : 16,081.50
No. of Points : 16
North Limits : >1544700,<1544733.33
East Limits : >498033.33,<498066.67

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 31, 1995

Grid: **G09 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***G092	13,361.20
G093	13,257.63
G094	12,833.20

***Highest average 33" grid within the 1000" grid

Coordinates for:	G092096
North limits:	>1543833.33,<1543866.67
East limits:	>494866.67,<494900.00

Homestake Mining Company - Grants, New Mexico Project. 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G092 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G092096
Ave. Gamma : 13,361.20
No. of Points : 15
North Limits : >1543833.33,<1543866.67
East Limits : >494866.67,<494900

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G093 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G093199
Ave. Gamma : 13,257.63
No. of Points : 16
North Limits : >1543100,<1543133.33
East Limits : >494366.67,<494400

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G094 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G094067
Ave. Gamma : 12,833.20
No. of Points : 35
North Limits : >1543300,<1543333.33
East Limits : >494500,<494533.33

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 16, 1995

Grid: **G10**

Highest Average 33' Grid for each 500' Grid:

G101	12,377.07
G102	17,937.64
***G103	18,062.86
G104	15,551.25

***Highest average 33" grid within the 1000" grid

Coordinates for:	G103133
North limits:	>1543266.67,<1543300.00
East limits:	>495266.67,<495300.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G101 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G101238
Ave. Gamma : 12,377.07
No. of Points : 14
North Limits : >1543500,<1543533.33
East Limits : >495233.33,<495266.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G102 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : G102055
Ave. Gamma : 17,937.64
No. of Points : 14
North Limits : >1543933.33,<1543966.67
East Limits : >495933.33,<495966.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G103 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G103133
Ave. Gamma : 18,062.86
No. of Points : 14
North Limits : >1543266.67,<1543300
East Limits : >495266.67,<495300

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G104 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G104156
Ave. Gamma : 15,551.25
No. of Points : 16
North Limits : >1543233.33,<1543266.67
East Limits : >495966.67,<496000

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 9, 1995

Grid: **G11**

Highest Average 33' Grid for each 500' Grid:

***G111	17,927.88
G112	12,154.68
G113	15,924.60
G114	13,571.44

***Highest average 33" grid within the 1000" grid

Coordinates for:	G111021
North limits:	>1543966.67,<1544000.00
East limits:	>496100.00,<496133.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G111 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : G111021
Ave. Gamma : 17,927.88
No. of Points : 17
North Limits : >1543966.67,<1544000
East Limits : >496100,<496133.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G112 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G112019
Ave. Gamma : 12,154.68
No. of Points : 19
North Limits : >1543900,<1543933.33
East Limits : >496566.67,<496600

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G113 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G113176
Ave. Gamma : 15,924.60
No. of Points : 19
North Limits : >1543133.33,<1543166.67
East Limits : >496166.67,<496200

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G114 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G114222
Ave. Gamma : 13,571.44
No. of Points : 18
North Limits : >1543066.67,<1543100
East Limits : >496633.33,<496666.67

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **G12**

Highest Average 33' Grid for each 500' Grid:

***G124 12,067.17

***Highest average 33" grid within the 1000" grid

Coordinates for:	G124239
North limits:	>1543000.00,<1543033.33
East limits:	>497766.67,<497800.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID G124 **Zone: Outer**

The Grid with the Max. Gamma

Grid : G124239
Ave. Gamma : 12,067.17
No. of Points : 18
North Limits : >1543000,<1543033.33
East Limits : >497766.67,<497800

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 15, 1995

Grid: **H03 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***H034 16,379.95

***Highest average 33" grid within the 1000" grid

Coordinates for:	H034099
North limits:	>1542300.00,<1542333.33
East limits:	>488866.67,<488900.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H034 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H034099
Ave. Gamma : 16,379.95
No. of Points : 21
North Limits : >1542300,<1542333.33
East Limits : >488866.67,<488900

Min(No. of Points) : 20

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 15, 1995

Grid: **H03 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
H032			
H032106	17,977.82	>1542833.33,<1542866.67	>488966.67,<489000.00
H034			
H034057	16,592.45	>1542400.00,<1542433.33	>488900.00,<488933.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H032 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H032106
Ave. Gamma : 17,977.82
No. of Points : 66
North Limits : >1542833.33,<1542866.67
East Limits : >488966.67,<489000

Min(No. of Points) : 5

Number of grids with fewer than 7 data points: Count(No. of Points) : 1

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
H032099	12,689.60	5	>1542800,<1542833.33	>488866.67,<488900

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H034 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H034057
Ave. Gamma : 16,592.45
No. of Points : 20
North Limits : >1542400,<1542433.33
East Limits : >488900,<488933.33

Min(No. of Points) : 18

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 15, 1995

Grid: **H04-OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***H043 14,980.82

***Highest average 33" grid within the 1000" grid

Coordinates for:	H043239
North limits:	>1542000.00,<1542033.33
East limits:	>489266.67,<489300.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H043 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H043239
Ave. Gamma : 14,980.82
No. of Points : 11
North Limits : >1542000,<1542033.33
East Limits : >489266.67,<489300

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 22, 1995

Grid: **H04 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
H041			
H041065	18,512.11	>1542833.33,<1542866.67	>489033.33,<489066.67
H042			
H042246	14,685.00	>1542533.33,<1542566.67	>489866.67,<489900.00
H043			
H043039	17,579.42	>1542400.00,<1542433.33	>489266.67,<489300.00
H044			
H044028	15,489.44	>1542400.00,<1542433.33	>489633.33,<489666.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H041 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H041065
Ave. Gamma : 18,512.11
No. of Points : 45
North Limits : >1542833.33,<1542866.67
East Limits : >489033.33,<489066.67

Min(No. of Points) : 15

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H042 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H042246
Ave. Gamma : 14,685.00
No. of Points : 33
North Limits : >1542533.33,<1542566.67
East Limits : >489866.67,<489900

Min(No. of Points) : 16

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H043 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H043039
Ave. Gamma : 17,579.42
No. of Points : 19
North Limits : >1542400,<1542433.33
East Limits : >489266.67,<489300

Min(No. of Points) : 10

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H044 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H044028
Ave. Gamma : 15,489.44
No. of Points : 54
North Limits : >1542400,<1542433.33
East Limits : >489633.33,<489666.67

Min(No. of Points) : 9

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 22, 1995

Grid: **H05 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
H051			
H051252	18,933.68	>1542566.67,<1542600.00	>490433.33,<490466.67
H052			
H052157	18,473.50	>1542700.00,<1542733.33	>490900.00,<490933.33
H053			
H053033	15,048.13	>1542466.67,<1542500.00	>490266.67,<490300.00
H054			
H054046	16,322.25	>1542433.33,<1542466.67	>490866.67,<490900.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H051 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H051252
Ave. Gamma : 18,933.68
No. of Points : 19
North Limits : >1542566.67,<1542600
East Limits : >490433.33,<490466.67

Min(No. of Points) : 11

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H052 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H052157
Ave. Gamma : 18,473.50
No. of Points : 26
North Limits : >1542700,<1542733.33
East Limits : >490900,<490933.33

Min(No. of Points) : 11

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H053 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H053033
Ave. Gamma : 15,048.13
No. of Points : 30
North Limits : >1542466.67,<1542500
East Limits : >490266.67,<490300

Min(No. of Points) : 18

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H054 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H054046
Ave. Gamma : 16,322.25
No. of Points : 97
North Limits : >1542433.33,<1542466.67
East Limits : >490866.67,<490900

Min(No. of Points) : 17

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 22, 1995

Grid: **H06 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
H061			
H061259	20,461.04	>1542500.00,<1542533.33	>491466.67,<491500.00
H062			
H062258	26,112.53	>1542500.00,<1542533.33	>491933.33,<491966.67
H063			
H063056	21,616.23	>1542433.33,<1542466.67	>491466.67,<491500.00
H064			
H064028	48,460.42	>1542400.00,<1542433.33	>491633.33,<491666.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H061 **Zone:** **Inner**

The Grid with the Max. Gamma

Grid : H061259
Ave. Gamma : 20,461.04
No. of Points : 28
North Limits : >1542500,<1542533.33
East Limits : >491466.67,<491500

Min(No. of Points) : 14

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H062 **Zone:** **Inner**

The Grid with the Max. Gamma

Grid : H062258
Ave. Gamma : 26,112.53
No. of Points : 32
North Limits : >1542500,<1542533.33
East Limits : >491933.33,<491966.67

Min(No. of Points) : 16

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H063 **Zone:** **Inner**

The Grid with the Max. Gamma

Grid : H063056
Ave. Gamma : 21,616.23
No. of Points : 52
North Limits : >1542433.33,<1542466.67
East Limits : >491466.67,<491500

Min(No. of Points) : 23

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H064 **Zone:** **Inner**

The Grid with the Max. Gamma

Grid : H064028
Ave. Gamma : 48,460.42
No. of Points : 36
North Limits : >1542400,<1542433.33
East Limits : >491633.33,<491666.67

The Grid with the Max. Gamma less than 28000

Grid : H064025
Ave. Gamma : 27,855.16
No. of Points : 61
North Limits : >1542433.33,<1542466.67
East Limits : >491633.33,<491666.67

Min(No. of Points) : 16

Count(No. of Points) : 0

Number of grids with fewer than 7 data points:

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 11

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
H064016	28,240.46	54	>1542433.33,<1542466.67	>491566.67,<491600
H064024	29,377.70	56	>1542433.33,<1542466.67	>491600,<491633.33
H064026	36,421.33	55	>1542433.33,<1542466.67	>491666.67,<491700
H064027	42,902.68	36	>1542400,<1542433.33	>491600,<491633.33
H064028	48,460.42	36	>1542400,<1542433.33	>491633.33,<491666.67
H064042	28,024.57	23	>1542466.67,<1542500	>491833.33,<491866.67
H064052	28,898.40	25	>1542466.67,<1542500	>491933.33,<491966.67
H064053	29,733.30	37	>1542466.67,<1542500	>491966.67,<492000
H064054	28,919.69	28	>1542433.33,<1542466.67	>491900,<491933.33
H064055	30,168.46	26	>1542433.33,<1542466.67	>491933.33,<491966.67
H064056	30,787.38	24	>1542433.33,<1542466.67	>491966.67,<492000

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: June 22, 1995

Grid: **H07 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
H071			
H071175	23,942.00	>1542633.33,<1542666.67	>492133.33,<492166.67
H072			
H072237	25,069.28	>1542500.00,<1542533.33	>492700.00,<492733.33
H073			
H073053	35,532.46	>1542466.67,<1542500.00	>492466.67,<492500.00
H074			
H074011	33,277.00	>1542466.67,<1542500.00	>492500.00,<492533.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H071 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H071175
Ave. Gamma : 23,942.00
No. of Points : 31
North Limits : >1542633.33,<1542666.67
East Limits : >492133.33,<492166.67

Min(No. of Points) : 17

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H072 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H072237
Ave. Gamma : 25,069.28
No. of Points : 29
North Limits : >1542500,<1542533.33
East Limits : >492700,<492733.33

Min(No. of Points) : 14

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H073 **Zone: Inner**

The Grid with the Max. Gamma

Grid : H073053
Ave. Gamma : 35,532.46
No. of Points : 24
North Limits : >1542466.67,<1542500
East Limits : >492466.67,<492500

The Grid with the Max. Gamma less than 28000

Zero grids with an average less than 28000

Min(No. of Points) : 15 Count(No. of Points) : 0

Number of grids with fewer than 7 data points:

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 11

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
H073011	29,276.65	26	>1542466.67,<1542500	>492000,<492033.33
H073012	28,100.59	46	>1542466.67,<1542500	>492033.33,<492066.67
H073013	31,047.45	33	>1542466.67,<1542500	>492066.67,<492100
H073014	31,606.76	29	>1542433.33,<1542466.67	>492000,<492033.33
H073015	31,647.82	33	>1542433.33,<1542466.67	>492033.33,<492066.67
H073016	32,842.44	27	>1542433.33,<1542466.67	>492066.67,<492100
H073052	32,035.10	30	>1542466.67,<1542500	>492433.33,<492466.67
H073053	35,532.46	24	>1542466.67,<1542500	>492466.67,<492500
H073054	32,797.07	15	>1542433.33,<1542466.67	>492400,<492433.33
H073055	31,558.69	26	>1542433.33,<1542466.67	>492433.33,<492466.67
H073056	31,516.55	22	>1542433.33,<1542466.67	>492466.67,<492500

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H074 **Zone:** **Inner**

The Grid with the Max. Gamma

Grid : H074011
Ave. Gamma : 33,277.00
No. of Points : 18
North Limits : >1542466.67,<1542500
East Limits : >492500,<492533.33

The Grid with the Max. Gamma less than 28000

Grid : H074034
Ave. Gamma : 27,679.10
No. of Points : 29
North Limits : >1542433.33,<1542466.67
East Limits : >492700,<492733.33

Min(No. of Points) : 15

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 9

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
H074011	33,277.00	18	>1542466.67,<1542500	>492500,<492533.33
H074012	31,170.21	19	>1542466.67,<1542500	>492533.33,<492566.67
H074013	29,820.17	18	>1542466.67,<1542500	>492566.67,<492600
H074014	30,580.04	23	>1542433.33,<1542466.67	>492500,<492533.33
H074015	29,859.84	19	>1542433.33,<1542466.67	>492533.33,<492566.67
H074016	29,780.64	22	>1542433.33,<1542466.67	>492566.67,<492600
H074021	29,329.38	16	>1542466.67,<1542500	>492600,<492633.33
H074022	28,223.29	17	>1542466.67,<1542500	>492633.33,<492666.67
H074024	29,323.40	15	>1542433.33,<1542466.67	>492600,<492633.33

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 31, 1995

Grid: **H08 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***H084 16,764.17

***Highest average 33" grid within the 1000" grid

Coordinates for:	H084259
North limits:	>1542000.00,<1542033.33
East limits:	>493966.67,<494000.00

Homestake Mining Company - Grants, New Mexico Project

7/20/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H084 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H084259
Ave. Gamma : 16,764.17
No. of Points : 23
North Limits : >1542000,<1542033.33
East Limits : >493966.67,<494000

Min(No. of Points) : 18

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **H09**

Highest Average 33' Grid for each 500' Grid:

***H091	20,764.00
H092	17,007.17
H093	18,226.17
H094	14,418.08

***Highest average 33" grid within the 1000" grid

Coordinates for:	H091138
North limits:	>1542700.00,<1542733.33
East limits:	>494233.33,<494266.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H091 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H091138
Ave. Gamma : 20,764.00
No. of Points : 20
North Limits : >1542700,<1542733.33
East Limits : >494233.33,<494266.67

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H092 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : H092225
Ave. Gamma : 17,007.17
No. of Points : 23
North Limits : >1542533.33,<1542566.67
East Limits : >494633.33,<494666.67

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H093 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H093095
Ave. Gamma : 18,226.17
No. of Points : 18
North Limits : >1542333.33,<1542366.67
East Limits : >494333.33,<494366.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H094 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H094013
Ave. Gamma : 14,418.08
No. of Points : 12
North Limits : >1542466.67,<1542500
East Limits : >494566.67,<494600

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homs taks Mining Company - Grant , Nsw Msxico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **H10**

Highest Average 33' Grid for each 500' Grid:

***H101	18,279.47
H102	17,289.80
H103	15,727.93
H104	16,235.36

***Highest average 33" grid within the 1000" grid

Coordinates for: H101052
North limits: >1542966.67,<1543000.00
East limits: >495433.33,<495466.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H101 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H101052
Ave. Gamma : 18,279.47
No. of Points : 15
North Limits : >1542966.67,<1543000
East Limits : >495433.33,<495466.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H102065
Ave. Gamma : 17,289.80
No. of Points : 10
North Limits : >1542833.33,<1542866.67
East Limits : >495533.33,<495566.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H103 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : H103015
Ave. Gamma : 15,727.93
No. of Points : 40
North Limits : >1542433.33,<1542466.67
East Limits : >495033.33,<495066.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project

7/20/95

GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H104 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H104174
Ave. Gamma : 16,235.36
No. of Points : 11
North Limits : >1542133.33,<1542166.67
East Limits : >495600,<495633.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **H11**

Highest Average 33' Grid for each 500' Grid:

H111	16,673.31
H112	15,055.57
***H113	16,783.04
H114	14,945.00

***Highest average 33" grid within the 1000" grid

Coordinates for: H113041
North limits: >1542466.67,<1542500.00
East limits: >496300.00,<496333.33

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H111 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H111017
Ave. Gamma : 16,673.31
No. of Points : 13
North Limits : >1542900,<1542933.33
East Limits : >496000,<496033.33

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H112 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H112131
Ave. Gamma : 15,055.57
No. of Points : 21
North Limits : >1542766.67,<1542800
East Limits : >496700,<496733.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H113 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H113041
Ave. Gamma : 16,783.04
No. of Points : 50
North Limits : >1542466.67,<1542500
East Limits : >496300,<496333.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H114 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H114061
Ave. Gamma : 14,945.00
No. of Points : 20
North Limits : >1542366.67,<1542400
East Limits : >496500,<496533.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **H12**

Highest Average 33' Grid for each 500' Grid:

H121	14,089.96
H122	12,021.40
***H123	15,255.71

***Highest average 33" grid within the 1000" grid

Coordinates for: H123099
North limits: >1542300.00,<1542333.33
East limits: >497366.67,<497400.00

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H121 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H121218
Ave. Gamma : 14,089.96
No. of Points : 24
North Limits : >1542500,<1542533.33
East Limits : >497033.33,<497066.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project
GPS Radiological Surveys

7/20/95

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H122 **Zone: Outer**

The Grid with the Max. Gamma

Grid : H122088
Ave. Gamma : 12,021.40
No. of Points : 10
North Limits : >1542800,<1542833.33
East Limits : >497733.33,<497766.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID H123 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : H123099
Ave. Gamma : 15,255.71
No. of Points : 17
North Limits : >1542300,<1542333.33
East Limits : >497366.67,<497400

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 15, 1995

Grid: **J03**

Highest Average 33' Grid for each 500' Grid:

J032	14,799.21
***J034	16,463.15

***Highest average 33" grid within the 1000" grid

Coordinates for: J034101
North limits: >1541366.67,<1541400.00
East limits: >488900.00,<488933.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J032 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J032253
Ave. Gamma : 14,799.21
No. of Points : 29
North Limits : >1541566.67,<1541600
East Limits : >488966.67,<489000

Min(No. of Points) : 15

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J034 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J034101
Ave. Gamma : 16,463.15
No. of Points : 13
North Limits : >1541366.67,<1541400
East Limits : >488900,<488933.33

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 16, 1995

Grid: **J04 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

J041	15,650.17
J042	15,408.93
J043	17,786.06
***J044	18,150.58

***Highest average 33" grid within the 1000" grid

Coordinates for:	J044238
North limits:	>1541000.00,<1541033.33
East limits:	>489733.33,<489766.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J041 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J041053
Ave. Gamma : 15,650.17
No. of Points : 18
North Limits : >1541966.67,<1542000
East Limits : >489466.67,<489500

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J042 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J042218
Ave. Gamma : 15,408.93
No. of Points : 15
North Limits : >1541500,<1541533.33
East Limits : >489533.33,<489566.67

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J043 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J043192
Ave. Gamma : 17,786.06
No. of Points : 16
North Limits : >1541166.67,<1541200
East Limits : >489333.33,<489366.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J044 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J044238
Ave. Gamma : 18,150.58
No. of Points : 12
North Limits : >1541000,<1541033.33
East Limits : >489733.33,<489766.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 16, 1995

Grid: **J04 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
J042			
J042092	14,365.09	>1541866.67,<1541900.00	>489833.33,<489866.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J042 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J042092
Ave. Gamma : 14,365.09
No. of Points : 23
North Limits : >1541866.67,<1541900
East Limits : >489833.33,<489866.67

Min(No. of Points) : 11

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 16, 1995

Grid: **J05 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

J051	14,390.43
J053	17,500.75
***J054	18,230.27

***Highest average 33" grid within the 1000" grid

Coordinates for: J054255
North limits: >1541033.33,<1541066.67
East limits: >490933.33,<490966.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J051 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J051164
Ave. Gamma : 14,390.43
No. of Points : 21
North Limits : >1541633.33,<1541666.67
East Limits : >490000,<490033.33

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J053 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J053217
Ave. Gamma : 17,500.75
No. of Points : 12
North Limits : >1541000,<1541033.33
East Limits : >490000,<490033.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J054 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J054255
Ave. Gamma : 18,230.27
No. of Points : 11
North Limits : >1541033.33,<1541066.67
East Limits : >490933.33,<490966.67

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 16, 1995

Grid: **J05 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
J051			
J051233	15,734.53	>1541566.67,<1541600.00	>490266.67,<490300.00
J052			
J052237	10,763.95	>1541500.00,<1541533.33	>490700.00,<490733.33
J053			
J053041	11,444.43	>1541466.67,<1541500.00	>490300.00,<490333.33
J054			
J054099	18,797.50	>1541300.00,<1541333.33	>490866.67,<490900.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J051 **Zone:** **Inner**

The Grid with the Max. Gamma

Grid : J051233
Ave. Gamma : 15,734.53
No. of Points : 17
North Limits : >1541566.67,<1541600
East Limits : >490266.67,<490300

Min(No. of Points) : 11

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J052 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J052237
Ave. Gamma : 10,763.95
No. of Points : 21
North Limits : >1541500,<1541533.33
East Limits : >490700,<490733.33

Min(No. of Points) : 13

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J053 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J053041
Ave. Gamma : 11,444.43
No. of Points : 21
North Limits : >1541466.67,<1541500
East Limits : >490300,<490333.33

Min(No. of Points) : 10

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J054 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J054099
Ave. Gamma : 18,797.50
No. of Points : 8
North Limits : >1541300,<1541333.33
East Limits : >490866.67,<490900

Min(No. of Points) : 8

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 16, 1995

Grid: **J06 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***J063 17,487.58

***Highest average 33" grid within the 1000" grid

Coordinates for: J063218
North limits: >1541000.00,<1541033.33
East limits: >491033.33,<491066.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J063 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J063218
Ave. Gamma : 17,487.58
No. of Points : 12
North Limits : >1541000,<1541033.33
East Limits : >491033.33,<491066.67

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 16, 1995

Grid: **J06 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
J063			
J063212	19,582.18	>1541066.67,<1541100.00	>491033.33,<491066.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J063 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J063212
Ave. Gamma : 19,582.18
No. of Points : 11
North Limits : >1541066.67,<1541100
East Limits : >491033.33,<491066.67

Min(No. of Points) : 11

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **J07 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
J074			
J074236	20,941.38	>1541033.33,<1541066.67	>492766.67,<492800.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J074 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J074236
Ave. Gamma : 20,941.38
No. of Points : 13
North Limits : >1541033.33,<1541066.67
East Limits : >492766.67,<492800

Min(No. of Points) : 13

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **J08 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***J082	16,513.67
J084	15,199.92

***Highest average 33" grid within the 1000" grid

Coordinates for: J082059
North limits: >1541900.00,<1541933.33
East limits: >493966.67,<494000.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J082 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J082059
Ave. Gamma : 16,513.67
No. of Points : 12
North Limits : >1541900,<1541933.33
East Limits : >493966.67,<494000

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J084 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J084225
Ave. Gamma : 15,199.92
No. of Points : 13
North Limits : >1541033.33,<1541066.67
East Limits : >493633.33,<493666.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **J08- INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
J083			
J083114	19,288.81	>1541233.33,<1541266.67	>493000.00,<493033.33
J084			
J084017	12,836.92	>1541400.00,<1541433.33	>493500.00,<493533.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J083 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J083114
Ave. Gamma : 19,288.81
No. of Points : 36
North Limits : >1541233.33,<1541266.67
East Limits : >493000,<493033.33

Min(No. of Points) : 9

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J084 **Zone: Inner**

The Grid with the Max. Gamma

Grid : J084017
Ave. Gamma : 12,836.92
No. of Points : 24
North Limits : >1541400,<1541433.33
East Limits : >493500,<493533.33

Min(No. of Points) : 24

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 9, 1995

Grid: **J09**

Highest Average 33' Grid for each 500' Grid:

J091	17,219.20
J092	15,019.56
***J093	17,645.60
J094	15,400.92

***Highest average 33" grid within the 1000" grid

Coordinates for: J093178
North limits: >1541100.00,<1541133.33
East limits: >494133.33,<494166.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J091 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J091041
Ave. Gamma : 17,219.20
No. of Points : 10
North Limits : >1541966.67,<1542000
East Limits : >494300,<494333.33

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J092 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J092033
Ave. Gamma : 15,019.56
No. of Points : 9
North Limits : >1541966.67,<1542000
East Limits : >494766.67,<494800

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J093 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J093178
Ave. Gamma : 17,645.60
No. of Points : 42
North Limits : >1541100,<1541133.33
East Limits : >494133.33,<494166.67

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J094 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J094181
Ave. Gamma : 15,400.92
No. of Points : 13
North Limits : >1541166.67,<1541200
East Limits : >494700,<494733.33

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **J10**

Highest Average 33' Grid for each 500' Grid:

***J101	14,037.65
J102	13,524.36
J103	13,417.15
J104	13,071.94

***Highest average 33" grid within the 1000" grid

Coordinates for:	J101221
North limits:	>1541566.67,<1541600.00
East limits:	>495100.00,<495133.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J101 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J101221
Ave. Gamma : 14,037.65
No. of Points : 17
North Limits : >1541566.67,<1541600
East Limits : >495100,<495133.33

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J102078
Ave. Gamma : 13,524.36
No. of Points : 11
North Limits : >1541800,<1541833.33
East Limits : >495633.33,<495666.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J103 **Zone: Outer**

The Grid with the Max. Gamma

Grid : j103013
Ave. Gamma : 13,417.15
No. of Points : 20
North Limits : >1541466.67,<1541500
East Limits : >495066.67,<495100

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J104 **Zone: Outer**

The Grid with the Max. Gamma

Grid : j104218
Ave. Gamma : 13,071.94
No. of Points : 16
North Limits : >1541000,<1541033.33
East Limits : >495533.33,<495566.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 8, 1995

Grid: **J12**

Highest Average 33' Grid for each 500' Grid:

***J121 13,098.93

***Highest average 33" grid within the 1000" grid

Coordinates for: J121036
North limits: >1541933.33,<1541966.67
East limits: >497266.67,<497300.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID J121 **Zone: Outer**

The Grid with the Max. Gamma

Grid : J121036
Ave. Gamma : 13,098.93
No. of Points : 15
North Limits : >1541933.33,<1541966.67
East Limits : >497266.67,<497300

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 11, 1995

Grid: **K03**

Highest Average 33' Grid for each 500' Grid:

***K032	17,712.84
K034	16,832.31

***Highest average 33" grid within the 1000" grid

Coordinates for:	K032193
North limits:	>1540666.67,<1540700.00
East limits:	>488866.67,<488900.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K032 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K032193
Ave. Gamma : 17,712.84
No. of Points : 31
North Limits : >1540666.67,<1540700
East Limits : >488866.67,<488900

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K034 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K034145
Ave. Gamma : 16,832.31
No. of Points : 13
North Limits : >1540233.33,<1540266.67
East Limits : >488833.33,<488866.67

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 12, 1995

Grid: **K04**

Highest Average 33' Grid for each 500' Grid:

K041	15,581.27
***K042	19,789.67
K043	15,861.07
K044	10,814.35

***Highest average 33" grid within the 1000" grid

Coordinates for:	K042055
North limits:	>1540933.33,<1540966.67
East limits:	>489933.33,<489966.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K041 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K041181
Ave. Gamma : 15,581.27
No. of Points : 15
North Limits : >1540666.67,<1540700
East Limits : >489200,<489233.33

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K042 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K042055
Ave. Gamma : 19,789.67
No. of Points : 12
North Limits : >1540933.33,<1540966.67
East Limits : >489933.33,<489966.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K043 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K043064
Ave. Gamma : 15,861.07
No. of Points : 14
North Limits : >1540333.33,<1540366.67
East Limits : >489000,<489033.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K044 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : K044022
Ave. Gamma : 10,814.35
No. of Points : 17
North Limits : >1540466.67,<1540500
East Limits : >489633.33,<489666.67

Min(No. of Points) : 14

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico

GPS Radiological Surveys

By: Environmental Restoration Group, Inc.

Anderson Engineering Company, Inc.

Date: May 12, 1995

Grid: **K05**

Highest Average 33' Grid for each 500' Grid:

***K051	20,387.00
K052	17,806.06

***Highest average 33" grid within the 1000" grid

Coordinates for:	K051179
North limits:	>1540600.00,<1540633.33
East limits:	>490166.67,<490200.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K051 **Zone:** Outer

The Grid with the Max. Gamma

Grid : K051179
Ave. Gamma : 20,387.00
No. of Points : 11
North Limits : >1540600,<1540633.33
East Limits : >490166.67,<490200

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K052 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K052063
Ave. Gamma : 17,806.06
No. of Points : 17
North Limits : >1540866.67,<1540900
East Limits : >490566.67,<490600

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 15, 1995

Grid: **K06 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

***K061	18,007.95
K062	16,969.69
K063	17,874.38
K064	16,043.72

***Highest average 33" grid within the 1000" grid

Coordinates for:	K061142
North limits:	>1540766.67,<1540800.00
East limits:	>491333.33,<491366.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K061 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K061142
Ave. Gamma : 18,007.95
No. of Points : 19
North Limits : >1540766.67,<1540800
East Limits : >491333.33,<491366.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K062 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K062225
Ave. Gamma : 16,969.69
No. of Points : 16
North Limits : >1540533.33,<1540566.67
East Limits : >491633.33,<491666.67

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K063 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K063196
Ave. Gamma : 17,874.38
No. of Points : 15
North Limits : >1540133.33,<1540166.67
East Limits : >491366.67,<491400

Min(No. of Points) : 6

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K064 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K064177
Ave. Gamma : 16,043.72
No. of Points : 18
North Limits : >1540100,<1540133.33
East Limits : >491600,<491633.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 15, 1995

Grid: **K06 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
K061			
K061095	16,258.83	>1540833.33,<1540866.67	>491333.33,<491366.67
K062			
K062259	12,830.40	>1540500.00,<1540533.33	>491966.67,<492000.00
K064			
K064052	12,882.44	>1540466.67,<1540500.00	>491933.33,<491966.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K061 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K061095
Ave. Gamma : 16,258.83
No. of Points : 17
North Limits : >1540833.33,<1540866.67
East Limits : >491333.33,<491366.67

Min(No. of Points) : 13

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
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GRID K062 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K062259
Ave. Gamma : 12,830.40
No. of Points : 79
North Limits : >1540500,<1540533.33
East Limits : >491966.67,<492000

Min(No. of Points) : 79

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K064 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K064052
Ave. Gamma : 12,882.44
No. of Points : 51
North Limits : >1540466.67,<1540500
East Limits : >491933.33,<491966.67

Min(No. of Points) : 32

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **K07 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

K073	13,934.36
***K074	15,601.27

***Highest average 33" grid within the 1000" grid

Coordinates for:	K074174
North limits:	>1540133.33,<1540166.67
East limits:	>492600.00,<492633.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K073 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K073084
Ave. Gamma : 13,934.36
No. of Points : 11
North Limits : >1540333.33,<1540366.67
East Limits : >492200,<492233.33

Min(No. of Points) : 5

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K074 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K074174
Ave. Gamma : 15,601.27
No. of Points : 15
North Limits : >1540133.33,<1540166.67
East Limits : >492600,<492633.33

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **K07 - INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
K071			
K071155	14,997.26	>1540733.33,<1540766.67	>492433.33,<492466.67
K072			
K072035	20,101.97	>1540933.33,<1540966.67	>492733.33,<492766.67
K073			
K073026	15,171.27	>1540433.33,<1540466.67	>492166.67,<492200.00
K074			
K074042	15,065.18	>1540466.67,<1540500.00	>492833.33,<492866.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K071 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K071155
Ave. Gamma : 14,997.26
No. of Points : 30
North Limits : >1540733.33,<1540766.67
East Limits : >492433.33,<492466.67

Min(No. of Points) : 4

Number of grids with fewer than 7 data points: Count(No. of Points) : 2

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
K071253	10,126.75	4	>1540566.67,<1540600	>492466.67,<492500
K071259	9,910.00	6	>1540500,<1540533.33	>492466.67,<492500

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K072 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K072035
Ave. Gamma : 20,101.97
No. of Points : 33
North Limits : >1540933.33,<1540966.67
East Limits : >492733.33,<492766.67

Min(No. of Points) : 6

Number of grids with fewer than 7 data points: Count(No. of Points) : 1

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
K072167	12,002.00	6	>1540600,<1540633.33	>492500,<492533.33

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K073 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K073026
Ave. Gamma : 15,171.27
No. of Points : 15
North Limits : >1540433.33,<1540466.67
East Limits : >492166.67,<492200

Min(No. of Points) : 6

Number of grids with fewer than 7 data points: Count(No. of Points) : 1

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
K073055	9,936.17	6	>1540433.33,<1540466.67	>492433.33,<492466.67

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K074 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K074042
Ave. Gamma : 15,065.18
No. of Points : 17
North Limits : >1540466.67,<1540500
East Limits : >492833.33,<492866.67

Min(No. of Points) : 7

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **K08 - OUTER ZONE**

Highest Average 33' Grid for each 500' Grid:

K081	16,305.43
K082	16,690.50
***K083	17,133.88
K084	14,305.54

***Highest average 33" grid within the 1000" grid

Coordinates for: K083219
North limits: >1540000.00,<1540033.33
East limits: >493066.67,<493100.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K081 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K081206
Ave. Gamma : 16,305.43
No. of Points : 13
North Limits : >1540633.33,<1540666.67
East Limits : >493466.67,<493500

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K082 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : K082076
Ave. Gamma : 16,690.50
No. of Points : 24
North Limits : >1540833.33,<1540866.67
East Limits : >493666.67,<493700

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K083 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K083219
Ave. Gamma : 17,133.88
No. of Points : 17
North Limits : >1540000,<1540033.33
East Limits : >493066.67,<493100

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K084 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K084012
Ave. Gamma : 14,305.54
No. of Points : 13
North Limits : >1540466.67,<1540500
East Limits : >493533.33,<493566.67

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 30, 1995

Grid: **K08- INNER ZONE**

Highest Average 33' Grid for each 500' Grid:

Grid	Gamma	North Limits	East Limits
K081			
K081061	16,039.69	>1540866.67,<1540900.00	>493000.00,<493033.33
K083			
K083013	13,161.17	>1540466.67,<1540500.00	>493066.67,<493100.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K081 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K081061
Ave. Gamma : 16,039.69
No. of Points : 13
North Limits : >1540866.67,<1540900
East Limits : >493000,<493033.33

Min(No. of Points) : 6

Number of grids with fewer than 7 data points: Count(No. of Points) : 1

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits
K081028	14,185.00	6	>1540900,<1540933.33	>493133.33,<493166.67

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K083 **Zone: Inner**

The Grid with the Max. Gamma

Grid : K083013
Ave. Gamma : 13,161.17
No. of Points : 12
North Limits : >1540466.67,<1540500
East Limits : >493066.67,<493100

Min(No. of Points) : 11

Number of grids with fewer than 7 data points: Count(No. of Points) : 0

List of grids with fewer than 7 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 28,000: Count(Grid) : 0

List of grids with Gamma greater than 28,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 9, 1995

Grid: **K09**

Highest Average 33' Grid for each 500' Grid:

***K091	14,953.15
K092	13,474.31
K093	14,429.82

***Highest average 33" grid within the 1000" grid

Coordinates for:	K091089
North limits:	>1540800.00,<1540833.33
East limits:	>494266.67,<494300.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K091 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K091089
Ave. Gamma : 14,953.15
No. of Points : 13
North Limits : >1540800,<1540833.33
East Limits : >494266.67,<494300

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K092 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K092015
Ave. Gamma : 13,474.31
No. of Points : 16
North Limits : >1540933.33,<1540966.67
East Limits : >494533.33,<494566.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K093 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K093092
Ave. Gamma : 14,429.82
No. of Points : 17
North Limits : >1540366.67,<1540400
East Limits : >494333.33,<494366.67

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 9, 1995

Grid: **K10**

Highest Average 33' Grid for each 500' Grid:

K101	13,232.20
***K102	13,832.89

***Highest average 33" grid within the 1000" grid

Coordinates for:	K102014
North limits:	>1540933.33,<1540966.67
East limits:	>495500.00,<495533.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K101 **Zone:** Outer

The Grid with the Max. Gamma

Grid : K101037
Ave. Gamma : 13,232.20
No. of Points : 15
North Limits : >1540900,<1540933.33
East Limits : >495200,<495233.33

Min(No. of Points) : 11

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID K102 **Zone: Outer**

The Grid with the Max. Gamma

Grid : K102014
Ave. Gamma : 13,832.89
No. of Points : 18
North Limits : >1540933.33,<1540966.67
East Limits : >495500,<495533.33

Min(No. of Points) : 14

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 11, 1995

Grid: **L03**

Highest Average 33' Grid for each 500' Grid:

***L032 15,671.11

***Highest average 33" grid within the 1000" grid

Coordinates for: L032043
North limits: >1539966.67,<1540000.00
East limits: >488866.67,<488900.00

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L032 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L032043
Ave. Gamma : 15,671.11
No. of Points : 18
North Limits : >1539966.67,<1540000
East Limits : >488866.67,<488900

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 12, 1995

Grid: **L04**

Highest Average 33' Grid for each 500' Grid:

***L041 15,188.61

***Highest average 33" grid within the 1000" grid

Coordinates for:	L041117
North limits:	>1539700.00,<1539733.33
East limits:	>489000.00,<489033.33

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L041 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L041117
Ave. Gamma : 15,188.61
No. of Points : 17
North Limits : >1539700,<1539733.33
East Limits : >489000,<489033.33

Min(No. of Points) : 16

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 12, 1995

Grid: **L06**

Highest Average 33' Grid for each 500' Grid:

***L061	16,182.18
L062	14,230.73

***Highest average 33" grid within the 1000" grid

Coordinates for: L061048
North limits: >1539900.00,<1539933.33
East limits: >491333.33,<491366.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L061 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L061048
Ave. Gamma : 16,182.18
No. of Points : 11
North Limits : >1539900,<1539933.33
East Limits : >491333.33,<491366.67

Min(No. of Points) : 10

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L062 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L062064
Ave. Gamma : 14,230.73
No. of Points : 22
North Limits : >1539833.33,<1539866.67
East Limits : >491500,<491533.33

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 26, 1995

Grid: **L07**

Highest Average 33' Grid for each 500' Grid:

***L071	13,413.47
L072	13,074.79
L073	11,100.08
L074	10,197.15

***Highest average 33" grid within the 1000" grid

Coordinates for:	L071222
North limits:	>1539566.67,<1539600.00
East limits:	>492133.33,<492166.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L071 **Zone:** **Outer**

The Grid with the Max. Gamma

Grid : L071222
Ave. Gamma : 13,413.47
No. of Points : 17
North Limits : >1539566.67,<1539600
East Limits : >492133.33,<492166.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L072 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L072165
Ave. Gamma : 13,074.79
No. of Points : 14
North Limits : >1539633.33,<1539666.67
East Limits : >492533.33,<492566.67

Min(No. of Points) : 7

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L073 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L073056
Ave. Gamma : 11,100.08
No. of Points : 12
North Limits : >1539433.33,<1539466.67
ast Limits : >492466.67,<492500

Min(No. of Points) : 12

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L074 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L074011
Ave. Gamma : 10,197.15
No. of Points : 13
North Limits : >1539466.67,<1539500
East Limits : >492500,<492533.33

Min(No. of Points) : 13

Number of grids with fewer than 5 data points: Count(Grid) : 0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico
GPS Radiological Surveys
By: Environmental Restoration Group, Inc.
Anderson Engineering Company, Inc.
Date: May 26, 1995

Grid: **L08**

Highest Average 33' Grid for each 500' Grid:

***L081	18,054.07
L082	13,010.79

***Highest average 33" grid within the 1000" grid

Coordinates for:	L081015
North limits:	>1539933.33,<1539966.67
East limits:	>493033.33,<493066.67

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L081 **Zone: Outer**

The Grid with the Max. Gamma

Grid :	L081015
Ave. Gamma :	18,054.07
No. of Points :	14
North Limits :	>1539933.33,<1539966.67
East Limits :	>493033.33,<493066.67

Min(No. of Points) : 8

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Homestake Mining Company - Grants, New Mexico Project 7/20/95
GPS Radiological Surveys

By: ENVIRONMENTAL RESTORATION GROUP, INC.
ANDERSON ENGINEERING COMPANY, INC.

GRID L082 **Zone: Outer**

The Grid with the Max. Gamma

Grid : L082012
Ave. Gamma : 13,010.79
No. of Points : 14
North Limits : >1539966.67,<1540000
East Limits : >493533.33,<493566.67

Min(No. of Points) : 9

Number of grids with fewer than 5 data points: Count(Grid) :0

List of grids with fewer than 5 data points:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

Number of grids with Gamma greater than 21,000: Count(Grid) : 0

List of grids with Gamma greater than 21,000:

Grid	Ave. Gamma	No. of Points	North Limits	East Limits

APPENDIX C2
REPORT APPROVAL

January 28, 1999

Mr. Roy Cellan
Homestake Mining Company
P.O. Box 98
Grants, New Mexico 87020

SUBJECT: CLEANUP OF MILL AND WINDBLOWN CONTAMINATION, AMENDMENT NO. 32

The U. S. Nuclear Regulatory Commission (NRC) staff has completed its review of Homestake Mining Company's (HMC's) Completion Report for Reclamation of Off-Pile Areas, submitted by letter dated December 18, 1995, and HMC's Mill Decommissioning Completion Report and amendment request, submitted by letter dated March 7, 1996.

Based on the information contained in the two completion reports (CR's), and the various telephone conversations and HMC addenda to the CR's, the staff has determine that the radiological cleanup of soil and buildings at the Grants Mill site met applicable standards and license conditions, as documented in Enclosure 1, the Technical Evaluation Report (TER). In addition, the requested amendments to Materials License SUA-1471 have been evaluated and determined to be acceptable, with the changes discussed with HMC (Roy Cellan) and documented in the TER.

Therefore, pursuant to Title 10 of the Code of Federal Regulations (10 CFR), Part 40, Source Material License SUA-1471 is hereby amended as discussed in the TER. All other conditions of this license shall remain the same. The license is being reissued to incorporate the revised and new license conditions (Enclosure 2). An environmental report is not required from HMC, since the amendment does not meet the criteria of 10 CFR 51.60(b)(2). An NRC staff environmental assessment was not performed, since this action is categorically excluded under 10 CFR 51.22(c)(11).

If you have any questions regarding this letter or the enclosures, please contact the NRC Project Manager for the HMC site, Ken Hooks, at (301) 415-7777.

Sincerely, [Signed by]
N. King Stablein, Acting Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-8903
License No.: SUA-1471, Amendment No. 32
Enclosures: As stated
cc: R. Edge, DOE Grand Junction
M. Hanning, NMED, Santa Fe
G. Lyssy, EPA Region 6, Dallas
Cases Closed: L51329, L51390
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 28, 1999

Mr. Roy Cellan
Homestake Mining Company
P.O. Box 98
Grants, New Mexico 87020

SUBJECT: CLEANUP OF MILL AND WINDBLOWN CONTAMINATION, AMENDMENT NO. 32

The U. S. Nuclear Regulatory Commission (NRC) staff has completed its review of Homestake Mining Company's (HMC's) Completion Report for Reclamation of Off-Pile Areas, submitted by letter dated December 18, 1995, and HMC's Mill Decommissioning Completion Report and amendment request, submitted by letter dated March 7, 1996.

Based on the information contained in the two completion reports (CR's), and the various telephone conversations and HMC addenda to the CR's, the staff has determine that the radiological cleanup of soil and buildings at the Grants Mill site met applicable standards and license conditions, as documented in Enclosure 1, the Technical Evaluation Report (TER). In addition, the requested amendments to Materials License SUA-1471 have been evaluated and determined to be acceptable, with the changes discussed with HMC (Roy Cellan) and documented in the TER.

Therefore, pursuant to Title 10 of the Code of Federal Regulations (10 CFR), Part 40, Source Material License SUA-1471 is hereby amended as discussed in the TER. All other conditions of this license shall remain the same. The license is being reissued to incorporate the revised and new license conditions (Enclosure 2). An environmental report is not required from HMC, since the amendment does not meet the criteria of 10 CFR 51.60(b)(2). An NRC staff environmental assessment was not performed, since this action is categorically excluded under 10 CFR 51.22(c)(11).

If you have any questions regarding this letter or the enclosures, please contact the NRC Project Manager for the HMC site, Ken Hooks, at (301) 415-7777.

Sincerely,

King Stablein

N. King Stablein, Acting Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-8903
License No.: SUA-1471
Amendment No. 32

Enclosures: As stated

cc: R. Edge, DOE Grand Junction
M. Hanning, NMED, Santa Fe
G. Lyssy, EPA Region 6, Dallas

TECHNICAL EVALUATION REPORT

HOMESTAKE MINING COMPANY'S
COMPLETION REPORT FOR RECLAMATION OF OFF-PILE AREAS
AND THE MILL DECOMMISSIONING COMPLETION REPORT

DATE: December 16, 1998

DOCKET NO. 40-8903 LICENSE NO. SUA-1471

LICENSEE: Homestake Mining Company of California

FACILITY: Homestake (Grants Uranium Mill Site)

PROJECT MANAGER: K. Hooks

TECHNICAL REVIEWERS: E. Brummett, Ted Johnson

SUMMARY AND CONCLUSIONS:

By letter dated December 18, 1995, the Homestake Mining Company of California (HMC) submitted, as required by License Condition 29F, a Completion Report For Reclamation of Off-Pile Areas, documenting soil cleanup and verification for most of the Homestake uranium mill site near Grants, New Mexico. Also, by letter dated March 7, 1996, HMC provided the Mill Decommissioning Completion Report (CR) and requested an amendment to remove License Conditions (LCs) 29, 29D, and 29F. The NRC staff has reviewed both CRs, the subsequent revisions, supporting documents, and results of the staff's confirmatory survey and concludes that the reclamation data provides reasonable assurance that the radiological cleanup of soil and buildings meets the applicable standards in 10 CFR Part 40 and that applicable LCs were met.

DESCRIPTION OF LICENSEE'S AMENDMENT REQUEST:

In response to an NRC staff comment, HMC revised its amendment request (May 21, 1998) such that: LC 29E becomes LC 37K; LC 29 is deleted because mill and windblown cleanup is complete; LC 37B is revised to include decommissioning of the groundwater restoration facilities; and LC 37J is added to require use of the approved 1994 soil cleanup verification plan for the groundwater restoration facilities area.

BACKGROUND:

Staff reviewed both CRs and provided 32 comments to HMC on September 23, 1996. HMC's response was submitted October 15, 1996, and additional data were later provided: soil Ra-226 analysis for the split confirmatory samples on November 26, and soil background data on December 18, 1996. HMC provided additional information dated March 27 and July 23, 1997, May 21 and October 8, 1998, related to comments on the CRs and comments resulting from the 1998, related to comments on the CRs and comments resulting from the site inspections conducted October 1996 and January 1998. These HMC documents should be considered part of the CRs.

Enclosure

HMC performed cleanup of radiological contamination at the Homestake site from 1988 to 1995. The soil cleanup was done in two phases, each under a different approved plan. LC 29 directed the early cleanup and verification of windblown tailings and was revised in 1995 for the second phase (90 percent of the site) of windblown cleanup and verification to reflect the improved verification program. Mill decommissioning was also specified by LC 29.

HMC buried mill process and miscellaneous structures in pits as described in Sections 2.3 and 2.4 of the 1993 Reclamation Plan. The disposal pits do not contain significant amounts of 11e.(2) byproduct material (page two of mill CR), but HMC provided radon barrier covers and performed testing to demonstrate that the pits meet the disposal cell criteria of Part 40 Appendix A.

TECHNICAL EVALUATION:

The NRC staff reviewed radiation aspects of remedial actions at the HMC Homestake mill site to ensure that residual radioactive materials were cleaned up and controlled in accordance with: specifications in the Reclamation Plan, LC 29, and Part 40 Appendix A Criterion 6 (radiological requirements for disposal cell covers and limits for radium (Ra-226) in soil). The regulations to be met for this review also include 10 CFR 40.42(j) which requires, in part, a radiation survey and report with gamma radiation levels in mSieverts or microroentgen per hour at one meter, and Part 40.42(k) requirements that a reasonable effort has been made to eliminate residual radioactive contamination, and a radiation survey and other submitted information to demonstrate that the premises is suitable for release. Areas of review included contaminated material excavation, soil and building cleanup verification procedures and data, final radon flux measurements, and cover radiological data.

Decommissioning records review and confirmatory survey activities were conducted by staff during inspections performed September 30 to October 2, 1996 (NRC, 1997a), February 13, 1997 (NRC, 1997b), and January 12-14, 1998 (NRC, 1998). These inspections document that the data reviewed and the radiological survey and soil analysis results were acceptable. One follow-up item related to the trucking yard soil and buildings was addressed by HMC's submittal of May 21, 1998.

Soil cleanup of mill-related radionuclides other than Ra-226 was considered, but cleanup criteria were not proposed because soil thorium-230 levels in excess of Ra-226 were not anticipated from the alkaline process used at the mill. Some uranium measurements were performed, but most of the mill yard, where yellowcake spills were likely, was treated as a disposal area.

During the review, with respect to the above criteria and commitments, NRC staff noted the following:

1. Soil Cleanup and Verification: The CR indicates that approved procedures for soil verification were appropriately applied. The licensee divided the site into 33 X 33 foot (10 x 10 meter) grids and composite soil samples (taken in grid with highest gamma level in each block) and gamma readings were taken, as designated in the plan, to verify cleanup levels. Of the 72 soil samples taken in the inner zone (around the tailings piles), the average Ra-226 value was 1.1 pCi/g and no sample exceeded 5 pCi/g. Of the 78 samples taken in the outer zone, the average value was 2.9 pCi/g and no sample

exceeded 8 pCi/g. The cleanup criterion was exceeded in one grid in the buffer zone (beyond the excavated area) but additional analysis of the sample indicated an acceptable level of Ra-226.

The staff determined that the quality control program delineated in LC 29E appears to have been followed (considering both the Ra-226 and uranium data), and that the data are adequate to demonstrate compliance with the soil Ra-226 cleanup standards.

2. Equipment and Building Cleanup: A potential problem with the determination of surface activity was discovered during the inspection of October 1996, because an incorrect efficiency factor was used for converting instrument readings (counts) to activity (disintegrations). However, HMC reviewed procedures (HMC, 1997) and found that a conservative error in determining probe size reduced the underestimation of total activity from 100 to 24 percent. Also, the removable activity had been overestimated 130 percent. Examination of records by NRC staff, allowing for the needed corrections, indicated that released material did not exceed the recommended release limits. The remaining buildings also meet release limits.

3. Cover Radon Flux: The six disposal pits in the mill yard and the two between the two tailings piles contain mill-related debris (and grout for stability). HMC measured the radon flux over the three areas (mill yard, pit 4, and pit 5) with results averaging 5.6, 5.6, and 3.4 pCi/m^{2}s, respectively, well below the 20 pCi/m^{2}s limit. The measurements were determined to have been performed appropriately. The disposal pits have at least 4 feet of radon barrier cover (would control radon emanation for over 1000 years) and are in the area to be deeded to the federal government for custody in perpetuity.

4. Cover Radiation Levels: Staff determined that the number of measurements and resulting data for the disposal pits and mill yard area are acceptable for demonstrating that the covers have reduced gamma exposure levels from the waste to approximately background. Also, the licensee provided data (HMC, 1994 and 1995a) indicating that the material to be utilized for the radon barrier of the cover had Ra-226 values within the range of local soil background values.

5. Cover Stability: The stability of the cover over the disposal pits/mill yard was partially addressed in the Reclamation Plan (HMC,1993 - see App B #8) by placing a cement mixture over the debris to reduce settlement/subsidence. The NRC staff has yet to review the final site drainage plan. The approved site drainage plan should provided assurance that the disposal pit covers will be stable (minimal erosion) for at least 200 years.

Based on the above observations, and on the results of on-site inspections performed by NRC staff, the NRC staff concludes that the radiological aspects of construction were performed in accordance with the approved Reclamation Plan and that radiological cleanup and control verification data demonstrate compliance with the criteria in 10 CFR Part 40. The NRC staff determined that the CR information provides reasonable assurance that the land, beyond the area to be deeded to the federal government, is suitable for release.

RECOMMENDED LICENSE CHANGES:

Delete all of LC 29 (see LC 37K below) because the mill decommissioning is complete and approved, the borrow area locations have been documented and approved, and the 90 day requirement for CR submittal has been met.

Revise LC 37B to read "The final reclamation of the area that includes the small tailings pile and the two evaporation ponds will include the disposal of the contaminated groundwater restoration materials and precipitated solids from the evaporation ponds. The small tailings pile and evaporation ponds will be recontoured and covered with radon barrier material. The placement of the barrier on the small tailings pile shall be done in accordance with the material types, thicknesses, and placement criteria described in Homestake Mining Company's Final Radon Barrier Design for the Small Tailings Pile, transmitted to the NRC in August 1996. [Applicable Amendments: 27, 32]"

Add LC 37J to read "The soil cleanup program associated with the decommissioning of the groundwater restoration facilities and small tailings pile reclamation shall be done as specified in the submittal of September 15, 1994, and as modified by the submittal of December 13, 1995."

Add LC 37K (revision of the previous LC 29E) to read, "The licensee shall implement a quality control (QC) program for the soil cleanup verification program to include sending at least 10 percent of the samples (randomly selected) to a vendor laboratory for Ra-226 analysis. If the vendor laboratory uses gamma spectroscopy, at least 30 percent of these QC samples shall also be chemically analyzed. [Applicable Amendments: 20 and 32]"

REFERENCES:

HMC "Reclamation Plan, Revision 10/93," issued by letter dated October 29, 1993.

HMC Letter "Radon Barrier Material Test Results," March 15, 1994.

HMC Letter "Final Radon Barrier Design for the Large Tailings Facility," June 16, 1995a.

HMC Letter "Completion Report for Reclamation of Off-Pile Areas," December 18, 1995b.

HMC Letter "Completion Report - Mill Decommissioning," March 7, 1996a.

HMC Letter "Response to 9/23/96 NRC Comments," October 15, 1996b.

HMC Letter "Laboratory Results for 11 Soil Samples Taken 10/2/96," November 26, 1996c.

HMC Letter "Submittal of Map for 1988 Radium Background Information," December 18, 1996d.

HMC Letter "Response to NRC's 2/11/97 Draft Comments," March 27, 1997a.
HMC Letter "Resubmittal of Responses to Earlier NRC Comments," July 23, 1997b.

HMC Letter "Responses to NRC Comments in 4/23/98 Letter," May 21, 1998a.

HMC Letter "Response to Comments on Completion Reports for Off-Pile Cleanup and Mill Decommissioning," October 8, 1998b.

HMC Letter "Mill Cover Inspection Dated 10/15/98, Response to Comments," October 22, 1998c.

NRC Letter "Soil Cleanup Verification Survey and Sampling Plan," (License Amendment No. 20) March 1, 1995.

NRC Letter "Comments on Radiological Sections of Completion Reports," September 23, 1996.

NRC Inspection Report 40-8903/96-02, January 23, 1997a.

NRC FAX of Draft Comments on Completion Reports, February 11, 1997b.

NRC Inspection Report 40-8903/97-01, April 2, 1997c.

NRC FAX of Comments on HMC's 3/27/97 Letter, May XX, 1997d.

NRC Inspection Report 40-8903/98-01, February 13, 1998a.

NRC Letter "Previously Faxed Comments on Completion Reports," April 23, 1998b.

NRC Inspection Report 40-8903/98201, November 9, 1998c.

ENVIRONMENTAL IMPACT EVALUATION:

An environmental report from HMC is not required by 10 CFR51.60(b)(2), since this amendment will not authorize or result in: (i) a significant expansion of a site, (ii) a significant change in the types of effluents, (iii) a significant increase in the amount of effluents, (iv) a significant increase in individual or cumulative occupational radiation exposures, or (v) a significant increase in the potential for or consequences from radiological accident.

An NRC staff environmental assessment was not performed, since this amendment is categorically excluded under 10 CFR 51.22 (c)(11), as: (i) there is no significant change in the types or significant increase in the amounts of any effluent that may be released off site, (ii) there is no significant increase in individual or cumulative occupational radiation exposure, (iii) there is no significant construction impact, and (iv) there is no significant increase in the potential for, or consequences from, radiological accidents.

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee		
1. Homestake Mining Company	3. License Number	SUA-1471, Amendment No. 32
2. P.O. Box 98 Grants, New Mexico 87020	4. Expiration Date	Until NRC determines site reclamation is adequate. [Applicable Amendment: 12]
	5. Docket or Reference No.	40-8903

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
Uranium	Any	Unlimited

9. Authorized Place of Use: The licensee's uranium mill located in Cibola County, New Mexico, County, New Mexico. [Applicable Amendment: 12, 29]

10. This license authorizes only the possession of residual uranium and byproduct material in the form of uranium waste tailings and other byproduct waste generated by the licensee's past milling operations in accordance with Tables 1 and 3 and the procedures submitted by letter dated September 2, 1993, as modified by letter dated March 7, 1996.

    Anywhere the word "will" is used, it shall denote a requirement.

    [Applicable Amendments: 2, 6, 12, 16, 24]

11. DELETED by Amendment 21.

12. Periodic embankment inspections of the large and small tailings embankment shall be conducted by knowledgeable individuals who are familiar with the site and mining operations. An annual status report shall be included in the Semi-Annual Environmental Report for the second half of the year.

    [Applicable Amendments: 2, 12, 14, 24]

13. DELETED by Amendment No. 27.

14. Release of equipment or packages from the restricted area shall be in accordance with the [illegible] to SUA-1471 entitled "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984. [Applicable Amendments: 21, 31]

15. The results of all effluent and environmental monitoring required by this license shall be reported in accordance with 10 CFR 40, Section 40.65, with copies of the report sent to the NRC. Monitoring

data shall be reported in the format shown in the attachment to SUA-1471 entitled, "Sample Format for Reporting Monitoring Data." For purposes of 10 CFR 40.65 reporting requirements, only groundwater radionuclide data from the point of compliance wells and backgrounds well P shall be reported. [Applicable Amendments: 5, 31]

16. Before engaging in any activity not previously assessed by the NRC, the licensee shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not previously assessed or that is greater than that previously assessed, the licensee shall provide a written evaluation of such activities and obtain prior approval of the NRC in the form of a license amendment.

17. Prior to termination of this license, the licensee shall provide for transfer of title to byproduct material and land, including any interests therein (other than land owned by the United States or the State of New Mexico), which is used for the disposal of such byproduct material or is essential to ensure the long-term stability of such disposal site, to the United States or the State of New Mexico, at the State's option.

18. DELETED by Amendment No. 27.

19. DELETED by Amendment No. 17.

20. DELETED by Amendment No. 21.

21. The site Radiation Protection Administrator (RPA), who is responsible for conducting the site radiation safety program, shall possess the minimum qualifications as specified in Section 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As is Reasonably Achievable." [Applicable Amendment: 27]

22. The results of sampling, analyses, surveys and monitoring; the results of calibration of equipment, reports on audits and inspections; all meetings and training courses required by this license and any subsequent reviews, investigations, and corrective actions, shall be documented. Unless otherwise specified in the NRC regulations, all such documentation shall be maintained for a period of at least 5 years.

23. Standard procedures shall be established for all activities involving radioactive materials that are handled, processed, or stored. Procedures shall enumerate pertinent radiation safety practices to be followed. Additionally, written procedures shall be established for environmental monitoring, bioassay analyses, and instrument calibrations. An up-to-date copy of each written procedure shall be kept in the area to which it applies.

    All written procedures shall be reviewed and approved in writing by the RPA before implementation and whenever a change in procedure is proposed to ensure that proper radiation protection principles are being applied. In addition, the RPA shall perform a documented review of all existing procedures at least annually.

    [Applicable Amendment: 27]

24. The licensee shall be required to use a Radiation Work Permit (RWP) for all work or nonroutine maintenance jobs where the potential for significant exposure to radioactive material exists and for

License Number
SUA-1471, Amendment No. 32

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Docket or Reference Number 40-8903

which no standard written procedure already exists. The RWP shall be approved by the RPA or his designee, qualified by way of specialized radiation protection training, and shall at least describe the following:

A. The scope of work to be performed.

B. Any precautions necessary to reduce exposure to uranium and its daughters.

C. The supplemental radiological monitoring and sampling necessary prior to, during, and following completion of the work.

25. DELETED by Amendment No. 21.

26. Mill tailings, other than small samples for purposes such as research or analysis, shall not be transferred from the site without specific prior approval of the NRC in the form of a license amendment. The licensee shall maintain a permanent record of all transfers made under the provisions of this condition.

27. DELETED by Amendment No. 21.

28. The licensee shall maintain an NRC-approved financial surety arrangement consistent with 10 CFR 40, Criteria 9 and 10, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination of the mill and mill site, reclamation of tailings or waste disposal areas, ground-water restoration, and the long-term surveillance fee. Within 3 months of NRC approval of a revised reclamation plan, the licensee shall submit for NRC review and approval a proposed revision to the financial surety arrangement if estimated costs for the newly approved plan exceed the amount covered in the existing financial surety. The revised surety arrangement shall then be in effect within 3 months of written NRC approval.

Annual updates to the surety amount by 10 CFR Part 40, Appendix A, Criteria 9 and 10, shall be submitted to the NRC at least 3 months prior to the anniversary date, which is designated as June 30 of each year. Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of costs and the basis for the cost estimate. The attachment to the license entitled, "Recommended Outline for Site Specific Reclamation and Stabilization Cost Estimates," outlines the minimum considerations used by the NRC in the review of site closure cost estimates.

The licensee's currently approved surety, a Parent Company Guarantee issued by Homestake Mining Company, shall be continuously maintained in an amount no less than $24,000,000 for the purpose of complying with 10 CFR 40, Criteria 9 and 10, until a replacement is authorized by the NRC. The use of a parent company guarantee necessitates an evaluation of the corporate parent as part of the annual surety update. In addition to the cost information required above, the annual submittal must include updated documentation of the (1) letter from the chief financial officer of the parent company, (2) auditor's special report confirmation of chief financial officer's letter, (3) schedule reconciling amounts in chief financial officer's letter to amounts in financial statements, and (4) parent company guarantee if any changes are appropriate.

[Applicable Amendments: 9, 12, 23, 24, 26]

License Number: SUA-1471, Amendment No. 32

MATERIALS LICENSE SUPPLEMENTARY SHEET

Docket or Reference Number: 40-8903

29. DELETED BY Amendment No. 32

30. DELETED by Amendment No. 21.

31. DELETED by Amendment No. 27]

32. The licensee shall comply with the following:

    A. DELETED by Amendment No. 27.

    B. Analysis of urine samples shall utilize an LLD of at least 5 ug/l uranium.

    C. A copy of the report documenting the annual ALARA audit shall be submitted to the NRC, review within 30 days of completion of the audit.

    [Applicable Amendment: 2]

33. DELETED by Amendment No. 21.

34. DELETED by Amendment No. 4.

35. The licensee shall implement a groundwater compliance monitoring program to assess the performance of the groundwater restoration program. This program is separate from the requirements in License Condition 15. The Licensee shall:

    A Implement the groundwater monitoring program shown in groundwater monitoring program Table 2 as revised by the licensee's August 25, 1997 submittal.

    B. Comply with the following groundwater protection standards at the point of compliance wells D1, BP, X, S4, S3, M5, and DQ with background being recognized in well P.

    chromium = 0.06 mg/l, molybdenum = 0.03 mg/l, selenium = 0.10 mg/l, vanadium =0.02 mg/l, uranium = 0.04 mg/l, radium-226 and -228 = 5.0 pCi/l, and thorium-230 =0.30 pCi/l.

    C. Implement the corrective action program described in the September 15, 1989 submittal, due to exceeding the groundwater protection standards, and as modified by the reverse osmosis system described in the January 15, 1998, submittal with the objective of returning the concentrations of molybdenum, selenium, thorium-230, uranium, and vanadium to the site standards as listed in LC 35B. In addition, the reverse osmosis system will include the addition of Sample Point 2 downstream of the Mixing Tank. Composite samples from Sample Point 2 will be taken weekly for the first month, monthly for the rest of the first year, then quarterly thereafter and analyzed for U and Mo. The Sample Point 2 decrease in sampling is dependent on demonstrating acceptable levels of constituents before decreasing sampling frequency.

    D Operate the two lined evaporation ponds, Pond #1 and Pond #2, and enhanced evaporation systems located in each pond as described in the June 8 and 28, 1990; and July 26, August 16, August 19, September 2 and 15, 1994 submittals.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

E Submit by March 31 of each year, a performance review of the corrective action program that details the progress towards attaining groundwater protection standards.

[Applicable Amendments: 3, 4, 5, 7, 8, 10, 11, 16, 21, 28, 30, 31]

36. The licensee shall complete site reclamation in accordance with an approved reclamation plan. The ground-water corrective action plan shall be conducted as authorized by License Condition No. 35. All activities shall be completed in accordance with the following schedules.

A. To ensure timely compliance with target completion dates established in the Memorandum of Understanding with the Environmental Protection Agency (56 FR 55432, October 25, 1991), the licensee shall complete reclamation to control radon emissions as expeditiously as practicable, considering technological feasibility, in accordance with the following schedule:

(1) Windblown tailings retrieval and placement on the pile:

For the Large Impoundment - December 31, 1996.

For the Small Impoundment - May 31, 1997.

(2) Placement of the interim cover to decrease the potential for tailings dispersal and erosion:
For the Large Impoundment - December 31, 1996.

For the Small Impoundment - May 31, 1997.

(3) Placement of final radon barrier designed and constructed to limit radon emissions to an average flux of no more than 20 pCi/m^2/s.

For the Large Impoundment which has no evaporation ponds - December 31, 2003.

For the Small Impoundment, tailings pile surface areas are essentially covered by evaporation ponds constructed as part of the ground-water corrective action program. Prior to December 31, 2012, the areas not covered by the evaporation ponds shall have final radon barrier in place. Final radon barrier placement over the entire pile shall be completed within 2 years of completion of ground-water corrective actions.

[Applicable Amendment: 25]

B. Reclamation, to ensure required longevity of the covered tailings and ground-water protection, shall be complete as expeditiously as is reasonably achievable, in accordance with the following target dates for completion:

(1) Placement of erosion protection as part of reclamation to comply with Criterion [illegible] of Appendix A of 10 CFR Part 40:

For the Large Impoundment - September 30, 2004.

For the Small Impoundment - September 30, 2013.

[Applicable Amendment: 25]

(2) Projected completion of ground-water corrective actions to meet performance objectives specified in the ground-water corrective action plan - May 1, 2010.

C. Any license amendment request to revise the completion dates specified in Section A must demonstrate that compliance was not technologically feasible (including inclement weather, litigation which compels delay to reclamation, or other factors beyond the control of the licensee).

D. Any license amendment request to change the target dates in Section B above, must address added risk to the public health and safety and the environment, with due consideration to the economic costs involved and other factors justifying the request such as delays caused by inclement weather, regulatory delays, litigation, and other factor beyond the control of the licensee.

[Applicable Amendment: 13, 22]

37. The licensee shall reclaim the large and small tailings impoundments as stated in their October 29, 1993, submittal, including the following requirements.

A. The radon barrier for the large tailings pile shall be in accordance with material types, thicknesses and placement criteria described in Homestake Mining Company's *Final Radon Barrier Design for the Large Tailings Pile,* submitted June 16, 1995. [Applicable Amendment: 22]

B. The final reclamation of the area that includes the small tailings pile and the two evaporation ponds will include the disposal of the contaminated groundwater restoration materials and precipitated solids from the evaporation ponds.The small tailings pile and evaporation ponds will be reconstructed and covered with radon barrier material. The placement of the barrier on the small tailings pile shall be done in accordance with the material types, thicknesses, and placement criteria described in Homestake Mining Company's Final Radon Barrier Design for the Small Tailings Pile, transmitted to the NRC in August 1996. [Applicable Amendments: 27, 32]

C. The licensee shall submit a construction quality control program for NRC review and approval prior to placing any portion of the radon barrier that will ensure that the specification which limits the activity of the radon barrier material to 5 pCi/g above background is not exceeded.

D. The construction quality assurance and control program shall be as defined in the Staff Technical Position On Testing and Inspection (NRC, 1989). The acceptable correlation between ASTM D 2922 and ASTM D 1556 shall be as defined in the licensee's April 30, 1992, submittal.

E. OMITTED in Amendment No. 14.

F. The radon barrier shall not be placed on the top surface of the large tailings impoundment until the settlement has been demonstrated to be at least 90 percent of expected settlement, and the results of this determination have been reviewed and accepted by the NRC. The

MATERIALS LICENSE
SUPPLEMENTARY SHEET

the impoundment. Care shall be taken to preclude the possibility of ponding. Before the erosion protection is placed, it shall be verified that the radon barrier material meets the specifications.

G. The adequacy of the erosion protection proposed for the side slopes of both the large and small impoundments shall be reevaluated considering any increases in impoundment heights due to the revised radon attenuation cover design.

H. DELETED by Amendment No. 21.

I. A completion report shall be provided within 6 months of the completion of construction. This report, including as-built drawings, shall verify that reclamation of the site has been performed according to the approved plan. The report shall also include summaries of results of the quality assurance and control testing to demonstrate that approved specifications were met.

J. The soil cleanup program associated with the decommissioning of the groundwater restoration facilities and small tailings pile reclamation shall be done as specified in the submittal of September 15, 1994, and as modified by the submittal of December 13, 1995. [Applicable Amendment: 32]

K. The licensee shall implement a quality control (QC) program for the soil cleanup verification program to include sending at least 10 percent of the samples (randomly selected) to a vendor laboratory for Ra-226 analysis. If the vendor laboratory uses gamma spectroscopy, at least 30 percent of these QC samples shall also be chemically analyzed. [Applicable Amendment: 32]

[Applicable Amendment: 14]

38. The licensee is authorized to use water collected as part of the site ground-water corrective action program for conditioning soils during placement of the interim cover or the radon barrier on the tailings impoundments. The licensee shall also analyze samples of the collection water being used for this purpose for radium-226 and 228 content semiannually. If sample results exceed 30 pCi/l combined radium, the licensee shall perform an evaluation of the potential impacts of using this water on the required design of the radon barrier and submit the evaluation for NRC review within 30 days of receipt of sample results. [Applicable Amendment: 18]

39. DELETED by Amendment No. 31.

FOR THE NUCLEAR REGULATORY COMMISSION

N. King Stablein

Date 1/28/99

N. King Stablein, Acting Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

APPENDIX C3
REPORT PLATES

DATE	REVISION	NO.

DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.

Long Beach California — Salt Lake City Utah — Grants New Mexico

Telephone (801) 972-6222 Fax (801) 972-6235

CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY SHEET INDEX

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 12-15, 1994
HORIZ.SCALE:	1" = 500'
VERT.SCALE:	N/A
REFERENCE	Indx1215\ SHEET 1 OF 1

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.

Long Beach California — Salt Lake City Utah — Grants New Mexico

Telephone (801) 972-6222 — Fax (801) 972-6235

CIVIL ENGINEERS — CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEYS SHEET INDEX

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 14-30, 1994
HORIZ.SCALE:	1" = 500'
VERT.SCALE:	N/A
REFERENCE	HMCDAILY\ SHEET 1 OF 1

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach California — Salt Lake City Utah — Grants New Mexico
Telephone (801) 972-6222 Fax (801) 972-6235
CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEYS SHEET INDEX

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 10, 14, 1994
HORIZ.SCALE:	1" = 500'
VERT.SCALE:	N/A
REFERENCE	HMCDAILY\ SHEET 1 OF 1

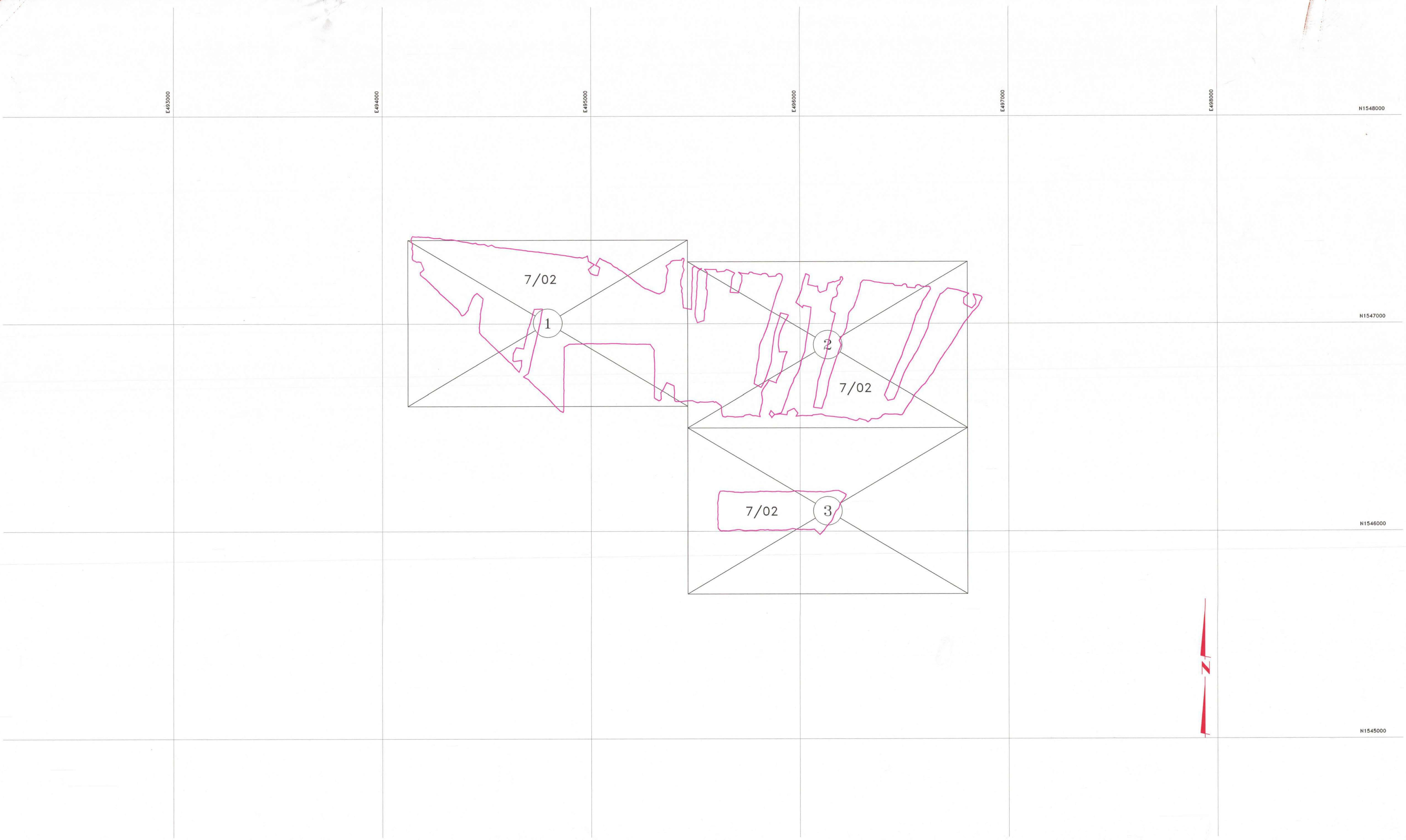
DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach California | Salt Lake City Utah | Grants New Mexico
Telephone (801) 731-4596 Fax (801) 731-7809
CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY GPS RADIOLOGICAL SURVEYS AS OF 6/22/94

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE, 1994
HORIZ.SCALE:	1" = 500'
VERT.SCALE:	N/A
REFERENCE	HMCDAILY\HMCBASE



DATE	REVISION	NO.

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ANDERSON ENGINEERING CO., INC.
Long Beach California — Salt Lake City Utah — Grants New Mexico
Telephone (801) 731-4596 Fax (801) 731-7809
CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY SHEET INDEX

ERG
Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: CFS
ENGINEER: SDA
APPROVED KRB
DATE: JULY 2, 1994
HORIZ.SCALE: 1" = 200'
VERT.SCALE: N/A
REFERENCE 702IND SHEET 1 OF 1

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach California | Salt Lake City Utah | Grants New Mexico
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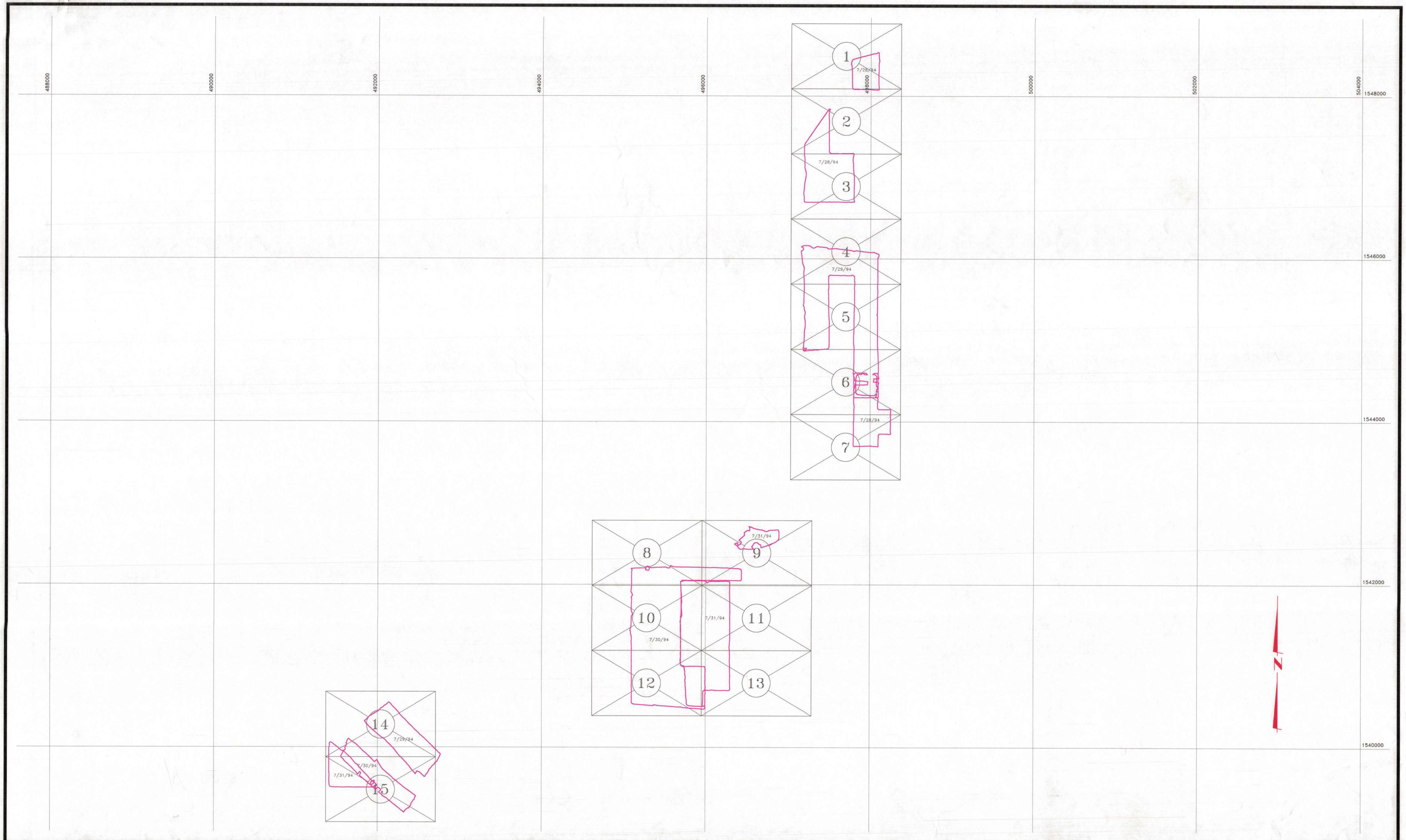
HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY SHEET INDEX

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: RKT
ENGINEER: SDA
APPROVED KRB
DATE: JULY 5-13, 1994
HORIZ.SCALE: 1" = 500'
VERT.SCALE: N/A
REFERENCE INDX7513\ SHEET 1 OF 1



DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach, California — Salt Lake City, Utah — Grants, New Mexico
Telephone (801) 731-4596 Fax (801) 731-7809
CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
INDEX MAP (7/28/94-7/31/94)

ERG
Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	JMF
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 28, 29, 30, 31, 1994
HORIZ.SCALE:	1" = 500'
VERT.SCALE:	N/A
REFERENCE	2831BASE\ SHEET 1

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach California | Salt Lake City Utah | Grants New Mexico
Telephone (801) 972-6222 Fax (801) 972-6235
CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY SITE INDEX MAP

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	JMF
ENGINEER:	SDA
APPROVED	KRB
DATE:	AUGUST, 1994
HORIZ.SCALE:	1" = 1200' 1" = 600'
VERT.SCALE:	N/A
REFERENCE	HMCINDEX\ SHEET 1 OF 1

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach California — Salt Lake City Utah — Grants New Mexico
Telephone (801) 972-6222 Fax (801) 972-6235
CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY SITE INDEX MAP

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: CFS
ENGINEER: SDA
APPROVED: KRB
DATE: AUGUST, 1994
HORIZ.SCALE: 1" = 600'
VERT.SCALE: N/A
REFERENCE: HMCINDEX\ SHEET 1 OF 1

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.

Long Beach California | Salt Lake City Utah | Grants New Mexico

Telephone (801) 731-4596 Fax (801) 731-7809

CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY NORTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 2, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	702HMC SHEET 1 OF 3

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach California | Salt Lake City Utah | Grants New Mexico
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CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
NORTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 2, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	702HMC SHEET 2 OF 3

DATE	REVISION	NO.	DATE	REVISION	NO.

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CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY NORTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 2, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	702HMC SHEET 3 OF 3

DATE	REVISION	NO.	DATE	REVISION	NO.

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Long Beach California — Salt Lake City Utah — Grants New Mexico
Telephone (801) 731-4596 Fax (801) 731-7809
CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
SOUTH OF TAILINGS PILE

ERG
Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: RKT
ENGINEER: SDA
APPROVED: KRB
DATE: JUNE 14, 1994
HORIZ.SCALE: 1" = 40'
VERT.SCALE: N/A
REFERENCE: HMC61014\ SHEET 1 OF 4

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.
Long Beach California — Salt Lake City Utah — Grants New Mexico
Telephone (801) 731-4596 Fax (801) 731-7809
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RADIOLOGICAL SURVEY
SOUTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
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Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 14, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC61014\ SHEET 2 OF 4

DATE	REVISION	NO.	DATE	REVISION	NO.

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ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 10, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC61014\ SHEET 3 OF 4

DATE	REVISION	NO.

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CIVIL ENGINEERS CONSTRUCTION MANAGERS

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SOUTH OF TAILINGS PILE

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(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
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DATE:	JUNE 10, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC61014\ SHEET 4 OF 4

DATE	REVISION	NO.

SHEET INDEX

COUNTY ROAD

TAILINGS PILE

ANDERSON ENGINEERING CO., INC.

Long Beach California · Salt Lake City Utah · Grants New Mexico

Telephone (801) 972-6222 · Fax (801) 972-6235

CIVIL ENGINEERS · CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
SOUTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 14, 1994
HORIZ. SCALE:	1" = 40'
VERT. SCALE:	N/A
REFERENCE	HMC71215\ SHEET 1 OF 10

DATE	REVISION	NO.

SHEET INDEX

ANDERSON ENGINEERING CO., INC.
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CIVIL ENGINEERS — CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
SOUTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 12, 1994
HORIZ.SCALE:	1" = 40'
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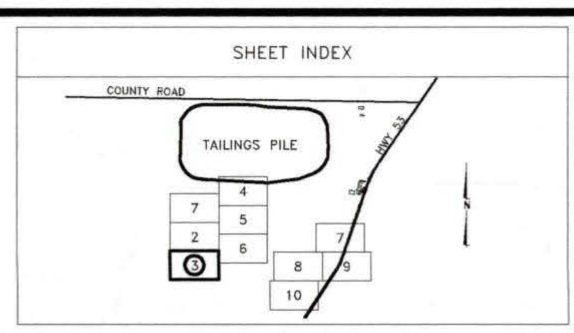
REFERENCE	HMC71215\ SHEET 2 OF 10

DATE	REVISION	NO.



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CIVIL ENGINEERS CONSTRUCTION MANAGERS

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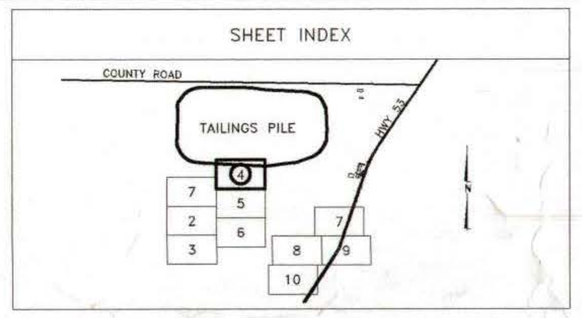
RADIOLOGICAL SURVEY
SOUTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: RKT
ENGINEER: SDA
APPROVED KRB
DATE: JULY 12, 1994
HORIZ.SCALE: 1" = 40'
VERT.SCALE: N/A
REFERENCE HMC71215\ SHEET 3 OF 10

DATE	REVISION	NO.



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(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 14, 1994
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VERT.SCALE:	N/A
REFERENCE	HMC71215\ SHEET 4 OF 10

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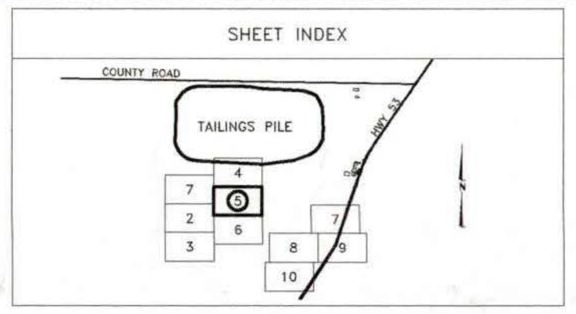

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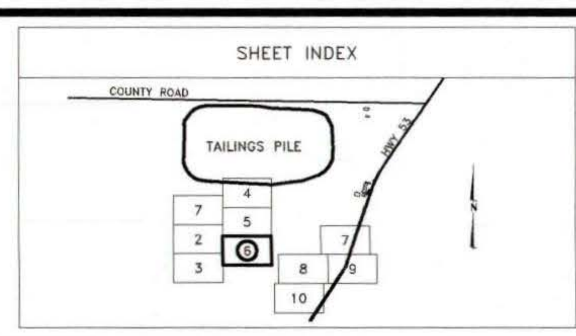
DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 12, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC71215\ SHEET 5 OF 10

DATE	REVISION	NO.



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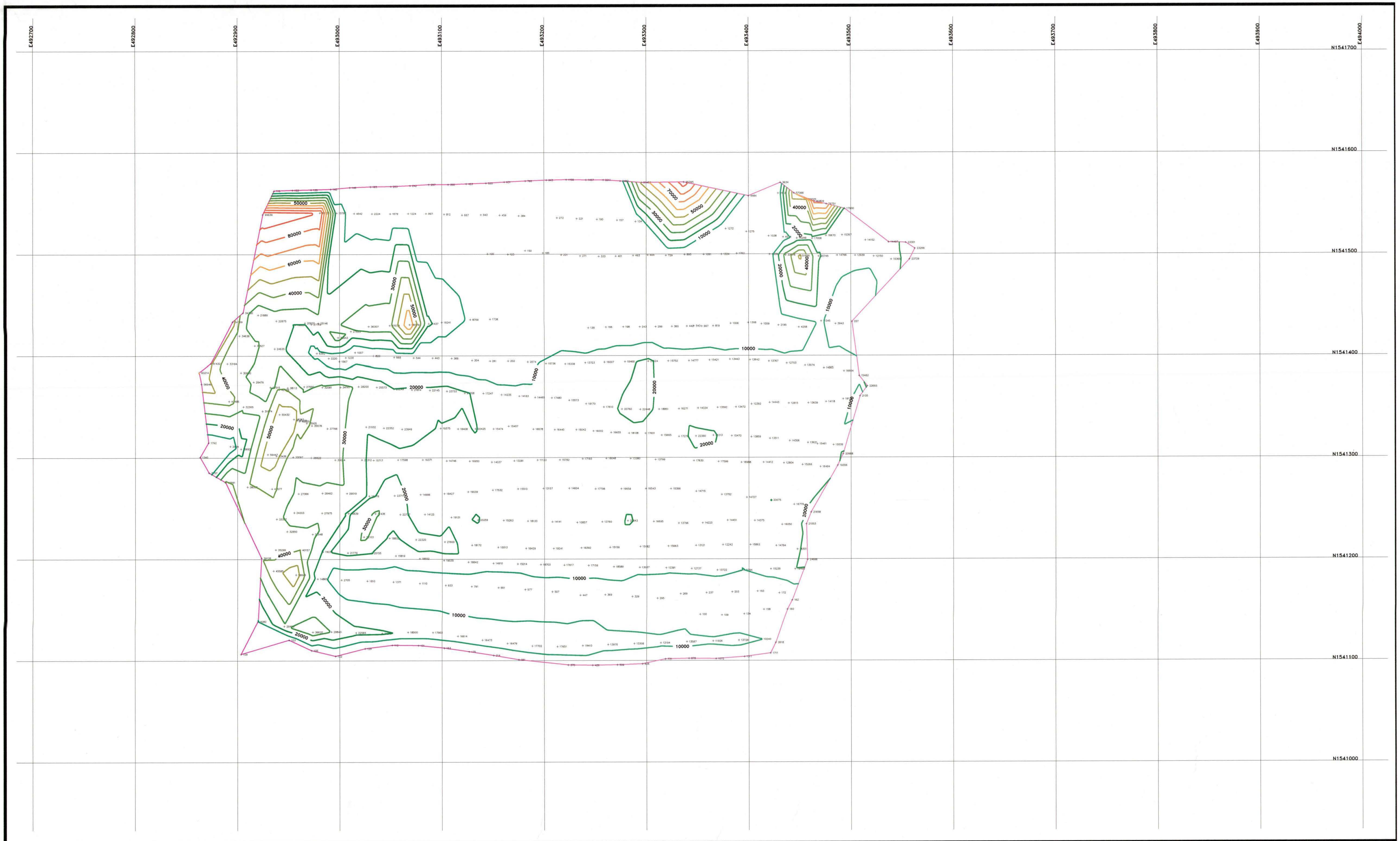
DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 12, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC71215\ SHEET 6 OF 10



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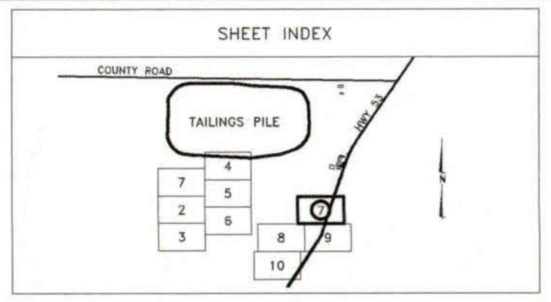

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CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY SOUTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 14, 1994
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VERT.SCALE:	N/A
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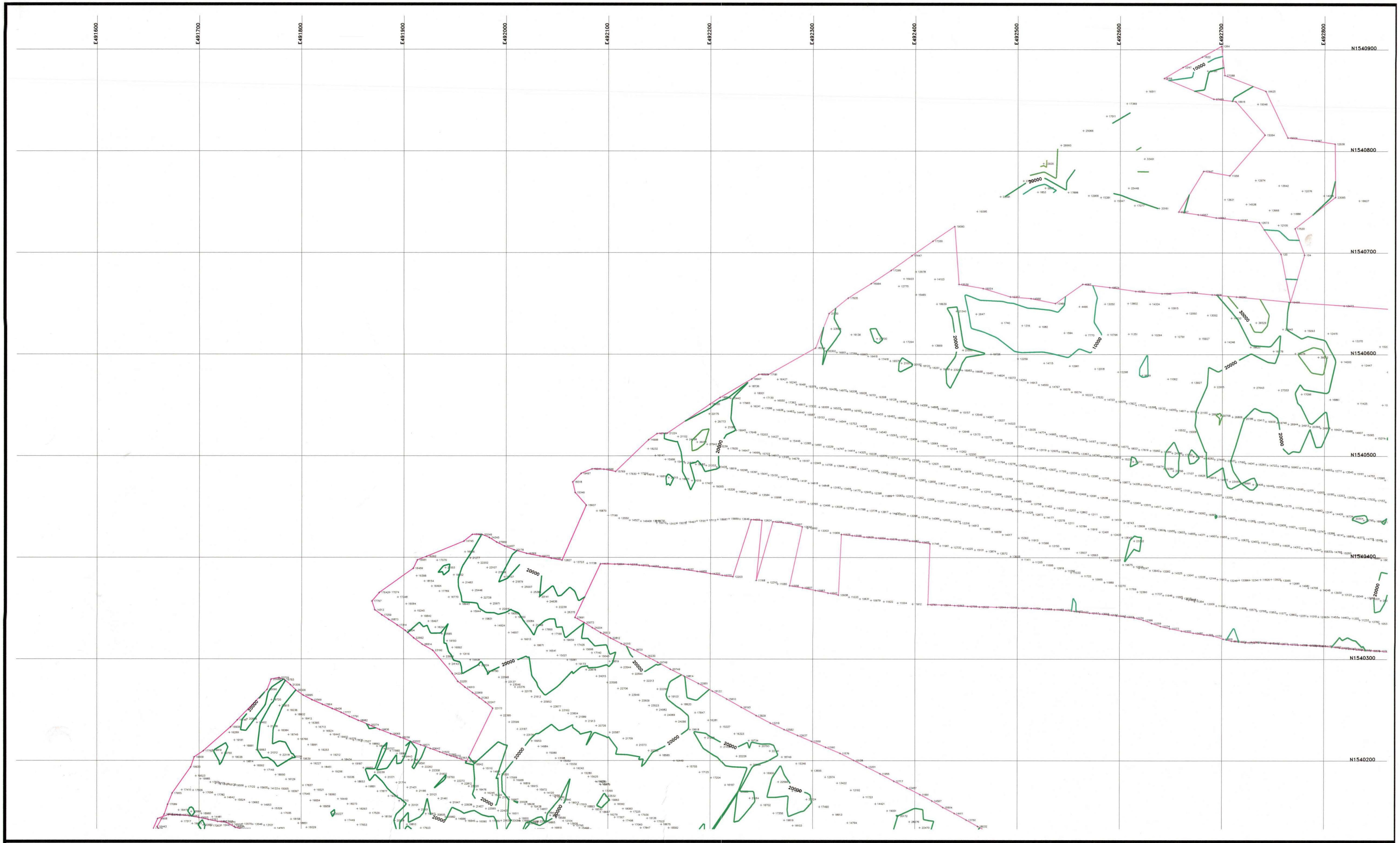

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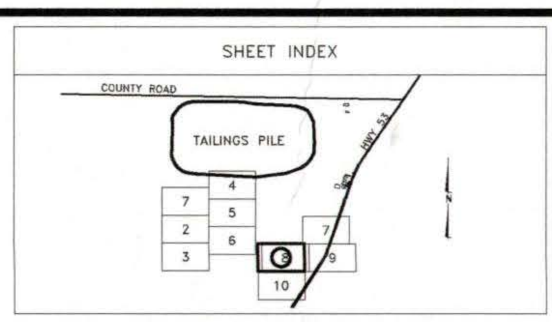

ANDERSON ENGINEERING CO., INC.
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Salt Lake City Utah
Grants New Mexico
Telephone (801) 972-6222
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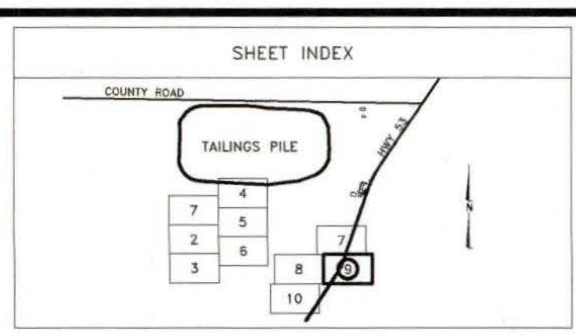
CIVIL ENGINEERS
CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
SOUTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: RKT
ENGINEER: SDA
APPROVED: KRB
DATE: JULY 14, 1994
HORIZ.SCALE: 1" = 40'
VERT.SCALE: N/A
REFERENCE: HMC71215\ SHEET 8 OF 10

DATE	REVISION	NO.



ANDERSON ENGINEERING CO., INC.
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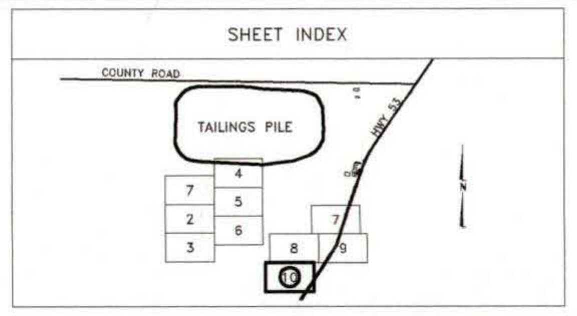
Salt Lake City Utah
Grants New Mexico
Telephone (801) 972-6222
Fax (801) 972-6235
CIVIL ENGINEERS
CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY SOUTH OF TAILINGS PILE

ERG
Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 14, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC71215\ SHEET 9 OF 10

DATE	REVISION	NO.



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Salt Lake City Utah
Grants New Mexico
Telephone (801) 731-4596
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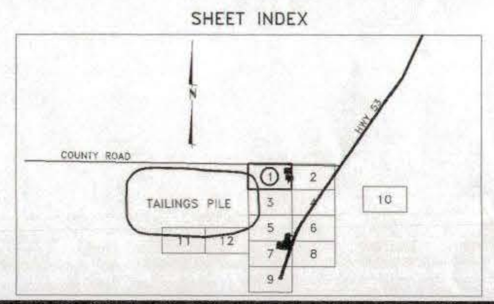
CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
SOUTH OF TAILINGS PILE

ERG
Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: RKT
ENGINEER: SDA
APPROVED: KRB
DATE: JULY 14,15, 1994
HORIZ.SCALE: 1" = 40'
VERT.SCALE: N/A
REFERENCE: HMC71215\
SHEET 10 OF 10

DATE	REVISION	NO.



ANDERSON ENGINEERING CO., INC.
Long Beach California | Salt Lake City Utah | Grants New Mexico
Telephone (801) 972-6222 Fax (801) 972-6235
CIVIL ENGINEERS CONSTRUCTION MANAGERS

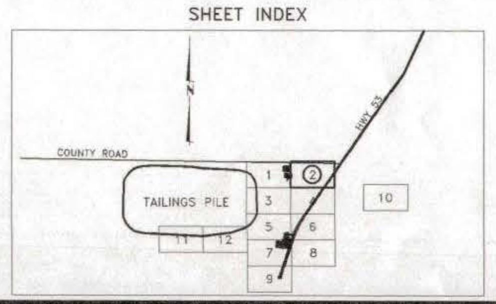
HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY EAST OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 22, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	722BASE\ SHEET 1 OF 12

DATE	REVISION	NO.

SHEET INDEX



ANDERSON ENGINEERING CO., INC.
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Telephone (801) 972-6222 Fax (801) 972-6235
CIVIL ENGINEERS CONSTRUCTION MANAGERS

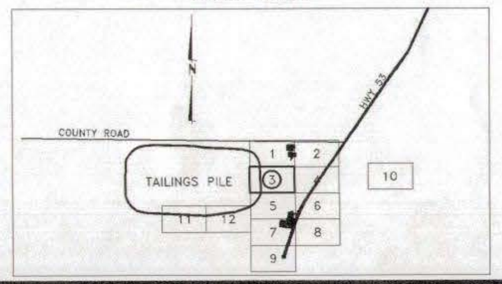
HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY EAST OF TAILINGS PILE

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 22, 23, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	722BASE\ SHEET 2 OF 12

DATE	REVISION	NO.

SHEET INDEX



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CIVIL ENGINEERS   CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY EAST OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
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(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
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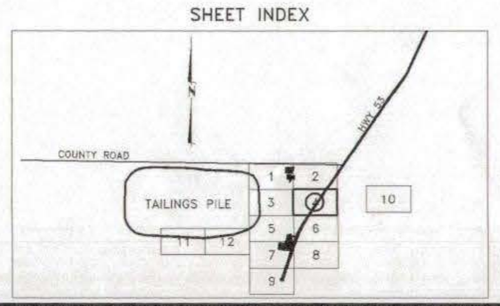
DATE:	JULY 22, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	722BASE\ SHEET 3 OF 12

DATE	REVISION	NO.

SHEET INDEX



ANDERSON ENGINEERING CO., INC.

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Telephone (801) 972-6222 Fax (801) 972-6235

CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
EAST OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 22, 23, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	722BASE\ SHEET 4 OF 12

DATE	REVISION	NO.

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(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED:	KRB
DATE:	JULY 22, 1994
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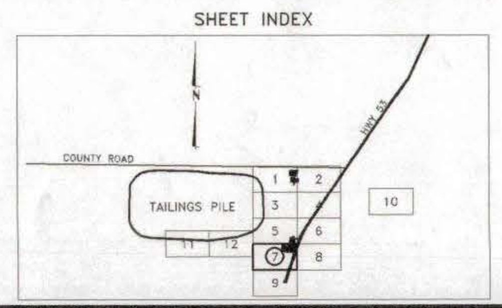
VERT. SCALE:	N/A
REFERENCE	722BASE SHEET 5 OF 12

DATE	REVISION	NO.

SHEET INDEX



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(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
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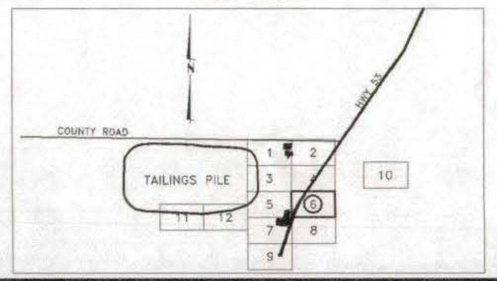
DATE	REVISION	NO.

SHEET INDEX



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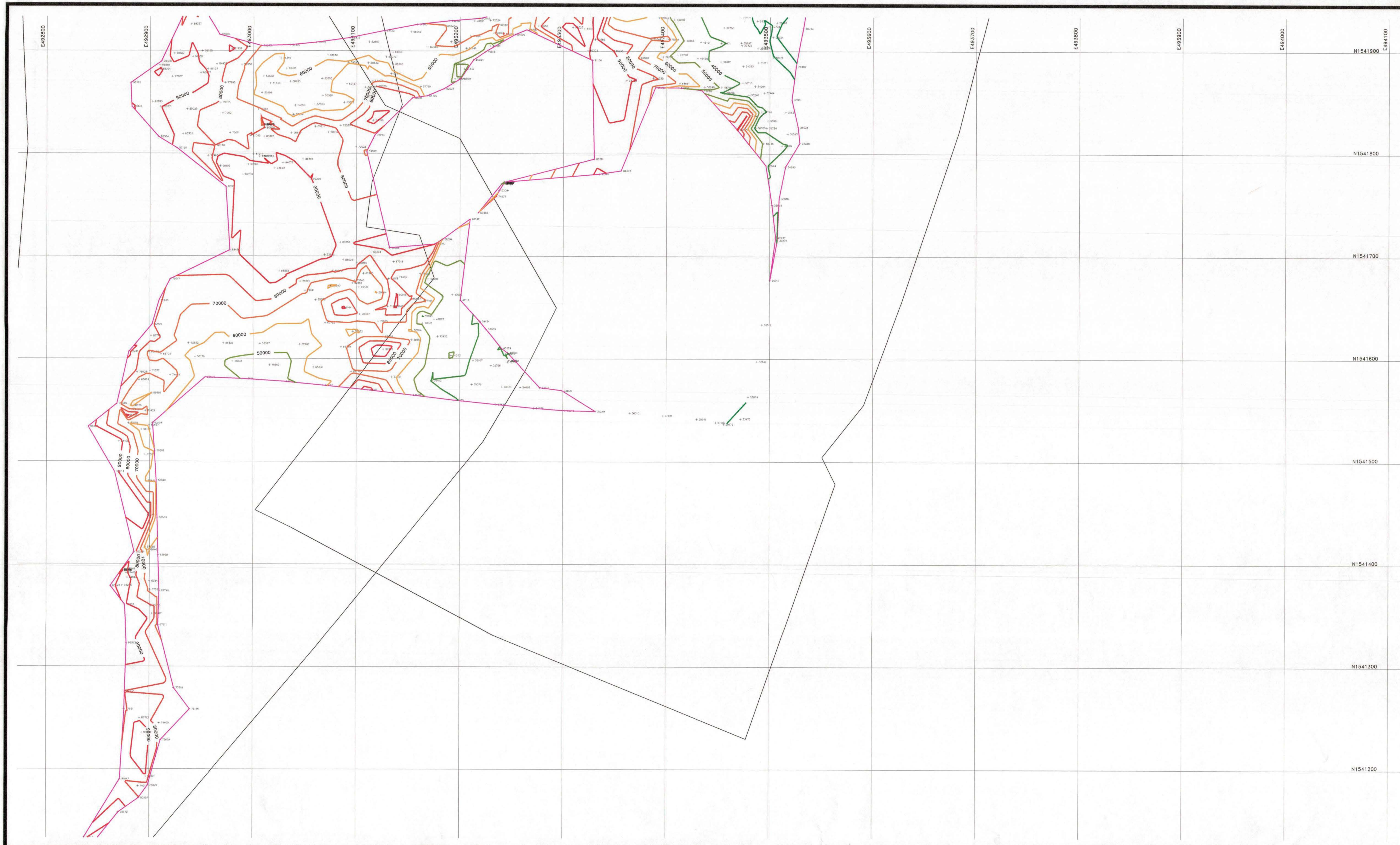
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: CFS
ENGINEER: SDA
APPROVED KRB
DATE: JULY 22, 23, 1994
HORIZ.SCALE: 1" = 40'
VERT.SCALE: N/A
REFERENCE 722BASE\ SHEET 6 OF 12



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SHEET INDEX

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DRAWN BY:	CFS
ENGINEER:	SDA
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DATE:	JULY 22, 1994
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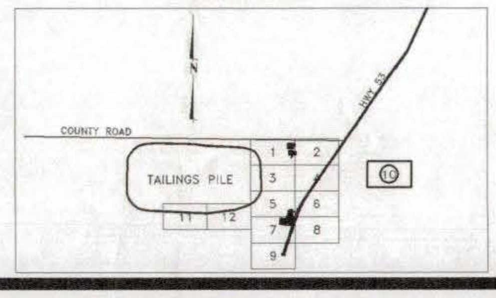
REFERENCE	722BASE\ SHEET 9 OF 12

DATE	REVISION	NO.

SHEET INDEX



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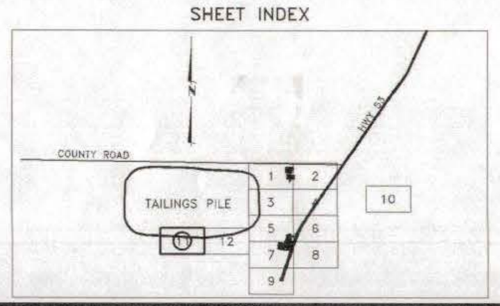

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DATE	REVISION	NO.

SHEET INDEX

COUNTY ROAD

TAILINGS PILE

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DRAWN BY: CFS
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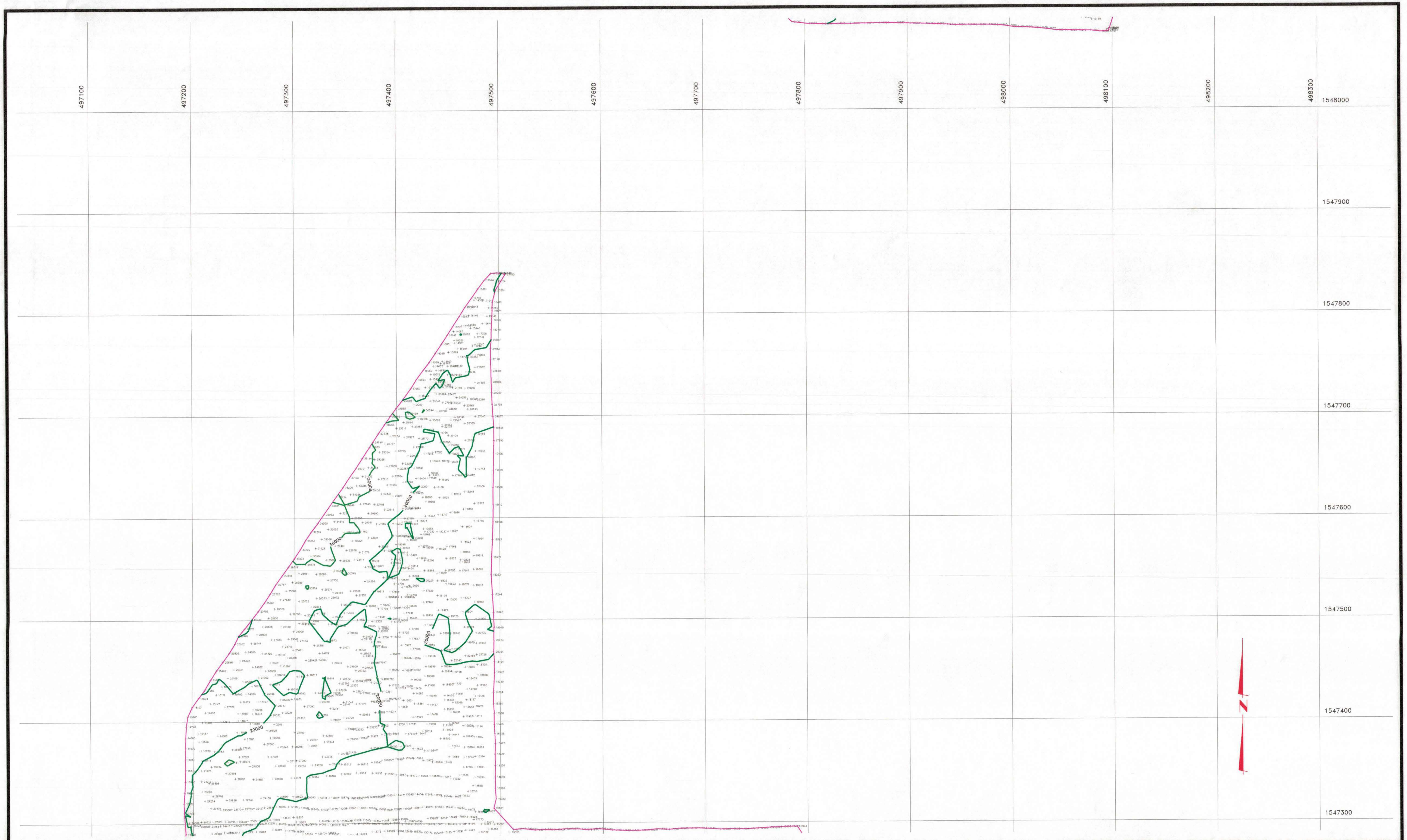
ERG
Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	JMF
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 28, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	2831HMC\ SHEET 1 OF 15



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DRAWN BY:	JMF
ENGINEER:	SDA
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DATE:	JULY 29, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	2831HMC\ SHEET 5 OF 15

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(505) 298-4224

DRAWN BY:	JMF
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 30, 31, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	2831HMC\ SHEET 8 OF 15

DATE	REVISION	NO.	DATE	REVISION	NO.

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DRAWN BY:	JMF
ENGINEER:	SDA
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DATE:	JULY 31, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	2831HMC\ SHEET 11 OF 15

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12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 15, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMCNORTH\ SHEET 1 OF 17

DATE	REVISION	NO.	DATE	REVISION	NO.

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NORTH OF TAILINGS PILE

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Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE ~~14~~, 1994 6/15, 6/16, 6/17
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMCNORTH SHEET 2 OF 17

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DRAWN BY:	RKT
ENGINEER:	SDA
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DATE:	JUNE 14, 1994 6/17, 6/21, 6/22, 6/23
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
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DRAWN BY:	CFS
ENGINEER:	SDA
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DATE:	JUNE 23, 24, 27, 1994
HORIZ.SCALE:	1" = 40'
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APPROVED	KRB
DATE:	JUNE 29, 30, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMCNORTH\ SHEET 11 OF 17

DATE	REVISION	NO.	DATE	REVISION	NO.

ANDERSON ENGINEERING CO., INC.

Long Beach California — Salt Lake City Utah — Grants New Mexico

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CIVIL ENGINEERS CONSTRUCTION MANAGERS

HOMESTAKE MINING COMPANY
RADIOLOGICAL SURVEY
NORTH OF TAILINGS PILE

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 14, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMCNORTH\ SHEET 12 OF 17

DATE	REVISION	NO.	DATE	REVISION	NO.

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(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 14, 1994 6/14, 6/16, 6/17
HORIZ. SCALE:	1" = 40'
VERT. SCALE:	N/A
REFERENCE	HMCNORTH\ SHEET 13 OF 17

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DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 14, 1994 6/17, 6/22, 6/23
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMCNORTH\ SHEET 14 OF 17

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NORTH OF TAILINGS PILE

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12809 Arroyo de Vista NE
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(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 23, 24, 27, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMCNORTH\ SHEET 15 OF 17

DATE	REVISION	NO.	DATE	REVISION	NO.

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(505) 298-4224

DRAWN BY:	CFS
ENGINEER:	SDA
APPROVED	KRB
DATE:	JUNE 24, 27, 28, 29, 30, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMCNORTH\ SHEET 16 OF 17

DATE	REVISION	NO.	DATE	REVISION	NO.

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ENGINEER:	SDA
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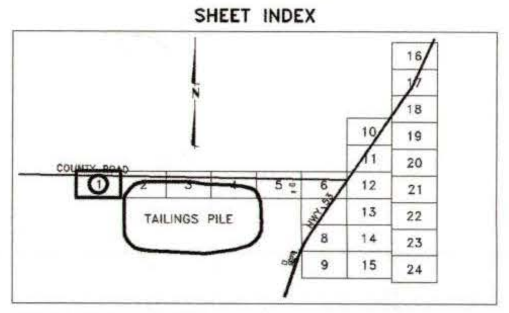
SHEET INDEX



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CIVIL ENGINEERS CONSTRUCTION MANAGERS

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ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
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(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 13, 1994
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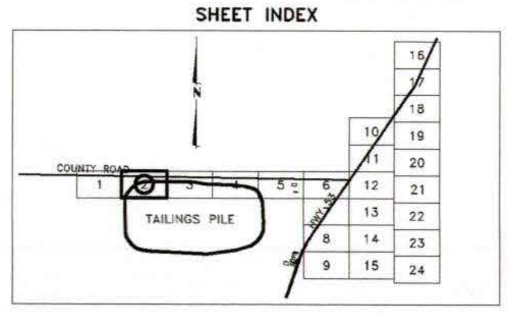
DATE	REVISION	NO.

SHEET INDEX



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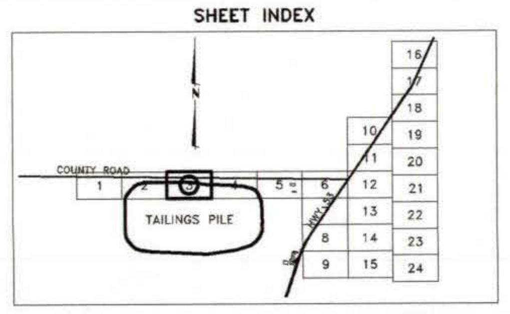
SHEET INDEX



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DATE	REVISION	NO.

SHEET INDEX

COUNTY ROAD

TAILINGS PILE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

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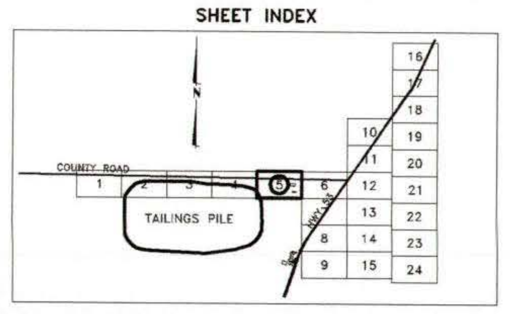
SHEET INDEX



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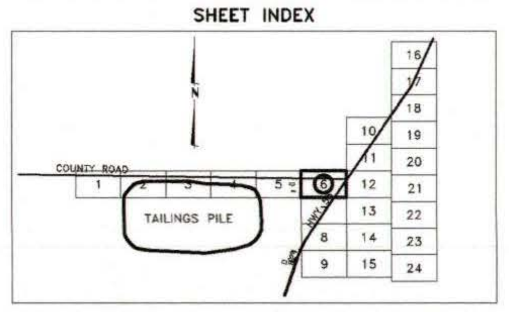
SHEET INDEX



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HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY EAST OF HIGHWAY 53

ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 12,13, 1994
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VERT.SCALE:	N/A
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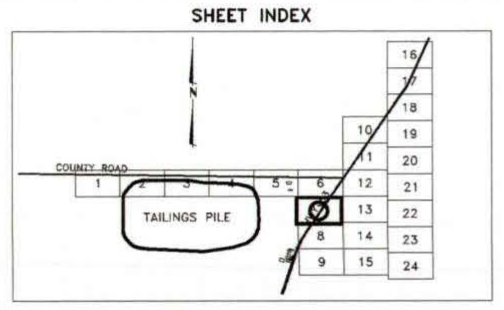
DATE	REVISION	NO.

SHEET INDEX



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RADIOLOGICAL SURVEY
EAST OF HIGHWAY 53

ERG
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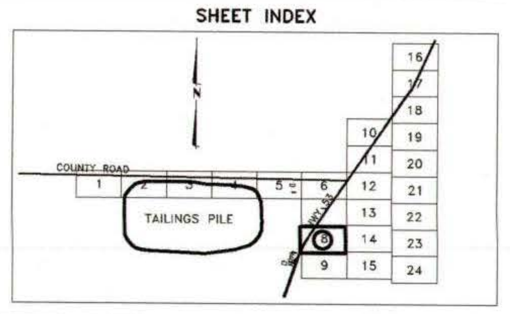
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY: RKT
ENGINEER: SDA
APPROVED KRB
DATE: JULY 11,12, 1994
HORIZ.SCALE: 1" = 40'
VERT.SCALE: N/A
REFERENCE HMC70513\ SHEET 7 OF 24

DATE	REVISION	NO.

SHEET INDEX



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DRAWN BY:	RKT
ENGINEER:	SDA
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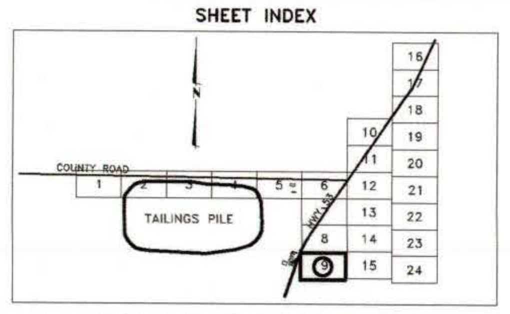
DATE:	JULY 11, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 8 OF 24

DATE	REVISION	NO.

SHEET INDEX



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(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 11,12, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 9 OF 24

DATE	REVISION	NO.

SHEET INDEX

COUNTY ROAD
TAILINGS PILE

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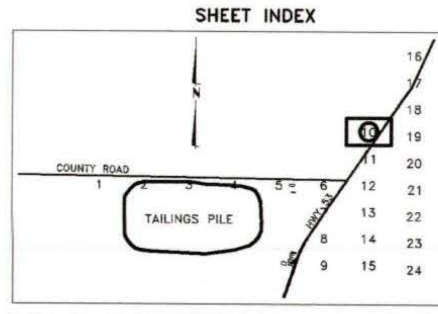
ERG Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 25,26 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC71926\ SHEET 10 OF 24

DATE	REVISION	NO.

SHEET INDEX



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12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 5,9, 1994
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DATE	REVISION	NO.

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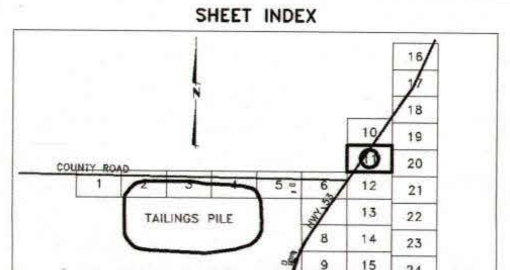

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DATE:	JULY 25,26 1994
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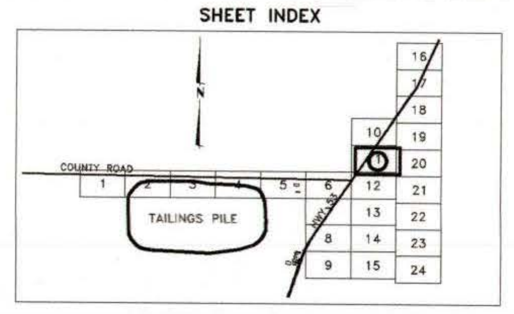
SHEET INDEX



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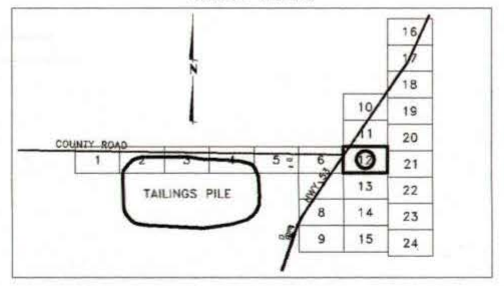

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ENGINEER:	SDA
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DATE:	JULY 24-26 1994
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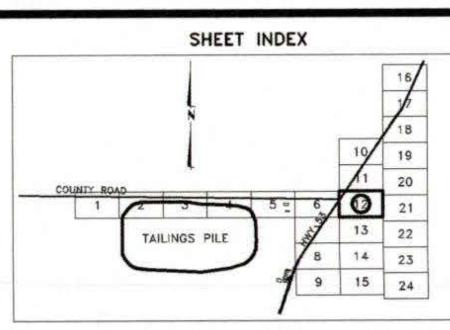

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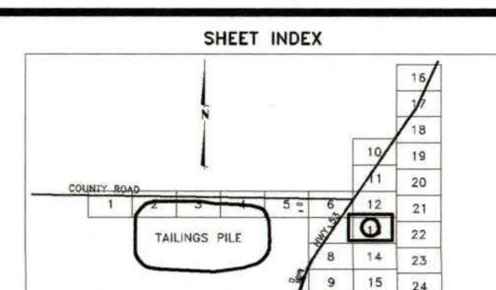

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SHEET INDEX

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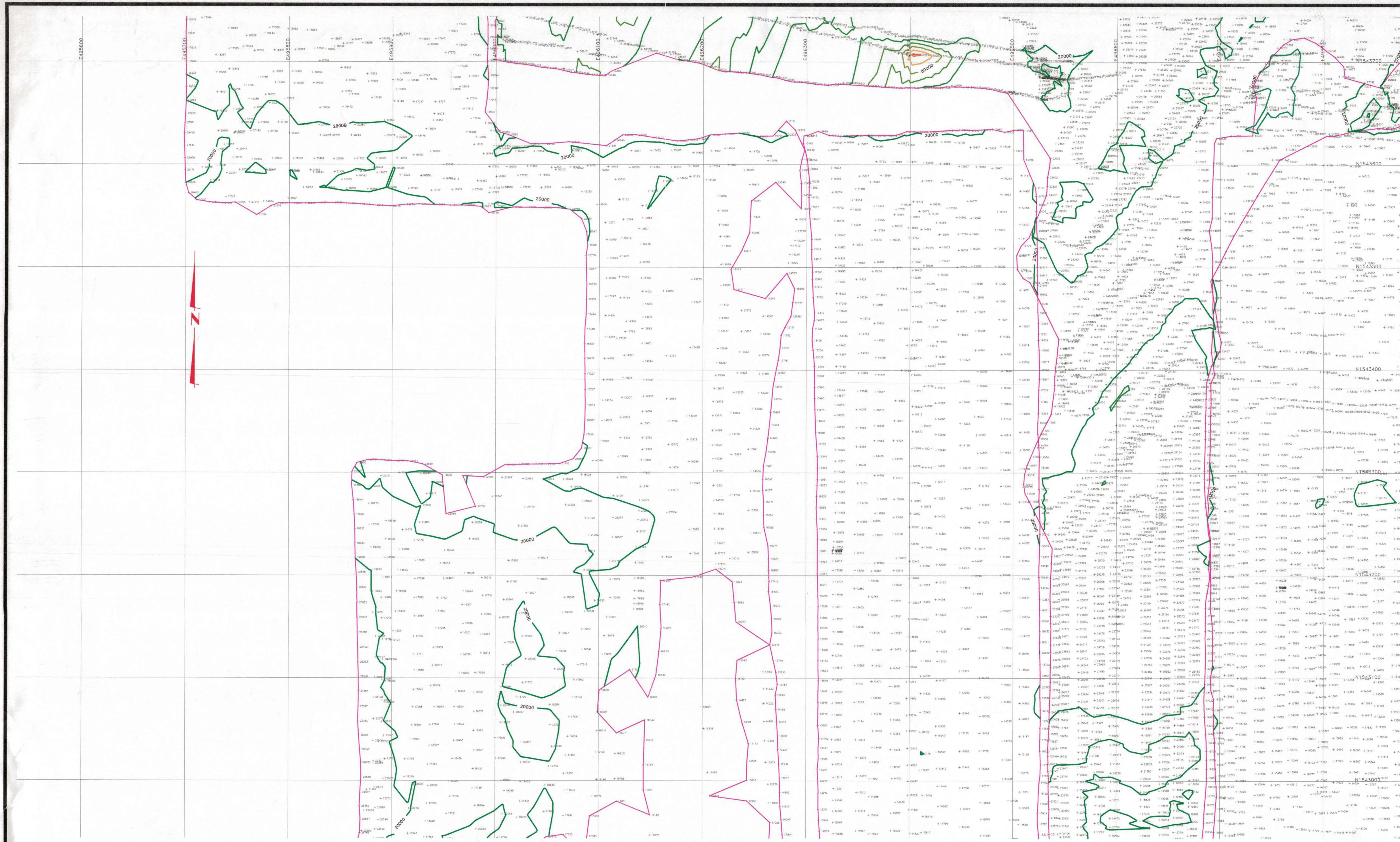

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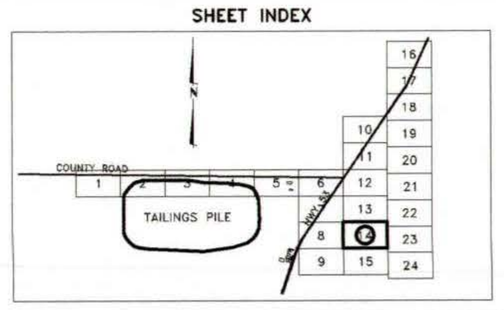
SHEET INDEX



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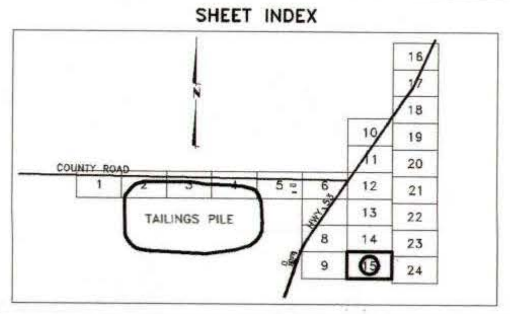

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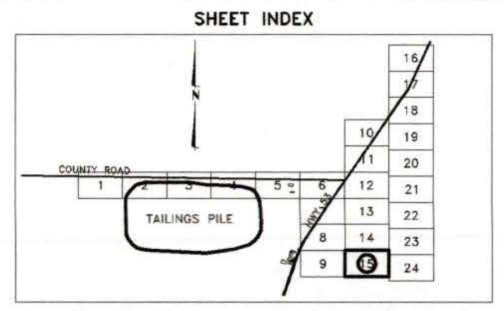

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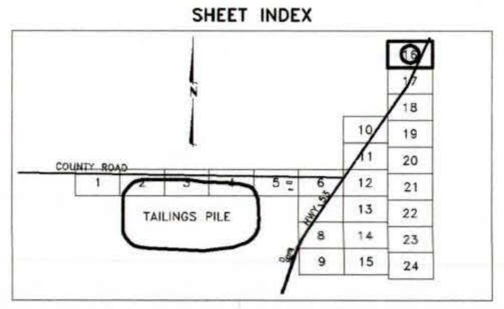
APPROVED	KRB
DATE:	JULY 10,11, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 15 OF 24

DATE	REVISION	NO.

SHEET INDEX



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Long Beach California | Salt Lake City Utah | Grants New Mexico

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CIVIL ENGINEERS CONSTRUCTION MANAGERS

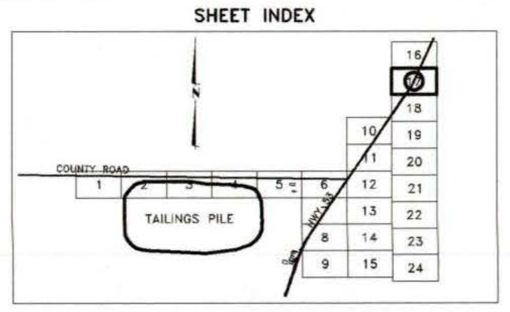
HOMESTAKE MINING COMPANY RADIOLOGICAL SURVEY EAST OF HIGHWAY 53

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, New Mexico 87111
(505) 298-4224

DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 6, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 16 OF 24

DATE	REVISION	NO.

SHEET INDEX



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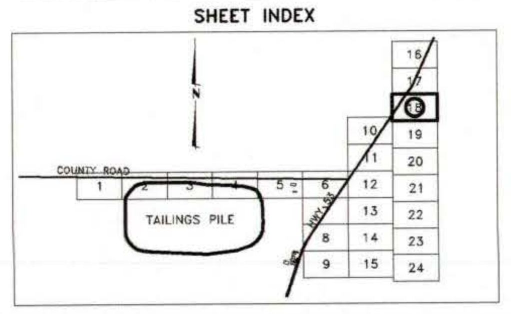
DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 6,8, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 17 OF 24

DATE	REVISION	NO.

SHEET INDEX



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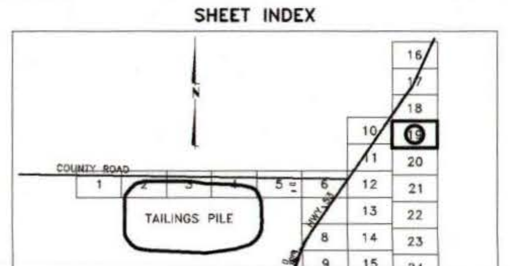
DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 6,8,9, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 18 OF 24

DATE	REVISION	NO.

SHEET INDEX



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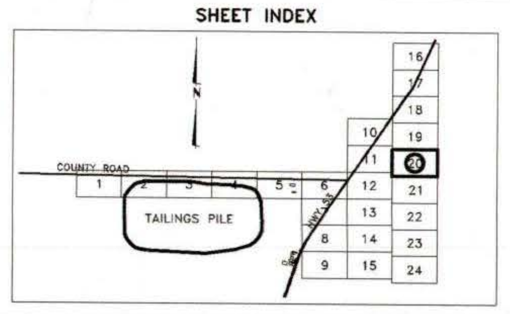
DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 6-9, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 19 OF 24

DATE	REVISION	NO.

SHEET INDEX



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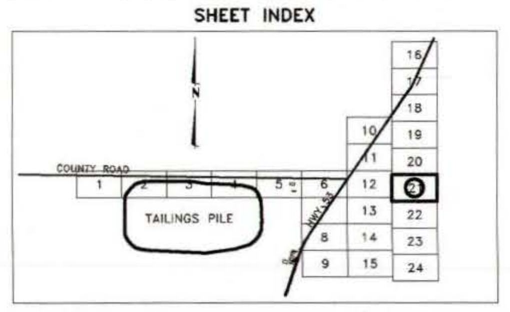
DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 7,9, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 20 OF 24

DATE	REVISION	NO.

SHEET INDEX



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DRAWN BY:	RKT
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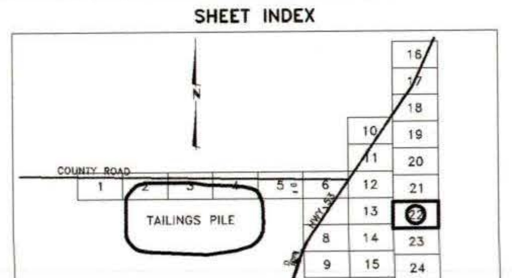
DATE:	JULY 7-9, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 21 OF 24

DATE	REVISION	NO.

SHEET INDEX



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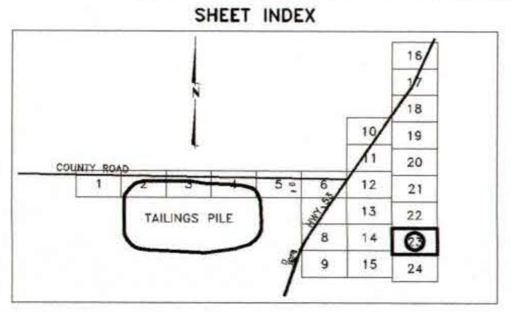
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 6-9, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 22 OF 24

DATE	REVISION	NO.

SHEET INDEX



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DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 24, 26 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC71926\ SHEET 23 OF 24

DATE	REVISION	NO.

SHEET INDEX

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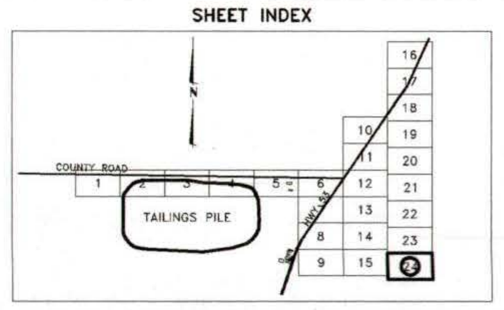
DRAWN BY:	RKT
ENGINEER:	SDA
APPROVED	KRB
DATE:	JULY 5,7,8, 1994
HORIZ.SCALE:	1" = 40'
VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 23 OF 24

DATE	REVISION	NO.



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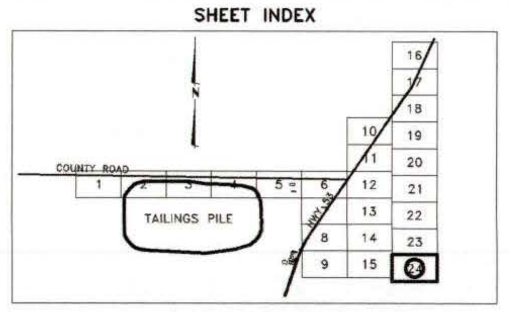
DATE	REVISION	NO.

SHEET INDEX



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VERT.SCALE:	N/A
REFERENCE	HMC70513\ SHEET 24 OF 24

Appendix D

EPA Soil Data

Soil Analytical Data
EPA Draft HHRA, 2013

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
BK1-1	BK1-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Beta	26.3	PCI/GDRY			5.52	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Bi212	0.87	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Bi214	0.821	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0229	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Cs137	0.093	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	4.4	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	K40	16.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Pb212	0.89	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Pb214	0.86	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Ra223	0.251	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Ra226	1.45	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Ra228	0.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Th227	0.12	PCI/GDRY			0.129	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Th228	0.98	PCI/GDRY			0.096	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Th230	0.7	PCI/GDRY			0.0794	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Th232	0.87	PCI/GDRY			0.0793	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Th234	0.56	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Tl208	0.285	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	U234	0.6	PCI/GDRY			0.07	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	U235	0.091	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	U235	0.03	PCI/GDRY			0.0838	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	U238	0.73	PCI/GDRY			0.083	PCI/GDRY		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Yield	94.7	*%				*%		EPA Sampling		B1.09889H
BK1-1	BK1-1	SOIL	NAREL	Radiation	Yield	89.6	*%				*%		EPA Sampling		B1.09889H
BK1-2	BK1-2	SOIL	NAREL	Radiation	Alpha	5.8	PCI/GDRY			3.41	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	1.94	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Beta	25.4	PCI/GDRY			5.74	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Bi212	1.11	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Bi214	0.86	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0195	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Cs137	0.068	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	4.16	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	K40	18	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Pb212	1.01	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Pb214	0.94	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Ra226	1.66	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Ra228	1.04	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Th227	0.061	PCI/GDRY			0.132	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Th228	1.21	PCI/GDRY			0.1	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Th230	1.02	PCI/GDRY			0.107	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Th232	1.12	PCI/GDRY			0.0556	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Th234	0.39	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Tl208	0.316	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	U234	0.78	PCI/GDRY			0.0723	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	U235	0.101	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	U235	0	PCI/GDRY			0.0654	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	U238	0.8	PCI/GDRY			0.0723	PCI/GDRY		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Yield	79.6	*%				*%		EPA Sampling		B1.09890A
BK1-2	BK1-2	SOIL	NAREL	Radiation	Yield	85.6	*%				*%		EPA Sampling		B1.09890A
BK1-3	BK1-3	SOIL	NAREL	Radiation	Alpha	5.6	PCI/GDRY			3.71	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	1.65	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Beta	27.6	PCI/GDRY			5.57	PCI/GDRY		EPA Sampling		B1.09891B

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
BK1-3	BK1-3	SOIL	NAREL	Radiation	Bi212	1.24	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Bi214	1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.018	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Cs137	0.066	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	3.38	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	K40	17.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Pa234m	1.09	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Pb212	1.19	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Pb214	1.06	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Ra223	0.313	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Ra226	2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Ra228	1.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Th227	0.065	PCI/GDRY			0.0934	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Th228	1.15	PCI/GDRY			0.0999	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Th230	1.16	PCI/GDRY			0.0691	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Th232	1.1	PCI/GDRY			0.0791	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Th234	0.88	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Tl208	0.378	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	U234	1.07	PCI/GDRY			0.0937	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	U235	0.059	PCI/GDRY			0.0889	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	U235	0.123	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	U238	1.12	PCI/GDRY			0.0648	PCI/GDRY		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Yield	88.4	*%				*%		EPA Sampling		B1.09891B
BK1-3	BK1-3	SOIL	NAREL	Radiation	Yield	88.9	*%				*%		EPA Sampling		B1.09891B
BK1-4	BK1-4	SOIL	NAREL	Radiation	Alpha	6.5	PCI/GDRY			3.33	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2.36	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Beta	22.8	PCI/GDRY			5.6	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Bi212	1.12	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Bi214	0.94	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.023	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Cs137	0.063	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	5.65	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	K40	17.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Pb212	1.13	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Pb214	1.04	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Ra223	0.344	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Ra226	1.75	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Ra228	1.13	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Th227	0.14	PCI/GDRY			0.099	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Th228	1.44	PCI/GDRY			0.0732	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Th230	1.56	PCI/GDRY			0.0733	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Th232	1	PCI/GDRY			0.0838	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Th234	0.74	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Tl208	0.377	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	U234	1.22	PCI/GDRY			0.0913	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	U235	0.107	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	U235	0.08	PCI/GDRY			0.0805	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	U238	1.21	PCI/GDRY			0.103	PCI/GDRY		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Yield	84.8	*%				*%		EPA Sampling		B1.09892C
BK1-4	BK1-4	SOIL	NAREL	Radiation	Yield	85.3	*%				*%		EPA Sampling		B1.09892C
BK1-5	BK1-5	SOIL	NAREL	Radiation	Alpha	6	PCI/GDRY			3.33	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	1.85	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Beta	27.4	PCI/GDRY			5.48	PCI/GDRY		EPA Sampling		B1.09893D

Soil Analytical Data
EPA Draft HHRA, 2013

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
BK1-5	BK1-5	SOIL	NAREL	Radiation	Bi212	1.21	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Bi214	0.94	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0158	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Cs137	0.063	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	4.26	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	K40	17.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Pa234m	1.01	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Pb212	1.07	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Pb214	1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Ra223	0.273	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Ra226	1.68	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Ra228	1.12	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Th227	0.1	PCI/GDRY			0.126	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Th228	1.39	PCI/GDRY			0.0888	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Th230	1.05	PCI/GDRY			0.0704	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Th232	1.09	PCI/GDRY			0.0703	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Th234	0.32	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Tl208	0.347	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	U234	0.88	PCI/GDRY			0.0431	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	U235	0.056	PCI/GDRY			0.0683	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	U235	0.102	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	U238	0.89	PCI/GDRY			0.0431	PCI/GDRY		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Yield	92.2	*%				*%		EPA Sampling		B1.09893D
BK1-5	BK1-5	SOIL	NAREL	Radiation	Yield	98.6	*%				*%		EPA Sampling		B1.09893D
BK1-6	BK1-6	SOIL	NAREL	Radiation	Alpha	2.8	PCI/GDRY			3.5	PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2.89	PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Beta	24.2	PCI/GDRY			5.3	PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Bi212	1.27	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Bi214	1.05	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0206	PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Cs137	0.063	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	7.2	PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	K40	17.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Pb212	1.22	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Pb214	1.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Ra226	1.95	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Ra228	1.26	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	Tl208	0.394	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK1-6	BK1-6	SOIL	NAREL	Radiation	U235	0.123	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09894E
BK2-1	BK2-1	SOIL	NAREL	Radiation	Alpha	4.7	PCI/GDRY			3.21	PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.69	PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Beta	24.5	PCI/GDRY			5.57	PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Bi212	1.19	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Bi214	0.95	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0239	PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Cs137	0.079	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	9.34	PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	K40	19.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Pa234m	1.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Pb212	1.09	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Pb214	1.04	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Ra223	0.246	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Ra226	1.87	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
BK2-1	BK2-1	SOIL	NAREL	Radiation	Ra228	1.13	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	Tl208	0.334	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-1	BK2-1	SOIL	NAREL	Radiation	U235	0.118	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09895F
BK2-2	BK2-2	SOIL	NAREL	Radiation	Alpha	2	PCI/GDRY			3.65	PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.09	PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Beta	19.1	PCI/GDRY			5.25	PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Bi212	1.06	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Bi214	0.811	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0281	PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Cs137	0.07	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	7.01	PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	K40	17.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Pa234m	0.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Pb212	0.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Pb214	0.84	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Ra226	1.29	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Ra228	0.94	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	Tl208	0.312	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-2	BK2-2	SOIL	NAREL	Radiation	U235	0.081	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09896G
BK2-3	BK2-3	SOIL	NAREL	Radiation	Alpha	6.6	PCI/GDRY			3.12	PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2.56	PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Beta	25.4	PCI/GDRY			5.7	PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Bi212	0.93	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Bi214	0.806	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0211	PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Cs137	0.056	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	6.26	PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	K40	17.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Pb212	0.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Pb214	0.86	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Ra223	0.241	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Ra226	1.48	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Ra228	0.96	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Th234	0.45	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	Tl208	0.305	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-3	BK2-3	SOIL	NAREL	Radiation	U235	0.091	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09897H
BK2-4	BK2-4	SOIL	NAREL	Radiation	Alpha	6.7	PCI/GDRY			3.49	PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.5	PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Beta	21.2	PCI/GDRY			5.23	PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Bi212	1.04	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Bi214	0.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0254	PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Cs137	0.063	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	9.7	PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	K40	19.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Pb212	1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Pb214	0.97	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Ra223	0.263	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Ra226	1.81	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Ra228	1.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Th234	0.81	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	Tl208	0.323	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J
BK2-4	BK2-4	SOIL	NAREL	Radiation	U235	0.113	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09898J

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
BK2-5	BK2-5	SOIL	NAREL	Radiation	Alpha	2.7	PCI/GDRY			3.23	PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.56	PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Beta	23.5	PCI/GDRY			5.54	PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Bi212	1.11	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Bi214	0.81	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0294	PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Cs137	0.053	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	8.43	PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	K40	17.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Pb212	0.98	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Pb214	0.89	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Ra223	0.224	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Ra226	1.74	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Ra228	1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Th234	0.64	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	Tl208	0.321	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-5	BK2-5	SOIL	NAREL	Radiation	U235	0.109	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09899K
BK2-6	BK2-6	SOIL	NAREL	Radiation	Alpha	3	PCI/GDRY			3.68	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2.98	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2.84	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Beta	22.5	PCI/GDRY			5.44	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Bi212	1.34	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Bi212	1.12	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Bi214	0.96	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Bi214	0.97	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0215	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0243	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Cs137	0.074	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Cs137	0.074	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	7.36	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	7.47	PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	K40	18.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	K40	17.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Pb212	1.13	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Pb212	1.15	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Pb214	1.04	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Pb214	1.03	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ra223	0.292	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ra223	0.275	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ra226	1.67	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ra226	1.74	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ra228	1.17	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Ra228	1.19	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Th234	0.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Th234	0.42	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Tl208	0.378	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	Tl208	0.375	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	U235	0.105	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
BK2-6	BK2-6	SOIL	NAREL	Radiation	U235	0.109	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09900J
EP1-1	EP1-1	SOIL	NAREL	Radiation	Alpha	69	PCI/GDRY			3.18	PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.27	PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Beta	81	PCI/GDRY			8.28	PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Bi212	0.34	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
EP1-1	EP1-1	SOIL	NAREL	Radiation	Bi214	1.18	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0203	PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Cs137	0.0113	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	9.42	PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	K40	7.33	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Pa234m	52.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Pb212	0.342	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Pb214	1.26	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Ra223	0.057	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Ra226		PCI/GDRY		ND	0.534	PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Ra228	0.388	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Th234	28.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	Tl208	0.095	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-1	EP1-1	SOIL	NAREL	Radiation	U235	1.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09901K
EP1-2	EP1-2	SOIL	NAREL	Radiation	Alpha	28.3	PCI/GDRY			3.54	PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.91	PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Be7	0.17	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Beta	53.8	PCI/GDRY			6.81	PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Bi212	0.53	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Bi214	3.62	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0264	PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0309	PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	10.1	PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	K40	8.26	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Pa234m	31.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Pb212	0.434	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Pb214	3.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Ra223	0.155	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Ra226	5.24	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Ra228	0.484	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Rn219	0.22	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Th227	0.112	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Th234	21.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	Tl208	0.144	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
EP1-2	EP1-2	SOIL	NAREL	Radiation	U235	1.31	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09902L
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Alpha	4.3	PCI/GDRY			3.14	PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.83	PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Beta	24.2	PCI/GDRY			5.46	PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Bi212	1.47	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Bi214	1.01	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0293	PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Cs137	0.046	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	13.8	PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	K40	17.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Pa234m	1.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Pb212	1.15	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Pb214	1.03	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Ra226	1.85	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Ra228	1.21	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	Tl208	0.382	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-1	FIA1-1	SOIL	NAREL	Radiation	U235	0.116	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09903M
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Alpha	4.9	PCI/GDRY			3.6	PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	5.25	PCI/GDRY		EPA Sampling		B1.09904N

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Beta	22.3	PCI/GDRY			5.36	PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Bi212	1.41	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Bi214	1.16	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0268	PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Cs137	0.055	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	17.3	PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	K40	20.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Pa234m	1.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Pb212	1.38	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Pb214	1.29	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Ra223	0.334	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Ra226	2.43	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Ra228	1.46	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Th234	0.92	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	Tl208	0.423	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA1-2	FIA1-2	SOIL	NAREL	Radiation	U235	0.152	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09904N
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Alpha	7.3	PCI/GDRY			2.99	PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.93	PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Beta	30.3	PCI/GDRY			5.69	PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Bi212	1.71	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Bi214	1.38	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0234	PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Cs137	0.052	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	14.9	PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	K40	17.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Pa234m	3.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Pb212	1.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Pb214	1.46	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Ra226	3.11	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Ra228	1.66	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	Tl208	0.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-1	FIA2-1	SOIL	NAREL	Radiation	U235	0.193	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09905P
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Alpha	5.3	PCI/GDRY			3.41	PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.14	PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Beta	24.7	PCI/GDRY			5.25	PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Bi212	1.34	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Bi214	1.13	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0173	PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Cs137	0.074	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	9.87	PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	K40	17.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Pa234m	1.25	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Pb212	1.21	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Pb214	1.23	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Ra223	0.317	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Ra226	2.41	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Ra228	1.32	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Th234	0.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	Tl208	0.393	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA2-2	FIA2-2	SOIL	NAREL	Radiation	U235	0.145	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09906Q
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Alpha	2.3	PCI/GDRY			3.12	PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	5.19	PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Beta	21.2	PCI/GDRY			5.28	PCI/GDRY		EPA Sampling		B1.09907R

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Bi212	1.42	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Bi214	1.34	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0256	PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Cs137	0.062	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	17.1	PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	K40	18.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Pa234m	1.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Pb212	1.36	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Pb214	1.46	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Ra223	0.355	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Ra226	2.87	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Ra228	1.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Th234	0.74	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	Tl208	0.415	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-1	FIA3-1	SOIL	NAREL	Radiation	U235	0.18	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09907R
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Alpha	5.1	PCI/GDRY			3.5	PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.31	PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Beta	27	PCI/GDRY			5.43	PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Bi212	1.38	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Bi214	1.44	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0231	PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Cs137	0.085	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	13.6	PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	K40	16.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Pa234m	1.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Pb212	1.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Pb214	1.55	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Ra223	0.364	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Ra226	3.05	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Ra228	1.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Th227	0.087	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Th234	2.09	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	Tl208	0.466	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
FIA3-2	FIA3-2	SOIL	NAREL	Radiation	U235	0.184	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09908T
P1-1	P1-1	SOIL	NAREL	Radiation	Alpha	2.2	PCI/GDRY			3.63	PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.02	PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Beta	16.6	PCI/GDRY			5.12	PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Bi212	0.73	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Bi214	0.468	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0255	PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Cs137	0.016	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	11.7	PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	K40	13.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Pa234m	1.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Pb212	0.537	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Pb214	0.501	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Ra223	0.161	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Ra226	1.14	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Ra228	0.562	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Th234	0.58	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	Tl208	0.179	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-1	P1-1	SOIL	NAREL	Radiation	U235	0.072	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09913P
P1-2	P1-2	SOIL	NAREL	Radiation	Alpha	2.7	PCI/GDRY			3.56	PCI/GDRY		EPA Sampling		B1.09914Q

Soil Analytical Data
EPA Draft HHRA, 2013

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
P1-2	P1-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.51	PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Beta	21.5	PCI/GDRY			5.38	PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Bi212	0.64	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Bi214	0.516	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.019	PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Cs137	0.047	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	10.8	PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	K40	14.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Pb212	0.584	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Pb214	0.531	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Ra223	0.176	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Ra226	1.18	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Ra228	0.57	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	Tl208	0.18	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-2	P1-2	SOIL	NAREL	Radiation	U235	0.074	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09914Q
P1-3	P1-3	SOIL	NAREL	Radiation	Alpha	7.7	PCI/GDRY			3.32	PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.92	PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Beta	25.4	PCI/GDRY			5.73	PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Bi212	0.76	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Bi214	0.597	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0209	PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Cs137	0.073	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	12.2	PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	K40	16	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Pa234m	1.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Pb212	0.734	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Pb214	0.667	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Ra223	0.258	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Ra226	1.56	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Ra228	0.725	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	Tl208	0.225	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-3	P1-3	SOIL	NAREL	Radiation	U235	0.098	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09915R
P1-4	P1-4	SOIL	NAREL	Radiation	Alpha	2.9	PCI/GDRY			3.38	PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.38	PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Beta	19.3	PCI/GDRY			5.15	PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Bi212	0.61	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Bi214	0.498	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0179	PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Cs137	0.0519	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	11	PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	K40	16.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Pb212	0.616	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Pb214	0.547	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Ra223	0.167	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Ra226	1.08	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Ra228	0.61	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Th234	0.47	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	Tl208	0.188	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-4	P1-4	SOIL	NAREL	Radiation	U235	0.067	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09916T
P1-5	P1-5	SOIL	NAREL	Radiation	Alpha	4.9	PCI/GDRY			3.15	PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2.24	PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Beta	17.9	PCI/GDRY			5.43	PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Bi212	0.63	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
P1-5	P1-5	SOIL	NAREL	Radiation	Bi214	0.494	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0128	PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Cs137	0.0228	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	6.91	PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	K40	14.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Pa234m	0.66	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Pb212	0.565	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Pb214	0.528	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Ra223	0.129	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Ra226	1.17	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Ra228	0.582	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Th234	0.624	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	Tl208	0.184	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-5	P1-5	SOIL	NAREL	Radiation	U235	0.071	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09917U
P1-6	P1-6	SOIL	NAREL	Radiation	Alpha	5	PCI/GDRY			3.52	PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.12	PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Beta	20.6	PCI/GDRY			5.34	PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Bi212	0.73	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Bi214	0.513	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.022	PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Cs137	0.034	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	14.5	PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	K40	14.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Pa234m	1.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Pb212	0.593	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Pb214	0.589	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Ra223	0.176	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Ra226	1.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Ra228	0.652	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Th234	0.42	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	Tl208	0.179	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6	P1-6	SOIL	NAREL	Radiation	U235	0.081	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09918V
P1-6D	P1-6D	SOIL	NAREL	Radiation	Alpha	3.1	PCI/GDRY			3.34	PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.24	PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Beta	16.4	PCI/GDRY			5.34	PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Bi212	0.71	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Bi214	0.549	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0208	PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Cs137	0.047	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	14.6	PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	K40	15.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Pa234m	0.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Pb212	0.607	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Pb214	0.587	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Ra223	0.175	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Ra226	1.19	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Ra228	0.668	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Th234	0.45	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P1-6D	P1-6D	SOIL	NAREL	Radiation	Tl208	0.181	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09919W
P2-1	P2-1	SOIL	NAREL	Radiation	Alpha	2.5	PCI/GDRY			3.37	PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.54	PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	2.91	PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Beta	18.7	PCI/GDRY			5.11	PCI/GDRY		EPA Sampling		B1.09920N

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
P2-1	P2-1	SOIL	NAREL	Radiation	Bi212	0.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Bi212	0.49	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Bi214	0.534	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Bi214	0.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0201	PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0155	PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Cs137	0.111	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Cs137	0.114	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	15.2	PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	8.74	PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	K40	12.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	K40	13	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Pa234m	1.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Pb212	0.51	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Pb212	0.517	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Pb214	0.576	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Pb214	0.598	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ra223	0.15	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ra223	0.137	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ra226	1.16	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ra226	1.17	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ra228	0.535	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Ra228	0.516	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Th234	0.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Th234	0.42	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Tl208	0.146	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	Tl208	0.158	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-1	P2-1	SOIL	NAREL	Radiation	U235	0.072	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09920N
P2-2	P2-2	SOIL	NAREL	Radiation	Alpha	4.7	PCI/GDRY			3.19	PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.91	PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Beta	21.6	PCI/GDRY			5.62	PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Bi212	0.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Bi214	0.501	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0189	PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Cs137	0.078	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	13.9	PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	K40	12.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Pb212	0.462	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Pb214	0.561	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Ra223	0.137	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Ra226	0.98	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Ra228	0.483	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Th234	0.38	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-2	P2-2	SOIL	NAREL	Radiation	Tl208	0.142	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09921P
P2-3	P2-3	SOIL	NAREL	Radiation	Alpha	4.1	PCI/GDRY			3.58	PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.12	PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Beta	15.4	PCI/GDRY			5.17	PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Bi212	0.46	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Bi214	0.462	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.017	PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Cs137	0.062	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	13.7	PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	K40	12.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
P2-3	P2-3	SOIL	NAREL	Radiation	Pa234m	0.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Pb212	0.419	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Pb214	0.517	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Ra226	0.99	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Ra228	0.453	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Th234	0.27	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-3	P2-3	SOIL	NAREL	Radiation	Tl208	0.135	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09922Q
P2-4	P2-4	SOIL	NAREL	Radiation	Alpha	3.6	PCI/GDRY			3.4	PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Alpha	4.9	PCI/GDRY			3.4	PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.2	PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Beta	16.6	PCI/GDRY			5.07	PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Beta	16.2	PCI/GDRY			5.45	PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Bi212	0.47	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Bi214	0.43	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0182	PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Cs137	0.0384	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	11	PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	K40	12.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Pb212	0.443	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Pb214	0.485	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Ra223	0.147	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Ra226	0.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Ra228	0.463	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	Tl208	0.144	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-4	P2-4	SOIL	NAREL	Radiation	U235	0.059	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09923R
P2-5	P2-5	SOIL	NAREL	Radiation	Alpha	6	PCI/GDRY			3.17	PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.5	PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Beta	15.4	PCI/GDRY			5.37	PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Bi212	0.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Bi214	0.507	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0173	PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Cs137	0.08	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	11.7	PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	K40	11.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Pb212	0.444	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Pb214	0.536	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Ra223	0.117	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Ra226	1.16	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Ra228	0.472	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	Tl208	0.137	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-5	P2-5	SOIL	NAREL	Radiation	U235	0.072	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09924T
P2-6	P2-6	SOIL	NAREL	Radiation	Alpha	8	PCI/GDRY			3.61	PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.27	PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Beta	14.6	PCI/GDRY			5.26	PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Bi212	0.45	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Bi214	0.512	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0194	PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Cs137	0.096	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	14.9	PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	K40	12.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Pb212	0.451	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Pb214	0.549	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Ra226	0.83	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
P2-6	P2-6	SOIL	NAREL	Radiation	Ra228	0.475	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Th234	0.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6	P2-6	SOIL	NAREL	Radiation	Tl208	0.134	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09925U
P2-6D	P2-6D	SOIL	NAREL	Radiation	Alpha	4.5	PCI/GDRY			3.39	PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.26	PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Beta	13.9	PCI/GDRY			5.33	PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Bi212	0.58	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Bi214	0.529	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0205	PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Cs137	0.092	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	16.5	PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	K40	12.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Pb212	0.479	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Pb214	0.593	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Ra223	0.093	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Ra226	1.05	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Ra228	0.491	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Th234	0.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
P2-6D	P2-6D	SOIL	NAREL	Radiation	Tl208	0.135	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09926V
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Alpha	10.8	PCI/GDRY			3.4	PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.86	PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Beta	19.5	PCI/GDRY			5.33	PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Bi212	0.64	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Bi214	0.614	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0189	PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0183	PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	17.7	PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	K40	13.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Pa234m	1.43	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Pb212	0.573	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Pb214	0.658	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Ra223	0.147	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Ra226	1.55	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Ra228	0.635	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Th234	0.76	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	Tl208	0.178	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10A	RUN-10A	SOIL	NAREL	Radiation	U235	0.098	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09927W
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Alpha	22.6	PCI/GDRY			3.03	PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.01	PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Beta	31.5	PCI/GDRY			6.02	PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Bi212	1.48	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Bi214	1.48	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0159	PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Cs137	0.0237	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	10.5	PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	K40	19.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Pa234m	3.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Pb212	1.37	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Pb214	1.61	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Ra223	0.32	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Ra226	3.63	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Ra228	1.43	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Th234	1.73	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	Tl208	0.435	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10B	RUN-10B	SOIL	NAREL	Radiation	U235	0.225	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09928X
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Alpha	20	PCI/GDRY			3.39	PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	7.57	PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Beta	44.2	PCI/GDRY			6.27	PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Bi212	1.76	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Bi214	5.79	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0345	PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Cs137	0.151	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	26.1	PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	K40	19.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Pa234m	3.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Pb212	1.53	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Pb214	6.13	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Ra223	0.56	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Ra226	8.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Ra228	1.57	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Rn219	0.29	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Th227	0.227	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Th234	3.12	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	Tl208	0.457	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10C	RUN-10C	SOIL	NAREL	Radiation	U235	0.541	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09929Y
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Alpha	13.7	PCI/GDRY			3.22	PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	8.22	PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Beta	35.9	PCI/GDRY			6.06	PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Bi212	2.04	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Bi214	3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0294	PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Cs137	0.148	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	27.2	PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	K40	21.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Pa234m	3.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Pb212	1.67	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Pb214	3.22	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Ra223	0.474	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Ra226	5.73	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Ra228	1.68	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Th227	0.108	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Th234	3.12	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	Tl208	0.479	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10D	RUN-10D	SOIL	NAREL	Radiation	U235	0.35	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09930Q
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Alpha	18	PCI/GDRY			3.23	PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	6.55	PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Beta	42.1	PCI/GDRY			6.08	PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Bi212	1.75	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Bi214	3.71	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0313	PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Cs137	0.127	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	22.8	PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	K40	18.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Pa234m	3.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Pb212	1.49	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Pb214	3.96	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Ra223	0.374	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Ra226	6.27	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Ra228	1.47	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Th227	0.132	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Th234	2.27	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	Tl208	0.432	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10E	RUN-10E	SOIL	NAREL	Radiation	U235	0.374	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09931R
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Alpha	5.6	PCI/GDRY			3.15	PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	6.28	PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Beta	24.8	PCI/GDRY			5.7	PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Bi212	0.79	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Bi214	1.58	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0244	PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Cs137	0.093	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	21	PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	K40	15.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Pa234m	1.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Pb212	0.691	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Pb214	1.71	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Ra223	0.293	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Ra226	2.84	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Ra228	0.736	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	Tl208	0.198	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F	RUN-10F	SOIL	NAREL	Radiation	U235	0.178	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09932T
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Alpha	15	PCI/GDRY			3.53	PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	6.13	PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Beta	24.6	PCI/GDRY			5.68	PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Bi212	0.82	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Bi214	1.57	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0225	PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Cs137	0.099	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	21.9	PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	K40	15.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Pa234m	1.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Pb212	0.658	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Pb214	1.72	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Ra223	0.205	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Ra226	2.79	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Ra228	0.711	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Th234	0.89	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	Tl208	0.208	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-10F-D	RUN-10F-D	SOIL	NAREL	Radiation	U235	0.173	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09933U
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Alpha	28.5	PCI/GDRY			3.89	PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.91	PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Beta	44.6	PCI/GDRY			6.6	PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Bi212	0.39	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Bi214	0.504	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0208	PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0186	PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	17.1	PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	K40	12.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Pa234m	18.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Pb212	0.425	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Pb214	0.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Ra223	0.097	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Ra226	1.69	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Ra228	0.483	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Th234	11.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	Tl208	0.138	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3A	RUN-3A	SOIL	NAREL	Radiation	U235	0.697	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09934V
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Alpha	7	PCI/GDRY			3.59	PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	5.11	PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Beta	22.3	PCI/GDRY			5.69	PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Bi212	0.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Bi214	0.697	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0202	PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0184	PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	17.6	PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	K40	14.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Pb212	0.706	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Pb214	0.733	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Ra223	0.199	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Ra226	1.53	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Ra228	0.764	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Th234	0.28	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	Tl208	0.225	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3B	RUN-3B	SOIL	NAREL	Radiation	U235	0.096	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09935W
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Alpha	11.3	PCI/GDRY			4.01	PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	6.76	PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Beta	27.9	PCI/GDRY			5.78	PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Bi212	0.98	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Bi214	1.57	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.024	PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Cs137	0.08	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	22.1	PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	K40	17.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Pa234m	1.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Pb212	0.99	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Pb214	1.67	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Ra223	0.28	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Ra226	3.04	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Ra228	1.03	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Th234	1.14	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	Tl208	0.313	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3C	RUN-3C	SOIL	NAREL	Radiation	U235	0.191	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09936X
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Alpha	10.5	PCI/GDRY			3.11	PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	5.38	PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Beta	31.6	PCI/GDRY			5.79	PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Bi212	1.45	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Bi214	1.58	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0253	PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Cs137	0.036	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	18.6	PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	K40	18.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Pa234m	1.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Pb212	1.39	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Pb214	1.62	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Ra223	0.385	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Ra226	1.53	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Ra228	1.38	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Th227	0.089	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Th234	1.93	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	Tl208	0.416	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D	RUN-3D	SOIL	NAREL	Radiation	U235	0.096	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09937Y
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Alpha	8	PCI/GDRY			3.72	PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	5.44	PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Beta	31.4	PCI/GDRY			5.61	PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Bi212	1.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Bi214	1.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0244	PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Cs137	0.026	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	19.8	PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	K40	18.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Pa234m	1.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Pb212	1.38	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Pb214	1.62	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Ra223	0.335	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Ra226	3.08	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Ra228	1.42	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Th227	0.047	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Th234	1.87	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	Tl208	0.443	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3D-D	RUN-3D-D	SOIL	NAREL	Radiation	U235	0.186	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09938Z
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Alpha	10.1	PCI/GDRY			3.4	PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	5.9	PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Beta	29.6	PCI/GDRY			5.75	PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Bi212	1.58	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Bi214	1.75	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0264	PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Cs137	0.026	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	20.7	PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	K40	18	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Pa234m	2.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Pb212	1.48	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Pb214	1.82	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Ra223	0.401	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Ra226	3.68	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Ra228	1.58	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Th234	0.87	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	Tl208	0.472	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3E	RUN-3E	SOIL	NAREL	Radiation	U235	0.228	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09939A
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Alpha	9.1	PCI/GDRY			3.9	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	6.11	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	5.71	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Beta	36.6	PCI/GDRY			5.93	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Bi212	1.62	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Bi212	1.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Bi214	1.79	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Bi214	1.76	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0249	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0318	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Cs137	0.076	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Cs137	0.069	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	18.5	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	18.1	PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	K40	20.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	K40	20.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Pa234m	2.2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Pa234m	2.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Pb212	1.48	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Pb212	1.42	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Pb214	1.89	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Pb214	1.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Ra223	0.435	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Ra226	3.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Ra226	3.67	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Ra228	1.55	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Ra228	1.55	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Th234	1.57	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Tl208	0.472	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	Tl208	0.471	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	U235	0.222	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-3F	RUN-3F	SOIL	NAREL	Radiation	U235	0.223	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09940T
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Alpha	10.8	PCI/GDRY			3.19	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Alpha	7.3	PCI/GDRY			3.74	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	3.48	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Beta	23.3	PCI/GDRY			5.62	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Beta	30.6	PCI/GDRY			5.6	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Bi212	1.24	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Bi214	1.21	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.017	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0161	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	11.7	PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	K40	17.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Pa234m	2	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Pb212	1.07	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Pb214	1.27	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Ra223	0.283	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Ra226	1.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Ra228	1.12	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Th234	1.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	Tl208	0.325	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4A	RUN-4A	SOIL	NAREL	Radiation	U235	0.071	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09941U
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Alpha	10.1	PCI/GDRY			3.5	PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	4.51	PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Beta	32.3	PCI/GDRY			5.98	PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Bi212	0.98	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Bi214	1.07	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0195	PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0189	PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	15.7	PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	K40	16.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Pa234m	3.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Pb212	0.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Pb214	1.07	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Ra226	4.22	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Ra228	1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	Tl208	0.306	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4B	RUN-4B	SOIL	NAREL	Radiation	U235	0.259	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09942V
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Alpha	6.3	PCI/GDRY			3.79	PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	7.38	PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Beta	31.1	PCI/GDRY			5.57	PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Bi212	1.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Bi214	1.26	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0293	PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0267	PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	18.9	PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	K40	16.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Pa234m	1.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Pb212	1.44	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Pb214	1.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Ra226	3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Ra228	1.56	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	Tl208	0.481	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4C	RUN-4C	SOIL	NAREL	Radiation	U235	0.186	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09943W
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Alpha	8.9	PCI/GDRY			3.1	PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	6.66	PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Beta	24.8	PCI/GDRY			5.51	PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Bi212	1.73	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Bi214	1.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.023	PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Cs137	0.0105	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	18.5	PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	K40	17.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Pa234m	2.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Pb212	1.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Pb214	1.54	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Ra226	3.31	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Ra228	1.61	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	Tl208	0.506	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4D	RUN-4D	SOIL	NAREL	Radiation	U235	0.208	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09944X
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Alpha	15.3	PCI/GDRY			3.6	PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	8.51	PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Beta	32.3	PCI/GDRY			5.63	PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Bi212	1.51	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Bi214	1.74	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0336	PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Cs137	0.014	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	20.4	PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	K40	18.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Pa234m	6.7	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Pb212	1.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Pb214	1.76	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Ra226	2.83	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Ra228	1.68	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Rn219	0.124	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	Tl208	0.521	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4E	RUN-4E	SOIL	NAREL	Radiation	U235	0.248	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09945Y
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Alpha	24.3	PCI/GDRY			3.49	PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	7.2	PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Beta	29.9	PCI/GDRY			6.1	PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Bi212	1.31	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Bi214	2.79	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0236	PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Cs137	0.074	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	19.2	PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	K40	15.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Pa234m	3.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Pb212	1.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Pb214	2.85	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Ra226	6.14	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Ra228	1.16	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Rn219	0.138	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Th227	0.145	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	Tl208	0.365	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-4F	RUN-4F	SOIL	NAREL	Radiation	U235	0.375	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09946Z
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Alpha	4.6	PCI/GDRY			4.01	PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	7.06	PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Beta	21.4	PCI/GDRY			5.41	PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Bi212	0.77	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Bi214	0.86	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0284	PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Cs137		PCI/GDRY		ND	0.0256	PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	18.1	PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	K40	14.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Pa234m	1.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Pb212	0.85	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Pb214	0.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Ra223	0.234	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Ra226	2.52	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Ra228	0.82	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Th234	1.36	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	Tl208	0.265	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6A	RUN-6A	SOIL	NAREL	Radiation	U235	0.153	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09947A
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Alpha	13.7	PCI/GDRY			3.1	PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	7.37	PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Beta	35.5	PCI/GDRY			5.96	PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Bi212	1.69	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Bi214	2.27	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0272	PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Cs137	0.074	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	19.4	PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	K40	18.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Pa234m	5.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Pb212	1.57	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Pb214	2.39	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Ra223	0.513	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Ra226	2.14	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Ra228	1.64	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Th234	2.65	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	Tl208	0.525	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6B	RUN-6B	SOIL	NAREL	Radiation	U235	0.21	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09948B
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Alpha	12.4	PCI/GDRY			3.68	PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	7.62	PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Beta	36.9	PCI/GDRY			5.84	PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Bi212	1.69	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Bi214	2.11	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0259	PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Cs137	0.102	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	20.2	PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	K40	17.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Pa234m	4.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Pb212	1.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Pb214	2.22	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Ra223	0.508	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Ra226	4.98	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Ra228	1.53	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Th227	0.141	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Th234	2.78	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	Tl208	0.471	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6C	RUN-6C	SOIL	NAREL	Radiation	U235	0.302	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09949C
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Alpha	10.3	PCI/GDRY			3.36	PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	11.8	PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Beta	33	PCI/GDRY			5.82	PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Bi212	1.74	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Bi214	1.68	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0271	PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Cs137	0.065	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	20.9	PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	K40	18.3	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Pa234m	2.9	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Pb212	1.6	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Pb214	1.79	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Ra223	0.434	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Ra226	4.28	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Ra228	1.64	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Th234	1.97	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	Tl208	0.527	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6D	RUN-6D	SOIL	NAREL	Radiation	U235	0.267	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09950V
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Alpha	6.4	PCI/GDRY			3.89	PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	7.66	PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Beta	29.7	PCI/GDRY			5.62	PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Bi212	1.57	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Bi214	1.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0257	PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Cs137	0.013	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	20.6	PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	K40	18.4	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Pa234m	2.5	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Pb212	1.18	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Pb214	1.91	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W

Sample #	Location	Lab Matrix	Lab_Name	Analysis	Analyte	Result	Units	Qualifier	Lab Qualifier	MDL	MDL Units	Lab COC No	Event	Comments	Lab_Samp_No
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Ra226	4.17	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Ra228	1.65	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Th234	1.71	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	Tl208	0.515	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6E	RUN-6E	SOIL	NAREL	Radiation	U235	0.25	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09951W
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Alpha	9.7	PCI/GDRY			3.15	PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Ba140		PCI/GDRY		ND	9.02	PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Beta	36.3	PCI/GDRY			6	PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Bi212	1.75	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Bi214	3.92	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Co60		PCI/GDRY		ND	0.0302	PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Cs137	0.078	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	I131		PCI/GDRY		ND	24.8	PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	K40	18.8	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Pa234m	5.1	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Pb212	1.65	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Pb214	4.24	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Ra223	0.67	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Ra226	1.48	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Ra228	1.71	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Th227	0.195	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Th234	4.02	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	Tl208	0.518	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X
RUN-6F	RUN-6F	SOIL	NAREL	Radiation	U235	0.387	PCI/GDRY				PCI/GDRY		EPA Sampling		B1.09952X

Appendix E

Land Treatment Area Background Soil Concentration Data

Table 3-1. Pre-Operation and Background Soil Sample Results for Section 34

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
0-1	S33-1	Untreated	0-6	0.96	1.42	0.13		1998
	S33-1	Untreated	6-24	1.23	1.82	0.19		1998
	S33-2	Untreated	0-6	1.12	1.65	0.18		1998
	S33-2	Untreated	6-24	1.2	1.51	0.19		1998
	S3-1	Untreated	0-14	0.7	1.03	0.11		1998
	S34-1	Untreated	3-24	@5.85	@8.77	0.10		1998
	S34-3	Treated	4-26	1.03	1.52	0.11		1998
	S34-5	Untreated	3-40	0.84	1.24	0.14		1998
	S34-7	Untreated	3-28	0.78	1.15	0.06		1998
	S34-8	Untreated	2-30	1.26	1.86	0.31		1998
	S34-10	Untreated	3-28	1.01	1.49	0.13		1998
	S34-11	Untreated	3-15	1.36	2.01	0.03		*1998
	S34-13	Untreated	4-18	@3.93	@5.81	0.11		1998
	S34-14	Treated	4-24	0.79	1.17	0.19		1998
	34A	Treated	0-6	1.84	2.72	0.40	36	1999
	34B	Treated	0-6	1.6	2.36	0.40	54	1999
	34C	Treated	0-6	1.18	1.75	0.30	79	1999
	34D	Treated	0-6	2.44	3.6	0.60	36	1999
	34E	Treated	0-6	1.56	2.31	0.40	25	1999
	34F	Treated	0-6	2.05	3.03	0.80	68	1999
	34G	Treated	0-6	1.25	1.85	0.30	13	1999
	34H	Treated	0-6	2.29	3.38	0.70	43	1999
	34I	Treated	0-6	0.67	0.99	0.10	42	1999
	BG-1-34	Untreated	0-12	1.67	2.47	0.3	100	2001
	BG-1-34	Untreated	0-12	0.30	0.45		7	#2002
	BG-1-34	Untreated	0-12	1.58	2.33	0.42	83	2003
	BG-1-34	Untreated	0-12	1.89	2.79	0.75	151	2004
	BG-1-34	Untreated	0-12	1.63	2.41	0.53	@400	2005
	BG-1-33F	Untreated	0-12	1.06	1.56	0.47	30	2004
	BG-1-33F	Untreated	0-12	0.76	1.12	0.25	76	2005
	BG-1-33F	Untreated	0-12	1.05	1.55	0.56	24	2006
	BG-1-34	Untreated	0-12	2.07	3.06	0.69	@253	2006
	BG-1-33F	Untreated	0-12	1.21	1.79	0.38	64	2007
	BG-1-34	Untreated	0-12	2.23	3.3	0.74	@267	2007
	BG-1-33F	Untreated	0-12	0.97	1.44	0.32	@220	2008
	BG-1-34	Untreated	0-12	1.71	2.52	0.57	@289	2008
	BG-1-33F	Untreated	0-12	0.83	1.22	0.23	50	2009
	BG-1-34	Untreated	0-12	2.27	3.35	0.59	135	2009
	BF-1-22F	Untreated	0-12	0.96	1.42	0.27	150	2010
	BF-1-34	Untreated	0-12	2.21	3.27	0.58	190	2010
			Mean	1.35	2.00	0.35	69.76	
			SDV	0.55	0.81	0.22	51.23	
			CV	40.34	40.37	63.10	73	

@ = considered an outlier, did not use
* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025
# = 2002 Se MDL = 0.8 All data reported as <MDL, did not use
CV = coefficient of variation
SDV = standard deviation

Table 3-1. Pre-Operation and Background Soil Sample Results for Section 34 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
1-2	S33-1	Untreated	6-24	1.23	1.82	0.19		1998
	S33-2	Untreated	6-24	1.02	1.51	0.19		1998
	S3-1	Untreated	14-38	0.71	1.05	0.09		1998
	S34-1	Untreated	3-24	@5.85	@8.77	0.10		1998
	S34-3	Treated	4-26	1.03	1.52	0.11		1998
	S34-5	Untreated	3-40	0.84	1.24	0.14		1998
	S34-7	Untreated	3-28	0.78	1.15	0.06		1998
	S34-8	Untreated	2-30	1.26	1.86	0.31		1998
	S34-10	Untreated	3-28	1.01	1.49	0.13		1998
	S34-11	Untreated	15-60	0.58	0.86	0.03		*1998
	S34-13	Untreated	4-18	@3.93	@5.81	0.11		1998
	S34-13	Untreated	18-30	0.68	1.00	0.14		1998
	S34-14	Treated	4-24	0.79	1.17	0.19		1998
	BG-2	Untreated	12-24	1.30	1.92	0.2	120	2001
	BG-2	Untreated	12-24	0.36	0.53		4	#2002
	BG-2	Untreated	12-24	0.99	1.46	0.35	131	2003
	BG-2-34	Untreated	12-24	1.38	2.04	0.68		2004
	BG-2-34	Untreated	12-24	1.65	2.44	0.69		2005
	BG-2-33F	Untreated	12-24	0.88	1.30	0.39	35	2004
	BG-2-33F	Untreated	12-24	0.62	0.92	0.20	103	2005
	BG-2-33F	Untreated	12-24	0.78	1.15	0.35	20	2006
	BG-2-34	Untreated	12-24	@2.66	@3.93	@0.87	@219	2006
	BG-2-33F	Untreated	12-24	0.87	1.29	0.31	57	2007
	BG-2-34	Untreated	12-24	1.87	2.67	0.78	@271	2007
	BG-2-33F	Untreated	12-24	0.80	1.18	0.31	90	2008
	BG-2-34	Untreated	12-24	1.48	2.19	0.48	@257	2008
	BG-2-33F	Untreated	12-24	1.08	1.6	0.29	70	2009
	BG-2-34	Untreated	12-24	1.46	2.15	0.39	168	2009
	BG-2-33F	Untreated	12-24	0.99	1.46	0.27	120	2010
	BG2-34	Untreated	12-24	1.77	2.61	0.56	284	2010
			Mean	1.04	1.54	0.29	100.17	
			SDV	0.38	0.55	0.20	75.64	
			CV	35.99	35.57	69.20	76	

@ = considered an outlier, did not use

* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025

= 2002 Se MDL = 0.8 All data reported as <MDL, did not use

CV = coefficient of variation

SDV = standard deviation

Table 3-1. Pre-Operation and Background Soil Sample Results for Section 34 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
2-3	S33-1	Untreated	24-48	1.32	1.95	0.23		1998
	S3-1	Untreated	14-38	0.71	1.05	0.09		1998
	S34-1	Untreated	24-36	0.43	0.64	0.13		1998
	S34-5	Untreated	3-40	0.84	1.24	0.14		1998
	S34-7	Untreated	28-40	0.43	0.64	0.41		1998
	S34-8	Untreated	30-60	0.69	1.02	0.34		1998
	S34-13	Untreated	18-30	0.68	1.00	0.14		1998
	S33-2	Untreated	24-48	0.40	0.59	0.09		1998
	S34-11	Untreated	15-60	0.58	0.86	0.03		*1998
	S34-14	Treated	30-90	0.20	0.30	0.03		*1998
	BG-3	Untreated	24-36	0.53	0.79	0.20	120	2001
	BG-3	Untreated	24-36	0.27	0.40		4	#2002
	BG-3	Untreated	24-36	1.12	1.66	0.36	141	2003
	BG-3-34	Untreated	24-36	0.93	1.38	0.40	@169	2004
	BG3-33F	Untreated	24-36	0.90	1.33	0.42	30	2004
	BG-3-34	Untreated	24-36	1.44	2.13	0.51	@354	2005
	BG-3-33F	Untreated	24-36	0.61	0.90	0.19	81	2005
	BG-3-33F	Untreated	24-36	0.71	1.05	0.34	14	2006
	BG-3-34	Untreated	24-36	1.55	2.29	0.54	@259	2006
	BG-3-33F	Untreated	24-36	0.84	1.24	0.35	43	2007
	BG-3-34	Untreated	24-36	1.11	1.64	0.53	@246	2007
	BG-3-33F	Untreated	24-36	0.66	0.97	0.25	@170	2008
	BG-3-34	Untreated	24-36	0.85	1.26	0.27	@210	2008
	BG-3-33F	Untreated	24-36	0.41	0.61	0.10	40	2009
	BG-3-34	Untreated	24-36	0.43	0.63	0.17	159	2009
	BG-3-33F	Untreated	24-36	0.58	0.86	0.17	110	2010
	BG-3-34	Untreated	24-36	1.14	1.69	0.42	265	2010
			Mean	0.75	1.12	0.26	91.55	
			SDV	0.35	0.52	0.16	77.99	
			CV	46.26	46.2	58.99	85	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
3-4	S34-11	Untreated	15-60	0.58	0.86	<0.05		1998
	S34-11	Untreated	36-60	0.39	0.58	0.068		1998
	S34-8	Untreated	30-60	0.69	1.02	0.34		1998
	S33-1	Untreated	24-48	1.32	1.95	0.23		1998
	S33-8	Untreated	20-48	0.35	0.52	<0.05		1998
	S33-9	Untreated	24-48	0.70	1.30	0.10		1998
	S33-10	Untreated	30-60	0.40	0.59	<0.05		1998
	S34-14	Treated	30-90	0.20	0.30	<0.05		1998
	S34-5	Untreated	40-53	0.30	0.44	0.08		1998
	S33-2	Untreated	24-48	0.40	0.59	0.09		1998
	S32-2	Treated	24-48	0.39	0.58	<0.05		1998
	BG-43-33F	Untreated	24-36	0.59	0.87	0.12	12	2009
	BG-4-34	Untreated	24-36	0.37	0.55	0.10	135	2009
	BG-4-33F	Untreated	36-48	0.64	0.94	0.16	40	2010
	BG4-34	Untreated	36-48	0.38	0.56	0.17	105	2010
			Mean	0.51	0.76	0.15	73	
			SDV	0.27	0.40	0.08	56.80	
			CV	52.25	52.12	57.54	77.81	

@ = considered an outlier, did not use
* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025
# = 2002 Se MDL = 0.8 All data reported as <MDL, did not use
CV = coefficient of variation
SDV = standard deviation

Table 3-1. Pre-Operation and Background Soil Sample Results for Section 34 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
4-5	S34-11	Untreated	15-60	0.58	0.86	<0.05		1998
	S34-1	Untreated	36-60	0.39	0.58	0.068		1998
	S34-8	Untreated	30-60	0.69	1.02	0.34		1998
	S33-10	Untreated	30-60	0.40	0.59	<0.05		1998
	S34-3	Treated	50-90	0.20	0.30	<0.05		1998
	S34-14	Treated	30-90	0.20	0.30	<0.05		1998
	S34-5	Treated	40-53	0.76	1.12	0.07		1998
	BG-5-33F	Untreated	24-36	0.59	0.87	0.12	30	2009
	BG-5-34	Untreated	24-36	0.22	0.33	0.04	55	2009
	BG-5-33F	Untreated	48-60	0.39	0.58	<0.05	30	2010
	BG-5-34	Untreated	48-60	0.35	0.52	0.11	156	2010
			Mean	0.43	0.64	0.12	67.75	
			SDV	0.20	0.29	0.11	60.00	
			CV	45.04	44.75	87.85	88.56	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
5-7	S34-5	Untreated	53-73	0.76	1.12	0.07		1998
	S34-11	Untreated	60-90	0.26	0.38	<0.05		1998
	BG 8-7-33F	Untreated	60-72	0.28	0.42	0.05	60	2009
	BG 8-7-34	Untreated	60-72	0.21	0.31	0.04	33	2009
	BG 5-7-33F	Untreated	60-72	0.35	0.52	<0.05	50	2010
	BG 8-7-34	Untreated	60-72	0.35	0.52	0.09	79	2010
			Mean	0.37	0.55	0.06	55.50	
			SDV	0.20	0.29	0.02	19.23	
			CV	53.80	53.81	35.43	34.64	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
7-9	S34-11	Untreated	60-90	0.26	0.38	<0.05		1998
	BG 7-9-33F	Untreated	72-96	0.24	0.35	<0.05	70	2009
	BG 7-9-34	Untreated	72-96	0.63	0.93	0.09	84	2009
	BG 7-9-33F	Untreated	72-96	0.22	0.33	<0.05	40	2010
	BG 7-9-34	Untreated	72-96	0.55	0.81	0.12	51	2010
			Mean	0.38	0.56	0.11	61.25	
			SDV	0.19	0.29	0.02	19.59	
			CV	51.01	51.2	20.20	31.98	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
9-11	BG 9-11-33F	Untreated	96-120	0.3	0.44	0.07	40	2009
	BG 9-11-34	Untreated	96-120	0.75	1.11	0.17	139	2009
	BG 9-11-33F	Untreated	96-120	0.18	0.27	<0.05	40	2010
	BG 9-11-34	Untreated	96-120	0.62	0.91	0.11	100	2010
			Mean	0.46	0.68	0.12	79.75	
			SDV	0.27	0.39	0.05	48.58	
			CV	57.59	57.59	43.14	60.92	

@ = considered an outlier, did not use
* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025
# = 2002 Se MDL = 0.8 All data reported as <MDL, did not use
CV = coefficient of variation
SDV = standard deviation

Table 3-1. Pre-Operation and Background Soil Sample Results for Section 34 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
11-13	BG 11-13-33F	Untreated	120-144	0.90	1.33	0.14	60	2009
	BG 11-13-34	Untreated	120-144	0.85	1.26	1.31	150	2009
	BG 11-13-33F	Untreated	120-144	0.44	0.65	0.07	<30	2010
	BG 11-13-34	Untreated	120-144	0.83	1.23	0.14	63	2010
			Mean	0.76	1.12	0.42	91.00	
			SDV	0.20	0.29	0.11	60.00	
			CV	45.04	44.75	87.85	88.56	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
13-15	BG13-15-34	Untreated	144-168	0.65	0.96	0.53	57	2009
15-17	BG 15-17-34	Untreated	168-192	0.66	0.97	0.27	62	2009

@ = considered an outlier, did not use

* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025

= 2002 Se MDL = 0.8 All data reported as <MDL, did not use

CV = coefficient of variation

SDV = standard deviation

Table 3-2. Pre-Operation and Background Soil Sample Results for Section 28

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
0-1	S28-2	Untreated	0-40	@1.06	@1.57	0.14		1998
	S28-3	Untreated	4-22	0.23	0.34	0.18		1998
	S28-9	Treated	0-40	0.33	0.49	0.06		1998
	NE27-1	Untreated	0-6	0.34	0.50	0.03		*1998
	NE28-2	Untreated	0-6	0.24	0.35	0.03		*1998
	NE28-4	Untreated	0-8	0.13	0.19	0.16		1998
	NE28-5	Untreated	0-12	0.50	0.74	0.1		1998
	NE28-7	Untreated	0-8	0.51	0.75	0.12		1998
	BG-1	Untreated	0-12	2.02	@2.99		14	#2002
	BG-1	Untreated	0-12	0.35	0.51	0.15	6	2003
	BG-1	Untreated	0-12	0.60	0.88	0.22	12	2004
	BG-1	Untreated	0-12	0.32	0.47	0.12	@283	2005
	BG-1	Untreated	0-12	0.42	0.62	0.1	19	2006
	BG-1	Untreated	0-12	0.53	0.78	0.23	32	2007
	BG-1	Untreated	0-12	0.40	0.59	0.15	@220	2008
	BG-1	Untreated	0-12	0.75	1.11	0.16	60	2009
	BG-1	Untreated	0-12	0.44	0.65	0.16	30	2010
			Mean	0.41	0.60	0.13	24.71	
			SDV	0.16	0.23	0.06	18.19	
			CV	38.87	38.9	45.51	74	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
1-2	S28-2	Untreated	0-40	@1.06	@1.57	0.14		1998
	S28-3	Untreated	4-22	0.23	0.34	0.18		1998
	S28-9	Treated	0-40	0.33	0.49	0.06		1998
	NE28-4	Untreated	8-28	0.23	0.34	0.03		*1998
	NE28-7	Untreated	8-24	0.23	0.34	0.05		1998
	BG-2	Untreated	12-24	@1.10	@1.62		13	#2002
	BG-2	Untreated	12-24	0.41	0.61	0.10	6	2003
	BG-2	Untreated	12-24	0.52	0.77	0.22	14	2004
	BG-2	Untreated	12-24	0.32	0.47	0.07		2005
	BG-2	Untreated	12-24	0.35	0.51	0.03	14	2006
	BG-2	Untreated	12-24	0.62	0.91	0.24	26	2007
	BG-2	Untreated	12-24	0.31	0.46	0.15	@240	2008
	BG-2	Untreated	12-24	0.39	0.57	0.10	50	2009
	BG-2	Untreated	12-24	0.27	0.40	0.13	40	2010
			Mean	0.35	0.52	0.11	23.29	
			SDV	0.12	0.18	0.07	16.21	
			CV	34.20	34.19	60.66	70	

@ = considered an outlier, did not use
* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025
# = 2002 Se MDL = 0.8 All data reported as <MDL, did not use
CV = coefficient of variation
SDV = standard deviation

Table 3-2. Pre-Operation and Background Soil Sample Results for Section 28 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
2-3	S28-2	Untreated	0-40	@1.06	@1.57	0.14		1998
	S28-9	Treated	0-40	0.33	0.49	0.06		1998
	NE27-1	Untreated	24-80	0.14	0.21	0.03		*1998
	NE28-4	Untreated	28-84	0.22	0.32	0.03		*1998
	NE28-5	Untreated	25-84	0.44	0.65	0.03		*1998
	NE28-7	Untreated	24-48	0.14	0.21	0.03		*1998
	BG-3	Untreated	24-36	@0.98	@1.45		13	#2002
	BG-3	Untreated	24-36	0.36	0.53	0.12	11	2003
	BG-3	Untreated	24-36	0.55	0.81	0.19	10	2004
	BG-3	Untreated	24-36	0.37	0.55	0.07	@290	2005
	BG-3	Untreated	24-36	0.39	0.58	0.06	16	2006
	BG-3	Untreated	24-36	0.54	0.80	0.25	30	2007
	BG-3	Untreated	24-36	0.36	0.53	0.15	@270	2008
	BG-3	Untreated	24-36	0.38	0.56	0.11	70	2009
	BG-3	Untreated	24-36	0.30	0.45	0.13	60	2010
			Mean	0.35	0.51	0.10	30.00	
			SDV	0.16	0.23	0.06	18.19	
			CV	38.87	38.9	45.51	74	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
3-4	BG-4	Untreated	36-48	0.35	0.52	0.07	60	2009
	BG-4	Untreated	36-48	0.26	0.39	0.09	70	2010
			Mean	0.31	0.46	0.08	65.00	
			SDV	0.06	0.09	0.01	7.07	
			CV	20.20	20.2	17.68	11	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
4-5	BG-5	Untreated	48-60	0.30	0.45	0.06	90	2009
	BG-5	Untreated	48-60	0.24	0.36	0.07	80	2010
			Mean	0.27	0.41	0.06	85.00	
			SDV	0.04	0.06	0.01	7.07	
			CV	15.71	15.71	12.06	8	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
5-7	BG-7	Untreated	60-72	0.42	0.62	0.08	100	2009
	BG-7	Untreated	60-72	0.29	0.43	0.08	90	2010
			Mean	0.36	0.53	0.08	95.00	
			SDV	0.09	0.13	0.00	7.07	
			CV	25.59	25.59	0.00	7	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
7-9	BG-7-9	Untreated	72-96	0.53	0.79	0.08	61	2009
	BG-7-9	Untreated	72-96	0.30	0.44	0.09	140	2010
			Mean	0.42	0.62	0.09	100.50	
			SDV	0.09	0.25	0.01	55.86	
			CV	25.59	40.24	8.32	56	

@ = considered an outlier, did not use
* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025
# = 2002 Se MDL = 0.8 All data reported as <MDL, did not use
CV = coefficient of variation
SDV = standard deviation

Table 3-2. Pre-Operation and Background Soil Sample Results for Section 28 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
9-11	BG-9-11	Untreated	96-120	0.35	0.52	0.09	60	2009
	BG-9-11	Untreated	96-120	0.32	0.48	0.09	40	2010
			Mean	0.34	0.50	0.09	50	
			SDV	0.02	0.03	0.00	14.14	
			CV	5.66	5.66	0.00	28	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
11-13	BF-11-13	Untreated	120-144	0.66	0.97	0.12	15	2009
	BF-11-13	Untreated	120-144	0.44	0.65	0.12	30	2010
			Mean	0.55	0.81	0.12	22.50	
			SDV	0.15	0.23	0.00	10.61	
			CV	27.94	27.94	0.00	47	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
13-15	BF-13-15	Untreated	144-168	0.41	0.60	0.08	70	2009
	BF-13-15	Untreated	144-168	0.46	0.68	0.13	50	2010
			Mean	0.43	0.64	0.11	60.00	
			SDV	0.04	0.06	0.04	14.14	
			CV	8.84	8.84	33.67	24	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
15-17	BG-15-17	Untreated	168-192	0.57	0.84	0.1	70	2009
	BG-15-17	Untreated	168-192	0.37	0.54	0.09	40	2010
			Mean	0.47	0.69	0.10	55.00	
			SDV	0.14	0.21	0.01	21.21	
			CV	30.74	30.74	7.44	39	

@ = considered an outlier, did not use

* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025

= 2002 Se MDL = 0.8 All data reported as <MDL, did not use

CV = coefficient of variation

SDV = standard deviation

Table 3-3. Pre-Operation and Background Soil Sample Results for Section 33

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
0-1	S33-4	Treated	0-6	0.37	0.55	0.03		*1998
	S33-4	Treated	6-48	0.36	0.53	0.03		*1998
	S33-7	Treated	0-24	0.30	0.44	0.03		*1998
	S33-8	Treated	0-20	0.58	0.86	0.07		1998
	S33-9	Untreated	0-24	0.56	0.83	0.15		1998
	S33-10	Untreated	0-12	0.70	1.03	0.05		1998
	33A	Treated	0-6	0.24	0.36	0.10	13	1999
	33B	Treated	0-6	0.56	0.82	0.20	7	1999
	33C	Treated	0-6	0.44	0.65	0.05	35	**1999
	33D	Untreated	0-6	0.49	0.73	0.20	22	1999
	33D1	Untreated	0-6	0.77	1.14	0.20	18	2000
	BG-1	Untreated	0-12	0.66	0.98	0.10	32	2001
	BG-1	Untreated	0-12	0.58	0.85		2	&#2002
	BG-1	Untreated	0-12	0.53	0.78	0.12	21	2003
	BG-1	Untreated	0-12	0.60	0.88	0.27	28	2004
	BG-1	Untreated	0-12	0.53	0.78	0.18	27	2005
	BG-1	Untreated	0-12	0.60	0.88	0.18	18	2006
	BG-1	Untreated	0-12	0.60	0.89	0.39	68	2007
	BG-1	Untreated	0-12	0.49	0.72	0.21	@170	2008
	BG-1	Untreated	0-12	0.69	1.02	0.19	33	2009
	BG-1	Untreated	0-12	0.68	1.00	0.17	60	2010
			Mean	0.54	0.80	0.15	27.43	
			SDV	0.14	0.20	0.09	18.27	
			CV	25.28	25.28	64.28	67	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
1-2	S33-4	Treated	6-48	0.36	0.53	0.03		*1998
	S33-7	Treated	0-24	0.30	0.44	0.03		*1998
	S33-8	Treated	0-20	0.58	0.86	0.07		1998
	S33-9	Untreated	0-24	0.56	0.83	0.15		1998
	S33-10	Untreated	12-30	0.38	0.56	0.03		*1998
	BG-2	Untreated	12-24	0.51	0.76	0.20	29	2001
	BG-2	Untreated	12-24	0.40	0.59		8	#2002
	BG-2	Untreated	12-24	0.35	0.52	0.12	25	2003
	BG-2	Untreated	12-24	0.53	0.79	0.24	32	2004
	BG-2	Untreated	12-24	0.47	0.69	0.15	71	2005
	BG-2	Untreated	12-24	0.60	0.88	0.16	21	2006
	BG-2	Untreated	12-24	0.60	0.89	0.44	73	2007
	BG-2	Untreated	12-24	0.41	0.61	0.23	@160	2008
	BG-2	Untreated	12-24	0.49	0.73	0.15	25	2009
	BG-2	Untreated	12-24	0.50	0.74	0.14	80	2010
			Mean	0.47	0.69	0.15	40.44	
			SDV	0.10	0.14	0.11	26.62	
			CV	20.71	20.71	72.04	66	

@ = considered an outlier, did not use
* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025
# = 2002 Se MDL = 0.8 All data reported as <MDL, did not use
CV = coefficient of variation
SDV = standard deviation

Table 3-3. Pre-Operation and Background Soil Sample Results for Section 33 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
2-3	S33-4	Treated	6-48	0.36	0.53	0.03		*1998
	S33-7	Treated	24-48	0.24	0.35	0.03		*1998
	S33-8	Treated	20-48	0.35	0.52	0.03		*1998
	S33-9	Untreated	24-48	0.70	1.03	0.10		1998
	S33-10	Untreated	12-30	0.38	0.56	0.03		*1998
	S33-10	Untreated	30-60	0.40	0.59	0.03		*1998
	BG-3	Untreated	24-36	0.56	0.83	0.30	41	2001
	BG-3	Untreated	24-36	0.45	0.66		8	#2002
	BG-3	Untreated	24-36	0.45	0.67	0.12	22	2003
	BG-3	Untreated	24-36	0.55	0.81	0.26	31	2004
	BG-3	Untreated	24-36	0.53	0.79	0.15	@222	2005
	BG-3	Untreated	24-36	0.74	1.09	0.15	16	2006
	BG-3	Untreated	24-36	0.58	0.86	0.27	63	2007
	BG-3	Untreated	24-36	0.49	0.72	0.20	@180	2008
	BG-3	Untreated	24-36	0.56	0.82	0.13	70	2009
	BG-3	Untreated	24-36	0.58	0.86	0.19	40	2010
			Mean	0.49	0.73	0.13	36.38	
			SDV	0.13	0.19	0.10	21.81	
			CV	26.64	26.61	72.64	60	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
3-4	S32-2	Untreated	24-48	0.26	0.39	<0.05		*1998
	S33-2	Untreated	24-48	0.27	0.40	0.09		*1998
	S33-4	Treated	6-48	0.36	0.53	0.03		*1998
	S33-7	Treated	24-48	0.24	0.35	0.03		*1998
	S33-8	Treated	20-48	0.35	0.52	0.03		*1998
	S33-9	Untreated	24-48	0.70	1.03	0.10		1998
	S33-10	Untreated	30-60	0.40	0.59	0.03		*1998
	BG-4	Untreated	36-48	0.68	1.01	0.15	60	2009
	BG-4	Untreated	36-48	0.70	1.03	0.18	50	2010
			Mean	0.44	0.65	0.08	55.00	
			SDV	0.20	0.29	0.06	7.07	
			CV	44.64	44.64	80.80	12.86	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
4-5	S33-10	Untreated	30-60	0.40	0.59	0.03		*1998
	BG-5	Untreated	48-60	0.61	0.90	0.12	60	2009
	BG-5	Untreated	48-60	0.64	0.94	0.17	60	2010
			Mean	0.55	0.81	0.11	60	
			SDV	0.19	0.29	0.02	19.59	
			CV	51.01	51.2	20.20	31.98	

@ = considered an outlier, did not use

* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025

= 2002 Se MDL = 0.8 All data reported as <MDL, did not use

CV = coefficient of variation

SDV = standard deviation

Table 3-3. Pre-Operation and Background Soil Sample Results for Section 33 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
5-7	BG-5-7	Untreated	60-72	0.35	0.52	0.08	70	2009
	BG-5-7	Untreated	60-72	0.46	0.68	0.11	50	2010
			Mean	0.41	0.60	0.10	60	
			SDV	0.08	0.11	0.02	14.14	
			CV	18.86	18.86	22.33	23.57	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
7-9	BG-7-9	Untreated	72-96	0.54	0.8	0.09	30	2009
	BG-7-9	Untreated	72-96	0.67	0.99	0.14	40	2010
			Mean	0.61	0.90	0.12	35.00	
			SDV	0.09	0.13	0.04	7.07	
			CV	15.01	15.01	30.74	20.20	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
9-11	BG-9-11	Untreated	96-120	0.49	0.72	0.05	32	2009
	BG-9-11	Untreated	96-120	0.67	0.99	0.11	<30	2010
			Mean	0.58	0.86	0.08	31.00	
			SDV	0.13	0.19	0.04	1.41	
			CV	22.33	22.33	53.03	4.56	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
11-13	BG-11-13	Untreated	120-144	0.51	0.76	<0.05	40	2009
	BG-11-13	Untreated	120-144	0.38	0.56	0.06	<30	2010
			Mean	0.45	0.66	0.06	35.00	
			SDV	0.10	0.14	0.01	7.07	
			CV	21.43	21.43	14.14	20.20	

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
13-15	BG-13-15	Untreated	144-168	0.46	0.68	0.10	70	2009
	Bg-13-15	Untreated	144-168	0.28	0.42	0.06	<30	2010
			Mean	0.37	0.55	0.08	50.00	
			SDV	0.12	0.18	0.03	28.28	
			CV	33.43	33.43	35.36	56.57	

@ = considered an outlier, did not use
* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025
# = 2002 Se MDL = 0.8 All data reported as <MDL, did not use
CV = coefficient of variation
SDV = standard deviation

Table 3-3. Pre-Operation and Background Soil Sample Results for Section 33 (continued)

Interval (ft.)	Location ID	Area	Depth (in)	Natural Uranium (pCi/g)	Natural Uranium mg/kg	Selenium (mg/kg)	Chloride (mg/kg)	Comment
15-17	BG-15-17	Untreated	168-192	0.67	0.99	0.14	70	2009
	BG-15-17	Untreated	168-192	0.3	0.45	0.09	<30	2010
			Mean	0.49	0.72	0.12	70	
			SDV	0.08	0.11	0.02	14.14	
			CV	18.86	18.86	22.33	23.57	

@ = considered an outlier, did not use

* = 1998 Se Reported as less than LLD of 0.05 mg/kg, used 0.025

= 2002 Se MDL = 0.8 All data reported as <MDL, did not use

CV = coefficient of variation

SDV = standard deviation

Appendix F

HHRA Supporting Information

Site-Specific

Composite Worker Soil Inputs - Secular Equilibrium

*** Inputted values different from Composite Worker defaults are highlighted.**

Variable	Composite Worker Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	6609630250
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	81.84858573
A_s (acres)	0.5	0.5
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250
ET_w (exposure time - composite worker) hr/day	8	8
IRA_w (inhalation rate - composite worker) m^3/day	60	60
IRS_w (soil intake rate - composite worker) mg/day	100	100
t_w (time - composite worker) yr	25	25
TR (target cancer risk) unitless	0.000001	0.000001
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-Specific

Composite Worker Air Inputs - Secular Equilibrium

*** Inputted values different from Composite Worker defaults are highlighted.**

Variable	Composite Worker Air Default Value	Form-input Value
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250
ET_w (exposure time - composite worker) hr/day	8	8
GSF_a (gamma shielding factor - air) unitless	1	1
IRA_w (inhalation rate - composite worker) m^3/day	60	60
t_w (time - composite worker) yr	25	25
TR (target cancer risk) unitless	0.000001	0.000001

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Composite Worker - Homestake Facility (HF) Default Scenario

Composite Worker Risk for Surface Soil Exposure Pathways - Secular Equilibrium

								TRIMMED TRAILING DIGITS		
Isotope	**HF EPC (pCi/g)**	**Ingestion Risk**	**Inhalation Risk**	**External Exposure Risk**	**Total HF Risk**	**BKG**	**Inherent Site Risk Before Trimming Trailing Digits**	**Risk**	**BKG**	**Inherent Site Risk After Trimming Trailing Digits**
**Secular Equilibrium Risk for Bi-212*	1.498	4E-10	3E-12	5E-05	5E-05	4E-05	1E-05	5E-05	4E-05	1E-05
**Secular Equilibrium Risk for Bi-214*	2.333	3E-06	1E-09	8E-05	8E-05	3E-05	5E-05	8E-05	3E-05	5E-05
**Secular Equilibrium Risk for Cs-137*	0.0672	1E-09	1E-13	7E-07	7E-07	8E-07	0E+00	7E-07	8E-07	0E+00
**Secular Equilibrium Risk for K-40*	18.1	2E-07	8E-11	7E-05	7E-05	7E-05	0E+00	7E-05	7E-05	0E+00
**Secular Equilibrium Risk for Pa-234m*	4.603	7E-06	1E-08	2E-04	2E-04	5E-05	1E-04	2E-04	5E-05	2E-04
**Secular Equilibrium Risk for Pb-212*	1.348	1E-08	2E-11	5E-05	5E-05	4E-05	9E-06	5E-05	4E-05	1E-05
**Secular Equilibrium Risk for Pb-214*	2.468	3E-06	1E-09	1E-04	1E-04	4E-05	6E-05	1E-04	4E-05	6E-05
**Secular Equilibrium Risk for Ra-223*	0.414	3E-08	2E-10	2E-06	2E-06	2E-06	6E-07	2E-06	2E-06	0E+00
**Secular Equilibrium Risk for Ra-226*	4	6E-06	4E-09	2E-04	2E-04	7E-05	9E-05	2E-04	7E-05	1E-04
**Secular Equilibrium Risk for Ra-228*	1.422	7E-07	5E-09	8E-05	8E-05	6E-05	2E-05	8E-05	6E-05	2E-05
**Secular Equilibrium Risk for Th-227*	0.174	2E-08	2E-10	1E-06	1E-06	9E-07	3E-07	1E-06	9E-07	1E-07
**Secular Equilibrium Risk for Th-228*	1.604	2E-07	4E-09	6E-05	6E-05	5E-05	7E-06	6E-05	5E-05	1E-05
**Secular Equilibrium Risk for Th-230*	2.593	4E-06	5E-09	1E-04	1E-04	6E-05	5E-05	1E-04	6E-05	4E-05
**Secular Equilibrium Risk for Th-232*	1.372	8E-07	6E-09	7E-05	8E-05	6E-05	1E-05	8E-05	6E-05	2E-05
**Secular Equilibrium Risk for Th-234*	3.26	5E-06	7E-09	1E-04	1E-04	3E-05	1E-04	1E-04	3E-05	7E-05
**Secular Equilibrium Risk for Tl-208*	0.434	0E+00	0E+00	4E-05	4E-05	3E-05	7E-06	4E-05	3E-05	1E-05
**Secular Equilibrium Risk for U-234*	4.287	7E-06	1E-08	2E-04	2E-04	5E-05	1E-04	2E-04	5E-05	2E-04
**Secular Equilibrium Risk for U-235*	0.307	1E-07	2E-09	3E-06	3E-06	1E-06	2E-06	3E-06	1E-06	2E-06
**Secular Equilibrium Risk for U-238*	4.323	7E-06	1E-08	2E-04	2E-04	5E-05	1E-04	2E-04	5E-05	2E-04
****Total Risk***		***4E-05***	***7E-08***	***2E-03***	***2E-03***	***7E-04***	***8E-04***	***2E-03***	***7E-04***	***9E-04***

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Bkg Based on UCL95s from Table 5-20

Isotope	BKG EPC (pCi/g)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for Bi-212	1.195	3E-10	3E-12	4E-05	4E-05
*Secular Equilibrium Risk for Bi-214	0.948	1E-06	6E-10	3E-05	3E-05
*Secular Equilibrium Risk for Cs-137	0.0731	1E-09	2E-13	8E-07	8E-07
*Secular Equilibrium Risk for K-40	18.35	2E-07	8E-11	7E-05	7E-05
*Secular Equilibrium Risk for Pa-234m	1.15a	2E-06	3E-09	5E-05	5E-05
*Secular Equilibrium Risk for Pb-212	1.104	9E-09	2E-11	4E-05	4E-05
*Secular Equilibrium Risk for Pb-214	1.017	1E-06	6E-10	4E-05	4E-05
*Secular Equilibrium Risk for Ra-223	0.296	2E-08	2E-10	2E-06	2E-06
*Secular Equilibrium Risk for Ra-226	1.81	3E-06	2E-09	7E-05	7E-05
*Secular Equilibrium Risk for Ra-228	1.14	6E-07	4E-09	6E-05	6E-05
*Secular Equilibrium Risk for Th-227	0.13	1E-08	2E-10	9E-07	9E-07
*Secular Equilibrium Risk for Th-228	1.412	1E-07	4E-09	5E-05	5E-05
*Secular Equilibrium Risk for Th-230	1.393	2E-06	2E-09	5E-05	6E-05
*Secular Equilibrium Risk for Th-232	1.135	7E-07	5E-09	6E-05	6E-05
*Secular Equilibrium Risk for Th-234	0.703	1E-06	2E-09	3E-05	3E-05
*Secular Equilibrium Risk for Tl-208	0.357	0E+00	0E+00	3E-05	3E-05
*Secular Equilibrium Risk for U-234	1.141	2E-06	3E-09	4E-05	5E-05
*Secular Equilibrium Risk for U-235	0.112	4E-08	7E-10	1E-06	1E-06
*Secular Equilibrium Risk for U-238	1.147	2E-06	3E-09	5E-05	5E-05

a - Value based on a mean (n=4)
Risks based on EPC of surface soil

December 3 2019, Feb 13,2020

Site-Specific Land Treatment Areas (LTAs)
Composite Worker Risk for Surface Soil - Secular Equilibrium

Isotope	LTA EPC (pCi/g)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk	BKG	Inherent Site Risk Before Trimming Trailing Digits	TRIMMED TRAILING DIGITS: Total Risk	TRIMMED TRAILING DIGITS: BKG	TRIMMED TRAILING DIGITS: Inherent Site Risk After Trimming Trailing Digits
*Secular Equilibrium Risk for Bi-212	1E+00	3E-10	2E-12	3E-05	3E-05	4E-05	0E+00	3E-05	4E-05	0E+00
*Secular Equilibrium Risk for Bi-214	9E-01	1E-06	5E-10	3E-05	3E-05	3E-05	0E+00	3E-05	3E-05	0E+00
*Secular Equilibrium Risk for Cs-137	7E-02	1E-09	2E-13	8E-07	8E-07	8E-07	0E+00	8E-07	8E-07	0E+00
*Secular Equilibrium Risk for K-40	2E+01	2E-07	7E-11	6E-05	6E-05	7E-05	0E+00	6E-05	7E-05	0E+00
234m	1E+00	3E-06	4E-09	7E-05	8E-05	5E-05	3E-05	8E-05	5E-05	1E-05
*Secular Equilibrium Risk for Pb-212	9E-01	8E-09	1E-11	3E-05	3E-05	4E-05	0E+00	3E-05	4E-05	0E+00
*Secular Equilibrium Risk for Pb-214	9E-01	1E-06	5E-10	4E-05	4E-05	4E-05	0E+00	4E-05	4E-05	0E+00
*Secular Equilibrium Risk for Ra-223	3E-01	2E-08	1E-10	1E-06	1E-06	2E-06	0E+00	1E-06	2E-06	0E+00
*Secular Equilibrium Risk for Ra-226	1E+00	2E-06	2E-09	6E-05	6E-05	7E-05	0E+00	5E-05	7E-05	0E+00
*Secular Equilibrium Risk for Ra-228	1E+00	5E-07	3E-09	5E-05	5E-05	6E-05	0E+00	5E-05	6E-05	0E+00
*Secular Equilibrium Risk for Rn-222	-	-	-	-	-	-	-	-	-	-
*Secular Equilibrium Risk for Th-228	2E+00	2E-07	5E-09	6E-05	6E-05	5E-05	1E-05	6E-05	5E-05	1E-05
*Secular Equilibrium Risk for Th-230	1E+00	2E-06	2E-09	5E-05	5E-05	6E-05	0E+00	4E-05	6E-05	0E+00
*Secular Equilibrium Risk for Th-232	2E+00	1E-06	8E-09	1E-04	1E-04	6E-05	3E-05	1E-04	6E-05	3E-05
*Secular Equilibrium Risk for Th-234	9E-01	1E-06	2E-09	4E-05	4E-05	3E-05	8E-06	4E-05	3E-05	8E-06
*Secular Equilibrium Risk for Tl-208	3E-01	0E+00	0E+00	3E-05	3E-05	3E-05	0E+00	3E-05	3E-05	0E+00
*Secular Equilibrium Risk for U-234	2E+00	3E-06	5E-09	9E-05	9E-05	5E-05	4E-05	9E-05	5E-05	4E-05
*Secular Equilibrium Risk for U-235	1E-01	5E-08	8E-10	1E-06	1E-06	1E-06	2E-07	1E-06	1E-06	2E-07
*Secular Equilibrium Risk for U-238	2E+00	3E-06	6E-09	9E-05	9E-05	5E-05	4E-05	9E-05	5E-05	4E-05
Total		**2E-05**	**4E-08**	**8E-04**	**8E-04**	**7E-04**	**2E-04**	**8E-04**	**7E-04**	**1E-04**

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Bkg Based on UCL95s from Table 5-20

Isotope	BKG EPC (pCi/g)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for Bi-212	1.195	3E-10	3E-12	4E-05	4E-05
*Secular Equilibrium Risk for Bi-214	0.948	1E-06	6E-10	3E-05	3E-05
*Secular Equilibrium Risk for Cs-137	0.0731	1E-09	2E-13	8E-07	8E-07
*Secular Equilibrium Risk for K-40	18.35	2E-07	8E-11	7E-05	7E-05
234m	1.15a	2E-06	3E-09	5E-05	5E-05
*Secular Equilibrium Risk for Pb-212	1.104	9E-09	2E-11	4E-05	4E-05
*Secular Equilibrium Risk for Pb-214	1.017	1E-06	6E-10	4E-05	4E-05
*Secular Equilibrium Risk for Ra-223	0.296	2E-08	2E-10	2E-06	2E-06
*Secular Equilibrium Risk for Ra-226	1.81	3E-06	2E-09	7E-05	7E-05
*Secular Equilibrium Risk for Ra-228	1.14	6E-07	4E-09	6E-05	6E-05
*Secular Equilibrium Risk for Th-227	0.13	1E-08	2E-10	9E-07	9E-07
*Secular Equilibrium Risk for Th-228	1.412	1E-07	4E-09	5E-05	5E-05
*Secular Equilibrium Risk for Th-230	1.393	2E-06	2E-09	5E-05	6E-05
*Secular Equilibrium Risk for Th-232	1.135	7E-07	5E-09	6E-05	6E-05
*Secular Equilibrium Risk for Th-234	0.703	1E-06	2E-09	3E-05	3E-05
*Secular Equilibrium Risk for Tl-208	0.357	0E+00	0E+00	3E-05	3E-05
*Secular Equilibrium Risk for U-234	1.141	2E-06	3E-09	4E-05	5E-05
*Secular Equilibrium Risk for U-235	0.112	4E-08	7E-10	1E-06	1E-06
*Secular Equilibrium Risk for U-238	1.147	2E-06	3E-09	5E-05	5E-05

a - Value based on a mean (n=4)
Risks based on EPC of surface soil

December 3 2019, Feb 13,2020

Site-specific Composite Worker Risk for Soil - Background

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	K_d (cm^3/g)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Dermal HQ	Inhalation HQ	Non-carcinogenic HI
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I	0.000015	C	1	0.03	0.6	29	CRC89	6.61E+09	5.01	1E-06	3E-07	3E-10	2E-06	9E-03	2E-03	1E-05	1E-02
Molybdenum	-		-		0.005	I	-		1	-	1	20	YAWS	6.61E+09	0.447	-	-	-	-	8E-05	-	-	8E-05
Selenium	-		-		0.005	I	0.02	C	1	-	1	5	CRC89	6.61E+09	0.799	-	-	-	-	1E-04	-	1E-09	1E-04
Uranium	-		-		0.0002	A	0.00004	A	1	-	1	450	YAWS	6.61E+09	1.69	-	-	-	-	7E-03	-	1E-06	7E-03
Total Risk/HI	-		-		-		-		-	-	-	-		-	-	*1E-06*	*3E-07*	*3E-10*	*2E-06*	*2E-02*	*2E-03*	*1E-05*	*2E-02*

Risks based on EPC of surface soil

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Site-specific Homestake Facility (HF)
Composite Worker Risk for Surface Soil

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	K_d (cm^3/g)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Inhalation Risk	Dermal Risk	Carcinogenic Risk	Ingestion HQ	Inhalation HQ	Dermal HQ	Non-carcinogenic HI	Trimmed Digits HQs: HF	Trimmed Digits HQs: BKG	Trimmed Digits HQs: Inherent Site Risk/HQ
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I	0.000015	C	1	0.03	0.6	29	CRC89	6.61E+09	6.33	2E-06	3E-10	4E-07	2E-06	1E-02	1E-05	2E-03	1E-02	1E-02	1E-02	0E+00
Molybdenum	-		-		0.005	I	-		1	-	1	20	YAWS	6.61E+09	36.5	-	-	-	-	6E-03	-	-	6E-03	6E-03	8E-05	6E-03
Selenium	-		-		0.005	I	0.02	C	1	-	1	5	CRC89	6.61E+09	3.8	-	-	-	-	7E-04	7E-09	-	7E-04	7E-04	1E-04	6E-04
Uranium (Soluble Salts)	-		-		0.0002	A	0.00004	A	1	-	1	450		6.61E+09	14.3	-	-	-	-	6E-02	1E-05	-	6E-02	6E-02	7E-03	5E-02
Total Risk/HI	-		-		-		-		-	-	-	-		-	-	*2E-06*	*3E-10*	*4E-07*	*2E-06*	*8E-02*	*3E-05*	*2E-03*	*8E-02*	8E-02	2E-02	6E-02

Risks based on EPC of surface soil

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Site-specific Land Treatment Area (LTAs)
Composite Worker Risk for Surface Soil

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	K_d (cm^3/g)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Inhalation HQ	Dermal HQ	Non-carcinogenic HI	Trimmed Digits HQs: LTAs	Trimmed Digits HQs: BKG	Trimmed Digits HQs: Inherent Site Risk/HQ
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I	0.000015	C	1	0.030	0.6	29	CRC89	6.61E+09	4.69	1E-06	3E-07	2E-10	2E-06	8E-03	1E-05	2E-03	1E-02	1E-02	1E-02	0E+00
Molybdenum	-		-		0.005	I	-		1	-	1	20	YAWS	6.61E+09	0.628	-	-	-	-	1E-04	-	-	1E-04	1E-04	8E-05	2E-05
Selenium	-		-		0.005	I	0.02	C	1	-	1	5	CRC89	6.61E+09	1.12	-	-	-	-	2E-04	2E-09	-	2E-04	2E-04	1E-04	1E-04
Uranium (Soluble Salts)	-		-		0.0002	A	0.00004	A	1	-	1	450		6.61E+09	3.99	-	-	-	-	2E-02	3E-06	-	2E-02	2E-02	7E-03	1E-02
**Total Risk/HI*	-		-		-		-		-	-	-	-		-	-	*1E-06*	*3E-07*	*2E-10*	*2E-06*	*3E-02*	*1E-05*	*2E-03*	*3E-02*	*3E-02*	2E-02	1E-02

Risks based on EPC of surface soil

Output generated 02SEP2019:12:35:37

Site-Specific

Construction Worker Equation Inputs for Soil - Other Construction Activities

* Inputted values different from Construction Worker defaults are highlighted.

Variable	Construction Worker Soil - Other Default Value	Form-input Value
$A_{c\text{-}doz}$ (areal extent of dozing) acres	.	10
A_{excav} (area of excavation site) m^2	.	10
$A_{c\text{-}grade}$ (areal extent of grading) acres	.	10
A (PEF Dispersion Constant)	2.4538	2.4538
A_{surf} (areal extent of site) m^2	2023.43	121405.8
A_{till} (areal extent of tilling) acres	.	10
$B_{l\text{-}doz}$ (dozing blade length) m	.	2
$B_{l\text{-}grade}$ (grading blade length) m	.	2
B (PEF Dispersion Constant)	17.566	17.566
C (PEF Dispersion Constant)	189.0426	189.0426
d_{excav} (average depth of excavation site) m	.	1
F_D Unitless Dispersion Correction Factor	0.185837208	0.185837208
F(x) (function dependant on U_m/U_t derived using Cowherd et al. (1985))	0.194	0.194
$M_{m\text{-}doz}$ (Gravimetric soil moisture content) %	7.9	7.9
$M_{m\text{-}excav}$ (Gravimetric soil moisture content) %	12	12
M_{wind} (dust emitted by wind erosion) g	51288.84717	396176.1096
$N_{A\text{-}doz}$ (number of times site was dozed)	.	1
$N_{A\text{-}dump}$ (number of times soil is dumped)	2	2
$N_{A\text{-}grade}$ (number of times site was graded)	.	1
$N_{A\text{-}till}$ (number of times soil is tilled)	2	2
Q/C_{sa} (inverse of the ratio of the geometric mean air concentration to the emission flux at the center of a square source) g/m^2-s per kg/m^3	14.31407	7.092192704
ρ_{soil} (density) g/cm^3 - chemical-specific	1.68	1.68
s_{doz} (soil silt content) %	6.9	6.9
AF_{cw} (skin adherence factor - construction worker) mg/cm^2	0.3	0.3
AT_{cw} (averaging time - construction worker) days	365	365
BW_{cw} (body weight - construction worker) kg	80	80
ED_{cw} (exposure duration - construction worker) yr	1	1
EF_{cw} (exposure frequency - construction worker) day/yr	250	250
ET_{cw} (exposure time - construction worker) hr/day	8	8
THQ (target hazard quotient) unitless	0.1	1
IRS_{cw} (soil ingestion rate - construction worker) mg/day	330	330
LT (lifetime) yr	70	70
SA_{cw} (surface area - construction worker) cm^2/day	3527	3527
TR (target cancer risk) unitless	0.000001	0.000001
S_{doz} (dozing speed) kph	11.4	11.4
S_{grade} (grading speed) kph	11.4	11.4
s_{till} (soil silt content) %	18	18
t_c (overall duration of construction) hours	8400	8400
T_c (overall duration of construction) s	30240000	30240000
T (time over which traffic occurs) s	7200000	7200000
T_t (overall duration of traffic) s	7200000	7200000
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value) m/s	11.32	11.32
V (fraction of vegetative cover)	0	0.25

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Site-Specific Background HMC-16 Outdoor Air

Composite Worker Individual Risk Contributions for Air - Secular Equilibrium

Isotope	Inhalation Slope Factor (risk/pCi)	Submersion External Exposure Slope Factor (risk/yr per pCi/m^3)	Concentration (pCi/m^3)	Inhalation CDI (no decay) (pCi)	External Exposure CDI (no decay) (pCi)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)
**Secular Equilibrium Risk for Rn-222*	-	-	-	-	-			
At-218	0.00E+00	3.08E-14	551	6.9E+07	3.1E+03	0E+00	2E-14	2E-14
Bi-214	6.18E-11	6.69E-09	551	6.9E+07	3.1E+03	4E-03	2E-05	4E-03
Pb-214	7.77E-11	1.02E-09	551	6.9E+07	3.1E+03	5E-03	3E-06	5E-03
Po-214	0.00E+00	3.57E-13	551	6.9E+07	3.1E+03	0E+00	1E-09	1E-09
Po-218	1.39E-11	3.95E-17	551	6.9E+07	3.1E+03	1E-03	1E-13	1E-03
Rn-218	0.00E+00	3.19E-12	551	6.9E+07	3.1E+03	0E+00	2E-15	2E-15
Rn-222	2.28E-12	1.62E-12	551	6.9E+07	3.1E+03	2E-04	5E-09	2E-04
Total Risk						1E-02	2E-05	1E-02

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Site-Specific Homestake Facility (HF) and Land Treatment Area (LTAs) Combined Indoor and Outdoor Air

Composite Worker Individual Risk Contributions for Air - Secular Equilibrium

Isotope	Inhalation Slope Factor (risk/pCi)	Submersion External Exposure Slope Factor (risk/yr per	Concentration (pCi/m^3)	Inhalation CDI (no decay) (pCi)	External Exposure CDI (no decay) (pCi)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)
**Secular Equilibrium Risk for Rn-222*	-	-	-	-	-	-	-	-
At-218	0.00E+00	3.1E-14	1074	1.3E+08	6.1E+03	0E+00	4E-14	4E-14
Bi-214	6.18E-11	6.7E-09	1074	1.3E+08	6.1E+03	8E-03	4E-05	8E-03
Pb-214	7.77E-11	1.0E-09	1074	1.3E+08	6.1E+03	1E-02	6E-06	1E-02
Po-214	0.00E+00	3.6E-13	1074	1.3E+08	6.1E+03	0E+00	2E-09	2E-09
Po-218	1.39E-11	4.0E-17	1074	1.3E+08	6.1E+03	2E-03	2E-13	2E-03
Rn-218	0.00E+00	3.2E-12	1074	1.3E+08	6.1E+03	0E+00	4E-15	4E-15
Rn-222	2.28E-12	1.6E-12	1074	1.3E+08	6.1E+03	3E-04	1E-08	3E-04
Total Risk						2E-02	5E-05	2E-02

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Site-Specific Homestake Facility (HF)
Construction Worker Risk for Soil - Other Construction Activities - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk	BKG	Inherent Site Risk Before Trimming Trailing	TRIMMED TRAILING DIGITS Risk	BKG	Inherent Site Risk After Trimming Trailing
*Secular Equilibrium Risk for Bi-212	5E-11	1E-11	2E-06	2E-06	2E-06	4E-07	2E-06	2E-06	4E-07
*Secular Equilibrium Risk for Bi-214	4E-07	5E-09	3E-06	4E-06	1E-06	2E-06	4E-06	1E-06	2E-06
*Secular Equilibrium Risk for Cs-137	2E-10	5E-13	3E-08	3E-08	3E-08	0E+00	3E-08	3E-08	0E+00
*Secular Equilibrium Risk for K-40	2E-08	3E-10	3E-06	3E-06	3E-06	0E+00	3E-06	3E-06	0E+00
*Secular Equilibrium Risk for Pa-234m	9E-07	4E-08	7E-06	8E-06	2E-06	6E-06	8E-06	2E-06	6E-06
*Secular Equilibrium Risk for Pb-212	2E-09	7E-11	2E-06	2E-06	2E-06	4E-07	2E-06	2E-06	4E-07
*Secular Equilibrium Risk for Pb-214	4E-07	5E-09	4E-06	4E-06	2E-06	3E-06	4E-06	2E-06	3E-06
*Secular Equilibrium Risk for Ra-223	4E-09	8E-10	9E-08	9E-08	7E-08	3E-08	9E-08	7E-08	3E-08
*Secular Equilibrium Risk for Ra-226	8E-07	2E-08	7E-06	8E-06	3E-06	4E-06	8E-06	3E-06	4E-06
*Secular Equilibrium Risk for Ra-228	1E-07	2E-08	3E-06	3E-06	3E-06	6E-07	3E-06	3E-06	6E-07
*Secular Equilibrium Risk for Rn-222	-	-	-	-	-	-	-	-	-
*Secular Equilibrium Risk for Th-227	2E-09	8E-10	5E-08	5E-08	4E-08	1E-08	5E-08	4E-08	1E-08
*Secular Equilibrium Risk for Th-228	2E-08	2E-08	2E-06	2E-06	2E-06	3E-07	2E-06	2E-06	3E-07
*Secular Equilibrium Risk for Th-230	5E-07	2E-08	4E-06	5E-06	2E-06	2E-06	5E-06	2E-06	2E-06
*Secular Equilibrium Risk for Th-232	1E-07	2E-08	3E-06	3E-06	3E-06	5E-07	3E-06	3E-06	5E-07
*Secular Equilibrium Risk for Th-234	7E-07	3E-08	5E-06	6E-06	1E-06	5E-06	6E-06	1E-06	5E-06
*Secular Equilibrium Risk for Tl-208	0E+00	0E+00	2E-06	2E-06	1E-06	3E-07	2E-06	1E-06	3E-07
*Secular Equilibrium Risk for U-234	9E-07	4E-08	7E-06	8E-06	2E-06	6E-06	8E-06	2E-06	6E-06
*Secular Equilibrium Risk for U-235	1E-08	7E-09	1E-07	1E-07	5E-08	9E-08	1E-07	5E-08	9E-08
*Secular Equilibrium Risk for U-238	9E-07	4E-08	7E-06	8E-06	2E-06	6E-06	8E-06	2E-06	6E-06
Total Risk	***6E-06***	***3E-07***	***6E-05***	***7E-05***	***3E-05***	***4E-05***	***7E-05***	***3E-05***	***4E-05***

Construction Worker Background Risk based on UCL95 from Table 5-20					
Isotope	**BKG EPC (pCi/g)**	**Ingestion Risk**	**Inhalation Risk**	**External Exposure Risk**	**Total Risk**
*Secular Equilibrium Risk for Bi-212	1.195	4E-11	9E-12	2E-06	2E-06
*Secular Equilibrium Risk for Bi-214	0.948	2E-07	2E-09	1E-06	1E-06
*Secular Equilibrium Risk for Cs-137	0.0731	2E-10	6E-13	3E-08	3E-08
*Secular Equilibrium Risk for K-40	18.35	2E-08	3E-10	3E-06	3E-06
*Secular Equilibrium Risk for Pa-234m	1.15a	2E-07	1E-08	2E-06	2E-06
*Secular Equilibrium Risk for Pb-212	1.104	1E-09	6E-11	2E-06	2E-06
*Secular Equilibrium Risk for Pb-214	1.017	2E-07	2E-09	2E-06	2E-06
*Secular Equilibrium Risk for Ra-223	0.296	3E-09	6E-10	6E-08	7E-08
*Secular Equilibrium Risk for Ra-226	1.81	3E-07	7E-09	3E-06	3E-06
*Secular Equilibrium Risk for Ra-228	1.14	8E-08	1E-08	2E-06	3E-06
*Secular Equilibrium Risk for Th-227	0.13	2E-09	6E-10	4E-08	4E-08
*Secular Equilibrium Risk for Th-228	1.412	2E-08	1E-08	2E-06	2E-06
*Secular Equilibrium Risk for Th-230	1.393	3E-07	9E-09	2E-06	2E-06
*Secular Equilibrium Risk for Th-232	1.135	9E-08	2E-08	2E-06	3E-06
*Secular Equilibrium Risk for Th-234	0.703	1E-07	6E-09	1E-06	1E-06
*Secular Equilibrium Risk for Tl-208	0.357	0E+00	0E+00	1E-06	1E-06
*Secular Equilibrium Risk for U-234	1.141	2E-07	9E-09	2E-06	2E-06
*Secular Equilibrium Risk for U-235	0.112	5E-09	2E-09	4E-08	5E-08
*Secular Equilibrium Risk for U-238	1.147	2E-07	1E-08	2E-06	2E-06

a - Value based on a mean (n=4)
Risks based on EPC of combined surface and subsurface soil

December 3 2019, Feb 13,2020

Site-Specific LTAS

Construction Worker Risk for Soil - Other Construction Activities - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk	BKG	Inherent Site Risk Before Trimming Trailing Digits	TRIMMED TRAILING DIGITS Risk	TRIMMED TRAILING DIGITS BKG	TRIMMED TRAILING DIGITS Inherent Site Risk After Trimming Trailing Digits
*Secular Equilibrium Risk for Bi-212	4E-11	8E-12	1E-06	1E-06	2E-06	0E+00	1E-06	2E-06	0E+00
*Secular Equilibrium Risk for Bi-214	1E-07	2E-09	1E-06	1E-06	1E-06	0E+00	1E-06	1E-06	0E+00
*Secular Equilibrium Risk for Cs-137	2E-10	5E-13	3E-08	3E-08	3E-08	0E+00	3E-08	3E-08	0E+00
*Secular Equilibrium Risk for K-40	2E-08	2E-10	2E-06	2E-06	3E-06	0E+00	2E-06	3E-06	0E+00
*Secular Equilibrium Risk for Pa-234m	4E-07	2E-08	3E-06	3E-06	2E-06	1E-06	3E-06	2E-06	6E-07
*Secular Equilibrium Risk for Pb-212	1E-09	5E-11	1E-06	1E-06	2E-06	0E+00	1E-06	2E-06	0E+00
*Secular Equilibrium Risk for Pb-214	2E-07	2E-09	1E-06	2E-06	2E-06	0E+00	2E-06	2E-06	0E+00
*Secular Equilibrium Risk for Ra-223	2E-09	5E-10	5E-08	5E-08	7E-08	0E+00	5E-08	7E-08	0E+00
*Secular Equilibrium Risk for Ra-226	3E-07	5E-09	2E-06	2E-06	3E-06	0E+00	2E-06	3E-06	0E+00
*Secular Equilibrium Risk for Ra-228	7E-08	1E-08	2E-06	2E-06	3E-06	0E+00	2E-06	3E-06	0E+00
*Secular Equilibrium Risk for Rn-222	-	-	-	-	-	-	-	-	-
*Secular Equilibrium Risk for Th-228	2E-08	2E-08	3E-06	3E-06	4E-08	3E-06	3E-06	2E-06	5E-07
*Secular Equilibrium Risk for Th-230	2E-07	7E-09	2E-06	2E-06	2E-06	0E+00	2E-06	2E-06	0E+00
*Secular Equilibrium Risk for Th-232	1E-07	3E-08	4E-06	4E-06	2E-06	1E-06	4E-06	3E-06	1E-06
*Secular Equilibrium Risk for Th-234	2E-07	7E-09	1E-06	2E-06	3E-06	0E+00	2E-06	1E-06	3E-07
*Secular Equilibrium Risk for Tl-208	0E+00	0E+00	1E-06	1E-06	1E-06	0E+00	1E-06	1E-06	0E+00
*Secular Equilibrium Risk for U-234	5E-07	2E-08	3E-06	4E-06	1E-06	3E-06	4E-06	2E-06	2E-06
*Secular Equilibrium Risk for U-235	6E-09	3E-09	5E-08	6E-08	2E-06	0E+00	6E-08	5E-08	9E-09
*Secular Equilibrium Risk for U-238	5E-07	2E-08	4E-06	4E-06	5E-08	4E-06	4E-06	2E-06	2E-06
***Total Risk**	***2E-06***	***1E-07***	***3E-05***	***4E-05***	***3E-05***	***1E-05***	**3E-05**	**3E-05**	**6E-06**

Construction Worker Background Risk based on UCL95 from Table 5-20					
Isotope	**BKG EPC (pCi/g)**	**Ingestion Risk**	**Inhalation Risk**	**External Exposure Risk**	**Total Risk**
*Secular Equilibrium Risk for Bi-212	1.195	4E-11	9E-12	2E-06	2E-06
*Secular Equilibrium Risk for Bi-214	0.948	2E-07	2E-09	1E-06	1E-06
*Secular Equilibrium Risk for Cs-137	0.0731	2E-10	6E-13	3E-08	3E-08
*Secular Equilibrium Risk for K-40	18.35	2E-08	3E-10	3E-06	3E-06
*Secular Equilibrium Risk for Pa-234m	1.15a	2E-07	1E-08	2E-06	2E-06
*Secular Equilibrium Risk for Pb-212	1.104	1E-09	6E-11	2E-06	2E-06
*Secular Equilibrium Risk for Pb-214	1.017	2E-07	2E-09	2E-06	2E-06
*Secular Equilibrium Risk for Ra-223	0.296	3E-09	6E-10	6E-08	7E-08
*Secular Equilibrium Risk for Ra-226	1.81	3E-07	7E-09	3E-06	3E-06
*Secular Equilibrium Risk for Ra-228	1.14	8E-08	1E-08	2E-06	3E-06
*Secular Equilibrium Risk for Th-227	0.13	2E-09	6E-10	4E-08	4E-08
*Secular Equilibrium Risk for Th-228	1.412	2E-08	1E-08	2E-06	2E-06
*Secular Equilibrium Risk for Th-230	1.393	3E-07	9E-09	2E-06	2E-06
*Secular Equilibrium Risk for Th-232	1.135	9E-08	2E-08	2E-06	3E-06
*Secular Equilibrium Risk for Th-234	0.703	1E-07	6E-09	1E-06	1E-06
*Secular Equilibrium Risk for Tl-208	0.357	0E+00	0E+00	1E-06	1E-06
*Secular Equilibrium Risk for U-234	1.141	2E-07	9E-09	2E-06	2E-06
*Secular Equilibrium Risk for U-235	0.112	5E-09	2E-09	4E-08	5E-08
*Secular Equilibrium Risk for U-238	1.147	2E-07	1E-08	2E-06	2E-06

a - Value based on a mean (n=4)
Risks based on EPC of combined surface and subsurface soil

December 3 2019, Feb 13,2020

Site-specific Background
Construction Worker Risk for Soil - Other Construction Activities

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	K_d (cm^3/g)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Dermal HQ	Inhalation HQ	Noncarcinogenic HI
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I /Chronic	0.000015	C /Chronic	1	0.03	0.6	-	29	CRC89	7.31E+07	5.01	2E-07	3E-08	1E-09	2E-07	3E-02	5E-03	1E-03	4E-02
Molybdenum	-		-		0.005	H /Subchronic	-		1	-	1	-	20	YAWS	7.31E+07	0.447	-	-	-	-	3E-04	-	-	3E-04
Selenium	-		-		0.005	H /Subchronic	0.02	C /Chronic	1	-	1	-	5	CRC89	7.31E+07	0.799	-	-	-	-	5E-04	-	1E-07	5E-04
Uranium	-		-		0.0002	A /Subchronic	0.0001	A /Subchronic	1	-	1	-	450	YAWS	7.31E+07	1.69	-	-	-	-	2E-02	-	6E-05	3E-02
*Total Risk/HI	-		-		-		-		-	-	-	-	-		-	-	2E-07	3E-08	1E-09	2E-07	6E-02	5E-03	1E-03	6E-02

Risks based on EPC of surface soil

Output generated 02DEC2019:11:32:00

Site-specific Homestake Facility (HF)
Construction Worker Risk for Soil - Other Construction Activities

Chemical	SFo (mg/kg-day)-1	SFo Ref	IUR (ug/m3)-1	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	Kd (cm3/g)	TC Ref	Particulate Emission Factor (m3/kg)	Concentration (mg/kg)	Ingestion Risk	Inhalation Risk	Dermal Risk	Carcinogenic Risk	Ingestion HQ	Inhalation HQ	Dermal HQ	Noncarcinogenic HI	HF	BKG	Inherent Site HQ
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I /Chronic	0.000015	C /Chronic	1	0.03	0.6	-	29	CRC89	7.31E+07	6.33	2E-07	1E-09	4E-08	3E-07	4E-02	1E-03	6E-03	4E-02	4E-02	4E-02	0E+00
Molybdenum	-		-		0.005	H /Subchronic	-		1	-	1	-	20	YAWS	7.31E+07	36.5	-	-	-	-	2E-02	-	-	2E-02	2E-02	3E-04	2E-02
Selenium	-		-		0.005	H /Subchronic	0.02	C /Chronic	1	-	1	-	5	CRC89	7.31E+07	3.869	-	-	-	-	2E-03	6E-07	-	2E-03	2E-03	5E-04	2E-03
Uranium (Soluble Salts)	-		-		0.0002	A /Subchronic	0.0001	A /Subchronic	1	-	1	-	450		7.31E+07	15.53	-	-	-	-	2E-01	5E-04	-	2E-01	2E-01	3E-02	2E-01
*Total Risk/HI	-		-		-		-		-	-	-	-	-		-	-	2E-07	1E-09	4E-08	3E-07	3E-01	2E-03	6E-03	3E-01	3E-01	6E-02	2E-01

Concentration based on EPC of combined surface and subsurface soil

Output generated 31AUG2019:14:07:39

Site-specific Land Treatment Area (LTAs)
Construction Worker Risk for Soil - Other Construction Activities

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	K_d (cm^3/g)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Dermal HQ	Inhalation HQ	Noncarcinogenic HI	LTA	BKG	Inherent Site HQ
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I /Chronic	0.000015	C /Chronic	1	0.03	0.6	-	29	CRC89	7.31E+07	4.69	2E-07	3E-08	9E-10	2E-07	3E-02	4E-03	1E-03	3E-02	3E-02	4E-02	0E+00
Molybdenum	-		-		0.005	H /Subchronic	-		1	-	1	-	20	YAWS	7.31E+07	2.45	-	-	-	-	1E-03	-	-	1E-03	1E-03	3E-04	7E-04
Selenium	-		-		0.005	H /Subchronic	0.02	C /Chronic	1	-	1	-	5	CRC89	7.31E+07	0.975	-	-	-	-	6E-04	-	2E-07	6E-04	6E-04	5E-04	1E-04
Uranium (Soluble Salts)	-		-		0.0002	A /Subchronic	0.0001	A /Subchronic	1	-	1	-	450		7.31E+07	4.33	-	-	-	-	6E-02	-	1E-04	6E-02	6E-02	3E-02	3E-02
*Total Risk/HI	-		-		-		-		-	-	-	-	-		-	-	2E-07	3E-08	9E-10	2E-07	9E-02	4E-03	1E-03	1E-01	1E-01	6E-02	4E-02

Concentration based on EPC of combined surface and subsurface soil

Output generated 02SEP2019:14:53:59

Construction Worker Individual Risk Contributions for Air - Secular Equilibrium UCL95 for BKG

Isotope	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/m3)	Concentration (pCi/m3)	CDI (no decay) (pCi)	CDI (no decay) (pCi)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)
**Secular Equilibrium Risk for Rn-222*	-	-	-	-	-	-	-	-
At-218	0.00E+00	3.08E-14	551	2.76E+06	1.26E+02	0E+00	8E-16	8E-16
Bi-214	6.18E-11	6.69E-09	551	2.76E+06	1.26E+02	2E-04	8E-07	2E-04
Pb-214	7.77E-11	1.02E-09	551	2.76E+06	1.26E+02	2E-04	1E-07	2E-04
Po-214	0.00E+00	3.57E-13	551	2.76E+06	1.26E+02	0E+00	4E-11	4E-11
Po-218	1.39E-11	3.95E-17	551	2.76E+06	1.26E+02	4E-05	5E-15	4E-05
Rn-218	0.00E+00	3.19E-12	551	2.76E+06	1.26E+02	0E+00	8E-17	8E-17
Rn-222	2.28E-12	1.62E-12	551	2.76E+06	1.26E+02	6E-06	2E-10	6E-06
Total Risk						***4E-04***	***1E-06***	***4E-04***

Output generated   15SEP2019:14:56:59

Site-Specific Homestake Facility (HF) and Land Treatment Areas (LTAs)
Construction Worker Individual Risk Contributions for Air - Secular Equilibrium

Isotope	Inhalation Slope Factor (risk/pCi)	Submersion External Exposure Slope Factor (risk/yr per pCi/m3)	Concentration (pCi/m3)	Inhalation CDI (no decay) (pCi)	External Exposure CDI (no decay) (pCi)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)
*Secular Equilibrium Risk for Rn-222	-	-		-	-	-	-	-
At-218	0	3.08E-14	1074	5.37E+06	2.45E+02	0E+00	2E-15	2E-15
Bi-214	6.18E-11	6.69E-09	1074	5.37E+06	2.45E+02	3E-04	2E-06	3E-04
Pb-214	7.77E-11	1.02E-09	1074	5.37E+06	2.45E+02	4E-04	3E-07	4E-04
Po-214	0	3.57E-13	1074	5.37E+06	2.45E+02	0E+00	9E-11	9E-11
Po-218	1.39E-11	3.95E-17	1074	5.37E+06	2.45E+02	7E-05	1E-14	7E-05
Rn-218	0	3.19E-12	1074	5.37E+06	2.45E+02	0E+00	2E-16	2E-16
Rn-222	2.28E-12	1.62E-12	1074	5.37E+06	2.45E+02	1E-05	4E-10	1E-05
Revised Decay Chain						***8E-04***	***2E-06***	***8E-04***

Output generated   22AUG2019:17:53:08

Site-specific Recreator Equation Inputs for Soil

* Inputted values different from Recreator defaults are highlighted.

Variable	Recreator Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
A (VF Dispersion Constant)	11.911	14.9421
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	17.9869
B (VF Dispersion Constant)	18.4385	17.9869
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Albuquerque, NM
$City_{VF}$ (Climate Zone) Selection	Default	Albuquerque, NM
C (PEF Dispersion Constant)	216.108	205.1782
C (VF Dispersion Constant)	209.7845	205.1782
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	6609630250
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	81.84858573
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	81.84858573
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Site area for ACF (area correction factor) m^2	1000029 m^2	1000 m^2
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (skin adherence factor) mg/cm^2	0.2	0
AF_{2-6} (skin adherence factor) mg/cm^2	0.2	0
AF_{6-16} (skin adherence factor) mg/cm^2	0.07	0
AF_{16-30} (skin adherence factor) mg/cm^2	0.07	0.07
AF_{rec-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{rec-c} (skin adherence factor - child) mg/cm^2	0.2	0
AT_{rec} (averaging time)	365	365
BW_{0-2} (body weight) kg	15	0
BW_{2-6} (body weight) kg	15	0
BW_{6-16} (body weight) kg	80	0
BW_{16-30} (body weight) kg	80	80
BW_{rec-a} (body weight - adult) kg	80	80
BW_{rec-c} (body weight - child) kg	15	0
$DFS_{rec-adj}$ (age-adjusted soil dermal factor) mg/kg	.	1481.34
$DFSM_{rec-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	.	1481.34
ED_{rec} (exposure duration - recreator) years	26	10
ED_{0-2} (exposure duration) year	2	0
ED_{2-6} (exposure duration) year	4	0
ED_{6-16} (exposure duration) year	10	0
ED_{16-30} (exposure duration) year	10	10
ED_{rec-c} (exposure duration - child) years	6	0
EF_{rec} (exposure frequency) days/year	.	48
EF_{0-2} (exposure frequency) days/year	.	0

Site-specific Recreator Equation Inputs for Soil

* Inputted values different from Recreator defaults are highlighted.

Variable	Recreator Soil Default Value	Form-input Value
EF_{2-6} (exposure frequency) days/year	.	0
EF_{6-16} (exposure frequency) days/year	.	0
EF_{16-30} (exposure frequency) days/year	.	48
EF_{rec-a} (exposure frequency - adult) days/year	.	48
EF_{rec-c} (exposure frequency - child) days/year	.	0
ET_{rec} (exposure time - recreator) hours/day	.	2
ET_{0-2} (exposure time) hours/day	.	0
ET_{2-6} (exposure time) hours/day	.	0
ET_{6-16} (exposure time) hours/day	.	0
ET_{16-30} (exposure time) hours/day	.	2
ET_{rec-a} (adult exposure time) hours/day	.	2
ET_{rec-c} (child exposure time) hours/day	.	0
THQ (target hazard quotient) unitless	0.1	1
$IFS_{rec-adj}$ (age-adjusted soil ingestion factor) mg/kg	.	600
$IFSM_{rec-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	.	600
$IFA_{rec-adj}$ (age-adjusted inhalation rate - recreator) m^3		800
$IFS_{rec-adj}$ (age-adjusted soil intake rate - recreator) mg		48000
IRS_{0-2} (soil intake rate) mg/day	200	0
IRS_{2-6} (soil intake rate) mg/day	200	0
IRS_{6-16} (soil intake rate) mg/day	100	0
IRS_{16-30} (soil intake rate) mg/day	100	100
IRS_{rec-a} (soil intake rate - adult) mg/day	100	100
IRS_{rec-c} (soil intake rate - child) mg/day	200	0
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2/day	2373	0
SA_{2-6} (skin surface area) cm^2/day	2373	0
SA_{6-16} (skin surface area) cm^2/day	6032	0
SA_{16-30} (skin surface area) cm^2/day	6032	3527
SA_{rec-a} (skin surface area - adult) cm^2/day	6032	3527
SA_{rec-c} (skin surface area - child) cm^2/day	2373	0
TR (target risk) unitless	0.000001	0.000001
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5
VF_{ml} (volitization factor - mass limit) m^3/kg	.	0

Output generated 02DEC2019:11:53:08

Site-specific Recreator Equation Inputs for Soil

* Inputted values different from Recreator defaults are highlighted.

Variable	Recreator Air Default Value	Form-input Value
ED_{rec} (exposure duration - recreator) yr	0	10
ED_{rec-a} (exposure duration - recreator adult) yr	0	10
ED_{rec-c} (exposure duration - recreator child) yr	0	0
EF_{rec} (exposure frequency) day/yr	0	48
EF_{rec-a} (exposure frequency - recreator adult) day/yr	0	48
EF_{rec-c} (exposure frequency - recreator child) day/yr	0	0
ET_{rec} (exposure time - recreator) hr/day	0	2
ET_{rec-a} (exposure time - recreator adult) hr/day	0	2
ET_{rec-c} (exposure time - recreator child) hr/day	0	0
GSF_a (gamma shielding factor - air) unitless	1	1
$IFA_{rec-adj}$ (age-adjusted inhalation factor) m^3	0	800
IRA_{rec-a} (inhalation rate - recreator adult) m^3/day	20	20
IRA_{rec-c} (inhalation rate - recreator child) m^3/day	10	10
t_{rec} (time - recreator) yr	0	10
TR (target cancer risk) unitless	0.000001	0.000001

Recreator Inputs For Surface Water and Sediment Risk Outputs

Variable	Recreator Soil Default Value	Form-input Value
ED_{rec} (exposure duration - recreator) yr	0	10
ED_{rec-a} (exposure duration - recreator adult) yr	0	10
ED_{resc-c} (exposure duration - recreator child) yr	0	0
EF_{rec} (exposure frequency - recreator) day/yr	0	6
EF_{rec-a} (exposure frequency - recreator adult) day/yr	0	6
EF_{rec-c} (exposure frequency - recreator child) day/yr	0	0
ET_{rec} (exposure time - recreator) hr/day	0	0.2
ET_{rec-a} (exposure time - recreator) hr/day	0	0.2
ET_{rec-c} (exposure time - recreator) hr/day	0	0
$IFA_{rec-adj}$ (age-adjusted inhalation rate - recreator) m^3	0	10
$IFS_{rec-adj}$ (age-adjusted soil intake rate - recreator) mg	0	6000
IRA_{rec-a} (inhalation rate - recreator adult) m^3/day	20	20
IRA_{rec-c} (inhalation rate - recreator child) m^3/day	10	10
IRS_{rec-a} (soil intake rate - recreator adult) mg/day	100	100
IRS_{rec-c} (soil intake rate - recreator child) mg/day	200	200
t_{rec} (time - recreator) yr	0	10
TR (target cancer risk) unitless	0.000001	0.000001

Output generated 22AUG2019:22:15:02

Site-Specific Homestake Facility (HF) Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for Bi-212	1E-10	2E-14	1E-06	**1E-06**
*Secular Equilibrium Risk for Bi-214	6E-07	9E-12	2E-06	**2E-06**
*Secular Equilibrium Risk for Cs-137	1E-10	9E-16	1E-08	**1E-08**
*Secular Equilibrium Risk for K-40	5E-08	5E-13	1E-06	**1E-06**
234m	1E-06	7E-11	4E-06	**5E-06**
*Secular Equilibrium Risk for Pb-212	4E-09	1E-13	9E-07	**9E-07**
*Secular Equilibrium Risk for Pb-214	6E-07	9E-12	2E-06	**2E-06**
223	1E-08	1E-12	4E-08	**5E-08**
226	1E-06	3E-11	3E-06	**4E-06**
228	2E-07	3E-11	1E-06	**2E-06**
222	-	-	-	**-**
*Secular Equilibrium Risk for Th-227	6E-09	1E-12	2E-08	**3E-08**
*Secular Equilibrium Risk for Th-228	6E-08	3E-11	1E-06	**1E-06**
*Secular Equilibrium Risk for Th-230	7E-07	3E-11	2E-06	**3E-06**
*Secular Equilibrium Risk for Th-232	2E-07	4E-11	1E-06	**2E-06**
*Secular Equilibrium Risk for Th-234	1E-06	5E-11	2E-06	**3E-06**
*Secular Equilibrium Risk for Tl-208	0E+00	0E+00	7E-07	**7E-07**
*Secular Equilibrium Risk for U-234	1E-06	6E-11	3E-06	**4E-06**
*Secular Equilibrium Risk for U-235	2E-08	1E-11	6E-08	**8E-08**
*Secular Equilibrium Risk for U-238	1E-06	8E-11	3E-06	**5E-06**
Total risk	8E-06	4E-10	3E-05	4E-05

BKG	Inherent Site Risk Before Trimming Trailing Digits
8E-07	2E-07
9E-07	1E-06
2E-08	0E+00
1E-06	0E+00
1E-06	3E-06
8E-07	2E-07
1E-06	1E-06
4E-08	2E-08
2E-06	3E-06
1E-06	3E-07
-	-
2E-08	8E-09
1E-06	1E-07
1E-06	1E-06
1E-06	3E-07
7E-07	3E-06
6E-07	1E-07
1E-06	3E-06
3E-08	5E-08
1E-06	3E-06
2E-05	2E-05

TRIMMED TRAILING DIGITS

Total Risk	BKG	Inherent Site Risk After Trimming Trailing Digits
1E-06	8E-07	2E-07
2E-06	9E-07	1E-06
1E-08	2E-08	0E+00
1E-06	1E-06	0E+00
5E-06	1E-06	3E-06
9E-07	8E-07	1E-07
2E-06	1E-06	1E-06
5E-08	4E-08	1E-08
4E-06	2E-06	2E-06
2E-06	1E-06	3E-07
-	-	-
3E-08	2E-08	1E-08
1E-06	1E-06	0E+00
3E-06	1E-06	2E-06
2E-06	1E-06	1E-06
3E-06	7E-07	2E-06
7E-07	6E-07	1E-07
4E-06	1E-06	3E-06
8E-08	3E-08	5E-08
5E-06	1E-06	4E-06
4E-05	1E-05	2E-05

Site-Specific Background with Current ROPCs

Isotope	BKG EPC (pCi/g)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for Bi-212	1.195	1E-10	2E-14	8E-07	8E-07
*Secular Equilibrium Risk for Bi-214	0.948	2E-07	4E-12	6E-07	9E-07
*Secular Equilibrium Risk for Cs-137	0.0731	1E-10	1E-15	2E-08	2E-08
*Secular Equilibrium Risk for K-40	18.35	5E-08	5E-13	1E-06	1E-06
*Secular Equilibrium Risk for Pa-234m	1.15a	3E-07	2E-11	9E-07	1E-06
*Secular Equilibrium Risk for Pb-212	1.104	3E-09	1E-13	8E-07	8E-07
*Secular Equilibrium Risk for Pb-214	1.017	2E-07	4E-12	8E-07	1E-06
*Secular Equilibrium Risk for Ra-223	0.296	9E-09	1E-12	3E-08	4E-08
*Secular Equilibrium Risk for Ra-226	1.81	5E-07	1E-11	1E-06	2E-06
*Secular Equilibrium Risk for Ra-228	1.14	1E-07	3E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-227	0.13	5E-09	1E-12	2E-08	2E-08
*Secular Equilibrium Risk for Th-228	1.412	5E-08	2E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-230	1.393	4E-07	2E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-232	1.135	2E-07	3E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-234	0.703	2E-07	1E-11	5E-07	7E-07
*Secular Equilibrium Risk for Tl-208	0.357	0E+00	0E+00	6E-07	6E-07
*Secular Equilibrium Risk for U-234	1.141	3E-07	2E-11	9E-07	1E-06
*Secular Equilibrium Risk for U-235	0.112	8E-09	4E-12	2E-08	3E-08
*Secular Equilibrium Risk for U-238	1.147	3E-07	2E-11	9E-07	1E-06
*Total Risk		3E-06	2E-10	1E-05	2E-05

a - Value based on a mean (n=4)
Risks based on EPC of surface soil

December 3 2019, Feb 13,2020

Trespasser Risk for Soil - Secular Equilibrium Land Treatment Areas (LTAs)

							TRIMMED TRAILING DIGITS		
Isotope	**Ingestion Risk**	**Inhalation Risk**	**External Exposure Risk**	**Total Risk**	**BKG**	**Inherent Site Risk Before Trimming Trailing Digits**	**Total Risk**	**BKG**	**Inherent Site Risk After Trimming Trailing Digits**
*Secular Equilibrium Risk for Bi-212	8E-11	1E-14	7E-07	7E-07	8E-07	0E+00	7E-07	8E-07	0E+00
*Secular Equilibrium Risk for Bi-214	2E-07	3E-12	6E-07	8E-07	9E-07	0E+00	8E-07	9E-07	0E+00
*Secular Equilibrium Risk for Cs-137	1E-10	1E-15	2E-08	2E-08	2E-08	0E+00	2E-08	2E-08	0E+00
*Secular Equilibrium Risk for K-40	4E-08	4E-13	1E-06	1E-06	1E-06	0E+00	1E-06	1E-06	0E+00
*Secular Equilibrium Risk for Pa-234m	5E-07	3E-11	1E-06	2E-06	1E-06	4E-07	2E-06	1E-06	4E-07
*Secular Equilibrium Risk for Pb-212	3E-09	8E-14	6E-07	6E-07	8E-07	0E+00	6E-07	8E-07	0E+00
*Secular Equilibrium Risk for Pb-214	2E-07	4E-12	7E-07	9E-07	1E-06	0E+00	9E-07	1E-06	0E+00
*Secular Equilibrium Risk for Ra-223	7E-09	9E-13	2E-08	3E-08	4E-08	0E+00	3E-08	4E-08	0E+00
*Secular Equilibrium Risk for Ra-226	4E-07	9E-12	1E-06	1E-06	2E-06	0E+00	1E-06	2E-06	0E+00
*Secular Equilibrium Risk for Ra-228	1E-07	2E-11	1E-06	1E-06	1E-06	0E+00	1E-06	1E-06	0E+00
*Secular Equilibrium Risk for Rn-222	-	-	-	-			-		
*Secular Equilibrium Risk for Th-228	6E-08	3E-11	1E-06	1E-06	1E-06	3E-07	1E-06	1E-06	3E-07
*Secular Equilibrium Risk for Th-230	3E-07	1E-11	8E-07	1E-06	1E-06	0E+00	1E-06	1E-06	0E+00
*Secular Equilibrium Risk for Th-232	2E-07	5E-11	2E-06	2E-06	1E-06	7E-07	2E-06	1E-06	7E-07
*Secular Equilibrium Risk for Th-234	3E-07	1E-11	7E-07	9E-07	7E-07	2E-07	9E-07	7E-07	2E-07
*Secular Equilibrium Risk for Tl-208	0E+00	0E+00	5E-07	5E-07	6E-07	0E+00	5E-07	6E-07	0E+00
*Secular Equilibrium Risk for U-234	6E-07	3E-11	2E-06	2E-06	1E-06	1E-06	2E-06	1E-06	1E-06
*Secular Equilibrium Risk for U-235	9E-09	5E-12	2E-08	3E-08	3E-08	5E-09	3E-08	3E-08	5E-09
*Secular Equilibrium Risk for U-238	7E-07	4E-11	2E-06	2E-06	1E-06	1E-06	2E-06	1E-06	1E-06
*Total Risk	4E-06	2E-10	2E-05	2E-05	2E-05	4E-06	2E-05	1E-05	4E-06

Site-Specific Background ROPCs

Isotope	BKG EPC (pCi/g)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for Bi-212	1.195	1E-10	2E-14	8E-07	8E-07
*Secular Equilibrium Risk for Bi-214	0.948	2E-07	4E-12	6E-07	9E-07
*Secular Equilibrium Risk for Cs-137	0.0731	1E-10	1E-15	2E-08	2E-08
*Secular Equilibrium Risk for K-40	18.35	5E-08	5E-13	1E-06	1E-06
*Secular Equilibrium Risk for Pa-234m	1.15a	3E-07	2E-11	9E-07	1E-06
*Secular Equilibrium Risk for Pb-212	1.104	3E-09	1E-13	8E-07	8E-07
*Secular Equilibrium Risk for Pb-214	1.017	2E-07	4E-12	8E-07	1E-06
*Secular Equilibrium Risk for Ra-223	0.296	9E-09	1E-12	3E-08	4E-08
*Secular Equilibrium Risk for Ra-226	1.81	5E-07	1E-11	1E-06	2E-06
*Secular Equilibrium Risk for Ra-228	1.14	1E-07	3E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-227	0.13	5E-09	1E-12	2E-08	2E-08
*Secular Equilibrium Risk for Th-228	1.412	5E-08	2E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-230	1.393	4E-07	2E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-232	1.135	2E-07	3E-11	1E-06	1E-06
*Secular Equilibrium Risk for Th-234	0.703	2E-07	1E-11	5E-07	7E-07
*Secular Equilibrium Risk for Tl-208	0.357	0E+00	0E+00	6E-07	6E-07
*Secular Equilibrium Risk for U-234	1.141	3E-07	2E-11	9E-07	1E-06
*Secular Equilibrium Risk for U-235	0.112	8E-09	4E-12	2E-08	3E-08
*Secular Equilibrium Risk for U-238	1.147	3E-07	2E-11	9E-07	1E-06
*Total Risk		3E-06	2E-10	1E-05	2E-05

a - Value based on a mean (n=4)
Risks based on EPC of surface soil

December 3 2019, Feb 13,2020

Site-specific Trespasser Risk for Soil - Background

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	K_d (cm^3/g)	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I	0.000015	C	1	0.03	0.6	29	888.15	PHYSPROP	1673	CRC89	6.61E+09	5.01E+00	1E-07	1E-08	5E-12	1E-07	-	-	-	-	2E-03	2E-04	6E-07	2E-03
Molybdenum	-		-		0.005	I	-		1	-	1	20	4912.15	PHYSPROP	9620	YAWS	6.61E+09	4.47E-01	-	-	-	-	-	-	-	-	1E-05	-	-	1E-05
Selenium	-		-		0.005	I	0.02	C	1	-	1	5	958.15	PHYSPROP	1766	CRC89	6.61E+09	7.99E-01	-	-	-	-	-	-	-	-	3E-05	-	7E-11	3E-05
Uranium	-		-		0.0002	A	0.00004	A	1	-	1	450	4091.15	CRC89	13712.6	YAWS	6.61E+09	1.69E+00	-	-	-	-	-	-	-	-	1E-03	-	7E-08	1E-03
Total Risk/HI	-		-		-		-		-	-	-	-	-		-		-	-	*1E-07*	*1E-08*	*5E-12*	*1E-07*	-	-	-	-	*3E-03*	*2E-04*	*6E-07*	*3E-03*

Risks based on EPC of surface soil
Output generated 02DEC2019:11:53:08

Site-specific Trespasser Risk for Soil - Homestake Facility (HF)

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	K_d (cm^3/g)	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Inhalation Risk	Dermal Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Non-carcinogenic Child HI	Ingestion Adult HQ	Inhalation Adult HQ	Dermal Adult HQ	Non-carcinogenic Adult HI
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I	0.000015	C	1	0.03	0.6	29	888.15	PHYSPROP	1673	CRC89	6.61E+09	6.33	3E-07	1E-11	6E-08	3E-07	-	-	-	-	2E-03	7E-07	4E-04	3E-03
Molybdenum	-		-		0.005	I	-		1	-	1	20	4912.15	PHYSPROP	9620	YAWS	6.61E+09	36.5	-	-	-	-	-	-	-	-	1E-03	-	-	1E-03
Selenium	-		-		0.005	I	0.02	C	1	-	1	5	958.15	PHYSPROP	1766	CRC89	6.61E+09	3.8	-	-	-	-	-	-	-	-	1E-04	-	3E-10	1E-04
Uranium (Soluble	-		-		0.0002	A	0.00004	A	1	-	1	450	4091.15	CRC89	-		6.61E+09	14.3	-	-	-	-	-	-	-	-	1E-02	-	6E-07	1E-02
Total Risk/HI	-		-		-		-		-	-	-	-	-		-		-	-	*3E-07*	*1E-11*	*6E-08*	*3E-07*	-	-	-	-	*2E-02*	*7E-07*	*4E-04*	*2E-02*

Risks based on EPC of surface soil
Output generated 31AUG2019:20:18:55

Site-specific Trespasser Risk for Soil - Land Treatment Areas (LTAs)

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	K_d (cm^3/g)	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Non-carcinogenic Child HI	Ingestion Adult HQ	Inhalation Adult HQ	Dermal Adult HQ	Non-carcinogenic Adult HI
Arsenic, Inorganic	1.5	I	0.0043	I	0.0003	I	0.000015	C	1	0.03	0.6	29	888.15	PHYSPROP	1673	CRC89	6.61E+09	4.69	1E-07	1E-08	5E-12	1E-07	-	-	-	-	2E-03	5E-07	2E-04	2E-03
Molybdenum	-		-		0.005	I	-		1	-	1	20	4912.15	PHYSPROP	9620	YAWS	6.61E+09	0.628	-	-	-	-	-	-	-	-	2E-05	-	-	2E-05
Selenium	-		-		0.005	I	0.02	C	1	-	1	5	958.15	PHYSPROP	1766	CRC89	6.61E+09	1.12	-	-	-	-	-	-	-	-	4E-05	-	9E-11	4E-05
Uranium (Soluble	-		-		0.0002	A	0.00004	A	1	-	1	450	4091.15	CRC89			6.61E+09	3.99	-	-	-	-	-	-	-	-	3E-03	-	2E-07	3E-03
Total Risk/HI	-		-		-		-		-	-	-	-	-		-		-	-	*1E-07*	*1E-08*	*5E-12*	*1E-07*	-	-	-	-	*5E-03*	*5E-07*	*2E-04*	*5E-03*

Risks based on EPC of surface soil
Output generated 02SEP2019:16:09:07

Site-specific Trespasser Risk for Surface Water - Homestake Facility (HF) Evaporation Ponds

Chemical	SFo (mg/kg-day)-1	SFo Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m3)	RfC Ref	RAGSe GIABS (unitless)	Kp (cm/hr)	MW	FA (unitless)	In EPD?	DAevent (ca)	Ingestion Risk	Dermal Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Non-carcinogenic Child HQ	Ingestion Adult HQ	Dermal Adult HQ	Non-carcinogenic Adult HQ
Manganese (Non-diet)	-		0.024	S	0.00005	I	0.04	0.001	54.938	1	Yes	-	-	-	-	-	-	-	3E-06	3E-04	3E-04
Molybdenum	-		0.005	I	-		1	0.001	95.94	1	Yes	-	-	-	-	-	-	-	4E-02	1E-01	2E-01
Nitrate (measured as nitrogen)	-		1.6	I	-		1	0.001	62	1	Yes	-	-	-	-	-	-	-	3E-07	1E-06	1E-06
Selenium	-		0.005	I	0.02	C	1	0.001	78.96	1	Yes	-	-	-	-	-	-	-	3E-05	1E-04	1E-04
Uranium	-		0.0002	A	0.00004	A	1	0.001	238.03	1	Yes	-	-	-	-	-	-	-	6E-01	2E+00	3E+00
Vanadium and Compounds	-		0.00504	S	0.0001	A	0.026	0.001	50.94	1	Yes	-	-	-	-	-	-	-	4E-06	7E-04	7E-04
Total Risk/HI	**-**		**-**		**-**		**-**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**-**	***6E-01***	***2E+00***	***3E+00***

Site-Specific Background HMC 16 UCL95
Trespasser Individual Risk Contributions for Air - Secular Equilibrium

Trimmed Trailing Digits

Isotope	Inhalation Slope Factor (risk/pCi)	Submersion External Exposure Slope Factor (risk/yr per pCi/m^3)	Concentration (pCi/m^3)	Inhalation CDI (no decay) (pCi)	External Exposure CDI (no decay) (pCi)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)
*Secular Equilibrium Risk for Rn-222								
At-218	0.00E+00	3.08E-14	551	441000	60	0E+00	4E-16	**4E-16**
Bi-214	6.18E-11	6.69E-09	551	441000	60	3E-05	4E-07	**3E-05**
Pb-214	7.77E-11	1.02E-09	551	441000	60	3E-05	6E-08	**3E-05**
Po-214	0.00E+00	3.57E-13	551	441000	60	0E+00	2E-11	**2E-11**
Po-218	1.39E-11	3.95E-17	551	441000	60	6E-06	2E-15	**6E-06**
Rn-218	0.00E+00	3.19E-12	551	441000	60	0E+00	4E-17	**4E-17**
Rn-222	2.28E-12	1.62E-12	551	441000	60	1E-06	1E-10	**1E-06**
Total Risk						**7E-05**	**5E-07**	**7E-05**

Inhalation	External Exposure	Total
0E+00	4E-16	**4E-16**
3E-05	4E-07	**3E-05**
3E-05	6E-08	**3E-05**
0E+00	2E-11	**2E-11**
6E-06	2E-15	**6E-06**
0E+00	4E-17	**4E-17**
1E-06	1E-10	**1E-06**
7E-05	**5E-07**	**7E-05**

Output generated 15SEP2019:20:55:23

Site-Specific Homestake Facility (HF)
Trespasser Individual Risk Contributions for Air - Secular Equilibrium

Isotope	Inhalation Slope Factor (risk/pCi)	Submersion External Exposure Slope Factor (risk/yr per pCi/m3)	Outdoor Air Concentration (pCi/m3)	Inhalation CDI (no decay) (pCi)	External Exposure CDI (no decay) (pCi)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)
*Secular Equilibrium Risk for Rn-222								
At-218	0	3.08E-14	949	759000	104	0E+00	6E-16	6E-16
Bi-214	6.18E-11	6.69E-09	949	759000	104	5E-05	7E-07	5E-05
Pb-214	7.77E-11	1.02E-09	949	759000	104	6E-05	1E-07	6E-05
Po-214	0	3.57E-13	949	759000	104	0E+00	4E-11	4E-11
Po-218	1.39E-11	3.95E-17	949	759000	104	1E-05	4E-15	1E-05
Rn-218	0	3.19E-12	949	759000	104	0E+00	7E-17	7E-17
Rn-222	2.28E-12	1.62E-12	949	759000	104	2E-06	2E-10	2E-06
Total Risk						**1E-04**	**8E-07**	**1E-04**

Trimmed Trailing Digits

Inhalation	External Exposure	Total
0E+00	6E-16	6E-16
5E-05	7E-07	5E-05
6E-05	1E-07	6E-05
0E+00	4E-11	4E-11
1E-05	4E-15	1E-05
0E+00	7E-17	7E-17
2E-06	2E-10	2E-06
1E-04	**8E-07**	**1E-04**

Site-Specific Land Treatment Areas (LTAs)
Trespasser Individual Risk Contributions for Air - Secular Equilibrium

Isotope	Inhalation Slope Factor (risk/pCi)	Submersion External Exposure Slope Factor (risk/yr per pCi/m^3)	Concentration (pCi/m^3)	Inhalation CDI (no decay) (pCi)	External Exposure CDI (no decay) (pCi)	Inhalation Risk (no decay)	External Exposure Risk (no decay)	Total Risk (no decay)	Trimmed Trailing Digits: Inhalation	Trimmed Trailing Digits: External Exposure	Trimmed Trailing Digits: Total
**Secular Equilibrium Risk for Rn-222*											
At-218	0.00E+00	3.08E-14	949	759000	104	0E+00	6E-16	6E-16	0E+00	6E-16	6E-16
Bi-214	6.18E-11	6.69E-09	949	759000	104	5E-05	7E-07	5E-05	5E-05	7E-07	5E-05
Pb-214	7.77E-11	1.02E-09	949	759000	104	6E-05	1E-07	6E-05	6E-05	1E-07	6E-05
Po-214	0.00E+00	3.57E-13	949	759000	104	0E+00	4E-11	4E-11	0E+00	4E-11	4E-11
Po-218	1.39E-11	3.95E-17	949	759000	104	1E-05	4E-15	1E-05	1E-05	4E-15	1E-05
Rn-218	0.00E+00	3.19E-12	949	759000	104	0E+00	7E-17	7E-17	0E+00	7E-17	7E-17
Rn-222	2.28E-12	1.62E-12	949	759000	104	2E-06	2E-10	2E-06	2E-06	2E-10	2E-06
Total Risk						**1E-04**	**8E-07**	**1E-04**	**1E-04**	**8E-07**	**1E-04**

Output generated 22AUG2019:21:40:03

Site-Specific Evaporation Ponds, Homestake Facility (HF)
Trespasser Risk for Surface Water - Secular Equilibrium

Isotope	Ingestion Risk	Immersion Risk	Surface Water Risk
**Secular Equilibrium Risk for Ra-226*	*8E-09*	*1E-12*	*8E-09*
**Secular Equilibrium Risk for Ra-228*	*6E-09*	*2E-12*	*6E-09*
**Secular Equilibrium Risk for Th-230*	*2E-07*	*3E-11*	*2E-07*
**Secular Equilibrium Risk for U-234*	*4E-05*	*4E-09*	*4E-05*
**Secular Equilibrium Risk for U-238*	*4E-05*	*4E-09*	*4E-05*
***Total Risk**	**7E-05**	**9E-09**	**7E-05**

Output generated 22AUG2019:21:40:03

*U-234 and U-238 - Calculated as UCL95 for Utotal (548.8 mg/L) *1000 (ug/mg)* 0.67 pCi/ug = 367696 pCi/L divided by 2 = 185357.2 pCi/L for U-234 and 185357.2 for U-238*

Site-Specific Evaporation Ponds, Homestake Facility (HF)
Trespasser Risk for Sediment - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for Ra-226	1E-06	3E-12	3E-07	1E-06
*Secular Equilibrium Risk for Th-230	2E-08	7E-14	5E-09	2E-08
*Secular Equilibrium Risk for U-234	5E-05	2E-10	1E-05	6E-05
*Secular Equilibrium Risk for U-238	5E-05	3E-10	1E-05	6E-05
*Total Risk	1E-04	5E-10	2E-05	1E-04

Output generated 22AUG2019:22:15:02

The exposure parameters were set to the same as for water in order to predict sediment exposure.

Site-specific
Resident Risk for Tap Water

Isotope	Ingestion Risk	Inhalation Risk	Immersion Risk	Produce Consumption Risk	Total Tapwater Risk
**Secular Equilibrium Risk for Ra-226*	1.46E-04	1.18E-02	2.93E-11	3.79E-04	1.24E-02
**Secular Equilibrium Risk for Ra-228*	6.40E-05	3.72E-02	3.99E-11	1.98E-04	3.74E-02
**Secular Equilibrium Risk for U-234*	6.60E-03	6.48E-01	1.26E-09	1.69E-02	6.56E-01

Chemical	SFo (mg/kg-day)-1	SFo Ref	IUR (ug/m3)-1	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m3)	RfC Ref	GIABS	Kp (cm/hr)	MW	B (unitless)	t* (hr)	τevent (hr/event)	FA (unitless)	In EPD?	DAevent (ca)	DAevent (nc child)	DAevent (nc adult)
Molybdenum	-		-		0.005	I	-		1	0.001	95.94	0.00377	0.87	0.362	1	Yes	-	0.00123	0.00212
Nitrate (measured as nitrogen)	-		-		1.6	I	-		1	0.001	62	0.00303	0.561	0.234	1	Yes	-	0.393	0.679
Selenium	-		-		0.005	I	0.02	C	1	0.001	78.96	0.00342	0.699	0.291	1	Yes	-	0.00123	0.00212
Sulfate	-		-		-		-		1	0.001	98.07	0.00381	0.894	0.372	1	Yes	-	-	-
Uranium	-		-		0.0002	A	0.00004	A	1	0.001	238.03	0.00593	5.43	2.26	1	Yes	-	0.0000492	0.0000849
Vanadium and Compounds	-		-		0.00504	S	0.0001	A	0.026	0.001	50.94	0.00275	0.487	0.203	1	Yes	-	0.0000322	0.0000556
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-		-	-	-

Output generated 06MAR2020:13:46:33

Chemical	MCL (ug/L)	Concentration (ug/L)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Molybdenum	-	100	-	-	-	-	1E+00	4E-03	-	1E+00	6E-01	3E-03	-	6E-01
Nitrate (measured as nitrogen)	10000	12000	-	-	-	-	4E-01	2E-03	-	4E-01	2E-01	1E-03	-	2E-01
Selenium	50	320	-	-	-	-	3E+00	1E-02	-	3E+00	2E+00	1E-02	-	2E+00
Sulfate	-	1500000	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	30	160	-	-	-	-	4E+01	2E-01	-	4E+01	2E+01	1E-01	-	2E+01
Vanadium and Compounds	-	20	-	-	-	-	2E-01	3E-02	-	2E-01	1E-01	3E-02	-	1E-01
*Total Risk/HI	-	-	-	-	-	-	4E+01	2E-01	-	4E+01	3E+01	2E-01	-	3E+01

Output generated 06MAR2020:13:46:33

Appendix G

Data Usability Report

DATA USABILITY ANALYSIS
HOMESTAKE MINE SITE

To meet the primary objectives of the Remedial Investigation at the Homestake Mining Site (Homestake), soil and aqueous samples were evaluated. All analytical sample results were generated by Energy Laboratories of Casper, WY (Energy), or ACZ Laboratories of Steamboat Springs, CO (ACZ). The following laboratory data were evaluated at a Level IIa for data quality for potential use in risk assessments:

Table 1: Analytical Analysis Information

Laboratory	Date	Analysis	Method	Matrix
C13120860				
Energy	Dec. 2013	Molybdenum	EPA 6020	Soil
Energy	Dec. 2013	Selenium	EPA 6020	Soil
Energy	Dec. 2013	Uranium	EPA 6020	Soil
L78105				
ACZ	Sept. 2009	Molybdenum	EPA 6020	Soil
ACZ	Sept. 2009	Selenium	EPA 6020	Soil
ACZ	Sept. 2009	Uranium	EPA 6020	Soil
ACZ	Sept. 2009	Radium 226	M903.1	Soil
ACZ	Sept. 2009	Thorium 230	ESM 4506	Soil
L78106				
ACZ	Sept. 2009	Molybdenum	EPA 6020	Soil
ACZ	Sept. 2009	Selenium	EPA 6020	Soil
ACZ	Sept. 2009	Uranium	EPA 6020	Soil
ACZ	Sept. 2009	Radium 226	M903.1	Soil
ACZ	Sept. 2009	Thorium 230	ESM 4506	Soil
L78107				
ACZ	Sept. 2009	Molybdenum	EPA 6020	Soil
ACZ	Sept. 2009	Selenium	EPA 6020	Soil
ACZ	Sept. 2009	Uranium	EPA 6020	Soil
ACZ	Sept. 2009	Radium 226	M903.1	Soil
ACZ	Sept. 2009	Thorium 230	ESM 4506	Soil
551, 553, 554, 649, 658, 647, 650				
Energy	Feb. 6, 2013	Molybdenum	E200.7	Aqueous
Energy	Feb. 6, 2013	Selenium	E200.8	Aqueous
Energy	Feb. 6, 2013	Uranium	E200.8	Aqueous
Energy	Feb. 6, 2013	Radium	E903.0	Aqueous
555, 556, 557, 844, 855				
Energy	Feb. 5, 2013	Molybdenum	E200.7/E200.8	Aqueous
Energy	Feb. 5, 2013	Selenium	E200.8	Aqueous
Energy	Feb. 5, 2013	Uranium	E200.8	Aqueous
Energy	Feb. 5, 2013	Radium	E903.0	Aqueous

Table 1: Analytical Analysis Information (Con't)

Laboratory	Date	Analysis	Method	Matrix
634				
Energy	Nov. 11, 2013	Molybdenum	E200.7/E200.8	Aqueous
Energy	Nov. 11, 2013	Selenium	E200.8	Aqueous
Energy	Nov. 11, 2013	Uranium	E200.8	Aqueous
649				
Energy	Feb. 6, 2013	Molybdenum	E200.7/E200.8	Aqueous
Energy	Feb. 6, 2013	Selenium	E200.8	Aqueous
Energy	Feb. 6, 2013	Uranium	E200.8	Aqueous
Energy	Feb. 6, 2013	Radium	E903.0	Aqueous
649, 650, 555, 556, 557, 845				
Energy	Aug. 15, 2013	Molybdenum	E200.7	Aqueous
Energy	Aug. 15, 2013	Selenium	E200.8	Aqueous
Energy	Aug. 15, 2013	Uranium	E200.8	Aqueous
Energy	Aug. 15, 2013	Radium	E903.0	Aqueous
657				
Energy	May 13, 2013	Molybdenum	E200.8	Aqueous
Energy	May 13, 2013	Selenium	E200.8	Aqueous
Energy	May 13, 2013	Uranium	E200.8	Aqueous
Energy	May 13, 2013	Vanadium	E200.8	Aqueous
Energy	May 13, 2013	Radium	E903.0	Aqueous
Energy	May 13, 2013	Thorium	E908.0	Aqueous
657, 647, 554, 553, 551, 884, 893, 892, 885, 888				
Energy	Aug. 8, 2013	Molybdenum	E200.7	Aqueous
Energy	Aug. 8, 2013	Selenium	E200.8	Aqueous
Energy	Aug. 8, 2013	Uranium	E200.8	Aqueous
Energy	Aug. 8, 2013	Radium	E903.0	Aqueous
658, 846, 888				
Energy	Oct. 30, 2013	Molybdenum	E200.7	Aqueous
Energy	Oct. 30, 2013	Selenium	E200.7/E200.8	Aqueous
Energy	Oct. 30, 2013	Uranium	E200.7/E200.8	Aqueous
Energy	Oct. 30, 2013	Vanadium	E200.7/E200.8	Aqueous
Energy	Oct. 30, 2013	Radium	E903.0	Aqueous
Energy	Oct. 30, 2013	Thorium	E908.0	Aqueous
846				
Energy	Feb. 19, 2013	Molybdenum	E200.7/E200.8	Aqueous
Energy	Feb. 19, 2013	Selenium	E200.8	Aqueous
Energy	Feb. 19, 2013	Uranium	E200.7/E200.8	Aqueous

Table 1: Analytical Analysis Information (Con't)

Laboratory	Date	Analysis	Method	Matrix
881, 884, 886, 893				
Energy	Feb. 8, 2013	Molybdenum	E200.7	Aqueous
Energy	Feb. 8, 2013	Selenium	E200.8	Aqueous
Energy	Feb. 8, 2013	Uranium	E200.7/E200.8	Aqueous
886				
Energy	Nov. 15, 2013	Molybdenum	E200.8	Aqueous
Energy	Nov. 15, 2013	Selenium	E200.8	Aqueous
Energy	Nov. 15, 2013	Uranium	E200.8	Aqueous
Energy	Nov. 15, 2013	Radium	E903.0	Aqueous
887				
Energy	Mar. 19, 2013	Molybdenum	E200.8	Aqueous
Energy	Mar. 19, 2013	Selenium	E200.8	Aqueous
Energy	Mar. 19, 2013	Uranium	E200.8	Aqueous
887,888				
Energy	Mar. 19, 2013	Molybdenum	E200.8	Aqueous
Energy	Mar. 19, 2013	Selenium	E200.8	Aqueous
Energy	Mar. 19, 2013	Uranium	E200.8	Aqueous
890				
Energy	Apr. 30, 2013	Molybdenum	E200.8	Aqueous
Energy	Apr. 30, 2013	Selenium	E200.8	Aqueous
Energy	Apr. 30, 2013	Uranium	E200.8	Aqueous
2010 Vegetation				
Energy	Oct. 30, 2010	Selenium	SW6020	Soil
Energy	Oct. 30, 2010	Uranium	SW6020	Soil
2011 Vegetation				
Energy	Oct. 31, 2011	Selenium	SW6020	Soil
Energy	Oct. 31, 2011	Uranium	SW6020	Soil

Note: All methods were analyzed utilizing the latest method updates.

The results provided by the laboratories are considered definitive data and underwent a systematic data validation to provide assurance that the data were adequate for its intended use. The evaluation was performed based on an evaluation of project objectives, method-specific QA/QC information (such as holding times, calibration records, laboratory-and field-supplied blanks, duplicate precision, and surrogate and spike recovery), relevant sections of the Environmental Protection Agency (EPA) National Functional Guidelines for Inorganic Data Validation, and/or the best professional judgment of the validator. Validation was performed by HDR personnel with the appropriate training and/or experience in performing data validation for the analyses of interest associated with the project. Qualifiers (as appropriate) were added to the data based on the results of the validation.

Note: The focus of the data evaluation was placed on site-specific contaminants of concern such as

molybdenum, selenium, uranium and radioactive isotopes (thorium and radium). Analytes for water or soil quality (e.g., Soil Adsorption Ratio, chloride, sulfate) were not evaluated as part of this data evaluation. For comparative purposes, detection limits and reporting limits were compared to the Nuclear Regulatory Commission (NRC) 10 Code of Federal Regulations (CFR) Part 40 Appendix A Maximum Values for Ground-Water Protection and the EPA Regional Screening Levels for Residential, and Hazard Quotient = 0.1.

As part of the data assessment, data qualifiers are presented along with the analytical results. Qualifiers used with regard to the assessment are provided as follows:

- U- The analyte was not detected at or above the method detection limit.
- J - The identification of the analyte is acceptable; the reported value is an estimate.
- B – A result with associated blank result, which is outside the control limit. Note: ACZ uses the B qualifier in place of the J qualifier.
- E – The hold time for metals was exceeded (dissolved metals filtering).
- P – The replicate analysis is outside the acceptable control limits.
- N – The analyte concentration was not sufficiently high to calculate a relative percent difference (RPD) for the serial dilution test.
- N1- The analysis indicates Performance Blank Samples are outside of acceptable criteria.
- S - A result with a related spike result (laboratory control sample [LCS], matrix spike [MS] or matrix spike duplicate [MSD]) is outside the control limit for recovery (%R)

The data assessment for inorganic aqueous samples is typically performed for the following criteria per the National Functional Guidelines or Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Data Validation procedures: preservation, holding time, contract required detection limit (CRDL) standard, matrix spike, Interference Check Sample (ICS), laboratory duplicate, field duplicate, Inductively Coupled Plasma serial dilution, and field blank. As part of this evaluation, additional elements reviewed include the chain of custody documentation, Method Blanks (MBs), Continuing Calibration Blanks (CCBs), Initial and Continuing Calibration Verification (ICVs/CCVs), Matrix Spike/Matrix Spike Duplicates (MS/MSDs), Laboratory Control Samples (LCSs), and Laboratory Control Sample Duplicates (LCSDs).

<u>Package Specific Notes:</u>

ACZ Package L78105 (September 3, 2009)

- The data package was evaluated for Uranium (U), Selenium (Se), and Molybdenum (Mo) in soil.
- A Quality Assurance Project Plan (QAPP) was not provided for this evaluation, but the requirements meet the NRC License SUA-1471 and10 CFR Part 40, Appendix A, Criterion 6.
- CCB and CCV samples were not provided.
- Method Blanks (MBs) were not provided, but initial calibration verification (ICV) standards

were acceptable.
- All MS/MSDs were within acceptable criteria.
- All LCS/LCSD samples were within acceptable criteria.
- Two lab replicates from this data package were evaluated. The Duplicate – Relative Error Ratio (DUP-RER) exceeded the acceptance criteria and the parent samples should be qualified "P".
- No field duplicates were specified

ACZ Package L78106 (September 3, 2009)

- The data package was evaluated for U, Se, Mo, Th and Ra in soil.
- A QAPP was not provided for this evaluation but detection limits were compared to 10 CFR Part 40, Appendix A, Criterion 6.
- CCB and CCV samples were not provided.
- MBs were not provided, but ICVs were acceptable, except for Ra in the Preparation Blank – Soil (PBS) associated with WG271357 (-0.18 pCi/g) and Th in the PBS associated with WG271791 (0.39 pCi/g). These are less than half of the Reporting Level.
- All MS/MSDs were within acceptable criteria.
- All LCS/LCSD samples were within acceptable criteria, except for WG272331, which had high recoveries in both the LCS and LCSD for Mo, WG272758 which had high recoveries of Mo in the LCS, and WG272510 which had high recoveries of Se in the LCS.
- No lab replicates from data package was evaluated.
- No field duplicates were specified

ACZ Package L78107 (September 4, 2009)

- The data package was evaluated for U, Se, Mo, Th, Ra in soil.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471 and 10 CFR Part 40, Appendix A, Criterion 6.
- CCB and CCV samples were not provided.
- MBs were not provided, but ICVs were acceptable, except for Ra in the PBS associated with WG271357 and WG272161 (-0.18 and 0.16 pCi/g, respectively) and Th in the PBS associated with WG271791 and WG171994 (0.39 and -0.07 pCi/g, respectively). These are less than half of the Reporting Level.
- All MS/MSDs were within acceptable criteria.
- All LCS/LCSD samples were within acceptable criteria.
- One lab replicate from this data package was evaluated L78107-01DUP. The DUP-RER significantly exceeded the acceptance criteria and the parent will be qualified "P". This data should be further evaluated to determine if it should be rejected "R". An outlier evaluation may be warranted for this result.
- No field duplicates were specified

Energy Package 2010 Vegetation (October 30, 2010)

- The data package was evaluated for U and Se in soil.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the soil samples and were non-detect.

- CCB, CCV and ICV samples were not provided.
- All MS/MSDs were within acceptable criteria.
- No LCS/LCSDs were provided.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.
-

Energy Package 2011 Vegetation (October 31, 2011)

- The data package was evaluated for U and Se in soil.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the soil samples and were non-detect.
- CCB and CCV samples were not provided. The ICVs were acceptable.
- All MS/MSDs were within acceptable criteria.
- LCS/LCSDs were acceptable.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 555, 556, 557, 844, 855 (February 5, 2013)

- The data package was evaluated for U, Se, Mo, and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for Mo in MB-130212A (0.004 milligrams per liter (mg/L)), and Se in the Laboratory Reagent Blank (LRB) (0.0004 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria.
- All LCS/LCSD and Lab Fortified Blank (LFB) samples were within acceptable criteria.
- One lab replicate from this data package was evaluated C13020313-001EDUP. The DUP-RER RPD exceeded the acceptance criteria and the parent sample will be qualified "P". This data should be further evaluated to determine if it should be rejected "R". An outlier evaluation may be warranted for this result.
- No field duplicates were specified.

Energy Package 846 (February 19, 2013)

- The data package was evaluated for U, Se, and Mo in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for Se in the LRB (0.0007 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria.
- No LCS/LCSD samples were provided. LFBs were acceptable.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 551, 553, 554, 649, 658, 747, 650 (February 6, 2013)

- The data package was evaluated for U, Se, Mo, and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for Mo in MB-130214A (0.007 mg/L), and Se in LRB (0.002 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were completed.
- No field duplicates were specified.

Energy Package 881, 884, 886, 893 (February 8, 2013)

- The data package was evaluated for U, Se, and Mo in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for Mo in MB-130214A (0.007 mg/L) and Se and Mo in two separate LRB samples (0.002 and 0.00005 mg/L, respectively).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 649 (March 6, 2013)

- The data package was evaluated for U, Se, Mo and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for U in LRB (0.0004 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 887 (March 19, 2013)

- The data package was evaluated for U, Se, and Mo in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect.
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs were within acceptable criteria.

- No LCS/LCSDs were provided.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 887, 888 (March 19, 2013)

- The data package was evaluated for U, Se, and Mo in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect.
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs were within acceptable criteria.
- No LCS/LCSDs were provided, but the LFB was acceptable.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.
-

Energy Package 890 (April 40, 2013)

- The data package was evaluated for U, Se, and Mo in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect.
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs were within acceptable criteria.
- No LCS/LCSDs were provided, but the LFB was acceptable.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 657 (May 13, 2013)

- The data package was evaluated for U, Se, Mo, V, Th and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for Mo which was found at the detection limit in the LRB (0.00004 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs were within acceptable criteria.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 657, 647, 554, 553, 551, 884, 893, 892, 885, 888 (August 8, 2013)

- The data package was evaluated for U, Se, Mo and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- The holding time for dissolved metals was exceeded by up to 4.68 days. Dissolved metals data should be qualified "E" for this exceedance. Samples were not filtered by the lab after

receipt.
- MBs were analyzed for the aqueous samples and were non-detect, except for U in the LRB (0.00005 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria, except for the Ra MS sample number C1300980-004AMSD. The RPD was 22.4%.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 649, 650, 555, 556, 557, 845 (August 15, 2013)

- The data package was evaluated for U, Se, Mo and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- The holding time for dissolved metals was exceeded by up to 14.7 days. Dissolved metals data should be qualified "E" for this exceedance. Samples were not filtered by the lab after receipt.
- MBs were analyzed for the aqueous samples and were non-detect, except for U in the LRB (0.00005 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria, except for the Ra MS sample number C1300980-004AMSD. The RPD was 22.4%.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 658, 846, 881 (October 30, 2013)

- The data package was evaluated for U, Se, Mo, V, Th and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for Mo and Se in the MB-131104A (0.009 and 0.02 mg/L, respectively).
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs were within acceptable criteria.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 886 (November 15, 2013)

- The data package was evaluated for U, Se, Mo and Ra in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect, except for Mo in the LRB (0.00004 mg/L).
- CCB and CCV samples were not provided, but ICVs were acceptable.

- All MS/MSDs and ICS were within acceptable criteria.
- All LCS/LCSD were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package 634 (November 23, 2013)

- The data package was evaluated for U, Se, and Mo in water.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471, Amendment 39.
- MBs were analyzed for the aqueous samples and were non-detect.
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs and ICS were within acceptable criteria.
- All LCS/LCSD and LFB samples were within acceptable criteria.
- No lab replicates or serial dilutions were provided.
- No field duplicates were specified.

Energy Package C13120860 (December 2013)

- The report was revised to add pH, conductivity, SAR, sulfate and Mo by Adrian Venable on January 8, 2014. Samples were still within holding times for the metals analyses. No radiochemical data were collected for this data delivery group.
- The data package was evaluated for U, Se, and Mo in soil.
- A QAPP was not provided for this evaluation, but the requirements meet the NRC License SUA-1471 and 10 CFR Part 40, Appendix A, Criterion 6.
- No MB was analyzed for the soil samples; however, the Initial Calibration Blank and PBS samples were non-detect for U, Se, and Mo.
- CCB and CCV samples were not provided, but ICVs were acceptable.
- All MS/MSDs were within acceptable criteria.
- All LCS/LCSD samples were within acceptable criteria.
- No lab replicates were completed. Serial dilutions were completed and acceptable, except for C13120860-025DIL which was qualified as N due to inability to calculate a recovery.
- No field duplicates were specified

The following sections provide an overall evaluation of the usability of the data for the Site.

Precision

Precision is the measurement of agreement in repeated tests of the same or identical samples, under prescribed conditions. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been. For the Site data, precision was determined through replicate measurements of the same or identical samples, i.e., a field duplicate sample. The acceptance criterion for the duplicate is a RPD of less than 20 percent (for aqueous) or 30 percent (for soils). The RPD was not calculated for any set of sample pairs where concentrations were not detected in both of the data sets; agreement between the original sample and the duplicate can be inferred when both of the results are non-detects. The remainder of the sample pairs contained detections in both

of the data sets and were within the RPD limits prescribed. All results outside the specified range are provided in Table 2. Results indicate the sampling program generally achieved good reproducibility.

Accuracy

Accuracy is the degree of agreement of a measured sample result or average of results with an accepted reference or true value. It is the quantitative measurement of the bias of a system, and is expressed in terms of percent recovery (%R). Accuracy of the data can be determined through the use of surrogate compounds, internal standard compounds, matrix spike samples, and laboratory control spike samples. In some cases, the laboratory provided results for the laboratory control sample, laboratory control sample duplicate, laboratory fortified blank and method blank. Results that were outside QC limits and qualified are provided in Table 2. Based on the information provided and available results, the laboratories achieved a good degree of accuracy.

Representativeness

Representativeness is the degree to which the results of the analyses accurately and precisely represent a characteristic of a population, a process condition, or an environmental condition. In this case, representativeness is the degree to which the data reflect the contaminants present and their concentration magnitudes in the sampled site areas. Representativeness of data occurs through the selection of appropriate sampling locations and the implementation of approved sampling procedures. The sampling locations for these rounds of sampling consisted primarily of fixed sample locations.

Comparability

To increase the degree of comparability between data results and between past, present and future sampling events, standard environmental analytical methods were employed by the off-site laboratories. The methods used were standard EPA methodology for soil and aqueous samples. In general, the EPA 200 series methods or the SW-846 protocols were used to complete the analyses.

Completeness

Completeness is determined by the percentage of samples that meet or exceed all of the criteria objective levels (i.e., the number of useable sample results for the data set). Most of the sample results were determined to be useable. Several of the laboratory samples, primarily replicates, indicated much higher RPDs than acceptable. These data should be qualified as “P”, and further evaluated to determine if they should be rejected.

Sensitivity

Sensitivity is the ability of the analytical method or instrument to detect a target analyte at the level of interest. The method detection limit (MDL) is a statistically-derived value that represents a 99 percent confidence level that the reported instrument signal is different from a blank sample. The quantitation limit (QL) is the minimum concentration of an analyte that can be routinely identified by the laboratory, and is generally between three and ten times the MDL. Analytical methods are matrix-, moisture-and dilution-dependent. The reporting limit (RL) actually determined for a constituent for a specific sample may be higher than the QL due to these issues. The laboratory was able to achieve the appropriate limits for each analyte requested.

Table 2: Additional Qualifiers and Rationale

Sample #	Date	Q	Rationale
L78105-18DUP	ACZ-09-03/4-2009	P	Ra RPD-RER of 3.43 greater than acceptance limit of 2 RPD-RER. This sample should be evaluated as an outlier and potentially rejected.
L78107-01DUP	ACZ-09-03/4-2009	P	Ra RPD-RER of 8.24 greater than acceptance limit of 2 RPD-RER. This sample should be evaluated as an outlier and potentially rejected.
WG271357	ACZ-09-03/4-2009	B	Ra PBS indicated detections above MDL
WG271791	ACZ-09-03/4-2009	B	Th PBs indicated detections above MDL
C13020313-001EDUP	Energy-05-05-2013	P	Ra RPD (24%) exceeded acceptance criteria of 20%. This sample should be further evaluated as an outlier and potentially rejected.
All Dissolved Metals	Energy-08-08-2013	E	Metals were not filtered by the laboratory in a timely manner (up to 4.68 days). Data are estimated.
All Dissolved Metals	Energy-08-15-2013	E	Metals were not filtered by the laboratory in a timely manner (up to 14.7 days). Data are estimated.
C13120860-025DIL	Energy-12-17-2013	N	Serial dilutions qualified due to inability to calculate a recovery.

Usability Summary

The definitive data for the Homestake events fulfilled the site-specific quality assurance/quality control (QA/QC) requirements, as the majority of the results were determined to be useable. Therefore, the results are acceptable for use to support Site decisions with a few possible exceptions that are noted in Table 2 related to the RPD-RER.

References

10 CFR Part 40, Appendix A, Criterion 6

MARLAP Section 8, Radioactive Data Verification and Validation, July 2004.

NRC License SUA-1471, Amendment 39.

EPA Method 6020, SW-846 Test Methods for Evaluating Solid Waste, 3rd Edition, 1986 (latest revision).

EPA Method 200.7, Determination of Metals And Trace Elements In Water And Wastes By Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 4.4.

EPA Method 200.8, Determination of Trace Elements In Waters And Wastes By Inductively Coupled Plasma - Mass Spectrometry, Revision 5.4.

EPA Method 903.0, Alpha-Emitting Radium Isotopes In Drinking Water (latest revision).

EPA Method 908.0, Uranium in Drinking Water - Radiochemical Method (latest revision).

EPA National Functional Guidelines for Inorganic Superfund Data Review (ISM02.1), OSWER 9200.2-133, EPA 540-R-013-001, October 2013

Appendix H

Risk Assessment Guidance for Superfund Part D Planning Tables

TABLE 0

SITE RISK ASSESSMENT IDENTIFICATION INFORMATION

Site Name: Homestake Mining Company Superfund Site

Site Name/OU:	Homestake Mining Company Superfund Site, Cibola County, New Mexico • OU1: Tailings seepage contamination of groundwater aquifers • OU2: Long-term tailings stabilization, surface reclamation and site closure
Region:	VI
EPA ID Number:	NMD007860935
State:	New Mexico
Status:	NPL Final
Federal Facility (Y/N):	N
EPA Project Manager:	Mark Purcell
EPA Risk Assessor:	Dr. Ghassan A. Khoury
Prepared by (Organization):	Homestake Mining Company
Prepared for (Organization):	EPA, Region VI
Document Title:	Remedial Investigation
Document Date:	September 2019
Probabilistic Risk Assessment (Y/N):	N
Comments:	

TABLE 1.1
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Soil	Surface a Soil	WLB	CI-IOW	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
								Future use is likely limited to maintenance of protective tailing caps and site facilities
		Particulates (Dust)	WLB	CI-IOW	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air

TABLE 1.2
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Air	Indoor /Outdoor Air	WLB	CI-IOW	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers

TABLE 1.3
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Soil	Surface Soil	LTAs	CI-IOW	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
								Future use is likely limited to maintenance of protective tailing caps and site facilities
		Particulates (Dust)	LTAs	CI-IOW	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air

TABLE 1.4
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Air	Indoor /Outdoor Air	LTAs	CI-IOW	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers

Key: WLB = within license boundary (on-Site); LTAs = land treatment areas (off-Site); CI-IOW = commercial-industrial indoor/outdoor worker

TABLE 1.5
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Soil	Surface and Subsurface Soil	WLB	Construction Worker	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
								Future use is likely limited to maintenance of protective tailing caps and site facilities
		Particulates (Dust)	WLB	Construction Worker	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air

TABLE 1.6
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Air	Outdoor Air	WLB	Construction Worker	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
		Trench Air (modeled from indoor air)	WLB	Construction Worker	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers

TABLE 1.7
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Soil	Surface and Subsurface Soil	LTAs	Construction Worker	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind;
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
								Future use is likely limited to maintenance of protective tailing caps and site facilities
		Particulates (Dust)	LTAs	Construction Worker	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air

TABLE 1.8
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Air	Outdoor Air	LTAs	Construction Worker	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
		Trench Air (modeled from indoor air)	LTAs	Construction Worker	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers

Key: WLB = within license boundary (on-Site); LTAs = land treatment areas (off-Site)

TABLE 1.9
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Soil	Surface Soil	WLB	Trespasser	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
		Particulates (Dust)	WLB	Trespasser	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air
Future	Soil	Surface Soil	WLB	Trespasser	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
		Particulates (Dust)	WLB	Trespasser	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air

TABLE 1.10
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Outdoor Air	Air	WLB	Trespasser	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
Future	Outdoor Air	Air	WLB	Trespasser	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to onsite workers

TABLE 1.11
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Water	Pond Water	WLB	Trespasser	Adult	Incidental Ingestion	Quantitative	Potential for accidental exposure to pond water during operations
						Immersion	Quantitative	Presence of gamma-emitting radionuclides
						Inhalation	Quantitative	There is no exposure pathway for inhalation in the EPA Rad PRG calculator; addressed through evaluation of outdoor air
Current	Sediment	Sediment	WLB	Trespasser	Adult	Incidental Ingestion	Quantitative	Potential for accidental exposure during operations
						Particulate Inhalation	Quantitative	Potential for accidental exposure tduring operations
						External Radiation	Quantitative	Potential for accidental exposure during operations

TABLE 1.12
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Soil	Surface Soil	LTAs	Trespasser	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
		Particulates (Dust)	LTAs	Trespasser	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air
Future	Soil	Surface Soil	LTAs	Trespasser	Adult	Incidental Ingestion	Quantitative	Soil is exposed, not vegetated, and subject to wind
						External Radiation	Quantitative	Presence of gamma-emitting radionuclides in soil
		Particulates (Dust)	LTAs	Trespasser	Adult	Inhalation	Quantitative	Soil particulates can be easily transported into the air

Key: WLB = within license boundary (on-Site); LTAs = land treatment areas (off-Site)

TABLE 1.13
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Ambient Air	Air	LTAs	Trespasser	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to ambient air
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to ambient air
Future	Ambient Air	Air	LTAs	Trespasser	Adult	Inhalation	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to ambient air
						Submersion	Quantitative	Potential release of radon gas and particulates from soil and tailings pile to ambient air

Key: WLB = within license boundary (on-Site); LTAs = land treatment areas (off-Site)

TABLE 1.14
SELECTION OF EXPOSURE PATHWAYS
Homestake Mining Company Superfund Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Groundwater	Drinking Water	LTAs	CI-IOW	Adult	Ingestion	Quantitative	Potable water supply; Remediated to Action Levels of background and MCLs
						Immersion	Quantitative	Presence of gamma-emitting radionuclides
						Inhalation	Quantitative	There is no exposure pathway for inhalation in the EPA Rad PRG calculator; addressed through evaluation of outdoor air

Key: WLB = within license boundary (on-Site); LTAs = land treatment areas (off-Site)

TABLE 2.1.1

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Homestake Mining Company Superfund Site

Scenario Timeframe: Future - Default Composite Worker
Medium: Soil
Exposure Medium: **Surface Soil**
Exposure Point: LTAs

CAS Number	Chemical		Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Detection Frequency			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (SL) (4)	COPC or ROPC Flag (Y/N)	Rationale for Selection or Deletion (5)
7440-38-2	As	Arsenic	2.04	6.79	mg/kg	19	/	19	6.79	*5.01*	3	Y	MDC>SL
14798-08-4	Ba-140	Barium-140	0	0	pCi/g	0	/	21	NV	All ND	0.0143	N	NA
14913-49-6	Bi-212	Bismuth-212	0.45	1.71	pCi/g	21	/	21	1.71	*1.195*	0.0258	Y	MDC>SL
14733-03-3	Bi-214	Bismuth-214	0.43	1.44	pCi/g	21	/	21	1.44	*0.948*	0.0231	Y	MDC>SL
10198-40-0	Co-60	Cobalt-60	0	0	pCi/g	0	/	21	NV	All ND	0.0142	N	NA
10045-97-3	Cs-137	Cesium-137	0.016	0.114	pCi/g	21	/	21	0.114	*0.0731*	0.069	Y	MDC>SL
10043-66-0	I-131	Iodine-131	0	0	pCi/g	0	/	21	NV	All ND	0.109	N	NA
13966-00-2	K-40	Potassium-40	11.5	20.3	pCi/g	21	/	21	20.3	*18.35*	0.219	Y	MDC>SL
7439-98-7	Mo	Molybdenum	0.283	1.28	mg/kg	19	/	21	1.28	0.447	580	N*	MDC<SL
15100-28-4	Pa-234m	metastable	0.66	3.3	pCi/g	13	/	13	3.3	*1.15*	0.02	Y	MDC>SL
7439-92-1	Pb	Lead	3.47	18	mg/kg	19	/	19	18	*11.94*	800	N	MDC<SL
15092-94-1	Pb-212	Lead-212	0.419	1.52	pCi/g	21	/	21	1.52	*1.104*	0.024	Y	MDC>SL
15067-28-4	Pb-214	Lead-214	0.485	1.55	pCi/g	21	/	21	1.55	*1.017*	0.0204	Y	MDC>SL
15623-45-7	Ra-223	Radium-223	0.093	0.364	pCi/g	17	/	17	0.364	*0.296*	0.146	Y	MDC>SL
13982-63-3	Ra-226	Radium-226	0.29	3.9	pCi/g	247	/	247	3.9	*1.81*	0.0203	Y	MDC>SL
15262-20-1	Ra-228	Radium-228	0.453	1.66	pCi/g	21	/	21	1.66	1.139	0.0153	Y	MDC>SL
7782-49-2	Se	Selenium	0.3	2.6	mg/kg	181	/	204	2.6	0.799	580	N*	MDC<SL
15623-47-9	Th-227	Thorium-227	0.087	0.087	pCi/g	1	/	1	0.087	*0.13*	0.106	N	MDC<SL
14274-82-9	Th-228	Thorium-228	1.02	1.84	pCi/g	6	/	6	1.84	*1.412*	0.0238	Y	MDC>SL
14269-63-7	Th-230	Thorium-230	0.1	3.4	pCi/g	30	/	47	3.4	*1.393*	0.0203	Y	MDC>SL
7440-29-1	Th-232	Thorium-232	1.04	1.92	pCi/g	6	/	6	1.92	1.135	0.0153	Y	MDC>SL
7440-61-1	Th-234	Thorium-234	0.27	2.09	pCi/g	15	/	15	2.09	*0.703*	0.02	Y	MDC>SL
14913-50-9	Tl-208	Thallium-208	0.134	0.5	pCi/g	21	/	21	0.5	*0.357*	0.01	Y	MDC>SL
	U total	Uranium total	1.45	7.47	mg/kg	41	/	41	7.47	NV	23	N	MDC<SL
13966-29-5	U-234	Uranium-234	0.88	2.73	pCi/g	6	/	6	2.73	1.141	0.0203	Y	MDC>SL
15117-96-1	U-235	Uranium-235	0.059	0.193	pCi/g	15	/	15	0.193	*0.112*	0.0731	Y	MDC>SL
7440-61-1	U-238	Uranium-238	1.06	2.49	pCi/g	6	/	6	2.49	1.147	0.02	Y	MDC>SL
	U-nat (mg/kg)	U-natural (mg/kg)	0.5	7.2	mg/kg	185	/	185	7.2	NV	23	N	MDC<SL
7440-62-2	V	Vanadium	9.16	39.6	mg/kg	19	/	19	39.6	29.87	580	N	MDC<SL

Footnote Instructions:

(1) no qualifier codes provided with data
(2) maximum detected concentration, MDC
(3) Background threshold value is the UCL95 calculated with ProUCL (2015), except Pa234m which is the mean
(4) EPA, 2019 and ORNL/EPA, 2019
(5) MDC < SSL: maximum detected concentration is less than the soil screening level; MDC>SSL : MDC is greater than the :
mg/kg = milligram per kilogram
NA = not available or not applicable
pCi/g = picoCurie per gram

Y = Yes analyte is carried forward; N = analyte is not carried forward
NV - No value
ND - Not detected
* - Carried forward at request of EPA
Italics, shaded - statistical hypothesis testing indicated site was less than background

TABLE 2.1.2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Scenario Timeframe: Future - Default Composite Worker
Medium: Soil
Exposure Medium: **Surface Soil**
Exposure Point: Homestake Facility

CAS Number	Analyte		Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Detection Frequency			Concentratior Used for Screening (2)	Background Value (3)	Screening oxicity Value (SL (N/C) (4)	COPC or ROPC Flag (Y/N)	Rationale for Selection or Deletion (5)
7440-38-2	As	Arsenic	1.91	9.58	mg/kg	26	/	26	9.58	5.01	3	Y	MDC>SL
14798-08-4	Ba-140	Barium-140	All ND	All ND	pCi/g	0	/	27	All ND	All ND	0.0143	N	All ND
14913-49-6	Bi-212	Bismuth-212	0.39	2.04	pCi/g	27	/	27	2.04	1.195	0.0258	Y	MDC>SL
14733-03-3	Bi-214	Bismuth-214	0.504	5.79	pCi/g	27	/	27	5.79	0.948	0.0231	Y	MDC>SL
10198-40-0	Co-60	Cobalt-60	All ND	All ND	pCi/g	0	/	27	All ND	All ND	0.0142	N	All ND
10045-97-3	Cs-137	Cesium-137	0.0105	0.151	pCi/g	20	/	27	0.151	*0.0731*	0.069	Y	MDC>SL
10043-66-0	I-131	Iodine-131	All ND	All ND	pCi/g	0	/	27	All ND	All ND	0.109	N	All ND
13966-00-2	K-40	Potassium-40	12.9	21.2	pCi/g	27	/	27	21.2	*18.35*	0.219	Y	MDC>SL
7439-98-7	Mo	Molybdenum	0.619	126	mg/kg	33	/	43	126	0.447	580	N*	MDC<SL
15100-28-4	Pa-234m	metastable	1.2	18.9	pCi/g	26	/	26	18.9	1.15	0.02	Y	MDC>SL
7439-92-1	Pb	Lead	3.88	19.7	mg/kg	26	/	26	19.7	11.94	800	N	MDC<SL
15092-94-1	Pb-212	Lead-212	0.425	1.67	pCi/g	27	/	27	1.67	*1.104*	0.024	Y	MDC>SL
15067-28-4	Pb-214	Lead-214	0.54	6.13	pCi/g	27	/	27	6.13	1.017	0.0204	Y	MDC>SL
15623-45-7	Ra-223	Radium-223	0.097	0.67	pCi/g	20	/	20	0.67	0.296	0.146	Y	MDC>SL
13982-63-3	Ra-226	Radium-226	0.65	9	pCi/g	50	/	50	9	1.81	0.0203	Y	MDC>SL
15262-20-1	Ra-228	Radium-228	0.483	1.71	pCi/g	27	/	27	1.71	1.139	0.0153	Y	MDC>SL
14835-02-0	Rn-219	Radon-219	0.124	0.29	pCi/g	3	/	3	0.29	NV	NV	N	MDC<SL
7782-49-2	Se	Selenium	0.283	11.1	mg/kg	30	/	43	11.1	0.799	580	N*	MDC<SL
15623-47-9	Th-227	Thorium-227	0.047	0.227	pCi/g	8	/	8	0.227	*0.13*	0.106	Y	MDC>SL
14274-82-9	Th-228	Thorium-228	0.47	2.34	pCi/g	27	/	27	2.34	*1.412*	0.0238	Y	MDC>SL
14269-63-7	Th-230	Thorium-230	0.44	7.4	pCi/g	50	/	51	7.4	1.393	0.0203	Y	MDC>SL
7440-29-1	Th-232	Thorium-232	0.39	1.81	pCi/g	27	/	27	1.81	*1.135*	0.0153	Y	MDC>SL
7440-61-1	Th-234	Thorium-234	0.28	11.2	pCi/g	20	/	20	11.2	0.703	0.02	Y	MDC>SL
14913-50-9	Tl-208	Thallium-208	0.138	0.527	pCi/g	27	/	27	0.527	0.357	0.01	Y	MDC>SL
NA	U natural (pCi/g)	Uranium, natural (pCi/g)	1	30	pCi/g	24	/	24	30	1.14	0.02015	Y	MDC>SL
NA	U total	Uranium, total	2	44	mg/kg	24	/	49	44	NV	23	Y	MDC>SL
13966-29-5	U-234	Uranium-234	0.58	18.3	pCi/g	27	/	27	18.3	1.141	0.0203	Y	MDC>SL
15117-96-1	U-235	Uranium-235	0.071	0.697	pCi/g	27	/	27	0.697	*0.112*	0.0731	Y	MDC>SL
7440-61-1	U-238	Uranium-238	0.79	19	pCi/g	27	/	27	19	1.147	0.02	Y	MDC>SL
7440-62-2	V	Vanadium	11.7	60.7	mg/kg	26	/	26	60.7	29.87	580	N	MDC<SL

Footnote Instructions:

(1) no qualifier codes provided with data
(2) maximum detected concentration, MDC
(3) Background threshold value is the UCL95 calculated with ProUCL (2015), except Pa234m which is the mean
(4) EPA, 2019 and ORNL/EPA, 2019
(5) MDC < SSL: maximum detected concentration is less than the soil screening level; MDC>SSL : MDC is greater than the SSL; ND = no
mg/kg = milligram per kilogram
NA = not available or not applicable
pCi/g = picoCurie per gram

Y = Yes analyte is carried forward; N = analyte is not carried forward
NV - No value
ND - Not detected
* - Carried forward at request of EPA
Italics, shaded - statistical hypothesis testing indicated site was less than background

TABLE 2.1.3
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Scenario Timeframe: Current
Medium: Water
Exposure Medium: **Surface Water/Pond Water**
Exposure Point: Evaporation Ponds

CAS Number	Analyte		Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Detection Frequency			Concentration Used for Screening (2)	Background	Screening Toxicity Value (SL) (N/C) (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
7439-96-5	Manganese (total	Mn	0.001	1.4	mg/L	42	/	43	674	NA	0.043	Y	MDC>SL
7439-98-7	Molybdenum	Mo	3.46	4300	mg/L	95	/	95	0.0789	NA	0.01	Y	MDC>SL
7439-98-7	Molybdenum (tota	Mo	3.82	4760	mg/L	80	/	80	270	NA	0.01	Y	MDC>SL
14797-55-8	Nitrate	NO3	0.1	9	mg/L	15	/	25	4.7	NA	3.2	Y	MDC>SL
Ra-226	Ra-226	Ra-226	0.06	130	pCi/L	24	/	24	1.16	NA	0.000397	Y	MDC>SL
Ra-228	Ra228	Ra228	-0.5	140	pCi/L	21	/	24	59	NA	0.000966	Y	MDC>SL
7782-49-2	Selenium	Se	0.131	1.48	mg/L	95	/	95	135	NA	0.01	Y	MDC>SL
7782-49-2	Selenium (total)	Se	0.11	5.98	mg/L	63	/	64	1030	NA	0.01	Y	MDC>SL
Th-230	Th230	Th231	0.006	2210	pCi/L	24	/	24	34	NA	0.000396	Y	MDC>SL
E715565	U-natural	U-natural	1.89	2680	mg/L	95	/	95	129000	NA	0.0004	Y	MDC>SL
E715565	U-natural (total)	U-natural (total)	2	2940	mg/L	80	/	80	6600	NA	0.0004	Y	MDC>SL
7440-62-2	Vanadium	Vanadium	0.01	0.32	mg/L	16	/	24	129000	NA	0.0086	Y	MDC>SL

Footnote Instructions:

(1) no qualifier codes provided with data
(2) maximum detected concentration, MDC
(3) Background threshold value calculated with ProUCL (2015)
(4) EPA, 2019 and ORNL/EPA, 2019
(5) MDC < SSL: maximum detected concentration is less than the soil screening level; MDC>SSL : MDC is greater than the SSL
mg/kg = milligram per kilogram
NA = not available or not applicable
pCi/g = picoCurie per gram
SL was either a tapwater RSL (EPA, 2019) for metals or a residential tapwater RadPRG (ORNL/EPA, 2019) for radionuclides

Y = Yes analyte is carried forward; N = analyte is not carried forward
NV - No value
ND - Not detected

TABLE 2.1.4
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Scenario Timeframe: Current & Future
Medium: Air
Exposure Medium: **Indoor/Outdoor Air**
Exposure Point: Homestake Facility and LTAs

CAS Number	Analyte		Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Detection Frequency			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Ra-226	Radium-226	Ra-226	2E-12	2E-10	pCi/L	120	/	120	2E-10	NA	1.35E-07	N	MDC<SL
14859-67-7	Radon-222	Rn-222	0.37	2.9	pCi/L	200	/	200	2.9	0.551 HMC16 2 Cibola Cty Indoor Air	2.58E-07	Y	**MDC>SL**
Th-230	Thorium-230	Th-230	3E-12	3E-10	pCi/L	120	/	120	3E-10	NA	8.58E-08	N	MDC<SL
U-Nat	Uranium-natural	U-Nat	1.9E-13	6.7E-09	pCi/L	120	/	120	6.7E-09	NA	2.54E-08	N	MDC<SL

Footnote Instructions:

(1) no qualifier codes provided with data
(2) maximum detected concentration, MDC
(3) Background threshold value calculated with ProUCL (2015)
(4) ORNL/EPA, 2019
(5) MDC < SSL: maximum detected concentration is less than the soil screening level; MDC>SSL : MDC is greater than the SSL; ND = not detected
NA = not available or not applicable
pCi/L = picoCurie per liter

Y = Yes analyte is carried forward; N = analyte is not carried forward
NV - No value
ND - Not detected
Background for particulates not calculated since they were som much lower than the screening levels

TABLE 2.1.5
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Scenario Timeframe: Future -Construction Worker
Medium: Soil
Exposure Medium: **Surface and Subsurface Soil**
Exposure Point: LTAs

CAS Number	Chemical		Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Detection Frequency			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (SL) (4)	COPC or ROPC Flag (Y/N)	Rationale for Selection or Deletion (5)
7440-38-2	As	Arsenic	2.04	6.79	mg/kg	19	/	19	6.79	*5.01*	3	Y	MDC>SL
14798-08-4	Ba-140	Barium-140	0	0	pCi/g	0	/	21	NV	All ND	0.0143	N	NA
14913-49-6	Bi-212	Bismuth-212	0.45	1.71	pCi/g	21	/	21	1.71	*1.195*	0.0258	Y	MDC>SL
14733-03-3	Bi-214	Bismuth-214	0.43	1.44	pCi/g	21	/	21	1.44	*0.948*	0.0231	Y	MDC>SL
10198-40-0	Co-60	Cobalt-60	0	0	pCi/g	0	/	21	NV	All ND	0.0142	N	NA
10045-97-3	Cs-137	Cesium-137	0.016	0.114	pCi/g	21	/	21	0.114	*0.0731*	0.069	Y	MDC>SL
10043-66-0	I-131	Iodine-131	0	0	pCi/g	0	/	21	NV	All ND	0.109	N	NA
13966-00-2	K-40	Potassium-40	11.5	20.3	pCi/g	21	/	21	20.3	*18.35*	0.219	Y	MDC>SL
7439-98-7	Mo	Molybdenum	0.283	4	mg/kg	51	/	134	4	0.447	580	N*	MDC<SL
15100-28-4	Pa-234m	Protactinium-234 metastable	0.66	3.3	pCi/g	13	/	13	3.3	*1.15*	0.02	Y	MDC>SL
7439-92-1	Pb	Lead	3.47	18	mg/kg	19	/	19	18	*11.94*	800	N	MDC<SL
15092-94-1	Pb-212	Lead-212	0.419	1.52	pCi/g	21	/	21	1.52	*1.104*	0.024	Y	MDC>SL
15067-28-4	Pb-214	Lead-214	0.485	1.55	pCi/g	21	/	21	1.55	*1.017*	0.0204	Y	MDC>SL
15623-45-7	Ra-223	Radium-223	0.093	0.364	pCi/g	17	/	17	0.364	*0.296*	0.146	Y	MDC>SL
13982-63-3	Ra-226	Radium-226	0.218	3.9	pCi/g	309	/	309	3.9	*1.81*	0.0203	Y	MDC>SL
15262-20-1	Ra-228	Radium-228	0.453	1.66	pCi/g	21	/	21	1.66	1.139	0.0153	Y	MDC>SL
7782-49-2	Se	Selenium	0.06	2.6	mg/kg	244	/	319	2.6	0.799	580	N*	MDC<SL
15623-47-9	Th-227	Thorium-227	0.087	0.087	pCi/g	1	/	1	0.087	*0.13*	0.106	N	MDC<SL
14274-82-9	Th-228	Thorium-228	1.02	1.84	pCi/g	6	/	6	1.84	*1.412*	0.0238	Y	MDC>SL
14269-63-7	Th-230	Thorium-230	0.1	3.4	pCi/g	65	/	109	3.4	*1.393*	0.0203	Y	MDC>SL
7440-29-1	Th-232	Thorium-232	1.04	1.92	pCi/g	6	/	6	1.92	1.135	0.0153	Y	MDC>SL
7440-61-1	Th-234	Thorium-234	0.27	2.09	pCi/g	15	/	15	2.09	*0.703*	0.02	Y	MDC>SL
14913-50-9	Tl-208	Thallium-208	0.134	0.5	pCi/g	21	/	21	0.5	*0.357*	0.01	Y	MDC>SL
	U total	Uranium total	0.19	7.47	mg/kg	192	/	218	7.47	NV	23	N	MDC<SL
13966-29-5	U-234	Uranium-234	0.88	2.73	pCi/g	6	/	6	2.73	1.141	0.0203	Y	MDC>SL
15117-96-1	U-235	Uranium-235	0.059	0.193	pCi/g	15	/	15	0.193	*0.112*	0.0731	Y	MDC>SL
7440-61-1	U-238	Uranium-238	1.06	2.49	pCi/g	6	/	6	2.49	1.147	0.02	Y	MDC>SL
	U-nat (mg/kg)	U-natural (mg/kg)	0.5	7.2	mg/kg	185	/	185	7.2	NV	23	N	MDC<SL
7440-62-2	V	Vanadium	9.16	39.6	mg/kg	19	/	19	39.6	29.87	580	N	MDC<SL

Footnote Instructions:

(1) no qualifier codes provided with data
(2) maximum detected concentration, MDC
(3) Background threshold value is the UCL95 calculated with ProUCL (2015)
(4) EPA, 2019 and ORNL/EPA, 2019

(5) MDC < SSL: maximum detected concentration is less than the soil screening level; MDC>SSL : MDC is greater than the SSL; ND = not detected
mg/kg = milligram per kilogram
NA = not available or not applicable
pCi/g = picoCurie per gram

Y = Yes analyte is carried forward; N = analyte is not carried forward
NV - No value
ND - Not detected
* - Carried forward at request of EPA

Italics, shaded - statistical hypothesis testing indicated site was less than background

TABLE 2.1.6
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Scenario Timeframe: Future -Construction Worker
Medium: Soil
Exposure Medium: **Surface and Subsurface Soil**
Exposure Point: Homestake Facility

CAS Number	Analyte		Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Detection Frequency			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (SL) (N/C) (4)	COPC or ROPC Flag (Y/N)	Rationale for Selection or Deletion (5)
7440-38-2	As	Arsenic	1.91	9.58	mg/kg	26	/	26	9.58	5.01	3	Y	MDC>SL
14798-08-4	Ba-140	Barium-140	All ND	All ND	pCi/g	0	/	27	All ND	All ND	0.0143	N	All ND
14913-49-6	Bi-212	Bismuth-212	0.39	2.04	pCi/g	27	/	27	2.04	1.195	0.0258	Y	MDC>SL
14733-03-3	Bi-214	Bismuth-214	0.504	5.79	pCi/g	27	/	27	5.79	0.948	0.0231	Y	MDC>SL
10198-40-0	Co-60	Cobalt-60	All ND	All ND	pCi/g	0	/	27	All ND	All ND	0.0142	N	All ND
10045-97-3	Cs-137	Cesium-137	0.0105	0.151	pCi/g	20	/	27	0.151	*0.0731*	0.069	Y	MDC>SL
10043-66-0	I-131	Iodine-131	All ND	All ND	pCi/g	0	/	27	All ND	All ND	0.109	N	All ND
13966-00-2	K-40	Potassium-40	12.9	21.2	pCi/g	27	/	27	21.2	*18.35*	0.219	Y	MDC>SL
7439-98-7	Mo	Molybdenum	0.619	126	mg/kg	33	/	61	126	0.447	580	N*	MDC<SL
15100-28-4	Pa-234m	Protactinium-234 metastable	1.2	18.9	pCi/g	26	/	26	18.9	1.15	0.02	Y	MDC>SL
7439-92-1	Pb	Lead	3.88	19.7	mg/kg	26	/	26	19.7	11.94	800	N	MDC<SL
15092-94-1	Pb-212	Lead-212	0.425	1.67	pCi/g	27	/	27	1.67	*1.104*	0.024	Y	MDC>SL
15067-28-4	Pb-214	Lead-214	0.54	6.13	pCi/g	27	/	27	6.13	1.017	0.0204	Y	MDC>SL
15623-45-7	Ra-223	Radium-223	0.097	0.67	pCi/g	20	/	20	0.67	0.296	0.146	Y	MDC>SL
13982-63-3	Ra-226	Radium-226	0.65	9	pCi/g	50	/	75	9	1.81	0.0203	Y	MDC>SL
15262-20-1	Ra-228	Radium-228	0.483	1.71	pCi/g	27	/	27	1.71	1.139	0.0153	Y	MDC>SL
14835-02-0	Rn-219	Radon-219	0.124	0.29	pCi/g	3	/	3	0.29	NV	NV	N	MDC<SL
7782-49-2	Se	Selenium	0.283	11.1	mg/kg	30	/	61	11.1	0.799	580	N*	MDC<SL
15623-47-9	Th-227	Thorium-227	0.047	0.227	pCi/g	8	/	8	0.227	*0.13*	0.106	Y	MDC>SL
14274-82-9	Th-228	Thorium-228	0.47	2.34	pCi/g	27	/	27	2.34	*1.412*	0.0238	Y	MDC>SL
14269-63-7	Th-230	Thorium-230	-0.1	7.4	pCi/g	50	/	76	7.4	1.393	0.0203	Y	MDC>SL
7440-29-1	Th-232	Thorium-232	0.39	1.81	pCi/g	27	/	27	1.81	*1.135*	0.0153	Y	MDC>SL
7440-61-1	Th-234	Thorium-234	0.28	11.2	pCi/g	20	/	20	11.2	0.703	0.02	Y	MDC>SL
14913-50-9	Tl-208	Thallium-208	0.138	0.527	pCi/g	27	/	27	0.527	0.357	0.01	Y	MDC>SL
NA	U natural (pCi/g)	Uranium, natural (pCi/g)	1	30	pCi/g	24	/	49	30	1.14	0.02015	Y	MDC>SL
NA	U total	Uranium, total	2	44	mg/kg	24	/	49	44	NV	23	Y	MDC>SL
13966-29-5	U-234	Uranium-234	0.58	18.3	pCi/g	27	/	27	18.3	1.141	0.0203	Y	MDC>SL
15117-96-1	U-235	Uranium-235	0.071	0.697	pCi/g	27	/	27	0.697	*0.112*	0.0731	Y	MDC>SL
7440-61-1	U-238	Uranium-238	0.79	19	pCi/g	27	/	27	19	1.147	0.02	Y	MDC>SL
7440-62-2	V	Vanadium	11.7	60.7	mg/kg	26	/	26	60.7	29.87	580	N	MDC<SL

Footnote Instructions:

(1) no qualifier codes provided with data
(2) maximum detected concentration, MDC
(3) Background threshold valueis the UCL95 calculated with ProUCL (2015)
(4) EPA, 2019 and ORNL/EPA, 2019
(5) MDC < SSL: maximum detected concentration is less than the soil screening level; MDC>SSL : MDC is greater than the SSL; ND = no
mg/kg = milligram per kilogram
NA = not available or not applicable
pCi/g = picoCurie per gram

Y = Yes analyte is carried forward; N = analyte is not carried forward
NV - No value
ND - Not detected
* - Carried forward at request of EPA
Italics, shaded - statistical hypothesis testing indicated site was less than background

TABLE 2.1.7
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Scenario Timeframe: Current
Medium: Sediment
Exposure Medium: Evaporation Pond Sediment
Exposure Point: Evaporation Ponds

CAS Number	Analyte		Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Detection Frequency			Concentration Used for Screening (2)	Background	Screening Toxicity Value (SL) (N/C) (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Ra-226	Ra-226	Ra-226	32.5	32.5	pCi/g	1	/	1	32.5	NA	0.0203	Y	MDC>SL
Th-230	Th230	Th230	0.5	0.5	pCi/g	1	/	1	0.5	NA	0.0203	Y	MDC>SL
E715565	U-natural	U-natural	2566	2566	pCi/g	1	/	1	2566	NA	0.02015	Y	MDC>SL

Footnote Instructions:

(1) no qualifier codes provided with data
(2) maximum detected concentration, MDC
(3) Background threshold value calculated with ProUCL (2015)
(4) EPA, 2019 and ORNL/EPA, 2019 Industrial soil SL
(5) MDC < SL: maximum detected concentration is less than the soil screening level; MDC>SL : MDC is greater than the SL; ND = not detected
mg/kg = milligram per kilogram
NA = not available or not applicable
pCi/g = picoCurie per gram
SL was either a tapwater RSL (EPA, 2019) for metals or a residential tapwater RadPRG (ORNL/EPA, 2019) for radionuclides

Y = Yes analyte is carried forward; N = analyte is not carried forward
NV - No value
ND - Not detected

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site
Table 3.1.1

Scenario Timeframe: Future Composite Worker, Current/Future Trespasser
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: LTAs

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
LTAs	As	mg/kg	3.73	Approx. Gamma	6.79	4.693	mg/kg	95% Adjusted Gamma UCL	Recommended value
	Bi-212	pCi/g	0.84	No Dist	1.71	1.015	pCi/g	95% Student's-t UCL	Recommended value
	Bi-214	pCi/g	0.72	No Dist	1.44	0.87	pCi/g	95% Modified-t UCL	Recommended value
	Cs-137	pCi/g	0.06	Normal	0.114	0.0711	pCi/g	95% Student's-t UCL	Recommended value
	K-40	pCi/g	14.87	Normal	20.3	15.92	pCi/g	95% Student's-t UCL	Recommended value
	Mo	mg/kg	0.50	No Dist	1.28	0.628	mg/kg	95% Modified t UCL	< SLs but retain
	Pa-234m	pCi/g	1.45	Gamma	3.3	1.844	pCi/g	95% Adjusted Gamma UCL	Recommended value
	Pb-212	pCi/g	0.77	No Dist	1.52	0.935	pCi/g	95% Student's-t UCL	Recommended value
	Pb-214	pCi/g	0.78	No Dist	1.55	0.942	pCi/g	95% Modified-t UCL	Recommended value
	Ra-223	pCi/g	0.20	Approx. Lognormal	0.364	0.253	pCi/g	95% H-UCL	Recommended value
	Ra-226	pCi/g	1.37	Gamma	3.9	1.41	pCi/g	95% Approximate Gamma UCL	Recommended value
	Ra-228	pCi/g	0.80	No Dist	1.66	0.978	pCi/g	95% Student's-t UCL	Recommended value
	Se	mg/kg	0.76	No Dist	2.6	1.12	mg/kg	99% KM (Chebyshev) UCL	< SLs but retain
	Th-228	pCi/g	1.48	Normal	1.84	1.763	pCi/g	95% Student's-t UCL	Recommended value
	Th-230	pCi/g	1.45	Normal	3.4	1.164	pCi/g	95% KM (t) UCL	Recommended value
	Th-232	pCi/g	1.48	Normal	1.92	1.74	pCi/g	95% Student's-t UCL	Recommended value
	Th-234	pCi/g	0.63	Gamma	2.09	0.892	pCi/g	95% Adjusted Gamma UCL	Recommended value
	Tl-208	pCi/g	0.24	No Dist.	0.5	0.294	pCi/g	95% Student's-t UCL	Recommended value
	U natural (pCi/g)	pCi/g	1.71	No Data	2.73	2.22	pCi/g	NA	Mean of U-234 and U-
	U total	mg/kg	3.51	No Dist.	7.47	3.987	mg/kg	95% Modified t UCL	< SLs but retain
	U-234	pCi/g	1.66	Normal	2.73	2.23	pCi/g	95% Student's-t UCL	Recommended value
	U-235	pCi/g	0.11	No Dist	0.193	0.131	pCi/g	95% Student's-t UCL	Recommended value
	U-238	pCi/g	1.76	Normal	2.49	2.21	pCi/g	95% Student's-t UCL	Recommended value
	U-nat	mg/kg	2.00	No Dist	7.2	2.791	mg/kg	95% Chebyshev (Mean, Sd) UCL	< SLs but retain

Footnote Instructions:
1) NA = not applicable
2) MDC = maximum detectable concentration; UCL=upper confidence limit
LTAs = land treatment areas
mg/kg = milligram per kilogram
pCi/g = picoCurie per gram
ProUCL V5.0.00 (EPA, 2013)

Dist - Distribution
Use recommended UCL. If more than one UCL recommended, use the highest. If n<6 use a median.
If number of detects <4, use a median detected value.

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site
Table 3.1.2

Scenario Timeframe: Future Composite Worker, Current/Future Trespasser
Medium: Soil
Exposure Medium: Surface
Exposure Point: Homestake Facility (HF)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
HF	As	mg/kg	5.71	Approx. Normal	9.58	6.328	mg/kg	95% Student's-t UCL	Recommended Value
	Bi-212	pCi/g	1.36	No Dist	2.04	1.498	pCi/g	95% Student's-t UCL	Recommended Value
	Bi-214	pCi/g	1.89	Approx. Gamma	5.79	2.333	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Cs-137	pCi/g	0.07	Normal	0.151	0.0672	pCi/g	95% KM (t) UCL	Recommended Value
	K-40	pCi/g	17.55	Approx. Normal	21.2	18.1	pCi/g	95% Student's-t UCL	Recommended Value
	Mo	mg/kg	8.81	No Dist	126	36.53	mg/kg	99% KM (Chebyshev) UCL	< SLs but retain
	Pa-234m	pCi/g	3.50	Approx. Gamma	18.9	4.603	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Pb-212	pCi/g	1.23	No Dist	1.67	1.348	pCi/g	95% Student's-t UCL	Recommended Value
	Pb-214	pCi/g	2.00	Approx. Gamma	6.13	2.468	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Ra-223	pCi/g	0.36	Normal	0.67	0.414	pCi/g	95% Student's-t UCL	Recommended Value
	Ra-226	pCi/g	3.47	Gamma	9	4	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Ra-228	pCi/g	1.30	No Dist	1.71	1.422	pCi/g	95% Student's-t UCL	Recommended Value
	Se	mg/kg	1.51	No Dist	11.1	3.797	mg/kg	99% KM (Chebyshev) UCL	< SLs but retain
	Th-227	pCi/g	0.14	Normal	0.227	0.174	pCi/g	95% Student's-t UCL	Recommended Value
	Th-228	pCi/g	1.39	Approx. Normal	2.34	1.604	pCi/g	95% Student's-t UCL	Recommended Value
	Th-230	pCi/g	2.19	Gamma	7.4	2.593	pCi/g	95% KM Approximate Gamma UC	Recommended Value
	Th-232	pCi/g	1.18	No Dist	1.81	1.372	pCi/g	95% Student's-t UCL	Recommended Value
	Th-234	pCi/g	2.34	Gamma	11.2	3.26	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Tl-208	pCi/g	0.39	No Dist	0.527	0.434	pCi/g	95% Student's-t UCL	Recommended Value
	U natural (pCi/g) (use individual isotopes since there are data)	pCi/g	6.75	Lognormal	30	9.75	pCi/g	95% BCA Bootstrap UCL	Recommended Value was H-statistic; use nonparametric closest to recommended value
	U total	mg/kg	10.13	Lognormal	44	14.33	mg/kg	95% BCA Bootstrap UCL	Recommended Value was H-statistic; use nonparametric closest to recommended value
	U-234	pCi/g	3.70	Approx. Gamma	18.3	4.287	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	U-235	pCi/g	0.25	Gamma	0.697	0.307	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	U-238	pCi/g	3.76	Lognormal	19	4.323	pCi/g	95% H-UCL	Recommended Value
	U-nat	mg/kg	2.00	No data	NV	7.5643	mg/kg	U-natural (pCi/g)*0.67	Convert from activity to mass

Footnote Instructions:
1) NA = not applicable
2) MDC = maximum detectable concentration; UCL=upper confidence limit
KM = Kaplan-Meier
mg/kg = milligram per kilogram
pCi/g = picoCurie per gram
ProUCL V5.0.00 (EPA, 2015)
WLB = within license boundary

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site
Table 3.1.3

Scenario Timeframe: Current Trespasser
Medium: Water
Exposure Medium: Surface (Pond) Water
Exposure Point: Homestake Facility (HF)

Exposure	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
Evaporation & Collection Ponds	Manganese (total)	mg/L	0.13	No Distribution	1.4	0.302	mg/L	95% KM (Chebyshev) UCL	Recommended
	Molybdenum	mg/L	339.41	Lognormal	4300	601.5	mg/L	95% H-UCL	Recommended
	Molybdenum (total)	mg/L	402.13	Lognormal	4760	864.4	mg/L	95% H-UCL	Recommended
	Nitrate	mg/L	1.47	Approx. Normal	9	2.135	mg/L	95% KM (t) UCL	Recommended
	Ra-226	pCi/L	23.93	Gamma	130	45.75	pCi/L	95% Adjusted Gamma UCL	Recommended
	Ra228	pCi/L	11.93	No Distribution	140	71.01	pCi/L	99% KM (Chebyshev) UCL	Recommended
	Selenium	mg/L	0.53	Approx. Normal	1.48	0.572	mg/L	95% Student's-t UCL	Recommended
	Selenium (total)	mg/L	0.69	Approx. Lognormal	5.98	0.733	mg/L	KM H-UCL	Recommended
	Th230	pCi/L	215.44	Lognormal	2210	1,200	pCi/L	99% Chebyshev (Mean, Sd) UCL	Recommended
	U-natural	mg/L	186.09	Approx. Lognormal	2680	396.7	mg/L	95% H-UCL	Recommended
	U-natural (total)	mg/L	229.98	Lognormal	2940	549	mg/L	95% H-UCL	Recommended
	Vanadium	mg/L	0.07	Gamma	0.32	0.11	mg/L	95% KM Adjusted Gamma UCL	Recommended

Footnote Instructions:
1) UCL=upper confidence limit
2) MDC = maximum detectable concentration
LTAs = land treatment areas
mg/L = milligram per liter
pCi/L = picoCurie per liter
ProUCL V5.0.00 (EPA, 2015)

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site
Table 3.1.4.

Scenario Timeframe: Future Composite Worker, Future Construction Worker
Medium: Air
Exposure Medium: Indoor/Outdoor Air, Trench/Outdoor Air
Exposure Point: Homestake Facility and LTAs

Exposure Point	Chemical or Radionuclide of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
HF and LTAs	Radon (Rn-222)	pCi/L	1.02	Appr. Gamma Distribution	2.9	1.074	pCi/L	95% Approximate Gamma UCL	Recommended

Footnote Instructions:
1) UCL=upper confidence limit
2) MDC = maximum detectable concentration;
UCL = upper confidence limit
pCi/L = picoCurie per Liter
MDC = maximum detected concentration
LTAs - Land Treatment Area
HF - Homestake Facility

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site
Table 3.1.5.

Scenario Timeframe: Current & Future Trespasser
Medium: Air
Exposure Medium: Outdoor Air
Exposure Point: HF and LTAs

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	re Point Concentration			
						Value	Units	Statistic (2)	Rationale
HF and LTAs	Radon (Rn-222)	pCi/L	0.904	Appr. Gamma Distribution	1.77	0.949	pCi/L	95% Approximate Gamma UCL	Recommended

Footnote Instructions:
1) UCL=upper confidence limit
2) MDC = maximum detected concentration
LTAs = land treatment areas
MDC = maximum detected concentration
pCi/L = picoCurie per liter

LTAs - Land Treatment Area
HF - Homestake Facility

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site
Table 3.1.6.

Scenario Timeframe: Current Trespasser
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: HF Evaporation Ponds

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	re Point Concentration			
						Value	Units	Statistic (2)	Rationale
Evaporation Ponds	Ra226	pCi/g	NA	NA	32.5	32.5	pCi/g	Maximum	n = 1
	Th230	pCi/g	NA	NA	0.5	0.5	pCi/g	Maximum	n = 1
	Unat	pCi/g	NA	NA	2566	2566	pCi/g	Maximum	n = 1

Footnote Instructions:
1) UCL=upper confidence limit
2) MDC = maximum detected concentration
LTAs = land treatment areas
MDC = maximum detected concentration
pCi/L = picoCurie per liter

LTAs - Land Treatment Area
HF - Homestake Facility

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Table 3.1.7

Scenario Timeframe: Future Construction Worker
Medium: Soil
Exposure Medium: Surface and Subsurface Soil
Exposure Point: LTAs

Exposure	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
LTAs	As	mg/kg	3.73	Approx. Gamma	6.79	4.693	mg/kg	95% Adjusted Gamma UCL	Recommended value
	Bi-212	pCi/g	0.84	No Dist	1.71	1.015	pCi/g	95% Student's-t UCL	Recommended value
	Bi-214	pCi/g	0.72	No Dist	1.44	0.87	pCi/g	95% Modified-t UCL	Recommended value
	Cs-137	pCi/g	0.06	Normal	0.114	0.0711	pCi/g	95% Student's-t UCL	Recommended value
	K-40	pCi/g	14.87	Normal	20.3	15.92	pCi/g	95% Student's-t UCL	Recommended value
	Mo	mg/kg	1.35	No Dist	1.28	1.971	pCi/g	95% Chebyshev UCL	Recommended value
	Pa-234m	pCi/g	1.45	Gamma	3.3	1.844	pCi/g	95% Adjusted Gamma UCL	Recommended value
	Pb-212	pCi/g	0.77	No Dist	1.52	0.935	pCi/g	95% Student's-t UCL	Recommended value
	Pb-214	pCi/g	0.78	No Dist	1.55	0.942	pCi/g	95% Modified-t UCL	Recommended value
	Ra-223	pCi/g	0.20	Approx. Lognormal	0.364	0.253	pCi/g	95% H-UCL	Recommended value
	Ra-226	pCi/g	1.14	No Dist	3.9	1.325	pCi/g	95% Chebyshev (Mean, Sd) UCL	Recommended value
	Ra-228	pCi/g	0.80	No Dist	1.66	0.978	pCi/g	95% Student's-t UCL	Recommended value
	Se	mg/kg	0.66	No Dist	2.6	0.829	pCi/g	95% Chebyshev (Mean, Sd) UCL	Recommended value
	Th-228	pCi/g	1.48	Normal	1.84	1.763	pCi/g	95% Student's-t UCL	Recommended value
	Th-230	pCi/g	1.47	Normal	3.4	1.646	pCi/g	95% Student's-t UCL	Recommended value
	Th-232	pCi/g	1.48	Normal	1.92	1.74	pCi/g	95% Student's-t UCL	Recommended value
	Th-234	pCi/g	0.63	Gamma	2.09	0.892	pCi/g	95% Adjusted Gamma UCL	Recommended value
	Tl-208	pCi/g	0.24	No Dist.	0.5	0.294	pCi/g	95% Student's-t UCL	Recommended value
	U total	mg/kg	3.51	No Dist.	7.47	4.329	pCi/g	99% KM (Chebyshev) UCL	Recommended value
	U-234	pCi/g	1.66	Normal	2.73	2.23	pCi/g	95% Student's-t UCL	Recommended value
	U-235	pCi/g	0.11	No Dist	0.193	0.131	pCi/g	95% Student's-t UCL	Recommended value
	U-238	pCi/g	1.76	Normal	2.49	2.21	pCi/g	95% Student's-t UCL	Recommended value
	U-nat	mg/kg	2.00	No Dist	7.2	2.791	mg/kg	95% Chebyshev (Mean, Sd) UCL	< SLs but retain

Footnote Instructions:

1) NA = not applicable
2) MDC = maximum detectable concentration; UCL=upper confidence limit
LTAs = land treatment areas
mg/kg = milligram per kilogram
pCi/g = picoCurie per gram
ProUCL V5.0.00 (EPA, 2013)

Dist - Distribution
Use recommended UCL. If more than one UCL recommended, use the highest. If n<6 use a median.
If number of detects <4, use a median detected value.

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site
Table 3.1.8

Scenario Timeframe: Future Construction Worker
Medium: Soil
Exposure Medium: Surface and Subsurface Soil
Exposure Point: Homestake Facility (HF)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
HF	As	mg/kg	5.71	Approx. Normal	9.58	6.328	mg/kg	95% Student's-t UCL	Recommended Value
	Bi-212	pCi/g	1.36	No Dist	2.04	1.498	pCi/g	95% Student's-t UCL	Recommended Value
	Bi-214	pCi/g	1.89	Approx. Gamma	5.79	2.333	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Cs-137	pCi/g	0.07	Normal	0.151	0.0672	pCi/g	95% KM (t) UCL	Recommended Value
	K-40	pCi/g	17.55	Approx. Normal	21.2	18.1	pCi/g	95% Student's-t UCL	Recommended Value
	Mo	mg/kg	9.15	No Dist	126	23.65	mg/kg	95% Chebyshev	< SLs but retain
	Pa-234m	pCi/g	3.50	Approx. Gamma	18.9	4.603	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Pb-212	pCi/g	1.23	No Dist	1.67	1.348	pCi/g	95% Student's-t UCL	Recommended Value
	Pb-214	pCi/g	2.00	Approx. Gamma	6.13	2.468	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Ra-223	pCi/g	0.36	Normal	0.67	0.414	pCi/g	95% Student's-t UCL	Recommended Value
	Ra-226	pCi/g	3.47	Gamma	9	3.736	pCi/g	95% Approx. Gamma UCL	Recommended value
	Ra-228	pCi/g	1.30	No Dist	1.71	1.422	pCi/g	95% Student's-t UCL	Recommended Value
	Se	mg/kg	1.64	Lognormal	11.1	3.134	mg/kg	95% Chebyshev	< SLs but retain. Recommended Value was H-statistic; use nonparametric
	Th-227	pCi/g	0.14	Normal	0.227	0.174	pCi/g	95% Student's-t UCL	Recommended Value
	Th-228	pCi/g	1.39	Approx. Normal	2.34	1.604	pCi/g	95% Student's-t UCL	Recommended Value
	Th-230	pCi/g	1.91	No Dist	7.4	2.666	pCi/g	95% Chebyshev	Recommended value
	Th-232	pCi/g	1.18	No Dist	1.81	1.372	pCi/g	95% Student's-t UCL	Recommended Value
	Th-234	pCi/g	2.34	Gamma	11.2	3.26	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	Tl-208	pCi/g	0.39	No Dist	0.527	0.434	pCi/g	95% Student's-t UCL	Recommended Value
	U natural (pCi/g) (use individual isotopes since there are data)	pCi/g	5.75	Lognormal	30	9.76	pCi/g	95% Chebyshev	Recommended Value was H-statistic; use nonparametric
	U total	mg/kg	10.13	Lognormal	44	15.53	mg/kg	95% Adjusted Gamma UCL	< SLs but retain
	U-234	pCi/g	3.70	Approx. Gamma	18.3	4.287	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	U-235	pCi/g	0.25	Gamma	0.697	0.307	pCi/g	95% Adjusted Gamma UCL	Recommended Value
	U-238	pCi/g	3.76	Lognormal	19	4.323	pCi/g	95% H-UCL	Recommended Value
	U-nat	mg/kg	2.00	No data	NV	7.5643	mg/kg	U-natural (pCi/g)*0.67	Convert from activity to mass

Footnote Instructions:
1) NA = not applicable
2) MDC = maximum detectable concentration; UCL=upper confidence limit
KM = Kaplan-Meier
mg/kg = milligram per kilogram
pCi/g = picoCurie per gram
ProUCL V5.0.00 (EPA, 2015)

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: **Surface Soil**
Exposure Point: WLB & LTAs
Receptor Population **CI-IOW**
Receptor Age: Adult

Note: Outdoor Air Inhalation is restricted to Radon (there were no other data and/or COPCs or ROPCs for this air pathway)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale	Ref
Ingestion	CI-IOW	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/kg		
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	9125	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	0.000001 (usual)	unitless		
				CSF	Cancer Slope Factor	Chemical-specific	(mg/kg-day)-1	for carcinogens	2
				ED	Exposure Duration	25	y		1
				EF	Exposure Frequency	250	d/y		1
				ET	Exposure time	8	h		1
				IRS	Soil Ingestion Rate	100	mg/d		1
				RfD	Reference Dose	Chemical-specific	mg/kg-d	for non-carcinogens	2
Inhalation (Fugitive	CI-IOW	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/kg		
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	9125	d	for non-carcinogens	1
				CF	Conversion Factor	1000	ug/g		
				CF	Conversion Factor	1/24	d/h		1
				ED	Exposure Duration	25	y		1
				EF	Exposure Frequency	250	d/y		1
				ET	Exposure time	8	h		1
				INH	Inhalation Rate	60	m3/d		1
				IUR	Inhalation Unit Risk	Chemical-specific	(ug/m3)-1	for carcinogens	2
				PEF	Particulate Emission	1.19E+09	m3/kg		
				RfC	Reference Concentration	Chemical-specific	mg/m3	for non-carcinogens	2
Inhalation (Indoor Air)	CI-IOW	Adult	WLB/LTAs	EPCa	Exposure Point	Site and Chemical-	mg/m3		
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	9125	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	0.000001 (usual)	unitless		
				ED	Exposure Duration	25	y		1
				EF	Exposure Frequency	250	d/y		1
				ET	Exposure Time	8	h		1
				INH	Inhalation Rate	60	m3/d		1
				IUR	Inhalation Unit Risk	Chemical-specific	(ug/m3)-1	for carcinogens	2
				RfC	Reference Concentration	Chemical-specific	mg/m3	for non-carcinogens	2
Dermal Absorption	CI-IOW	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/kg		
				ABS	Skin Absorption Factor	Chemical-specific	unitless		
				AF	Adherence Factor	0.12	mg/cm2		1
				ATnc	Averaging Time,	9125	d	for non-carcinogens	
				ATc	Averaging Time, cancer	25550	d	for carcinogens	
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	0.000001 (usual)	unitless		
				ED	Exposure Duration	25	y		1
				EF	Exposure Frequency	250	d/y		1
				Ev	Event/d	1	unitless		1
				GI-abs	Gastrointestinal	Chemical-specific	unitless		2
				SA	Skin Surface Area	3527	cm2		1
				Kp	Permeability Coefficient	Chemical-specific	cm/h	only for volatiles	2

TABLE 4.1.2 RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: **Surface & Subsurface Soil**
Exposure Point: WLB & LTAs
Receptor Population: **Construction Worker (CW)**
Receptor Age: Adult

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Ref
Ingestion	CW	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/kg or pCi/g		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	9125	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	1E-06	unitless		1
				CSF	Cancer Slope Factor	Chemical-specific	(mg/kg-day)-1	for carcinogens	1
				ED	Exposure duration, adult	1	y		1
				EF	Exposure Frequency	250	d/y		1
				ET	Exposure time	8	h		1
				IRS	Soil Ingestion Rate	330	mg/d		1
				RfD	Reference Dose	Chemical-specific	mg/kg-d	for non-carcinogens	1
Inhalation (Fugitive	CW	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/kg		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	9125	d	for non-carcinogens	1
				CF	Conversion Factor	0.000001 (usual)	unitless		1
				ED	Exposure duration	1	y		1
				EF	Exposure Frequency	250	d/y		1
				ET	Exposure time	8	h		1
				PEF	Particulate Emission	7.31E+07	m3/kg		1
				IUR	Inhalation Unit Risk	Chemical-specific	(ug/m3)-1	for carcinogens	1
				RfC	Reference Concentration	Chemical-specific	mg/m3	for non-carcinogens	1
Absorption (Dermal)	CW	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/kg or pCi/g		1
				ABS	Skin absorption factor	Chemical-specific			1
				AF	Adherence Factor	0.3	mg/cm2		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	9125	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	0.000001 (usual)	unitless		1
				CSF	Cancer Slope Factor	Chemical-specific	(mg/kg-day)-1	for carcinogens	1
				ED	Exposure duration, adult	1	y		1
				EF	Exposure Frequency	250	d/y		1
				Ev	Event/d	1	unitless		1
				RfD	Reference Dose	Chemical-specific	mg/kg-d	for non-carcinogens	1
				SA	Skin Surface Area	3527	cm2	for non-carcinogens	1

TABLE 4.1.3 RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Current/Future
Medium: Soil and Water
Exposure Medium: **Surface Soil, Sediment & Pond Water**
Exposure Point: WLB & LTAs
Receptor Population: **Trespasser**
Receptor Age: Adult

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Ref
Ingestion (Soil)	Trespasser	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/kg		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	3650	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	1E-06	unitless		1
				CSF	Cancer Slope Factor	Chemical-specific	(mg/kg-day)-1	for carcinogens	1
				ED	Exposure duration, adult	10	y		3
				EF	Exposure Frequency	48	d/y		3
				ET	Exposure time	2	h/d		3
				IRS	Soil Ingestion Rate	100	mg/d		1
				RfD	Reference Dose	Chemical-specific	mg/kg-d		1
Inhalation (Fugitive Dust)	Trespasser	Adult	WLB/LTAs	EPCs	Exposure Point	Site and Chemical-	mg/m3		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	3650	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	1E-06	unitless		1
				ED	Exposure duration, adult	10	y		3
				EF	Exposure Frequency	48	d/y		3
				ET	Exposure time	2	h/d		3
				INH	Ambient Air Inhalation	20	m3/d		1
				IUR	Inhalation Unit Risk	Chemical-specific	(ug/m3)-1	for carcinogens	1
				PEF	Particulate Emission	1.19E+09	m3/kg		1
				RfC	Reference Concentration	Chemical-specific	mg/m3	for non-carcinogens	1
Absorption (Immersion in Pond Water) [Current Only]	Trespasser	Adult	WLB	EPCsw	Exposure Point	Site and Chemical-	mg/L		
				ATc	Averaging Time, cancer	25550	d	for carcinogens	
				ATnc	Averaging Time,	3650	d	for non-carcinogens	
				BW	Body Weight	80	kg		
				CF	Conversion Factor	0.000001 (usual)	unitless		
				ED	Exposure duration, adult	10	y		3
				EF	Exposure Frequency	6	d/y		3
				ET	Exposure time	0.2	h/d		3
				EV	Event/d	1	unitless		
				Kp	Permeability Coefficient	Chemical-specific	cm/h	only for volatiles	2
				SA	Skin Surface Area	3527	cm2		1
				t_{ev}	Contact Time with Pond	0.2	h/event		3
				IRW	Ingestion Rate, water	0.005	L/d		3
Incidental Ingestion and Dermal Contact (Surface/Pond Water) [Current Only]	Trespasser	Adult	WLB	EPCsw	Exposure Point	Site and Chemical-	mg/L		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	3650	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	1E-06	unitless		1
				CSF	Cancer Slope Factor	Chemical-specific	(mg/kg-day)-1	for carcinogens	1
				ED	Exposure duration, adult	**10**	y		3
				EF	Exposure Frequency	**6**	d/y		3
				ET	Exposure time	**2**	h		3
				IRW	Water Ingestion Rate	0.005	L/d		1
				RfD	Reference Dose	Chemical-specific	mg/kg-d		1

TABLE 4.1.3 RME (Con't)
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Incidental Ingestion and Dermal Contact	Trespasser	Adult	WLB	EPCs	Exposure Point	Site and Chemical-	mg/kg		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	3650	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	1E-06	unitless		1
				CSF	Cancer Slope Factor	Chemical-specific	(mg/kg-day)-1	for carcinogens	1
				ED	Exposure duration, adult	10	y		3
				EF	Exposure Frequency	6	d/y		3
				ET	Exposure time	0.2	h/d		3
				IRS	Soil Ingestion Rate	100	mg/d		1
				RfD	Reference Dose	Chemical-specific	mg/kg-d		1
Inhalation (Fugitive Dust from Sediment, Current Only)	Trespasser	Adult	WLB	EPCs	Exposure Point	Site and Chemical-	mg/m3		1
				ATc	Averaging Time, cancer	25550	d	for carcinogens	1
				ATnc	Averaging Time,	3650	d	for non-carcinogens	1
				BW	Body Weight	80	kg		1
				CF	Conversion Factor	1E-06	unitless		1
				ED	Exposure duration, adult	10	y		3
				EF	Exposure Frequency	6	d/y		3
				ET	Exposure time	0.2	h/d		3
				INH	Ambient Air Inhalation	20	m3/d		1
				IUR	Inhalation Unit Risk	Chemical-specific	(ug/m3)-1	for carcinogens	1
				PEF	Particulate Emission	1.19E+09	m3/kg		1
				RfC	Reference Concentration	Chemical-specific	mg/m3	for non-carcinogens	1

1 - EPA 2019a
2 - EPA 2019b
3 - Professional judgment

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
Homestake Mining Company Superfund Site

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Gastrointestinal Absorption Coefficient (GIABS) (1)	Dermal Absorption Coefficient (ABS)	Relative Bioavailability	Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units						Source(s)	Date(s)
Arsenic, inorganic	Chronic	0.0003	mg/kg-d	1.00E+00	0.03	0.6	skin;increased hyperpigmentation; keratosis and possibly vascular complications	3/1	IRIS	2/1/1993
Manganese	Chronic	0.14	mg/kg-d	4.00E-02	-	1	CNS effects	1/1	IRIS	11/1/1995
Molybdenum	Chronic	0.005	mg/kg-d	1.00E+00	-	1	kidney-gout-like disease; increased uric acid levels in blood	30/1	IRIS	8/1/1993
Nitrate	Chronic	1.6	mg/kg-d	1.00E+00	-	1	Neonate methemoglobinemia	1/1	IRIS	5/1/1991
Selenium	Chronic	0.005	mg/kg-d	1.00E+00	-	1	liver dysfunction - prolonged clotting time;hair or finger nail loss;circulatory problems lowered hemoglobin levels	3/1	IRIS	9/1/1991
Uranium, total *	Chronic	2E-04	mg/kg-d	1.00E+00	-	1E+00	Kidney-nephrotoxic	NA	ATSDR	EPA RSL 9/1/2019
Vanadium ***	Chronic	5E-03	mg/kg-d	2.60E-02	-	1	Hair - decreased hair cystine	NA	ATSDR	EPA RSL 9/1/2019

Footnote Instructions:
(1) oral absorption is assumed to be 100%
(2) metal absorption through the dermal route of intake is assumed to be 3%
(3) Uncertainty (UF) and Modifying factors (MF):
UF for arsenic— The UF of 3 is to account for both the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty in whether the NOAEL of the critical study accounts for all sensitive individuals.

In general, the use of uncertainty factors follows the following guidelines
A UF of 10 is used to account for variation in the general population to protect sensitive subpopulations (e.g. Elderly, children)
A UF of 10 is used when a NOAEL derived from a subchronic instead of a chronic study is used as the basis for a chronic RfD
A UF of 10 is used when extrapolating from animals to humans. This factor is intended to account for the interspecies variability between humans and other mammal
A UF of 10 is used when a LOAEL is used instead of a NOAEL. This factor is intended to account for the uncercetainty associated with extrapolating from LOAELs to NOAELs
A MF ranging from 1 to 10 is inculuded to reflect a qualitative professional assessment of additional uncertainties in the critical study. The default value for the MF is
ATSDR -Agency for Toxic Substances and Disease Registry
IRIS = Integrated Risk Information System
*based on soluble salts

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
Homestake Facility

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s)
Arsenic, inorganic	Chronic	1.5E-05	mg/m3	NA	NA	NA	NA	Cal EPA	EPA (2019a)
Manganese	Chronic	5.0E-05	mg/m3	NA	NA	CNS	1000/1	IRIS	12/1/1993
Molybdenum	Chronic	-	mg/m3	NA	NA	NA	NA		
Nitrate	Chronic	-	mg/m3	NA	NA	NA	NA		
Selenium	Chronic	2E-02	mg/m3	NA	NA	NA	NA	Cal EPA	EPA (2019a)
Uranium, total	Chronic	4.0E-05	mg/m3	NA	NA	NA	NA	ATSDR	EPA (2019a)
Vanadium	Chronic	0.0001	mg/m3	NA	NA	NA	NA	ATSDR	EPA (2019a)

Value from EPA (May 2019) Region 9 Regional Screening Levels (RSLs) formerly PRGs
IRIS - Integrated Risk Information System
ATSDR: Agency for Toxic Substances Disease Registry
CNS - Central nervous system

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/IMMERSION
Homestake Mining Company Superfund Site

Chemical/ Radionuclide of Potential Concern	Oral Cancer Slope Factor		Water Ingestion Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units	Value	Units		Source(s)	Date(s)
Arsenic, inorganic	1.5	(mg/kg-d)-1	NA	NA	A	IRIS	4/10/1998

A-human carcinogen
Radionuclide slope factors are media and receptor specific
† now referred to as an inhalation unit risk, IUR.
d = day
EPA = U.S. Environmental Protection Agency
g = gram
IRIS = Integrated Risk Information System
L = liter
mg/kg = milligram per kilogram
NA = not available or not applicable
ORNL = Oak Ridge National Laboratory
pCi = picoCurie
y = year
µg/m3 = microgram per cubic meter

Radionuclide PRGs For Decay Chains - Composite and Construction Worke

Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per	Worker Soil Ingestion Slope Factor (risk/pCi)	Tresspasser Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Halflife (yr)	1000 m^2 Soil Volume Area Correction Factor
*Secular Equilibrium Risk for Bi-212								
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	1.68E-12	6.02E+03	1.15E-04	8.05E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	0.00E+00	1.19E+05	5.81E-06	8.71E-01
*Secular Equilibrium Risk for Bi-214								
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
*Secular Equilibrium Risk for Cs-137								
Ba-137m	-	0.00E+00	2.69E-06	0.00E+00	0.00E+00	1.43E+05	4.86E-06	7.63E-01
Cs-137	S	1.12E-10	5.52E-10	3.18E-11	4.26E-11	2.30E-02	3.02E+01	7.22E-01
*Secular Equilibrium Risk for K-40								
K-40	S	2.22E-10	7.99E-07	1.51E-11	5.85E-11	5.54E-10	1.25E+09	8.32E-01
*Secular Equilibrium Risk for Pa-234m								
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	5.37E-12	9.06E+02	7.65E-04	8.02E-01
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	0.00E+00	3.11E+05	2.23E-06	8.23E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	7.92E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	6.77E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	1.66E-10	9.19E-06	7.54E+04	9.34E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	1.48E-10	2.82E-06	2.46E+05	1.00E+00
*Secular Equilibrium Risk for Pb-212								
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	1.68E-12	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	6.33E-11	5.71E+02	1.21E-03	6.98E-01

Radionuclide PRGs For Decay Chains - Composite and Construction Worker								
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per	Adult Soil Ingestion Slope Factor (risk/pCi)	Tresspasser Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Halflife (yr)	1000 m^2 Soil Volume Area Correction Factor
Po-212	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	0.00E+00	1.19E+05	5.81E-06	8.71E-01
*Secular Equilibrium Risk for Pb-214								
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	7.92E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
*Secular Equilibrium Risk for Ra-223								
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	9.55E-13	1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	5.99E-10	2.21E+01	3.13E-02	7.31E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	0.00E+00	7.64E+04	9.08E-06	8.21E-01
*Secular Equilibrium Risk for Ra-226								
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	7.92E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	6.77E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
*Secular Equilibrium Risk for Ra-228								
Ac-228	S	4.92E-11	4.04E-06	8.58E-13	4.92E-12	9.87E+02	7.02E-04	8.18E-01
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	1.68E-12	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	6.33E-11	5.71E+02	1.21E-03	6.98E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Po-216	-	0.00E+00	7.10E-11	0.00E+00	0.00E+00	1.51E+08	4.60E-09	8.03E-01
Ra-224	S	1.13E-08	3.91E-08	8.47E-11	4.26E-10	6.91E+01	1.00E-02	6.86E-01
Ra-228	S	4.37E-08	3.43E-11	6.70E-10	1.98E-09	1.21E-01	5.75E+00	1.00E+00
Rn-220	-	1.15E-12	2.77E-09	0.00E+00	0.00E+00	3.93E+05	1.76E-06	7.72E-01
Th-228	S	1.32E-07	5.64E-09	6.40E-11	2.43E-10	3.63E-01	1.91E+00	7.95E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	0.00E+00	1.19E+05	5.81E-06	8.71E-01
*Secular Equilibrium Risk for Rn-219								
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Pb-211	S	4.03E-11	2.91E-07	2.63E-13		1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	0.00E+00	7.64E+04	9.08E-06	8.21E-01
*Secular Equilibrium Risk for Rn-222								
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	0.00E+00	1.36E+04	5.10E-05	7.68E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1.72E-09	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	7.92E-13	1.17E+05	5.90E-06	9.00E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	3.27E-09	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	6.62E+01	1.05E-02	7.84E-01

Radionuclide PRGs For Decay Chains - Composite and Construction Worker								
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per	Adult Soil Ingestion Slope Factor (risk/pCi)	Tresspasser Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Halflife (yr)	1000 m^2 Soil Volume Area Correction Factor
*Secular Equilibrium Risk for Th-227								
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	9.55E-13	1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	5.99E-10	2.21E+01	3.13E-02	7.31E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Th-227	S	3.50E-08	4.45E-07	2.06E-11	1.29E-10	1.35E+01	5.12E-02	7.25E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	0.00E+00	7.64E+04	9.08E-06	8.21E-01
*Secular Equilibrium Risk for Th-228								
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	1.68E-12	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	6.33E-11	5.71E+02	1.21E-03	6.98E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Po-216	-	0.00E+00	7.10E-11	0.00E+00	0.00E+00	1.51E+08	4.60E-09	8.03E-01
Ra-224	S	1.13E-08	3.91E-08	8.47E-11	4.26E-10	6.91E+01	1.00E-02	6.86E-01
Rn-220	-	1.15E-12	2.77E-09	0.00E+00	0.00E+00	3.93E+05	1.76E-06	7.72E-01
Th-228	S	1.32E-07	5.64E-09	6.40E-11	2.43E-10	3.63E-01	1.91E+00	7.95E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	0.00E+00	1.19E+05	5.81E-06	8.71E-01
*Secular Equilibrium Risk for Th-230								
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	7.92E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	6.77E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	1.66E-10	9.19E-06	7.54E+04	9.34E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
*Secular Equilibrium Risk for Th-232								
Ac-228	S	4.92E-11	4.04E-06	8.58E-13	4.92E-12	9.87E+02	7.02E-04	8.18E-01
Bi-212	S	1.13E-10	4.96E-07	4.44E-13	1.68E-12	6.02E+03	1.15E-04	8.05E-01
Pb-212	S	6.29E-10	4.96E-07	1.31E-11	6.33E-11	5.71E+02	1.21E-03	6.98E-01
Po-212	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	9.00E-01
Po-216	-	0.00E+00	7.10E-11	0.00E+00	0.00E+00	1.51E+08	4.60E-09	8.03E-01
Ra-224	S	1.13E-08	3.91E-08	8.47E-11	4.26E-10	6.91E+01	1.00E-02	6.86E-01
Ra-228	S	4.37E-08	3.43E-11	6.70E-10	1.98E-09	1.21E-01	5.75E+00	1.00E+00
Rn-220	-	1.15E-12	2.77E-09	0.00E+00	0.00E+00	3.93E+05	1.76E-06	7.72E-01
Th-228	S	1.32E-07	5.64E-09	6.40E-11	2.43E-10	3.63E-01	1.91E+00	7.95E-01
Th-232	S	4.33E-08	3.58E-10	8.47E-11	1.84E-10	4.93E-11	1.41E+10	9.79E-01
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	0.00E+00	1.19E+05	5.81E-06	8.71E-01
*Secular Equilibrium Risk for Th-234								
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	5.37E-12	9.06E+02	7.65E-04	8.02E-01
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	0.00E+00	3.11E+05	2.23E-06	8.23E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	7.92E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	6.77E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	1.66E-10	9.19E-06	7.54E+04	9.34E-01
Th-234	S	3.08E-11	1.77E-08	9.51E-12	6.25E-11	1.05E+01	6.60E-02	7.64E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	1.48E-10	2.82E-06	2.46E+05	1.00E+00

Radionuclide PRGs For Decay Chains - Composite and Construction Worker								
Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per	Adult Soil Ingestion Slope Factor (risk/pCi)	Tresspasser Soil Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Halflife (yr)	1000 m^2 Soil Volume Area Correction Factor
*Secular Equilibrium Risk for Tl-208								
Tl-208	-	0.00E+00	1.75E-05	0.00E+00	0.00E+00	1.19E+05	5.81E-06	8.71E-01
*Secular Equilibrium Risk for U-234								
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	7.92E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	6.77E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	1.66E-10	9.19E-06	7.54E+04	9.34E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	1.48E-10	2.82E-06	2.46E+05	1.00E+00
*Secular Equilibrium Risk for U-235								
Ac-227	S	1.49E-07	1.98E-10	2.01E-10	2.90E-10	3.18E-02	2.18E+01	9.60E-01
At-219	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E+05	1.78E-06	9.00E-01
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	0.00E+00	1.70E+05	4.07E-06	7.90E-01
Bi-215	-	0.00E+00	1.08E-06	0.00E+00	0.00E+00	4.79E+04	1.45E-05	7.74E-01
Fr-223	S	4.07E-11	1.35E-07	4.88E-12	1.69E-11	1.66E+04	4.19E-05	7.64E-01
Pa-231	F	7.62E-08	1.27E-07	1.54E-10	2.98E-10	2.12E-05	3.28E+04	7.85E-01
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	9.55E-13	1.01E+04	6.87E-05	8.11E-01
Po-211	-	0.00E+00	3.76E-08	0.00E+00	0.00E+00	4.24E+07	1.64E-08	8.02E-01
Po-215	-	0.00E+00	7.48E-10	0.00E+00	0.00E+00	1.23E+10	5.65E-11	8.12E-01
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	5.99E-10	2.21E+01	3.13E-02	7.31E-01
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	0.00E+00	5.52E+06	1.26E-07	7.62E-01
Th-227	S	3.50E-08	4.45E-07	2.06E-11	1.29E-10	1.35E+01	5.12E-02	7.25E-01
Th-231	S	1.50E-12	2.49E-08	9.07E-13	5.96E-12	2.38E+02	2.91E-03	8.49E-01
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	0.00E+00	7.64E+04	9.08E-06	8.21E-01
U-235	S	2.50E-08	5.51E-07	4.92E-11	1.48E-10	9.84E-10	7.04E+08	6.88E-01
*Secular Equilibrium Risk for U-238								
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.46E+07	4.76E-08	9.00E-01
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	2.40E-11	5.05E+01	1.37E-02	7.28E-01
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	4.03E-13	1.83E+04	3.79E-05	8.27E-01
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	4.47E+04	1.55E-05	7.49E-01
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	5.37E-12	9.06E+02	7.65E-04	8.02E-01
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	0.00E+00	3.11E+05	2.23E-06	8.23E-01
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1.72E-09	3.12E-02	2.22E+01	8.75E-01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	7.92E-13	1.36E+04	5.10E-05	7.68E-01
Po-210	S	1.45E-08	4.51E-11	1.44E-09	3.27E-09	1.83E+00	3.79E-01	8.02E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	1.33E+11	5.21E-12	8.02E-01
Po-218	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	1.17E+05	5.90E-06	9.00E-01
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	6.77E-10	4.33E-04	1.60E+03	6.85E-01
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	6.24E+08	1.11E-09	7.57E-01
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	6.62E+01	1.05E-02	7.84E-01
Th-230	F	3.41E-08	8.45E-10	7.73E-11	1.66E-10	9.19E-06	7.54E+04	9.34E-01
Th-234	S	3.08E-11	1.77E-08	9.51E-12	6.25E-11	1.05E+01	6.60E-02	7.64E-01
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	8.67E+04	7.99E-06	7.69E-01
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.80E+05	2.47E-06	8.23E-01
U-234	S	2.78E-08	2.53E-10	5.11E-11	1.48E-10	2.82E-06	2.46E+05	1.00E+00
U-238	S	2.36E-08	1.24E-10	4.66E-11	1.34E-10	1.55E-10	4.47E+09	1.00E+00

Notes:
ICRP - International Commission on Radiological Protection
pCi - pico Curies
yr - year
g - gram
m2 – meters squared

Water Slope Factors (SFs) for the the Trespasser for ROPCs

Isotope	Water Ingestion Slope Factor (risk/pCi)	Immersion Slope Factor (risk/yr per pCi/L)
*Secular Equilibrium Risk for Ra-226	-	-
At-218	0.00E+00	5.13E-17
Bi-210	8.92E-12	7.82E-15
Bi-214	1.92E-13	1.45E-11
Hg-206	0.00E+00	1.08E-12
Pb-210	8.84E-10	9.08E-15
Pb-214	3.44E-13	2.23E-12
Po-210	1.78E-09	9.07E-17
Po-214	0.00E+00	7.74E-16
Po-218	0.00E+00	5.06E-20
Ra-226	3.85E-10	6.27E-14
Rn-218	0.00E+00	6.92E-15
Rn-222	0.00E+00	3.51E-15
Tl-206	0.00E+00	1.47E-14
Tl-210	0.00E+00	2.69E-11
*Secular Equilibrium Risk for Ra-228	-	-
Ac-228	1.88E-12	8.15E-12
Bi-212	7.18E-13	9.91E-13
Pb-212	2.52E-11	1.23E-12
Po-212	0.00E+00	0.00E+00
Po-216	0.00E+00	1.42E-16
Ra-224	1.67E-10	9.12E-14
Ra-228	1.04E-09	5.02E-16
Rn-220	0.00E+00	5.71E-15
Th-228	1.08E-10	1.66E-14
Tl-208	0.00E+00	3.46E-11
*Secular Equilibrium Risk for Th-230	-	-
At-218	0.00E+00	5.13E-17
Bi-210	8.92E-12	7.82E-15
Bi-214	1.92E-13	1.45E-11
Hg-206	0.00E+00	1.08E-12
Pb-210	8.84E-10	9.08E-15
Pb-214	3.44E-13	2.23E-12
Po-210	1.78E-09	9.07E-17
Po-214	0.00E+00	7.74E-16
Po-218	0.00E+00	5.06E-20
Ra-226	3.85E-10	6.27E-14
Rn-218	0.00E+00	6.92E-15
Rn-222	0.00E+00	3.51E-15
Th-230	9.14E-11	3.01E-15
Tl-206	0.00E+00	1.47E-14
Tl-210	0.00E+00	2.69E-11

Source: EPA 2019b. EPA 2019b. Output generated 22AUG2019:19:30:14

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
Site Name

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s)
Arsenic, inorganic	4.30E-03	(ug/m3)-1	NA	NA	A	EPA (2015)	6/1/2015

A: known carcinogen
Radionuclide slope factors are media and receptor and isotope specific
EPA = U.S. Environmental Protection Agency
NA=not available or not applicable
ORNL = Oak Ridge National Laboratory
pCi=picoCurie per gram
ug/m3 = microgram per cubic meter

Air Slope Factors (SFs) for Composite Worker, Construction Worker, and Trespasser for ROPCs in Radon Decay Chain

Isotope	Inhalation Slope	Submersion External
At-218	0.00E+00	3.08E-14
Bi-210	4.55E-10	5.29E-12
Bi-214	6.18E-11	6.69E-09
Pb-214	7.77E-11	1.02E-09
Po-214	0.00E+00	3.57E-13
Po-218	1.39E-11	3.95E-17
Rn-218	0.00E+00	3.19E-12
Rn-222	2.28E-12	1.62E-12

Source: EPA 2019b. Composite_rprg_table_run_pCi_25NOV14.xlsx

TABLE 7.1.1 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Future
Receptor Population: CI-IOW
Receptor Age: Adult

Key:
WLB = within license boundary (on-Site)
LTAs = land treatment areas (off-Site
CI-IOW = commercial-industrial indoor/outdoor worker

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		
					Value	Units	Value	Units		Value	Units	Hazard Quotient
Soil	Surface Soil	WLB	Incidental Ingestion	Arsenic	6.33	mg/kg	2E+00	$(mg/kg-d)^{-1}$	2E-06	3E-04	mg/kg-d	1E-02
				Molybdenum	36.53	mg/kg	No CSF	--	--	5E-03	mg/kg-d	6E-03
				Selenium	3.80	mg/kg	No CSF	--	--	5E-03	mg/kg-d	7E-04
				Uranium	14.33	mg/kg	No CSF	--	--	2E-04	mg/kg-d	6E-02
				Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	4E-10	--		
				Bi-214	2.33	pCi/g		risk/pCi	3E-06	--		--
				Cs-137	0.07	pCi/g		risk/pCi	1E-09	--		--
				K-40	18.10	pCi/g		risk/pCi	2E-07	--		--
				Pa-234m	4.60	pCi/g		risk/pCi	7E-06	--		--
				Pb-212	1.35	pCi/g		risk/pCi	1E-08	--		--
				Pb-214	2.47	pCi/g		risk/pCi	3E-06	--		--
				Ra-223	0.41	pCi/g		risk/pCi	3E-08	--		--
				Ra-226	4.00	pCi/g		risk/pCi	6E-06	--		--
				Ra-228	1.42	pCi/g		risk/pCi	7E-07	--		--
				Th-227	0.17	pCi/g		risk/pCi	2E-08	--		--
				Th-228	1.60	pCi/g		risk/pCi	2E-07	--		--
				Th-230	2.59	pCi/g		risk/pCi	4E-06	--		--
				Th-232	1.37	pCi/g		risk/pCi	8E-07	--		--
				Th-234	3.26	pCi/g		risk/pCi	5E-06	--		--
				Tl-208	0.43	pCi/g		risk/pCi	0E+00	--		--
				U-234	4.29	pCi/g		risk/pCi	7E-06	--		--
				U-235	0.31	pCi/g		risk/pCi	1E-07	--		--
				U-238	4.32	pCi/g		risk/pCi	7E-06	--		--
			Exp. Route Total						5E-05			8E-02
Soil	Surface Soil	WLB	Inhalation of Particulates	Arsenic	6.33	mg/kg	4E-03	$(ug/m^3)^{-1}$	3E-10	2E-05	mg/m^3	1E-05
				Molybdenum	36.53	mg/kg	No IUR	--	--	-	mg/m^3	-
				Selenium	3.80	mg/kg	No IUR	--	--	2E-02	mg/m^3	7E-09
				Uranium	14.33	mg/kg	No IUR	--	--	4E-05	mg/m^3	1E-05
				Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	3E-12	--		--
				Bi-214	2.33	pCi/g		risk/pCi	1E-09	--		--
				Cs-137	0.07	pCi/g		risk/pCi	1E-13	--		--
				K-40	18.10	pCi/g		risk/pCi	8E-11	--		--
				Pa-234m	4.60	pCi/g		risk/pCi	1E-08	--		--
				Pb-212	1.35	pCi/g		risk/pCi	2E-11	--		--
				Pb-214	2.47	pCi/g		risk/pCi	1E-09	--		--
				Ra-223	0.41	pCi/g		risk/pCi	2E-10	--		--
				Ra-226	4.00	pCi/g		risk/pCi	4E-09	--		--
				Ra-228	1.42	pCi/g		risk/pCi	5E-09	--		--
				Th-227	0.17	pCi/g		risk/pCi	2E-10	--		--
				Th-228	1.60	pCi/g		risk/pCi	4E-09	--		--
				Th-230	2.59	pCi/g		risk/pCi	5E-09	--		--
				Th-232	1.37	pCi/g		risk/pCi	6E-09	--		--
				Th-234	3.26	pCi/g		risk/pCi	7E-09	--		--
				Tl-208	0.43	pCi/g		risk/pCi	0E+00	--		--
				U-234	4.29	pCi/g		risk/pCi	1E-08	--		--
				U-235	0.31	pCi/g		risk/pCi	2E-09	--		--
				U-238	4.32	pCi/g		risk/pCi	1E-08	--		--
			Exp. Route Total						7E-08			3E-05
Soil	Surface Soil	WLB	Dermal Contact	Arsenic	6.33	mg/kg	2E+00	$(mg/kg-d)^{-1}$	4E-07	3E-04	mg/kg-d	4E-07
				Molybdenum	36.53	mg/kg	no CSF	--	--	no ABS	--	--
				Selenium	3.80	mg/kg	no CSF	--	--	no ABS	--	--
				Uranium	14.33	mg/kg	no CSF	--	--	no ABS	--	--
			Exp. Route Total						4E-07			4E-07
			External Exposure	Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/y per pCi/g	5E-05	--		--
				Bi-214	2.33	pCi/g		risk/y per pCi/g	8E-05	--		--
				Cs-137	0.07	pCi/g		risk/y per pCi/g	7E-07	--		--
				K-40	18.10	pCi/g		risk/y per pCi/g	7E-05	--		--
				Pa-234m	4.60	pCi/g		risk/y per pCi/g	2E-04	--		--
				Pb-212	1.35	pCi/g		risk/y per pCi/g	5E-05	--		--
				Pb-214	2.47	pCi/g		risk/y per pCi/g	1E-04	--		--
				Ra-223	0.41	pCi/g		risk/y per pCi/g	2E-06	--		--
				Ra-226	4.00	pCi/g		risk/y per pCi/g	2E-04	--		--
				Ra-228	1.42	pCi/g		risk/y per pCi/g	8E-05	--		--
				Th-227	0.17	pCi/g		risk/y per pCi/g	1E-06	--		--
				Th-228	1.60	pCi/g		risk/y per pCi/g	6E-05	--		--
				Th-230	2.59	pCi/g		risk/y per pCi/g	1E-04	--		--
				Th-232	1.37	pCi/g		risk/y per pCi/g	7E-05	--		--
				Th-234	3.26	pCi/g		risk/y per pCi/g	1E-04	--		--
				Tl-208	0.43	pCi/g		risk/y per pCi/g	4E-05	--		--
				U-234	4.29	pCi/g		risk/y per pCi/g	2E-04	--		--
				U-235	0.31	pCi/g		risk/y per pCi/g	3E-06	--		--
				U-238	4.32	pCi/g		risk/y per pCi/g	2E-04	--		--
			Exp. Route Total						2E-03			0E+00
		Exposure Point Total							2E-03			8E-02
	Exposure Medium Total (Surface Soil)								2E-03			8E-02
Soil Total									2E-03			8E-02

Air	Outdoor/Indoor Air	WLB	Inhalation	Rn-222	1074.00	pCi/m^3				--		--
				At-218	1074.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Bi-214	1074.00	pCi/m^3	6E-11	risk/pCi	8E-03	--		--
				Pb-214	1074.00	pCi/m^3	8E-11	risk/pCi	1E-02	--		--
				Po-214	1074.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Po-218	1074.00	pCi/m^3	1E-11	risk/pCi	2E-03	--		--
				Rn-218	1074.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Rn-222	1074.00	pCi/m^3	2E-12	risk/pCi	3E-04	--		--
			Exp. Route Total						2E-02			0E+00
		Exposure Point Total										
			External Exposure (Submersion)	Rn-222	1074.00	pCi/m^3				--		--
				At-218	1074.00	pCi/m^3	3E-14	risk/y per pCi/m^3	4E-14	--		--
				Bi-214	1074.00	pCi/m^3	7E-09	risk/y per pCi/m^3	4E-05	--		--
				Pb-214	1074.00	pCi/m^3	1E-09	risk/y per pCi/m^3	6E-06	--		--
				Po-214	1074.00	pCi/m^3	4E-13	risk/y per pCi/m^3	2E-09	--		--
				Po-218	1074.00	pCi/m^3	4E-17	risk/y per pCi/m^3	2E-13	--		--
				Rn-218	1074.00	pCi/m^3	3E-12	risk/y per pCi/m^3	4E-15	--		--
				Rn-222	1074.00	pCi/m^3	2E-12	risk/y per pCi/m^3	1E-08	--		--
			Exp. Route Total						5E-05			0E+00
		Exposure Point Total							2E-02			0E+00
	Exposure Medium Total								2E-02			0E+00
Air Total												
								Total of Receptor Risks Across All Media	2E-02	Total of Receptor Hazards Across All Media		8E-02

TABLE 7.1.2 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Future
Receptor Population: CI-IOW (Default Parameters
Receptor Age: Adul

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Surface Soil	LTAs	Incidental Ingestion	Arsenic	4.69	mg/kg	2E+00	(mg/kg-d)$^{-1}$	1E-06	3E-04	mg/kg-d	8E-03
				Molybdenum	0.63	mg/kg	No CSF	--	--	5E-03	mg/kg-d	1E-04
				Selenium	1.12	mg/kg	No CSF	--	--	5E-03	mg/kg-d	2E-04
				Uranium	3.99	mg/kg	No CSF	--	--	2E-04	mg/kg-d	2E-02
				Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	3E-10	--		--
				Bi-214	0.87	pCi/g		risk/pCi	1E-06	--		--
				Cs-137	0.07	pCi/g		risk/pCi	1E-09	--		--
				K-40	15.92	pCi/g		risk/pCi	2E-07	--		--
				Pa-234m	1.84	pCi/g		risk/pCi	3E-06	--		--
				Pb-212	0.94	pCi/g		risk/pCi	8E-09	--		--
				Pb-214	0.94	pCi/g		risk/pCi	1E-06	--		--
				Ra-223	0.25	pCi/g		risk/pCi	2E-08	--		--
				Ra-226	1.41	pCi/g		risk/pCi	2E-06	--		--
				Ra-228	0.98	pCi/g		risk/pCi	5E-07	--		--
				Th-228	1.76	pCi/g		risk/pCi	2E-07	--		--
				Th-230	1.16	pCi/g		risk/pCi	2E-06	--		--
				Th-232	1.74	pCi/g		risk/pCi	1E-06	--		--
				Th-234	0.89	pCi/g		risk/pCi	1E-06	--		--
				Tl-208	0.29	pCi/g		risk/pCi	0E+00	--		--
				U-234	2.23	pCi/g		risk/pCi	3E-06	--		--
				U-235	0.13	pCi/g		risk/pCi	5E-08	--		--
				U-238	2.21	pCi/g		risk/pCi	3E-06	--		--
			Exp. Route Total						2E-05			3E-02
		LTAs	Inhalation of Particulates	Arsenic	4.69	mg/kg	4E-03	(ug/m^3)$^{-1}$	2E-10	2E-05	mg/m^3	1E-05
				Molybdenum	0.63	mg/kg	No IUR	--	No IUR	No RfC	--	No RfC
				Selenium	1.12	mg/kg	No IUR	--	No IUR	2E-02	mg/m^3	2E-09
				Uranium	3.99	mg/kg	No IUR	--	No IUR	4E-05	mg/m^3	3E-06
				Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	2E-12	--		--
				Bi-214	0.87	pCi/g		risk/pCi	5E-10	--		--
				Cs-137	0.07	pCi/g		risk/pCi	2E-13	--		--
				K-40	15.92	pCi/g		risk/pCi	7E-11	--		--
				Pa-234m	1.84	pCi/g		risk/pCi	4E-09	--		--
				Pb-212	0.94	pCi/g		risk/pCi	1E-11	--		--
				Pb-214	0.94	pCi/g		risk/pCi	5E-10	--		--
				Ra-223	0.25	pCi/g		risk/pCi	1E-10	--		--
				Ra-226	1.41	pCi/g		risk/pCi	2E-09	--		--
				Ra-228	0.98	pCi/g		risk/pCi	3E-09	--		--
				Th-228	1.76	pCi/g		risk/pCi	5E-09	--		--
				Th-230	1.16	pCi/g		risk/pCi	2E-09	--		--
				Th-232	1.74	pCi/g		risk/pCi	8E-09	--		--
				Th-234	0.89	pCi/g		risk/pCi	2E-09	--		--
				Tl-208	0.29	pCi/g		risk/pCi	0E+00	--		--
				U-234	2.23	pCi/g		risk/pCi	5E-09	--		--
				U-235	0.13	pCi/g		risk/pCi	8E-10	--		--
				U-238	2.21	pCi/g		risk/pCi	6E-09	--		--
			Exp. Route Total						4E-08			1E-05
		LTAs	Dermal Contact	Arsenic	4.69	mg/kg	2E+00	(mg/kg-d)$^{-1}$	3E-07	3E-04	mg/kg-d	2E-03
			Dermal Contact	Molybdenum	0.63	mg/kg	No CSF	--	-	5E-03	mg/kg-d	No ABS
				Selenium	1.12	mg/kg	No CSF	--	-	5E-03	mg/kg-d	No ABS
				Uranium	3.99	mg/kg	No CSF	--	-	2E-04	mg/kg-d	No ABS
			Exp. Route Total						3E-07			2E-03
			External Exposure	Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/y per pCi/g	3E-05	--		--
				Bi-214	0.87	pCi/g		risk/y per pCi/g	3E-05	--		--
				Cs-137	0.07	pCi/g		risk/y per pCi/g	8E-07	--		--
				K-40	15.92	pCi/g		risk/y per pCi/g	6E-05	--		--
				Pa-234m	1.84	pCi/g		risk/y per pCi/g	7E-05	--		--
				Pb-212	0.94	pCi/g		risk/y per pCi/g	3E-05	--		--
				Pb-214	0.94	pCi/g		risk/y per pCi/g	4E-05	--		--
				Ra-223	0.25	pCi/g		risk/y per pCi/g	1E-06	--		--
				Ra-226	1.41	pCi/g		risk/y per pCi/g	6E-05	--		--
				Ra-228	0.98	pCi/g		risk/y per pCi/g	5E-05	--		--
				Th-228	1.76	pCi/g		risk/y per pCi/g	6E-05	--		--
				Th-230	1.16	pCi/g		risk/y per pCi/g	5E-05	--		--
				Th-232	1.74	pCi/g		risk/y per pCi/g	1E-04	--		--
				Th-234	0.89	pCi/g		risk/y per pCi/g	4E-05	--		--
				Tl-208	0.29	pCi/g		risk/y per pCi/g	3E-05	--		--
				U-234	2.23	pCi/g		risk/y per pCi/g	9E-05	--		--
				U-235	0.13	pCi/g		risk/y per pCi/g	1E-06	--		--
				U-238	2.21	pCi/g		risk/y per pCi/g	9E-05	--		--
			Exp. Route Total						8E-04			0E+00
		Exposure Point Total							8E-04			3E-02
	Exposure Medium Total								8E-04			3E-02
Soil Total									8E-04			3E-02
Air	Outdoor and Indoor Air	LTAs	Inhalation	Rn-222	1074.00	pCi/m^3				--		--
				At-218	1074.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Bi-214	1074.00	pCi/m^3	6E-11	risk/pCi	8E-03	--		--
				Pb-214	1074.00	pCi/m^3	8E-11	risk/pCi	1E-02	--		--
				Po-214	1074.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Po-218	1074.00	pCi/m^3	1E-11	risk/pCi	2E-03	--		--
				Rn-218	1074.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Rn-222	1074.00	pCi/m^3	2E-12	risk/pCi	3E-04	--		--
			Exp. Route Total						2E-02			0E+00
			External Exposure (Submersion)	Rn-222	1074.00	pCi/m^3						
				At-218	1074.00	pCi/m^3	3E-14	risk/yr per pCi/m^3	4E-14	--		--
				Bi-214	1074.00	pCi/m^3	7E-09	risk/yr per pCi/m^3	4E-05	--		--
				Pb-214	1074.00	pCi/m^3	1E-09	risk/yr per pCi/m^3	6E-06	--		--
				Po-214	1074.00	pCi/m^3	4E-13	risk/yr per pCi/m^3	2E-09	--		--
				Po-218	1074.00	pCi/m^3	4E-17	risk/yr per pCi/m^3	2E-13	--		--
				Rn-218	1074.00	pCi/m^3	3E-12	risk/yr per pCi/m^3	4E-15	--		--
				Rn-222	1074.00	pCi/m^3	2E-12	risk/yr per pCi/m^3	1E-08	--		--
			Exp. Route Total						5E-05			0E+00
		Exposure Point Total							2E-02			0E+00
	Exposure Medium Total								2E-02			0E+00
Air Total									2E-02			
							Total of Receptor Risks Across All Media		2E-02	Total of Receptor Hazards Across All Media		3E-02

TABLE 7.1.3 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Sit

Scenario Timeframe: Future
Receptor Population: Construction Worke
Receptor Age: Adul

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Surface and Subsurface Soil	WLB	Incidental Ingestion	Arsenic	6.33	mg/kg	2E+00	$(mg/kg\text{-}d)^{-1}$	2E-07	3E-04	mg/kg-d	4E-02
				Molybdenum	23.65	mg/kg	No CSF	--	-	5E-03	mg/kg-d	1E-02
				Selenium	3.13	mg/kg	No CSF	--	-	5E-03	mg/kg-d	2E-03
				Uranium	15.53	mg/kg	No CSF	--	-	2E-04	mg/kg-d	2E-01
				Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	5E-11	--		
				Bi-214	2.33	pCi/g		risk/pCi	4E-07	--		--
				Cs-137	0.07	pCi/g		risk/pCi	2E-10	--		--
				K-40	18.10	pCi/g		risk/pCi	2E-08	--		--
				Pa-234m	4.60	pCi/g		risk/pCi	9E-07	--		--
				Pb-212	1.35	pCi/g		risk/pCi	2E-09	--		--
				Pb-214	2.47	pCi/g		risk/pCi	4E-07	--		--
				Ra-223	0.41	pCi/g		risk/pCi	4E-09	--		--
				Ra-226	3.74	pCi/g		risk/pCi	7E-07	--		--
				Ra-228	1.42	pCi/g		risk/pCi	1E-07	--		--
				Th-227	0.17	pCi/g		risk/pCi	2E-09	--		--
				Th-228	1.60	pCi/g		risk/pCi	2E-08	--		--
				Th-230	2.67	pCi/g		risk/pCi	5E-07	--		--
				Th-232	1.37	pCi/g		risk/pCi	1E-07	--		--
				Th-234	3.26	pCi/g		risk/pCi	7E-07	--		--
				Tl-208	0.43	pCi/g		risk/pCi	0E+00	--		--
				U-234	4.29	pCi/g		risk/pCi	9E-07	--		--
				U-235	0.31	pCi/g		risk/pCi	1E-08	--		--
				U-238	4.32	pCi/g		risk/pCi	9E-07	--		--
			Exp. Route Total						6E-06			3E-01
Soil	Surface and Subsurface Soil	WLB	Inhalation of Particulates	Arsenic	6.33	mg/kg	4E-03	$(ug/m3)^{-1}$	1E-09	2E-05	mg/m^3	1E-03
				Molybdenum	23.65	mg/kg	No IUR	--	-	No RfC	--	-
				Selenium	3.13	mg/kg	No IUR	--	-	2E-02	mg/m^3	5E-07
				Uranium	15.53	mg/kg	No IUR	--	-	4E-05	mg/m^3	5E-04
				Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	1E-11	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.		
				Bi-214	2.33	pCi/g		risk/pCi	5E-09			--
				Cs-137	0.07	pCi/g		risk/pCi	5E-13			--
				K-40	18.10	pCi/g		risk/pCi	3E-10			--
				Pa-234m	4.60	pCi/g		risk/pCi	4E-08			--
				Pb-212	1.35	pCi/g		risk/pCi	7E-11			--
				Pb-214	2.47	pCi/g		risk/pCi	5E-09			--
				Ra-223	0.41	pCi/g		risk/pCi	8E-10			--
				Ra-226	3.74	pCi/g		risk/pCi	2E-08			--
				Ra-228	1.42	pCi/g		risk/pCi	2E-08			--
				Th-227	0.17	pCi/g		risk/pCi	8E-10			--
				Th-228	1.60	pCi/g		risk/pCi	2E-08			--
				Th-230	2.67	pCi/g		risk/pCi	2E-08			--
				Th-232	1.37	pCi/g		risk/pCi	2E-08			--
				Th-234	3.26	pCi/g		risk/pCi	3E-08			--
				Tl-208	0.43	pCi/g		risk/pCi	0E+00			--
				U-234	4.29	pCi/g		risk/pCi	4E-08			--
				U-235	0.31	pCi/g		risk/pCi	7E-09			--
				U-238	4.32	pCi/g		risk/pCi	4E-08			--
			Exp. Route Total						3E-07			2E-03
Soil	Surface and Subsurface Soil	WLB	Dermal Contact	Arsenic	6.33	mg/kg	2E+00	$(mg/kg\text{-}d)^{-1}$	4E-08	3E-04	mg/kg-d	6E-03
				Molybdenum	23.65	mg/kg	No CSF	--	-	5E-03	mg/kg-d	-
				Selenium	3.13	mg/kg	No CSF	--	-	5E-03	mg/kg-d	-
				Uranium	15.53	mg/kg	No CSF	--	-	2E-04	mg/kg-d	-
			Exp. Route Total						4E-08			6E-03
			External Exposure	Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/yr per pCi/g	2E-06	--		--
				Bi-214	2.33	pCi/g		risk/yr per pCi/g	3E-06	--		--
				Cs-137	0.07	pCi/g		risk/yr per pCi/g	3E-08	--		--
				K-40	18.10	pCi/g		risk/yr per pCi/g	3E-06	--		--
				Pa-234m	4.60	pCi/g		risk/yr per pCi/g	7E-06	--		--
				Pb-212	1.35	pCi/g		risk/yr per pCi/g	2E-06	--		--
				Pb-214	2.47	pCi/g		risk/yr per pCi/g	4E-06	--		--
				Ra-223	0.41	pCi/g		risk/yr per pCi/g	8E-08	--		--
				Ra-226	3.74	pCi/g		risk/yr per pCi/g	6E-06	--		--
				Ra-228	1.42	pCi/g		risk/yr per pCi/g	3E-06	--		--
				Th-227	0.17	pCi/g		risk/yr per pCi/g	5E-08	--		--
				Th-228	1.60	pCi/g		risk/yr per pCi/g	2E-06	--		--
				Th-230	2.67	pCi/g		risk/yr per pCi/g	4E-06	--		--
				Th-232	1.37	pCi/g		risk/yr per pCi/g	3E-06	--		--
				Th-234	3.26	pCi/g		risk/yr per pCi/g	5E-06	--		--
				Tl-208	0.43	pCi/g		risk/yr per pCi/g	2E-06	--		--
				U-234	4.29	pCi/g		risk/yr per pCi/g	7E-06	--		--
				U-235	0.31	pCi/g		risk/yr per pCi/g	1E-07	--		--
				U-238	4.32	pCi/g		risk/yr per pCi/g	7E-06			
			Exp. Route Total						6E-05			0E+00
		Exposure Point Total							7E-05			3E-01
	Exposure Medium Total								7E-05			3E-01
Soil Total									7E-05			3E-01
Air	Outdoor and Trench Air	WLB	Inhalation	Rn-222								
				At-218	1074.00	pCi/m3	0E+00	risk/pCi	0E+00	--		--
				Bi-214	1074.00	pCi/m3	6E-11	risk/pCi	3E-04	--		--
				Pb-214	1074.00	pCi/m3	8E-11	risk/pCi	4E-04	--		--
				Po-214	1074.00	pCi/m3	0E+00	risk/pCi	0E+00	--		--
				Po-218	1074.00	pCi/m3	1E-11	risk/pCi	7E-05	--		--
				Rn-218	1074.00	pCi/m3	0E+00	risk/pCi	0E+00	--		--
				Rn-222	1074.00	pCi/m3	2E-12	risk/pCi	1E-05	--		--
			Exp. Route Total						8E-04			0E+00
			External Exposure (Submersion)	Rn-222								
				At-218	1074.00	pCi/m3	3E-14	(risk/y per pCi/m3	2E-15	--		--
				Bi-214	1074.00	pCi/m3	7E-09	(risk/y per pCi/m3	2E-06	--		--
				Pb-214	1074.00	pCi/m3	1E-09	(risk/y per pCi/m3	3E-07	--		--
				Po-214	1074.00	pCi/m3	4E-13	(risk/y per pCi/m3	9E-11	--		--
				Po-218	1074.00	pCi/m3	4E-17	(risk/y per pCi/m3	1E-14	--		--
				Rn-218	1074.00	pCi/m3	3E-12	(risk/y per pCi/m3	2E-16	--		--
				Rn-222	1074.00	pCi/m3	2E-12	(risk/y per pCi/m3	4E-10	--		--
			Exp. Route Total						2E-06			0E+00
		Exposure Point Total							8E-04			0E+00
	Exposure Medium Total								8E-04			0E+00
Air Total									8E-04			0E+00
							Total of Receptor Risks Across All Media		9E-04	Total of Receptor Hazards Across All Media		3E-01

TABLE 7.1.4 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Surface and Subsurface Soil	LTAs	Incidental Ingestion	Arsenic	4.69	mg/kg	2E+00	$(mg/kg\text{-}d)^{-1}$	2E-07	3E-04	mg/kg-d	3E-02
				Molybdenum	1.97	mg/kg	no CSF	--	--	5E-03	mg/kg-d	1E-03
				Selenium	0.83	mg/kg	no CSF	--	--	5E-03	mg/kg-d	5E-04
				Uranium	4.33	mg/kg	no CSF	--	--	2E-04	mg/kg-d	6E-02
				Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	4E-11	--		--
				Bi-214	0.87	pCi/g		risk/pCi	1E-07	--		--
				Cs-137	0.07	pCi/g		risk/pCi	2E-10	--		--
				K-40	15.92	pCi/g		risk/pCi	2E-08	--		--
				Pa-234m	1.84	pCi/g		risk/pCi	4E-07	--		--
				Pb-212	0.94	pCi/g		risk/pCi	1E-09	--		--
				Pb-214	0.94	pCi/g		risk/pCi	2E-07	--		--
				Ra-223	0.25	pCi/g		risk/pCi	2E-09	--		--
				Ra-226	1.33	pCi/g		risk/pCi	3E-07	--		--
				Ra-228	0.98	pCi/g		risk/pCi	7E-08	--		--
				Th-228	1.76	pCi/g		risk/pCi	2E-08	--		--
				Th-230	1.65	pCi/g		risk/pCi	3E-07	--		--
				Th-232	1.74	pCi/g		risk/pCi	1E-07	--		--
				Th-234	0.89	pCi/g		risk/pCi	2E-07	--		--
				Tl-208	0.29	pCi/g		risk/pCi	0E+00	--		--
				U-234	2.23	pCi/g		risk/pCi	5E-07	--		--
				U-235	0.13	pCi/g		risk/pCi	6E-09	--		--
				U-238	2.21	pCi/g		risk/pCi	5E-07	--		--
			Exp. Route Total						3E-06			9E-02
		LTAs	Inhalation of Particulates	Arsenic	4.69	mg/kg	2E+00	$(mg/kg\text{-}d)^{-1}$	3E-08	2E-05	mg/m^3	1E-03
				Molybdenum	1.97	mg/kg	no CSF	--	--	--		-
				Selenium	0.83	mg/kg	no CSF	--	--	2E-02	mg/m^3	1E-07
				Uranium	4.33	mg/kg	no CSF	--	--	1E-04	mg/m^3	1E-04
				Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	8E-12	--		--
				Bi-214	0.87	pCi/g		risk/pCi	2E-09	--		--
				Cs-137	0.07	pCi/g		risk/pCi	5E-13	--		--
				K-40	15.92	pCi/g		risk/pCi	2E-10	--		--
				Pa-234m	1.84	pCi/g		risk/pCi	2E-08	--		--
				Pb-212	0.94	pCi/g		risk/pCi	5E-11	--		--
				Pb-214	0.94	pCi/g		risk/pCi	2E-09	--		--
				Ra-223	0.25	pCi/g		risk/pCi	5E-10	--		--
				Ra-226	1.33	pCi/g		risk/pCi	5E-09	--		--
				Ra-228	0.98	pCi/g		risk/pCi	1E-08	--		--
				Th-228	1.76	pCi/g		risk/pCi	2E-08	--		--
				Th-230	1.65	pCi/g		risk/pCi	1E-08	--		--
				Th-232	1.74	pCi/g		risk/pCi	3E-08	--		--
				Th-234	0.89	pCi/g		risk/pCi	7E-09	--		--
				Tl-208	0.29	pCi/g		risk/pCi	0E+00	--		--
				U-234	2.23	pCi/g		risk/pCi	2E-08	--		--
				U-235	0.13	pCi/g		risk/pCi	3E-09	--		--
				U-238	2.21	pCi/g		risk/pCi	2E-08	--		--
			Exp. Route Total						2E-07			1E-03
		LTAs	Dermal Contact	Arsenic	4.69	mg/kg	2E+00	$(mg/kg\text{-}d)^{-1}$	9E-10	3E-04	mg/kg-d	4E-03
				Molybdenum	1.97	mg/kg	no CSF	--	--	5E-03	mg/kg-d	No ABS
				Selenium	0.83	mg/kg	no CSF	--	--	5E-03	mg/kg-d	No ABS
				Uranium	4.33	mg/kg	no CSF	--	--	2E-04	mg/kg-d	No ABS
			Exp. Route Total						9E-10			4E-03
			External Exposure	Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/y per pCi/g	1E-06	--		--
				Bi-214	0.87	pCi/g		risk/y per pCi/g	1E-06	--		--
				Cs-137	0.07	pCi/g		risk/y per pCi/g	3E-08	--		--
				K40	15.92	pCi/g		risk/y per pCi/g	2E-06	--		--
				Pa-234m	1.84	pCi/g		risk/y per pCi/g	3E-06	--		--
				Pb-212	0.94	pCi/g		risk/y per pCi/g	1E-06	--		--
				Pb-214	0.94	pCi/g		risk/y per pCi/g	1E-06	--		--
				Ra-223	0.25	pCi/g		risk/y per pCi/g	5E-08	--		--
				Ra-226	1.33	pCi/g		risk/y per pCi/g	2E-06	--		--
				Ra-228	0.98	pCi/g		risk/y per pCi/g	2E-06	--		--
				Th-228	1.76	pCi/g		risk/y per pCi/g	3E-06	--		--
				Th-230	1.65	pCi/g		risk/y per pCi/g	3E-06	--		--
				Th-232	1.74	pCi/g		risk/y per pCi/g	4E-06	--		--
				Th-234	0.89	pCi/g		risk/y per pCi/g	1E-06	--		--
				Tl-208	0.29	pCi/g		risk/y per pCi/g	1E-06	--		--
				U-234	2.23	pCi/g		risk/y per pCi/g	3E-06	--		--
				U-235	0.13	pCi/g		risk/y per pCi/g	5E-08	--		--
				U-238	2.21	pCi/g		risk/y per pCi/g	4E-06	--		--
			Exp. Route Total						3E-05			0E+00
		Exposure Point Total							4E-05			1E-01
	Exposure Medium Total								4E-05			1E-01
Soil Total									4E-05			1E-01
Air	Outdoor and Trench Air	LTAs	Inhalation	Rn-222						--		--
				At-218	1074.00	risk/pCi	0E+00	risk/pCi	0E+00	--		--
				Bi-214	1074.00	risk/pCi	6E-11	risk/pCi	3E-04	--		--
				Pb-214	1074.00	risk/pCi	8E-11	risk/pCi	4E-04	--		--
				Po-214	1074.00	risk/pCi	0E+00	risk/pCi	0E+00	--		--
				Po-218	1074.00	risk/pCi	1E-11	risk/pCi	7E-05	--		--
				Rn-218	1074.00	risk/pCi	0E+00	risk/pCi	0E+00	--		--
				Rn-222	1074.00	risk/pCi	2E-12	risk/pCi	1E-05	--		--
			Exp. Route Total						8E-04			0E+00
			External Exposure (Submersion)	Rn-222						--		--
				At-218	1074.00	risk/pCi	3E-14	risk/y per pCi/m^3	2E-15	--		--
				Bi-214	1074.00	risk/pCi	7E-09	risk/y per pCi/m^3	2E-06	--		--
				Pb-214	1074.00	risk/pCi	1E-09	risk/y per pCi/m^3	3E-07	--		--
				Po-214	1074.00	risk/pCi	4E-13	risk/y per pCi/m^3	9E-11	--		--
				Po-218	1074.00	risk/pCi	4E-17	risk/y per pCi/m^3	1E-14	--		--
				Rn-218	1074.00	risk/pCi	3E-12	risk/y per pCi/m^3	2E-16	--		--
				Rn-222	1074.00	risk/pCi	2E-12	risk/y per pCi/m^3	4E-10	--		--
			Exp. Route Total						2E-06			0E+00
		Exposure Point Total							8E-04			0E+00
	Exposure Medium Total								8E-04			0E+00
Air Total									8E-04			0E+00
							Total of Receptor Risks Across All Media		9E-04	Total of Receptor Hazards Across All Media		1E-01

TABLE 7.1.5 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Current
Receptor Population: Trespasser
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Surface Soil	WLB	Incidental Ingestion	Arsenic	6.33	mg/kg	2E+00	(mg/kg-d)$^{-1}$	3E-07	3E-04	mg/kg-d	2E-03
				Molybdenum	36.53	mg/kg	No CSF	--	--	5E-03	mg/kg-d	1E-03
				Selenium	3.80	mg/kg	No CSF	--	--	5E-03	mg/kg-d	1E-04
				Uranium	14.33	mg/kg	No CSF	--	--	2E-04	mg/kg-d	1E-02
				Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	1E-10	--		--
				Bi-214	2.33	pCi/g		risk/pCi	6E-07	--		--
				Cs-137	0.07	pCi/g		risk/pCi	1E-10	--		--
				K-40	18.10	pCi/g		risk/pCi	5E-08	--		--
				Pa-234m	4.60	pCi/g		risk/pCi	1E-06	--		--
				Pb-212	1.35	pCi/g		risk/pCi	4E-09	--		--
				Pb-214	2.47	pCi/g		risk/pCi	6E-07	--		--
				Ra-223	0.41	pCi/g		risk/pCi	1E-08	--		--
				Ra-226	4.00	pCi/g		risk/pCi	1E-06	--		--
				Ra-228	1.42	pCi/g		risk/pCi	2E-07	--		--
				Th-227	0.17	pCi/g		risk/pCi	6E-09	--		--
				Th-228	1.60	pCi/g		risk/pCi	6E-08	--		--
				Th-230	2.59	pCi/g		risk/pCi	7E-07	--		--
				Th-232	1.37	pCi/g		risk/pCi	2E-07	--		--
				Th-234	3.26	pCi/g		risk/pCi	1E-06	--		--
				Tl-208	0.43	pCi/g		risk/pCi	0E+00	--		--
				U-234	4.29	pCi/g		risk/pCi	1E-06	--		--
				U-235	0.31	pCi/g		risk/pCi	2E-08	--		--
				U-238	4.32	pCi/g		risk/pCi	1E-06	--		--
			Exp. Route Total						9E-06			2E-02
			Inhalation of Particulates	Arsenic	6.33	mg/kg	4E-03	(ug/m^3)$^{-1}$	1E-11	2E-05	mg/m^3	7E-07
				Molybdenum	36.53	mg/kg	No IUR	--	--	--		--
				Selenium	3.80	mg/kg	No IUR	--	--	2E-02	mg/m^3	3E-10
				Uranium	14.33	mg/kg	No IUR	--	--	4E-05	mg/m^3	6E-07
				Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/pCi	2E-14	--		--
				Bi-214	2.33	pCi/g		risk/pCi	9E-12	--		--
				Cs-137	0.07	pCi/g		risk/pCi	9E-16	--		--
				K-40	18.10	pCi/g		risk/pCi	5E-13	--		--
				Pa-234m	4.60	pCi/g		risk/pCi	7E-11	--		--
				Pb-212	1.35	pCi/g		risk/pCi	1E-13	--		--
				Pb-214	2.47	pCi/g		risk/pCi	9E-12	--		--
				Ra-223	0.41	pCi/g		risk/pCi	1E-12	--		--
				Ra-226	4.00	pCi/g		risk/pCi	3E-11	--		--
				Ra-228	1.42	pCi/g		risk/pCi	3E-11	--		--
				Th-227	0.17	pCi/g		risk/pCi	1E-12	--		--
				Th-228	1.60	pCi/g		risk/pCi	3E-11	--		--
				Th-230	2.59	pCi/g		risk/pCi	3E-11	--		--
				Th-232	1.37	pCi/g		risk/pCi	4E-11	--		--
				Th-234	3.26	pCi/g		risk/pCi	5E-11	--		--
				Tl-208	0.43	pCi/g		risk/pCi	0E+00	--		--
				U-234	4.29	pCi/g		risk/pCi	6E-11	--		--
				U-235	0.31	pCi/g		risk/pCi	1E-11	--		--
				U-238	4.32	pCi/g		risk/pCi	8E-11	--		--
			Exp. Route Total						5E-10			1E-06
			Dermal Contact	Arsenic	6.33	mg/kg	2E+00	(mg/kg-d)$^{-1}$	6E-08	3E-04	mg/kg-d	4E-04
				Molybdenum	36.53	mg/kg	No CSF	--	No ABS	5E-03	mg/kg-d	No ABS
				Selenium	3.80	mg/kg	No CSF	--	No ABS	5E-03	mg/kg-d	No ABS
				Uranium	14.33	mg/kg	No CSF	--	No ABS	2E-04	mg/kg-d	No ABS
			Exp. Route Total						6E-08			4E-04
			External Exposure	Bi-212	1.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is not relevant.	risk/y per pCi/g	1E-06	--		--
				Bi-214	2.33	pCi/g		risk/y per pCi/g	2E-06	--		--
				Cs-137	0.07	pCi/g		risk/y per pCi/g	1E-08	--		--
				K-40	18.10	pCi/g		risk/y per pCi/g	1E-06	--		--
				Pa-234m	4.60	pCi/g		risk/y per pCi/g	4E-06	--		--
				Pb-212	1.35	pCi/g		risk/y per pCi/g	9E-07	--		--
				Pb-214	2.47	pCi/g		risk/y per pCi/g	2E-06	--		--
				Ra-223	0.41	pCi/g		risk/y per pCi/g	4E-08	--		--
				Ra-226	4.00	pCi/g		risk/y per pCi/g	3E-06	--		--
				Ra-228	1.42	pCi/g		risk/y per pCi/g	1E-06	--		--
				Th-227	0.17	pCi/g		risk/y per pCi/g	2E-08	--		--
				Th-228	1.60	pCi/g		risk/y per pCi/g	1E-06	--		--
				Th-230	2.59	pCi/g		risk/y per pCi/g	2E-06	--		--
				Th-232	1.37	pCi/g		risk/y per pCi/g	1E-06	--		--
				Th-234	3.26	pCi/g		risk/y per pCi/g	2E-06	--		--
				Tl-208	0.43	pCi/g		risk/y per pCi/g	7E-07	--		--
				U-234	4.29	pCi/g		risk/y per pCi/g	3E-06	--		--
				U-235	0.31	pCi/g		risk/y per pCi/g	6E-08	--		--
				U-238	4.32	pCi/g		risk/y per pCi/g	3E-06	--		--
			Exp. Route Total						3E-05			0E+00
	Exposure Medium Total								4E-05			2E-02
Soil Total									4E-05			2E-02
Air	Outdoor (Ambient) Air	WLB	Inhalation	Rn-222						--		--
				At-218	949.00	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Bi-214	949.00	pCi.m^3	6E-11	risk/pCi	5E-05	--		--
				Pb-214	949.00	pCi.m^3	8E-11	risk/pCi	6E-05	--		--
				Po-214	949.00	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Po-218	949.00	pCi.m^3	1E-11	risk/pCi	1E-05	--		--
				Rn-218	949.00	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Rn-222	949.00	pCi.m^3	2E-12	risk/pCi	2E-06	--		--
			Exp. Route Total						1E-04			0E+00
			External Exposure (Submersion)	Rn-222						--		--
				At-218	949.00	pCi.m^3	3E-14	risk/y per pCi/m^3	6E-16	--		--
				Bi-214	949.00	pCi.m^3	7E-09	risk/y per pCi/m^3	7E-07	--		--
				Pb-214	949.00	pCi.m^3	1E-09	risk/y per pCi/m^3	1E-07	--		--
				Po-214	949.00	pCi.m^3	4E-13	risk/y per pCi/m^3	4E-11	--		--
				Po-218	949.00	pCi.m^3	4E-17	risk/y per pCi/m^3	4E-15	--		--
				Rn-218	949.00	pCi.m^3	3E-12	risk/y per pCi/m^3	7E-17	--		--
				Rn-222	949.00	pCi.m^3	2E-12	risk/y per pCi/m^3	2E-10	--		--
			Exp. Route Total						8E-07			0E+00
		Exposure Point Total							1E-04			0E+00
	Exposure Medium Total								1E-04			0E+00
Air Total									1E-04			0E+00

Surface Water	Pond Water	WLB	Incidental Ingestion	Manganese (total)	0.30	mg/L	No CSF	--	--	2E-02	mg/kg-d	3E-06
				Molybdenum (total	864.40	mg/L	No CSF	--	--	5E-03	mg/kg-d	4E-02
				Nitrate	2.14	mg/L	No CSF	--	--	2E+00	mg/kg-d	3E-07
				Selenium (total	0.73	mg/L	No CSF	--	--	5E-03	mg/kg-d	3E-05
				U-natural (total	548.80	mg/L	No CSF	--	--	2E-04	mg/kg-d	6E-01
				Vanadium	0.11	mg/L	No CSF	--	--	5E-03	mg/kg-d	4E-06
				Ra-226	45.75	pCi/L	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for	risk/pCi	1E-07	--		--
				Ra-228	71.01	pCi/L		risk/pCi	8E-08	--		--
				Th-230	1200.00	pCi/L		risk/pCi	3E-06	--		--
				U-234*	183848	pCi/L		risk/pCi	4E-05	--		--
				U-238*	183848	pCi/L		risk/pCi	4E-05	--		--
			Exp. Route Total						8E-05			6E-01
			Immersion	Ra-226	45.75	pCi/L	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for	risk/y per pCi/L	1E-12	--		--
				Ra-228	71.01	pCi/L		risk/y per pCi/L	2E-12	--		--
				Th-230	1200.00	pCi/L		risk/y per pCi/L	3E-11	--		--
				U-234*	183848	pCi/L		risk/y per pCi/L	4E-09	--		--
				U-238*	183848	pCi/L		risk/y per pCi/L	4E-09	--		--
			Exp. Route Tota						9E-09			0E+00
			Dermal Contact	Manganese (total)	0.30	mg/L	No CSF		--	2E-02	mg/kg-d	3E-04
				Molybdenum (total)	864.40	mg/L	No CSF		--	5E-03	mg/kg-d	1E-01
				Nitrate	2.14	mg/L	No CSF		--	2E+00	mg/kg-d	1E-06
				Selenium (total)	0.73	mg/L	No CSF		--	5E-03	mg/kg-d	1E-04
				U-natural (total)	548.80	mg/L	No CSF		--	2E-04	mg/kg-d	2E+00
				Vanadium	0.11	mg/L	No CSF		--	5E-03	mg/kg-d	7E-04
			Exp. Route Total						0E+00			2E+00
		Exposure Point Total							8E-05			3E+00
	Exposure Medium Total								8E-05			3E+00
Surface Water Total									8E-05			3E+00
Sediment	Sediment	WLB	Incidental Ingestion	Ra-226	32.50	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	1E-06	--		--
				Th-230	0.50	pCi/g		risk/pCi	2E-08	--		--
				U-234*	1283.00	pCi/g		risk/pCi	5E-05	--		--
				U-235*	1283.00	pCi/g		risk/pCi	5E-05	--		--
			Exp. Route Total						1E-04			0E+00
			Inhalation	Ra-226	32.50	pCi/g		risk/pCi	3E-12	--		--
				Th-230	0.50	pCi/g		risk/pCi	7E-14	--		--
				U-234*	1283.00	pCi/g		risk/pCi	2E-10	--		--
				U-235*	1283.00	pCi/g		risk/pCi	3E-10	--		--
			Exp. Route Total						5E-10			0E+00
			External Exposure	Ra-226	32.50	pCi/g		risk/pCi	3E-07	--		--
				Th-230	0.50	pCi/g		risk/pCi	5E-09	--		--
				U-234*	1283.00	pCi/g		risk/pCi	1E-05	--		--
				U-235*	1283.00	pCi/g		risk/pCi	1E-05	--		--
			Exp. Route Total						2E-05			0E+00
		Exposure Point Total							1E-04			0E+00
	Exposure Medium Total								1E-04			0E+00
Sediment Total									1E-04			0E+00
								Total of Receptor Risks Across All Medi	4E-04	Total of Receptor Hazards Across All Media		3E+00

Notes: * U-234 and U-235 were not measured in surface water or sediment; activity estimated from U-natural activity by assigning half the activity of U-natural to each isotope
Trespassers were assumed to contact primarily surface soils; combined soil depth UCL95's used since Mo was higher in subsurface and this was considered conserv
U234 or U238 Utot EPC (548.8 mg/L)*0.67 pCi/ug *1000 ug/mg = 367696 pCi/L

TABLE 7.1.7 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Sit

Scenario Timeframe: Current & Future
Receptor Population: Trespasse
Receptor Age: Adul

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Surface Soil	LTAs	Incidental Ingestion	Arsenic	4.69	mg/kg	2E+00	(mg/kg-day)$^{-1}$	1E-07	3E-04	mg/kg-d	2E-03
				Molybdenum	0.63	mg/kg	No CSF		--	5E-03	mg/kg-d	2E-05
				Selenium	1.12	mg/kg	No CSF		--	5E-03	mg/kg-d	4E-05
				Uranium	3.99	mg/kg	No CSF		--	2E-04	mg/kg-d	3E-03
				Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	8E-11	--		--
				Bi-214	0.87	pCi/g		risk/pCi	2E-07	--		--
				Cs-137	0.07	pCi/g		risk/pCi	1E-10	--		--
				K-40	15.92	pCi/g		risk/pCi	4E-08	--		--
				Pa-234m	1.84	pCi/g		risk/pCi	5E-07	--		--
				Pb-212	0.94	pCi/g		risk/pCi	3E-09	--		--
				Pb-214	0.94	pCi/g		risk/pCi	2E-07	--		--
				Ra-223	0.25	pCi/g		risk/pCi	7E-09	--		--
				Ra-226	1.41	pCi/g		risk/pCi	4E-07	--		--
				Ra-228	0.98	pCi/g		risk/pCi	1E-07	--		--
				Th-228	1.76	pCi/g		risk/pCi	6E-08	--		--
				Th-230	1.16	pCi/g		risk/pCi	3E-07	--		--
				Th-232	1.74	pCi/g		risk/pCi	2E-07	--		--
				Th-234	0.89	pCi/g		risk/pCi	3E-07	--		--
				Tl-208	0.29	pCi/g		risk/pCi	0E+00	--		--
				U-234	2.23	pCi/g		risk/pCi	6E-07	--		--
				U-235	0.13	pCi/g		risk/pCi	9E-09	--		--
				U-238	2.21	pCi/g		risk/pCi	7E-07	--		--
			Exp. Route Total						4E-06			5E-03
			Inhalation of Particulates	Arsenic	4.69	mg/kg	4E-03	(ug/m3)$^{-1}$	5E-12	2E-05	mg/m^3	5E-07
				Molybdenum	0.63	mg/kg	No IUR		--	--		--
				Selenium	1.12	mg/kg	No IUR		--	2E-02	mg/m^3	9E-11
				Uranium	3.99	mg/kg	No IUR		--	4E-05	mg/m^3	2E-07
				Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	1E-14	--		--
				Bi-214	0.87	pCi/g		risk/pCi	3E-12	--		--
				Cs-137	0.07	pCi/g		risk/pCi	1E-15	--		--
				K-40	15.92	pCi/g		risk/pCi	4E-13	--		--
				Pa-234m	1.84	pCi/g		risk/pCi	3E-11	--		--
				Pb-212	0.94	pCi/g		risk/pCi	8E-14	--		--
				Pb-214	0.94	pCi/g		risk/pCi	4E-12	--		--
				Ra-223	0.25	pCi/g		risk/pCi	9E-13	--		--
				Ra-226	1.41	pCi/g		risk/pCi	1E-11	--		--
				Ra-228	0.98	pCi/g		risk/pCi	2E-11	--		--
				Th-228	1.76	pCi/g		risk/pCi	3E-11	--		--
				Th-230	1.16	pCi/g		risk/pCi	1E-11	--		--
				Th-232	1.74	pCi/g		risk/pCi	5E-11	--		--
				Th-234	0.89	pCi/g		risk/pCi	1E-11	--		--
				Tl-208	0.29	pCi/g		risk/pCi	0E+00	--		--
				U-234	2.23	pCi/g		risk/pCi	3E-11	--		--
				U-235	0.13	pCi/g		risk/pCi	5E-12	--		--
				U-238	2.21	pCi/g		risk/pCi	4E-11	--		--
			Exp. Route Total						3E-10			7E-07
			Dermal Contact	Arsenic	4.69	mg/kg	2E+00	(mg/kg-day)$^{-1}$	1E-08	3E-04	mg/kg-d	2E-04
				Molybdenum	0.63	mg/kg	No CSF		--	5E-03	mg/kg-d	No ABS
				Selenium	1.12	mg/kg	No CSF		--	5E-03	mg/kg-d	No ABS
				Uranium	3.99	mg/kg	No CSF		--	2E-04	mg/kg-d	No ABS
			Exp. Route Total						1E-08			2E-04
			External Exposure	Bi-212	1.02	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/yr per pCi/c	7E-07	--		--
				Bi-214	0.87	pCi/g		risk/yr per pCi/c	6E-07	--		--
				Cs-137	0.07	pCi/g		risk/yr per pCi/c	2E-08	--		--
				K40	15.92	pCi/g		risk/yr per pCi/c	1E-06	--		--
				Pa-234m	1.84	pCi/g		risk/yr per pCi/c	1E-06	--		--
				Pb-212	0.94	pCi/g		risk/yr per pCi/c	6E-07	--		--
				Pb-214	0.94	pCi/g		risk/yr per pCi/c	7E-07	--		--
				Ra-223	0.25	pCi/g		risk/yr per pCi/c	2E-08	--		--
				Ra-226	1.41	pCi/g		risk/yr per pCi/c	1E-06	--		--
				Ra-228	0.98	pCi/g		risk/yr per pCi/c	1E-06	--		--
				Th-228	1.76	pCi/g		risk/yr per pCi/c	1E-06	--		--
				Th-230	1.16	pCi/g		risk/yr per pCi/c	9E-07	--		--
				Th-232	1.74	pCi/g		risk/yr per pCi/c	2E-06	--		--
				Th-234	0.89	pCi/g		risk/yr per pCi/c	7E-07	--		--
				Tl-208	0.29	pCi/g		risk/yr per pCi/c	5E-07	--		--
				U-234	2.23	pCi/g		risk/yr per pCi/c	2E-06	--		--
				U-235	0.13	pCi/g		risk/yr per pCi/c	2E-08	--		--
				U-238	2.21	pCi/g		risk/yr per pCi/c	2E-06	--		--
			Exp. Route Total						2E-05			0E+00
		Exposure Point Total							2E-05			5E-03
	Exposure Medium Total								2E-05			5E-03
Soil Total									2E-05			5E-03
Air	Outdoor (Ambient) Air	LTAs	Inhalation	Rn-222						--		--
				At-218	949.00	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Bi-214	949.00	pCi.m^3	6E-11	risk/pCi	5E-05	--		--
				Pb-214	949.00	pCi.m^3	8E-11	risk/pCi	6E-05	--		--
				Po-214	949.00	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Po-218	949.00	pCi.m^3	1E-11	risk/pCi	1E-05	--		--
				Rn-218	949.00	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Rn-222	949.00	pCi.m^3	2E-12	risk/pCi	2E-06	--		--
			Exp. Route Total						1E-04			0E+00
			External Exposure (Submersion)	Rn-222						--		--
				At-218	949.00	pCi.m^3	3E-14	risk/y per pCi/m^3	6E-16	--		--
				Bi-214	949.00	pCi.m^3	7E-09	risk/y per pCi/m^3	7E-07	--		--
				Pb-214	949.00	pCi.m^3	1E-09	risk/y per pCi/m^3	1E-07	--		--
				Po-214	949.00	pCi.m^3	4E-13	risk/y per pCi/m^3	4E-11	--		--
				Po-218	949.00	pCi.m^3	4E-17	risk/y per pCi/m^3	4E-15	--		--
				Rn-218	949.00	pCi.m^3	3E-12	risk/y per pCi/m^3	7E-17	--		--
				Rn-222	949.00	pCi.m^3	2E-12	risk/y per pCi/m^3	2E-10	--		--
			Exp. Route Total						8E-07			0E+00
		Exposure Point Total							1E-04			0E+00
	Exposure Medium Total								1E-04			0E+00
Air Total									1E-04			0E+00
							Total of Receptor Risks Across All Media		1E-04	Total of Receptor Hazards Across All Media		5E-03

TABLE 7.1.8 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Sit

Scenario Timeframe: Future
Receptor Population: CI-IOW (Default Parameters
Receptor Age: Adul

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Background Surface Soil	Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Incidental Ingestion	Arsenic	5.01	mg/kg	2E+00	(mg/kg-d)$^{-1}$	1E-06	3E-04	mg/kg-d	9E-03
				Molybdenum	0.45	mg/kg	No CSF	--	--	5E-03	mg/kg-d	8E-05
				Selenium	0.80	mg/kg	No CSF	--	--	5E-03	mg/kg-d	1E-04
				Uranium	1.69	mg/kg	No CSF	--	--	2E-04	mg/kg-d	7E-03
				Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	3E-10	--		
				Bi-214	0.95	pCi/g		risk/pCi	1E-06	--		
				Cs-137	0.07	pCi/g		risk/pCi	1E-09	--		
				K-40	18.35	pCi/g		risk/pCi	2E-07	--		
				Pa-234m	1.15	pCi/g		risk/pCi	2E-06	--		
				Pb-212	1.10	pCi/g		risk/pCi	9E-09	--		
				Pb-214	1.02	pCi/g		risk/pCi	1E-06	--		
				Ra-223	0.30	pCi/g		risk/pCi	2E-08	--		
				Ra-226	1.81	pCi/g		risk/pCi	3E-06	--		
				Ra-228	1.14	pCi/g		risk/pCi	6E-07	--		
				Th-227	0.13	pCi/g		risk/pCi	1E-08			
				Th-228	1.41	pCi/g		risk/pCi	1E-07	--		
				Th-230	1.39	pCi/g		risk/pCi	2E-06	--		
				Th-232	1.14	pCi/g		risk/pCi	7E-07	--		
				Th-234	0.70	pCi/g		risk/pCi	1E-06	--		
				Tl-208	0.36	pCi/g		risk/pCi	0E+00	--		
				U-234	1.14	pCi/g		risk/pCi	2E-06	--		
				U-235	0.11	pCi/g		risk/pCi	4E-08	--		
				U-238	1.15	pCi/g		risk/pCi	2E-06	--		
			Exp. Route Total						2E-05			2E-02
		Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Inhalation of Particulates	Arsenic	5.01	mg/kg	4E-03	(ug/m^3)$^{-1}$	3E-07	2E-05	mg/m^3	1E-05
				Molybdenum	0.45	mg/kg	No IUR	--	No IUR	No RfC	--	-
				Selenium	0.80	mg/kg	No IUR	--	No IUR	2E-02	mg/m^3	1E-09
				Uranium	1.69	mg/kg	No IUR	--	No IUR	4E-05	mg/m^3	1E-06
				Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	3E-12	--		--
				Bi-214	0.95	pCi/g		risk/pCi	6E-10	--		--
				Cs-137	0.07	pCi/g		risk/pCi	2E-13	--		--
				K-40	18.35	pCi/g		risk/pCi	8E-11	--		--
				Pa-234m	1.15	pCi/g		risk/pCi	3E-09	--		--
				Pb-212	1.10	pCi/g		risk/pCi	2E-11	--		--
				Pb-214	1.02	pCi/g		risk/pCi	6E-10	--		--
				Ra-223	0.30	pCi/g		risk/pCi	2E-10	--		--
				Ra-226	1.81	pCi/g		risk/pCi	2E-09	--		--
				Ra-228	1.14	pCi/g		risk/pCi	4E-09	--		--
				Th-227	0.13	pCi/g		risk/pCi	2E-10			
				Th-228	1.41	pCi/g		risk/pCi	4E-09	--		--
				Th-230	1.39	pCi/g		risk/pCi	2E-09	--		--
				Th-232	1.14	pCi/g		risk/pCi	5E-09	--		--
				Th-234	0.70	pCi/g		risk/pCi	2E-09	--		--
				Tl-208	0.36	pCi/g		risk/pCi	0E+00	--		--
				U-234	1.14	pCi/g		risk/pCi	3E-09	--		--
				U-235	0.11	pCi/g		risk/pCi	7E-10	--		--
				U-238	1.15	pCi/g		risk/pCi	3E-09	--		--
			Exp. Route Total						3E-07			1E-05
		Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Dermal Contact	Arsenic	5.01	mg/kg	2E+00	(mg/kg-d)$^{-1}$	3E-10	3E-04	mg/kg-d	2E-03
				Molybdenum	0.45	mg/kg	No CSF	--	0E+00	5E-03	mg/kg-d	No ABS
				Selenium	0.80	mg/kg	No CSF	--	0E+00	5E-03	mg/kg-d	No ABS
				Uranium	1.69	mg/kg	No CSF	--	0E+00	2E-04	mg/kg-d	No ABS
			Exp. Route Total						3E-10			2E-03
			External Exposure	Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/y per pCi/g	4E-05	--		--
				Bi-214	0.95	pCi/g		risk/y per pCi/g	3E-05	--		--
				Cs-137	0.07	pCi/g		risk/y per pCi/g	8E-07	--		--
				K-40	18.35	pCi/g		risk/y per pCi/g	7E-05	--		--
				Pa-234m	1.15	pCi/g		risk/y per pCi/g	5E-05	--		--
				Pb-212	1.10	pCi/g		risk/y per pCi/g	4E-05	--		--
				Pb-214	1.02	pCi/g		risk/y per pCi/g	4E-05	--		--
				Ra-223	0.30	pCi/g		risk/y per pCi/g	2E-06	--		--
				Ra-226	1.81	pCi/g		risk/y per pCi/g	7E-05	--		--
				Ra-228	1.14	pCi/g		risk/y per pCi/g	6E-05	--		--
				Th-227	0.13	pCi/g		risk/y per pCi/g	9E-07			
				Th-228	1.41	pCi/g		risk/y per pCi/g	5E-05	--		--
				Th-230	1.39	pCi/g		risk/y per pCi/g	5E-05	--		--
				Th-232	1.14	pCi/g		risk/y per pCi/g	6E-05	--		--
				Th-234	0.70	pCi/g		risk/y per pCi/g	3E-05	--		--
				Tl-208	0.36	pCi/g		risk/y per pCi/g	3E-05	--		--
				U-234	1.14	pCi/g		risk/y per pCi/g	4E-05	--		--
				U-235	0.11	pCi/g		risk/y per pCi/g	1E-06	--		--
				U-238	1.15	pCi/g		risk/y per pCi/g	5E-05	--		--
			Exp. Route Total						7E-04			0E+00
		Exposure Point Total							7E-04			2E-02
	Exposure Medium Total								7E-04			2E-02
Soil Total									7E-04			2E-02
Air	Outdoor and Indoor Air	BKG	Inhalation	Rn-222						--		--
				At-218	551.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Bi-214	551.00	pCi/m^3	6E-11	risk/pCi	4E-03	--		--
				Pb-214	551.00	pCi/m^3	8E-11	risk/pCi	5E-03	--		--
				Po-214	551.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Po-218	551.00	pCi/m^3	1E-11	risk/pCi	1E-03	--		--
				Rn-218	551.00	pCi/m^3	0E+00	risk/pCi	0E+00	--		--
				Rn-222	551.00	pCi/m^3	2E-12	risk/pCi	2E-04	--		--
			Exp. Route Total						1E-02			0E+00
			External Exposure (Submersion)	Rn-222								
				At-218	551.00	pCi/m^3	3E-14	risk/yr per pCi/m^3	2E-14	--		--
				Bi-214	551.00	pCi/m^3	7E-09	risk/yr per pCi/m^3	2E-05	--		--
				Pb-214	551.00	pCi/m^3	1E-09	risk/yr per pCi/m^3	3E-06	--		--
				Po-214	551.00	pCi/m^3	4E-13	risk/yr per pCi/m^3	1E-09	--		--
				Po-218	551.00	pCi/m^3	4E-17	risk/yr per pCi/m^3	1E-13	--		--
				Rn-218	551.00	pCi/m^3	3E-12	risk/yr per pCi/m^3	2E-15	--		--
				Rn-222	551.00	pCi/m^3	2E-12	risk/yr per pCi/m^3	5E-09	--		--
			Exp. Route Total						2E-05			0E+00
		Exposure Point Total							1E-02			0E+00
	Exposure Medium Total								1E-02			0E+00
Air Total									1E-02			0E+00
							Total of Receptor Risks Across All Medi		1E-02	Total of Receptor Hazards Across All Media		2E-02

TABLE 7.1.9 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Sit

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adul

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Surface and Subsurface Soil (All BKG data are from the surface interval)	Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Incidental Ingestion	Arsenic	5.01	mg/kg	2E+00	(mg/kg-d)^{1}	2E-07	3E-04	mg/kg-d	3E-02
				Molybdenum	0.45	mg/kg	no CSF	--	--	5E-03	mg/kg-d	3E-04
				Selenium	0.80	mg/kg	no CSF	--	--	5E-03	mg/kg-d	5E-04
				Uranium	1.69	mg/kg	no CSF	--	--	2E-04	mg/kg-d	2E-02
				Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	4E-11	--		
				Bi-214	0.95	pCi/g		risk/pCi	2E-07	--		--
				Cs-137	0.07	pCi/g		risk/pCi	2E-10	--		--
				K-40	18.35	pCi/g		risk/pCi	2E-08	--		--
				Pa-234m	1.15	pCi/g		risk/pCi	2E-07	--		--
				Pb-212	1.10	pCi/g		risk/pCi	1E-09	--		--
				Pb-214	1.02	pCi/g		risk/pCi	2E-07	--		--
				Ra-223	0.30	pCi/g		risk/pCi	3E-09	--		--
				Ra-226	1.81	pCi/g		risk/pCi	3E-07	--		--
				Ra-228	1.14	pCi/g		risk/pCi	8E-08	--		--
				Th-227	0.13	pCi/g		risk/pCi	2E-09			
				Th-228	1.41	pCi/g		risk/pCi	2E-08	--		--
				Th-230	1.39	pCi/g		risk/pCi	3E-07	--		--
				Th-232	1.14	pCi/g		risk/pCi	9E-08	--		--
				Th-234	0.70	pCi/g		risk/pCi	1E-07	--		--
				Tl-208	0.36	pCi/g		risk/pCi	0E+00	--		--
				U-234	1.14	pCi/g		risk/pCi	2E-07	--		--
				U-235	0.11	pCi/g		risk/pCi	5E-09	--		--
				U-238	1.15	pCi/g		risk/pCi	2E-07	--		--
			Exp. Route Total						2E-06			6E-02
		Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Inhalation of Particulates	Arsenic	5.01	mg/kg	2E+00	(mg/kg-d)^{1}	1E-09	2E-05	mg/m^3	1E-03
				Molybdenum	0.45	mg/kg	no CSF	--	--	--		-
				Selenium	0.80	mg/kg	no CSF	--	--	2E-02	mg/m^3	1E-07
				Uranium	1.69	mg/kg	no CSF	--	--	1E-04	mg/m^3	6E-05
				Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	9E-12	--		
				Bi-214	0.95	pCi/g		risk/pCi	2E-09	--		--
				Cs-137	0.07	pCi/g		risk/pCi	6E-13	--		--
				K-40	18.35	pCi/g		risk/pCi	3E-10	--		--
				Pa-234m	1.15	pCi/g		risk/pCi	1E-08	--		--
				Pb-212	1.10	pCi/g		risk/pCi	6E-11	--		--
				Pb-214	1.02	pCi/g		risk/pCi	2E-09	--		--
				Ra-223	0.30	pCi/g		risk/pCi	6E-10	--		--
				Ra-226	1.81	pCi/g		risk/pCi	7E-09	--		--
				Ra-228	1.14	pCi/g		risk/pCi	1E-08	--		--
				Th-227	0.13	pCi/g		risk/pCi	6E-10			
				Th-228	1.41	pCi/g		risk/pCi	1E-08	--		--
				Th-230	1.39	pCi/g		risk/pCi	9E-09	--		--
				Th-232	1.14	pCi/g		risk/pCi	2E-08	--		--
				Th-234	0.70	pCi/g		risk/pCi	6E-09	--		--
				Tl-208	0.36	pCi/g		risk/pCi	0E+00	--		--
				U-234	1.14	pCi/g		risk/pCi	9E-09	--		--
				U-235	0.11	pCi/g		risk/pCi	2E-09	--		--
				U-238	1.15	pCi/g		risk/pCi	1E-08	--		--
			Exp. Route Total						1E-07			1E-03
		Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Dermal Contact	Arsenic	5.01	mg/kg	2E+00	(mg/kg-d)^{1}	3E-08	3E-04	mg/kg-d	5E-03
				Molybdenum	0.45	mg/kg	no CSF	--	--	5E-03	mg/kg-d	No ABS
				Selenium	0.80	mg/kg	no CSF	--	--	5E-03	mg/kg-d	No ABS
				Uranium	1.69	mg/kg	no CSF	--	--	2E-04	mg/kg-d	No ABS
			Exp. Route Total						3E-08			5E-03
			External Exposure	Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/y per pCi/g	2E-06	--		--
				Bi-214	0.95	pCi/g		risk/y per pCi/g	1E-06	--		--
				Cs-137	0.07	pCi/g		risk/y per pCi/g	3E-08	--		--
				K-40	18.35	pCi/g		risk/y per pCi/g	3E-06	--		--
				Pa-234m	1.15	pCi/g		risk/y per pCi/g	2E-06	--		--
				Pb-212	1.10	pCi/g		risk/y per pCi/g	2E-06	--		--
				Pb-214	1.02	pCi/g		risk/y per pCi/g	2E-06	--		--
				Ra-223	0.30	pCi/g		risk/y per pCi/g	6E-08	--		--
				Ra-226	1.81	pCi/g		risk/y per pCi/g	3E-06	--		--
				Ra-228	1.14	pCi/g		risk/y per pCi/g	2E-06			
				Th-227	0.13	pCi/g		risk/y per pCi/g	4E-08	--		--
				Th-228	1.41	pCi/g		risk/y per pCi/g	2E-06	--		--
				Th-230	1.39	pCi/g		risk/y per pCi/g	2E-06	--		--
				Th-232	1.14	pCi/g		risk/y per pCi/g	2E-06	--		--
				Th-234	0.70	pCi/g		risk/y per pCi/g	1E-06	--		--
				Tl-208	0.36	pCi/g		risk/y per pCi/g	1E-06	--		--
				U-234	1.14	pCi/g		risk/y per pCi/g	2E-06	--		--
				U-235	0.11	pCi/g		risk/y per pCi/g	4E-08	--		--
				U-238	1.15	pCi/g		risk/y per pCi/g	2E-06	--		--
			Exp. Route Total						3E-05			0E+00
		Exposure Point Total							3E-05			6E-02
	Exposure Medium Total								3E-05			6E-02
Soil Total									3E-05			6E-02
Air	Outdoor and Trench Air Note: no background indoor air used in this EPC so biased low. EPC is only outdoor	BKG	Inhalation	Rn-222						--		--
				At-218	551	$pCi.m^3$	0E+00	risk/pCi	0E+00	--		--
				Bi-214	551	$pCi.m^3$	6E-11	risk/pCi	2E-04	--		--
				Pb-214	551	$pCi.m^3$	8E-11	risk/pCi	2E-04	--		--
				Po-214	551	$pCi.m^3$	0E+00	risk/pCi	0E+00	--		--
				Po-218	551	$pCi.m^3$	1E-11	risk/pCi	4E-05	--		--
				Rn-218	551	$pCi.m^3$	0E+00	risk/pCi	0E+00	--		--
				Rn-222	551	$pCi.m^3$	2E-12	risk/pCi	6E-06	--		--
			Exp. Route Tota						4E-04			0E+00
			External Exposure (Submersion)	Rn-222						--		--
				At-218	551	$pCi.m^3$	3E-14	risk/y per pCi/m^3	8E-16	--		--
				Bi-214	551	$pCi.m^3$	7E-09	risk/y per pCi/m^3	8E-07	--		--
				Pb-214	551	$pCi.m^3$	1E-09	risk/y per pCi/m^3	1E-07	--		--
				Po-214	551	$pCi.m^3$	4E-13	risk/y per pCi/m^3	4E-11	--		--
				Po-218	551	$pCi.m^3$	4E-17	risk/y per pCi/m^3	5E-15	--		--
				Rn-218	551	$pCi.m^3$	3E-12	risk/y per pCi/m^3	8E-17	--		--
				Rn-222	551	$pCi.m^3$	2E-12	risk/y per pCi/m^3	2E-10	--		--
			Exp. Route Total						1E-06			0E+00
		Exposure Point Total							4E-04			0E+00
	Exposure Medium Total								4E-04			0E+00
Air Total									4E-04			0E+00
								Total of Receptor Risks Across All Medi	5E-04	Total of Receptor Hazards Across All Media		6E-02

TABLE 7.1.10 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FROM EPA/ORNL RADPRG CALCULATOR AUGUST-SEPTEMBER 2019
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company Superfund Site

Scenario Timeframe: Current & Future
Receptor Population: Trespasse
Receptor Age: Adul

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical or Radionuclide of Potential Concern	EPC		CSF/Unit Risk		Cancer Risk	RfD/RfC		Hazard Quotient
					Value	Units	Value	Units		Value	Units	
Soil	Surface Soil		Incidental Ingestion	Arsenic	5.01	mg/kg	2E+00	(mg/kg-day)$^{-1}$	1E-07	3E-04	mg/kg-d	2E-03
				Molybdenum	0.45	mg/kg	No CSF	--	--	5E-03	mg/kg-d	1E-05
				Selenium	0.80	mg/kg	No CSF	--	--	5E-03	mg/kg-d	3E-05
				Uranium	1.69	mg/kg	No CSF	--	--	2E-04	mg/kg-d	1E-03
		Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA. All background data are surface soils.		Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	1E-10	--	--	--
				Bi-214	0.95	pCi/g		risk/pCi	2E-07	--	--	--
				Cs-137	0.07	pCi/g		risk/pCi	1E-10	--	--	--
				K-40	18.35	pCi/g		risk/pCi	5E-08	--	--	--
				Pa-234m	1.15	pCi/g		risk/pCi	3E-07	--	--	--
				Pb-212	1.10	pCi/g		risk/pCi	3E-09	--	--	--
				Pb-214	1.02	pCi/g		risk/pCi	2E-07	--	--	--
				Ra-223	0.30	pCi/g		risk/pCi	9E-09	--	--	--
				Ra-226	1.81	pCi/g		risk/pCi	5E-07	--	--	--
				Ra-228	1.14	pCi/g		risk/pCi	1E-07	--	--	--
				Th-227	0.13	pCi/g		risk/pCi	5E-09	--	--	--
				Th-228	1.41	pCi/g		risk/pCi	5E-08	--	--	--
				Th-230	1.39	pCi/g		risk/pCi	4E-07	--	--	--
				Th-232	1.14	pCi/g		risk/pCi	2E-07	--	--	--
				Th-234	0.70	pCi/g		risk/pCi	2E-07	--	--	--
				Tl-208	0.36	pCi/g		risk/pCi	0E+00	--	--	--
				U-234	1.14	pCi/g		risk/pCi	3E-07	--	--	--
				U-235	0.11	pCi/g		risk/pCi	8E-09	--	--	--
				U-238	1.15	pCi/g		risk/pCi	3E-07	--	--	--
			Exp. Route Total						3E-06			3E-03
		Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Inhalation of Particulates	Arsenic	5.01	mg/kg	4E-03	(ug/m3)$^{-1}$	5E-12	2E-05	mg/m^3	6E-07
				Molybdenum	0.45	mg/kg	No IUR	--	--	--		-
				Selenium	0.80	mg/kg	No IUR	--	--	2E-02	mg/m^3	7E-11
				Uranium	1.69	mg/kg	No IUR	--	--	4E-05	mg/m^3	7E-08
				Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/pCi	2E-14	--		
				Bi-214	0.95	pCi/g		risk/pCi	4E-12	--		--
				Cs-137	0.07	pCi/g		risk/pCi	1E-15	--		--
				K-40	18.35	pCi/g		risk/pCi	5E-13	--		--
				Pa-234m	1.15	pCi/g		risk/pCi	2E-11	--		--
				Pb-212	1.10	pCi/g		risk/pCi	1E-13	--		--
				Pb-214	1.02	pCi/g		risk/pCi	4E-12	--		--
				Ra-223	0.30	pCi/g		risk/pCi	1E-12	--		--
				Ra-226	1.81	pCi/g		risk/pCi	1E-11	--		--
				Ra-228	1.14	pCi/g		risk/pCi	3E-11	--		--
				Th-227	0.13	pCi/g		risk/pCi	1E-12			
				Th-228	1.41	pCi/g		risk/pCi	2E-11	--		--
				Th-230	1.39	pCi/g		risk/pCi	2E-11	--		--
				Th-232	1.14	pCi/g		risk/pCi	3E-11	--		--
				Th-234	0.70	pCi/g		risk/pCi	1E-11	--		--
				Tl-208	0.36	pCi/g		risk/pCi	0E+00	--		--
				U-234	1.14	pCi/g		risk/pCi	2E-11	--		--
				U-235	0.11	pCi/g		risk/pCi	4E-12	--		--
				U-238	1.15	pCi/g		risk/pCi	2E-11	--		--
			Exp. Route Total						2E-10			6E-07
		Approximate BKG. Value must be adjusted to have the same ROPCs as either the WLB or the LTA.	Dermal Contact	Arsenic	5.01	mg/kg	2E+00	(mg/kg-day)$^{-1}$	1E-08	3E-04	mg/kg-d	2E-04
				Molybdenum	0.45	mg/kg	No CSF		--	5E-03	mg/kg-d	No ABS
				Selenium	0.80	mg/kg	No CSF		--	5E-03	mg/kg-d	No ABS
				Uranium	1.69	mg/kg	No CSF		--	2E-04	mg/kg-d	No ABS
			Exp. Route Total						1E-08			2E-04
			External Exposure	Bi-212	1.20	pCi/g	Risk at secular equilibrium is calculated by the RadPRG calculator with CSFs for progeny for each radionuclide and a slope factor for parent isotope is no relevant.	risk/yr per pCi/g	8E-07	--		--
				Bi-214	0.95	pCi/g		risk/yr per pCi/g	6E-07	--		--
				Cs-137	0.07	pCi/g		risk/yr per pCi/g	2E-08	--		--
				K40	18.35	pCi/g		risk/yr per pCi/g	1E-06	--		--
				Pa-234m	1.15	pCi/g		risk/yr per pCi/g	9E-07	--		--
				Pb-212	1.10	pCi/g		risk/yr per pCi/g	8E-07	--		--
				Pb-214	1.02	pCi/g		risk/yr per pCi/g	8E-07	--		--
				Ra-223	0.30	pCi/g		risk/yr per pCi/g	3E-08	--		--
				Ra-226	1.81	pCi/g		risk/yr per pCi/g	1E-06	--		--
				Ra-228	1.14	pCi/g		risk/yr per pCi/g	1E-06	--		--
				Th-227	0.13	pCi/g		risk/yr per pCi/g	2E-08			
				Th-228	1.41	pCi/g		risk/yr per pCi/g	1E-06	--		--
				Th-230	1.39	pCi/g		risk/yr per pCi/g	1E-06	--		--
				Th-232	1.14	pCi/g		risk/yr per pCi/g	1E-06	--		--
				Th-234	0.70	pCi/g		risk/yr per pCi/g	5E-07	--		--
				Tl-208	0.36	pCi/g		risk/yr per pCi/g	6E-07	--		--
				U-234	1.14	pCi/g		risk/yr per pCi/g	9E-07	--		--
				U-235	0.11	pCi/g		risk/yr per pCi/g	2E-08	--		--
				U-238	1.15	pCi/g		risk/yr per pCi/g	9E-07	--		--
			Exp. Route Total						1E-05			0E+00
		Exposure Point Total							2E-05			3E-03
	Exposure Medium Total								2E-05			3E-03
Soil Total									2E-05			3E-03
Air	Outdoor (Ambient) Ai	BKG	Inhalation	Rn-222						--		--
				At-218	551	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Bi-214	551	pCi.m^3	6E-11	risk/pCi	3E-05	--		--
				Pb-214	551	pCi.m^3	8E-11	risk/pCi	3E-05	--		--
				Po-214	551	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Po-218	551	pCi.m^3	1E-11	risk/pCi	6E-06	--		--
				Rn-218	551	pCi.m^3	0E+00	risk/pCi	0E+00	--		--
				Rn-222	551	pCi.m^3	2E-12	risk/pCi	1E-06	--		--
			Exp. Route Tota						7E-05			0E+00
			External Exposure (Submersion)	Rn-222						--		--
				At-218	551	pCi.m^3	3E-14	risk/y per pCi/m^3	4E-16	--		--
				Bi-214	551	pCi.m^3	7E-09	risk/y per pCi/m^3	4E-07	--		--
				Pb-214	551	pCi.m^3	1E-09	risk/y per pCi/m^3	6E-08	--		--
				Po-214	551	pCi.m^3	4E-13	risk/y per pCi/m^3	2E-11	--		--
				Po-218	551	pCi.m^3	4E-17	risk/y per pCi/m^3	2E-15	--		--
				Rn-218	551	pCi.m^3	3E-12	risk/y per pCi/m^3	4E-17	--		--
				Rn-222	551	pCi.m^3	2E-12	risk/y per pCi/m^3	1E-10	--		--
			Exp. Route Total						5E-07			0E+00
		Exposure Point Total							7E-05			0E+00
	Exposure Medium Total								7E-05			0E+00
Air Total									7E-05			0E+00
								Total of Receptor Risks Across All Media	9E-05	Total of Receptor Hazards Across All Media		3E-03

Note: Chronic daily intakes not available from the EPA RSL calculator
Shading of totals
Cancer risk <1E-6; HQ<1
Cancer risk ≤ 1E-4
Cancer risk>1E-4; HQ>1

TABLE 10.1.1 RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Homestake Mining Company

Scenario Timeframe: Future
Receptor Population: CI-IOW
Receptor Age: Adult

			COC or ROC	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	Homestake Facility	Arsenic	2E-06	3E-10	4E-07	NA	2E-06	Skin	1E-02	1E-05	4E-07	1E-02
			Molybdenum	--	--	--	--	--		6E-03	-	--	6E-03
			Selenium	--	--	--	--	--		7E-04	7E-09	--	7E-04
			Uranium	--	--	--	--	--	Kidney	6E-02	1E-05	--	6E-02
			Bi-212	4E-10	3E-12	--	5E-05	5E-05					
			Bi-214	3E-06	1E-09	--	8E-05	8E-05					
			Cs-137	1E-09	1E-13	--	7E-07	7E-07					
			K-40	2E-07	8E-11	--	7E-05	7E-05					
			Pa-234m	7E-06	1E-08		2E-04	2E-04					
			Pb-212	1E-08	2E-11	--	5E-05	5E-05					
			Pb-214	3E-06	1E-09	--	1E-04	1E-04					
			Ra-223	3E-08	2E-10	--	2E-06	2E-06					
			Ra-226	6E-06	4E-09	--	2E-04	2E-04					
			Ra-228	7E-07	5E-09	--	8E-05	8E-05					
			Th-227	2E-08	2E-10	--	1E-06	1E-06					
			Th-228	2E-07	4E-09	--	6E-05	6E-05					
			Th-230	4E-06	5E-09	--	1E-04	1E-04					
			Th-232	8E-07	6E-09	--	7E-05	8E-05					
			Th-234	5E-06	7E-09	--	1E-04	1E-04					
			Tl-208	0E+00	0E+00	--	4E-05	4E-05					
			U-234	7E-06	1E-08	--	2E-04	2E-04					
			U-235	1E-07	2E-09	--	3E-06	3E-06					
			U-238	7E-06	1E-08	--	2E-04	2E-04					
			Chemical Total	2E-06	3E-10	4E-07	NA	2E-06		8E-02	3E-05	4E-07	8E-02
			Radionuclide Total	4E-05	7E-08	0E+00	2E-03	2E-03		--	--	--	--
		Exposure Point Total						2E-03					8E-02
	Exposure Medium Total							2E-03					8E-02
Soil Total								2E-03					8E-02
Background Total								7E-04					2E-02
Excess Risk Attributable to Site (Chemical and Radiological)								8E-04					6E-02
Air	Indoor and Outdoor Air	Homestake Facility	Rn-222	--	2E-02	--	5E-05	2E-02		--	--	--	--
			Radionuclide Total	--	2E-02	--	5E-05	2E-02		--	--	--	--
		Exposure Point Total						2E-02					0E+00
	Exposure Medium Total							2E-02					0E+00
Air Total								2E-02					0E+00
Background Total (HMC-16 UCL95)								1E-02					0E+00
Excess Risk Attributable to Site								1E-02					0E+00
Receptor Total							**Receptor Risk Total**	1E-02				**Receptor HI Total**	8E-02
												Total Organ 1 HI Across All Media =	NA
												Total Organ 2 HI Across All Media =	NA

TABLE 10.1.2 RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Homestake Mining Company

Scenario Timeframe: Future
Receptor Population: CI-IOW
Receptor Age: Adult

			COC or ROC	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	LTAs	Arsenic	1E-06	2E-10	3E-07	NA	2E-06	Skin	8E-03	1E-05	2E-03	1E-02
			Molybdenum	--	No IUR	--	--	--		1E-04	No RfC	No ABS	1E-04
			Selenium	--	No IUR	--	--	--		2E-04	2E-09	No ABS	2E-04
			Uranium	--	No IUR	--	--	--	Kidney	2E-02	3E-06	No ABS	2E-02
			Bi-212	3E-10	2E-12	--	3E-05	3E-05					
			Bi-214	1E-06	5E-10	--	3E-05	3E-05					
			Cs-137	1E-09	2E-13	--	8E-07	8E-07					
			K-40	2E-07	7E-11	--	6E-05	6E-05					
			Pa-234m	3E-06	4E-09		7E-05	8E-05					
			Pb-212	8E-09	1E-11	--	3E-05	3E-05					
			Pb-214	1E-06	5E-10	--	4E-05	4E-05					
			Ra-223	2E-08	1E-10	--	1E-06	1E-06					
			Ra-226	2E-06	2E-09	--	6E-05	6E-05					
			Ra-228	5E-07	3E-09	--	5E-05	5E-05					
			Th-228	2E-07	5E-09	--	6E-05	6E-05					
			Th-230	2E-06	2E-09	--	5E-05	5E-05					
			Th-232	1E-06	8E-09	--	1E-04	1E-04					
			Th-234	1E-06	2E-09	--	4E-05	4E-05					
			Tl-208	0E+00	0E+00	--	3E-05	3E-05					
			U-234	3E-06	5E-09	--	9E-05	9E-05					
			U-235	5E-08	8E-10	--	1E-06	1E-06					
			U-238	3E-06	6E-09	--	9E-05	9E-05					
			Chemical Total	1E-06	2E-10	3E-07	0E+00	2E-06		3E-02	1E-05	2E-03	3E-02
			Radionuclide Total	2E-05	4E-08	0E+00	8E-04	8E-04		--	--	--	--
		Exposure Point Total						8E-04					3E-02
	Exposure Medium Total							8E-04					3E-02
Soil Total (Chemical and Radiological)								8E-04					3E-02
Background Total								7E-04					2E-02
Excess Risk Attributable to Site								1E-04					1E-02
Air	Indoor and Outdoor Air	LTAs	Rn-222	--	2E-02	--	5E-05	2E-02		--	--	--	--
			Radionuclide Total	--	2E-02	--	5E-05	2E-02		--	--	--	--
		Exposure Point Total						2E-02					0E+00
	Exposure Medium Total							2E-02					0E+00
Air Total								2E-02					0E+00
Background Total (HMC-16 UCL95)								1E-02					0E+00
Excess Risk Attributable to Site for Pathway								1E-02					0E+00
Receptor Total Attributable to Site							**Receptor Risk Total**	1E-02				**Receptor HI Total**	1E-02
										Total Organ 1 HI Across All Media =			NA

TABLE 10.1.3 RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Homestake Mining Company

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	COC or ROC	Carcinogenic Risk: Ingestion	Carcinogenic Risk: Inhalation	Carcinogenic Risk: Dermal	Carcinogenic Risk: External (Radiation)	Carcinogenic Risk: Exposure Routes Total	Primary Target Organ(s)	Non-Carcinogenic Hazard Quotient: Ingestion	Non-Carcinogenic Hazard Quotient: Inhalation	Non-Carcinogenic Hazard Quotient: Dermal	Non-Carcinogenic Hazard Quotient: Exposure Routes Total
Soil	Surface Soil	Homestake Facility	Arsenic	2E-07	1E-09	4E-08	NA	3E-07	Skin	4E-02	1E-03	6E-03	4E-02
			Molybdenum	-	-	-	--	--		1E-02	-	-	1E-02
			Selenium	-	-	-	--	--		2E-03	5E-07	-	2E-03
			Uranium	-	-	-	--	--	Kidney	2E-01	5E-04	-	2E-01
			Bi-212	5E-11	1E-11	--	2E-06	2E-06					
			Bi-214	4E-07	5E-09	--	3E-06	4E-06					
			Cs-137	2E-10	5E-13	--	3E-08	3E-08					
			K-40	2E-08	3E-10	--	3E-06	3E-06					
			Pa-234m	9E-07	4E-08	--	7E-06	8E-06					
			Pb-212	2E-09	7E-11	--	2E-06	2E-06					
			Pb-214	4E-07	5E-09	--	4E-06	4E-06					
			Ra-223	4E-09	8E-10	--	9E-08	9E-08					
			Ra-226	7E-07	2E-08	--	6E-06	7E-06					
			Ra-228	1E-07	2E-08	--	3E-06	3E-06					
			Th-227	2E-09	8E-10	--	5E-08	5E-08					
			Th-228	2E-08	2E-08	--	2E-06	2E-06					
			Th-230	5E-07	2E-08	--	4E-06	5E-06					
			Th-232	1E-07	2E-08	--	3E-06	3E-06					
			Th-234	7E-07	3E-08	--	5E-06	6E-06					
			Tl-208	0E+00	0E+00	--	2E-06	2E-06					
			U-234	9E-07	4E-08	--	7E-06	8E-06					
			U-235	1E-08	7E-09	--	1E-07	1E-07					
			U-238	9E-07	4E-08	--	7E-06	8E-06					
			Chemical Total	2E-07	1E-09	4E-08	NA	3E-07		3E-01	2E-03	6E-03	3E-01
			Radionuclide Total	6E-06	3E-07	0E+00	6E-05	7E-05		--	--	--	--
		Exposure Point Total						7E-05					3E-01
	Exposure Medium Total							7E-05					3E-01
Soil Total (Chemical and Radiological)								7E-05					3E-01
Background Total								3E-05					6E-02
Excess Risk Attributable to Site								4E-05					2E-01
Air	Trench (Indoor) and Outdoor Air	Homestake Facility	Rn-222	--	8E-04	--	2E-06	8E-04		--	--	--	--
			Radionuclide Total	--	8E-04	--	2E-06	8E-04		--	--	--	--
		Exposure Point Total						8E-04					0E+00
	Exposure Medium Total							8E-04					0E+00
Air Total								8E-04					0E+00
Background Total (Outdoor Air, HMC-16 UCL95)								4E-04					0E+00
Excess Risk Attributable to Site								4E-04					0E+00
Receptor Total Attributable to Site							Receptor Risk Total	4E-04				Receptor HI Total	2E-01

TABLE 10.1.4 RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Homestake Mining Company

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

			COC or ROC	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	LTAs	Arsenic	2E-07	3E-08	9E-10	NA	2E-07	Skin	3E-02	1E-03	4E-03	3E-02
			Molybdenum	--	--	--	--	--		1E-03	-	-	1E-03
			Selenium	--	--	--	--	--		5E-04	1E-07	-	5E-04
			Uranium	--	--	--	--	--	Kidney	6E-02	1E-04	-	6E-02
			Bi-212	4E-11	8E-12	--	1E-06	1E-06					
			Bi-214	1E-07	2E-09	--	1E-06	1E-06					
			Cs-137	2E-10	5E-13	--	3E-08	3E-08					
			K-40	2E-08	2E-10	--	2E-06	2E-06					
			Pa-234m	4E-07	2E-08	--	3E-06	3E-06					
			Pb-212	1E-09	5E-11	--	1E-06	1E-06					
			Pb-214	2E-07	2E-09	--	1E-06	2E-06					
			Ra-223	2E-09	5E-10	--	5E-08	5E-08					
			Ra-226	3E-07	5E-09	--	2E-06	2E-06					
			Ra-228	7E-08	1E-08	--	2E-06	2E-06					
			Th-228	2E-08	2E-08	--	3E-06	3E-06					
			Th-230	3E-07	1E-08	--	3E-06	3E-06					
			Th-232	1E-07	3E-08	--	4E-06	4E-06					
			Th-234	2E-07	7E-09	--	1E-06	2E-06					
			Tl-208	0E+00	0E+00	--	1E-06	1E-06					
			U-234	5E-07	2E-08	--	3E-06	4E-06					
			U-235	6E-09	3E-09	--	5E-08	6E-08					
			U-238	5E-07	2E-08	--	4E-06	4E-06					
			Chemical Total	2E-07	3E-08	9E-10	NA	2E-07		9E-02	1E-03	4E-03	1E-01
			Radionuclide Total	3E-06	1E-07	0E+00	3E-05	4E-05		--	--	--	--
		Exposure Point Total						4E-05					1E-01
	Exposure Medium Total							4E-05					1E-01
Soil Total (Chemical and Radiological)								4E-05					1E-01
Background Total								3E-05					6E-02
Excess Risk Attributable to Site								9E-06					4E-02
Air	Trench (Indoor) and Outdoor Air	LTAs	Rn-222	--	**8E-04**	--	2E-06	**8E-04**		--	--	--	--
			Radionuclide Total	--	**8E-04**	--	2E-06	**8E-04**		--	--	--	--
		Exposure Point Total						**8E-04**					0E+00
	Exposure Medium Total							**8E-04**					0E+00
Air Total								**8E-04**					0E+00
Background Total (HMC-16 UCL95)								**4E-04**					0E+00
Excess Risk Attributable to Site								**4E-04**					0E+00
Receptor Total Attributable to Site							**Receptor Risk Total**	**4E-04**				**Receptor HI Total**	4E-02

TABLE 10.1.5 RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Homestake Mining Company

Scenario Timeframe: Current and Future
Receptor Population: Trespasser
Receptor Age: Adult

			COC or ROC	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	Homestake Facility	Arsenic	3E-07	1E-11	6E-08	NA	3E-07	Skin	2E-03	7E-07	4E-04	3.00E-03
			Molybdenum	--	--	No ABS	--	0E+00		1E-03	--	-	1.00E-03
			Selenium	--	--	No ABS	--	0E+00		1E-04	3E-10	-	1.00E-04
			Uranium	--	--	No ABS	--	0E+00	Kidney	1E-02	6E-07	-	1.00E-02
			Bi-212	1E-10	2E-14	--	1E-06	1E-06					
			Bi-214	6E-07	9E-12	--	2E-06	2E-06					
			Cs-137	1E-10	9E-16	--	1E-08	1E-08					
			K-40	5E-08	5E-13	--	1E-06	1E-06					
			Pa-234m	1E-06	7E-11	--	4E-06	5E-06					
			Pb-212	4E-09	1E-13	--	9E-07	9E-07					
			Pb-214	6E-07	9E-12	--	2E-06	2E-06					
			Ra-223	1E-08	1E-12	--	4E-08	5E-08					
			Ra-226	1E-06	3E-11	--	3E-06	4E-06					
			Ra-228	2E-07	3E-11	--	1E-06	2E-06					
			Th-227	6E-09	1E-12		2E-08	3E-08					
			Th-228	6E-08	3E-11	--	1E-06	1E-06					
			Th-230	7E-07	3E-11	--	2E-06	3E-06					
			Th-232	2E-07	4E-11	--	1E-06	2E-06					
			Th-234	1E-06	5E-11	--	2E-06	3E-06					
			Tl-208	0E+00	0E+00	--	7E-07	7E-07					
			U-234	1E-06	6E-11	--	3E-06	4E-06					
			U-235	2E-08	1E-11	--	6E-08	8E-08					
			U-238	1E-06	8E-11	--	3E-06	5E-06					
			Chemical Total	3E-07	1E-11	6E-08	NA	3E-07		2E-02	1E-06	4E-04	1E-02
			Radionuclide Total	8E-06	4E-10	0E+00	3E-05	4E-05		--	--	--	--
		Exposure Point Total						4E-05					1E-02
	Exposure Medium Total							4E-05					1E-02
Soil Total (Chemical and Radiological)								4E-05					1E-02
Background Total								2E-05					3E-03
Excess Risk Attributable to Site								2E-05					1E-02
Air	Outdoor Air	Homestake Facility	Rn-222	--	1E-04	--	8E-07	1E-04		--	--	--	--
			Radionuclide Total	--	1E-04	--	8E-07	1E-04		--	--	--	--
		Exposure Point Total						1E-04					0E+00
	Exposure Medium Total							1E-04					0E+00
Air Total								1E-04					0E+00
Background Total (HMC-16 UCL95)								7E-05					0E+00
Excess Risk Attributable to Site								3E-05					0E+00
Receptor Total Attributable to Site							Receptor Risk Total	5E-05				Receptor HI Total	1E-02

There is additional potential intermittent exposure to sediment and surface water in the ponds. See text and RAGS D Table 7. These media not shown here because there is no background to compare to, and the ponds are pertinent to current scenarios only since they will be closed following remediation.

TABLE 10.1.7 RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Homestake Mining Company

Scenario Timeframe: Current and Future
Receptor Population: Trespasser
Receptor Age: Adult

			COC or ROC	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	LTAs	Arsenic	1E-07	5E-12	1E-08	NA	1E-07	Skin	2E-03	5E-07	2E-04	2E-03
			Molybdenum	--	--	--	--	--		2E-05	--	No ABS	2E-05
			Selenium	--	--	--	--	--		4E-05	9E-11	No ABS	4E-05
			Uranium	--	--	--	--	--	Kidney	3E-03	2E-07	No ABS	3E-03
			Bi-212	8E-11	1E-14	--	7E-07	7E-07					
			Bi-214	2E-07	3E-12	--	6E-07	8E-07					
			Cs-137	1E-10	1E-15	--	2E-08	2E-08					
			K-40	4E-08	4E-13	--	1E-06	1E-06					
			Pa-234m	5E-07	3E-11	--	1E-06	2E-06					
			Pb-212	3E-09	8E-14	--	6E-07	6E-07					
			Pb-214	2E-07	4E-12	--	7E-07	9E-07					
			Ra-223	7E-09	9E-13	--	2E-08	3E-08					
			Ra-226	4E-07	1E-11	--	1E-06	1E-06					
			Ra-228	1E-07	2E-11	--	1E-06	1E-06					
			Th-228	6E-08	3E-11	--	1E-06	1E-06					
			Th-230	3E-07	1E-11	--	9E-07	1E-06					
			Th-232	2E-07	5E-11	--	2E-06	2E-06					
			Th-234	3E-07	1E-11	--	7E-07	9E-07					
			Tl-208	0E+00	0E+00	--	5E-07	5E-07					
			U-234	6E-07	3E-11	--	2E-06	2E-06					
			U-235	9E-09	5E-12	--	2E-08	3E-08					
			U-238	7E-07	4E-11	--	2E-06	2E-06					
			Chemical Total	1E-07	5E-12	1E-08	NA	1E-07		5E-03	7E-07	2E-04	5E-03
			Radionuclide Total	4E-06	2E-10	0E+00	2E-05	2E-05		--	--	--	--
		Exposure Point Total						2E-05					5E-03
	Exposure Medium Total							2E-05					5E-03
Soil Total (Chemical and Radiological)								2E-05					5E-03
Background Total								2E-05					3E-03
Excess Risk Attributable to Site								4E-06					2E-03
Air	Outdoor Air	LTAs	Rn-222	--	1E-04	--	8E-07	1E-04		--	--	--	--
			Radionuclide Total	--	1E-04	--	8E-07	1E-04		--	--	--	--
		Exposure Point Total						1E-04					0E+00
	Exposure Medium Total							1E-04					0E+00
Air Total								1E-04					0E+00
Background Total (HMC-16 UCL95)								7E-05					0E+00
Excess Risk Attributable to Site								3E-05					0E+00
Receptor Total Attributable to Site							Receptor Risk Total	3E-05				Receptor HI Total	2E-03

Shading of totals:

- (green) Cancer risk <1E-6; HQ<1
- (yellow) Cancer risk < 1E-4
- (pink) Cancer risk>1E-4; HQ>1

Soil background risk differs between the Homestake Facility and LTAs because the ROPCs that contribute to background risk differ