APP-040-A

POWERTECH (USA) INC.

United States Nuclear Regulatory Commission Official Hearing Exhibit			
In the Matter of:	POWERTECH USA, INC. (Dewey-Burdock In Situ Uranium Recovery Facility)		
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Application for NRC Uranium Recovery License Proposed Action Fall River and Custer Counties South Dakota Environmental Report

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Prepared for

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POWERTECH (USA) INC.

Application for NRC Uranium Recovery License Proposed Action Fall River and Custer Counties South Dakota Environmental Report

Table of Contents

List of Tables

List of Figures

List of Plates

List of Appendices

Section 3.0

POWERTECH (USA) INC.

Section 4.0

Appendix 4.6-A	SPAW Model Results
Appendix 4.10-A	Cultural Resources Report
Appendix 4.10-B	Memorandum of Agreement
Appendix 4.14-A	MILDOS Area Simulation for Land Application
Appendix 4.14-B	MILDOS Area Simulation for Waste Disposal Well
Appendix 4.14-C	Radium Benchmark Dose Assessment

Section 6.0

Appendix 6.1-A	Baseline Radiological Report
Appendix 6.1-B	TVA Groundwater Data
Appendix 6.1-C	Number of Surface Water Samples Collected Analytical Method, and PQL by Constituent
Appendix 6.1-D	Surface Water Quality Data
Appendix 6.1-E	Statistics for Surface Water Constituents at or Above PQL
Appendix 6.1-F	Minimum and Maximum Result for Sampled Constituent Above PQL
Appendix 6.1-G	Percent Detections by Constituent Comparison Between Streams and Subimpoundments

List of Acronyms and Abbreviations

AADT	Annual Average Daily Traffic
ACS	American Community Survey
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AG	Agricultural Land
ALARA	As Low As Reasonably Achievable
AMS	air monitoring station
APLIC	Avian Power Line Interaction Committee
AEA	Atomic Energy Act
ANSI	American National Standards Institute
ARR	Airborne Release Rate
ASCE	American Society of Civil Engineers
Augustana	Archaeology Laboratory, Augustana College
AWDN	Automatic Weather Data Network
BNRR	Burlington Northern Rail Road
BEA	Bureau of Economic Analysis
bgs	below ground surface
BKS	BKS Environmental Associates, Inc.
BLM	Bureau of Land Management
BMP	Best Management Practices
BNSF	Burlington Northern Santa Fe Railroad
B.P.	before present
BPT	Best Practices Technology
BS	Big Sagebrush Shrubland
C	Celsius
CBA	cost-benefit analysis
CESQG	Conditionally Exempt Small Quantity Generator
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CG	Cottonwood Gallery
CIR	color infra-red
cm/sec	centimeters per second
cpm	counts per minute
CPP	central processing plant
dBA	A-weighted decibels
D&D	Decommissioning and Decontaminating
DES	Draft Environmental Statement
DGEIS	Draft Generic Environmental Impact Statement
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
DOT	Department of Transportation
DQO	Data Quality Objectives

DR	Damage Ratio
EC	electrical conductivity
EDE	effective dose equivalent
EFN	Energy Fuels Nuclear
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ERG	Environmental Restoration Group
ET	evapotranspiration
EXREFA	Extended Reference Area
F	Fahrenheit
FAC	facultative
FACU	facultative upland
FACW	facultative wet
FEMA	Federal Emergency Management Agency
g	gram
gpm	gallons per minute
GDP	gross domestic product
GPS	Global Positioning System
GW	Greasewood Shrubland
HAS	Historical Site Assessment
HDPE	high density polyethylene
HEPA	high efficiency particulate air
HPRCC	High Plains Regional Climate Center
HTF	heat transfer fluid
HVAC	heating, ventilation and air conditioning
ICF Jones & Stokes	Jones & Stokes, formerly Thunderbird-Jones & Stokes
IDLH	immediately dangerous to life and health
IMPLAN	IMpact analysis for PLANning
IQR	interquartile range
ISL	in situ leach (In this document ISL is synonymous with ISR)
ISR	in situ recovery
IX	Ion Exchange
kg	kilograms
km	kilometer
KP	Knight Piésold
L	liter
LAN	land application area north (Dewey)
LAS	land application south (Burdock)
LLD	lower limits of detection
LPF	Leak Path Factor
LSA	Low Specific Activity
m	meter
m^2	square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

MCL	Maximum Contaminant Level
MDC	minimum detectable concentrations
mg	milligram
mg/m^3	milligram per cubic meter
mi^2	square miles
mm	millimeters
mg/L	milligrams per liter
MIG	Minnesota IMPLAN Group, Inc.
MIT	Mechanical Integrity Test
MPA	main permit area
mph	miles per hour
mrem	millirem
NaI	sodium iodide
NAE	National Academy of Sciences
NAU	National American University
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Engineers
NEA	northeast area
NEPA	National Environmental Policy Act
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
NPDES	National Pollution Discharge Elimination System
NPV	net-present value
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NWP	Nationwide Permit
NWS	National Weather Service
OBL	obligate
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
OW	open water
OWUS	Other Waters of the United States
PAA	Proposed Action Area
PABJh	Palustrine Aquatic Bed Intermittently Flooded Diked
pCi/f	picocuries per filter composite
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^2-s	picocuries per meter squared second
PCN	Pre-construction Notification
PEM	Palustrine Emergent
PGA	peak ground acceleration
PIC	pressurized ion chamber
PP	Ponderosa Pine Woodland
PPE	Personal Protective Equipment
ppm	parts per million

PQL	Practical Quantitation Limit
Powertech (USA)	Powertech (USA) Inc.
psi	pounds per square inch
PUB	Palustrine Unconsolidated Bottom
PUSA	Palustrine Unconsolidated Shore Temporarily Flooded
PVC	polyvinyl chloride
QAPP	Quality Assurance Protection Plan
QC	quality control
R2EM	Riverine Lower Perennial Emergent
RCRA	Resource Conservation and Recovery Act
RER	Replicate Error Ratio
RESRAD	RESRAD Version 6.4 computer code
RFA	roll front area
RG	Regulatory Guide
RMP	Risk Management Program
RO	reverse osmosis
RPD	relative percent difference
RTV	Restoration Target Values
SAR	sodium adsorption ratio
SD	South Dakota
SDAR	South Dakota Administrative Rules
SD DENR	South Dakota Environment and Natural Resources
SDGFP	South Dakota Game, Fish and Parks
SD GOED	South Dakota Governor's Office of Economic Development
SDNHP	South Dakota Natural Heritage Program
SDSMT	South Dakota School of Mines and Technology
SD DOL	South Dakota Department of Labor
SDSU	South Dakota State University
SERP	Safety and Environmental Review Panel
SF	satellite facility
SIC	Standard Industrial Classification
SHPO	State Historical Preservation Office
SKM	Silver King Mines
SMA	surface mine area
SMCL	Secondary drinking water standards
SOP	Standard Operating Procedure
SPAW	Soil-Plant-Atmosphere-Water
SQRU	Scenic Quality Rating Units
SS	Silver Sagebrush Shrubland
SRP	Standard Review Plan
SWMP	Storm Water Management Plan
SWI	Susquehanna Western Inc.
T&E	threatened and endangered
TDS	total dissolved solids
TEDE	total effective dose equivalent

TENORM	Technologically Enhanced Naturally Occuring Radioactive Materials
TF	Thermal Fluid
THPO	Tribal Historic Preservation Office
TLD	thermoluminescent detectors
TPQ	Threshold Planning Quantities
TQ	threshold quantities
TR	Technical Report
TRG	total restoration goals
TRV	target restoration values
TSX	Toronto Stock Exchange
TVA	Tennessee Valley Authority
UCL	Upper Control Limits
UG	Upland Grassland
UIC	Underground Injection Control
U-nat	natural uranium
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UPL	upland
USCB	United States Census Bureau
USDA	United States Department of Agriculture
USDW	Underground Source of Drinking Water
USFS	U.S. Forest Service USFS
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VRM	Visual Resource Management
VSP	Visual Sampling Plan
WDEQ	Wyoming Department of Environmental Quality
WDTI	Western Dakota Technical Institute
WDW	Waste Disposal Well
WL	Working Level
WMC	Wyoming Mineral Corporation
WoUS	Waters of the United States
Wr	weight index
Ws	standard weight
μCi/ml	microcuries per milliliter
μCi/g	microcuries per gram
μg	microgram
μR/hr	microRoentgens per hour
μS/cm	microsiemens per centimeter

1.0 Introduction of the Environmental Report

1.1 Purpose and Need for the Proposed Action

Powertech (USA) Inc. "(Powertech (USA)" submits this Environmental Report (ER) to the United States Nuclear Regulatory Commission ("NRC" or the "Commission") as part of a uranium recovery license application to develop and operate the Dewey-Burdock Uranium Project ("The Proposed Action") using in situ leach (ISL) methods. The Proposed Action will be located near Edgemont, South Dakota in Custer and Fall River Counties and will consist of wellfields, comprised of injection, production, and monitor wells, satellite ion exchange (IX) production facilities, and a central processing plant (CPP), consisting of an elution (resin stripping) system and precipitation, drying and packaging processes to produce a final uranium product (yellowcake). In addition, the Proposed Action will include, waste management facilities, office buildings and other structures or facilities to house work areas and equipment.

During active ISL operations, Powertech (USA) will construct a series of sequentially developed well fields utilizing ISL technologies and processes to produce uranium from identified ore bodies at the Dewey and Burdock sites. The CPP at the Burdock site will perform all processing of uranium loaded IX resin to produce dried yellowcake product, with disposition of the resulting 11e.(2) byproduct material wastes in a manner consistent with NRC and other applicable regulations and guidance. After depletion of portions of the identified ore bodies in operating well fields, Powertech (USA) plans to restore the groundwater in each depleted well field consistent with pre-operational or baseline water quality conditions and in accordance with NRC's application of 10 CFR Part 40 Appendix A, Criterion 5_(b)(5). After active uranium recovery operations cease, Powertech (USA) intends to complete site decommissioning and decontamination (D&D), including groundwater restoration with the ultimate goal of releasing the Proposed Action site for unrestricted release.

Thus, in order to obtain authorization for the Proposed Action, Powertech (USA) is seeking a "Uranium Recovery" License (combined source material and 11e.(2) byproduct material license) from NRC pursuant to the Atomic Energy Act of 1954, as amended, 10 CFR Part 40, Appendix A Criteria, and applicable NRC guidance, as well as the provisions of the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) regulations, as reflected in the Commission's 10 CFR Part 51 regulations.

The uranium is produced as an oxide, with a trade name of "Yellowcake" in the form of U_3O_8. Uranium is used as fuel to produce electricity in nuclear power plants. In the United States, 20 % of the electric power supply is produced by nuclear power. There are currently 104 nuclear power plants in the US and there are more than 30 nuclear power plants planned for construction in the United States. Nuclear power plants produce minimal amounts of greenhouse gases, thereby decreasing the overall carbon footprint of energy production in the United States. In the United States, the operating nuclear power plants, currently have annual requirements for about 54 million pounds of uranium in the forms U_3O_8. The Proposed Action is planned to produce one million (1,000,000) pounds of U_3O_8 annually for seven years with the potential for extending the production life to 20 years with additional resource development in the area. Currently domestic uranium production is 4.5 million pounds of U_3O_8, with the remainder of the necessary uranium being imported from other countries. So the Proposed Action's uranium production will contribute significantly to the energy independence of the United States and will contribute *significantly* to reducing carbon dioxide and nitrogen oxide emissions in the United States.

This ER has been developed in accordance with and via review of the following technical and environmental regulations, reports, and guidance documents:

Regulatory Programs

10 CFR Part 40, Appendix A

40 CFR Part 190

40 CFR Part 192

40 CFR Part 61, Subpart W

40 CFR Part 144

40 CFR Part 146

Nuclear Regulatory Commission or Other Federal

NUREG-0706

NUREG-1508

NUREG/CR-6733

NUREG/CR-6870

EPA, Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing

EPA, Regulatory Impact Analysis of Environmental Standards for Uranium Mill Tailings at Active Sites

Nuclear Regulatory Commission Guidance Documents

NUREG-1620

NUREG-1748

NUREG-1569

NUREG-1623

NUREG-3.46

NUREG-1569

NUREG-1910

Nuclear Regulatory Commission/Agreement State Licenses and Applications

Hydro Resources, Inc., SUA-1508

Crowe Butte Resources, Inc., SUA-1534

Power Resources, Inc., SUA-1548

Lost Creek ISR, LLC Docket No. 40-9068

The Proposed Action will be conducted in naturally occurring geologic and hydrologic conditions that are conducive to both the ISL method and to the limitation of potential adverse impacts consistent with the benign nature of the ISL method. The proposed action will utilize state-of-the-art ISL technologies and processes and well-tested standard operating procedures (SOPs) consistent with standard industry practices to satisfy the Atomic Energy Act's (AEA's) mandate to provide adequate protection of public health, safety and the environment.

1.2 Proposed Action

1.2.1 Background

Uranium was first discovered in the Edgemont Uranium District (District) in 1951, and recovery of such uranium was conducted for a number of years using conventional surface and underground mining methods. In the mid-1970s, the Tennessee Valley Authority (TVA) bought a major interest in the District and focused its attention on the Dewey-Burdock area, where approximately 4,000 exploration holes were drilled. Silver King Mines (SKM), a TVA wholly owned subsidiary, served as the operator for TVA and continued drilling until the early 1980s when depressed uranium prices led to a halt in exploration activities. A Draft Environmental Statement (DES) was prepared by TVA to address the impact of a proposed underground mine in the Dewey-Burdock area, but TVA never completed the NEPA process. Later, TVA relinquished all leases and claims in the Dewey-Burdock area and withdrew from uranium resource development by the late 1980s. In 1994, Energy Fuels Nuclear (EFN) acquired mineral interests within the Dewey-Burdock area, but relinquished them in the late 1990s due to low uranium prices. In 2005, Powertech (USA) acquired the mineral interests and plans to develop them as the proposed action.

1.2.2 Corporate Entities Involved

This license application, ER and TR are submitted by Powertech (USA) a corporation registered in South Dakota. Powertech (USA) Inc is the wholly owned USA subsidiary of Powertech (USA) Uranium Corporation, a British Columbia, Canada, registered company. The Canadian corporate office is located in Vancouver, British Columbia and the Corporate Headquarters of Powertech (USA) is located in Greenwood Village, Colorado. Powertech (USA) will hold the uranium recovery license and comply with the NRC financial and technical qualification requirements. Powertech (USA) maintains an exploration office in Hot Springs, South Dakota and operations offices in Wellington, Colorado, Edgemont, South Dakota, and Albuquerque,

New Mexico. The Company's shares are publicly traded on the Toronto and Frankfort Stock Exchanges.

1.2.3 The Proposed Action Description

The PAA is located approximately 13 miles north-northwest of Edgemont, South Dakota and straddles the area between northern Fall River and southern Custer County line. The proposed project boundary encompasses approximately 10,580 acres (4,282 ha) of mostly private land on either side of Dewey Road (previously County Road 6463) and includes portions of Sections 1-5, 10-12, 14 and 15, Township 7 South, Range 1 East and Sections 20, 21, 27, 28, 29 and 30-35, Township 6 South, Range 1 East, Black Hill Meridian. Approximately 240 acres (97.1 ha) are under the control of the Bureau of Land Management (BLM) located in portions of sections 3, 10, 11, and 12. Figure 1.2-1 shows the land ownership status and the PAA boundary.

The PAA can be accessed from the northeast and the west via U.S. Highway 18 to Dewey Road. From the south, the site can be accessed from State Highway 471 to U.S. Highway 18 to Dewey Road. The main access road to the proposed plant facilities and well fields is located off Dewey Road in T7S, R1E, and Section 10. This access road joins with several preexisting roads that traverse the Burdock portion of the proposed project area. The access road for the Dewey portion of the proposed project area is located further to the north and joins with several other preexisting roads. These preexisting roads within the Burdock and Dewey portions of the proposed project area will be used to the extent possible to access facility structures and well fields. Secondary roads will be built from the existing roads to provide access to other facilities and well fields that are not currently accessible from the existing roads. While, the PAA encompasses 10,580 acres, the land potentially disturbed by the Proposed Action will be approximately 68 acres (facilities, piping, ponds, well fields and roads) during the year proceeding operation. The potentially disturbed area during the life of the project (production to restoration) is estimated to increase over time to a maximum of 108 acres. If the maximum area for land application of treated wastewater is included in the footprint of the Proposed Action, then a maximum of an additional 355 acres potentially would be affected by the Proposed Action for most of the project life. The maximum potential land disturbance at any given time is expected to be 463 acres.

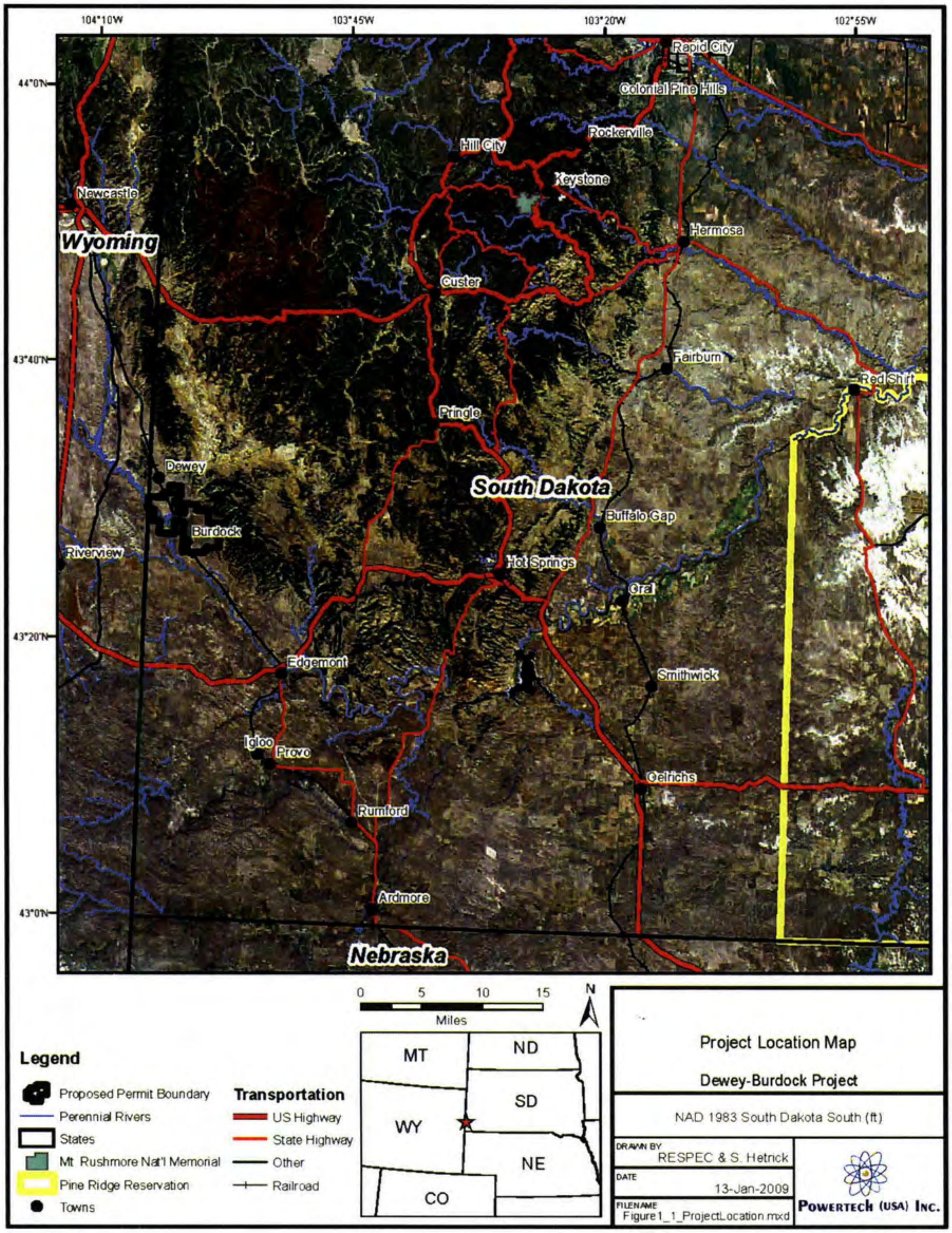

Figure 1.2-1: Proposed Project Location and Site Boundary

1.2.4 Ore Body

Operators must determine whether an ore body is commercially extractable before production commences. As part of this evaluation, geologic and hydrological characteristics demonstrated by ore bodies amenable to ISL methods are thoroughly studied. Well fields are defined based upon the geometric deposition and distribution. The permeability of an ore zone is one key factor evaluated for suitability to ISL methods. The geology both above and below the ore zone are studied for determination of existing confining layers; the confining layers inhibit movement of lixiviant into other geologic strata that may exist above or below the production zone of the exempted aquifer in which the ore is located. These are but a few of the important characteristics studied by operators to determine the suitability of the ore to be extracted economically and with minimal adverse environmental impacts (NUREG-1910, 2008).

The Proposed Action uranium deposit occurs in both the Fall River and Lakota formations of the lower Cretaceous age that make up the Inyan Kara Group. The Fall River and Lakota formations consist of permeable sandstones deposited in a major sand channel system that makes up a groundwater aquifer. The uranium occurs in the sandstones as classic roll front deposits with both oxidized and reduced zones located at both the Dewey and Burdock areas. These roll front deposits are usually "C" shaped in cross section, a few tens of feet wide and often thousands of feet long. Uranium minerals are deposited at the interface of the oxidized ground and reduced ground. As the uranium minerals precipitate, they coat the sand grains. Continual addition of uranium by oxidizing groundwater and re-solublization followed by re-deposition at the interface increases the uranium concentration of the ore body. Thickness of the ore body is generally a factor of the thickness of the sandstone host unit. Uranium mineralization has occurred in more than one horizon within the Inyan Kara Group resulting in multiple roll fronts. The estimated mineable resource (compliant with Form 43-101) within the PAA is 7.6 million pounds of U_3O_8 with an average grade of 0.21 percent.

It is anticipated that the well fields at the proposed Dewey and Burdock sites will operate at a nominal yearly average flow rate of 2000 gpm. Uranium will be extracted from groundwater and loaded onto ion exchange resin at both locations. Uranium extracted and loaded onto the ion exchange resin at the Dewey site will be transported by dedicated tanker trucks to the CPP at the Burdock site for elution, precipitation, drying and packaging. At the Burdock site, the transfer of loaded resin from the ion-exchange vessels to the processing facility will occur through resin transfer piping. The barren resin will be returned to the appropriate portion of the ion exchange circuit or, if exhausted, will be segregated as 11e.(2) byproduct material and transported pursuant

to applicable DOT requirements to a licensed 11e.(2) disposal facility for final disposition per 10 CFR Part 40, Appendix A, Criterion 2 and Commission policy directives. Total production from both sites is expected to be approximately 1,000,000 pounds of U_3O_8 per year, essentially evenly divided into 500,000 pounds per year from the well fields located at each area.

1.2.5 Well Construction and Integrity Testing

Well construction materials, methods, development, and integrity testing are described in the following subsections.

1.2.5.1 Well Construction Materials

Well casing material will typically be thermoplastic such as polyvinyl chloride (PVC). Wells typically will be 4, 5 and 6-inch nominal diameter, with wall thickness appropriate for design conditions. In order to provide an adequate annular seal, the drill hole diameter will be at least two inches greater in nominal diameter than the outside diameter of the well casing. The annular seal will be pressure-grouted and sealed with either cement grout or bentonite grout. Casing will be joined by fittings or using methods recommended by the casing manufacturer.

1.2.5.2 Well Construction Methods

Typical well installation will begin with drilling a pilot bore hole through the ore zone to obtain a measurement of the uranium grade and the depth. The pilot bore hole will be geologically and geophysically logged. After logging, the pilot bore hole will be reamed to the appropriate diameter to the top of the ore zone. A continuous string of PVC casing will be placed into the reamed borehole. Casing centralizers will be installed as appropriate. With the casing in place a cement/bentonite grout will be pumped into the casing. The grout will circulate out the bottom of the casing and back up the casing annulus to the ground surface. The volume of grout necessary to cement the annulus will be calculated from the bore hole diameter of the casing with sufficient additional allowance to achieve grout returning to surface. Grout remaining inside the well casing may be displaced by water or heavy drill mud to minimize the column of the grout plug remaining inside the casing. Care will be taken to assure that a grout plug remains inside the casing at completion. The casing and grout will then be allowed to set undisturbed for a minimum of 24 hours. When the grout has set, if the annular seal observed from the ground surface has settled below the ground surface, additional grout will be placed into the annular space to bring the grout seal to the ground surface.

After the 24-hour (minimum) setup period, a drill rig will be mobilized to finish well construction by drilling through the grout plug and through the mineralized zone to the specified total well depth. As illustrated in Figures 1.2-2 and 1.2-3, the open borehole will then be under reamed to a larger diameter.

A well screen assembly will then be lowered through the casing into the open hole. The top of the well screen assembly will be positioned inside the well casing and centralized and sealed inside the casing using "K" packers. With the drill pipe attached to the well screen, a one-inch diameter tremie pipe will be inserted through drill pipe and screen, and through the sand trap check valves at the bottom of well screen assembly. Filter sand, comprised of well rounded silica sand sized to optimize hydraulic communication between the target zone and well screen, will then be placed between the well screen and the formation. The volume of sand introduced will be calculated such that it fills the annular space. The sand will not extend upward beyond the K packers due to packer design. A well completion report will then be prepared for each well. The reports will be kept available on-site for review. Copies will be submitted to regulatory agencies upon request.

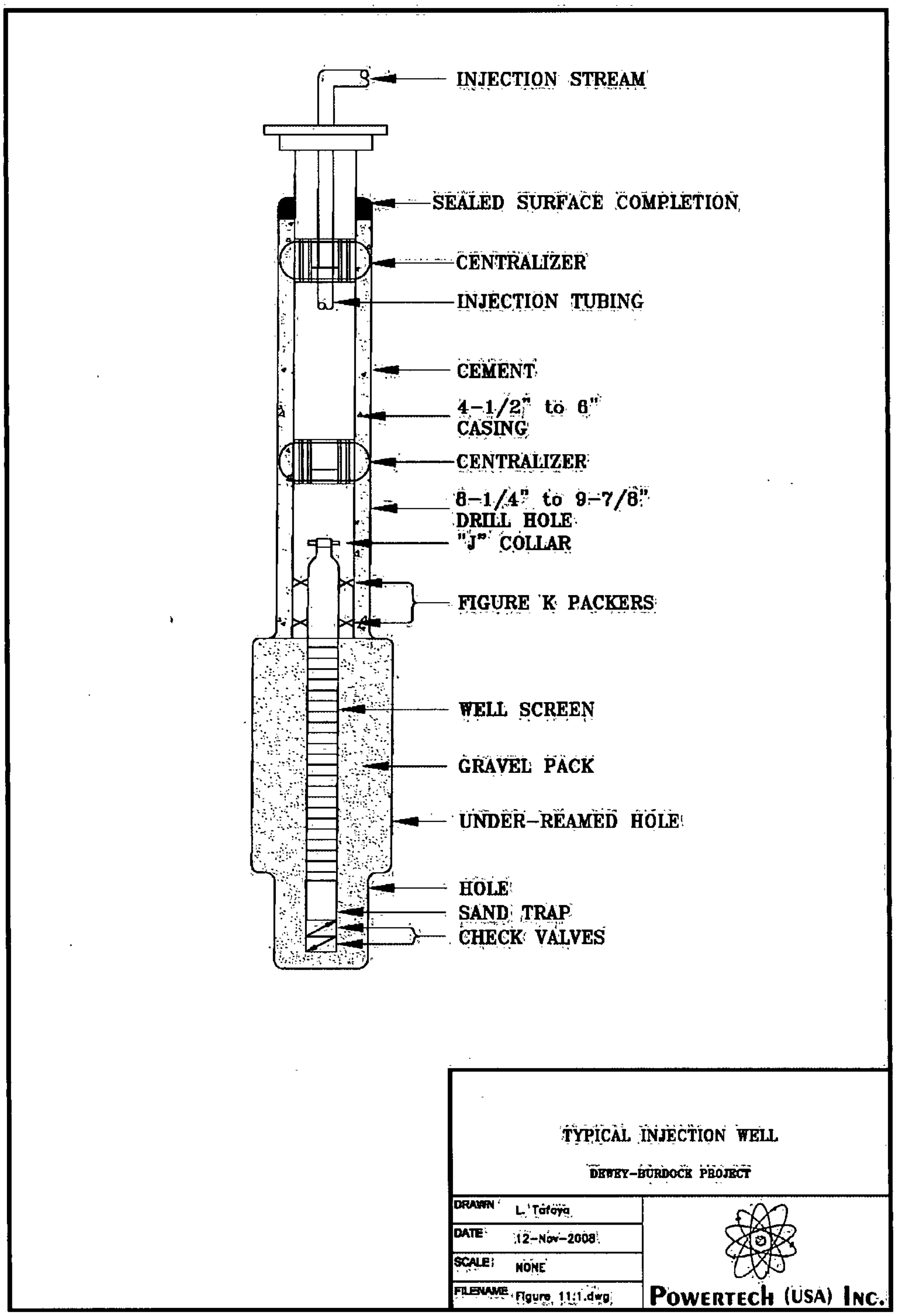

Figure 1.2-2: Typical Injection Well Construction Diagram

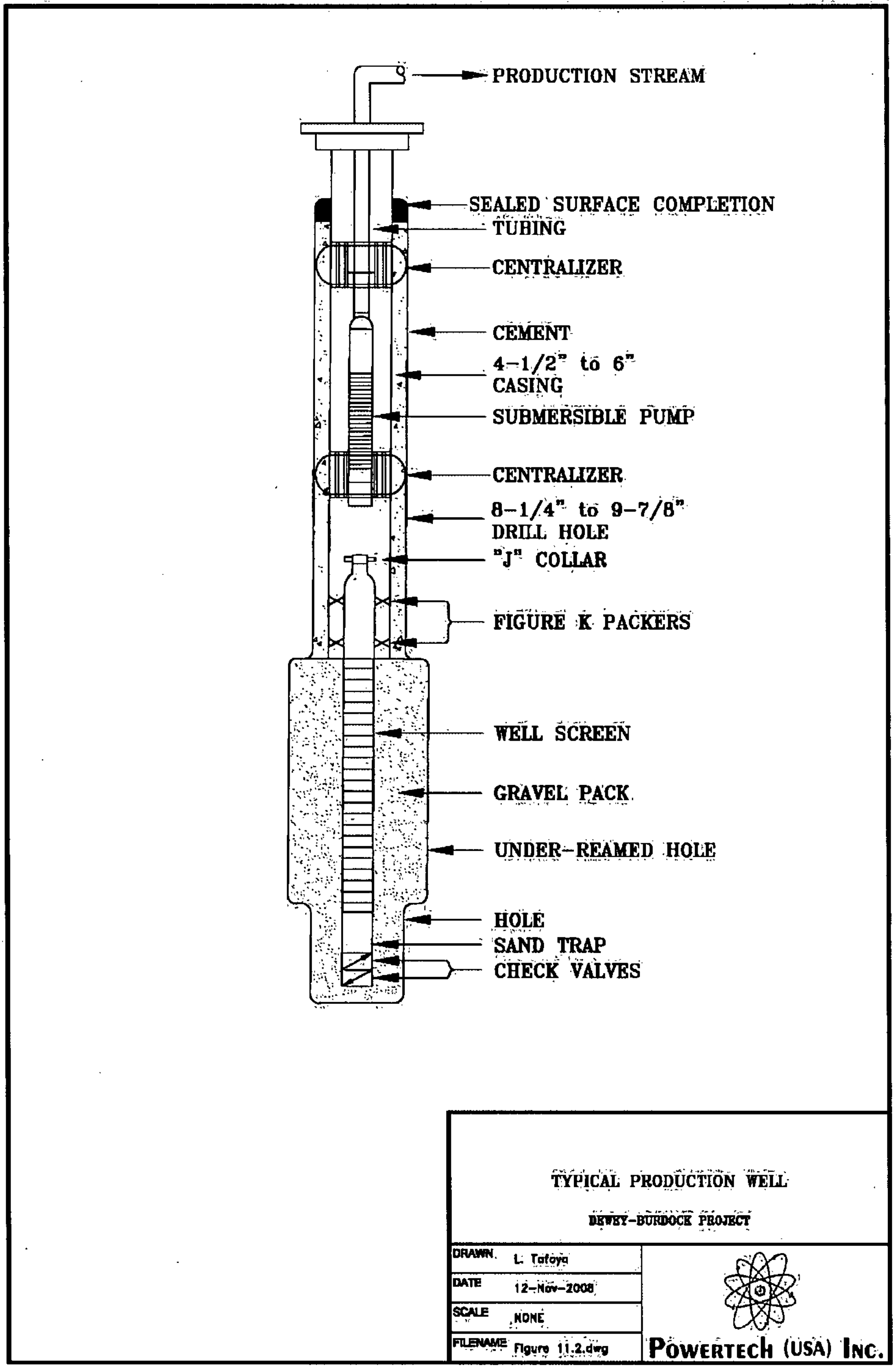

Figure 1.2-3: Typical Production Well Construction Diagram

1.2.5.2.1 Additional Construction Requirements

Prior to reaming the pilot holes to final diameter to run casing, ore grade gamma log, self potential and single point resistivity electric logs will be run in the pilot holes which will be drilled . These logs will determine the location and grade of uranium and the sand and clay units' depths to properly plan each wellfield pattern and to set the well screens in the proper depth to efficiently contact the uranium mineral deposit.

1.2.5.2.2 Well Development

The primary goals of well development are to allow formation water to enter the well screen and flush out drilling mud, or cement filtrate water and to develop the well bore to remove the finer clays and silts to reduce the pressure drop between the formation and the well screen. This process is necessary to allow representative samples of groundwater to be collected, if applicable, and to ensure efficient injection and recovery operations. Wells will be developed immediately after construction using air lifting, swabbing, pumping or other accepted development techniques which will remove water and drilling fluids from the casing and borehole walls along the screened interval. Prior to obtaining baseline samples from monitor or restoration wells, additional well development will be conducted to ensure that representative formation water is sampled. The water will be pumped sufficiently to show stabilization of pH and conductivity values prior to sampling and used to indicate that development activities have been effective.

1.2.5.3 Well Integrity Testing

Field-testing of all injection, recovery, and monitor wells will be performed to demonstrate the mechanical integrity of the well casing. The mechanical integrity test (MIT) will be performed using pressure-packer tests. The bottom of the casing will be sealed with a plug, downhole packer, or other suitable device. The casing will be filled with water and the top of the casing will be sealed with a threaded cap or mechanical seal. The well casing will then be pressurized with water or air and monitored with a calibrated pressure gauge. Internal casing pressure will be increased to 125 percent of the maximum operating pressure of the well field, 125 percent of the maximum operating pressure rating of the well casing (which is always less that the maximum pressure rating of the pipe), or 90 percent of the formation fracture pressure (which equates to approximately 1 psi per foot of overburden above the bottom of casing), whichever is less. A well must maintain 90 percent of this pressure for a minimum of 10 minutes to pass the test.

If there are obvious leaks, or the pressure drops by more than 10 percent during the 10 minute period, the seals and fittings on the packer system will be checked and/or reset and another test will be conducted. If the pressure drops less than 10 percent the well casing will have demonstrated acceptable mechanical integrity.

If a well casing does not meet the MIT criteria, the well will be removed from service. The casing may be repaired and the well re-tested, or the well may be plugged and abandoned. Plugging of wells will be in accordance with the EPA regulations located in Title 40 Part 146.10 which comply with the South Dakota Administrative Rules contained in Chapter 74:55:01:59. DENR will be notified of any well that fails the MIT. If a repaired well passes the MIT, it will be employed in its intended service following approval from EPA and/or DENR that the well has demonstrated mechanical integrity. If an acceptable test cannot be demonstrated following repairs, the well will be plugged and abandoned.

In addition to the integrity testing of new wells, a MIT will be conducted on any well following any repair where a downhole drill bit or under-reaming tool is used. Any injection well with evidence of suspected subsurface damage will require a new MIT prior to the well being returned to service. MITs will also be repeated once every five years for all active wells.

The mechanical integrity test of a well will be documented to include the well designation, date of test, test duration, beginning and ending pressures, and the signature of the individual responsible for conducting the test. Results of the MITs will be maintained on-site and will be available for inspection by EPA and DENR. Results of MITs shall be reported within quarterly reports in accordance with the EPA UIC regulations in Title 40 Part 146.33 which also meet the DENR requirements in § 74:55:01:49.

1.2.6 Monitoring Well Layout and Design

As discussed in Sections 5 and 6 of this application, an extensive groundwater sampling program specific to each well field will be conducted prior to, during, and following ISL operations to identify any potential impacts to water resources of the area. The groundwater monitoring program for individual well fields is designed to 1) establish baseline water quality prior to production, 2) detect excursions of lixiviant either horizontally or vertically outside the of the target mineralization zone, 3) demonstrate compliance with groundwater quality standards, and 4) determine when the depleted mineralized zone has been adequately restored following ISL production. Objectives 1 (partially) and 4 will accomplished using injection and production

wells. Objectives 1 (partially), 2, and 3 will be accomplished using perimeter and internal non-production zone monitoring wells.

The production wells are laid out in a regular grid to efficiently contact the mineralized deposit (Figure 1.2-4). Generally, the wells are laid out in regular geometric shapes, usually squares, rectangles, triangles, or hexagons. The important features are that the patterns cover the economically producible portions of the ore body, the production (pumping) well is in the center of each geometric shape, the injection wells are equally spaced from each other and from the production wells in each pattern (geometric shape). This is to ensure efficient contact with the ore by uniform flow distribution and to facilitate control of the flow to prevent excursion of leachate to the monitor well ring. The injection wells are on the outside of the well field patterns. A bleed withdrawing some 0.5 to 3 per cent of the leachate circulating maintains a cone of depression ensuring outside groundwater in the ore zone flows in toward the production well field to prevent flow of leachate outwards (NMA, 2007).

The production zone monitor wells are completed in the ore zone around the perimeter of the production well fields spaced 400 feet outside the production well field and evenly spaced around the perimeter of the well field with a minimum spacing either 400 feet or the spacing that will ensure a 70 degree angle between adjacent production zone monitor wells and the nearest injection well (NUREG/CR-6733; NUREG-1910, 2008; NUREG-1569).

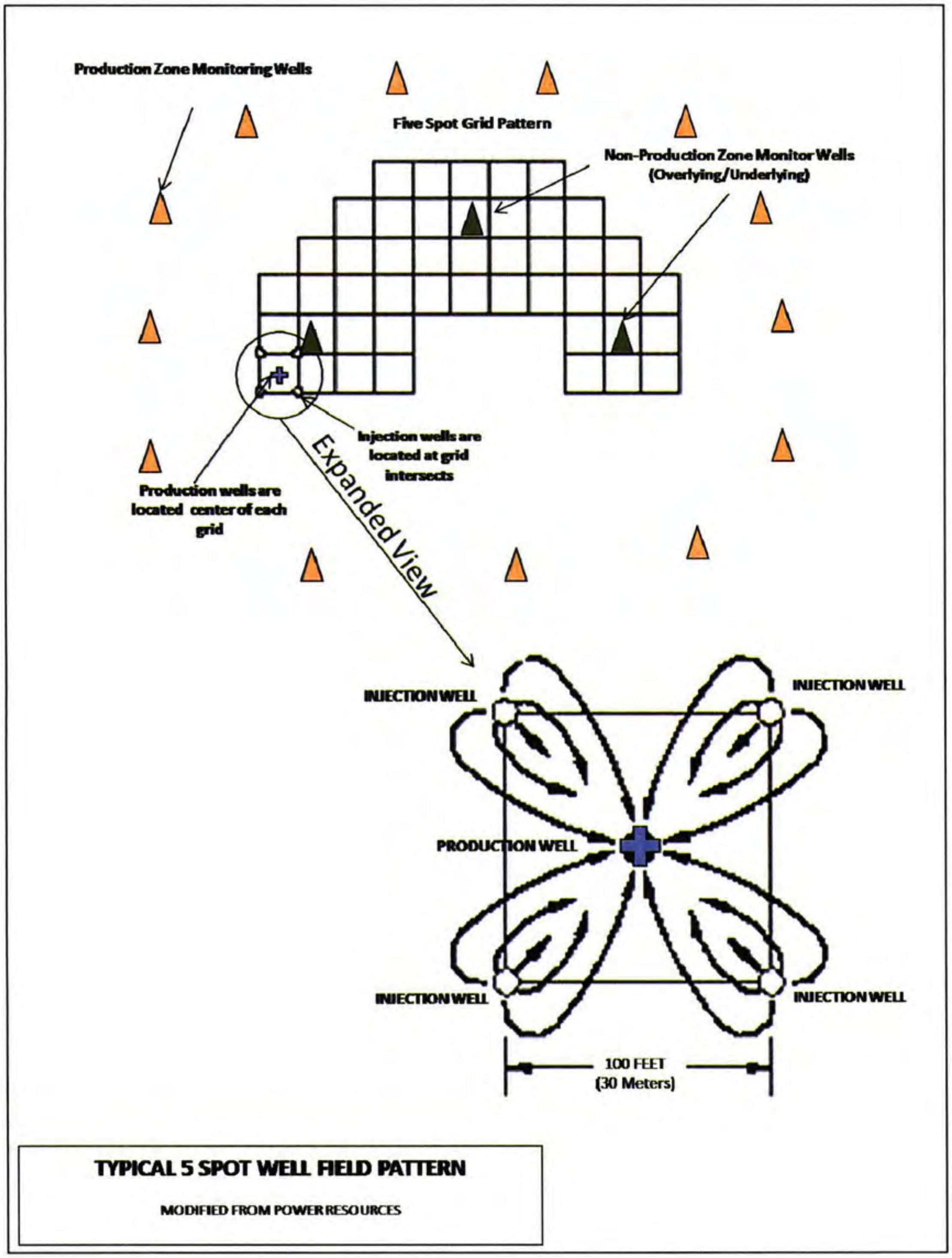

Figure 1.2-4: Typical 5 Spot Well Field Pattern

1.2.6.1 Well Field Operational Monitoring

The primary purpose of a monitoring well is to provide an early warning at the point of compliance (POC) of a potential excursion of leach fluids in accordance with NRC's interpretations of 10 CFR Part 40, Appendix A. The proposed monitoring system is described below.

1.2.6.1.1 Non-Production Monitoring Wells

Depending on site specific conditions, non-production monitoring wells may consist of two types of monitor wells termed "overlying" and "underlying". The screened intervals of overlying wells are located in the sand unit or aquifer immediately above the ore-bearing stratum. The overlying non-production monitoring wells are designed to provide monitoring of any upward movement of leach fluids that may occur from the production zone and to guard against potential leakage from production and injection well casing into any overlying aquifer. The overlying wells are used to obtain baseline water quality data and are used in the development of Upper Control Limits (UCL) for the overlying zones that will be used to determine if vertical migration of leach fluids is occurring.

Vertical monitoring is generally set up with a density of wells ranging from one every three or five acres but where confining layers are very thick and permeabilities are negligible, requirements for vertical excursion monitoring can be relaxed or eliminated (NUREG/CR-6733, 2001). The screened zone for the overlying wells is determined from electric logs by qualified geologists or hydrogeologists. The first layer of overlying non-production zone monitoring wells will be evenly distributed through the production area with a minimum of one well for every four acres of production area. Should additional aquifers exist above the first monitoring layer, additional overlying monitors will be located in these aquifers with a minimum of one well positioned for every eight acres of production area. The overlying wells will be placed within the geology just above the proposed project's upper confining layer the Skull Creek Shale; it has a thickness of approximately 200'. Core samples were collected from the lower Skull Creek Shale; analyses of these core samples demonstrate that the Skull Creek Clays have extremely low vertical permeabilities, in the range of 6.8×10^{-9} cm/sec (0.007 millidarcies).

A single layer of underlying monitor wells may be completed in the first sand unit or aquifer underlying the ore-bearing stratum similarly based on the local lithology. The underlying monitor wells are used to obtain baseline water quality data and are used in the development of UCL for the underlying aquifer that will be used to determine if vertical migration of leach fluids

downward is occurring. The screened zone for the underlying monitor wells is determined from electric logs by qualified geologists or hydrogeologists. Underlying non-production monitoring wells will be evenly distributed through the production area with a minimum of one well for every four acres of production area. Underlying wells likely will not be installed below the Lakota formation, primarily due to the presence of the approximately 100' thick and relatively impermeable Morrison formation immediately below the Lakota formation.

Non-production zone monitoring wells will be designed and installed for detection of potential excursions of lixiviant, if such an excursion were to occur. Design of the monitor ring and overlying and underlying monitor wells will be performed for each well field according to site specific lithology and processes of the production zone(s) of each well field. Powertech (USA) will present each monitoring well program to NRC, EPA and the South Dakota Department of Environmental Natural Resources (DENR) before installation of proposed well placement to ensure administrative approval is obtained. After completion of the required hydrologic tests it may be necessary to revise the location and/or number of wells proposed. Each well field will be handled on a case-by-case basis in consultation with NRC, EPA and DENR.

After submission and approval of at least one well field package (including injection, production and monitoring wells) Powertech (USA)'s Safety and Environmental Review Panel (SERP) established under NRC requirements, will review hydrologic test results and documentation to demonstrate that the monitoring wells are not hydrologically connected to the injection or production wells. Based on current knowledge of site lithology and processes of the production area, and industry proven practices, the number and spacing of overlying and underlying monitoring wells meets criteria to protect human health and the environment. Wells completed in overlying and underlying aquifers will be subject to sampling, remedial action, and reporting requirements pertinent to NRC, EPA and DENR rules.

The fact that the upper confining layer is approximately 200' thick and the lower confining layer is approximately 100' thick, minimize concerns about vertical excursion of lixiviant escaping.

Approximate locations for both well types are illustrated on Figure 1.2-5 and discussed below. Additional information about sampling parameters, frequencies, and procedures is provided in Section 6 of this application.

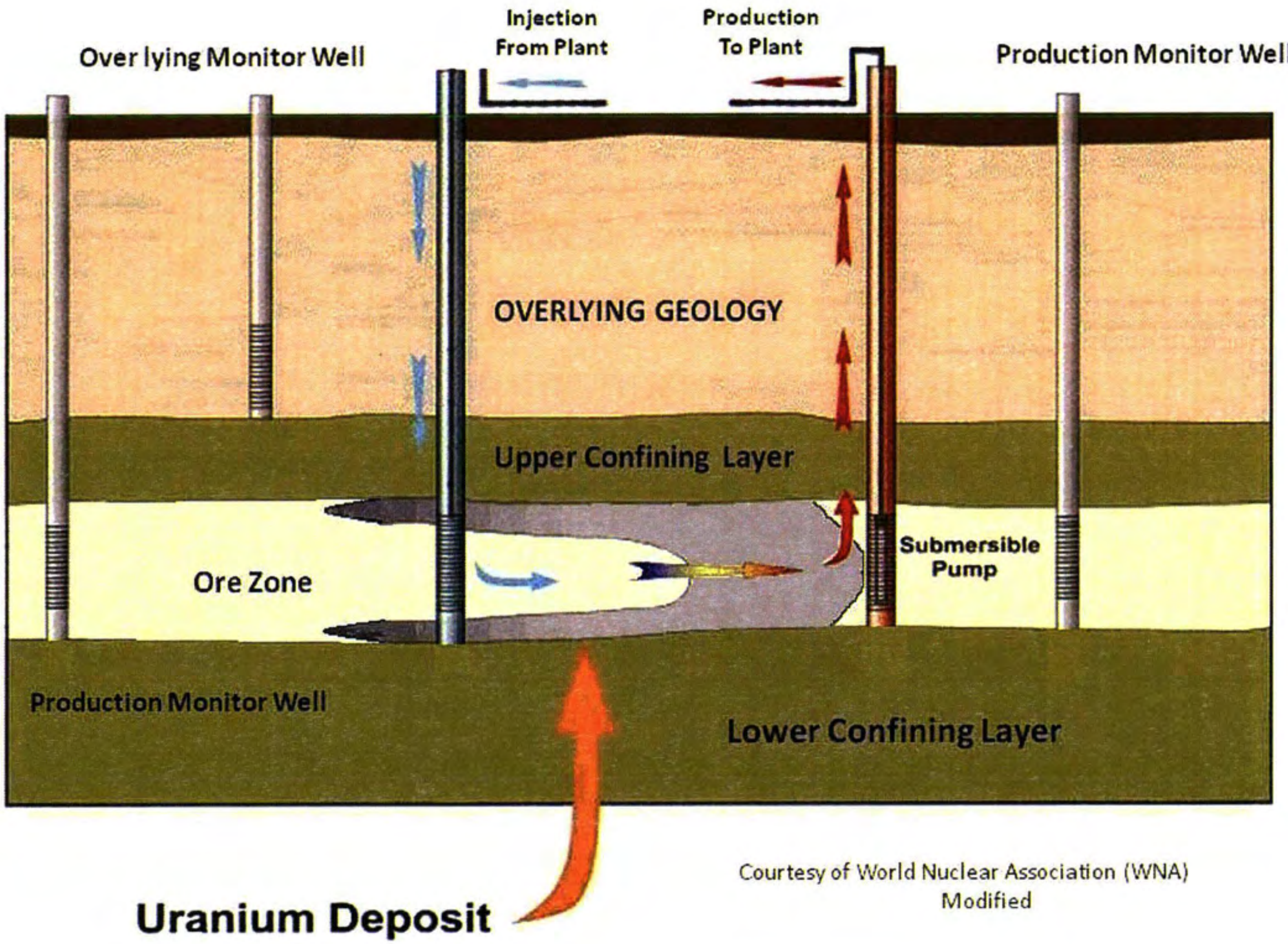

Figure1.2-5: Cross Section of Typical Well Placement

1.2.6.1.2 Production Monitoring Wells

Production zone monitoring wells are installed around the periphery of each production area to monitor for any fluids that might escape the hydraulic controls (Hunkin, G. G., 1977 and Dickinson, K. A., and J. S. Duval, 1977), with a screened interval open to the sand unit containing the production zone. This monitoring "ring" design serves two purposes: 1) to monitor any horizontal migration of fluid within the sand unit or aquifer where production is occurring, 2) to determine baseline water quality data and characterize the area outside the production pattern area. UCL are determined from indicator constituents that are selected due to their mobility to provide early warning with regards to potential excursions; these constituents are determined from the well field specific groundwater quality baseline data. By establishing UCL, the operator has the capability of early detection of an excursion at a monitor well and then has time to apply corrective action before water quality outside the aquifer exemption boundary is adversely affected (NUREG/CR-6733, 2001). Production zone monitor wells will be located no more than 400 feet from the production area, and spacing between production zone monitoring wells will be no more than 400 feet (NUREG/CR-6733; NUREG-1910, 2008; NUREG-1569). If the monitor wells are closer than 400 feet to the well field, the monitor wells will be located via a strategic distance to maintain a minimum angle between monitor wells and the nearest injection well of 70 degrees. This will ensure that no leach fluids will pass between the adjacent monitor wells undetected as the leach fluids flow radially outward from the initiation point of an excursion. Production zone monitoring wells are installed before the start of production activities in order that required baseline sampling and hydrologic tests can be conducted. Well design, construction, and development will be identical to those of injection and recovery wells, except well screens will be completed across the entire mineralized sandstone (Figure 1.2-6). As noted above, it is expected that NRC will review and accept at least one well field package (injection, production and monitoring wells) before Powertech's (USA) SERP becomes primarily responsible for formalizing packages. Additional information about sampling parameters, frequencies, and procedures is provided in Section 6 of this application.

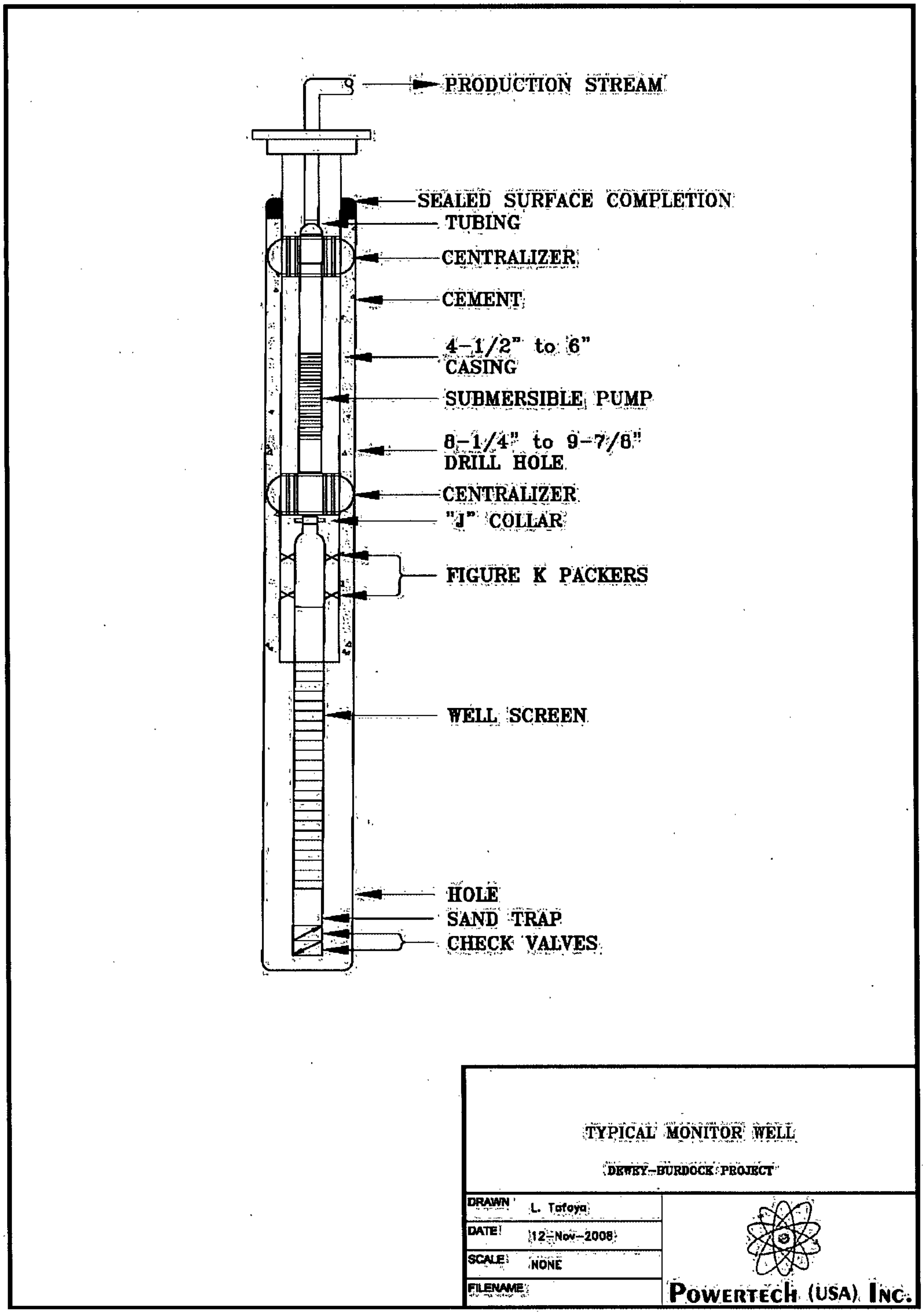

Figure 1.2-6: Typical Monitor Well Construction Diagram

1.2.6.2 Uranium Production

Recovery of the uranium from the uranium bearing or pregnant lixiviant solution will be accomplished via an ion exchange process. The pregnant lixiviant from the well field will be pumped through ion exchange vessels containing uranium-specific ion exchange resin beads (Dowex 21K XLT or equivalent). As the lixiviant flows through the resin beds, the complexed uranium molecules attach themselves to the beads of resin, displacing a chloride ion or bicarbonate ion as shown below:

$$2\ RCl + UO_2(CO_3)_2^{-2} \rightarrow R_2UO_2(CO_3)_2 + 2Cl^{-1}$$

$$2\ RHCO_3 + UO_2(CO_3)_2^{-2} \rightarrow R_2UO_2(CO_3)_2 + 2HCO_3^{-1}$$

Each resin bead has a finite number of sites where the uranium complex can attach. When most of the available sites on the beads in the resin bed are occupied by uranyl dicarbonate (UDC) or uranyl tricarbonate (UTC) ions, the resin will be considered to be "loaded" and will be ready for processing.

The ion exchange vessels will be designed to operate in pressurized downflow mode, and will each contain approximately 500 ft^3 of ion exchange resin. The ion exchange vessels will be arranged in pairs of two vessels in series. The lixiviant will be passed through the primary or lead vessel which will be where most of the resin loading takes place. The lixiviant will then pass through the secondary or lag vessel where the solution will be "polished" by removal of any remaining dissolved uranium. When the lead vessel becomes loaded, it will be taken off line and flow of lixiviant will be routed to the secondary vessel which will become the lead vessel. The resin in the off-line vessel will be removed and regenerated resin will be returned to the vessel. The vessel containing the regenerated resin will be then brought back on line in the lag position. The resin that was removed will be transferred to the elution and regeneration process in the CPP.

After passing through the ion exchange vessels, the barren lixiviant will be returned to the well field where oxygen and carbon dioxide will be added prior to reinjection. A booster pump station may be required to achieve the required injection pressure. A sidestream referred to as the production bleed will be removed from the barren lixiviant and routed to either the wastewater system or the production bleed reverse osmosis (RO) system, depending on which operating option, (land application or deep well disposal) is utilized. The flowrate of this

sidestream will be approximately 0.5 percent to 3 percent of the pregnant lixiviant flowrate. The purpose of the production bleed stream is to maintain a hydraulic gradient towards the well field.

1.2.6.3 Resin Transfer and Elution

Once the resin in an ion exchange column is loaded to capacity with uranium complexes, the column will be taken out of service. The resin will then be transferred to an elution vessel where it is contacted with a brine solution containing sodium chloride and sodium carbonate. This will strip the uranium from the resin according to the following reactions:

$$R_2UO_2(CO_3)_2 + 2Cl^- \rightarrow 2\ RCl + UO_2(CO_3)_2^{-2}$$

$$R_4UO_2(CO_3)_3 + 4Cl^- \rightarrow 4RCl + UO2(CO_3)_3^{-4}$$

After the uranium has been stripped from the resin, the resin will be rinsed with water and potentially a sodium carbonate or bicarbonate solution. This rinse removes the high chloride eluate physically entrained in the resin and, if sodium carbonate or bicarbonate is used, partially converts the resin to carbonate or bicarbonate form. In this manner, chloride ion buildup in the lixiviant will be controlled if the resin is still useable, it will then be returned to the ion exchange columns.

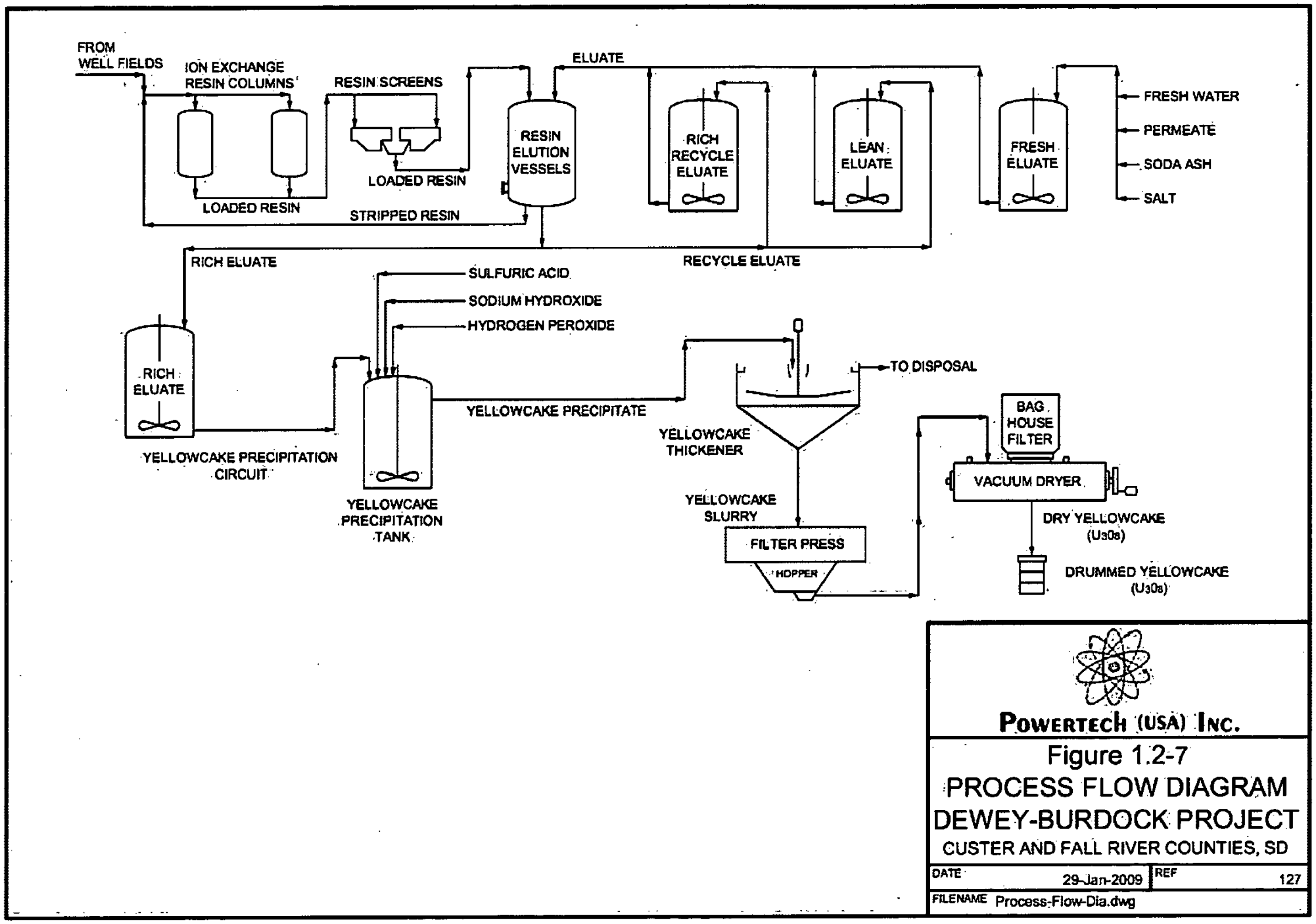

Figure 1.2-7: Overall Process Flow Diagram

1.2.6.4 Precipitation

The precipitation process will be designed to break the uranyl carbonate complex, precipitate the uranium as uranium peroxide, and settle the precipitated solids from the eluant solution. The precipitation process will be comprised of a series of chemical addition steps, each causing a specific change in the rich eluate solution.

Prior to beginning the precipitation process, the rich eluate transfer pump will be used to transfer the rich eluate from the rich eluate tank to the precipitation tank. The precipitation tank contents will be mixed via an agitator. The first stage of chemical addition will be to add sulfuric or hydrochloric acid to bring the pH down to a range of approximately 2-3 pH units. This change in pH will cause the uranyl carbonate complex to break, liberating carbon dioxide, which will be vented from the tank, as illustrated in the following chemical reaction.

$$UO_2(CO_3)_3^{-4} + 6H^+ \rightarrow UO_2^{++} + 3\ CO_2\uparrow + 3H_2O$$

Following completion of CO2 evolution, sodium hydroxide will be added to raise the pH of the solution to between 4 and 5 pH units. When the pH has stabilized, hydrogen peroxide (H2O2) will be added to the solution to form insoluble uranium peroxide (UO4). Following addition of H2O2 , the agitator speed will be slowed down to promote crystal growth.

$$UO_2^{++} + H_2O_2 + 2H_20 \rightarrow UO_4 \bullet 2H_2O + 2H^+$$

After a precipitation period of up to 8 hours, sodium hydroxide will be added to raise the pH to approximately 7, and the contents of the precipitation tank will be pumped into the thickener using the precipitation transfer pumps.

1.3 Proposed Operating Plans and Schedules

Following the issuance of the NRC Uranium Recovery License to Powertech (USA), it is anticipated that construction of the Burdock Well Field 1, the CPP and ancillary facilities, including storage ponds and land application pivots, if necessary, will commence. The construction of the Dewey Well Field 1 and Dewey satellite facility will also occur in the same timeframe. Restoration of the first well field at each site will commence immediately following the end of production activities in that well field. Subsequently, Powertech (USA) intends to simultaneously operate one well field in restoration for each well field in production at each site for the duration of the project, as additional well fields are completed along the roll fronts at both

Dewey and Burdock sites. The projected schedule for construction, operation, and decommissioning (including restoration) is provided in Figure 1.3-1.

In each well field, production activities will proceed until such time as the uranium concentration in the pregnant solution has declined to an uneconomic recovery level. After production ceases, Powertech (USA) will be restoring the groundwater consistent with baseline and in accordance with 10 CFR Part 40 Appendix A, Criterion 5(b)(5). Reclamation of surface disturbances will occur after completion of restoration activities in a well field and will continue the same manner after additional well fields are developed, produced and restored. Therefore, at any time there may be well fields in three different stages of the process: wellfields in production, well fields undergoing groundwater restoration, and well fields undergoing surface reclamation. Additionally, there also may be some small areas indirectly related to these process phases that are held unreclaimed for short periods of time (e.g., storage of top soil). This proposed operational and reclamation plan ensures minimal potential environmental impacts.

D&D of the well fields includes well abandonment, the removal of piping, tanks, ancillary buildings and equipment, cleanup of surface soil to radiological standards in 10 CFR Part 40, Appendix A, Criterion 6 and revegetation of disturbed areas. It is likely that the CPP at the Burdock site will continue to operate for several years following the D&D of the project well fields. The Proposed Action is for the plant to continue to receive and process uranium loaded resins from other Proposed Projects such as Powertech's nearby Aladdin and Dewey Terrace Proposed Satellite Facility Projects planned in Wyoming or from other licensed ISL operators or other licensed facilities generating uranium-loaded resins that are compatible with the Powertech (USA) production process.

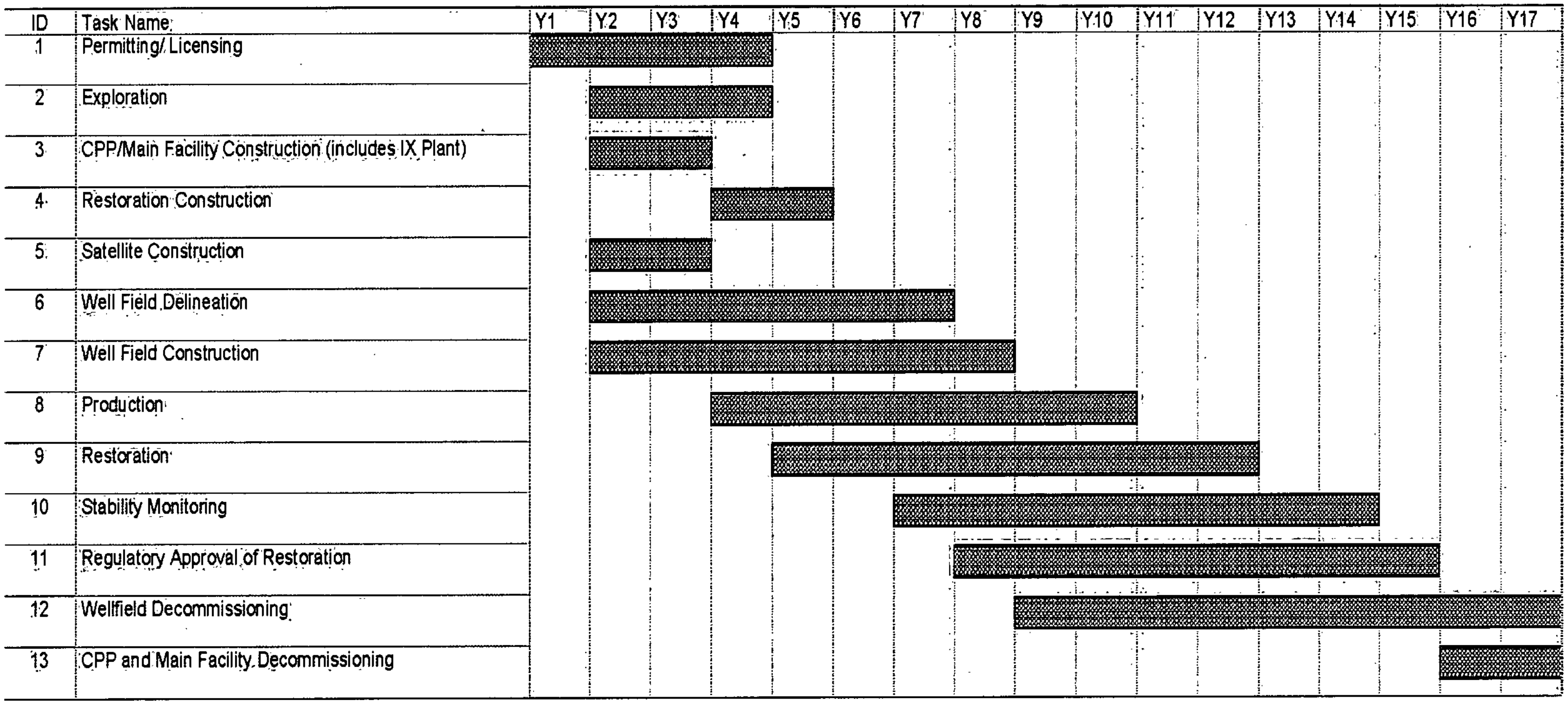

Figure 1.3-1: Projected Schedule for Construction, Operation, and Decommissioning (Including Restoration) Schedule

1.4 CPP SF, and Chemical Storage Facilities; Equipment used and Materials Processed

One SF will be located at the Dewey site and a combination SF/CPP facility will be located at the Burdock site (Figure 1.4-1). The downstream uranium recovery processes described in the preceding section will be accomplished in several steps. Uranium recovery from the solution by ion exchange, subsequent processing of the loaded ion exchange resin to remove the uranium (elution), the precipitation of uranium, thickening of the uranium slurry, and the dewatering, drying, and packaging of solid uranium oxide (yellowcake) will be performed at the CPP.

1.4.1 CPP Equipment

The CPP will be housed in a pre-engineered metal building. The CPP includes the following systems:

- Ion exchange
- Chemical addition
- Filtration
- Elution circuit
- Precipitation and thickening circuit
- Product dewatering, drying and packaging
- Liquid waste stream circuit

Based on preliminary design and site geotechnical evaluations, the proposed project CPP will be located within Section 2, T7S, R1E. Chemical storage and a septic tank and leachfield will also be located within this area. The Dewey SF will be located within Section 29, T6S, R1E. These plant locations are shown in Figure 1.4-1.

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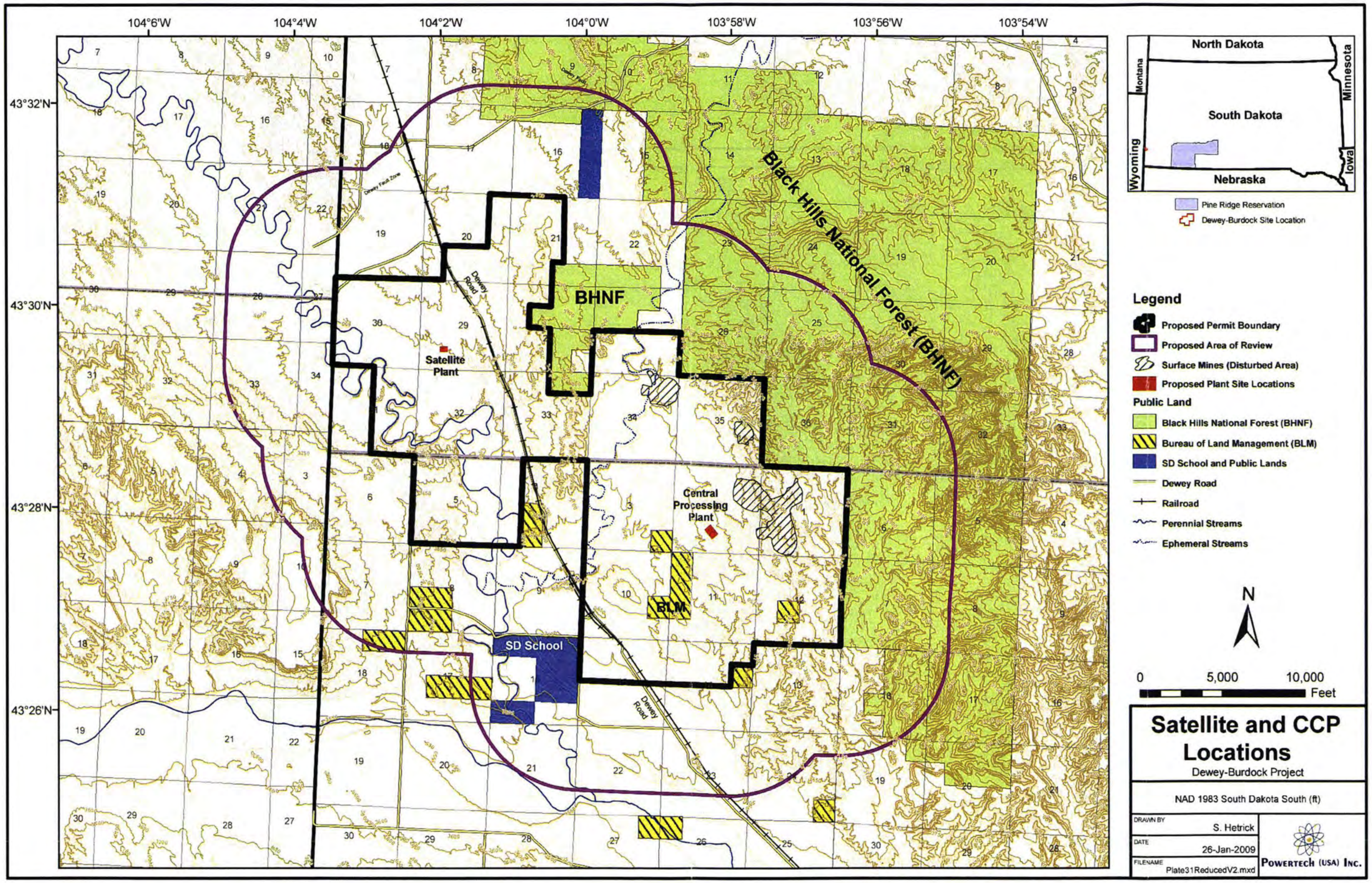


Figure 1.4-1: Satellite and CPP Locations

1.4.2 Ion Exchange System

The pregnant lixiviant pumped from the well field will be routed via underground piping to a satellite IX facility or to an IX facility within the CPP. Loaded resin from satellite IX facilities will be trucked to the CPP at the Burdock site in dedicated tanker trucks. Each IX system will consist of eight fixed bed IX columns. The columns will be operated as four sets of two vessels in series. The IX system is designed to process recovered solution at a rate of 2,000 gpm at each site with each vessel operated in a pressurized down-flow mode. As the pregnant lixiviant solution passes through the IX resin, the UDC and UTC are preferentially removed from the solution by exchanging with chloride ions on the resin sites. The barren lixiviant solution leaving the IX units normally contain less than 2 mg/l of uranium, expressed as U_3O_8.

After the barren lixiviant solution leaves the IX vessels, carbon dioxide is added as necessary to return the carbonate/ bicarbonate concentration to the desired operating level. The lixiviant solution is then pumped back to the well field, with oxygen added before it is reinjected into well fields.

1.4.3 Elution System

Using a three stage elution circuit, resin will be contacted with elution brine to strip the uranyl carbonate anions from the resin. The fresh eluant is prepared by mixing the proper quantities of a saturated sodium chloride (salt) solution and saturated sodium carbonate (soda ash) solution and water. In the first elution step intermediate eluant, from the previous batch of resin eluted, is passed through the elution vessel containing the loaded ion exchange resin, producing the most concentrated uranium-bearing solution, rich eluate. Next, lean eluant, from the previous batch of resin eluted, is contacted with the resin, producing intermediate eluant for the next batch of resin to be eluted. Finally, fresh eluant is passed through the resin, producing lean eluant for the next batch of resin to be eluted. Following the final flush of eluant, the resin is washed with fresh water to remove remaining eluant. This wash water is then used to prepare the next batch of fresh eluant.

1.4.4 Precipitation System

The precipitation process will be designed to break the uranyl carbonate complex, precipitate the uranium as uranium peroxide, and settle the precipitated solids from the eluant solution. The precipitation process will be comprised of a series of chemical addition steps, each causing a specific change in the rich eluate solution.

Prior to beginning the precipitation process, the rich eluate transfer pump will be used to transfer the rich eluate from the rich eluate tank to the precipitation tank. The precipitation tank contents will be mixed via an agitator. The first stage of chemical addition will be to add sulfuric or hydrochloric acid to bring the pH down to a range of approximately 2-3 pH units. This change in pH will cause the uranyl carbonate complex to break, liberating carbon dioxide, which will be vented from the tank, as illustrated in the following chemical reaction.

$$UO_2(CO_3)_3^{-4} + 6H^+ \rightarrow UO_2^{++} + 3\ CO_2\uparrow + 3H_2O$$

Following completion of CO2 evolution, sodium hydroxide will be added to raise the pH of the solution to between 4 and 5 pH units. When the pH has stabilized, hydrogen peroxide (H2O2) will be added to the solution to form insoluble uranium peroxide (UO4). Following addition of H2O2, the agitator speed will be slowed down to promote crystal growth.

$$UO_2^{++} + H_2O_2 + 2H_20 \rightarrow UO_4 \bullet 2H_2O + 2H^+$$

After a precipitation period of up to 8 hours, sodium hydroxide will be added to raise the pH to approximately 7, and the contents of the precipitation tank will be pumped into the thickener using the precipitation transfer pumps.

1.4.5 Yellowcake Dewatering and Drying and Packaging System

The gravity-thickened yellowcake solids will be pumped into a plate and frame filter press for dewatering. Dewatered yellowcake is transferred to an indirect fired (hot oil heated) rotary vacuum dryer.

The yellowcake will be dried in a rotary vacuum dryer at approximately 450°F. Angled paddles attached to a central shaft in the dryer will agitate the filter cake to promote even drying. The dryers will be heated with a thermal fluid (e.g., MultiTherm IG-4) that will be circulated through the dryer shell and the rotating central shaft. The thermal fluid (TF) will be heated by an electric heater with a pump for circulating the TF through the shell and central shaft of the dryer.

The vapor pulled from the dryer by the vacuum pump will be filtered through a baghouse filter located on the top of the dryer to remove particles down to approximately 1 micron in size. The vapor exiting the baghouse will be cooled using a condenser to remove water vapor and remaining small particles. Liquid ring vacuum pumps will provide the vacuum source. The water that will be collected from the condenser will be pumped to the solids removal tank in the wastewater system.

Two rotary vacuum dryers, baghouses, and packaging equipment will be housed in a separate room in the CPP. The vacuum pump and condenser system for each dryer, and the TF heaters and pumps will be located in the main CPP area to provide access for operation and maintenance. The vacuum pumps will discharge to the dryer room. Air in the dryer and packaging room will be monitored routinely for airborne dust. A dedicated air handler equipped with (HEPA) filters will ventilate the dryer and packaging room and will provide an additional level of controlling particulate emissions.

Packaging: The packaging system will be operated on a batch basis and will include conveyors, scales, and a spray booth. When the yellowcake is dried sufficiently, it will be discharged from the drying chamber through a knife gate valve on the bottom port of the dryer into steel containers, which will be sealed after the yellowcake has cooled sufficiently. Particulate emissions will be minimized by use a sealed hood that fits on the top of the drum. A weigh scale will be used to determine when a drum is full. A conveyor system will allow drums from both dryers to be moved from beneath the dryer to an enclosed spray booth where each drum will be rinsed with a spray of water. The conveyor system will then move the drum to a scanning station where the drum will be hand scanned for radioactivity and then placed in the storage area or rinsed further.

Effluent Monitoring: The drying process produces virtually no gaseous discharge since it operates as a batch process, and the water that evaporates from the wet yellowcake is condensed in the condenser. The water that is collected from the condenser will be recycled to the precipitation circuit, eluant makeup, or disposed with other process water. Room air will be monitored routinely for airborne dust.

Controls: The system will be instrumented and controlled sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures.

1.4.6 Yellowcake Storage, and Shipment

The dried yellowcake product in the steel drums will be stored for shipment within a restricted storage area and shipped by truck to other licensed facilities for further processing. An enclosed warehouse room, adjacent to the yellowcake drying area, will be provided for the storage of yellowcake. On-site inventory of drummed yellowcake typically will be less than 200,000 pounds. However, in periods of inclement weather or other interruptions in product shipments, all production will be stored on-site in designated restricted storage areas.

The drummed yellowcake will be shipped by exclusive use transport to another licensed facility for further processing. All yellowcake shipments will be made in compliance with applicable DOT and NRC regulations.

A discussion of the areas in the proposed plant facility where vapors or gases could be generated can be found in Section 4.14. The potential sources are minimal in the ion exchange process area since the production solutions contained in the process equipment are maintained sealed under a positive pressure, and thus are not vented to the atmosphere except potentially during resin transfers. In any event, building ventilation in the process equipment area will be accomplished by the use of an exhaust system that draws in fresh air and sweeps the plant air out to the atmosphere.

1.4.7 Chemical Storage Facilities

The ISL process requires chemical storage and feeding systems to store and use chemicals at various stages in the extraction, processing, and waste treatment processes. Chemical storage and feeding systems will include sulfuric and/or hydrochloric acid, sodium hydroxide, hydrogen peroxide, carbon dioxide, oxygen, sodium chloride, sodium carbonate, barium chloride, and propane. Each chemical storage and feeding system will be designed to safely store and accurately deliver process chemicals to their intended delivery point in the process. Design criteria for chemical storage and feeding systems include applicable sections of the international building code, international fire code, OSHA regulations, Resource Conservation and Recovery Act (RCRA) regulations, and Homeland Security regulations.

1.4.7.1 Sodium Chloride Storage

Sodium chloride will be used to make up fresh eluant and will be stored in tanks as a saturated solution (approximately 26 percent by weight) in equilibrium with a bed of crystals in each storage tank. Dry sodium chloride will be delivered by truck and will be blown into the storage tanks using air pressure.

1.4.7.2 Sodium Carbonate Storage

Sodium carbonate will be used to make up fresh eluant and will be stored in tanks as a saturated solution in equilibrium with a bed of crystals in the storage tank. Sodium carbonate solution must be kept above 140 °F to prevent precipitation in the tank and piping. This will be accomplished by heating the water added to the tank, and continuously circulating liquid from the tank through a heat exchanger. An electric heater will be used to heat a thermal fluid to heat

the exchanger. Dry sodium carbonate will be delivered by truck and will be blown into the storage tanks using air pressure.

1.4.7.3 Acid Storage and Feeding System

The acid storage and feeding system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a lined concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25 year, 24 hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. The acid feed pump will be located inside the building, directly adjacent to the storage tank.

1.4.7.4 Sodium Hydroxide Storage and Feeding System

The sodium hydroxide system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25-year, 24-hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. The sodium hydroxide feed pump will be located inside the building, directly adjacent to the storage tank. Sodium hydroxide will be purchased as aqueous caustic soda, and will be pumped directly into the storage tank from the supplier's tanker trucks.

1.4.7.5 Hydrogen Peroxide Storage and Feeding System

The hydrogen peroxide system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25 year, 24 hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. The hydrogen peroxide feed pump will be located inside the building, directly adjacent to the storage tank.

1.4.7.6 Oxygen Storage and Feeding System

Oxygen is typically stored near the central plant or within well field areas, where it is centrally located for addition to the injection stream in each header house. Since oxygen readily supports combustion, fire and explosion are the principal hazards that must be controlled. The oxygen storage facility will be located a safe distance from the CPP and other chemical storage areas for isolation. The storage facility will be designed to meet industry standards in NFPA-503.

1.4.7.7 Carbon Dioxide Storage and Feeding System

The carbon dioxide storage and feeding system will be used to dissolve carbon dioxide into the pregnant lixiviant to improve recovery of uranium in the ion exchange vessel. This system will be a vendor supplied packaged system including cryogenic tank, vaporizer, pressure gauges, and pressure relief devices.

1.4.7.8 Barium Chloride Storage and Feeding System

The barium chloride storage and feeding system includes a storage tank, agitator, and chemical metering pump. This system will be designed to dissolve solid barium chloride in water to make up the solution for feeding into the low total dissolved solids (TDS) wastewater for radium precipitation. This system will be located in a metal building located adjacent to the low TDS wastewater pond.

1.4.7.9 Non-Process Related Chemicals

Non-process related chemicals that will be stored at the project CPP include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities will be stored outside of process areas at the facility. All gasoline and diesel storage tanks are located above ground and within secondary containment structures to meet EPA requirements.

1.4.7.10 Waste Management

There are several disposal options for the liquid waste generated during the production and restoration process including brine concentrators, discharge to surface waters, evaporation ponds, deep well injection and land application. The National Pollution Discharge Elimination System (NPDES) permitting process allows for the discharge of treated liquid effluents to surface waters that meet state and federal water quality standards, but surface discharge has been rejected because it is a poor use of water resources in a water sensitive region. The sole use of evaporation ponds was rejected because of the large surface impoundment area that would be required to evaporate the daily bleed water and the severe winters that would freeze the ponds for several months out of the year, thereby decreasing the evaporation rates. The use of evaporation process in conjunction with the transportation of liquid waste for disposal at an off-site deep disposal well is one consideration being explored to handle the CPP waste. However, Powertech (USA) considers the use of deep well injection and/or land application to be the best alternatives to dispose of these types of liquid waste. The deep well(s) identified by Powertech (USA) will

isolate liquid waste generated during the production and restoration processes from any underground source of drinking water (USDW); in the case of land application the bleed stream will be treated with additional ion exchange to remove residual uranium, followed by contact with barium chloride to remove radium. Other treatments may also be required before the bleed stream can then be applied to the land through center-pivot irrigation systems and used to assist with production.

Non-radioactive solid waste will be managed in accordance with existing regulations and disposed of in a landfill that has been permitted under subtitle D of RCRA. Materials that cannot be decontaminated will be disposed of at a licensed 11e.(2) disposal facility.

1.5 Instrumentation and Control

The piping and metering system for production and injection solutions consists of buried trunk lines between the SF and the related operating well field areas and the CPP and its operating well field areas, with metering and flow distribution headers located in the well field header houses. The individual well flows and pressures are adjusted and controlled within the header houses. Well field instrumentation will be provided to measure total production and injection flow. In addition, instrumentation will be provided to indicate the pressure which is being applied to the injection wells. Well field header houses will be equipped with state-of-the-art water sensors and alarms to detect the presence of liquids in the well field header houses.

An integrated process control system will be utilized for monitoring and control of process variables in the well field, in the SF and in the CPP. Data from all sources will be available to personnel at the CPP. Instrumentation will be provided to monitor the total recovery flow into the CPP, the total injection flow leaving the facility, and the total waste flow leaving the CPP. Instrumentation will be provided on each injection and production well to produce an alarm in the event of a change in flow that might indicate a leak or rupture in the system. In the process areas within the CPP, storage and process tank levels will be equipped with automated level measuring instruments. A safety interlock system will be utilized to ensure that safe operating procedures are followed and to prevent releases of well field liquids or CPP streams. The control and monitoring system will be equipped with extensive alarms to alert the operations personnel of unsafe conditions or conditions that have the potential to release materials to the environment.

Handheld radiation detection instruments and portable samplers will be used to monitor radiological conditions at the SF and CPP.

1.6 Applicable Regulatory Requirements, Licenses, Permits, and Required Consultations

In order for Powertech (USA) to operate, license, permits and approvals from numerous Federal and State agencies will be required. This section identifies the issuing agencies, a description of the type of license, permit, or approvals needed, and the current status of securing these approvals.

Necessary environmental approvals from Federal and State Agencies required for the Proposed Action are listed in Table 1.6-1. The NRC licensing process for a uranium recovery license represents the most complex and broadest scope review process and, therefore, may require the longest lead-time for approval. The majority of the remaining approvals are in-progress or will be initiated within the next year. *All necessary approvals must be secured prior to commencement of commercial production at the site.*

1.6.1 Environmental Consultation

Over the course of license application preparation, consultations were conducted with several State and Federal agencies to ensure the technical and environmental aspects of their requirements are addressed within the application; these consultations will proceed with the various agencies through the entire licensing application review and acceptance process and continue throughout the life of the operation:

Table 1.6-1: Permits and Licenses for the Proposed Project

Issuing Agency	Description	Status
South Dakota Department of Environment and Natural Resources Joe Foss Building 523 E Capitol Pierre, SD 57501	Uranium Exploration Permit	Submitted
	Temporary Water Right for Testing	Submitted
	Temporary Discharge Permit for Testing	Submitted
	Scenic and Unique Lands Designation	Submitted
	Large Scale Mine Permit	Pending
	Water Appropriation Permit	Pending
	Class III Underground Injection Control Permit	Pending
	Air Quality Permit	Pending
	Groundwater Discharge Permit	Pending
	NPDES Water Discharge Permit	Pending
US Nuclear Regulatory Commission Washington, DC 20555	Uranium Recovery (Source and 11e. (2) Byproduct Material)	Application Submitted herein
US EPA Region 8 8OC-EISC 1595 Wynkoop St Denver, CO 80202-1129	Class III Underground Injection Control Permit and Aquifer Exemption	Submitted and deemed complete
Custer County 420 Mount Rushmore Road Custer, SD 57730-1934	Building Permits	Pending
Fall River County County Courthouse Hot Springs, SD 57747-1309	Building Permits	Pending
US Bureau of Land Management, South Dakota Field Office	Plan of Operations	Pending
State Historic Preservation Office	State and Federal Licensing/Permitting	Per NRC processing
Tribal Historic Preservation Office	State and Federal Licensing/Permitting	Per NRC processing

Table 1.6-2: Environmental Consultation

State Agency	**Department**	**Location**
South Dakota Game Fish and Parks	Wildlife	523 East Capitol Avenue Pierre, SD 57501
South Dakota State Archaeologist	Archaeologist	P.O. Box 1257 Rapid City, SD 57709-1257
South Dakota Department of Environment and Natural Resources	Minerals and Mining Program	523 E Capitol Ave. Pierre, SD 57501
Federal Agency		
U.S. Geological Survey	Dakota Mapping Partnership Office	1608 Mountain View Road Rapid City, SD 57702
U.S. Corps of Engineers	Resource Management	441 G. Street, NM Washington, DC 20314-1000
Natural Resources Conservation Service	Pierre Service Center	1717 N Lincoln Ave. Pierre, SD 57501-2398
U.S. Nuclear Regulatory Commission	Uranium Recovery Licensing Branch	Washington, DC 20555-0001
U.S. EPA Region 8	8P-W-GW	1595 Wynkoop Street Denver, CO 80202-1129
U.S. Bureau of Land Management	South Dakota Field Office	310 Roundup Street Belle Fourche, SD 57717
U.S. Forest Service	Forest Service, Supervisor's Office	Custer, SD 25041 North US Highway 16

2.0 Alternatives

2.1 No-Action Alternative

Under the provisions of the NEPA, one alternative that must be considered in each environmental review is the no-action alternative. In this case, the no-action alternative would be to not build or license the project facilities. This alternative will provide a baseline from which to compare the potential impacts of the other action alternatives.

2.2 Proposed Action

The project will use ISL technologies and processes to recover uranium deposited in typical "C" shaped roll-fronts within a stratabound deposit made up of sandstones amenable to the ISL method of extraction in the Fall River and Lakota formations of the Inyan Kara Group. ISL involves the circulation of native groundwater, fortified with oxygen and carbon dioxide to create leaching solutions (lixiviant). The lixiviant is pumped into the production zone through the injection wells and recovered by the production wells. At the surface, the pregnant lixiviant flows through IX columns where the uranium attaches to resin beads. Upon saturation the uranium loaded resin will be trucked or piped to the CPP where it will be stripped from the resin via the elution process. The stripped resin will be returned to IX columns for reuse unless exhausted. The eluted uranium will be precipitated, washed, filtered, pressed and dried into the final product -- yellowcake. This completes the first stage of the ISL uranium production cycle.

To minimize usage of native groundwater and maximize uranium production, the lixiviant is then re-fortified with oxygen and carbon dioxide re-circulated through the production zone in a continuous process until the uranium resources in a given well field are depleted. After uranium production is complete, groundwater in well-field production zones is restored consistent with baseline as reflected in NRC Appendix A, Criterion 5(b)(5); and the surface facilities are decontaminated and decommissioned such that ultimately there will be no visual evidence of site use and the entire disturbance area can be released for "unrestricted use." A detailed description of the proposed action is presented in Section 1 of this ER and Sections 3.4 and 5 of the TR.

2.3 Reasonable Alternatives

2.3.1 Proposed Location of Facilities

Locations of the CPP and the Satellite (SF) were strategically chosen based on site specific circumstances including, proximity to historical and current reserves within the northern Dewey and southern Burdock areas, historical environmental disturbance, wildlife concerns and the geology of the area. The CPP would be constructed in Section 2, T7S, R1E of the Burdock action area and the SF would be located in Section 29, T6S, R1E of the Dewey action area (see Figure 1.4-1).

- Based on the TVA data and current Powertech (USA) data, both the CPP and SF locations will be approximate to the center of ore reserves located within the proposed action areas although in locations that have little potential for ore directly beneath them.
- Environmental considerations were noted such as historical surface mining sites, nesting sites for raptors and drainage issues; the locations chosen will not have these issues.
- There were no issues with the surface or subsurface geology for either the CPP or the SF location.

2.3.1.1 Proposed Production Units and Production Zone Monitoring Well Rings

Typically, an ISL production unit consists of an ISL-amenable ore body located within a sandstone unit bounded by upper and lower hydrologic barriers. In the simplest scenario, there would be a single production zone and a monitor well ring radially bounding that production zone, which along with upper and lower hydrological barriers, including their monitor wells and proper well field generally are the means of ensuring control of leach fluids within a production unit. In more complex systems, there may be more than one production unit stacked vertically within a sandstone unit, and there may be more than one sandstone unit, with multiple production zones stacked vertically (Lost Creek Project, 2007).

Within the Dewey area, there exists at least one area where one production zone overlies another. There will be different scenarios concerning well completions within this type of production unit. The monitoring well rings will be adequate for production units containing approximately one million pounds of reserves. The basic scenario for well completion will be completion of

injection, production and monitoring wells within the one sand that contains the ore. A more complex well completion scenario will exist for the area(s) that contain more than one ore bearing sand. In this case, the production wells will be completed within the lowest ore bearing sand. After the ore has been recovered in the lowest sand, the injection and production wells will be completed in the next ore bearing sand unit above. Upon recovering the ore from all ore bearing sands, restoration will commence in the reverse order by restoring the uppermost horizon sands first and working down to the lowermost horizon sand(s). The monitoring well ring design will conform to open intervals corresponding to the depths of each sand adjacent to each well. This type of well completion is preferred over other completion methods such as:

- Multiple Completions

  Completion of wells across multiple sands within the same horizon, using the same wells and the same monitor ring could be an alternative method. However, this is not considered an appropriate alternative due to the difficulties of ensuring the leach fluids are being efficiently distributed through the various sands in the horizon and of monitoring the performance of the production unit.

- Larger Rings Encompassing More Reserves

  The wells are completed in the same manner as with the preferred option, but due to the increase in scale, the construction time, evaluation of pump tests, and all other activities associated with installing the well field would increase dramatically. Final restoration/reclamation of the production unit would be delayed until all operations for the area are complete. Therefore, this option is not considered the most efficient approach (Lost Creek Project, 2007).

2.3.2 Process Alternatives

2.3.2.1 Lixiviant Chemistry

The lixiviant is prepared using native groundwater fortified with oxygen, and carbon dioxide. The lixiviant is pumped into the injection wells, flows between the injection and production wells in the mineralized zone by the imposed hydraulic gradient, and is extracted by production wells. Production flow rates are estimated at 20-30 gallons per minute (gpm) per well.

The groundwater restoration method proposed for the project is based on the successful programs implemented by other projects such as the Lamprecht, Cogema Irigaray Restoration Project or Crow Butte Resources Inc., which have received regulatory approvals for successfully restoring groundwater.

Groundwater restoration will be implemented as part of the routine ISL operation so that restoration can be performed after a well field is depleted of uranium but concurrently with the development of subsequent well fields as ISL operations advance within the exempted aquifer. The goal of the restoration program will be to return the water quality within the exempted aquifer consistent with pre-operational baseline quality conditions or other NRC approved standard in accordance with 10 CFR Part 40 Appendix A Criterion 5(b)(5). It is anticipated that one or a combination of land application and/or deep well injection may be utilized to dispose of operational bleed and restoration fluids.

2.4 Eliminated Alternatives

Open pit and underground production alternatives to ISL production were eliminated based on economics, health, safety and environmental impacts.

2.4.1 Open Pit Mining Alternative

Open pit mining requires the removal of all material covering the ore body (overburden) and then the ore itself. The ore would then be transported to a conventional mill for further processing and extraction through grinding, leaching, purifying, concentrating, and drying. From an economic point of view, open pit mining of the relatively low grade ore at the depth of the Dewey-Burdock orebodies would require a much larger investment than ISL, especially in the early phase, when a significant investment would be required for acquisition of heavy equipment to perform the earthwork to expose the ore body. The overall footprint of the operation would be larger because of greater manpower and material handling requirements. Waste rock piles from excavation of the overburden would be substantial and the mine pit would make permanent changes to the topography, with a disturbed area approximately three times the area of the ore body mined in order to maintain slope stability. Potential personnel injury rates and potential radiological exposures at the mining site would also be higher with open pit mining then would be experienced with ISL. A mill tailings impoundment would be required to contain the millions of tons of waste produced from the uranium mill. This tonnage would represent a large volume of radioactive tailings slurry covering a large area of ground surface. Conventional mill operation would involve higher risks of spillage and radiological exposure to both personnel and the environment than those associated with the proposed ISL operations. Open pit mining at the PAA would also require dewatering of the pit to depress the potentiometric surface of all aquifers. Large quantities of groundwater would be discharged to the surface with potentially little appreciable benefit. Some of this groundwater contains naturally elevated radium-226 (Ra-226), radon, and uranium, which would have to be treated before discharge and the residue disposed of as radioactive solid waste (Lost Creek Project, 2007).

2.4.2 Underground Mining Alternative

Underground mining of the uranium resources at the Proposed Action Area (PAA) would involve sinking shafts to the vicinity of the orebodies, horizontally driving crosscuts and drifts to the ore bodies at different levels, physically removing the ore and transporting the mined ore to the conventional mill for further processing. Processes for milling and uranium extraction from underground mined ores would be the same as those for ores mined from the open pit. When

one considers the alternative of underground mining, the economic and environmental disadvantages closely parallel those of an open pit mine. These, as stated above, include large amounts' of initial investment, permanent changes to the topography (though in a smaller scale than open pit mining because less amounts of waste rock are being generated), generation of a significant amount of mine tailings, increased risks of injury and potential exposure to radioactive materials during mining and milling, and surface discharge of groundwater from mine dewatering with elevated radionuclide concentrations. One major concern for underground uranium mining is the potential exposure of miners to, radon gas if the gas -is not continuously vented to the atmosphere and such venting implicates Clean Air Act (NESHAPs) limits on radiation exposure to nearby residents (40 CFR Part 61, Subpart B). Subsequent land surface subsidence could also occur after the completion of underground mining.

Economic costs and environmental impacts associated with open pit and underground mining, demonstrate that ISL is the more benign and viable uranium recovery method to use. The initial investment is lower; the tailings problem is completely eliminated; radiation exposure and environmental impacts are minimized; and the groundwater resource is preserved. In addition, because of the reduced costs, lower grade ores can be recovered through ISL than can be recovered from open pit and underground mines (Lost Creek Project, 2007).

The NRC conducted a comparison of the overall impacts of open-pit and underground mining with ISL methods and concluded that ISL methods generate less potential adverse environmental impacts and more socioeconomic advantages. The relative advantages of ISL methods include:

- The degree and the quantity of disturbance to surface area are substantially less than with surface mining.
- No mill tailings are produced and the volume of solid waste is significantly less than conventional milling – typically more than 99 percent less waste is produced with ISL.
- The elimination of airborne emissions from overburden stockpiles or tailings stockpiles and the crushing and grinding processes, which are required for conventional mining.
- Exposure to radionuclides is markedly reduced with ISL methods because less than 5 percent of the radium in an ore body is brought to the surface compared with up to 95 percent with conventional mining techniques.

- Because of the lack of tailings and other significant sources of solid waste ISL facilities can be decontaminated readily and returned to unrestricted use within a relatively short time frame (12-15 years).
- ISL facilities typically consume much less water than conventional mining and milling, on the order of 1 percent of their production flow.
- The socioeconomic advantages of ISL include:

  2.5 Lower grade ores can be mined

  2.6 Requires less capital investment

  2.7 Provides a safer working environment for the miner

  2.8 Decreases amount of time before production begins

  2.9 Requires a smaller workforce

2.10 Cumulative Effects

2.10.1 Future Development

Powertech (USA) has identified other potential ore bodies near the project region that may be developed. Development of these facilities is dependent upon further site investigations by Powertech (USA), as well as the viability of the uranium market. If the ore bodies and markets prove to be favorable, Powertech (USA) may submit applications for permits to develop these additional resources.

2.11 Comparison of the Predicted Environmental Impacts

Table 2.11-1 outlines the predicted environmental impacts of the no-action alternative (Section 2.1) compared to the proposed action (Section 2.2), the process alternatives (2.3.2) mining alternatives (2.4). Potential environmental impacts are discussed in greater detail in Section 4.

Table 2.11-1: Comparison of Environmental and Socioeconomic Impacts based on Proposed Action and Alternatives

Impacts of Operation	Proposed Action	Process Alternatives		Mining Alternatives		No-Action Alternative
		Alternate Lixiviant Chemistry	Alternate Waste Management	Open-pit mining with a conventional mill	Underground mining with a conventional mill	
Land Surface Impacts	Minimal temporary impacts to the well field areas; significant temporary disturbance confined to a small portion of the project Site	Same as Proposed Action	Same as Proposed Action	Significant land disturbance with the potential for portions of the land surface to remain highly altered	Same as the open pit alternative	None
Land Use Impacts	Temporary loss of agricultural production (grazing livestock) and wildlife habitat within the PAA for the duration of the project	Same as Proposed Action	Same as Proposed Action	Land disturbance increases considerably and time required for reclamation is more extensive; Entire site may not return to unrestricted use	Same as the open pit alternative	None
Transportation Impacts	Minimal impact on current traffic levels	Same as Proposed Action	Same as Proposed Action	The traffic volume elevates substantially due to increased employment and vehicle requirements and considerable more opportunity for higher radiation exposure to the public due to transporting of uranium ores over public roads.	Same as the open pit alternative	None
Geology and Soil Impacts	No geologic impacts; temporary impacts to the soils from disturbance; possible impacts to soil from land application of treated wastewater	Same as the Proposed Action	Similar to the Proposed Action with minimal temporary soil impacts in disturbance areas from wind and water erosion	No geologic impacts; more potential land disturbance due to the possibility of long-term open pit mining	Same as the open pit alternative	None
Surface Water Impacts	None	None	None	Possible contamination of surficial water could result with the use of ponds	Possible contamination of surficial water could result with the use of ponds	None
Groundwater Impacts	Slight consumption of ore zone groundwater	Similar to Proposed Action but with increased difficulty in restoring water quality to baseline conditions	Same as the Proposed Action	Ore zone aquifer will be dewatered in order to mine	Ore zone aquifer will be dewatered in order to mine	None

Table 2.11-1: Comparison of Environmental and Socioeconomic Impacts based on Proposed Action and Alternatives (cont'd)

Impacts of Operation	Proposed Action	Process Alternatives		Mining Alternatives		No-Action Alternative
		Alternate Lixiviant Chemistry	Alternate Waste Management	Open-pit mining with a conventional mill	Underground mining with a conventional mill	
Ecological Impacts	Would only disturb ~ 108 (without land application) to 463 (with maximum amount of land application) acres per year over the life of the project with no substantial impact on the ecological or biological diversity (see ER 1.2.3 for details)	Same as the Proposed Action	Same as the Proposed Action	Similar to the Proposed Action, but considerably more time would be required for reclamation	Same as the open pit alternative	None
Air Quality Impacts	An increase of 10 tons per year of particulates due to increased traffic	Same as the Proposed Action	Same as the Proposed Action	Total dust emission would be increased significantly due to increased traffic and crushing and grinding processes	Same as the open pit alternative	None
Noise Impacts	Slight increase over background noise levels	Same as the Proposed Action	Same as the Proposed Action	Significant increase in noise levels due to explosions, excavation' and crushing and grinding of rock	Significant increase in noise levels due to crushing and grinding processes	None
Historical and Cultural Impacts	None	None	None	None	None	None
Visual/Scenic Impacts	Moderate and temporary impact; Well fields and Plants would negatively affect the aesthetics	Same as the Proposed Action	Same as the Proposed Action along with evaporation ponds that would further negatively affect the aesthetics	Large and temporary impact; open pit disturbs much more land area and requires much more heavy machinery that would negatively affect the aesthetics	Large and temporary impact; Mill, tailings pond, and increased use of heavy machinery would negatively affect aesthetics	None
Socioeconomic Impacts	Increased economic impact of $307M and the potential for 436 temporary and permanent jobs for Custer and Fall River Counties and the surrounding area	Same as the Proposed Action	Same as the Proposed Action	Similar to the Proposed Action but with an increase in economic impact and jobs created due to the larger workforce and required operation	Similar to the open pit alternative	Loss of positive economic impact of $307M along with potential for 436 temporary and permanent jobs for Custer and Fall River Counties and the surrounding area
Non-Radiological Health Impacts	None	None	None	None	None	None

Table 2.11-1: Comparison of Environmental and Socioeconomic Impacts based on Proposed Action and Alternatives (concl.)

Impacts of Operation	Proposed Action	Process Alternatives		Mining Alternatives		No-Action Alternative
		Alternate Lixiviant Chemistry	Alternate Waste Management	Open-pit mining with a conventional mill	Underground mining with a conventional mill	
Radiological Health Impacts	Estimated maximum TEDE at proposed project boundary is 12.5 mrem y^{-1} compared to the public dose limit of 100 mrem y^{-1} for the land application option; Estimated maximum TEDE at proposed project boundary is 2.5 mrem y^{-1} for the deep well disposal option.	Same as Proposed Action	Same as Proposed Action	Exposure to radioactive material is significantly increased because 95% of the radium in an ore body is brought to the surface	Same as open pit alternative	None
Waste Management Impacts	Generation of liquid and solid waste for disposal	Same as the Proposed Action, but potentially increased liquid waste due to the mobilization of additional hazardous elements in groundwater	Increased generation of 11e.(2) byproduct material for disposal	Waste generated is much greater than ISL and not all material can be removed from the site (e.g., tailings and waste rock)	Same as open pit alternative	None
Mineral Resource Recovery Impacts	Production of domestic energy resource	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Loss of domestic energy supply source; the current estimated reserves of uranium within the proposed permit area total 7.6 million pounds U_3O_8 currently valued at $456M (based on the spot market price of $60)

3.0 Affected Environment

3.1 Uses of Adjacent Lands

The information in this section provides data relevant to describe the major land uses nears Proposed Action Area (PAA).

The PAA straddles the western county border between Custer and Fall River, South Dakota. Land within the PAA is predominantly privately owned (97.5 percent) and the remaining 2.5 percent is managed by the Bureau of Land Management (BLM). Plate 3.1-1 shows the surface use agreements in the vicinity of the PAA.

3.1.1 Land Use

Land use within the proposed project boundary primarily consists of agriculture related to grazing, as well as hunting and historical mining. A 2.0-kilometer review area is not available for the PAA because the four counties in the study area do not utilize zoning or land use plans outside of urban areas. There is no commercial crop production within the permit area, although approximately 388.79 acres of land are irrigated in Sec. 32, T 6S, R. 1E along Beaver Creek. The majority of agricultural production is related to grazing. Most land serves as grazing land for cattle that are sold as food, as well as a small number of horses.

According to the United States Department of Agriculture's (USDA) 2002 census, Custer County generated $11,536,000 and Fall River County generated $49,003,000 from the sale of livestock, poultry and their products. The results from the 2007 Census will not be available until February 4, 2009. According to the National Agriculture Statistics Service, in 2008 (USDA, 2008) the two counties had a combined total 78,000 head of cattle (No data was available for poultry, pig, or sheep inventories). Table 3.1-1 shows the 2008 livestock inventory for Custer and Fall River Counties.

Table 3.1-1: 2008 Livestock Inventory for Custer and Fall River Counties

Type of Livestock	Number Custer County	Number Fall River County	Percent of Total (Custer and Fall River combined)
Beef Cows	17,000	45,000	22/58%
All Cattle and Calves – excluding Beef Cows	1,000	15,000	1/19%
Sheep and Lamb	N/A	N/A	N/A
Hogs and Pigs	N/A	N/A	N/A
Total Animals	18,000	60,000	100%

Source: USDA 2008.

Recreation lands are present in Custer, Fall River and Pennington counties within a 50-mile radius of the PAA (Table 3.1-2). Major attractions include Mount Rushmore National Memorial and Wind Cave National Park which are set in the backdrop of the Black Hill National Forest. Within the PAA or within the surrounding 2.0 kilometers there are no recreation lands present because most of the land is private with a small portion (240 acres) belonging to the BLM.

Recreational use within the PAA is limited primarily to large game hunting. Within the PAA, hunting is currently open to the public on approximately 5,689 acres. Approximately 240 acres are owned by the Bureau of Land Management (BLM); the South Dakota Game Fish and Parks (SDGFP) lease around 3,069 acres annually of privately owned land and currently designate this acreage as walk-in hunting areas.

Table 3.1-2: Recreational Areas within 50 Miles of the PAA

Name of Recreational Facility	Managing Agency	Distance From PAA (miles)
Mount Rushmore National Memorial	U.S. Department of the Interior	44.0
Jewel Cave National Monument	U.S. Department of the Interior	23.0
Buffalo Gap National Grassland	U.S. Forest Service	3.0
Custer State Park	South Dakota Department of Game, Fish and Parks	35.0
Wind Cave National Park	U.S. Department of the Interior	29.0
Black Hills National Forest	U.S. Forest Service	0.25
Angostura State Recreation Area	South Dakota Department of Game, Fish and Parks	29.0
George S. Mickelson Trail	South Dakota Department of Game, Fish and Parks	17.0

Source: Google Earth (20 June, 2008)

Table 3.1-3 lists the distance to the nearest resident from the PAA according to 22.5-degree sectors centered on the 16 cardinal compass points. The nearest resident is 0.9 miles to the west south-west of the PAA.

Table 3.1-3: Distance to Nearest Resident from the Center of the Proposed Project

Sector	Distance from Project Center	
	Miles	Km
N	7.2	11.6
NNE	8.3	13.3
NE	6.7	10.8
ENE	13.1	21.1
E	6.8	11.0
ESE	10.7	17.3
SE	7.5	12.1
SSE	5.9	9.4
S	0.9	1.4
SSW	3.4	5.5
SW	21.0	33.7
WSW	1.7	2.7
W	20.3	32.6
WNW	6.2	10.0
NW	3.5	5.6
NNW	4.2	6.7

Data from US Census Bureau, 2000 Census

3.1.1.1 Aesthetics

The PAA is located within the Great Plains physiographic province on the edge of the Black Hills Uplift. The vegetation is a mix of short grasses and shrubs typical of semi-arid steppe land along with Ponderosa Pine forest toward the Black Hills. The color of the landscape varies from light brown and green to dark green with wildflowers in the springtime to light brown to golden during the later drier months. The human influence on the area is minor with most of the area being used for grazing activities and associated facilities (e.g., fences and stock wells). The area's infrastructure includes the Burlington Northern Rail Road (BNRR) that runs north through Edgemont towards Newcastle, Country Road 6463 that parallels the BNRR to the town of Dewey and overhead electricity lines and several gravel access roads.

3.1.1.2 Transportation and Utilities

The PAA generally will be accessed north from Edgemont along County Road 9. To the east U.S. Highway 18 connects Edgemont with Hot Springs and to the north State Highway 89

connects Edgemont with Custer City. Annual Average Daily Traffic (AADT) counts on U.S. Highway 18 between Edgemont and the junction with State Highway 89 is 2,000 vehicles (SDDOT 2007). The AADT count on State Highway 89 between Custer City and the junction with U.S Highway 18 is 515 vehicles (SDDOT 2007).

3.1.1.3 Fuel Cycle Facilities

The NRC provides a list of all of the source material facilities operating in the United States which include uranium mills and fuel cycle facilities. According to the NRC website there are no fuel cycle facilities within 50 miles of the PAA. The closest fuel cycle facility is the AREVA NP, Inc. uranium fuel fabrication in Richland, Washington. Also in Eunice, New Mexico the Louisiana Energy Services fuel cycle facility is currently under construction (NRC, 2008).

There are no Resource Material Licenses for in situ uranium projects within 50 miles of the PAA. The nearest operational in situ facility is the Crow Butte ISL facility, SUA-1534, in Darrow County, near Crawford, Nebraska (NRC, 2008).

3.2 Transportation

3.2.1 Highways

The main highway that will be used to access the proposed project site is U.S. Highway 18, which connects Edgemont with Hot Springs, and highways U.S. 385 and S.D. 79 to the east, which connect to U.S. Highway 85 to the west of the PAA in the State of Wyoming.

3.2.2 Railroads

The Burlington Northern Santa Fe Railroad (BNSF) runs through the proposed PAA in a northwest-southeast direction. The BNSF is used for shipping coal from mining operations in the Powder River Basin of Wyoming and Montana. It is also used to transport many other agricultural, consumer, and industrial products. Powertech (USA) does not anticipate using the BNSF as a transportation option for any of the proposed project operations.

3.3 Geology, Soils, and Seismology

Proposed action is located in the Great Plains Physiographic province on the southwestern flank of the Black Hills uplift in southwestern South Dakota. To the west of the PAA is the Powder River Basin of Wyoming. The regional geologic map of this region is shown in Figure 3.3-1.

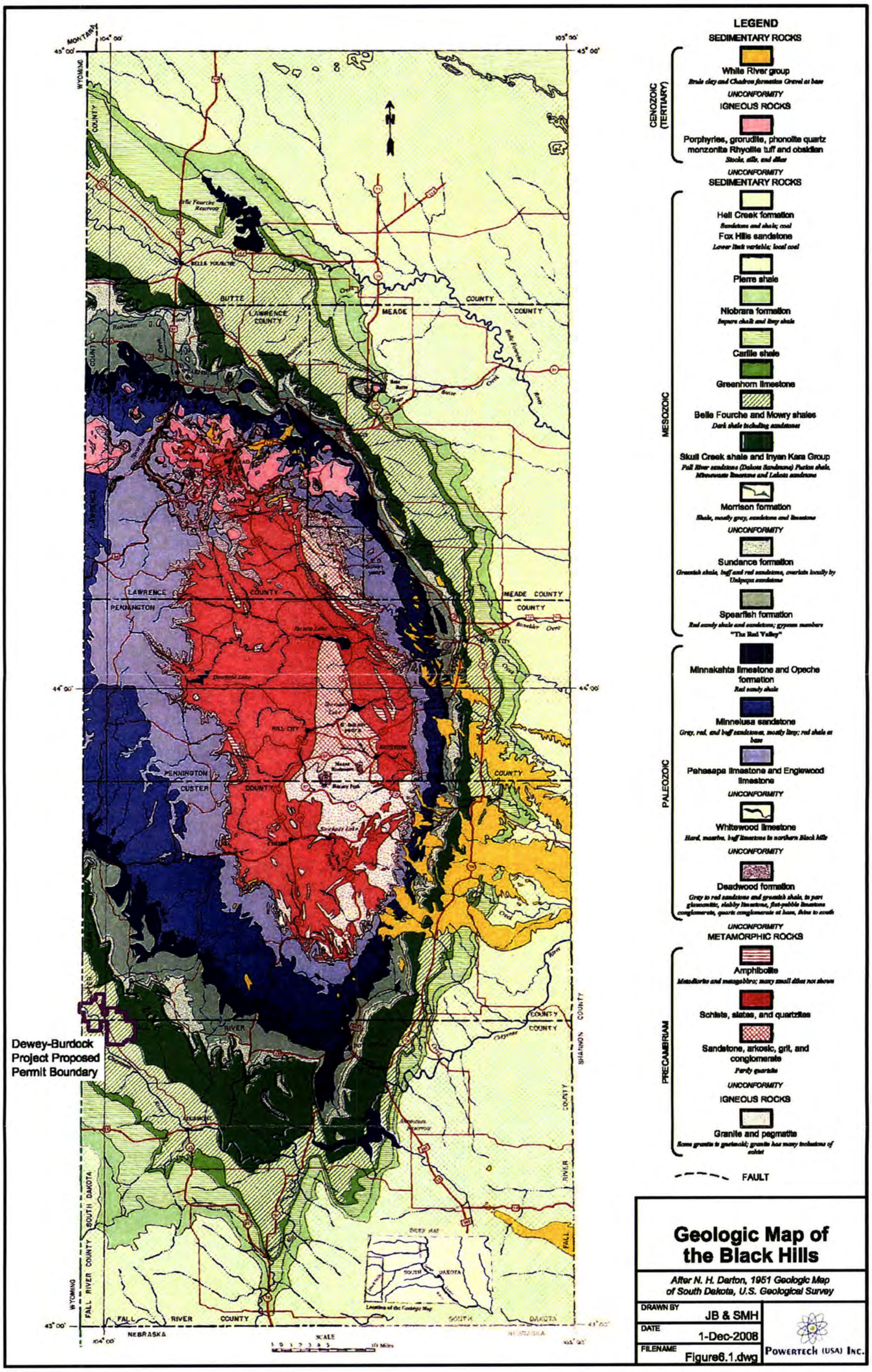


Figure 3.3-1: Geologic Map of the Black Hills

3.3.1.1 Regional Structure

The dominant structural feature in this region is the Black Hills Uplift. This uplift is of Laramide age (65 million years ago) and is an elongate northwest trending dome about 125 miles long and 60 miles wide. Igneous and metamorphic Precambrian-age rocks are exposed in the core of the uplift and are surrounded by outward-dipping Paleozoic and Mesozoic rocks that form cuestas and hogbacks around the core of the uplift. Folds constitute the major structural features in the Black Hills. In early Cretaceous time minor deformation along concealed northeast trending structures of Precambrian age affected the courses of the northwest flowing streams and their tributaries, thereby influencing the location of the fluvial sandstone deposits of the Inyan Kara Group.

3.3.1.2 Regional Stratigraphy

The oldest rocks in the region are Precambrian metamorphic rocks and granites. These form the core of the Black Hills Uplift and are exposed at the surfaced of this structural feature. Overlying these crystalline rocks are 2000-3000 feet of Paleozoic sediments. This sedimentary sequence contains several regional aquifers, to include the Deadwood Formation of Cambrian age, the Mississippian Madison Limestone and the Pennsylvanian/Permian-age Minnelusa Formation. See Figure 3.3-2 for a stratigraphic column of the Black Hills.

ERATHEM	SYSTEM	ABBREVIATION FOR STRATIGRAPHIC INTERVAL	STRATIGRAPHIC UNIT	THICKNESS IN FEET	DESCRIPTION
CENOZOIC	QUATERNARY & TERTIARY (?)	QTac	UNDIFFERENTIATED ALLUVIUM AND COLLUVIUM	0-50	Sand, gravel, boulder, and clay.
		Tw	WHITE RIVER GROUP	0-300	Light colored clays with sandstone channel fillings and local limestone lenses.
	TERTIARY	Tui	INTRUSIVE IGNEOUS ROCKS	–	Includes rhyolite, latite, trachyte, and phonolite
MESOZOIC	CRETACEOUS	Kps	PIERRE SHALE	1,200-2,700	Principal horizon of limestone lenses giving teepee buttes. Dark-gray shale containing scattered concretions. Widely scattered limestone masses, giving small teepee buttes. Black fissile shale with concretions.
			NIOBRARA FORMATION	[1]80-300	Impure chalk and calcareous shale.
			CARLILE SHALE — Turner Sandy Member, Wall Creek Member	[1]350-750	Light-gray shale with numerous large concretions and sandy layers. Dark-gray shale
			GREENHORN FORMATION	225-380	Impure slabby limestone. Weathers buff. Dark-gray calcareous shale, with thin Orman Lake limestone at base.
			GRANEROS GROUP: BELLE FOURCHE SHALE	150-850	Gray shale with scattered limestone concretions. Clay spur bentonite at base.
			GRANEROS GROUP: MOWRY SHALE	125-230	Light-gray siliceous shale. Fish scales and thin layers of bentonite.
			GRANEROS GROUP: MUDDY SANDSTONE / NEWCASTLE SANDSTONE	0-150	Brown to light-yellow and white sandstone.
			GRANEROS GROUP: SKULL CREEK SHALE	150-270	Dark-gray to black siliceous shale.
		Kik	INYAN KARA GROUP: FALL RIVER FORMATION	10-200	Massive to thin-bedded, brown to reddish-brown sandstone.
			INYAN KARA GROUP: LAKOTA FM — Fuson Shale Minnewaste Limestone Chilson Member	10-190 0-25 25-485	Yellow, brown, and reddish brown massive to thinly bedded sandstone, pebble conglomerate, siltstone, and claystone. Local fine-grained limestone and coal.
	JURASSIC	Ju	MORRISON FORMATION	0-220	Green to maroon shale. Thin sandstone.
			UNKPAPA SS	0-225	Massive fine-grained sandstone.
			SUNDANCE FORMATION — Redwater Member, Lak Member, Hulett Member, Stockade Beaver Mem., Canyon Spr Member	250-450	Greenish-gray shale, thin limestone lenses. Glauconitic sandstone; red sandstone near middle.
			GYPSUM SPRING FORMATION	0-45	Red siltstone, gypsum, and limestone.
	TRIASSIC	TRPs	SPEARFISH FORMATION — Goose Egg Equivalent	375-800	Red silty shale, soft red sandstone and siltstone with gypsum and thin limestone layers. Gypsum locally near the base.
PALEOZOIC	PERMIAN	Pmk	MINNEKAHTA LIMESTONE	[1]25-65	Thin to medium-bedded, fine-grained, purplish gray laminated limestone.
		Po	OPECHE SHALE	[1]25-150	Red shale and sandstone.
	PERMIAN / PENNSYLVANIAN	PIPm	MINNELUSA FORMATION	[1]375-1,175	Yellow to red cross-bedded sandstone, limestone, and anhydrite locally at top. Interbedded sandstone, limestone, dolomite, shale, and anhydrite. Red shale with interbedded limestone and sandstone at base.
	MISSISSIPPIAN	MDme	MADISON (PAHASAPA) LIMESTONE	[1]200-1,000	Massive light-colored limestone. Dolomite in part. Cavernous in upper part.
	DEVONIAN		ENGLEWOOD FORMATION	30-60	Pink to buff limestone. Shale locally at base.
	ORDOVICIAN	Ou	WHITEWOOD (RED RIVER) FORMATION	[1]0-235	Buff dolomite and limestone.
			WINNIPEG FORMATION	[1]0-150	Green shale with siltstone.
	CAMBRIAN	OЄd	DEADWOOD FORMATION	[1]0-500	Massive to thin-bedded buff to purple sandstone. Greenish glauconitic shale flaggy dolomite and flat-pebble limestone conglomerate. Sandstone, with conglomerate locally at the base.
PRECAMBRIAN		pЄu	UNDIFFERENTIATED IGNEOUS AND METAMORPHIC ROCKS		Schist, slate, quartzite, and arkosic grit. Intruded by diorite, metamorphosed to amphibolite, and by granite and pegmatite.

[1]Modified based on drill-hole data

STRATIGRAPHIC COLUMN OF THE BLACK HILLS AREA
(from Driscoll et al.)

DEWEY-BURDOCK PROJECT

DRAWN	L. Tafoya
DATE	12-Nov-2008
SCALE	NONE
FILENAME	Figure 6.7.dwg

POWERTECH (USA) INC.

Figure 3.3-2: Stratigraphic Column of the Black Hills Area

Mesozoic sediments include the Triassic age Spearfish Formation and the Sundance, Unkpapa and Morrison Formations of Jurassic age. The Sundance Formation is a minor aquifer in the southern Black Hills region. A thick sequence of Cretaceous age sediments completes the Mesozoic section.

The Early Cretaceous sediments of the Inyan Kara Group consist of the Lakota Formation and the Fall River Formation and is a transitional unit, exhibiting a change from terrestrial to marine deposition. The basal Lakota Formation (Chilson Member) is a fluvial sequence, which grades upward into marginal marine sediments as the Cretaceous Seaway inundated a stable land surface. Basal units of the Lakota Formation scour into clays of the underlying Morrison Formation and display the depositional nature of a large braided stream system, crossing a broad, flat coastal plain and flowing toward the northwest. Younger fluvial sand units of the Lakota become progressively thinner and less continuous and are separated by thin deposits of overbank and flood plain silts and clays. At the top of the Lakota is the Fuson Member. The Fuson consists of shale with minor beds of fine grained sandstone and siltstone. The Fuson separates the underlying Lakota Formation from the overlying Fall River Formation. The Fall River consists of thick, widespread fluvial sands in the lower portion, grading to thinner, less continuous, marginal sands in the upper part. The Cretaceous Lakota and Fall River Formations are the hosts of the roll front uranium mineralization in the Black Hills region.

Following deposition of the Fall River, this region was covered by the North American Cretaceous Seaway, which resulted in the accumulation of vast thicknesses of marine sediments. From 3000-5000 feet of these marine sediments are represented by the Skull Creek Shale, Newcastle Sandstone, Mowry Shale, Belle Fourche Shale, Greenhorn Formation, Carlisle Shale, Niobrara Formation and Pierre Shale. In Late Cretaceous time, the modern Rocky Mountain Uplift began, forcing the retreat of the Cretaceous seaway.

Unconformably overlying the Cretaceous sediments in the Black Hills region is the Tertiary-age (Oligocene) tuffaceous White River Formation. This thick, tuffaceous sequence was the result of volcanic eruptions to the west and was rich in volcanic fragments. The White River sediments have primarily been removed by erosion and can be found only as erosional remnants. This unit is thought to be the source of the uranium deposits found in the Black Hills region and the Powder River Basin of Wyoming.

The most recent sediments in the region are Quaternary-age deposits consisting of local material derived as a result of post-Laramide-uplift erosion. Recent deposits include alluvium and floodplain terrace deposits.

3.3.2 PAA Geology

The PAA geology is shown in Figure 3.3-3. The Fall River Formation outcrops across the eastern part of the PAA and the Skull Creek Shale and Mowry Shale outcrops across the western part of the PAA. The formations dip west and southwest at 2 to 6 degrees.

The geology of the Proposed Action was developed through the interpretation of data gathered from thousands of exploration drill holes. For each drill hole there was a suite of down-hole electric logs run to characterize natural radioactivity and the lithology (rock type) of the sediments in the subsurface. Resistivity and Self Potential provide the rock types encountered in the subsurface (sandstone, siltstone, shale, etc.). This is further enhanced by a geologist's description of the drill cuttings. Plate 3.3-1 is an example of a "type log" from PAA.

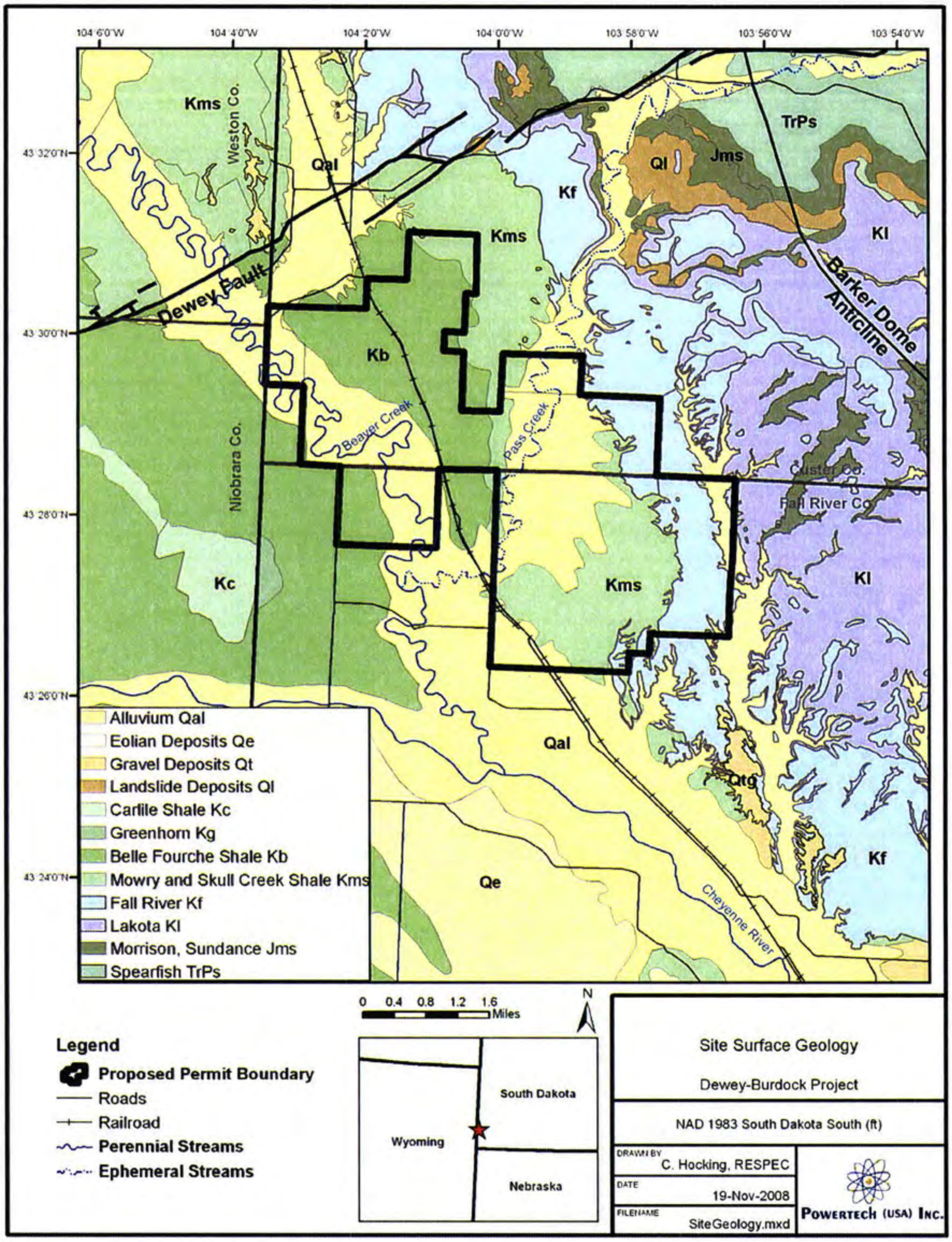


Figure 3.3-3: Site Surface Geology

3.3.2.1 Site Structure

The structure across the PAA is simple and shows sediments dipping gently 2 to 6 degrees to the southwest. This is illustrated by a structure contour maps on the tops of the Fall River Formation (Plates 3.3-2), the Chilson Member of the Lakota Formation (Plates 3.3-3) and the Unkpapa Formation (Plate 3.3-4).

The Dewey Fault, a northeast to southwest trending fault zone, is present approximately one mile north of the north and northwest parts of the PAA. The Dewey Fault is a steeply dipping to vertical normal fault with the north side uplifted approximately 500 feet by a combination of displacement and drag. The United States Geological Survey (USGS) considers an area 7 miles southeast of the PAA as the Long Mountain Structural Zone. This northeast – southwest trend contains several small shallow surface faults in the Inyan Kara. No faults show up along this trend on subsurface structure maps of the underlying Madison Formation, Minnelusa Formation or the Deadwood Formation. Despite the presence of faulting north and south of the site, there are no identified faults within the PAA.

There is some folding in the areas surrounding the Dewey-Burdock Project. East of the PAA is a northwest – southeast trending anticline that ends in a closed structure called the Barker Dome. To the west is the Fanny Peak Monocline. This monocline is the structural boundary between the Black Hills and the Powder River Basin.

3.3.2.2 Site Stratigraphy

The sedimentary rocks of primary interest that underlie the PAA range in age from Upper Jurassic to Early Cretaceous. The Upper Jurassic Morrison Formation is considered to be the Lower Confining Unit for the Proposed Action. The uranium mineralization is contained within the Inyan Kara Group (Lakota and Fall River Formations). The Skull Creek Shale is the Upper Confining Unit. Plate 3.3-5 is a generalized cross section of the PAA, illustrating the relationship between these sedimentary units, as well as their position to underlying rocks, ranging in age from Jurassic to Precambrian.

The following is a brief description of the formations of interest at Dewey-Burdock:

Morrison Formation - The Upper Jurassic Morrison Formation was deposited as flood plain deposits. It is composed of waxy, unctuous, calcareous, noncarbonaceous massive shale with numerous limestone lenses and a few thin fine grained sandstones. Below the site, this formation

has an average thickness of approximately 100 feet and is the Lower Confining Unit for Proposed Action. Analyses of core samples demonstrate that the Morrison clays have extremely low vertical permeabilities, ranging from 3.9 x 10^{-9} centimeters per second (cm/sec) to 4.2 x 10^{-8} cm/sec (0.004 millidarcies to 0.043 millidarcies).

Inyan Kara Group – This Group consists of the Lakota Formation and the Fall River Formation. Sandstones within these two formations are hosts to all the uranium mineralization for the Proposed Action.

Lakota Formation – The Lakota Formation consists of three members; from lower to upper are the Chilson Member, the Minnewasta Limestone Member and the Fuson Member.

<u>The Minnewasta Limestone Member</u> is not present in the PAA.

<u>The Chilson Member</u> (commonly referred to as the Lakota Sandstone) is composed largely of fluvial deposits. These deposits consist of sandstone, shale, siltstone, and shale. The member consists of a complex of channel sandstone deposits and their laterally fine-grained equivalents. The Chilson Member consists of two units: a basal carbonaceous black mudstone and an overlying unit of channel sandstones with laterally fine-grained equivalents and interbedded shales. The sandstones are very fine to medium-grained and well sorted and were deposited by a northwest flowing river system. Analyses of core samples of these sandstones indicate these units exhibit high horizontal permeabilities, ranging from 2.6 x 10^{-3} cm/sec to 4.1 x 10^{-3} cm/sec (2697 millidarcies to 4161 millidarcies). The massive sandstone is made up of numerous individual sand filled channels, which contain the uranium deposits.

The isopach map of the Chilson Member of the Lakota Formation shows the thickness of the channel sandstones and interbedded shales within the Chilson Member. Thicknesses vary from 100 to 240 feet. This isopach map may not adequately show the total thickness of the Chilson Member because drilling usually did not penetrate its entire extent. Drilling was usually stopped in the lower carbonaceous shale unit of the Chilson Member and did not reach the Morrison Formation. (Plate 3.3-6).

<u>The Fuson Member</u> is the upper most member of the Lakota Formation and the shale-siltstone portion of the Fuson has been used to divide the Lakota Formation from the Fall River Formation. Analyses of core samples of these lithologies demonstrate low vertical permeabilities, ranging from 7.8 x 10^{-9} cm/sec to 2.2 x 10^{-7} cm/sec (0.008 millidarcies to 0.228 millidarcies).

The Fuson Member is described as having a lower discontinuous sandstone unit at its base and an upper discontinuous sandstone at the top of the member. If present the lower sandstone unit was mapped as Lakota sandstone. Similarly if the upper sandstone was present it was mapped as Fall River sandstone. The isopach map of the Fuson Member shows the thickness of the shale – siltstone unit ranging from 30 to 80 feet. It shows thinning of the shale under the overlying channel sandstones of the Fall River Formation. (Plate 3.3-7).

Fall River Formation - The Fall River formation is composed of carbonaceous interbedded siltstone and sandstone, channel sandstones, and a sequence of interbedded sandstone and shale. The lower part of the Fall River consists of dark carbonaceous siltstone interbedded with thin laminations of fine-grained sandstone. Channels were cut into this interbedded sequence by northwest flowing rivers and fluvial sandstones were deposited. These channel sandstones occur across various parts of the Proposed Action and generally contain the uranium deposits. Overlying the channel sandstones is another sequence of alternating sandstone and shales. The sandstones are cross-bedded to massive, fine to medium-grained, and well-sorted.

The isopach map of the Fall River Formation shows a range of thickness of 120 to 160 feet. The thickening of the formation indicates the presence channel sandstones. Along the northeastern portion of the PAA, this formation is exposed on the surface and erosion has taken place (Plate 3.3-8).

Skull Creek Shale - The Skull Creek Shale directly overlies the Fall River Formation and consists of dark-grey to black shale, organic material, and some silt sized quartz grains. The Skull Creek Shale has a thickness of approximately 200 feet and is the Upper Confining Unit for the Proposed Action. Analyses of core samples demonstrate that the Skull Creek clays have extremely low vertical permeabilities, in the range of 6.8×10^{-9} cm/sec (0.007 millidarcies). The Skull Creek Shale is eroded from the eastern parts of the Proposed Action.

Mowry Shale – At the Proposed Action, the Skull Creek Shale is directly overlain by the Mowry shale and is also considered to be part of the Upper Confining Unit. Normally, the Newcastle Sandstone is present between the Skull Creek Shale and the Mowry Shale, but is absent across the PAA. The Mowry Shale consists of light gray marine shale with minor amounts of siltstone, fine grained sandstone, and a few thin beds of bentonite. Dark-gray to purple and black iron and manganese concretionary zones are common within the shale. The combined Skull Creek Shale – Mowry Shale reaches a thickness of 400 feet in the western part of the Proposed Action. Plate

3.3-9 is an isopach map showing the combined thickness of these two shale units. In the northeastern portion of the PAA, these units outcrop and have been eroded.

Terrace Deposits - Along the sides of drainages are relatively flat terrace deposits representing floodplains and former levels of streams. The terraces are primarily overbank deposits of clay and silt with gravel beds. Gravel deposits consist of boulders and pebbles of chert, sandstone, and limestone.

Alluvium - The most recent sedimentary units deposited within the PAA are the Quaternary age alluvium deposits. Alluvium is present in the major drainages and their tributaries. The alluvium consists of silt, clay sand and gravel.

Four site cross sections, based on exploration logs, were developed along each ore body to illustrate the relationship between mineralized Inyan Kara sands and their confining units. Plate 3.3-10 shows the locations of the four cross sections. The cross sections were generated in the MVS model and were hung on the elevation of each drill hole. Traces of electric logs of exploration holes were overlain on these cross sections to illustrate the data sources used in the preparation of these sections. Cross sections A-A'', F-F', H-H''', and J-J' show the Proposed Action stratigraphy and mineralization across the PAA and are presented in Plates 3.3-11, 3.3-12, 3.3-13, and 3.3-14. The Skull Creek Shale thickens from the east to the west. The Fall River Formation is continuous across the area and dips to the west. The Fuson Member of the Lakota thickens and thins across the area. The Chilson Member of the Lakota is continuous across the area and thickens and thins due to channeling. The uranium mineralization in the Fall River occurs in the lower sandstone unit. The mineralized sands in the Chilson Member of the Lakota occur within individual sandstone lenses or channels.

3.3.3 Ore Mineralogy and Geochemistry

Uranium deposits within the Proposed Action are classic, sandstone, roll-front type deposits, similar to those in Wyoming and Texas. These type deposits are usually "C" shaped in cross section, with the concave side of the deposit extending up-dip, toward the outcrop. Roll-front deposits are a few tens of feet-to-100 or more-feet wide and often thousands of feet long. Uranium minerals were emplaced in these deposits after migrating down gradient from the surface in oxygenated groundwater and precipitating in the subsurface upon encountering a reducing environment at depth. These roll-front deposits are centered at and follow the interface of naturally-occurring chemical boundaries between oxidized and reduced sands. Reducing

conditions are the result of a reductant in the sands these can be from organic material or from H_2s or methane in the host sands.

There is a geochemical "footprint" associated with these roll-front deposits, resulting from the passage of oxygenated groundwater through subsurface sands. The typical alteration pattern associated with these oxidizing solutions consists of limonitic and hematitic staining of the sandstones. This is due to the alteration of naturally-occurring iron rich minerals (valence state of Fe^{+2}) to iron oxides (valence state of Fe^{+3}). On outcrop, most of the sandstones of the Inyan Kara Group exhibit trace to pervasive limonite staining of various shades of yellow and orange. Red hematite staining is less common and occurs as scattered streaks in most outcrops. Generally, the more porous and thicker the sandstone, the more pronounced the alteration. Reduced or unaltered sands have a medium to dark grey color. Alteration within the host sands has been mapped for distances of over 12 miles within the sandstones of the Inyan Kara Group in the PAA.

The primary uranium minerals in the Proposed Action deposits are very fine-grained, opaque pitchblende and coffinite. This mineralization occurs as sand grain coatings in the host sand, and marginal to or as replacement of pyrite grains.

Mineralized sands within the Proposed Action occur at depths of less than 100 feet in the outcrop area of Fall River Formation and at depths of up to 800 feet in the Lakota in the northwest part of the Proposed Action. This mineralization occurs in three sandstones in the Fall River Formation and within six sandstones of the Lakota Formation. The uranium mineralization occurs along a large "U" shaped trend that is 5 miles long and 3 to 4 miles wide. The average thickness of this mineralization has been calculated to be 6.1feet and the average grade is 0.21 percent U_3O_8.

In 1988 in a Thesis for a Master of Science in Geology degree, Bonnie Janine Blake used scanning x-ray fluorescence supplemented by standard x-ray fluorescence, x-ray diffraction, electron microprobe, scanning electron microscopy, and atomic absorption to study core samples from the Burdock ore body. She did not identify any uranium or vanadium minerals but concluded that the uranium was in an amorphous or poorly-crystalline form or was associated with the clays or carbonaceous material. Bonnie Blake noted "quartz grains illustrated layered clay coatings in the paragenetic sequence of a smectite partially covered by kaolinite with remnants of possible illite on the kaolinite. The smectite coatings showed isolated concentrations of uranium and vanadium." This is to be expected where uranium cation exchanges with the clays. The uranium mineralization is probably uranphane and coffinite.

3.3.4 Historic Uranium Exploration Activities

Uranium was first discovered in the Edgemont District in 1951 by professors from the South Dakota Scholl of Mines and Technology. They mined about 500 pounds of ore and hauled it to Grand Junction, Colorado. The Atomic Energy Commission (AEC) announcement of a new district at Edgemont led to a boom of stacking, mining, and dealing in the summer of 1952. By 1953 the AEC had built a buying station in Edgemont. In July 1956 a 250-ton per-day mill went on stream and soon expanded to a 500-ton-per-day. In 1960 a vanadium circuit was added. Production from the Edgemont District (open pits in the Fall River), some mines in the Powder River basin and several mines in the Northern Black Hills continued until 1972. Susquehanna Western Inc. (SWI) bought the Edgemont mill and took control of the mines in the Edgemont District. Until the late 1960's early 1970's they were the only company active in the Edgemont District.

In 1967, Homestake Mining Company began exploration in the Dewey area. In 1974, Wyoming Mineral Corporation (WMC) (Westinghouse) acquired the Dewey properties from Homestake. In 1974, TVA bought out the mill and mines from SWI. The mill was shut down, but exploration continued. Besides WMC and TVA, other companies exploring in the district were Union Carbide, Federal Resources, and Kerr McGee. TVA acquired the Dewey Project from WMC in 1978 and continued exploration until 1986. In total, over 4000 exploration drill holes were completed on this project.

In 1981 TVA completed a mine feasibility study on the Dewey Burdock deposits. A preliminary EIS was also prepared for an underground mine at the Burdock area. Due to falling uranium prices the Dewey Burdock leases was allowed to expire. In 1992 Energy Fuels Nuclear (EFN) acquired the leases and data on the Proposed Action. Their intention was to mine the uranium deposits by ISL. EFN did no additional exploration drilling on the Proposed Action. In 2000 EFN dropped the leases.

In 2005 Denver Uranium, LLC acquired the leases and claims covering the Dewey Burdock ore bodies. The following year, these properties were transferred to Powertech (USA), Inc. Since the spring of 2007, Powertech (USA) has drilled approximately 115 exploration holes, including 20 monitoring wells on the Proposed Action. Both the historic and recent drill holes have helped to generate the geologic mode and delineate the extent of the mineralized sands. Figure 3.3-4 is a map showing the location of all known drill holes. Appendix 3.3-A includes a table summarizing all historic exploration drilling.

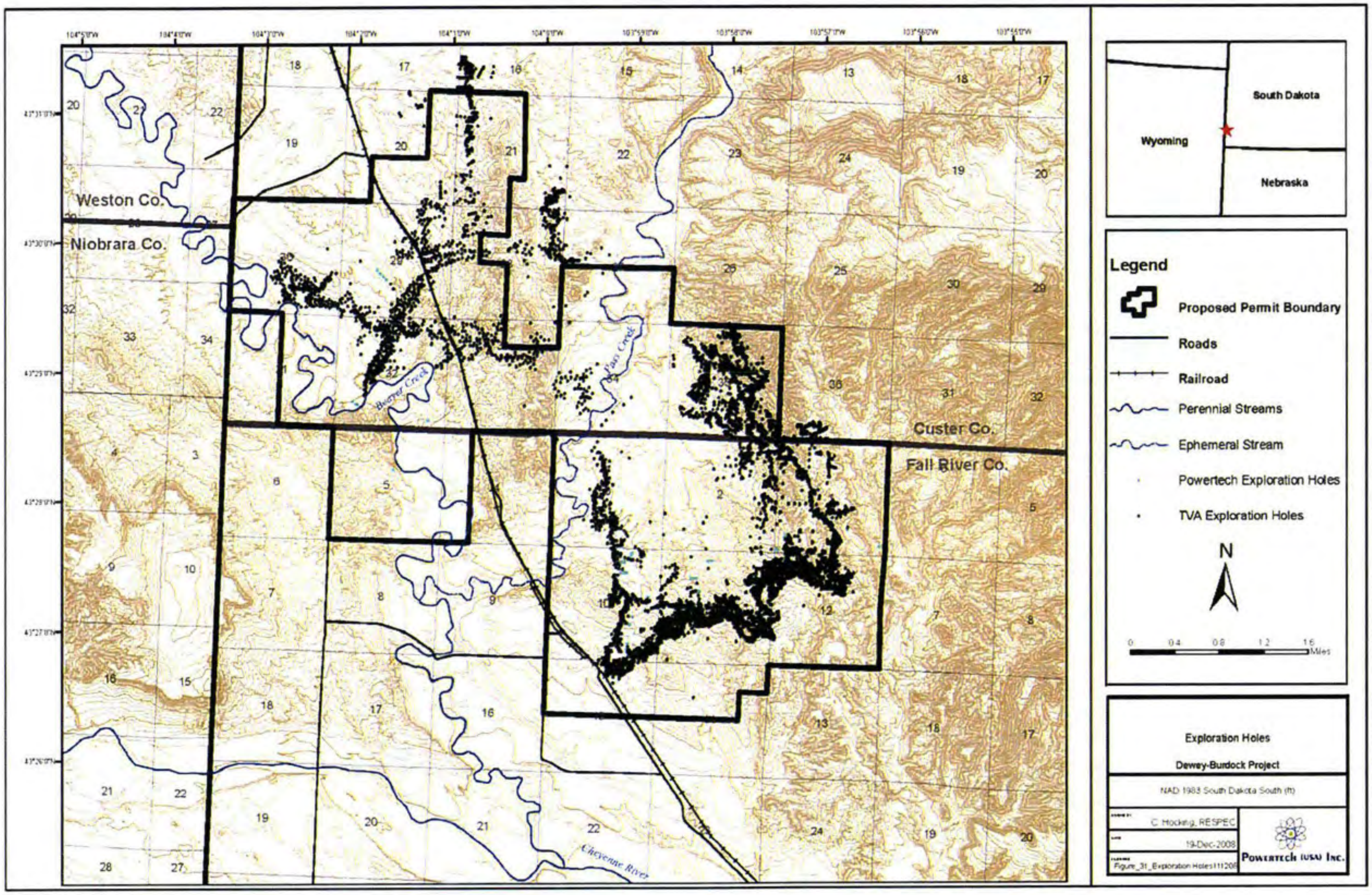


Figure 3.3-4: Location of all Known Exploration Drill Holes within the Proposed Project Site

3.3.5 Soils

Powertech (USA) conducted baseline soil sampling and mapping covering an estimated 7,964.26 acres as shown on Plate 3.3-15.

Stripping depths for the PAA were evaluated during mapping and sampling. Soil depths within a given mapping unit will vary based on any combination of the five primary soil forming factors, i.e., climate including effective precipitation, organisms, relief or topography, parent material, and time. Subtle differences in any one of the previously mentioned factors will impact development between series and within series designation but may not be as noticeable as when topography is a major factor. The proposed topsoil salvage depths are based on laboratory data of the samples found within the borders of the area, as well as field observations and knowledge of the soils in Custer and Fall River Counties, South Dakota.

Soils in the PAA are typical for semi-arid grasslands and shrublands in the Western United States. Parent material included colluvium, residuum, and alluvium. Most soils are classified taxonomically as Aridic Argiustolls, Aridic Ustorthents, and Aridic Haplusterts. Almost all soils have some suitable topsoil. The primary limiting factors within the PAA are EC-electrical conductivity, SAR-sodium adsorption ratio, calcium carbonates, and texture (clay percentage).

Refer to Appendix 3.3-B for the Soil Mapping Unit Descriptions. Refer to Appendix 3.3-C for the Soil Series Descriptions. Refer to Appendix 3.3-D for the Original Laboratory Data Sheets. Refer to Appendix 3.3-E for the Prime Farmland Designation. Refer to Appendix 3.3-F for the Site Photographs.

3.3.5.1 Methodology

3.3.5.1.1 Review of Existing Literature

The soils in this portion of Custer and Fall River Counties were studied and mapped to an Order 2 scale by the USDA, NRCS in 1982 and 1990. Information for Custer and Fall River Counties is available electronically as well as hard copy. The NRCS has also centralized dissemination of typical soil series descriptions; general information is available on the internet at www.nrcs.usda.gov.

3.3.5.1.2 Project Participants

BKS performed the 2007 soil survey field work and compiled the resulting report. All soil analysis was handled by Energy Labs in Gillette, Wyoming.

3.3.5.1.3 Soil Survey

Construction of the PAA soil map was completed according to techniques and procedures of the National Cooperative Soil Survey. Guideline No. 1 (August, 1994 Revision) of the WDEQ-LQD was followed during all phases of the work.

A total of 7,960.77 acres were included in the final soil mapping of the PAA, in which 3,065.74 of those acres were located in disturbance areas. Refer to Table 3.3-1 for soil mapping unit designations and associated acreage within the PAA. Table 3.3-1 also describes the soil map units in terms of actual map designations and slope percentages.

Table 3.3-1: PAA Soil Mapping Unit Acreages

Map Symbol	Map Unit Description	Permit Acreage	Disturbance Areas	% Total PAA
Aa	Alice, 0 to 6 percent slopes	36.99	0	0
Ar	Arvada, 0 to 6 percent slopes	258.3	121.78	3.97
As	Ascalon, 0 to 6 percent slopes	27.42	41.22	1.35
Bc	Barnum, 0 to 6 percent slopes	484.09	13.01	0.42
Bo	Boneek, 0 to 6 percent slopes	51.53	0	0
Br	Broadhurst, 6 to 15 percent slopes	60.22	190.74	6.22
Bw	Butche, 6 to 40 percent slopes	234.53	25.42	0.83
Cn	Colby, 6 to 15 percent slopes	72.2	0	0
Cy	Cushman, 6 to 15 percent slopes	110.06	12.26	0.40
Dg	Demar, 0 to 6 percent slopes	509.39	134.26	4.38
DA	Disturbed-Ag	196.05	41.36	1.35
GrA	Grummit, 0 to 6 percent slopes	250.81	37.85	1.24
GrB	Grummit, 6 to 15 percent slopes	632.43	369.1	12.04
GrC	Grummit, 15 to 60 percent slopes	550.67	48.43	1.58
Ha	Haverson, 0 to 6 percent slopes	233.1	0	0
He	Hisle, 0 to 6 percent slopes	307.65	54.52	1.78
Ky	Kyle, 0 to 6 percent slopes	471.39	333.96	10.89
Lo	Lohmiller, 0 to 6 percent slopes	38.06	5.66	0.19
Mm	Mathias, 15 to 40 percent slopes	331.62	34.08	1.11
MP	Mine Pit	340.48	18.31	0.60
Nf	Nihill, 15 to 50 percent slopes	11.36	25.61	0.84
No	Norka, 0 to 6 percent slopes	85.07	0	0
NuA	Nunn, 0 to 6 percent slopes	28.54	41.22	1.35
NuB	Nunn, 6 to 15 percent slopes	17.45	0	0
Pa	Paunsaugunt, 6 to 15 percent slopes	0.86	0	0
Pg	Penrose, 15 to 40 percent slopes	210.76	231.08	7.54
PeA	Pierre, 0 to 6 percent slopes	479.11	216.03	7.05
PeB	Pierre, 6 to 15 percent slopes	470.36	157.99	5.15
RO	Rock Outcrop	126.91	17.42	0.57
Sa	Samsil, 15 to 40 percent slopes	249.01	515.29	16.81
Sc	Satanta, 0 to 6 percent slopes	32.28	0	0
Sn	Shingle, 15 to 40 percent slopes	86.75	11.66	0.38
SS	Slickspots	536.39	148.77	4.85
Gs	Snomo, 6 to 15 percent slopes	179.92	106.06	3.46
Ta	Tillford, 0 to 6 percent slopes	171.69	7.84	0.26
W	Water	32.77	72.5	2.37
Wt	Winetti, 0 to 6 percent slopes	7.73	6.92	0.23
202	Worfka, 15 to 40 percent slopes	3.04	0	0
ZnB	Zigweid, 6 to 15 percent slopes	11.35	25.39	0.83
ZnC	Zigweid, 6 to 40 percent slopes	22.43	0	0
Total		**7,960.77**	3,065.74	**100**

3.3.5.1.4 Field Sampling

Soil series were sampled to reflect recommended sample numbers in WDEQ Guideline 1 (August 1994 Revision) based on mapping acreage. Most samples were taken either in or near disturbed areas. Additional sampling of soils in the permit area will occur as the operation is expanded outside the current disturbed areas.

Series were sampled and described by coring with a mechanical auger, i.e., truck-mounted Giddings. The physical and chemical nature of each horizon within the sampled profile was described and recorded in the field. Each hole augered for series and map unit verification was plotted on the soils map included with this report. Sampled soil material was placed in clean, labeled, polyethylene plastic bags and kept cool to limit chemical changes. Samples were kept out of direct sunlight and transported to Energy Labs for analysis. A total of 33 sites on the PAA were sampled for analysis; all had corresponding soil profile descriptions written. Refer to Table 3.3-2 Soils Series Sample Summary and Table 3.3-3 Soil Sample Locations.

Table 3.3-2: Soil Series Sample Summary for the PAA [1]

Soil Series	Number of Profiles Sampled for Chemical Analysis
Broadhurst	1
Kyle	3
Hisle	2
Nevee	1
Barnum	1
Ascalon	1
Cushman	1
Zigweid	1
Butche	1
Samsil	3
Paunsaugunt	1
Boneek	4
Arvada	1
Lohmiller	2
Pierre	2
Haverson	1
Demar	2
Penrose	1
Satanta	1
Snomo	1
Grummit	1
Shingle	1
Total	**33**

[1] Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

Table 3.3-3: PAA[1] Soil Sample Locations

Soil Sample Number	Map Unit Designation	Soil Series
17	Broadhurst silty clay, 6 to 15 percent slopes	Broadhurst
27	Kyle noncalcareous variant, 0 to 6 percent slopes	Kyle
36	Kyle noncalcareous variant, 0 to 6 percent slopes	Kyle
39	Hisle silt loam, 0 to 6 percent slopes	Hisle
40	Hisle noncalcareous variant, 0 to 6 percent slopes	Hisle
41	Nevee silt loam, 6 to 15 percent slopes	Nevee
42	Barnum silt loam, 0 to 6 percent slopes	Barnum
43	Ascalon clay loam, 0 to 6 percent slopes	Ascalon
50	Cushman loam, 6 to 15 percent slopes	Cushman
56	Zigweid loam, 0 to 6 percent slopes	Zigweid
57	Butche clay loam, 3 to 15 percent slopes	Butche
60	Samsil clay loam, 15 to 40 percent slopes	Samsil
63	Paunsaugunt loam, 6 to 15 percent slopes	Paunsaugunt
64	Boneek silty clay loam, 0 to 6 percent slopes	Boneek
72	Arvada silty clay loam, 0 to 6 percent slopes	Arvada
73	Lohmiller loam, 0 to 6 percent slopes	Lohmiller
74	Pierre sandy clay loam, 0 to 15 percent slopes	Pierre
75	Haverson clay loam, 0 to 6 percent slopes	Haverson
76	Demar loam, 0 to 6 percent slopes	Demar
77	Penrose clay loam, 0 to 6 percent slopes	Penrose
79	Demar silty clay loam, 0 to 6 percent slopes	Demar
82	Satanta loam, 0 to 6 percent slopes	Satanta
83	Snomo silty clay loam, 0 to 6 percent slopes	Snomo
84	Lohmiller silty clay loam, 0 to 6 percent slopes	Lohmiller
85	Kyle loam, 0 to 6 percent slopes	Kyle
88	Samsil noncalcareous variant, 15 to 40 percent slopes	Samsil
89	Pierre silty clay loam, 0 to 15 percent slopes	Pierre
90	Grummit silty clay, 0 to 6 percent slopes	Grummit
91	Boneek clay loam, 0 to 6 percent slopes	Boneek
92	Samsil silty clay loam, 15 to 40 percent slopes	Samsil
93	Shingle loam, 15 to 40 percent slopes	Shingle
94	Boneek noncalcareous variant, 0 to 6 percent slopes	Boneek
95	Boneek loam, 0 to 6 percent slopes	Boneek

[1]Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

3.3.5.1.5 Laboratory Analysis

Samples were individually placed into lined aluminum pans to air dry. Coarse fragments were measured with a 10 mesh screen prior to grinding; the entire sample was then hand ground to pass 10 mesh. An approximate 20 ounce subsample was obtained through splitting with a series of riffle splitters and subsequently analyzed. A second subsample was maintained in storage at Energy Labs. Approximately 10 percent of the samples are run for duplicate analysis. Actual laboratory analysis follows the methodology outlined in WDEQ-LQD Guideline 1 (August 1994 Revision). In general, samples were analyzed within 45 days of receipt of the samples at the laboratory. All analytical data is presented in Appendix 3.3-D, Original Laboratory Data Sheets.

3.3.5.2 Results and Discussion

3.3.5.2.1 Soil Survey - General

General topography of the area ranged from nearly level uplands to very steep hills, ridges and breaks of dissected shale plains. The soils occurring on the Powertech (USA) PAA were generally a clayey or very fine texture throughout with patches of sandy loam on upland areas and fine, clay textured soils occurring in or near drainages. The PAA contained deep soils on level upland areas with shallow and very shallow soils located on hills, ridges and breaks.

3.3.5.2.2 Soil Mapping Unit Interpretation

The primary purpose of the 2007 fieldwork was to characterize the soils within the PAA in terms of topsoil salvage depths and related physical and chemical properties. The total number of samples per series was established in line with WDEQ Guideline 1 (August 1994 Revision) recommendations based on estimated acreage of soil series known within the PAA. Refer to Appendix 3.3-B and 3.3-C for soil mapping unit descriptions and soil series descriptions, respectively.

3.3.5.2.3 Analytical Results

Analyzed parameters, as defined in WDEQ Guideline 1 (August 1994 Revision), are in Appendix 3.3-D, Original Laboratory Data Sheets. Laboratory soil texture analysis did not include percent fine sands. Field observations of fine sands within individual pedestals as well as sample site topographic position were used in conjunction with laboratory analytical results to determine series designation. Where applicable, field observation of fine sands is also included in the textures found in the soil series descriptions in Appendix 3.3-C. In several of the pedestal

sampling locations, laboratory analysis yielded finer than expected textures (based upon field observations). Where textures are finer than typical for the series, it is noted in the Range of Characteristics (according to field observations, lab analysis) in the soil series descriptions.

3.3.5.2.4 Evaluation of Soil Suitability as a Plant Growth Medium

Approximate salvage depths of each map unit series are presented in Table 3.3-4 and ranged from 0.0 to 5.0 feet. Within the PAA, suitability of soil as a plant growth medium is generally affected by physical factors such as texture (clay percentage) and saturation percentage. Chemical limiting factors included selenium (Se), calcium carbonate content (based upon field observations of strong or violent effervescence), SAR, EC, pH, and boron (B). Marginal material, according to WDEQ Guideline 1, was found in 26 of the 33 profiles. Unsuitable material, according to WDEQ Guideline 1, was found in 14 of the 33 profiles. Marginal or unsuitable parameter information for sampled profiles is identified in Table 3.3-5. A summary of trends in marginal or unsuitable parameters as it relates to soil series is found in Table 3.3-6. Based on laboratory analysis and field observations, marginal material parameters primarily consisted of texture (clay percentage), calcium carbonates, EC, and SAR.

Table 3.3-4: PAA Summary of Approximate Soil Salvage Depths

Map Symbol	Mapping Unit Description	Disturbance Areas[1]	Salvage Depth (feet)	Total Volume (Acre feet)
Ar	Arvada	121.78	1.5	182.67
As	Ascalon	41.22	1.17	48.23
Bc	Barnum	13.01	0.5	6.51
Br	Broadhurst	190.74	0.67	127.80
Bw	Butche	25.42	0.67	17.03
Cy	Cushman	12.26	2.08	25.50
Dg	Demar	134.26	0.21	28.20
DA	Disturbed-Ag	41.36	-	-
GrA	Grummit, 0 to 6 percent slopes	37.85	1.67	63.21
GrB	Grummit, 6 to 15 percent slopes	369.1	1.67	616.40
GrC	Grummit, 15 to 60 percent slopes	48.43	1.67	80.88
He	Hisle Noncalc. Variant Average	54.52	5 5 5	272.60
Ky	Kyle Noncalc. Variant Average	333.96	2.5 0.80 1.65	551.03
Lo	Lohmiller	5.66	0.34	1.92
Mm	Mathias	34.08	0	0
MP	Mine Pit	18.31	-	-
Nf	Nihill	25.61	0.42	10.76
Nu	Nunn	41.22	2	82.44
Pg	Penrose	231.08	3	693.24
PeA	Pierre, 0 to 6 percent slopes	216.03	0.71	153.38
PeB	Pierre, 6 to 15 percent slopes	157.99	0.71	112.17
RO	Rock Outcrop	17.42	-	-
Sa	Samsil Noncalc. Variant Average	515.29	0.42 1.5 0.96	494.68
Sn	Shingle	11.66	0.67	7.81
SS	Slickspots	148.77	-	-
Gs	Snomo	106.06	0	0
Ta	Tilford	7.84	3.33	26.11
W	Water	72.5	-	-
Wt	Winetti	6.92	0.33	2.28
Zn	Zigweid	25.39	5	126.95
Average Salvage Depth of Study Area			**1.44**	
Total		**3,065.74**		**3,731.80**

[1]Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

Table 3.3-5: PAA Summary of Marginal and Unsuitable Parameters within Sampled Profiles

Series	Sample Point	Depth (in)	Parameter
Broadhurst	17	0-3 3-8 8-24 24-40 40-54 54-60	Marginal clay %
Broadhurst	17	8-24	Marginal saturation %
Broadhurst	17	40-54	Marginal pH (Low)
Broadhurst	17	54-60	Unsuitable pH (Low)
Kyle	27	2-17 17-24 24-39 39-60	Marginal clay %
Kyle	27	24-39	Marginal saturation %
Kyle	27	17-24 24-39 39-60	Marginal SAR
Kyle	36	2-15 15-26 26-36 36-60	Marginal clay %
Kyle	36	2-15 26-36	Marginal saturation %
Kyle	36	15-26 26-36	Marginal SAR
Hisle	40	27-38 38-60	Marginal clay %
Nevee	41	21-36 36-45 45-60	Unsuitable EC (Conductivity) Unsuitable SAR Marginal Selenium
Nevee	41	21-36	Unsuitable Boron
Barnum	42	6-17 17-39	Unsuitable EC (Conductivity) Unsuitable SAR
Barnum	42	39-60	Marginal EC (Conductivity) Marginal SAR
Barnum	42	6-17	Marginal Selenium
Ascalon	43	2-14	Marginal clay %
Ascalon	43	38-60	Unsuitable SAR
Samsil	60	3-10	Marginal clay %
Samsil	60	10-18	Marginal EC (Conductivity) Marginal Selenium
Samsil	60	3-10 10-18	Marginal SAR
Boneek	64	17-33	Marginal pH (High)
Boneek	64	33-42	Marginal EC (Conductivity) Marginal Selenium
Arvada	72	18-28	Marginal clay %

Table 3.3-5: PAA Summary of Marginal and Unsuitable Parameters within Sampled Profiles (cont'd)

Series	Sample Point	Depth (in)	Parameter
Arvada	72	28-43 43-60	Marginal EC (Conductivity)
Arvada	72	28-43	Marginal SAR
Arvada	72	43-60	Unsuitable SAR
Arvada	72	18-28 28-43 43-60	Marginal Selenium
Lohmiller	73	3-15 15-23 23-34 34-38 38-60	Marginal clay % Unsuitable SAR
Lohmiller	73	15-23 23-34 38-60	Marginal saturation %
Lohmiller	73	15-23	Marginal EC (Conductivity)
Lohmiller	73	23-34 34-38 38-60	Unsuitable EC (Conductivity)
Lohmiller	73	15-23 23-34 34-38 38-60	Marginal Selenium
Pierre	74	15-27 27-38	Marginal pH (High)
Pierre	74	27-38 38-51 51-60	Unsuitable EC (Conductivity) Marginal Selenium
Pierre	74	15-27 27-38 38-51 51-60	Unsuitable SAR
Haverson	75	15-35	Marginal SAR
Haverson	75	35-46 46-60	Unsuitable SAR
Demar	76	2-21 21-29	Marginal clay % Marginal SAR
Demar	76	29-46 46-60	Unsuitable SAR
Demar	76	46-60	Marginal Selenium
Penrose	77	36-48	Unsuitable Boron
Demar	79	3-17 17-30 30-42 42-60	Marginal clay % Unsuitable pH (Low)
Satanta	82	0-4	Marginal pH (Low)
Snomo	83	3-17 17-33	Marginal clay % Marginal texture

Table 3.3-5: PAA Summary of Marginal and Unsuitable Parameters within Sampled Profiles (concl.)

Series	Sample Point	Depth (in)	Parameter
Snomo	83	42-52	Marginal saturation %
Snomo	83	0-3 3-17	Unsuitable pH (Low)
Snomo	83	33-42 42-52 52-60	Unsuitable Boron
Lohmiller	84	18-37	Marginal clay % Marginal texture Unsuitable EC (Conductivity) Unsuitable SAR
Lohmiller	84	0-5 5-18	Marginal saturation %
Lohmiller	84	5-18 37-47 47-60	Marginal EC (Conductivity)
Lohmiller	84	5-18 37-47	Marginal SAR
Kyle	85	2-7	Marginal saturation %
Samsil	88	2-9	Marginal clay % Marginal texture
Pierre	89	0-2	Marginal pH (Low)
Pierre	89	2-18 18-31 31-37	Marginal clay % Marginal texture Marginal saturation %
Grummit	90	0-2 2-8 8-20	Marginal clay % Marginal texture Marginal saturation %
Boneek	91	4-19 40-48 48-60	Marginal saturation %
Boneek	91	19-40 40-48 48-60	Unsuitable EC (Conductivity) Unsuitable SAR
Boneek	91	48-60	Marginal Selenium
Samsil	92	7-19	Marginal clay % Marginal texture Marginal saturation %
Boneek	94	0-2 2-8 8-20 32-44 44-60	Marginal clay % Marginal texture Marginal saturation %
Boneek	94	20-32	Marginal saturation %
Boneek	95	24-38	Marginal Selenium

Table 3.3-6: PAA Summary of Trends in Marginal and Unsuitable Parameters for Soil Series

Series	Unsuitable/Marginal Parameter
Arvada	Sodium/Salts, Selenium/Boron
Ascalon	Sodium/Salts
Barnum	Sodium/Salts, Selenium/Boron
Boneek	Texture, Sodium/Salts, Selenium/Boron
Broadhurst	Texture, pH
Demar	Sodium/Salts
Grummit	Texture
Haverson	Sodium/Salts
Hisle	Texture
Kyle	Texture
Lohmiller	Texture, Sodium/Salts
Nevee	Sodium/Salts, Selenium/Boron
Penrose	Selenium/Boron
Pierre	pH
Samsil	Texture
Satanta	pH
Snomo	Texture, pH, Selenium/Boron

3.3.5.2.5 Topsoil Volume Calculations

Based on the 2007 fieldwork with associated field observations and subsequent chemical analysis, the recommended topsoil average salvage depth over the PAA was determined to be 1.43 feet. Refer to Table 3.3-4, Approximate Soil Salvage Depths.

3.3.5.2.6 Soil Erosion Properties and Impacts

Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the PAA varies from negligible to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the very fine and clayey texture of the surface horizons throughout the majority of the PAA, the soils are more susceptible to erosion from water than wind. See Table 3.3-7 for a summary of wind and water erosion hazards within the PAA.

Table 3.3-7: PAA Summary of Wind and Water Erosion Hazards[1]

Soil Sample Number	Map Unit Description	Water Erosion Hazard	Wind Erosion Hazard
17	Broadhurst silty clay, 6 to 15 percent slopes	slight	very slight
27	Kyle noncalcareous variant, 0 to 6 percent slopes	moderate	very slight
36	Kyle noncalcareous variant, 0 to 6 percent slopes	moderate	very slight
39	Hisle silt loam, 0 to 6 percent slopes	moderate	slight
40	Hisle noncalcareous variant, 0 to 6 percent slopes	slight	very slight
41	Nevee silt loam, 6 to 15 percent slopes	moderate	slight
42	Barnum silt loam, 0 to 6 percent slopes	moderate	slight
43	Ascalon clay loam, 0 to 6 percent slopes	slight	slight
50	Cushman loam, 6 to 15 percent slopes	slight	moderate
56	Zigweid silty clay loam, 0 to 6 percent slopes	moderate	very slight
57	Butche clay loam, 3 to 15 percent slopes	slight	slight
60	Samsil clay loam, 15 to 40 percent slopes	slight	slight
63	Paunsaugunt loam, 6 to 15 percent slopes	slight	moderate
64	Boneek silty clay loam, 0 to 6 percent slopes	moderate	very slight
72	Arvada silty clay loam, 0 to 6 percent slopes	moderate	slight
73	Lohmiller loam, 0 to 6 percent slopes	very slight	slight
74	Pierre sandy clay loam, 0 to 15 percent slopes	negligible	severe
75	Haverson clay loam, 0 to 6 percent slopes	slight	slight
76	Demar loam, 0 to 6 percent slopes	slight	moderate
77	Penrose clay loam, 0 to 6 percent slopes	slight	slight
79	Demar silty clay loam, 0 to 6 percent slopes	slight	slight
82	Satanta loam, 0 to 6 percent slopes	very slight	severe
83	Snomo silty clay loam, 0 to 6 percent slopes	moderate	very slight
84	Lohmiller silty clay loam, 0 to 6 percent slopes	moderate	very slight
85	Kyle loam, 0 to 6 percent slopes	slight	slight
88	Samsil noncalcareous variant, 15 to 40 percent slopes	slight	slight
89	Pierre silty clay loam, 0 to 15 percent slopes	moderate	very slight
90	Grummit silty clay, 0 to 6 percent slopes	slight	negligible
91	Boneek clay loam, 0 to 6 percent slopes	slight	slight
92	Samsil silty clay loam, 15 to 40 percent slopes	slight	slight
93	Shingle loam, 15 to 40 percent slopes	slight	severe
94	Boneek noncalcareous variant, 0 to 6 percent slopes	slight	very slight
95	Boneek loam, 0 to 6 percent slopes	slight	moderate

[1]Based on lab analysis.

3.3.5.2.7 Prime Farmland Assessment

Prime farmland was assessed by Dan Shurtliff, the Acting State Soil Scientist out of Huron, South Dakota. The following sections in T6S R1E contain prime farmland if irrigated: Sections 27, 30, 31, 32, 34, and 35. The following sections in T7S R1E contain Prime farmland if irrigated: Sections 1, 3, 4, 5, 10, 12, 14, and 15. The following sections in T7S R1E contain Farmland of statewide importance: Sections 2, 3, 4, 5, 10, 11, 12, 14, and 15. See Appendix 3.3-E for prime farmland designation. The following soil series have been listed as Prime farmland if irrigated: Alice, Ascalon, Barnum, Boneek, Haverson, Norka, Nunn, Satanta, and Tilford. The following soil series have been listed as Farmland of statewide importance: Kyle, Lohmiller, Nunn, Pierre, Satanta, and Stetter.

3.3.6 Seismology

3.3.6.1 Seismic Hazard Review

The seismic hazard review was based on analysis of available literature and historical seismicity for the PAA. 10 CFR Part 40, Appendix A Criterion 4(e) states:

"The impoundment may not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. As used in this criterion, the term "capable fault" has the same meaning as defined in section III (g) of Appendix A of 10 CFR Part 100. The term "maximum credible earthquake" means that earthquake which would cause the maximum vibratory ground motion based upon an evaluation of earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material."

There are no capable faults (i.e. active faults) with surface expression mapped within a radius of 100 kilometers (62 miles) from the center of the PAA, according to the 2002 U.S. Geological Survey's Quaternary Fault and Fold Database. In addition, there are no capable faults mapped in the entire state of South Dakota. The closest capable faults to the site are located in central Wyoming, nearly 345 km (200 miles) to the west-southwest.

3.3.6.2 Seismicity

South Dakota has a comparatively higher rate of seismicity than other areas in the northern plains states, although earthquakes in the area tend to be relatively rare and of low to moderate magnitude, and no active faults have been mapped in the vicinity. It is unclear which

earthquakes, if any, in the PAA are associated with known faults. Since the Midwestern states are relatively stable in terms of earthquake activity, only a small number of seismograph stations are located in the region. South Dakota has one station located in Rapid City, which began operation in 1991. Two nearby stations are located in Golden, Colorado and French Village, Missouri.

Since 1872, a minimum of 65 earthquake epicenters have been identified in South Dakota (Hammond, 1992). These have mainly been concentrated in the southern and eastern regions of the state and are generally of low to moderate modified Mercalli intensity, with a maximum recorded intensity reaching VI. In general, the majority of the epicenters in the proximity of PAA (see Figure 3.3-5) exhibit modified Mercalli intensities from III to V (corresponding to Richter magnitudes ranging from 2.2 to 4.1). However, a 1966 earthquake with intensity VI (approximate Richter magnitude 4.4) was recorded approximately 63 miles northeast of PAA (17 miles northwest of Rapid City).

The U.S. Geological Survey Earthquake Database reports locations, times, and magnitudes for epicenters recorded since 1973. The database reports a total of 10 earthquakes with Richter magnitudes ranging from 2.3 to 3.7 within 100 km radius of the site (Appendix 3.3-G). This list includes epicenters in Wyoming and Nebraska. The closest historical earthquake to PAA (unknown magnitude) was recorded on May 16, 1975 approximately 19 km (12 miles) southeast of the site. The most recent earthquake recorded in the entire state of South Dakota took place on February 7, 2007, 35 miles east of Rapid City (approximately 80 miles northeast of PAA) and displayed a magnitude of 3.1.

According to the U.S. Geological Survey Earthquake Database (Appendix 3.3-G), two historical earthquakes, each exhibiting a magnitude of 3.7, represent the largest historical events recorded within 100 km (62 miles) of PAA. These events occurred on February 6, 1996, and April 9, 1996, and were located 76 km (47 miles) to the north and 30 km (19 miles) to the southwest of the site, respectively. If we expand the search radius to 200 km (124 miles), an earthquake with magnitude 5.50 occurring on October 18, 1984 approximately 180 km (112 miles) to the southwest of the site is the largest magnitude event near the site.

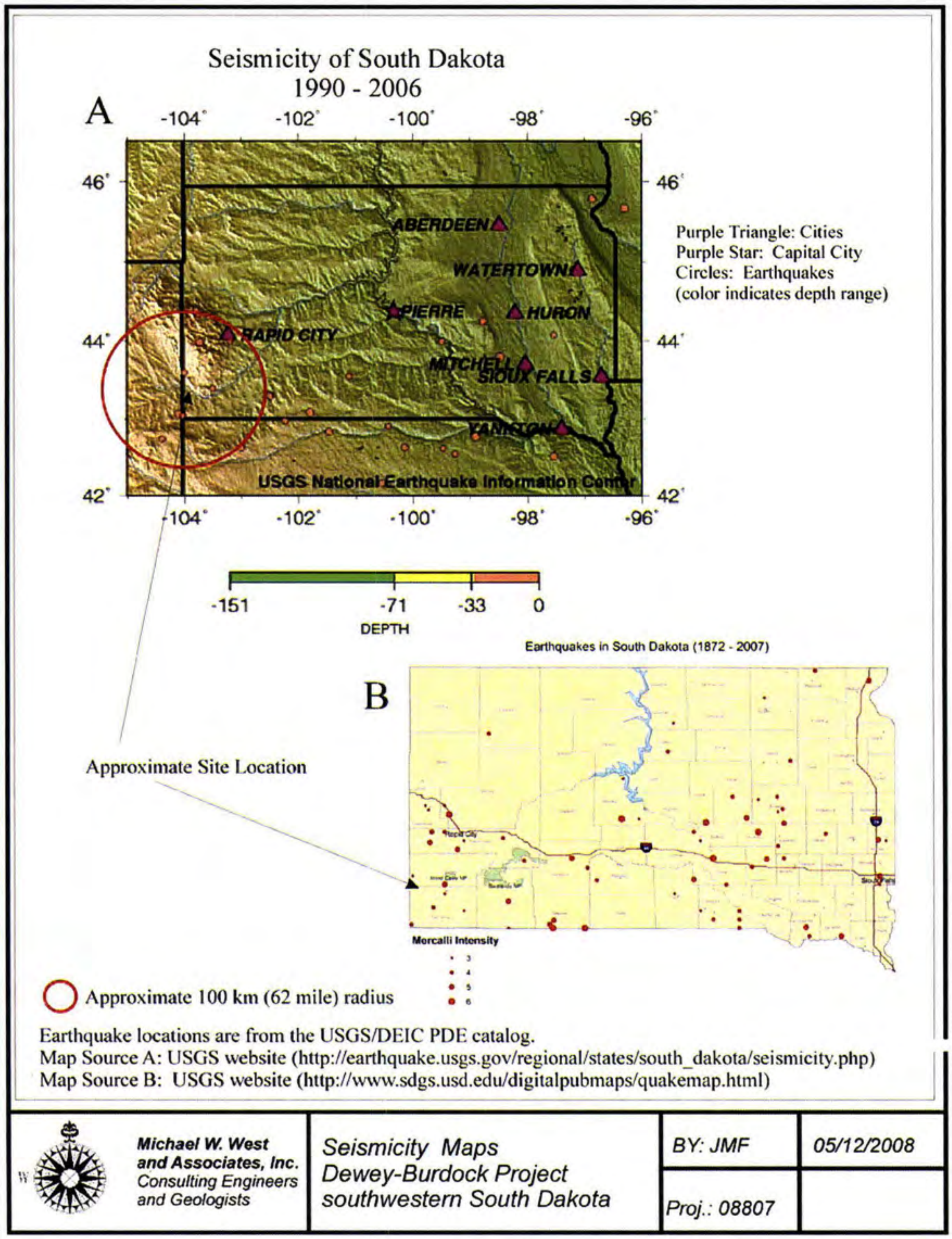
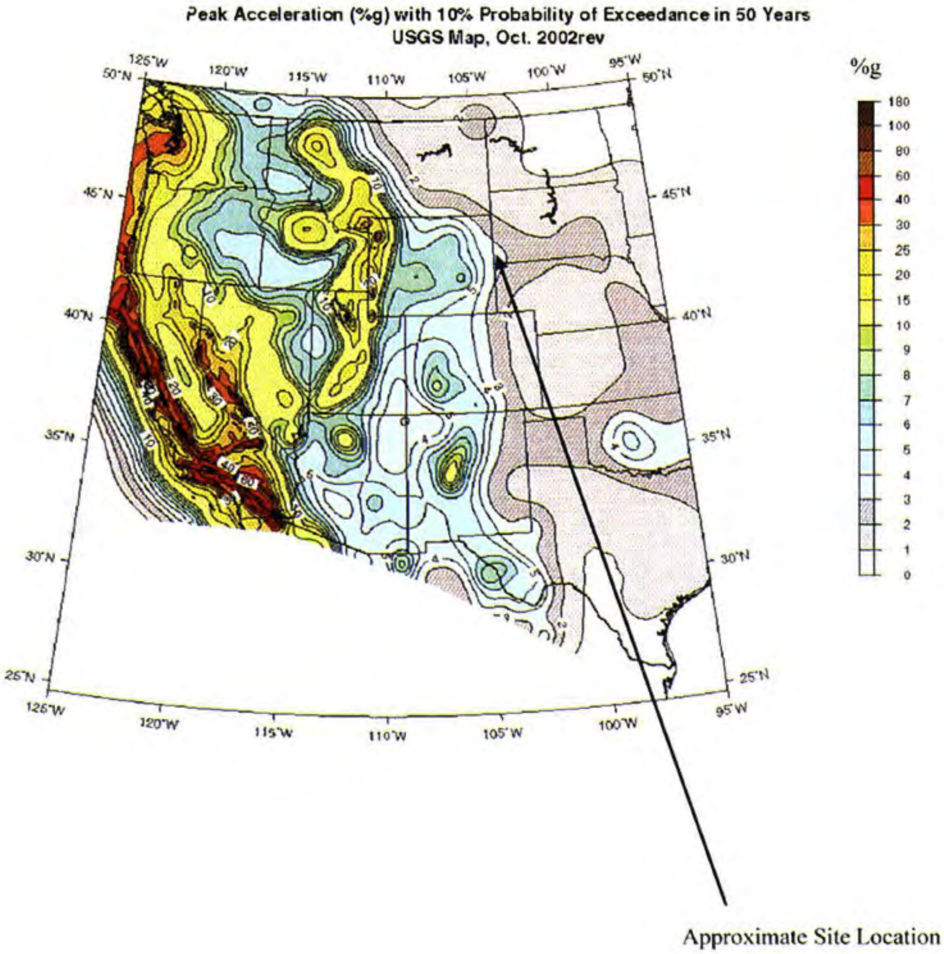


Figure 3.3-5: Seismicity of South Dakota, 1990 – 2006; and Earthquakes in South Dakota, 1872 - 2007

A zone of higher earthquake frequency is recorded along the eastern flank of the Black Hills (structural deformation also seems to be concentrated on the eastern flank; Geological Survey of South Dakota, 2004) and in the southwest corner of South Dakota (Figure 3.3-6). In addition, the peak ground acceleration (PGA) maps (USGS, 2002) of the area display an increase in ground motion to the west and southwest part of the state (Figures 3.3-7 and 3.3-8). Earthquakes may be concentrating along or near the boundaries of structural provinces (e.g. Black Hills and Missouri Plateau, or Missouri Plateau and High Plains) in the Precambrian, crystalline basement. Two possible faulting mechanisms may be at work: 1) initiation of movement along preexisting fractures due to crustal plate movements; or 2) fault movement and fracturing due to glacial rebound (South Dakota Department of Emergency Management website).

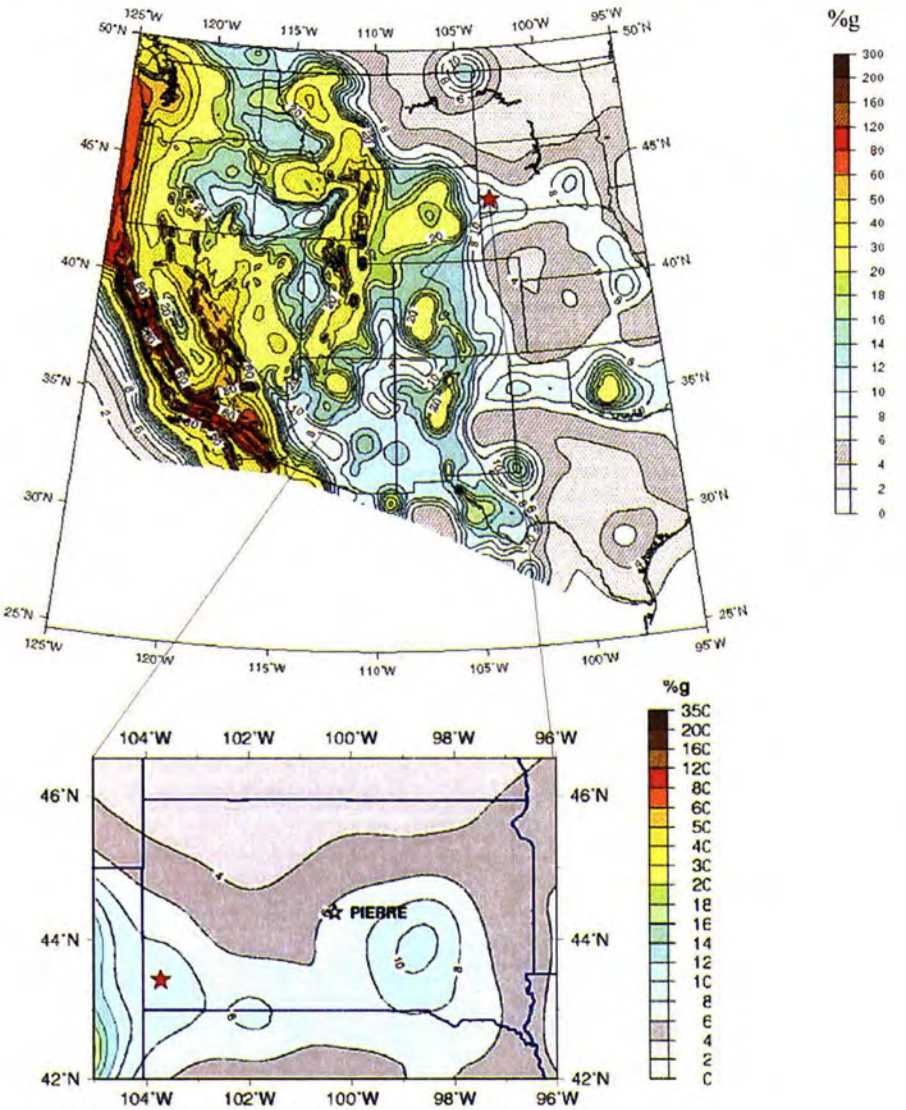
According to the U.S. Geological Survey's 2002 Seismic Hazard Mapping Program, the PGA derived from the probabilistic maximum bedrock acceleration with a 10 percent exceedance in 50 years (475-year return period) is 0.03g (Figure 3.3-7) for the southwestern part of South Dakota. The probabilistic maximum bedrock acceleration with a 2 percent chance of exceedance in 50 years (2,475-year return period) is 0.09g for the region (Figure 3.3-8).



Map Source: USGS website (http://earthquake.usgs.gov/research/hazmaps/products_data/2002/wus2002.php)

Michael W. West and Associates, Inc. Consulting Engineers and Geologists	PGA Map (10% Probability Exceedance 50 years) Dewey-Burdock Project southwestern South Dakota	BY: JMF	05/12/2008
		Proj.: 08807	

Figure 3.3-6: Peak Ground Acceleration (PGA), Illustrating 10% Probability of Exceedance in the Next 50 Years



Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
site: NEHRP B-C boundary
National Seismic Hazard Mapping Project

★ Approximate Site Location

Map Source: USGS website (http://earthquake.usgs.gov/research/hazmaps/products_data/2002/wus2002.php)

Michael W. West and Associates, Inc. *Consulting Engineers and Geologists*	*PGA Map (2% Probability Exceedance in 50 Years)*	*BY: JMF*	*05/12/2008*
	Dewey-Burdock Project southwestern South Dakota	*Proj.: 08807*	

Figure 3.3-7: Peak Ground Acceleration (PGA), Illustrating 2% Probability of Exceedance in the Next 50 Years

3.3.6.2.1 Seismic Sources

Assessment of seismic hazards requires consideration of potential earthquake source zones, either identifiable faults or larger areas with common seismic characteristics. Once potential source zones have been identified, design earthquakes can be assigned based on a synthesis of geological and seismological data.

3.3.6.2.2 Capable Faults

PAA is located in an area of historically low seismic potential. There are no known capable faults within 100 km (62 miles) of the site and a relatively low number of historical earthquakes (Figure 3.3-6; Appendix 3.3-G). The closest capable fault zone to PAA is located nearly 345 km (200 miles) west of the site in central Wyoming. Therefore, the randomly occurring 'floating' earthquake is considered to be the most significant seismic hazard for PAA (discussed below), the same as the maximum credible earthquake as defined in 10 CFR Part 40, Appendix A Criterion 4(e) quoted above.

3.3.6.2.3 The Randomly Occurring 'Floating' Earthquake

Industry standards and federal regulations require an analysis of the earthquake potential in regions where the surface expression of active faults is not mapped or exposed, and where earthquake epicenters are associated with buried faults with no associated surface rupture. Earthquakes associated with buried faults are assumed to occur randomly and can occur anywhere within that area of uniform earthquake potential. In reality, random earthquake distribution may not be the case, since all earthquakes are associated with specific faults. However, since all buried faults in the PAA have not been identified, it is reasonable to consider the distribution to be random. A 'floating' earthquake is an earthquake that is considered to occur randomly within a tectonic province.

The U.S. Geological Survey identified tectonic provinces for the contiguous United States (Algermissen et al., 1982). PAA is located in a source zone with a uniformly distributed seismicity which generally encompasses the Black Hills and surrounding environs. The zone is characterized by an earthquake with maximum magnitude M_{max}=6.1. We use this magnitude as our best estimate for the floating earthquake.

3.3.6.3 Conclusion

Seismic hazards at PAA include low to moderate ground shaking associated with regional and local earthquake sources. Figures 3.3-6 through 3.3-8 illustrate seismicity and PGA maps for the PAA, and Appendix 3.3-G is a summary of the USGS database results for historical earthquakes recorded within 100 and 200 km from the site since 1973.

There are no capable faults (as defined in section III(g) of Appendix A of 10 CFR Part 100) known to be present within 100 km of the PAA. The closest capable fault zone to the PAA is located nearly 345 kilometers (200 miles) west of the site in central Wyoming. Therefore, the most significant seismic hazard is the randomly occurring, or 'floating', earthquake for the PAA. This is the maximum credible earthquake estimated for the project based on available literature, geologic information of the surrounding area, and historical data. A magnitude M_{max}=6.1 is estimated for this event.

According to the U.S. Geological Survey's 2002 Seismic Hazard Mapping Program, PGA derived from the probabilistic maximum bedrock acceleration with a 10 percent exceedance in 50 years (475-year return period) is 0.03g (Figure 3.3-7) for the southwestern part of South Dakota. The probabilistic maximum bedrock acceleration with a 2 percent chance of exceedance in 50 years (2,475-year return period) is 0.09g for the region (Figure 3.3-8). Both of these estimates are considered to reflect a relatively low ground motion hazard.

3.4 Water Resources

3.4.1 Water Use

3.4.1.1 Regional Groundwater Use

The PAA is located at the southwestern edge of the Black Hills. The major aquifers of the Black Hills are the Inyan Kara, Minnelusa, Madison and Deadwood (see Section 3.3.1.2). Within Fall River and Custer Counties, each of these aquifers is used, with wells generally being drilled into the next underlying aquifer below the surface. There is no public data available to quantify the use from each of these aquifers within Fall River or Custer County.

3.4.1.2 Site Area Groundwater Use

In the PAA, the Fall River and Lakota Formations, together forming the Inyan Kara aquifer, are the principal sources of water. An inventory of private water-supply wells within an approximate 2 km radius of the proposed permit boundary was conducted in June 2007, during

which about 80 wells were located (see Appendix 3.4-A). Most wells within 2 km of the site serve as water supply for livestock (26), although some wells are used for domestic (10) or other purposes (47) including piezometers, mine dewatering wells, and garden watering.

Wells within 2 km of the site include 24 wells known to obtain water from the Fall River Formation, with 12 of these wells being flowing artesian wells. Based on measurements from flowing wells and estimates from others, an estimated 15 gpm is currently being consumed from the Fall River. Within this same 2 km radius, there are 39 wells currently obtaining water from the Lakota Formation, 14 of which are flowing artesian. The estimated flow from these Lakota wells is 46 gpm. Additionally, 10 wells are completed within an unknown formation of the Inyan Kara aquifer (Fall River, Lakota, or both). The total estimated flow from the Inyan Kara (including wells screened within the Fall River, Lakota, or both) within 2 km of the site is approximately 70 gpm. There are six wells completed in the Sundance/Unkpapa, with four that are flowing. Within 2 km, an additional eight wells are completed into an unknown aquifer. Wells within the PAA that are currently in use are shown on Figure 3.4-1. Twenty-six wells in the vicinity of the PAA were deemed abandoned because of the condition and inactivity of the well; these wells termed abandoned are not considered properly plugged and abandoned.

Well completion reports and other related data are found in Appendix 3.4-B.

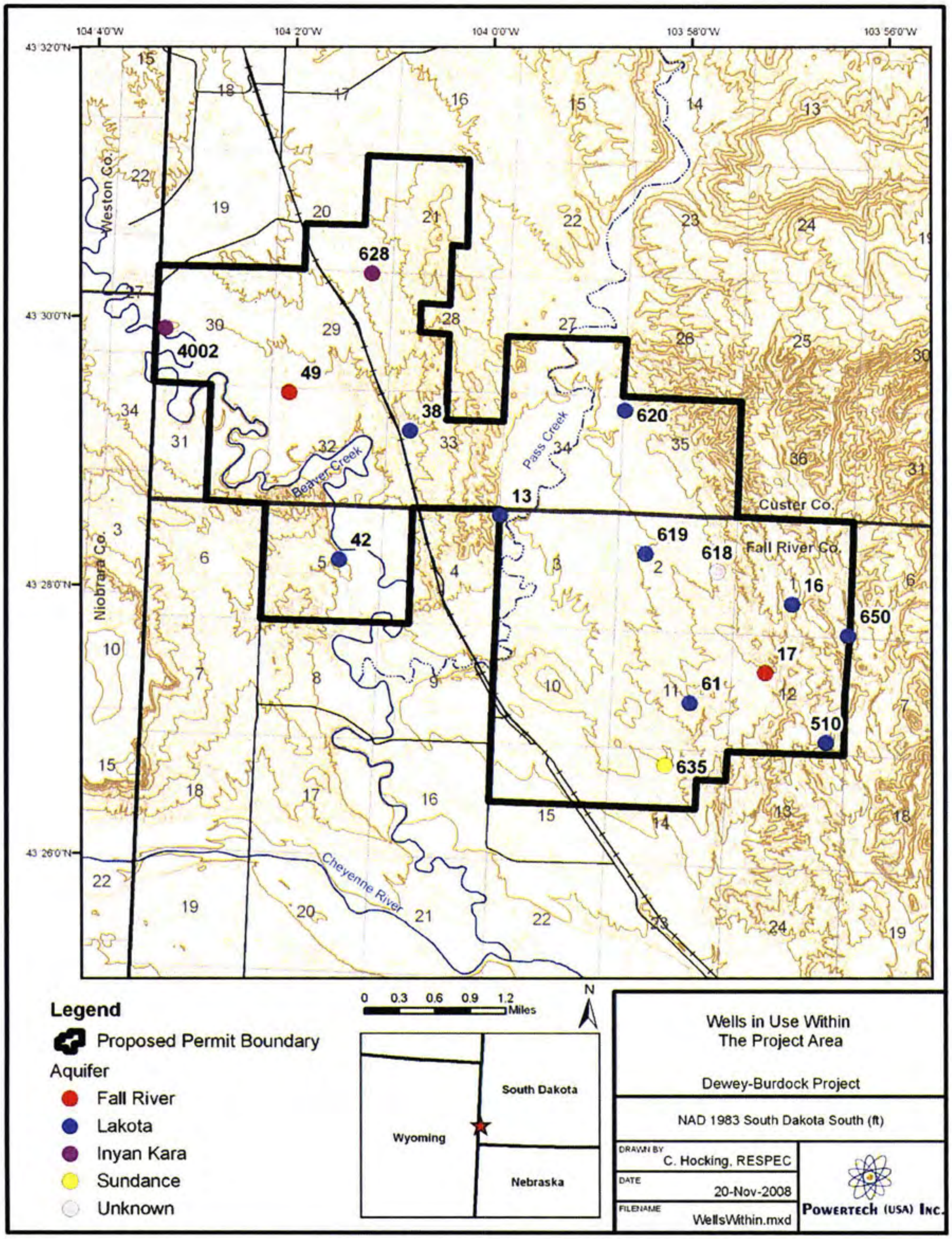


Figure 3.4-1: Wells in Use within the PAA

3.4.2 Surface Water

The Upper Cheyenne River basin extends through three states – Wyoming, Nebraska, and southwestern South Dakota (HUC No. 10120106, 10120107, 10120108). Within these states the Cheyenne River basin, above Angostura Reservoir in South Dakota, drains an area of approximately 8,996 square miles (mi^2) (Beauvais, 2000). The northern and central portions of the watershed are in the Black Hills division of the Great Plains and the southern portion is in the Pierre Hills division of the Great Plains (Kalvels, 1982 and Ensz, 1990). Land elevation ranges from about 3,160 feet (963 meters [m]) to 7,015 feet (2,138 m) above mean sea level.

3.4.2.1 Drainage Basins

The PAA lies primarily within the Beaver Creek Basin and is drained by both Beaver Creek and Pass Creek. The Pass Creek watershed is a sub-basin within the Beaver Creek basin, but the two watersheds were characterized as separate basins. The Beaver Creek system flows through the northwestern section of the PAA from the northwest to the southeast. The Pass Creek system flows south through the central portion of the PAA and joins Beaver Creek southwest of the PAA. Three miles south of this confluence, Beaver Creek converges with the Cheyenne River (Figure 3.4-2) which eventually flows into the Missouri River.

The nearest discharge gage on the Cheyenne River upstream of its confluence with Beaver Creek is USGS gage 06386500 near Spencer, WY. The nearest discharge gage downstream of the confluence of Beaver Creek and the Cheyenne River is USGS gage 06395000 at Edgemont, SD. This gage captures the contribution of flow to the Cheyenne River from Beaver Creek and Pass Creek between Spencer, WY and Edgemont, SD. Figure 3.4-3 shows an annual hydrograph for gage 06386500 from 1948 to 2008, and Figure 3.4-4 shows an annual hydrograph for gage 06395000 from 1903 to 2008. The lines in Figures 3.4-3 and 3.4-4 indicate the upper bound flow values for the 25th, 50th, and 95th flow percentiles for each of the 365 days per year. For example (in Figure 3.4-4), based on all of the January 1st flow values during 1903 to 2008 (106 data points), the flow was less than 1 cfs on 25 percent of those days (26 days), less than 4 cfs on 50 percent of those days (53 days) and less than 30 cfs on 95 percent of those days (101 days). Therefore, the graph indicates how variable the stream flow tends to be at various times during the year (e.g., more variable during a typical July than a typical November).

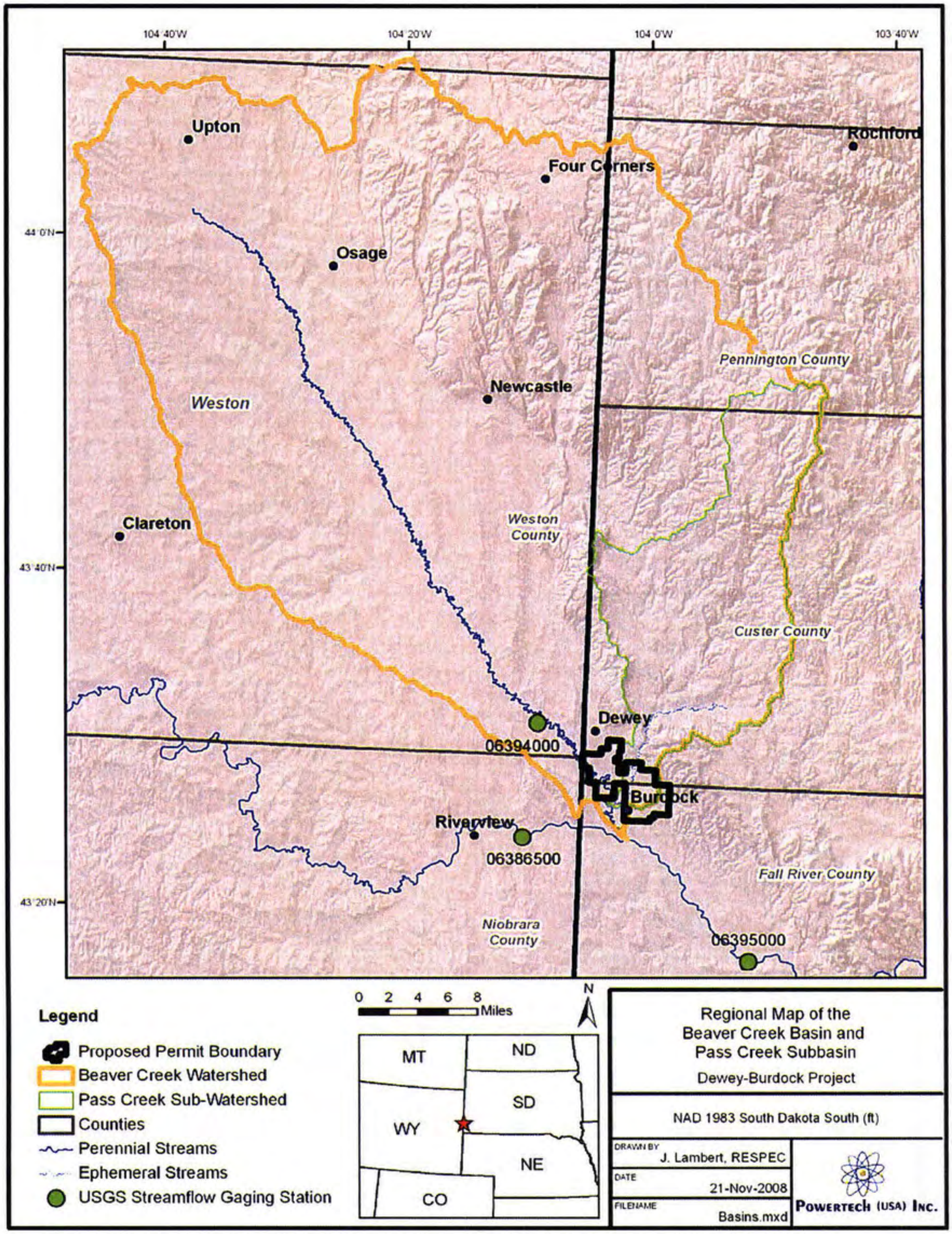


Figure 3.4-2: Regional map of the Beaver Creek and Pass Creek Basins

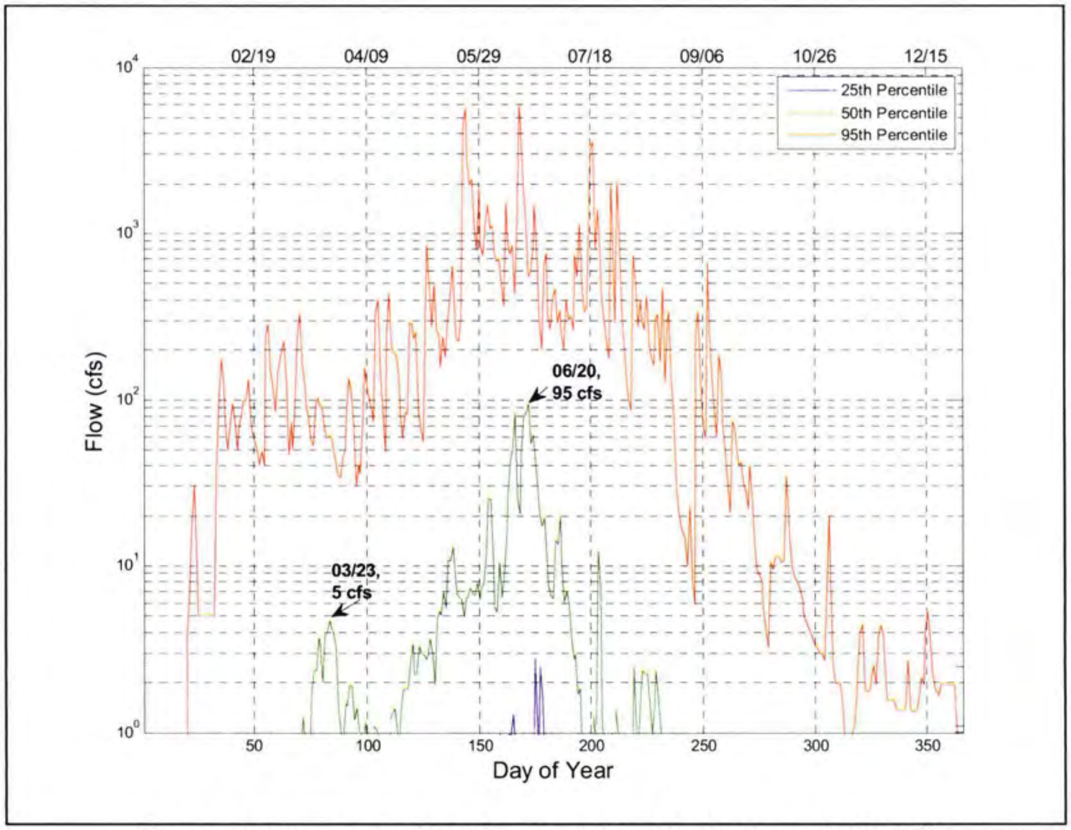


Figure 3.4-3: Annual Hydrograph for USGS Gage 06386500 on the Cheyenne River near Spencer, WY from 1948 to 2008

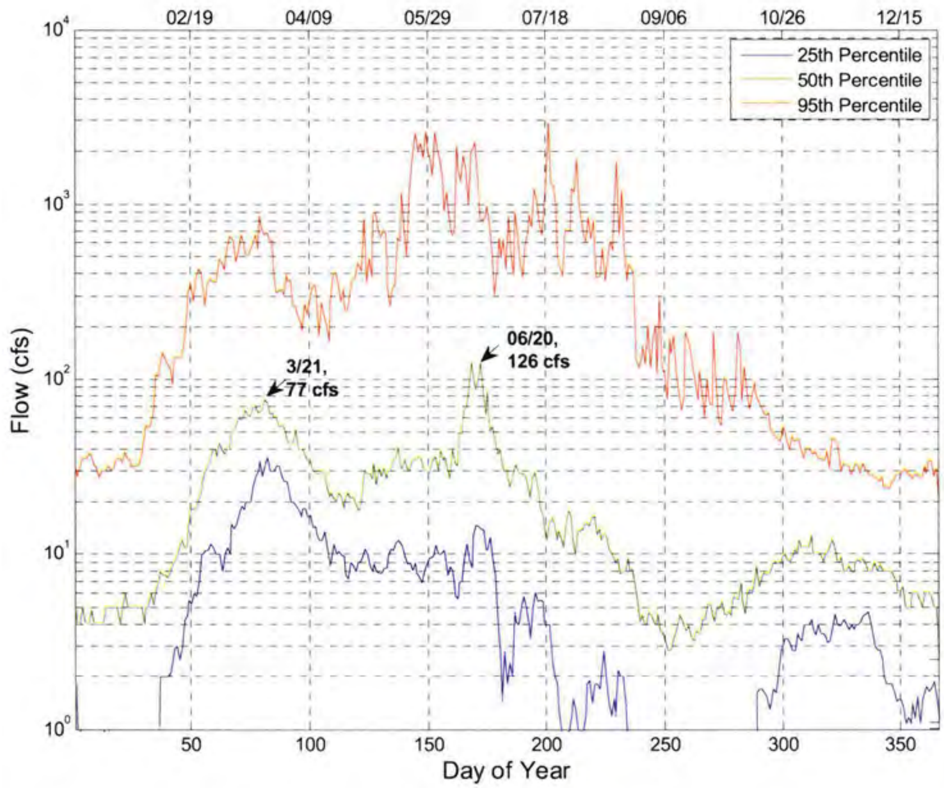


Figure 3.4-4: Annual Hydrograph for USGS Gage 06395000 on the Cheyenne River at Edgemont, SD from 1903 to 2008

3.4.2.1.1 Beaver Creek Basin

The Beaver Creek Basin is 1360 mi^2, excluding the Pass Creek sub-basin. It extends from a few miles northwest of Upton, WY to about eight miles southeast of Dewey, SD and lies within Weston, Niobrara and Crook Counties in Wyoming, and within Pennington, Custer and Fall River Counties in South Dakota. Beaver Creek is a perennial stream with ephemeral tributaries. Discharge data for Beaver Creek is collected at USGS gage 06394000 near Newcastle, WY (Figure 3.4-2). Figure 3.4-5 shows an annual hydrograph with the 25th, 50th and 95th flow percentiles for this gage from 1944 to 1998. Figure 3.4-6 shows monthly average flow data for this gage from 1944 to 1998.

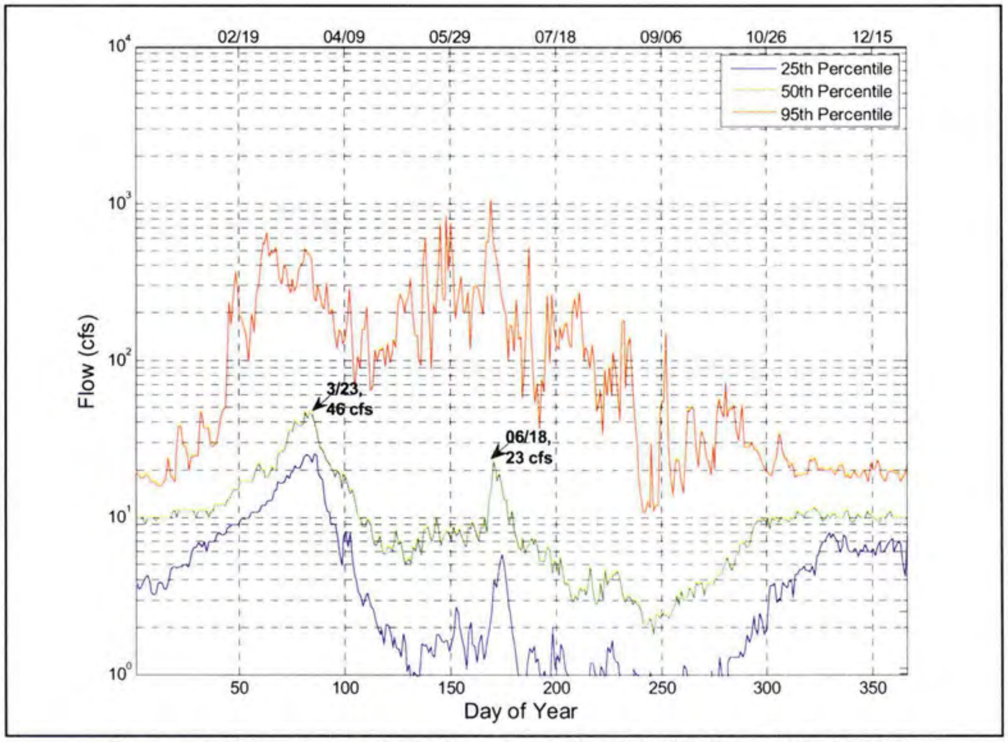


Figure 3.4-5: Annual Hydrograph for USGS Gage 06394000 on Beaver Creek near Newcastle, WY from 1944 to 1998

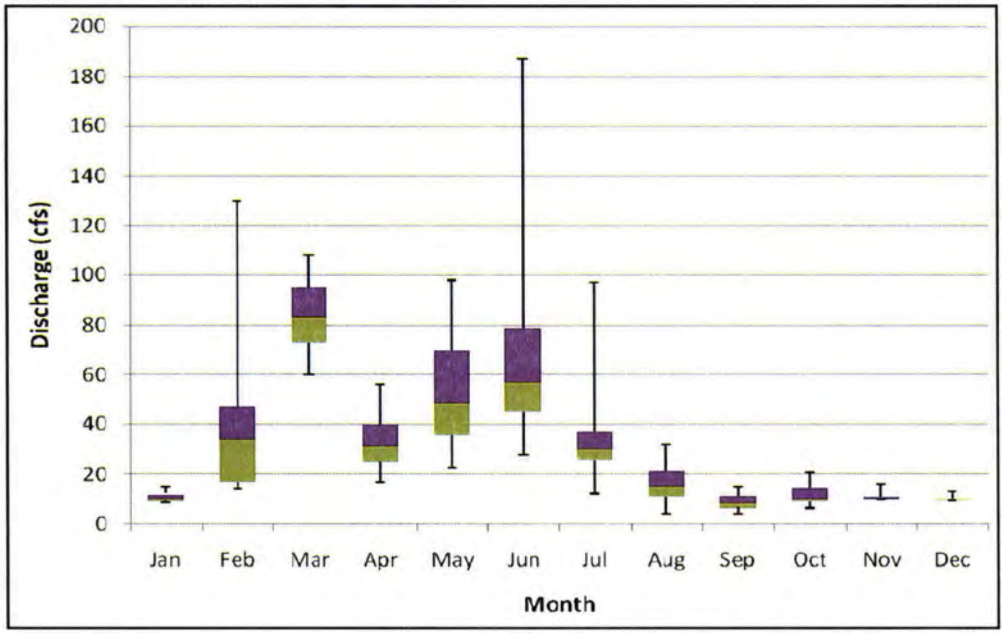


Figure 3.4-6: Monthly average flows at USGS gage 06394000 on Beaver Creek near Newcastle, WY from 1944 to 1998