LMS/SPR/S02613-0.0
Issue Date:
Effective Date:

DRAFT
Long-Term Surveillance Plan for the Split Rock, Wyoming, UMTRCA Title II Disposal Site, Jeffrey City, Wyoming

May 2020

U.S. DEPARTMENT OF ENERGY | Legacy Management

This page intentionally left blank

Long-Term Surveillance Plan for the Split Rock, Wyoming, UMTRCA Title II Disposal Site, Jeffrey City, Wyoming
Document History

Version No./ Revision No.	Revised	Description of Change
0.0	May 2020	Initial issue.

Approved:

____ __________________

Steve Hall
Split Rock Site Lead
Navarro Research and Engineering, Inc.

Date

This page intentionally left blank

Contents

Figures

Tables

Appendixes

Abbreviations

ACL	alternate concentration limit
ALARA	as low as reasonably achievable
BLM	U.S. Bureau of Land Management
CAP	corrective action program
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
COC	constituent of concern
COPC	constituent of potential concern
D_{50}	median diameter
DOE	U.S. Department of Energy
EA	Environmental Assessment
EMS	environmental management system
EPA	U.S. Environmental Protection Agency
FONSI	finding of no significant impact
ft	feet
gpm	gallons per minute
IC	institutional control
lb/day	pounds per day
LM	Office of Legacy Management
LQD	State of Wyoming Land Quality Division
LTSB	Long-Term Surveillance Boundary
LTS&M	long-term surveillance and maintenance
LTSP	Long-Term Surveillance Plan
MCL	maximum contaminant level
mg/L	milligrams per liter
mph	miles per hour
N	nitrogen
NRC	U.S. Nuclear Regulatory Commission
NWV	Northwest Valley
POC	point of compliance
POE	point of exposure
RCRA	Resource Conservation and Recovery Act
SGWCE	*Site Ground Water Characterization and Evaluation*

SMI	Shepherd Miller Inc.
SWDA	Solid Waste Disposal Act
SWV	Southwest Valley
TDS	total dissolved solids
UMTRCA	Uranium Mill Tailings Radiation Control Act
USC	*United States Code*
WDEQ	Wyoming Department of Environmental Quality
WNI	Western Nuclear Incorporated

1.0 Introduction

1.1 Purpose

This Long-Term Surveillance Plan (LTSP) explains how the U.S. Department of Energy (DOE) will fulfill general license requirements of Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28) as the long-term custodian of the Split Rock, Wyoming, Disposal Site (site) in Fremont County, Wyoming. The DOE Office of Legacy Management (LM) is responsible for the preparation, revision, and implementation of this LTSP, which specifies requirements for inspections, monitoring, maintenance, reporting, and maintaining site records.

1.2 Legal and Regulatory Requirements

The Split Rock site is regulated under Title II of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (Title 42 *United States Code* Section 7901 [42 USC 7901]) and licensed by the U.S. Nuclear Regulatory Commission (NRC). Because the State of Wyoming is an Agreement State (as of September 30, 2017), the specific license for the Split Rock site was regulated by the State of Wyoming. NRC administered the specific license prior to the State of Wyoming becoming an Agreement State. When uranium production operations cease, the specific licensee must remediate (reclaim) the site to a stable, compliant, and protective condition. These requirements and criteria are specified in Chapter 4 *Licensing Requirements for Source and Byproduct Material* of Wyoming Administrative Rules, which are consistent with NRC requirements and criteria specified in Appendix A of 10 CFR 40.

NRC regulations in 10 CFR 40.28 establish a general license for the long-term surveillance and maintenance (LTS&M) of reclaimed UMTRCA Title II mill sites operating under a specific license as of January 1, 1978. The license is regulated by NRC or the host states to which NRC has delegated Agreement State authority. NRC regulates the general license, which applies to all UMTRCA Title II disposal sites under long-term management, even those located in Agreement States. If the host state decides not to accept responsibility for long-term custody and care of the site, DOE is designated as the licensee under the NRC general license, unless the President designates the responsibility to another federal agency. The general license becomes effective for a site when NRC (1) determines that reclamation requirements have been satisfied, (2) accepts a site-specific LTSP (3) verifies that the licensee has paid the long-term surveillance charge to defer the cost of LTS&M, and (4) terminates the specific license. For Title II sites regulated by an Agreement State, NRC will concur in the Agreement State termination of the specific license.

Requirements for custody and LTS&M as specified in 10 CFR 40.28 and 10 CFR 40, Appendix A, Criterion 12, and as implemented in this LTSP are addressed in the sections identified in Table 1. LTS&M includes managing land use and institutional controls (ICs) and conducting inspections, monitoring, maintenance, and other measures to ensure that remediated UMTRCA disposal sites continue to perform as designed and protect public health, safety, and the environment. Long-term custody and care also include DOE's site-specific administrative activities and NRC's oversight activities. The plans, procedures, and specifications in this LTSP are based on the *Guidance for Developing and Implementing the Long-Term Surveillance Plans for UMTRCA Title I and Title II Disposal Sites* (DOE 2012) (referred to hereafter as the LTSP Guidance Document). The current version of the guidance document and this LTSP constitute DOE's operational plan for the long-term custody and care of the Split Rock disposal site.

Table 1. General License Requirements for the Split Rock Disposal Site

10 CFR 40.28 (b) Requirements		
	Requirement	*LTSP Section*
1.	Description of final site conditions	Section 2.0
2.	Legal description of the site	Appendix A
3.	Description of the long-term surveillance program	Section 3.0
4.	Criteria for follow-up inspections	Section 3.5.1
5.	Criteria for routine site maintenance and emergency measures	Section 3.6.3
10 CFR 40.28 (c) Requirements		
	Requirement	*LTSP Section*
1.	Implementation of the LTSP	Section 1.2
2.	Care for the site in accordance with provisions of the LTSP	Section 1.2
3.	Notification to NRC of any changes to the LTSP	Section 3.1
4.	Guarantee NRC permanent right-of-entry	Section 3.1
5.	Notification to NRC of significant construction, actions, or repairs at the site	Sections 3.5 and 3.6

1.3 Role of the U.S. Department of Energy

In December 2003, DOE formally established LM. The mission includes conducting LTS&M at closed “legacy” sites (i.e., reclaimed but with onsite waste disposal and/or residual legacy contamination) to ensure sustainable protection of public health, safety, and the environment. LM is responsible for performing LTS&M and land stewardship activities in accordance with the NRC-accepted LTSP after the NRC general license becomes effective for the site.

During long-term stewardship, changes in site conditions may require changes to this LTSP (e.g., if periodic evaluation of the long-term groundwater and surface water monitoring program warrants modifications). In such circumstances, before implementation, LM will notify NRC of the proposed modifications and revise the LTSP accordingly for NRC acceptance (10 CFR 40.28[c][3]).

LM may consider reuse opportunities during long-term stewardship, such as livestock grazing, maintaining and enhancing wildlife habitat, or promotion of existing onsite historical trails or markers. Any reuse opportunities considered will be evaluated by LM to ensure that the reuse will not negatively impact the tailings disposal system or site features, compromise human safety or the environment, or conflict with the requirements of this LTSP or the general license. Such reuse opportunities, if implemented, will not be cause for revising this LTSP; however, consultation with NRC will be sought before implementing any such reuse opportunities.

LM implements an environmental management system (EMS) to incorporate life-cycle environmental considerations into LTS&M. LM’s EMS process ensures LM maximizes beneficial use of finite resources; minimizes wastes and adverse environmental impacts; and meets or exceeds compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements.

2.0 Final Site Conditions

Decommissioning, demolition, and reclamation of the Western Nuclear Incorporated (WNI) Split Rock mill facility in Jeffrey City, Wyoming, began in 1988 and was completed in 2007 in accordance with the NRC approved reclamation plan (Shepherd Miller Inc. [SMI] 1999b). During reclamation activities, mill facilities were decommissioned and demolished and, with windblown tailings and contaminated topsoil, were removed and placed in the tailings impoundment. The tailings impoundment was covered, the evaporation pond was reclaimed, and groundwater corrective actions were completed.

2.1 General Description of the Disposal Site Vicinity

The site is approximately 2 miles northeast of Jeffrey City, Wyoming, in southeastern Fremont County, 97 miles southwest of Casper and 67 miles northwest of Rawlins (Figure 1). The county is sparsely populated, with an average population density of approximately 4 people per square mile. The estimated population of Jeffrey City was 58 in July 2010 (U.S. Census Bureau 2012).

The site lies in the high plains and sagebrush prairie of central Wyoming. Elevation at the site ranges from a low of about 6300 feet (ft) to a high of about 6800 ft. Topographically, the disposal cell itself lies at the base of a saddle between two of the granite peaks located on site. At the northern boundary of the site property is the Sweetwater River (NRC 1980), which is approximately 0.5 mile north of the disposal cell and an east-flowing tributary of the North Platte River.

The current primary land uses in the immediate vicinity of the site include cattle ranching, recreation, and wildlife habitat. Mineral exploration and oil and gas development also occur in the surrounding areas of the site, with the closest known development occurring approximately seven miles south of the site at the time the site transitioned to LM; no negative impacts to the site are anticipated from such developments. Emigrants of the Oregon, Mormon, and California trails used the Split Rock granite outcrops for navigation purposes. The site is within Eastern Shoshone, Crow, and Cheyenne aboriginal territory.

The climate of the Jeffrey City area is semiarid, with average annual precipitation of approximately 10 inches (https://en.wikipedia.org/wiki/Jeffrey_City,_Wyoming; data from NOAA, 1981–2010). More than 40% of the annual precipitation occurs during the months of April, May, and June in the form of wet snow and rain. The average annual snowfall is approximately 56 inches. The average annual high and low temperatures for the area are 56.5 °F and 27.6 °F, respectively. Temperatures range from an average high in July of 84.9 °F to an average low in January of 8.5 °F. The prevailing wind direction is from the west to southwest, with maximum wind speeds exceeding 60 miles per hour (mph) and monthly averages ranging from 10 to 17 mph. Net evaporation at the site averages approximately 36 inches per year (SMI 1999b).

DRAFT

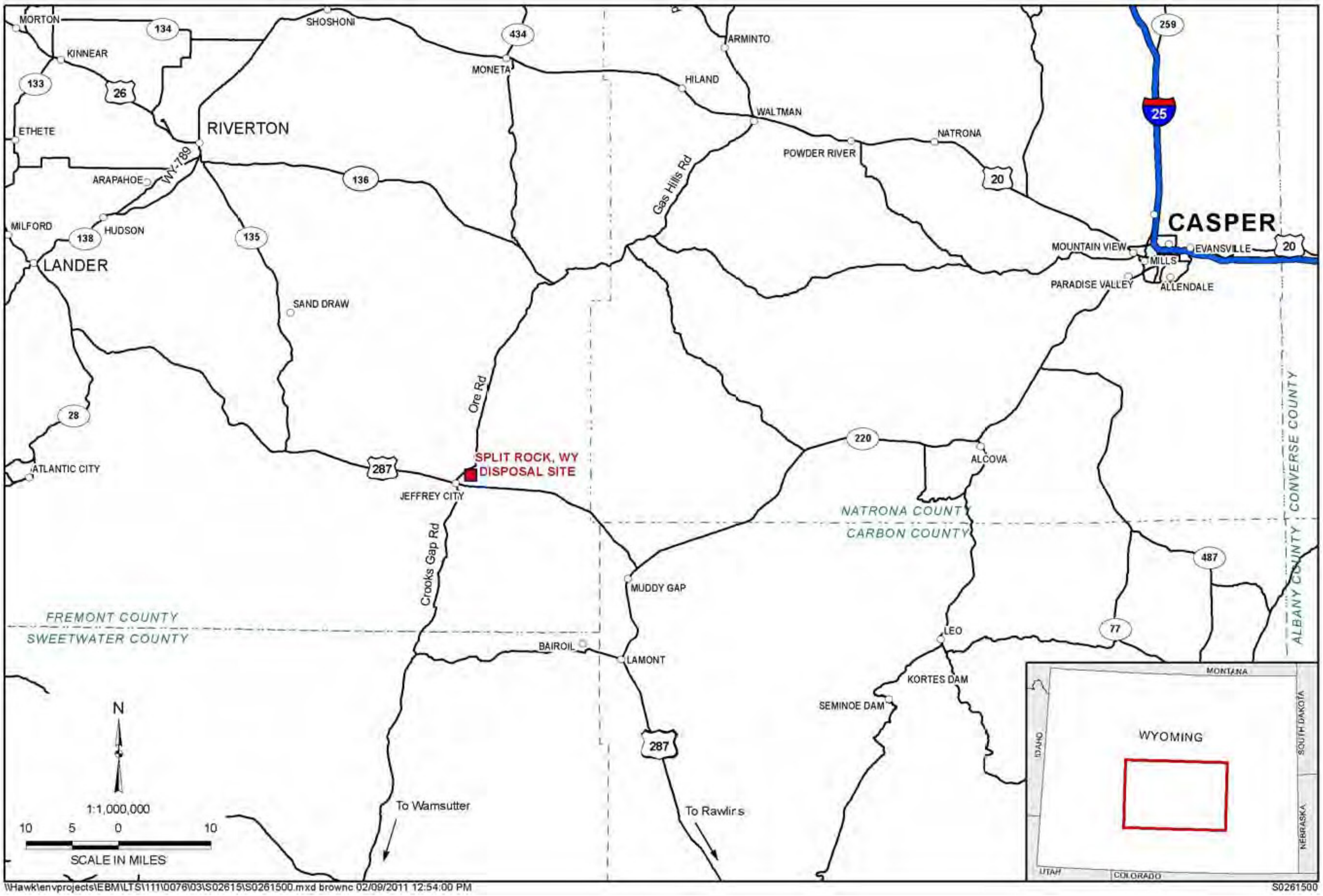


Figure 1. General Location Map of the Split Rock, Wyoming, Disposal Site

2.1.1 Site Ownership and Access

The surface area within the Split Rock disposal site's Long-Term Surveillance Boundary (LTSB) is approximately 5431 acres. Of the approximately 5431 acres within the LTSB, the following types of land ownership occur:

- About 1264 acres of WNI surface and WNI minerals (transferred to DOE in fee)
- About 219 acres of WNI surface and State minerals (WNI surface transferred to DOE in fee, and the State retains minerals)
- About 2097 acres of WNI surface and BLM-managed federal minerals (WNI surface transferred to DOE in fee)
- About 803 acres of BLM-managed federal surface and BLM-managed federal minerals
- About 1049 acres of institutional control areas (approximately 255 acres of private land with groundwater restrictive covenants and approximately 794 acres of private land where ownership below 7 feet, the depth at which groundwater in encountered, was obtained by WNI and transferred to DOE in fee, private and BLM-managed federal minerals)

Note that, within the LTSB, there is an approximately 370-acre central "island" of property which is not part of the site. This land is part of the Claytor Ranch and described as "excepted" in the legal description for the site's LTSB. The Claytor Ranch minerals are BLM-managed.

Real estate information is presented in Appendix A.

2.1.2 Directions to the Disposal Site

From Casper, Wyoming, travel southwest on State Highway 220 approximately 75 miles to Muddy Gap Junction. Head west on U. S. Highway 287 and travel 23 miles to Jeffrey City. At Jeffrey City, turn right on the county road (referred to locally as Ore Road) and travel approximately 2 miles to the site entrance on the east side of the road. Alternatively, from Rawlins, Wyoming, travel northwest on U.S. Highway 287 for 44 miles to Muddy Gap Junction. Turn right and continue to the disposal site as described above. From Riverton, Wyoming, travel southeast on WY-135 approximately 36 miles to Sweetwater Station. Head east on U.S. Highway 287 and travel approximately 19 miles to Jeffrey City. Turn left and continue to the disposal site as described above.

2.2 Site History

WNI milled uranium ore at the site from 1957 through 1981 under NRC source materials license number SUA-56 (Figure 2) (SMI 1999b). In 1981 the mill was placed on standby status, and in 1986 it was placed in possession-only status and the license was amended to complete tailings disposal. Most of the ore for the mill came from open pit mine operations in the Gas Hills district, approximately 20 miles north of the mill site. Ore was also supplied by underground mining operations in the Crooks Gap area, approximately 12 miles south of the mill site (Merritt 1971). The mill was an acid-leach, ion-exchange, and solvent-extraction operation that processed approximately 7.7 million tons of ore from 1957 to 1981 with a uranium extraction rate of up to 95%. The facility, originally designed to process 400 tons of ore per day, underwent

two capacity upgrades; by 1967 the milling capacity had been increased to 1200 tons per day, and by the 1970s the capacity had reached 1700 tons per day (SMI 1999b).

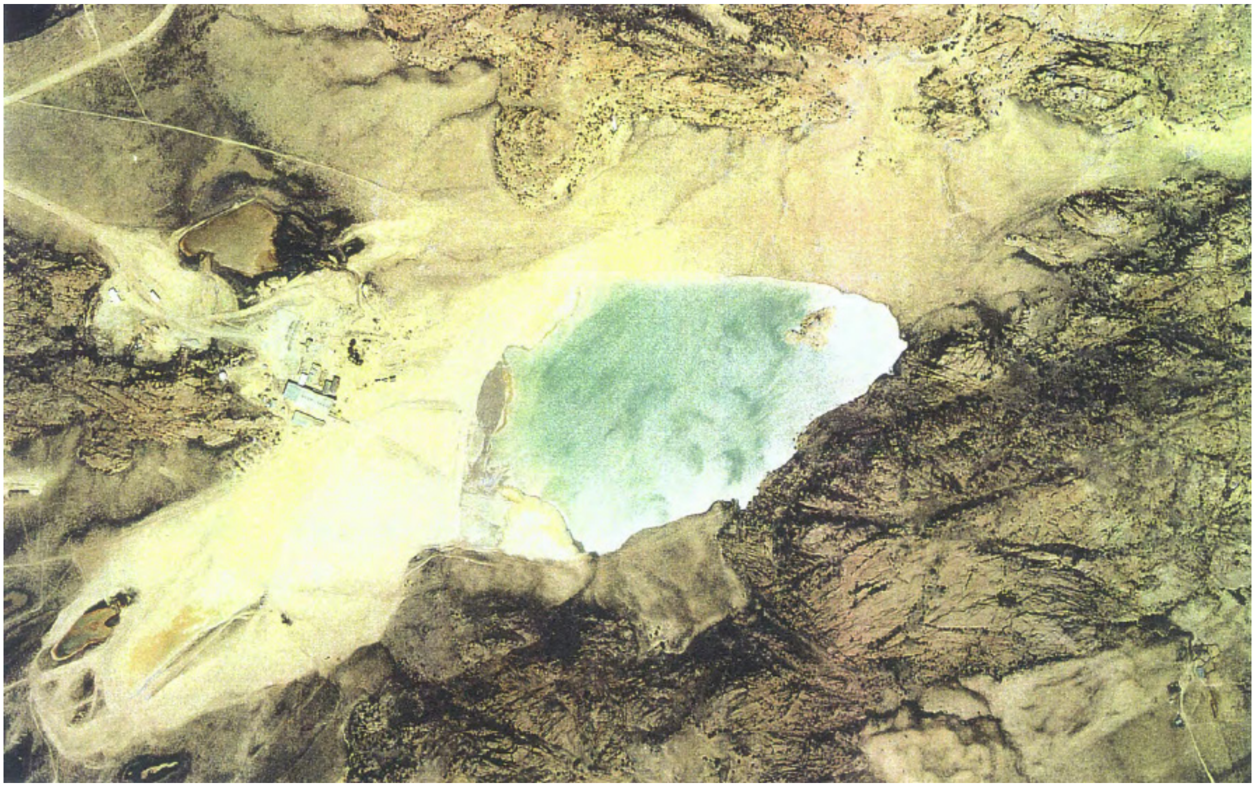


Figure 2. Aerial View of 1978 Prereclamation Split Rock, Wyoming, Disposal

During the milling period, process waste in the form of tailings solids and acidic liquids were discharged to the unlined tailings disposal areas. These tailings disposal areas or ponds were designed in 1957 when the design philosophy was to eliminate process effluent through seepage, thereby maximizing solid tailings storage while decreasing water storage and handling requirements. Waste estimates at the peak of milling indicated a ratio of 5 parts process effluent to 1-part solids were being discharged to the disposal areas. A total of approximately 7.7 million tons of tailings and billions of gallons of process effluent were deposited into three primary tailings disposal areas, known as the Main, Old, and Alternate Tailings Impoundments, that were used during the operational life of the mill (SMI 1999b).

Groundwater corrective action at the site began in 1990 with the extraction of contaminated groundwater in the area directly downgradient of the tailings impoundment. Recovered groundwater was piped to an evaporation pond and then to an evaporation misting system (SMI 1999b). The primary purpose of the system was to accelerate dewatering of the tailings impoundment, with the ultimate goal of achieving background concentrations in the groundwater. In 1999 this cleanup goal was determined to be unachievable and alternate concentration limits (ACLs) were applied for and subsequently approved in 2006 by NRC. The groundwater corrective action program (CAP) was terminated in 2006 after extracting approximately 375 million gallons of contaminated groundwater. Additional information regarding groundwater corrective action is provided in Section 2.7.4. In 2007, reclamation of the

Split Rock site was considered complete when NRC approved the reclamation of the final evaporation pond that had been used for groundwater corrective action.

In 2008, WNI reported an exceedance of the groundwater protection standards for selenium to NRC. The licensee proposed a revised ACL in 2009 for selenium at the Southwest Valley (SWV) point of compliance (POC) well, and NRC approved this revised ACL in 2010. In 2011, WNI reported an exceedance of the groundwater protection standards for nitrate to NRC. The licensee proposed a revised ACL in 2012 for nitrate at the Northwest Valley (NWV) POC well. WNI continued to work with NRC to resolve the nitrate ACL exceedance; address NRC concerns related to groundwater modeling used to establish the LTSB, also known as the long-term care boundary; and evaluate the protectiveness of ICs. NRC formally concurred that ICs at the site were protective in 2015. In 2016, WNI formally requested a license amendment to increase the nitrate ACL and expand the LTSB. As an Agreement State, Wyoming approved the nitrate ACL in 2019. In 2018, WNI reported an exceedance of the groundwater protection standards for selenium to the State of Wyoming Land Quality Division (LQD). The licensee proposed a revised ACL in 2019 for selenium at the NWV POC well, and LQD approved this revised ACL in 2019. Figure 3 summarizes the history of the site. A chronology of significant pretransition site-specific documents is provided as Appendix B.

2.3 Site Description

2.3.1 Description of Surface Conditions

The land surface of the disposal cell area at the Split Rock site was reclaimed to achieve gentle topography with a series of diversion channels that distribute storm water away from the reclaimed tailings impoundment. The final surface at the site combines grading and rock armoring to achieve the necessary surface water run-on and runoff control and erosion protection to satisfy the longevity design requirements. Although not required by the NRC-approved reclamation plan, all areas of the site disturbed by construction, except for the disposal cell, were revegetated (SMI 1999b). An aerial photograph of the reclaimed site is shown in Figure 4.

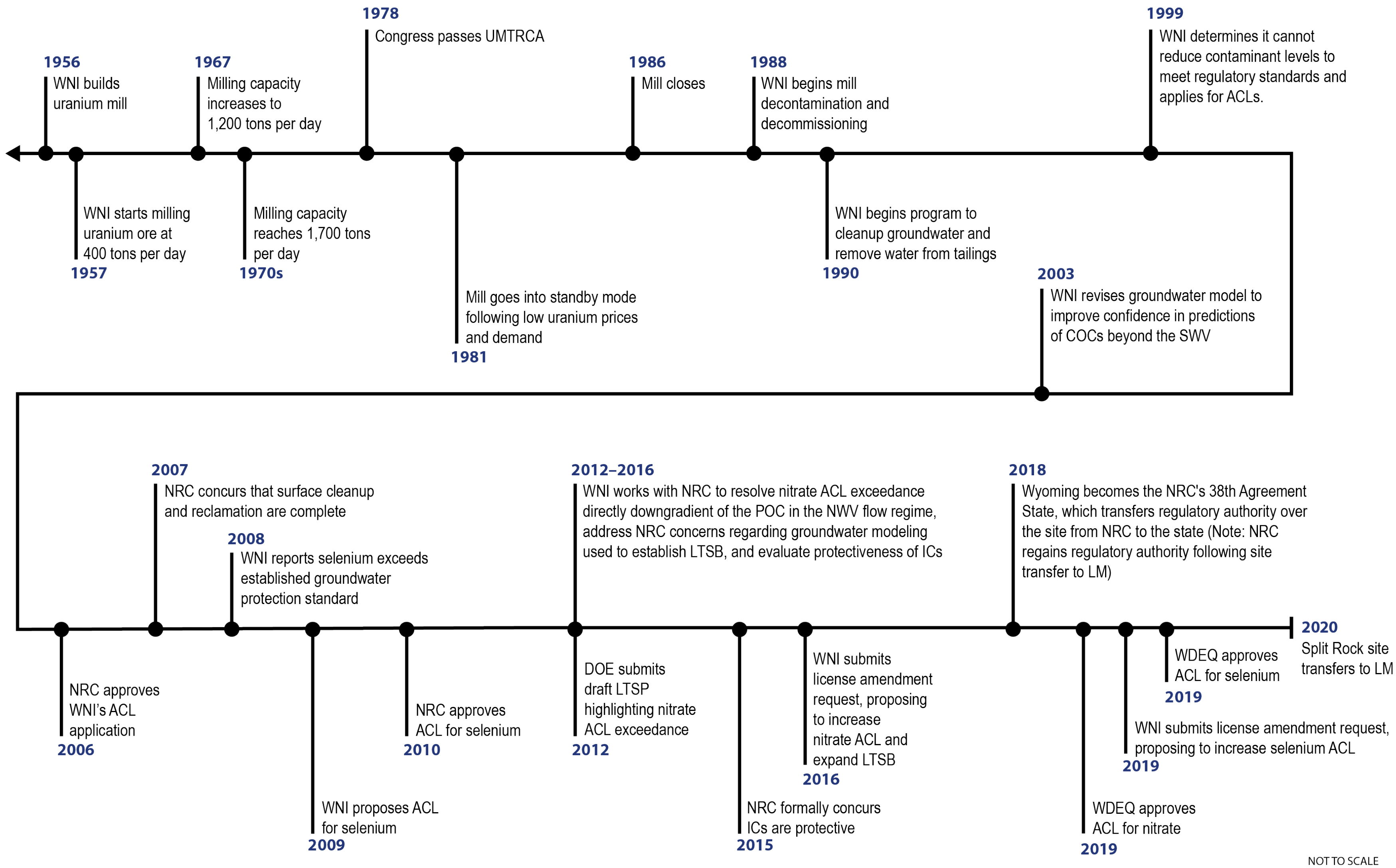


Figure 3. Timeline of Significant Actions at the Split Rock, Wyoming, Disposal Site

Figure 4. Aerial View of Reclaimed Split Rock, Wyoming, Disposal Site

The reclaimed tailings impoundment, or disposal cell, is an irregular shaped area of approximately 265 acres that lies between granite outcrops to the north, south, and east. On the west side, a granite outcrop splits the reclaimed impoundment to form two lobes, one which protrudes to the northwest of the outcrop and one which protrudes to the southwest of the outcrop. The erosion protection for the surface of the tailings impoundment consists primarily of rock mulch. The site topographic map is shown in Figure 5, and the site map is shown in Figure 6.

Four site diversion channels were designed and constructed to divert stormwater flood flows away from the tailings impoundment. The diversion channels were armored with riprap for erosion protection (SMI 1999a).

There are ten long-term monitoring wells located within the Split Rock site's LTSB. The Sweetwater River bounds the site on the north. Portions of the site property are enclosed by a barbed-wire stock fence to restrict livestock access to the disposal system.

2.3.2 Permanent Site Surveillance Features

Survey boundary monuments, a site marker, and posted perimeter warning signs are the permanent surveillance features at the Split Rock disposal site. These features will be inspected and maintained as necessary as part of the passive ICs for the site.

Thirty-seven survey boundary monuments mark the final LTSB on the west, south, and east sides of the site (Figure 6). The southerly bank of the meandering course of the Sweetwater River defines the site's northern boundary.

One unpolished granite marker with an incised message identifying the site of the Split Rock disposal area is placed just inside the main entrance gate (Figure 7). The main entrance gate is adjacent to the county road on the western portion of the site where a person entering the property would likely discover it.

A perimeter warning sign displaying the DOE 24-hour telephone number and LM website address (Figure 8) was placed near the entrance to the site to serve as an entrance sign. Thirty-six additional perimeter warning signs were placed around the perimeter of the site at locations where access to the site is most likely to occur.

2.4 Tailings Impoundment Design

The tailings impoundment at the Split Rock site is in two alluvial valleys, known as the NWV and the SWV, situated between surrounding granite outcrops. The final impoundment combines the three former tailings disposal areas (known as the Main, Old, and Alternate Tailings Impoundments) that had been in use at various times over the 1958 to 1981 operating period of the mill (SMI 1999b).

By the end of milling operations, the three former disposal areas encompassed approximately 180 acres and contained approximately 7.7 million tons of tailings. An estimated 1.67 million pounds of uranium were deposited into the tailings impoundments (based on the processing mill achieving a uranium extraction rate of approximately 95%). In 1999, it was estimated that 36% of the deposited uranium remained in the tailings impoundment while the other 64% had migrated out of the impoundment and is mostly associated with the aquifer solids (SMI 1999b). There are also an estimated 2750 curies of radioactivity (based on the activity of radium-226) in the disposal cell. Billions of gallons of process effluent were also discharged into these tailings disposal areas over the 24 years of milling operations. The maximum thickness of the tailings deposited into these disposal areas was approximately 80 ft (SMI 1999b). Figure 9 shows a general view of the site looking across the disposal cell.

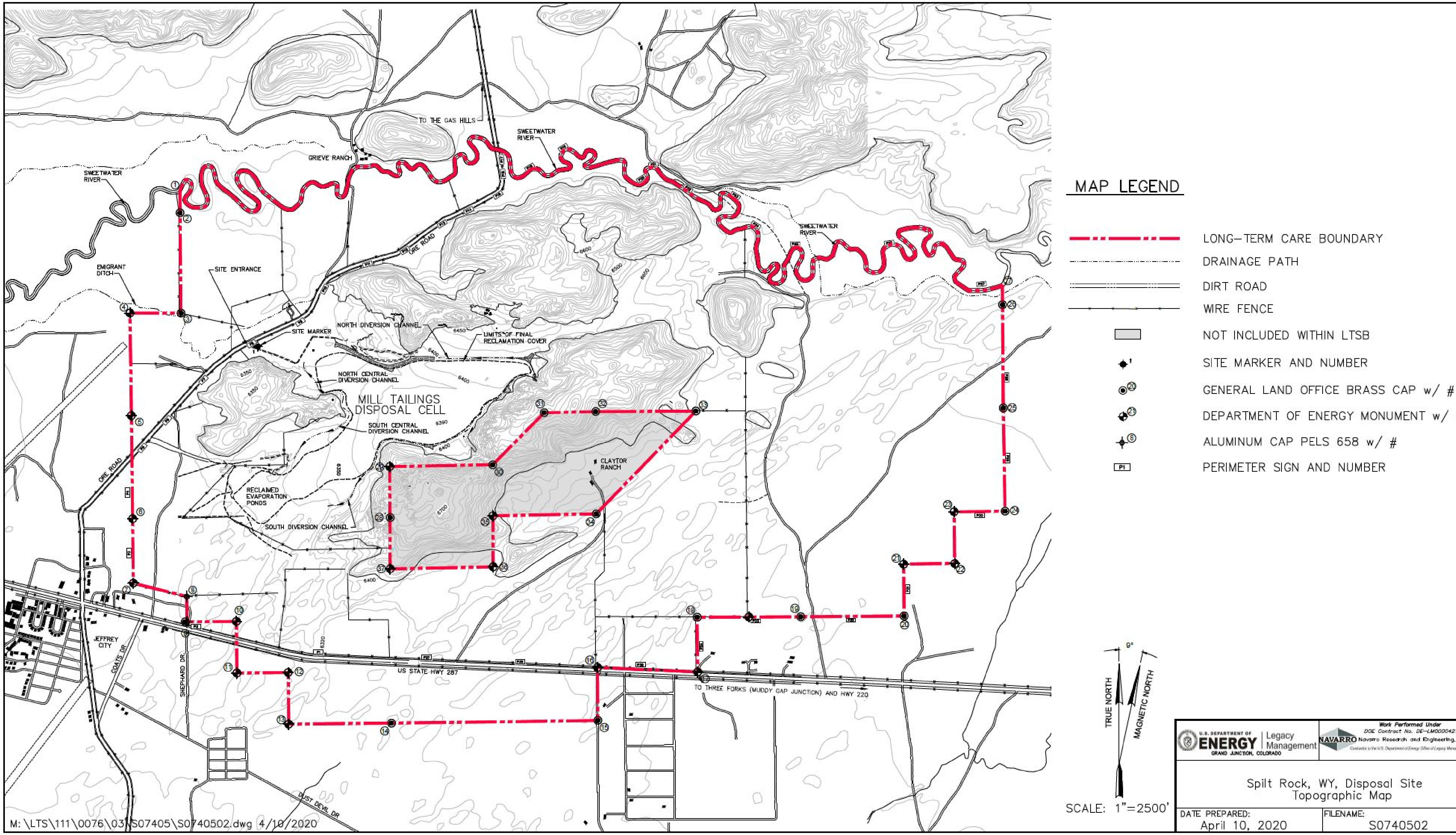


Figure 5. Split Rock, Wyoming, Disposal Site Topographic Map

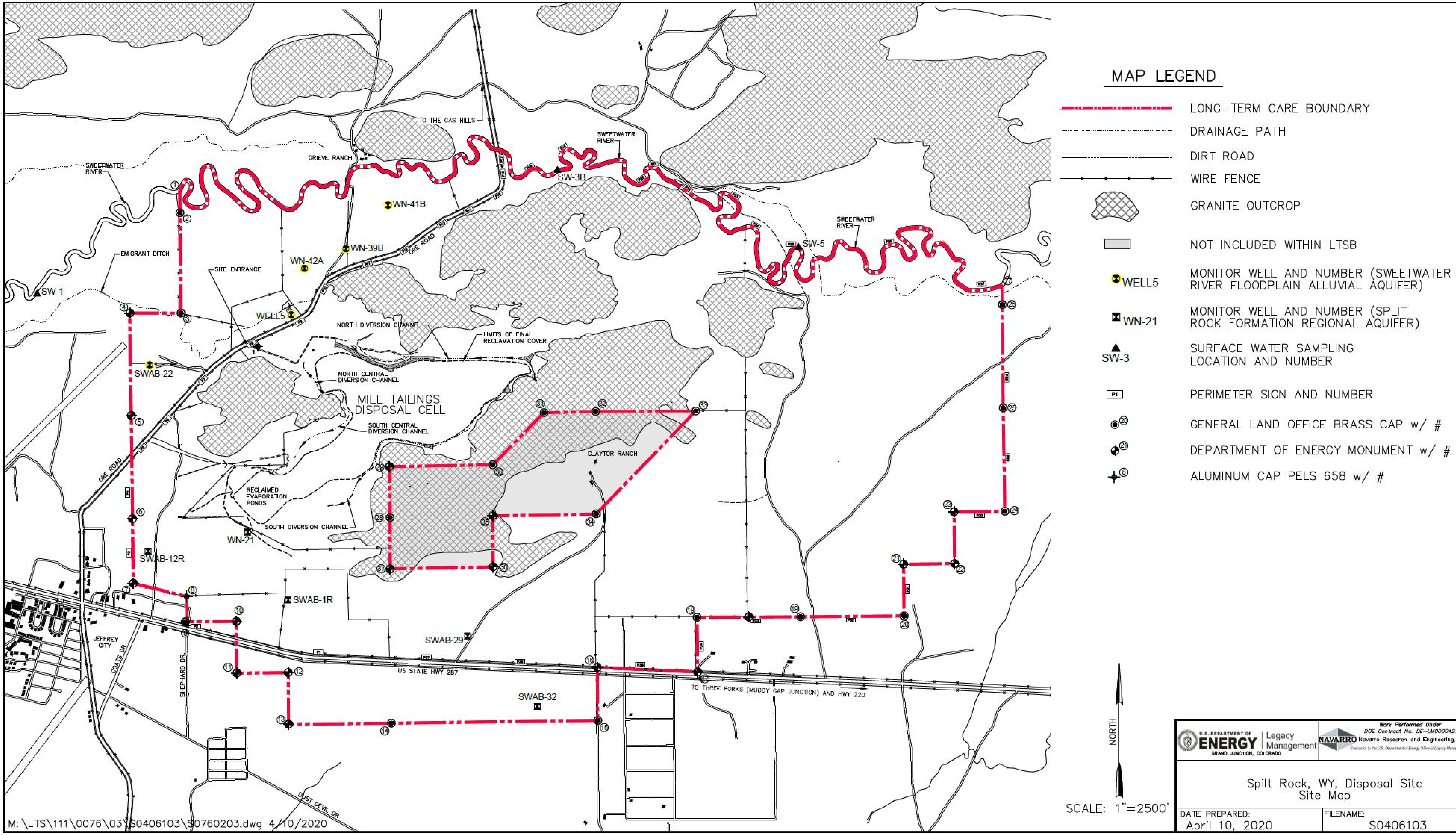


Figure 6. Split Rock, Wyoming, Disposal Site Map

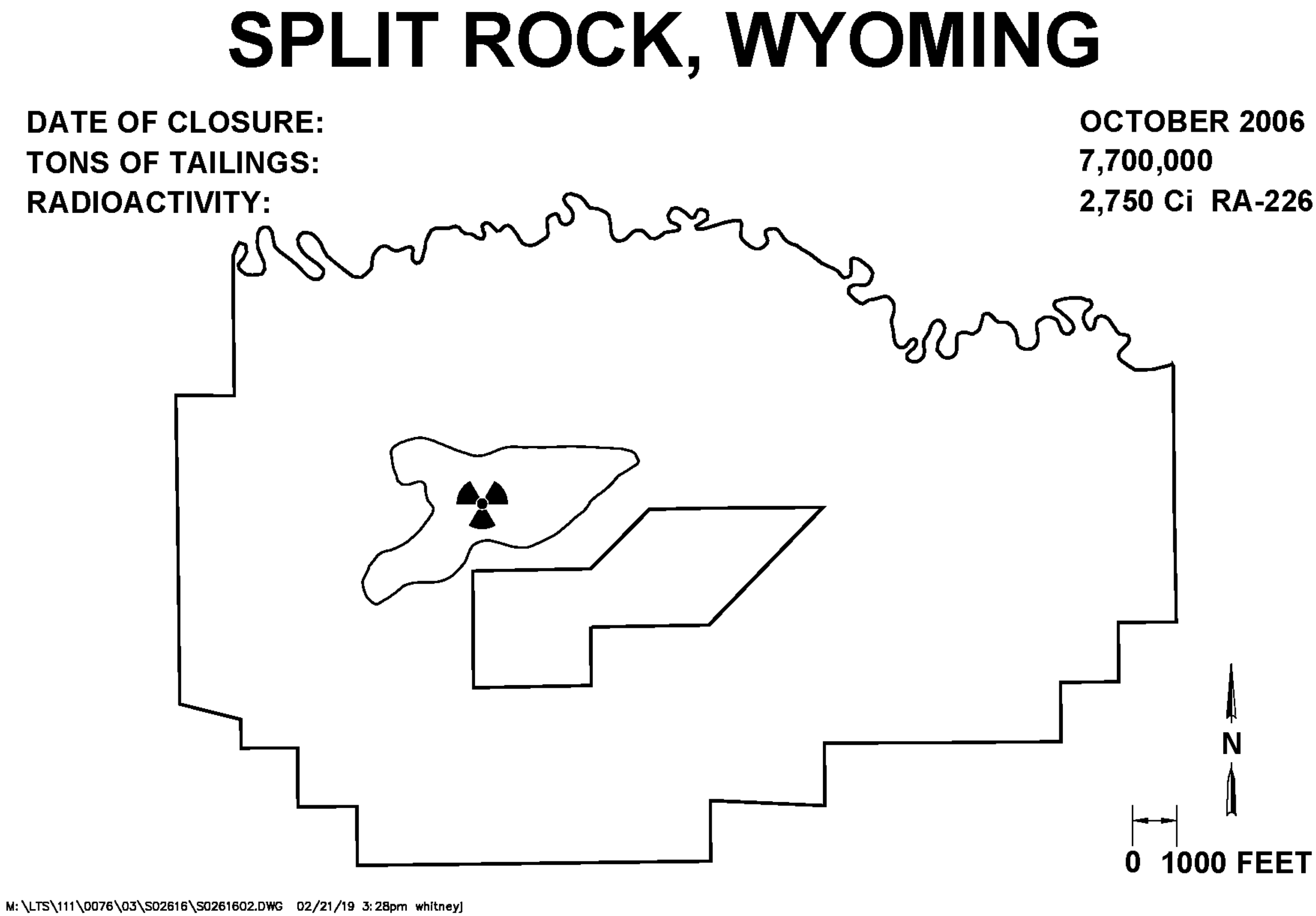


Figure 7. Site Marker at the Split Rock, Wyoming, Disposal Site

DRAFT

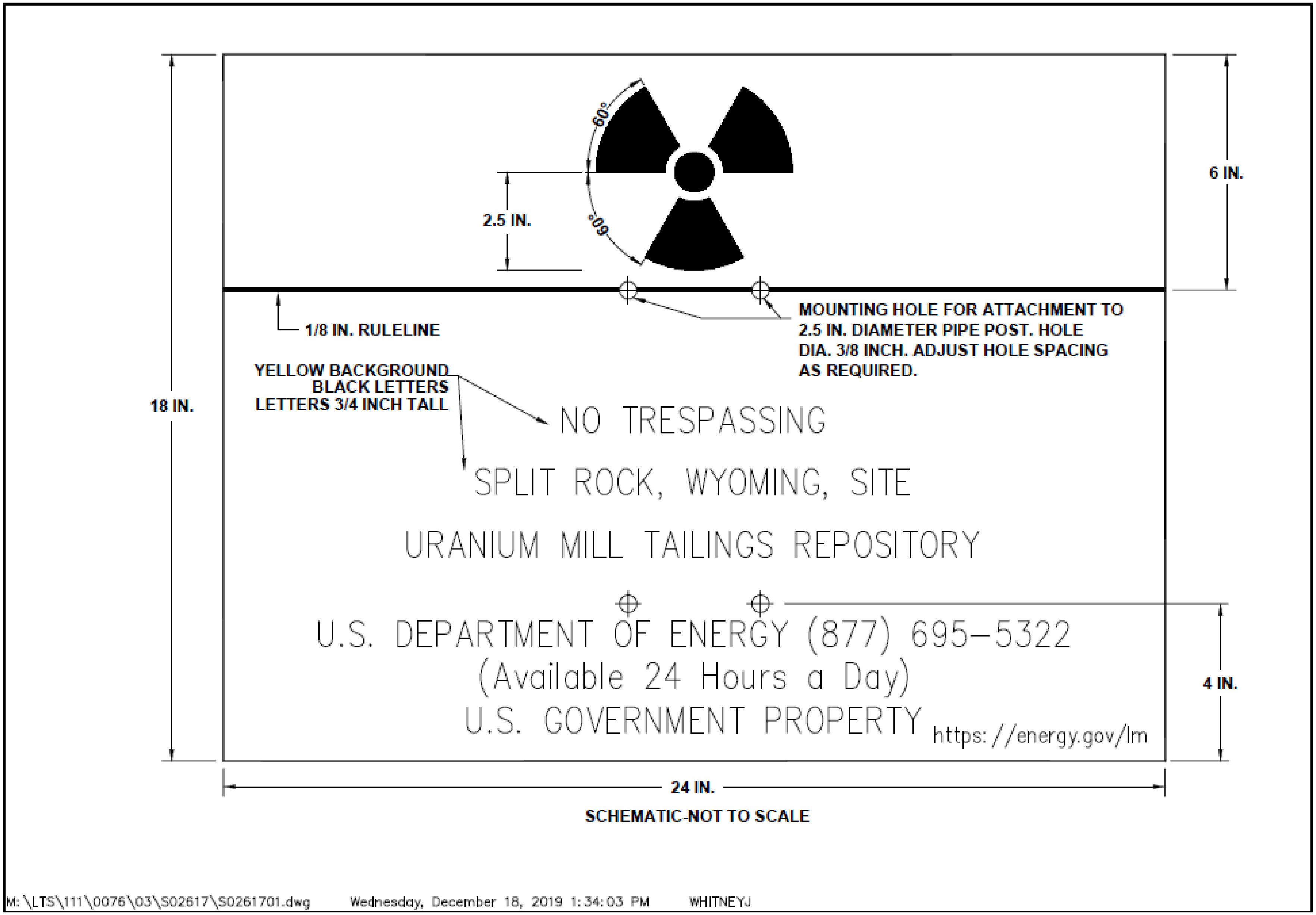


Figure 8. Warning Sign at Split Rock, Wyoming, Disposal Site

Figure 9. Disposal Cell at the Split Rock, Wyoming, Disposal Site

Decommissioning and demolition of the mill was conducted in 1988. Contaminated materials from the mill were crushed or cut into smaller pieces and buried in the tailings impoundment. Dissipation of standing water in the tailings impoundment began in 1982 and was completed in 1989. Standing water was evaporated with the use of sprinklers, an enhanced mist evaporation system, and an enhanced spray evaporation system (SMI 1999a).

Regrading and reshaping of the tailings began in 1990. This included the placement of coarse tailings over fine tailings and the retrieval and disposal of windblown and contaminated soils from outside the impoundment area. Borrow soils were placed over the regraded tailings to achieve the desired final reclamation subgrade. Vertical band drains (wicks) were installed in 1992 to accelerate settlement and dewatering of the tailings impoundment. Primary settlement was complete in 1996 (SMI 1999a).

The radon barrier material selected for the Split Rock site was Cody Shale. Material that met design requirements was transported to the site and moisture-conditioned for use in the radon barrier. Rock used as erosion protection material came from an onsite granite source on the north side of the tailings impoundment (SMI 1999a).

2.4.1 Encapsulation Design

The objective of the tailings impoundment cover is long-term isolation of the uranium mill tailings from the surrounding environment. This is accomplished by reducing radon gas emission rates to below the regulatory standard of 20 picocuries per square meter per second, minimizing infiltration of precipitation that could potentially leach contaminants into the subsurface, and physically containing the contaminated materials to prevent dispersion caused by erosion.

An interim cover was placed over both the regraded tailings and the former mill area in order to minimize the potential for windblown dispersal of the tailings and contaminated materials until the final cover was installed. The interim cover consisted of compacted borrow soil placed at a thickness which varied from between 1 and 2 ft. No credit was taken for any radon attenuation afforded by the interim cover when determining design specifications of the final cover for controlling radon gas emissions (SMI 1999a).

The final reclamation cover consists of a radon barrier layer, a borrow soil layer, and a rock mulch layer (or soil/rock matrix layer in some areas) for erosion protection. The radon barrier was placed on top of a 4-inch clay layer that was used to establish the final desired subgrade on top of the tailings. The radon barrier thickness varies from 6 inches to 45 inches, depending on the radium content of the tailings in the area being covered. The borrow soil layer thickness varies from 8 to 15 inches. The erosion protection layer consists of either a 4-inch-thick rock layer overlain by a 2-inch-thick soil layer (i.e., a soil/rock matrix) or just a 4-inch-thick rock layer (i.e., without the overlain soil component). Following the first year of construction, NRC approved WNI's request to discontinue the application of the soil component. The northwest lobe of the cell includes a soil/rock matrix for erosion protection, whereas the remaining portion of the cell consists of only a 4-inch-thick rock layer for erosion protection. The median diameter (D_{50}) of the granite rock used for erosion protection was 2 inches. Rock with a D_{50} of 3 inches was required for a small area in the northwest portion of the tailings impoundment, and rock with a D_{50} of 6 inches was required for the tailings area east and south of the North Diversion Channel. The 3- and 6-inch rock size layers were 4 inches and 12 inches thick, respectively (SMI 1999a). A typical cross section of the final cover for the tailings impoundment is shown on Figure 10.

Deep-rooted vegetation was allowed by the regulator to establish on the tailings impoundment before transition of the site to DOE. No negative impacts of disposal cell performance have been identified as a result of deep-rooted vegetation growth. Therefore, consistent with pretransition practices, removal and control of deep-rooted vegetation on the tailings impoundment will not be performed under long-term management.

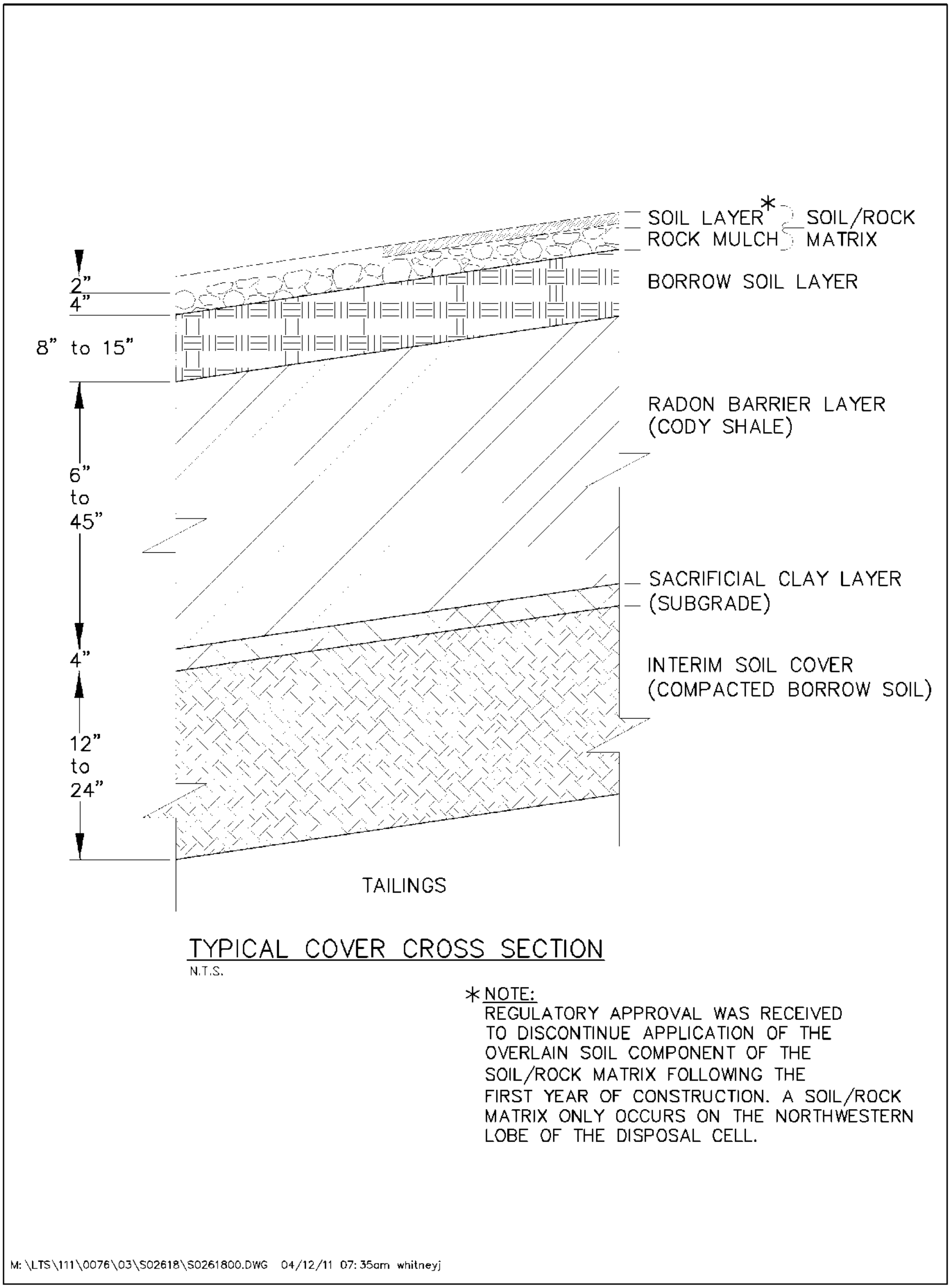


Figure 10. Typical Cross Section of the Final Cover for the Tailings Impoundment at the Split Rock, Wyoming, Disposal Site

2.4.2 Storm Water Diversion System

A site-wide grading plan was developed to determine the final grades and diversion structures that would be used to control surface water flows from impacting the disposal area. The final grade established for the site forms the basis of the surface water diversion system. The storm water diversion system for the site consists of four diversion ditches: North Diversion Channel (Figure 11 and Figure 12), South Diversion Channel, North Central Diversion Channel, and South Central Diversion Channel. In addition, a riprap-lined swale was constructed on top of the reclaimed tailings impoundment to direct flood flows into the North Diversion Channel. Riprapped erosion aprons and scour trenches were constructed at the outlets of all the diversion ditches to prevent head cutting and long-term erosion. The purpose of all these features is to convey surface water runoff away from the reclaimed tailings impoundment. The diversion system was designed to accommodate runoff from a probable maximum precipitation event of 9.2 inches of rain in a 1-hour period (WNI 1994).

Figure 11. Upper Portion of the North Diversion Channel at the Split Rock, Wyoming, Disposal Site

Figure 12. Lower Portion of the North Diversion Channel at the Split Rock, Wyoming, Disposal Site

To prevent erosion, each diversion channel was lined with a layer of riprap placed over one or two filter layers depending on the D_{50} size of the riprap. The as-built D_{50} of the riprap varied from 3 inches to 18 inches, depending upon the estimated flow velocities, and the riprap layer thickness varied from 6 inches to 27.5 inches.

The North Diversion Channel intercepts flow coming from the higher terrain north and east of the tailings impoundment and conveys it to the west. The South Diversion Channel intercepts flow coming from the higher terrain south of the tailings impoundment and conveys it to the southwest.

North Central and South Central Diversion Channels protect the impoundment from flows coming from the higher terrain to the west of the impoundment and drain water that flows off the impoundment cover. These channels convey the flow to the northwest and southwest, respectively.

2.5 Site Geology, Hydrogeology, and Groundwater Conditions

2.5.1 Geology

The Split Rock disposal site is approximately 2 miles south of the crest of the Granite Mountains in Fremont County, Wyoming. The Granite Mountains are bounded on the north by the Wind River Basin and on the south by the Great Divide Basin. The major structural features in the area surrounding the site are the Granite Mountains Uplift, the North and South Granite Mountains Fault Systems, and the Split Rock Syncline. The movement of these structures over time controlled depositional environments and the resulting stratigraphy at the Split Rock disposal site (SMI 1999b) (Figure 13).

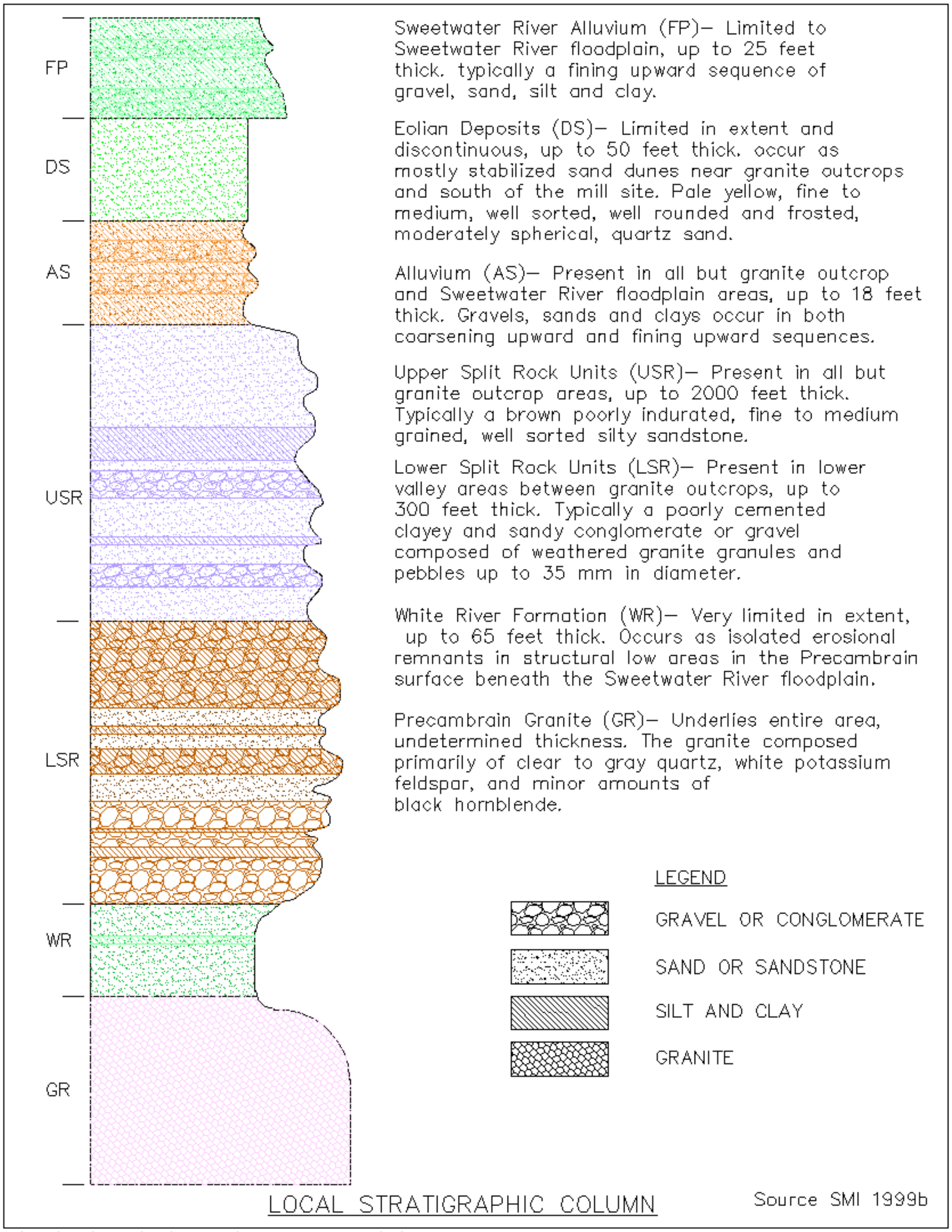
The Granite Mountains are a major anticlinal uplift in south-central Wyoming. The exposed Precambrian core trends west-northwest and is about 85 miles long and 30 miles wide. The uplift has a gentle north flank and a steep south and west flank. The mountains remain partly buried by upper Cenozoic sedimentary deposits. The Split Rock site is located within narrow valleys near the crest of the uplift (SMI 1999b).

During Miocene time, the southern portion of the Granite Mountains began to subside into the Split Rock Syncline. Simultaneously, an enormous volume of tuffaceous sandstone was deposited across most of Wyoming. These deposits became known as the Split Rock Formation in central Wyoming. The Granite Mountains were largely buried by the sandstones of the Split Rock Formation; only the highest peaks remained exposed. In the area of the Split Rock site, the Split Rock Formation lies directly on the Precambrian granite (SMI 1999b).

A regional uplift event began in late Pliocene time, beginning the present cycle of erosion in most of central Wyoming that has resulted in the crest of the buried mountains being exposed to a maximum height of approximately 1000 ft in the area. The easterly course of the Sweetwater River was also established at this time along the trough line of the Split Rock Syncline. During Pleistocene time, as the climate became more arid, wind erosion increased, scooping out some undrained depressions in the exposed sandstone of the Split Rock Formation in and around the protruding granite knobs. The Sweetwater River's reduced flow and low channel gradient now allow transport and deposition of sand, silt, and clay.

2.5.2 Regional Hydrogeology

There are two geologic units that occur within the area of the site that yield significant quantities of groundwater and have distinct baseline groundwater quality characteristics: Quaternary deposits (Sweetwater River floodplain alluvium) and Miocene rocks (Split Rock Formation). On a regional basis, the Sweetwater River floodplain alluvial aquifer is a minor component to the overall hydraulic system, whereas the Split Rock Formation covers an area of approximately 1500 square miles and its aquifer contains potentially large supplies of groundwater. Reported yields from wells completed in the Split Rock aquifer range from 3 to 1100 gallons per minute (gpm) (SMI 1999b).



M:\LTS\111\0076\03\S02619\S0261900.dwg 2/21/2020 10:11 AM whitneyj

Figure 13. Partial Stratigraphic Column of the Split Rock, Wyoming, Disposal Site

The Split Rock Formation aquifer is considered the regional aquifer and is divided into two hydrostratigraphic units referred to as the Upper Split Rock Unit and the Lower Split Rock Unit due to distinct lithologic and geologic characteristics, though they are hydraulically similar. Both regional and local groundwater flows, when forced up against the granite formation, move upward, creating an upward vertical gradient (SMI 1999b).

The saturated thickness of the regional Split Rock Formation aquifer ranges from approximately 500 to 3000 ft south of the Sweetwater River to 200 to 600 ft north of the river. The areas of greatest thickness are along the axis of the Split Rock Syncline, south of the site. The thickness can be much less where it comes up against the granite outcrops, as is the case in the area of the tailings impoundment. In the two valleys between the granite outcrops where the tailings impoundment was constructed, the thickness of the Split Rock Formation varies from 0 to 150 ft in the upper portion of the valleys to more than 500 ft at the mouth of the southwestern valley and approximately 330 ft at the mouth of the northwestern valley (SMI 1999b).

Hydrogeologic characteristics for the various aquifers (or aquifer units) at or near the site are provided in Table 2.

Table 2. Aquifer Hydrogeologic Characteristics for the Split Rock, Wyoming, Disposal Site

Unit	Hydraulic Conductivity (ft/day)	Transmissivity (ft^2/day)	Storativity
Upper Split Rock	19	2337	0.021
Lower Split Rock	6.6	1153	0.003
Floodplain	248	4185	0.21
Alluvial deposits	9.8	710	0.005

Note:
Source: NRC 2010b

Abbreviation:
ft^2/day = square feet per day

The movement of groundwater in the Sweetwater Basin is controlled by the location of recharge and discharge areas; by the thickness, gradient, and hydraulic conductivity of the geologic units; and by the location of impermeable and relatively impermeable units. Both the alluvial and regional aquifers discharge to the Sweetwater River that defines the site's northern boundary. The Sweetwater River is reported to gain approximately 17 cubic feet per second (cfs) between the gaging station near Sweetwater Station (approximately 11 miles upstream of the site) and the gaging station near Alcova (approximately 40 miles downstream of the site). However, reported discharge measurements indicate that the Sweetwater River loses water in the middle portion of this stretch from Alkali Creek to Jeffrey City and then returns to gaining water from Jeffrey City to Alcova (SMI 1999b).

The general direction of groundwater movement in the regional Split Rock Formation aquifer (within the Sweetwater Basin) is to the east and northeast, toward and in the direction of flow within the Sweetwater River (additional information regarding the localized groundwater flow direction at the site is provided below in Section 2.7.3). Uplifts along the southern boundary of the basin, including the Green Mountains and the Ferris Mountains, serve as recharge areas.

Deep recharge near the site also occurs from direct precipitation and from precipitation runoff from the surrounding granite hillsides (SMI 1999b).

Where the Sweetwater River has meandered through the valleys between the granite outcrops it has left deposits of sand, silt, and clay river sediments ranging from approximately 15 to 30 ft in thickness over the Split Rock Formation. The floodplain alluvial aquifer occurs within these river sediments (SMI 1999b). This shallow floodplain alluvial aquifer is hydrologically connected to the underlying regional Split Rock Formation aquifer and is highly permeable (SMI 1999b).

2.5.3 Local Hydrogeologic Conditions

The reclaimed tailings area at the Split Rock disposal site is at the head of a natural drainage that is bounded by steep granite outcrops to the north and the south of the tailings impoundment. Toward the outlet of this drainage, an additional granite outcrop separates the flow into two valleys that are referred to as the NWV and the SWV. Drainage from the NWV intersects the alluvial floodplain aquifer of the Sweetwater River, while drainage from the SWV intersects a plain of alluvial deposits in the regional Split Rock aquifer (SMI 1999b).

Horizontal groundwater flow gradients are directed out of the area of high elevation that surrounds the tailings impoundment and toward either the NWV or SWV. Groundwater in the Upper Split Rock unit underlying the tailings impoundment is primarily directed down the NWV (approximately 90% of the flow), with the balance of the flow (approximately 10%) directed down the SWV. This split in the flow is due to the presence of a subsurface granite high located at the head of the SWV and directly west of the tailings impoundment. Outside of either valley groundwater flowing from the tailings impoundment area merges with the east northeast trending regional groundwater flow of the Split Rock aquifer. An upward vertical gradient occurs in the groundwater of the regional Split Rock aquifer in this area due to the presence of the granite outcrops. This upward vertical gradient results in seepage from the tailings impoundments occurring primarily within the groundwater of the Upper Split Rock Unit in this area (SMI 1999b).

Groundwater flow exiting the NWV merges with the regional groundwater flow of the Split Rock aquifer that is entering the Sweetwater River floodplain alluvial aquifer. Most of the groundwater flow (approximately 80%) exiting the SWV merges with the east-northeast trending regional groundwater flow of the Split Rock aquifer. This flow continues along the southern edge of the granite outcrops directly south of the impoundment before migrating across the eastern portion of the site where it eventually enters the Sweetwater River floodplain alluvial aquifer. The balance of the groundwater exiting the SWV flows to the north around the granite outcrops west of the impoundment where it joins the east-northeast trending regional groundwater flow of the Split Rock aquifer that is merging with the east flowing groundwater of the Sweetwater River floodplain alluvial aquifer. All groundwater in the immediate area of the tailings impoundment eventually discharges to the Sweetwater River. Groundwater exiting the NWV reaches the Sweetwater River well before groundwater that exits the SWV, particularly the majority portion of the flow which travels to the south and joins with the east-northeast trending regional groundwater flow of the Split Rock aquifer (SMI 1999b). The groundwater flow patterns and affected aquifers are shown on Figure 14 and Figure 15, respectively.

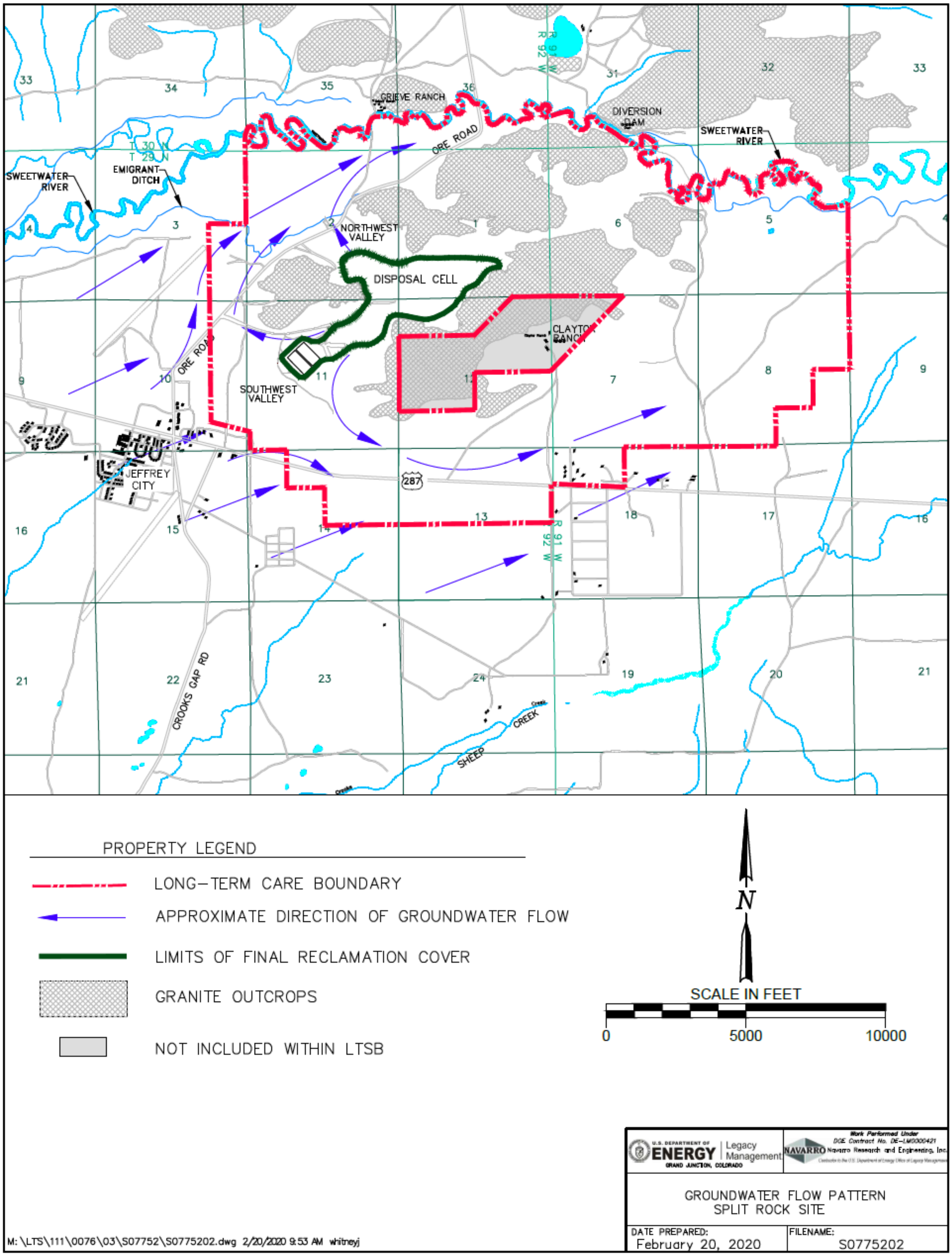


Figure 14. Groundwater Flow Patterns, Split Rock, Wyoming, Disposal Site

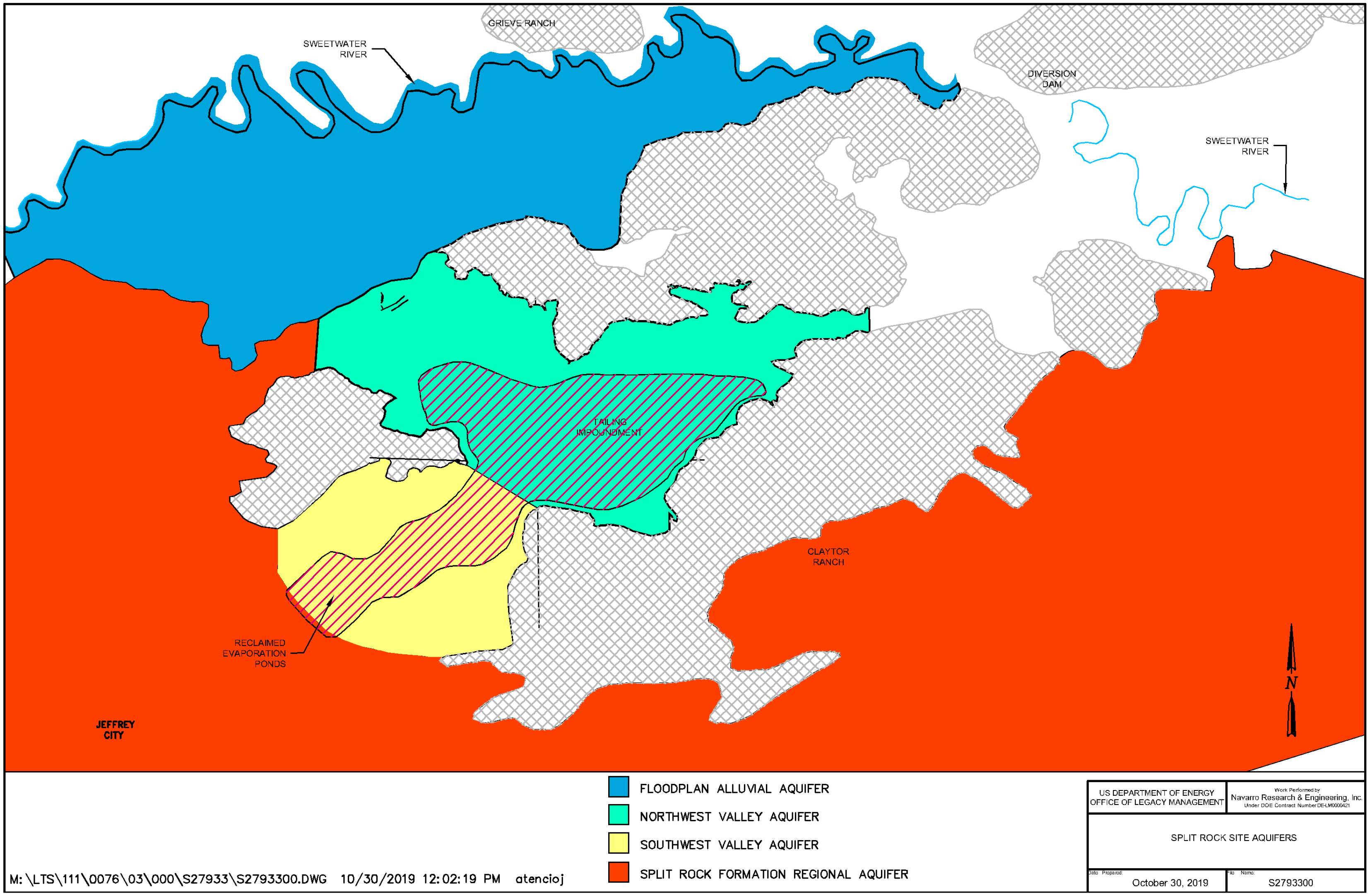


Figure 15. Aquifers in the Vicinity of the Split Rock, Wyoming, Disposal Site

DRAFT

Seepage from the tailings impoundments has impacted the groundwater within the Split Rock Formation (regional aquifer) and the Sweetwater River alluvium (floodplain aquifer) in the area underlying and downgradient of the tailings impoundment. Concentrations of site-related contaminants are typically highest in groundwater at the mouths of both the NWV and SWV, directly downgradient of the tailings impoundment. Contaminants (particularly uranium) are typically found at depth in the valleys but not outside the valley mouths. The higher hydraulic conductivity and lateral gradient in the alluvium (as compared to the Split Rock Formation) has allowed for further migration of contaminants in this shallower zone downgradient of the NWV than it has downgradient of the SWV. The alluvium may also contain buried channel deposits of coarse-grained material that provides preferred pathways for shallow groundwater flow in the floodplain (SMI 1999b).

Drainage of the tailings historically input up to 1400 gpm into the underlying groundwater system. Since tailings and water disposal in the impoundments ceased in 1986, drainage into the underlying system has greatly diminished, and the elevated groundwater level (i.e., mound) in the immediate area of the impoundment has largely dissipated. In 1999, tailing seepage rates were estimated to be approximately 150 gpm and were expected to reach long-term, steady-state rates of less than 5 gpm over the next 30 years (by 2029) (SMI 1999b).

2.5.4 Groundwater Remedy

This section provides a very brief overview of the groundwater remedy. Additional discussion is provided in Appendix E of this document. The groundwater CAP at the site began in 1990. The original goal was to achieve background concentrations in the groundwater. In 1999 WNI concluded that continued corrective action would not be effective in further reducing contaminant concentrations in groundwater. Therefore, WNI proposed that ACLs be determined for the site's POCs that are protective of human health and the environment and which would result in compliance with groundwater protection standards (or established background concentrations, whichever is higher) at the LTSB (i.e., the points of exposure [POEs]). The 1999 groundwater characterization and evaluation report submitted to NRC includes the ACL application. NRC approved ACLs for the site in 2006 (NRC 2006b). NRC also established trigger levels for groundwater and surface water, which were included in the amended license.

During preparation for site transition and development of the LTSP by DOE, issues were raised regarding nitrate concentrations in the SWV. There were exceedances in ACL in wells SWAB-1R and SWAB-2 directly downgradient of the POC. An exceedance of the selenium ACL was also observed in well WN-42A in the NWV, which is directly downgradient of the NWV POC. During the time that these issues were undergoing resolution, Wyoming became an Agreement State and licensing authority for the site was transferred from NRC to the State. The Wyoming license (WYSUA-56) adopted the same requirements as the prior NRC-issued license (SUA-56).

In 2019, the revision to the nitrate ACL was approved by the Wyoming Department of Environmental Quality (WDEQ), and the site boundary was expanded to encompass the SWV groundwater flowpath all the way to the Sweetwater River (WDEQ 2019a). A revised selenium ACL was developed and amended to the license (WDEQ 2019b). Final licensed values incorporated in WYSUA-56 are in Table 3 and Table 4.

Table 3. Final ACL Levels for the Split Rock Site Prior to Transfer to DOE

Constituent of Concern	NWV[a]	SWV[a]
Uranium	4.8	3.4
^{226}Ra and ^{228}Ra	7.2	19.9
Manganese	225	35
Molybdenum	0.66	0.22
Ammonia	0.61	0.84
Nitrate	317	500
Selenium	0.3	0.05

Note:
[a] All results in milligrams per liter except ^{226}Ra and ^{228}Ra in picocuries per liter.

Abbreviations:
^{226}Ra = radium-226
^{228}Ra = radium-228

Table 4. Final Trigger Levels for the Split Rock Site Prior to Transfer to DOE

Constituent of Concern	Surface Water Trigger Values[d]	Split Rock Aquifer Trigger Values[d]	Floodplain Alluvium Trigger Values[d]
Uranium	0.03	0.087/0.3[a]	0.044
^{226}Ra and ^{228}Ra	5	5.0	5.0
Manganese	0.05	0.73	2.39
Molybdenum	0.18	0.18	0.18
Ammonia[b]	0.5	0.5	0.5
Nitrate[c]	10	10	10

Notes:
[a] SWAB-32 trigger value.
[b] Though not specified, it is assumed that this is unionized ammonia based on subsequent monitoring reports (calculated as 2.5% of total ammonia—assumes pH is approximately 8).
[c] Though not specified, it is assumed this is nitrate reported as nitrogen.
[d] All results in milligrams per liter except ^{226}Ra and ^{228}Ra in picocuries per liter.

Abbreviations:
^{226}Ra = radium-226
^{228}Ra = radium-228

2.5.5 Final Groundwater Conditions

The current and future site-related groundwater contaminant plumes for both the NWV and SWV should be completely contained within the current site boundary. The ultimate point of discharge for both flow regimes is the Sweetwater River. Site-related groundwater in the SWV is not expected to reach the river until 2496. Maximum discharge of site-related contamination from the NWV to the river was reported to be in 1996. Except for nitrate and selenium, concentrations of all site-related constituents have been meeting licensed requirements. With the revision of the nitrate and selenium ACLs, continued compliance with all ACLs in the groundwater is anticipated.

2.5.6 Surface Water

Several locations along the river from upstream to downstream have been monitored since 2005. Samples have been collected in the spring and fall. Surface water concentrations show considerable variability, particularly for sulfate. The temporal variability is greater than the variability between sample locations. Concentrations are higher in the fall when river flows are low and lower in the spring when flows increase due to spring runoff. Observed concentrations for both constituents are within the statistical background range reported in the groundwater characterization report (SMI 1999b). The highest observed concentrations of both uranium and sulfate have been observed at surface water location SW-3 (Appendix E, Figure E-1), which is in the flowpath of the NWV groundwater plume.

Concentrations of site-related constituents in the Sweetwater River must be below applicable surface water protection standards or established background concentrations, whichever is higher. The Sweetwater River in the vicinity of the site is designated as a drinking water source, among other uses (WDEQ 2013). No exceedances of applicable standards have been observed in the Sweetwater River due to discharge of site-related groundwater contamination. Although, the licensee has reported that background levels of uranium in excess of the standard (0.03 milligram per liter [mg/L]) have occurred in the past.

2.6 Institutional Controls

In 2002, NRC approved the use of ICs within the LTSB to prevent direct human exposure to site-derived contaminants in groundwater for the duration of the 1000-year performance period (NRC 2006b). These ICs, which carry with the land, restrict the use of groundwater for human consumption and domestic use of groundwater through restrictive covenants and ownership of portions of the subsurface where groundwater occurs (i.e., deeper than 7 ft). This privately held subsurface estate was deeded to WNI and transferred to DOE. One of the three ICs, for the McIntosh property, includes a provision that allows groundwater to be used for agriculture, stock watering, or other ranching purposes. These site-specific groundwater ICs in place at transition are provided in Appendix A and are shown on Figure A–1. NRC determined that these ICs were both durable and enforceable (NRC 2016). DOE will maintain and monitor these groundwater ICs under long-term care. See Section 3.8 for more information.

3.0 Long-Term Surveillance Program

3.1 General License for Long-Term Custody

Under UMTRCA Section 202 [a], the host state has the right of first refusal for long-term custody of Title II disposal sites. On July 15, 1994, the State of Wyoming exercised its right of first refusal and declined the long-term custody of all UMTRCA Title II disposal sites in Wyoming, including the Split Rock disposal site (State of Wyoming 1994). Because the State declined this right, the site transitioned to DOE for long-term custody upon termination of the specific license.

NRC has accepted this LTSP and concurred with the State of Wyoming's termination of WNI's radioactive material license (WYSUA-56); the site is included under NRC's general license for long-term custody (10 CFR 40.28 [b]). Concurrent with this action, the deed and title to the site within the LTSB owned by WNI were transferred to DOE. The remaining balance of the property is federally owned or privately held and under IC restrictions (see Section 2.6, Section 3.8, Appendix A and Figure A-1). Although disposal structures (i.e., the disposal cell and its associated surface water diversion structures) are designed to last "for up to 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years" (10 CFR 40, Appendix A, Criterion 6), there is no termination of the general license for DOE's long-term custody of the site (10 CFR 40.28 [b]).

Representatives of NRC must be guaranteed permanent right-of-entry for periodic site inspections. Perpetual access to the site is gained from Fremont County Ore Road.

3.2 Requirements of the General License

To meet the requirements of NRC's license at 10 CFR 40, Section 28, and Appendix A Criterion 12, the long-term custodian must, at a minimum, fulfill the following requirements (the section in the LTSP in which each requirement is addressed is given in parentheses):

- Annual site inspection (Section 3.3)
- Annual inspection report (Section 3.4)
- Follow-up inspections and inspection reports, as necessary (Section 3.5)
- Site maintenance, as necessary (Section 3.6)
- Emergency measures in the event of catastrophe (Section 3.6.2)
- Environmental monitoring (Section 3.7)

3.3 Annual Site Inspections

3.3.1 Frequency of Inspections

At a minimum, sites must be inspected annually to confirm the integrity of visible features and to determine the need, if any, for maintenance, additional inspections, or monitoring (10 CFR 40, Appendix A, Criterion 12). To meet this requirement, DOE will inspect the site once each calendar year. The date of the inspection may vary from year to year, but DOE will endeavor to

inspect the site approximately once every 12 months unless circumstances warrant a variance. Any variance to this inspection frequency will be explained in the inspection report. DOE will notify NRC and the State of Wyoming of the inspection at least 30 days in advance of the scheduled inspection date.

3.3.2 Inspection Procedure

For the purpose of inspection, the site will be divided into different inspection areas. Inspection of each area occurs by walking or driving a series of unspecified traverses such that the entire site is inspected. Within each area, inspectors examine specific site surveillance features, such as boundary monuments, signs, site marker, and other features listed on the Initial Site Inspection Checklist (Appendix C). Table 5 lists the inspection areas for the site.

Table 5. Inspection Areas Used During First Inspection of the Split Rock, Wyoming, Disposal Site

Inspection Area	Description
Tailings Impoundment top slope and side slopes	Cover and vegetation; settlement and slumping; erosion; rock displacement or degradation; seeps and evidence of standing water; and bio-intrusion.
Tailings impoundment drainage diversion channels, toe drains, and apron	Riprap displacement and integrity; functionality of drainage structures; and erosion, sedimentation, and accumulation of debris.
Site perimeter and balance of site	Area between tailings impoundment and site boundary; entrance sign, site entrance and marker; fence, and boundary monuments, and perimeter warning signs; and monitor wells.
Outlying area	Land use in the area approximately 0.25 mile beyond site boundary.

The annual inspection will be a visual walk-through. The primary purpose of the site inspection will be to look for evidence of degradation, such as cover cracking or settlement, wind or water erosion, structural discontinuity of the disposal cell, vegetation condition, and animal or human intrusions that could result in adverse impacts to the site. Evidence of modifying processes that could be detrimental to the performance of the disposal system will be evaluated. Disposal site and disposal cell inspection techniques are described in detail in Attachment 3 of the guidance document (DOE 2012).

In addition to inspecting the site itself, inspectors will note changes and developments in the surrounding area. Significant changes within this area could include development or expansion of human habitation, erosion, road building, oil and gas development, or other changes in land use. Changes in land or groundwater use in the area immediately surrounding the site that could result in diminished protectiveness will be evaluated. The effectiveness of the groundwater ICs that are in place within the LTSB will be monitored annually by verifying with the Wyoming State Engineer's Office that no new permit has been granted for construction of water wells on the three privately held lands.

Inspectors take photographs to document conditions and observations of the inspection areas and site surveillance features. Observations may include evidence of vandalism or a slow modifying process, such as rill erosion, that should be monitored more closely during annual site inspections. Photographs are documented on a photograph log (Appendix D).

3.3.3 Inspection Checklist

The inspection checklist guides the inspection. The initial site-specific inspection checklist is presented in Appendix C. The checklist is reviewed and revised before each annual inspection. At the end of an annual site inspection, inspectors will make notes about revisions to the checklist, if necessary, in anticipation of the next annual site inspection. Revisions to the checklist will include such items as discoveries or changes in site conditions that must be inspected and evaluated during the next annual inspection.

3.3.4 Personnel

Annual inspections will be performed by a minimum of two inspectors. Inspectors will be experienced scientists or engineers who have been trained to perform inspections through participation in previous site inspections and annual training. Engineers may need to participate in the inspection if the inspectors identify potential concerns with the integrity of the disposal cell and diversion structures.

Scientists will include geologists, hydrologists, biologists, and environmental scientists representing various fields (e.g., ecology, soils, range management). Engineers will typically be trained in civil, geotechnical, or geological engineering. Additional scientists or engineers with specific expertise may be assigned to the inspection to evaluate serious or unusual problems and make recommendations.

3.4 Annual Inspection Report

Results of the annual site inspection are included in an annual inspection report that is submitted to NRC within 90 days of the last UMTRCA Title II site inspection of that calendar year (10 CFR 40, Appendix A, Criterion 12). If the annual report cannot be submitted within 90 days, DOE will notify NRC of the circumstances. The annual inspection report includes the annual inspection results for all UMTRCA Title II sites licensed under 10 CFR 40.28.

3.5 Follow-up Inspections

Follow-up inspections are unscheduled inspections that are targeted to evaluate specific findings or concerns. Follow-up inspections may be required (1) due to discoveries made during a previous annual site inspection or (2) due to changed site conditions reported by a citizen or outside agency.

3.5.1 Criteria for Follow-up Inspections

Criteria necessitating follow-up inspections are defined in 10 CFR 40.28 (b)(4). DOE will conduct follow-up inspections should any of the following occur:

- A condition is identified during the annual site inspection or other site visit that requires personnel, perhaps with specific expertise, to return to the site to evaluate the condition.
- DOE is notified by a citizen or outside agency that conditions at the site are substantially changed.
- An extreme natural event, such as a significant earthquake (6.5 Richter-scale or greater) or rainfall event (7 inches or more in an hour), occurs.

With respect to citizens and outside agencies, DOE will attempt to establish communication with local law enforcement and emergency response agencies to facilitate notification in the event of significant trespass, vandalism, or natural disaster. Because the site is remote, DOE recognizes that local agencies may not necessarily be aware of current site conditions; however, these agencies will be requested to notify DOE or provide information should they become aware of a significant event that might affect the security or integrity of the site.

DOE may request the assistance of local agencies to confirm the seriousness of a condition before conducting a follow-up inspection or emergency response. The public may use the 24-hour DOE telephone number posted prominently on the entrance sign to request information or to report a problem at the site.

Once a condition or concern is identified at the site, DOE will evaluate the information and determine whether a follow-up inspection is warranted. Conditions that may require a routine follow-up inspection include erosion, changes in vegetation, storm damage, trespassing, minor vandalism, or the need to evaluate or define maintenance tasks.

Conditions that threaten the safety or integrity of the site may require a more immediate (nonroutine) follow-up inspection. Slope failure, a disastrous storm, a major seismic event, fires, and deliberate human disturbance of an engineered structure are among these conditions.

DOE will use a graded approach with respect to follow-up inspections. The urgency of the follow-up inspection will be in proportion to the seriousness of the condition. The timing of the inspection may be governed by seasonal considerations. For example, a follow-up inspection to evaluate an erosion problem or perform maintenance might be scheduled to avoid snow cover and seasonal weather.

In the event of “unusual damage or disruption” (10 CFR 40, Appendix A, Criterion 12) that threatens or compromises site safety, security, or integrity, DOE will:

- Notify NRC in accordance with 10 CFR 40, Appendix A, Criterion 12, or 10 CFR 40.60, whichever is determined to apply.
- Begin the DOE environment, safety, and health reporting process.
- Respond with an immediate follow-up inspection or mobilization of an emergency response team.
- Implement measures as necessary to contain or prevent dispersion of radioactive materials (Section 3.6).

3.5.2 Personnel

Inspectors assigned to conduct follow-up inspections will be selected on the same basis as they are for annual site inspections (Section 3.3.4).

3.5.3 Reports of Follow-up Inspections

Results of routine follow-up inspections will be included in the next annual inspection report (Section 3.4). Separate reports will not be prepared unless DOE determines that it is advisable to notify NRC or other outside agency of a problem at the site.

If follow-up inspections are required for more serious or emergency reasons, DOE will submit to NRC a preliminary report of the follow-up inspection within the required 60 days (10 CFR 40, Appendix A, Criterion 12).

3.6 Routine Site Maintenance and Emergency Measures

3.6.1 Routine Site Maintenance

UMTRCA disposal sites are designed and constructed so that "ongoing active maintenance is not necessary to preserve isolation" of radioactive material (10 CFR 40, Appendix A, Criterion 12). The tailings impoundment and its associated surface water control structures have been designed and constructed to minimize the need for routine maintenance. DOE will conduct vegetation control as needed to control noxious and invasive weed species.

The surface of the tailings impoundment was constructed with minimal slope to promote positive drainage while minimizing runoff water velocities. The surface was covered with rock mulch that is expected to endure for the long term. Because of the rock mulch covering the compacted materials, along with mild slopes, adverse wind or water erosion impacts that would require maintenance are not anticipated. Areas adjacent to the impoundment where runoff water could achieve erosional velocities have been armored with riprap. The tailings impoundment area is also isolated by fencing and granite outcrops to prevent damage from livestock grazing. On the portions of the site where livestock grazing is permitted, the grazing leasee(s) will be required to maintain all fencing used for livestock management onsite.

If an inspection of the disposal cell reveals that an as-built structure or feature has failed or degraded in a way that compromises site protectiveness, an evaluation will be conducted to determine an appropriate response action that ensures protectiveness of the disposal system is maintained. DOE will perform routine site maintenance, where and when needed, to maintain protectiveness. Results of routine site maintenance will be summarized in the annual site inspection report.

3.6.2 Emergency Measures

Emergency measures are the actions that DOE will take in response to "unusual damage or disruption" (10 CFR 40, Appendix A, Criterion 12) that threatens or compromises site safety, security, or integrity. DOE will contain or prevent dispersal of radioactive materials in the unlikely event of a breach in cover materials.

3.6.3 Criteria for Routine Site Maintenance and Emergency Measures

Site intervention measures, from minor routine maintenance to large-scale reconstruction following potential disasters, fall on a continuum. Although required by 10 CFR 40.28 (b)(5), criteria for triggering particular DOE responses for each increasingly serious level of intervention are not easily defined because the nature and scale of all potential problems cannot be foreseen. The information in Table 6, however, serves as a guide for appropriate DOE responses to increasing levels of severity of maintenance and emergency measures. The table shows that the primary differences between routine maintenance and emergency response are the urgency of the activity and the degree of threat or risk. DOE's priority level, in the left column of

Table 6, bears an inverse relationship with DOE's estimate of probability of occurrence; the highest-priority response is believed to be the least likely.

Table 6. DOE Criteria for Maintenance and Emergency Measures

Priority	Description[a]	Example	Response
1	Breach of disposal cell with dispersal of radioactive material	Seismic event that exceeds design basis and causes massive discontinuity in cover.	Notify NRC. Immediate follow-up inspection by DOE emergency response team. Emergency actions to prevent further dispersal, recover radioactive materials, and repair breach.
2	Breach without dispersal of radioactive material	Partial or threatened exposure of radioactive materials.	Notify NRC. Immediate follow-up inspection by DOE emergency response team. Emergency actions to repair the breach.
3	Breach of site security	Human intrusion, vandalism.	Restore security; urgency based on assessment of risk.
4	Maintenance of specific site surveillance features	Deterioration of site marker, signs, boundary monuments.	Repair at first opportunity.
5	Minor erosion.	Erosion not immediately affecting disposal cell.	Evaluate, assess impact, and respond as appropriate.

Note:
[a] Other changes or conditions will be evaluated and treated similarly on the basis of perceived risk.

3.6.4 Reporting Maintenance and Emergency Measures

Routine maintenance completed during the previous 12 months will be summarized in the annual inspection report. In accordance with 10 CFR 40.60, within 4 hours of discovery of any Priority l or 2 event such as those listed in Table 6, DOE will contact the NRC 24-Hour Operations Center for Emergencies at (301) 816-5100 and notify the following NRC office:

Materials Decommissioning Branch
Division of Decommissioning, Uranium Recovery, and Waste Programs
Office of Nuclear Material Safety and Safeguards

3.6.5 Earthquake Monitoring

DOE subscribes to the U.S. Geological Survey National Earthquake Information Center to receive notification when an earthquake is of sufficient magnitude to threaten the integrity of a disposal site. This service provides data on the magnitude of the event and the location of the epicenter. DOE will receive email notifications from the center when a seismic event occurs that meets any of the following criteria:

- Magnitude 3.0 or greater on the Richter scale, within 0.3 degree (about 20 miles [30 kilometers]) of the site
- Magnitude 5.0 or greater on the Richter scale, within 1.0 degree (about 70 miles [110 kilometers]) of the site

As part of its review of the site reclamation plan, NRC evaluated the seismic slope stability of the Split Rock disposal system (i.e., cell and associated surface water diversion structures). Based on its analysis, the staff concluded that the design of the disposal system is sufficient to withstand the peak ground acceleration associated with the maximum credible earthquake (NRC 1996) (in process). Therefore, the site meets Criterion 4(e) of Appendix A to 10 CFR 40.

3.7 Environmental Monitoring

Long-term groundwater and surface water monitoring at the Split Rock disposal site will be conducted to ensure that (1) site-related contamination does not adversely impact groundwater or surface water uses outside of the LTSB and (2) the disposal cell is performing as expected. The long-term monitoring program will also be used to confirm through observation that no unexpected changes in site conditions occur (including changes in behavior of the legacy plume), that downward contaminant trends continue, and that protectiveness at the POE is maintained under long-term management.

The site's LTSB was established to encompass the expected extent of the site-related plumes from the source areas to points of discharge in the Sweetwater River. The Sweetwater River is the most likely POE for site-related contamination in both the NWV and SWV flow regimes (see Section 2.5.3 for further discussion). According to WNI (SMI 1999b), contamination discharging to the Sweetwater River was predicted to peak in 1996 and decline since that time. Site-related contamination has already reached the Sweetwater River along the NWV flow regime; whereas, contamination exiting the SWV has traveled only a small portion of the total distance along the flowpath to the predicted discharge point in the Sweetwater River (SMI 1999b).

Site-related contamination exiting the NWV flow regime impacts the floodplain alluvial aquifer, which is not used as a source of drinking water. Site-related contamination exiting the NWV has reached and continues to discharge into the Sweetwater River, but measured river concentrations remain below applicable surface water protection standards. The Sweetwater River is classified as a source for drinking water (i.e., a Wyoming Class 2AB surface water). The Split Rock formation regional aquifer receives site-related contamination exiting the SWV flow regime. This aquifer is used as a source of drinking water by Jeffrey City in an area upgradient of the Split Rock site that is unaffected by site-related contamination. Continued extraction of groundwater from this upgradient unaffected offsite area is not likely to draw contamination from the site. Modeling completed by Shepherd Miller Inc. for WNI (WNI 2000) showed that constant and prolonged pumping of an extraction well at rates much higher than currently in use would take hundreds of years to draw site-related contamination to the Jeffrey City area. Since that time, Jeffrey City population has declined and is not expected to significantly increase in size in the foreseeable future, though this is not a certainty. Because of the size of the LTSB, it is unlikely that site-related contamination exiting the SWV will migrate beyond the boundary at concentrations greater than background or applicable groundwater protection standards unless site conditions change significantly and in an unexpected manner. General changes in land and water use will be monitored as part of long-term site surveillance. However, the long-term monitoring program is limited in scope, and its main purpose is to confirm that general trends and groundwater conditions remain within expected bounds and that there are no unexpected changes in disposal cell performance.

3.7.1 Long-Term Groundwater and Surface Water Monitoring Program

Based on conclusions and recommendations from the evaluation of WNI's pretransition groundwater and surface water monitoring program (Appendix E), the following long-term monitoring program was developed. Table 7 presents the long-term groundwater and surface water monitoring network, along with the rationale for monitoring each location, expected trends based on past monitoring and the conceptual site model, and observations for comparison with long-term monitoring results. Table 8 and Table 9 summarize DOE's long-term monitoring requirements for the site. Table 8 provides the long-term groundwater and surface water monitoring plan. Table 9 provides established ACLs and Wyoming groundwater and surface water protection standards.

ACLs, established by WNI and approved by NRC prior to site transition to DOE, apply only "during operations and prior to the end of closure" (10 CFR 40, Appendix A, Criterion 5). Therefore, they are not considered enforceable groundwater protection standards under long-term management. Wyoming groundwater and surface water protection standards are enforceable at the POE (i.e., LTSB).

These ACLs will be used under long-term management for comparison to measured results as a possible indication of cell performance and compliance with protection standards applicable at the POE. If an ACL is exceeded, DOE will notify NRC and take no further action until the next scheduled sampling event. The well(s) exceeding the ACL will be sampled annually until the concentration(s) drops back below the ACL. DOE will determine the need for additional sampling or investigation in consultation with NRC. However, under UMTRCA, DOE, as the long-term custodian, is only "authorized to carry out monitoring, maintenance, and emergency measures" and no other actions "unless expressly authorized by Congress" (UMTRCA, Section 104[f][2]). Therefore, potential response actions are limited.

The locations of the monitoring wells and the surface water monitoring points in the long-term monitoring program can be found on Figure 6.

Table 7. Long-Term Groundwater and Surface Water Monitoring Network

Monitoring Location	Rationale	Observations
NWV Flow Regime		
Well-5	POC well. Should be stable or show decline in concentrations over time as seepage rates decrease.	Uranium has declined from peak concentrations in early 1990s. Fairly stable over last several years.
WN-42A	Well is located where seepage from tailings meets the floodplain alluvial aquifer. Should have lower concentrations than POC well due to mixing with uncontaminated alluvial groundwater. As tailings seepage rates decline, concentrations here should similarly decline.	Lower concentrations of uranium than POC well (factor of 2 or less); appeared to trend upward for about a decade followed by declining concentrations; slight increase in last few sampling rounds.
WN-39B	Downgradient of WN-42A in the floodplain alluvial aquifer flowpath. Should see decreasing concentrations if the plume has passed through this area.	Concentrations of uranium consistently lower than WN-42A. Recent concentrations nearly an order of magnitude lower. Uranium at 3 to 4 times the drinking water standard.

Table 7. Long-term Groundwater and Surface Water Monitoring Network (continued)

Monitoring Location	Rationale	Observations
WN-41B	Well location closest to the river; best available location remaining to indicate concentrations discharging to river. If plume has already passed this location, concentrations should be steady or declining. If not, could see some concentrations increases.	Uranium concentrations very low (low end of background); no evidence of site-related effects. Note concern over well screen depth (i.e., screen too deep to monitor plume because plume rises as it approaches discharging to the river); see Appendix E for more detail.
SW-1	Historical upstream/background surface water location (offsite). Monitors surface water quality entering portion of the river where the NWV plume discharges.	Fluctuations of background uranium over time.
SW-3B	Surface water location at downstream edge of predicted NWV plume discharge point. Monitors actual POE.	Uranium fluctuations at WNI surface water location SW-3 mirror background; concentrations slightly higher than background but below current uranium standard.
SW-5	Historical downstream-most surface water location. Monitors river water quality as it nears leaving the site.	Currently, no evidence of site-related contamination above applicable water quality standards.
SWV Flow Regime		
WN-21	POC well; should be stable or show continuing decreases in concentrations over time.	Highest concentrations in early years of monitoring. Nitrate and sulfate have declined to below benchmarks. Uranium in background range.
SWAB-12R	Well at southwest corner of site; between site and Jeffrey City. Provides early warning should Jeffrey City significantly increase pumping of groundwater.	Currently, no evidence of site-related contamination.
SWAB-1R	Currently has highest uranium and nitrate concentrations—concentrations of uranium and nitrate both exceed standards. Could see possible nitrate increase if plume has not completely passed. Long-term expect to see stable or decreasing concentrations of both uranium and nitrate as plume migrates downgradient from the well.	Concentrations for both nitrate and uranium have been relatively steady. Uranium concentrations greater than background. No clear decreasing trend for uranium or nitrate—fluctuations within historical range.
SWAB-29	Downgradient-most location in the SWV flow regime. Location will be used to track plume movement. Should eventually see site-related contamination as plume migrates downgradient.	Currently, no evidence of site-related contamination.
SWAB-32	Well at southern border of site; location will confirm SWV plume stays within LTSB; should continue to have concentrations in background range.	Nitrate and uranium at background levels. Stable—no evidence of site-related contamination, though has naturally elevated uranium (up to 0.3 mg/L).
SWAB-22	Demonstrates that the predicted small portion of the plume exiting the SWV that intercepts the northeast trending regional aquifer remains on site.	No evidence of site-related contamination. Lies directly upgradient of the McIntosh IC area.

Table 8. Long-Term Monitoring Plan for the Split Rock, Wyoming, Disposal Site

Groundwater Monitoring[a]		
Wells*	**Analytes**	**Frequency**
NWV Flow Regime: Well-5 (POC well), WN-41B (furthest downgradient well), WN-42A, WN-39B **SWV Flow Regime**: WN-21 (POC well), SWAB-12R, SWAB-29, SWAB-1R, SWAB-32, SWAB-22	nitrate, sulfate, selenium, uranium (and standard field measurements; pH, temperature, conductivity, alkalinity, dissolved oxygen, and turbidity)	Annually for 5 years; reduce to every 3 years thereafter.
Surface Water Monitoring[b]		
Location	**Analytes**	**Frequency**
Sweetwater River: SW-3B (downstream edge of predicted NWV plume discharge point), SW-1 (upstream, background), SW-5 (downstream-most location, represents concentrations leaving the site)	nitrate, sulfate, selenium, uranium (and standard field measurements; pH, temperature, conductivity, alkalinity, dissolved oxygen, and turbidity); note river flow rate(s) from the Sweetwater Station gaging station during each sampling event	Annually for 5 years; reduce to every 3 years thereafter

Notes:
[a] Site-related constituents monitored in groundwater will be compared to Wyoming Class I Groundwater Protection Standards for domestic use.
[b] Site-related constituents being monitored in surface water will be compared to the Human Health Values for Fish and Drinking Water that are applicable to Wyoming Class 2AB surface waters (Section 18, Chapter 1 of WDEQ's Water Quality Rules and Regulations).
* Note: Water level measurements will be taken at each well prior to sampling. The designations for both the groundwater monitoring wells and the surface water monitoring location were adopted from WNI's historical names used for these monitoring locations to maintain continuity.

Table 9. Alternate Concentration Limits and Groundwater/Surface Water Protection Standards for Long-Term Monitoring at the Split Rock, Wyoming, Disposal Site

Analyte[a]	ACL[b] NWV (POC; Well-5)	ACL[b] SWV (POC; Well WN-21)	Wyoming Groundwater Standard (Domestic Use)[c]	Surface Water Standard[d]
Nitrate (total as N)	317 mg/L	500 mg/L	10 mg/L	10 mg/L
Sulfate	N/A	N/A	250 mg/L	N/A
Selenium	0.3 mg/L	0.05 mg/L	0.05 mg/L	0.005 mg/L
Uranium (natural)	4.8 mg/L	3.4 mg/L	N/A	0.03 mg/L

Notes:
[a] Uranium processing-related indicator constituents of concern.
[b] ACLs were established by WNI and approved by NRC prior to site transition to DOE, but apply only "during operations and prior to the end of closure" (10 CFR 40, Appendix A, Criterion 5) and, therefore, are not considered enforceable groundwater protection standards under long-term management (i.e., ACLs will be used for comparison o measured results as a possible indication of cell performance and maintaining compliance with protection standards applicable at the POE; DOE will report ACL exceedances to the NRC).
[c] Standards are Wyoming Class I Groundwater Protection Standards for domestic use and applicable at the POE.
[d] Standards are Human Health Values for Fish and Drinking Water that are applicable to Wyoming Class 2AB surface waters, which the portion of the Sweetwater River that defines the site's northern boundary (and POE) is designated. Compliance with the chronic selenium standard is required.

Abbreviations:
N = nitrogen N/A = not applicable.

Monitoring results will be used to (1) verify that groundwater quality in both the NWV and SWV flow regimes is consistent with expected concentrations and trends and that concentrations remain below Wyoming Class I groundwater protection standards for domestic use at the POE (i.e., the LTSB); (2) verify that surface water concentrations of site-related constituents are below Human Health Values for Fish and Drinking Water, standards applicable to Wyoming Class 2AB surface waters, which is the designation of the Sweetwater River (i.e., the predicted discharge point and current POE for site-related contamination); and (3) monitor disposal cell performance.

If surface water concentrations in the Sweetwater River remain below Wyoming Class 2AB standards and groundwater concentrations remain below Wyoming Class I standards at the LTSB and ACLs at the POC, the site will be considered protective and functioning as intended. Exceedance of any of these standards will not, however, be considered a violation of compliance or an immediate cause for concern. Remnant groundwater contamination persists at the site in concentrations exceeding groundwater standards. ICs prevent unacceptable groundwater uses to assure site protection. ACLs were intended to be protective of surface water but were not established based on the currently applicable surface water standards (e.g., 0.03 mg/L for uranium). Calculations provided by the licensee indicate that groundwater meeting the uranium ACL could still result in river exceedances of the current surface water standard. For example, a uranium concentration of 0.09 mg/L in the Sweetwater River at a 7-day low flow was predicted in 2004 (see Table H-c-3 in SMI 1999b), which was the last date provided. This prediction relied on a random walk particle tracking transport model that did not include uranium retardation (SMI 1999b). In addition, while the ACLs for most site constituents represent maximum historical groundwater concentrations for the POC well, which are not likely to be exceeded in the future, this is not true in the case of uranium. As the site represents a large long-term source of uranium, the possibility of an ACL exceedance cannot be discounted, particularly based on DOE’s experience at other UMTRCA sites. Additional detail is provided in Appendix E.

Despite some simplified assumptions and inconsistencies with certain predictions to date, modeling, in conjunction with historical monitoring data, provides a reasonable indication that site-related impacts to the groundwater system have been declining over time and are likely to continue to lessen into the future. Again, the long-term monitoring program will also be used to confirm through observation that no unexpected changes in site conditions occur (including degradation of cell performance and changes in behavior of the legacy plume), that existing downward contaminant trends continue, and that protectiveness at the POE is maintained under long-term management.

While it is likely that the ACLs for groundwater will continue to be met under DOE’s long-term management of the site, exceedances may not be wholly unexpected and will not be automatic grounds for DOE action. Confirmatory sampling, data analysis and communication about the exceedances with the NRC and WDEQ would be the extent of DOE’s action under these conditions. Likewise, while it is probable that surface water quality standards will be maintained under the long-term surveillance program, modeling data provided by the licensee suggest that compliance with the uranium standard cannot be guaranteed.

DOE’s monitoring network was selected from existing WNI wells at the time of site transition. Monitoring locations are generally considered to be reasonable for tracking remnant plume movement at the site. However, well screen depths may not be optimal for monitoring quality of

groundwater discharge to the river, particularly at location WN-41B. This downgradient-most well in the NWV plume flowpath is a "sentinel well" for the river and is screened at a depth of 92.4 to 112.4 ft below land surface. Historical data show higher concentrations at this location at much shallower depths near the water table (SMI 1999b), which are more indicative of groundwater discharging to the river (see Appendix E for more detail). Therefore, continued surface water monitoring is needed to verify that surface water quality is being maintained.

Surface water samples are collected from three locations on the Sweetwater River every 3 years following the first 5 years of annual sampling. Surface water samples are analyzed for the same constituents as the groundwater samples and are specified in Table 8. The surface water sampling locations are shown on Figure 6. Location SW-1 is upstream of the site and represents background. Location SW-3 was replaced with location SW-3B, which is approximately one half mile downstream (i.e., east) from the original location of SW-3 to ensure any impacts from the entire NWV plume are being monitored (see Appendix E for additional details). Location SW-5 is the most downstream sampling location and represents river concentrations leaving the site. Since the Sweetwater River is the POE for contamination exiting the NWV, the purpose of the surface water sampling is to verify that concentrations continue to meet applicable surface water standards (i.e., the Human Health Values for Fish and Drinking Water applicable to the Wyoming Class 2AB waters; Section 18, Chapter 1 of the Wyoming Department of Environmental Quality's Water Quality Rules and Regulations).

Groundwater exiting the SWV also discharges to the Sweetwater River but is understood to take several centuries for the plume to reach the river. Groundwater modeling indicates concentrations of site-related constituents will not exceed background at the long-term care boundary (i.e., the river) (WNI 2017), the designated POE for this flow regime. Monitoring well SWAB-29 will likely detect the plume front in future years. This well is the farthest downgradient well in the flowpath for contamination exiting the SWV and closest to the POE (approximately 3 miles downgradient of SWAB-29). Groundwater quality data from SWAB-29 will be compared to modeling predictions to ensure that contaminant concentrations are equal or less than predicted. Such a comparison will provide extra assurance that future contaminant concentrations at the POE (i.e., the Sweetwater River) will likely meet acceptable levels in the future.

Because the Sweetwater River and the Split Rock Aquifer are both potential drinking water sources, drinking water standards are the most relevant values to assure site protectiveness. For nitrate, selenium, and uranium, those values are 10 mg/L (as nitrogen [N]), 0.05 mg/L, and 0.03 mg/L, respectively. If a drinking water standard is exceeded at a boundary well (SWAB-32, SWAB-12R, SWAB-22, or WN-41B), DOE will notify NRC and WDEQ and conduct confirmatory sampling. The exception is that SWAB-32 would need to exceed 0.3 mg/L for uranium for notification and sampling to occur (see Appendix E for more detail). Results of confirmatory sampling will be provided to NRC and WDEQ.

If a surface water standard is exceeded in the river, NRC and WDEQ will be notified. Confirmation sampling will only be conducted if river levels are comparable or lower than at the time of the original sampling. This will require professional judgement and depend on actual river flows and the magnitude of the exceedance. Results of confirmatory sampling will be provided to NRC and WDEQ. No further response will be required on the part of DOE. If

noncompliance were to occur, it is DOE's understanding that "LQD would actively advocate a solution with WQD, which would not impact the DOE." (WDEQ 2019c)

Results of the groundwater and surface water monitoring program will be included in the annual inspection and monitoring report submitted to NRC (Section 3.4).

3.7.1.1 Periodic Long-Term Monitoring Program Evaluations

Following the establishment of a post-transition baseline (5 years), the long-term monitoring program will be reevaluated after four monitoring events (i.e., after 12 years) to determine if the long-term monitoring program can be discontinued entirely. The evaluation will be performed 17 years following the year in which the site transition occurred. Monitoring evaluations and recommended modifications to the long-term program will be submitted to NRC for concurrence prior to implementation.

3.7.1.2 Criteria for Discontinuing Long-Term Monitoring

Long-term groundwater and surface water monitoring at the site will be discontinued entirely once the following criteria have been met: (1) trends have established that water quality is stable at the POC (i.e., concentrations of site-related constituents are steady or declining to acceptable levels); (2) trends have demonstrated that water quality will remain protective at the POE—no exceedance of applicable groundwater or surface water standards or concentrations above established background values at the POE will occur (i.e., attenuation of site-related contamination is occurring as predicted by WNI's groundwater transport model); and (3) monitoring has demonstrated that the disposal system is performing as designed (i.e., there is no evidence that any additional contamination is being mobilized from the cell due to cover degradation that will result in an exceedance of groundwater or surface water standards at the POE). Discontinuing of groundwater monitoring will only occur after NRC technical review of a formal request and their concurrence that doing so is protective of human health and the environment.

3.8 Institutional Control Monitoring

Federal land ownership is the primary IC which serves to ensure long-term protectiveness at the Split Rock disposal site. IC monitoring will be performed during the annual inspection. During the inspection, DOE will check the site for unauthorized entry, surrounding land use, and disturbance of site features.

Groundwater monitoring will be used to demonstrate that concentrations of site-related constituents remain below applicable groundwater protection standards at the LTSB. Additionally, between 1999 and 2000, because groundwater quality within the LTSB was considered unsuitable for human consumption or domestic use, ICs were established by WNI with the owners of three privately held properties that lie within the LTSB. These ICs, which are tied to the property, approved by NRC, and transferred to DOE, are in the form of either a restrictive covenant that restricts human consumption or domestic use of groundwater within the site's LTSB (the McIntosh and Peterson properties) or ownership of the portion of the subsurface where groundwater occurs (i.e., deeper than 7 ft; the Claytor property). These three ICs are presented in Appendix A. The ICs apply to the deeded property and automatically transfer to any future owner of the affected property. Figure A–1 in Appendix A shows the location of the three

properties for which groundwater ICs are in place within the LTSB. The remainder of the surface and subsurface property within the site's LTSB is owned by the federal government or the State of Wyoming, and, therefore, groundwater use restrictive covenants were not considered necessary.

Annually, DOE will verify the effectiveness of the groundwater ICs within the LTSB in providing protection from site-related groundwater contamination. Specifically, DOE will verify awareness of the ICs by contacting the current land owners and confirming (and documenting) that groundwater is not being used for human consumption or domestic purposes. DOE will also confirm that no drinking water wells have been established within the site's LTSB. Groundwater ICs may no longer be needed if the criteria to discontinue long-term groundwater monitoring (as specified in Section 3.7.1.2) have been met and regulatory approval to discontinue monitoring has been received. Termination of any established groundwater IC will only occur if regulatory concurrence to do so has been received.

Once every 5 years, beginning in 2025, DOE will also check the records at the Wyoming State Engineer's Office to determine if there have been significant changes in water demands near the site.

3.9 Records

DOE receives and maintains selected records to support post-closure site maintenance and preserve historical information for long-term stewardship. Site records contain critical information required to protect human health and the environment, manage land and assets, protect the legal interests of DOE and the public, and mitigate community impacts resulting from the cleanup of legacy waste. The records are managed in accordance with the appropriate records management requirements as specified in the *Records and Information Management Transition Guidance* (DOE 2016). Inactive records are preserved in collections under DOE's control.

3.10 Quality Assurance

All activities related to the surveillance and maintenance of the site will comply with appropriate DOE orders and other requirements as specified in the LTSP Guidance Document (DOE 2012). Quality assurance requirements are routinely fulfilled by use of a work planning process, standard operating procedures, trained personnel, documents and records maintenance, and assessment activities. Requirements will be transmitted through procurement documents to subcontractors when appropriate.

3.11 Health and Safety

Health and safety requirements and procedures for DOE activities are consistent with DOE orders, federal regulations, and applicable codes and standards as specified in the LTSP Guidance Document (DOE 2012). The DOE Integrated Safety Management process serves as the basis for the contractor's safety and health program. Project-specific safety plans are used to identify specific hazards associated with the anticipated scope of work and provide direction for the control of these hazards. During the preinspection briefing, inspectors are required to review safety plans and the LTSP to ensure that they have an understanding of the site. Before entering the site, all personnel accessing the site are briefed on the health and safety requirements associated with the site and any work to be performed, such as all-terrain vehicle use, sign replacement, or noxious weed control.

This page intentionally left blank

4.0 References

10 CFR 40. "Domestic Licensing of Source Material," *Code of Federal Regulations*.

40 CFR 141. U.S. Environmental Protection Agency, "National Primary Drinking Water Regulations," *Code of Federal Regulations*.

40 CFR Subpart D. U.S. Environmental Protection Agency, "Lists of Hazardous Wastes," *Code of Federal Regulations*.

40 CFR Subpart E. U.S. Environmental Protection Agency, "Hazardous Substance Response," *Code of Federal Regulations*.

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations*.

42 USC 7901. "Uranium Mill Tailings Radiation Control Act of 1978," *United States Code*.

DOE (U.S. Department of Energy), 2001. *Guidance for Implementing Long-Term Surveillance Program for UMTRCA Title I and Title II Disposal Sites*, prepared by the U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado, GJO–2001–215–TAR, April.

DOE (U.S. Department of Energy), 2009. *Review Comments to the Draft Environmental Assessment for Revised Groundwater Protection Standards, Western Nuclear Incorporated, Split Rock Uranium Mill Tailings Site,* September 14.

DOE (U.S. Department of Energy), 2016. *Records and Information Management Transition Guidance*, Guide 243.1B, Office of Legacy Management, May.

EPA (U.S. Environmental Protection Agency), 1998. *1998 Update of Ambient Water Quality Criteria for Ammonia*, EPA 822-R-98-008, Office of Water, Washington, DC.

EPA (U.S. Environmental Protection Agency), 1999. *1999 Update of Ambient Water Quality Criteria for Ammonia*, EPA-822-R-99-014, Office of Water, Washington, DC, December.

EPA (U.S. Environmental Protection Agency), 2009. *2009 Edition of the Drinking Water Standards and Health Advisories*, EAP 822-R-09-011, October.

Merritt, R.C., 1971. *The Extractive Metallurgy of Uranium*, Colorado School of Mines Research Institute, prepared under contract with the United States Atomic Energy Commission.

MFG Inc., 2003. *Supplemental Groundwater Modeling Report for the Split Rock, Wyoming Site,* March.

Miller, L., 2009. Email to Richard Chang and Stephen Cohen, NRC, "Subject: Split Rock Information," October 2.

NRC (U.S. Nuclear Regulatory Commission), 1980. *Final Environmental Statement related to operation of Split Rock Uranium Mill*, Western Nuclear, Inc., NUREG-0639, February.

NRC (U.S. Nuclear Regulatory Commission), 1996a. *Staff Technical Position, Alternate Concentration Limits for Title II Uranium Mills, Standard Format and Content Guide and Standard Review Plan for Alternate Concentration Limit Applications*, January.

NRC (U.S. Nuclear Regulatory Commission), 1996b. *Technical Brief: Review of Seismicity & Tailing Stability*, October 31.

NRC (U.S. Nuclear Regulatory Commission), 2003. *Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978 Final Report*, NUREG-1620 Rev. 1, Division of Fuel Cycle Safety and Safeguards, June.

NRC (U.S. Nuclear Regulatory Commission), 2006a. *Environmental Assessment for Amendment to Source Materials License SUA-56 for Ground Water Alternate Concentration Limits*, Western Nuclear Inc., Split Rock Uranium Mill Tailings Site, Jeffrey City, Wyoming, Docket No. 40-1162, August.

NRC (U.S. Nuclear Regulatory Commission), 2006b. *Technical Evaluation Report, Alternate Concentration Limits, Western Nuclear, Inc., Split Rock Site, Jeffrey City, Fremont County, Wyoming,* Docket No. 40-1162, SUA-56, September.

NRC (U.S. Nuclear Regulatory Commission), 2010a. *Environmental Assessment for Amendment to Source Material License SUA-56 Revised Groundwater Protection Standards*, *Western Nuclear Incorporated Split Rock Uranium Mill Tailings Site Jeffrey City, Fremont County, Wyoming*, January.

NRC (U.S. Nuclear Regulatory Commission), 2010b. Letter from NRC to Western Nuclear Incorporated, "RE: License Amendment 105, Approving Request to Modify Groundwater Protection Standards, Source Material License SUA-56, Western Nuclear Incorporated, Split Rock Site, Jeffrey City, Wyoming (TAC J00577)," February.

NRC (U.S. Nuclear Regulatory Commission), 2016. Letter from D. Orlando to M. Meyer, "RE: Meeting Summary – Technical Meeting to Discuss the Decommissioning of the Western Nuclear Incorporated Site in Jeffrey City, Wyoming (Docket 040-01162)", June.

SMI (Shepherd Miller Inc.), 1999a. *Split Rock Tailing Reclamation Construction Completion Report*, prepared for Western Nuclear Inc., Split Rock Project, Jeffrey City, Wyoming, April.

SMI (Shepherd Miller Inc.), 1999b. *Site Ground Water Characterization and Evaluation*, prepared for Western Nuclear Inc., Split Rock Project, Jeffrey City, Wyoming.

SMI (Shepherd Miller Inc.), 2000. Technical Memorandum from Toby Wright to Terry Fairbanks regarding "Evaluation of Hypothetical Pumping Stresses on Transport of Site-derived Constituents at the WNI Split Rock Site, Jeffrey City, Wyoming," February 25.

State of Wyoming, 1994. Letter to Joseph E. Virgona, Project Manager, U.S. Department of Energy, from Dennis Hemmer, Director of the Wyoming Department of Environmental Quality, declining custody of all UMTRCA Title II sites within the State of Wyoming, July.

Thompson, A.J., 2005. Letter to U.S. Nuclear Regulatory Commission, Attn: Mr. Robert Nelson, dated May 26, 2005, Request for Exemption, ADAMS accession no. ML051530255.

U.S. Census Bureau, 2012. *United States Summary: 2010: Population and Housing Unit Counts*, U.S. Department of Commerce, Economics and Statistics Administration, September.

WDEQ (Wyoming Department of Environmental Quality), 2013. *Wyoming Surface Water Classification List: Water Quality Division Surface Water Standards*, July 26.

WDEQ (Wyoming Department of Environmental Quality), 2018. "Wyoming Surface Water Quality Standards," Chapter 1 of the *Water Quality Rules and Regulations*, last updated April 24, 2018.

WDEQ (Wyoming Department of Environmental Quality), 2019a. *State Decision Document: Technical Review of Western Nuclear Incorporated Split Rock Uranium Mill Alternate Concentration Limit for Nitrate in Groundwater in the Southwest Valley*, April 23.

WDEQ (Wyoming Department of Environmental Quality), 2019b. *State Decision Document: Technical Review of Western Nuclear Incorporated Split Rock Uranium Mill Alternate Concentration Limit for Selenium in Groundwater in the Northwest Valley*, December.

WDEQ (Wyoming Department of Environmental Quality), 2019c. "Re: Long-Term Compliance with Selenium and Uranium Concentrations in the Sweetwater River at the Split Rock, Wyoming, Uranium Mill Tailing Radiation Control Act (UMTRCA) Title II site," December 6.

WNI (Western Nuclear Inc.), 1994. *Western Nuclear, Inc., Split Rock Mill, Addendum A (February 1994) to the Revision No. 5 to the June 30, 1987 Uranium Tailings Reclamation Plan,* February.

WNI (Western Nuclear Inc.), 2000. *Supplement to October 29, 1999 Split Rock Site Closure Report*, prepared by Shepherd Miller Inc. for Western Nuclear Inc., January 14.

WNI (Western Nuclear Inc.), 2001. *Supplement to October 29, 1999 Split Rock Site Closure Report*, prepared by Shepherd Miller Inc. for Western Nuclear Inc., February 1.

WNI (Western Nuclear Inc.), 2002. *WNI Response to NRC Request of 9/6/01 for Additional Information on the Site Closure Plan for the Split Rock, Wyoming Site*, May.

WNI (Western Nuclear Inc.), 2004. Letter from Lawrence J. Corte to NRC, "RE: Response to November 18, 2003, Nuclear Regulatory Commission Staff Letter Regarding Western Nuclear, Inc.'s Split Rock Uranium Mill Site Final Site Closure Proposal, SUA-56," February 16.

WNI (Western Nuclear Inc.), 2016. Letter from Lawrence J. Corte to Dominick Orlando, "RE: License Amendment Request for Western Nuclear, Inc. Split Rock Mill Site, Source Materials License SUA-56," October 25.

WNI (Western Nuclear Inc.), 2017. "RE: Licenses Amendment Request for Western Nuclear, Inc., Split Rock Mill Site," Letter from Lawrence J. Corte to Dominick Orlando, June 21.

WNI (Western Nuclear Inc.), 2019. "RE: License Amendment Request for Western Nuclear Inc., Split Rock Mill Site (Northwest Valley Se ACL), Source Material License WYSUA-56," May l5.

WWDC (Wyoming Water Development Commission), 2013. *Jeffrey City Water Supply Final Report*, prepared by 609 Consulting LLC, April.

Appendix A

Real Estate Information and Institutional Control Instruments

This page intentionally left blank

Site Long-Term Surveillance Boundary Legal Description

This page intentionally left blank

A Tract of land in Sections 1-3, 10-14, Township 29 North, Range 92 West;
Sections 5-8, and 18; Township 29 North, Range 91 West;
Section 31, Township 30 North, Range 91 West;
Sections 35 and 36; Township 30 North, Range 92 West;
All of the 6th P.M., Fremont County, Wyoming.
Said tract of land is also described as the “2018 Revised Long Term Care Boundary” and is described as follows:
Commencing from Point #1, the Point of Beginning, being a point of intersection with the southerly bank of the Sweetwater
River and the section line common to said Sections 34 and 35, T30N, R92W, which point bears N00°18’03”W, a distance of
555.49’ more or less from the Southwest corner of said Section 35;
Thence proceed S00°18’03”E, a distance of 555.49’ along said section line to Point 2, being the Southwest corner of Section
35;
Thence S00°34’42”E, a distance of 2567.23’ along the section line common to said Sections 2 and 3 to Point 3, being the 1/4
corner common to said Sections 2 and 3, T29N, R92W;
Thence N89°53’13W, a distance of 1308.03’ along the E-W centerline of said Section 3 to Point 4, being the CE1/16 corner
of said Section 3;
Thence S00°49’12E, a distance of 2624.95’ to Point 5, being the E1/16 corner common to said Sections 3 and 10;
Thence S00°42’21”E, a distance of 2639.98’ to Point 6, being the CE1/16 corner of said Section 10;
Thence S00°34’57”E, a distance of 1647.60’ to Point 7, being a point on the northerly boundary of the “Home on the Range
Estates” Subdivision;
Thence S75°57’12”E, a distance of 1408.89’ along the northerly boundary of the said subdivision to Point 8, being the
Northeast corner of the said “Home on the Range Estates” Subdivision;
Thence S00°42'53"E, a distance of 646.79' along the easterly boundary of the said subdivision to Point 9, being the
Southeast corner of the said "Home on the Range Estates" Subdivision;
Thence N89°29’51”E, along the section line common to Section 11 and Section 14 a distance of 1262.65’ to Point 10, being
the W1/16 corner common to said Sections 11 and 14, T29N, R92W;
Thence S00°29’03”E, a distance of 1322.15’ to Point 11, being the NW1/16 corner of said Section 14;
Thence N89°27’12”E, a distance 1314.91’ to point 12, being the CN1/16 corner of said Section 14;
Thence S00°33’52”E, a distance of 1321.28' along the N-S centerline of said Section 14 to Point 13, being the C1/4 of said
Section 14;
Thence N89°24’42”E, a distance of 2626.11' along the E-W centerline of said Section 14 to Point 14, being the 1/4 corner
common between said Sections 13 and 14;

Thence N89°15’34”E, along the East-West centerline of said Section 13 a distance of 5282.83’ to Point 15, being the 1/4
corner common to said Section 18, T29N, R91W and said Section 13, T29N, R92W;
Thence N00°23’54”W, along the section line common to said Section 18 and Section 13, a distance of 1355.66’ to Point 16,
being the intersection of the said section line and the northerly right-of-way of U.S. Highway 287;
Thence S87°26’17”E along the said northerly right-of-way a distance of 2566.22' to Point 17, being the intersection of the
said northerly right-of-way of U.S. Highway 287 and the North-South centerline of said Section 18;
Thence N00°34’41”W, a distance of 1399.72’ to Point 18, being the 1/4 corner common to said Section 18 and Section 7;
Thence N89°43’23”E, along the section line a distance of 2648.99’ to Point 19, being the SE corner of said Section 7;
Thence N89°33’05”E, along the section line common to Section 8 and Section 17 a distance of 2648.26’ to Point 20, being
the 1/4 corner common to said Sections 8 and 17;
Thence N00°28’51”W, along the North-South centerline of said section 8 a distance of 1325.50’ to Point 21, being the
CS1/16 corner of said Section 8;
Thence N89°14’01”E, a distance of 1304.86’ to Point 22, being the SE1/16 corner of said Section 8;
Thence N00°35’07”W, a distance of 1322.72’ to Point 23, being the CE1/16 corner of said Section 8;
Thence N89°21’20”E along the East-West centerline of said Section 8, a distance of 1302.44’ to Point 24, being the 1/4
corner common to said Section 8 and Section 9, T29N, R91W;
Thence N01°00’41”W, along the section line a distance of 2643.44’ to Point 25, being the NE corner of said Section 8;
Thence N00°24’49”W, along the section line common to Section 5 and Section 4 a distance of 2640.87’ to Point 26, being the
1/4 corner common to said Section 5 and Section 4;
Thence N00°24’49”W along the section line, a distance of 501.96’ more or less to Point 27, being the intersection point of the
East section line of said Section 5 and the southerly bank of the Sweetwater river;
From Point 27 the “2018 Revised Long Term Care Boundary” follows the southerly bank of the Sweetwater River upstream to
Point 1, the Point of Beginning.
Less and except the following described parcel of land:
Commencing at Point 28, being the Point of Beginning and being the 1/4 corner common to said Section 11 and Section 12,
T29N, R92W;
Thence N00°30'06"W, along the section line common to said Section 11 and Section 12 a distance of 1304.14' to Point 29,
being the N1/16 corner common to said Section 11 and 12;
Thence N88°58'03"E, a distance of 2639.91' to Point 30, being the CN1/16 corner of said Section 12;

Thence N44°35'39"E, a distance of 1871.55' to Point 31, being the E1/16 corner common to said section 12 and Section 1;
Thence N88°47'18"E, along the section line common to said Section 12 and Section 1 a distance of 1319.13' to Point 32,
being the Northeast corner of said Section 12;
Thence N89°43'03"E, along the section line common to said Section 6 and Section 7, T29N, R91W, a distance of 2561.40' to
Point 33, being the 1/4 corner common to said Section 6 and Section 7;
Thence S44°04'42"W, a distance of 3662.52' to Point 34, being the 1/4 corner common to said Section 7 and Section 12;
Thence S88°58'52"W, along the East-West centerline of said Section 12 a distance of 2641.93' to Point 35, being the C1/4
of said Section 12;
Thence S00°12'47"E, along the North-South centerline of said Section 12 a distance of 1307.09' to Point 36, being the
CS1/16 corner of said Section 12;
Thence S88°53'14"W, a distance of 2635.35' to Point 37, being the S1/16 corner common to said Section 11 and Section 12;
Thence N00°07'40"W, along the section line common to said Section 11 and Section 12 a distance of 1311.45' to Point 28,
being the Point of Beginning.
Said excepted parcel containing 373.77 acres more or less.
Said “2018 Revised Long Term Care Boundary” as described above contains 5,428.34 acres, more or less, dependant upon
the course of the Sweetwater River.

This page intentionally left blank

Warranty Deed

This page intentionally left blank

Public Land Order

(Federal Register Notice of Permanent Withdrawal)

This page intentionally left blank

Groundwater Institutional Controls

This page intentionally left blank

McIntosh Land Use Restrictive Covenant

This page intentionally left blank

FILE DATE: 06/04/1999 FILE TIME: 11:49 PAGE #: 0001 OF 0003
FREMONT COUNTY, WY, JULIE A FREESE - COUNTY CLERK DOC #: 1201197 **

LAND USE RESTRICTIVE COVENANT

THIS COVENANT, effective as of the 31st day of May, 1999, is given by Joe E. McIntosh and Jennifer Ann McIntosh for themselves and all future owners of the property identified in Exhibit "A-1" attached hereto ("Owners") for the benefit of Western Nuclear, Inc., a Delaware corporation, c/o Lawrence J. Corte, 200 Union Blvd., Suite 300, Lakewood, Colorado 80228 as owner of the land set forth in Exhibit "A-2" attached hereto and as holder of Nuclear Regulatory Commission ("NRC") License SUA-56, for the benefit of all future or successor owners of the property described in Exhibit "A-2" and for the benefit of all NRC successor licensees charged with responsibility of the Split Rock mill and tailings site described below ("Licensee"), for the reasons and upon the terms hereinafter set forth.

WITNESS

WHEREAS, Licensee formerly operated a uranium mill which was located in the SE¼ of Section 2, T29N, R92W, 6th Principal Meridian, Fremont County, Wyoming under license SUA-56 from the NRC and its predecessor federal agencies; and

WHEREAS, Licensee is in the process of stabilizing the waste or by-product material which resulted from its previous operation of the mill in accordance with the Uranium Mill Tailings Radiation Control Act of 1978 as required by the NRC; and

WHEREAS, Licensee, in its attempt to comply with that statute, desires to arrange for the control and management of by-product material so it will not pose a hazard to public health and safety or the environment; and

WHEREAS, certain by-product material has entered the groundwater and may now or in the future be located under the McIntosh land identified in Exhibit "A-1"; and

WHEREAS, Owners are willing to assist Licensee in its efforts to limit access to by- product material in groundwater under said land.

FILE DATE: 06/04/1999 FILE TIME: 11:49
FREMONT COUNTY, WY, JULIE A FREESE - COUNTY CLERK PAGE #: 0002 OF 0003
DOC #: 1201197

NOW THEREFORE, in exchange for good and valuable consideration, the sufficiency and receipt whereof being acknowledged, the Owners for themselves, and their successors and assigns and all future owners of the land described in Exhibit "A-1", agrees to refrain from allowing any human use or consumption or any domestic use of water from any new or existing water wells in or upon the land identified in Exhibit "A-1" except upon prior consent of Licensee or any successor Licensee or any successor owner of the land described in Exhibit "A-2". Owners shall permit signage at any existing or new well identifying such restriction. There is no restriction on usage for agricultural, stock water or other ranching purposes.

The Owners specifically agree that the restriction in the preceding paragraph shall be a burden on the land described in Exhibit "A-1" and shall run in favor of and provide benefit to the land described in Exhibit "A-2" and its owner and run in favor of and provide benefit to Licensee and any successor owner or Licensee.

Done and signed this 29 day of May, 1999.

Joe E. McIntosh — Jennifer Ann McIntosh

Joe E. McIntosh Jennifer Ann McIntosh

STATE OF Wyoming)
)
COUNTY OF Fremont)

This Land Use Restrictive Covenant was acknowledged before me this 29th day of May, 1999 by Joe E. McIntosh and Jennifer Ann McIntosh.

My commission expires: June 3, 2001

Judy A. Quarles
Notary Public

(SEAL) JUDY A. QUARLES NOTARY PUBLIC FREMONT COUNTY, WYOMING

FILE DATE: 06/04/1999 FILE TIME: 11:49 PAGE #: 0003 OF 0003
FREMONT COUNTY, WY, JULIE A FREESE - COUNTY CLERK DOC #: 1201197

EXHIBIT A-1

The following described land in Fremont County, Wyoming, is burdened by the McIntosh/Western Nuclear Land Use Restrictive Covenant:

<u>Township 29 North, Range 92 West</u>
NW1/4SW1/4, Section 2
NE1/4SE1/4, Section 3
<u>Township 30 North, Range 91 West</u>
S1/2SW1/4, Section 31

EXHIBIT A-2

The following described land in T29N, R92W, Fremont County, Wyoming is benefitted by the McIntosh/Western Nuclear Land Use Restrictive Covenant: The SW¼ of Section 1 and the NW¼ of Section 12.

This page intentionally left blank

Peterson Land Use Restrictive Covenant and Access Easement

This page intentionally left blank

FILE DATE: 10/10/2000 FILE TIME: 02:17 PAGE #: 0001 OF 0003
FREMONT COUNTY, WY, JULIE A FREESE - COUNTY CLERK DOC #: 1214580 **

RESTATED LAND USE RESTRICTIVE COVENANT AND ACCESS EASEMENT

THIS COVENANT AND ACCESS EASEMENT, effective as of the 1st day of June, 1999, is given by Beulah M. Walker, a/k/a Beulah Peterson Walker, c/o Arliss C. Peterson, 2379 W. Bell Ct., #81, Medford, Oregon 97504 and given by Arliss C. Peterson, 2379 W. Bell Ct., #81, Medford, Oregon 97504, for themselves and all future owners of the property identified in Exhibit A-1 attached hereto ("Owners") for the benefit of Western Nuclear, Inc., a Delaware corporation, c/o Lawrence J. Corte, 17222 South Golden Road, Suite A, Golden, Colorado 80401 as owner of the land set forth in Exhibit A-2 attached hereto and as holder of NRC License SUA-56, for the benefit of all future or successor owners of the property described in Exhibit A-2 and for the benefit of Western Nuclear, Inc. and all NRC successor licensees charged with responsibility of the Split Rock mill and tailings site described below for the reasons and upon the terms hereinafter set forth.

WITNESSETH

WHEREAS, Western Nuclear, Inc. formerly operated a uranium mill which was located in the SE 1/4 of Section 2, T29N, R92W 6th Principal Meridian, Fremont County, Wyoming under license SUA-56 from the Nuclear Regulatory Commission (NRC) and its predecessor federal agencies; and

WHEREAS, Western Nuclear, Inc. is in the process of stabilizing the waste or by-product material which resulted from its previous operation of the mill in accordance with the Uranium Mill Trailings Radiation Control Act of 1978 as required by the NRC; and

WHEREAS, Western Nuclear, Inc. in its attempt to comply with that statute, desires to arrange for the control and management of by-product material so it will not pose a hazard to public health and safety or the environment; and

WHEREAS, certain by-product material has entered the ground water and may now or in the future be located under the Peterson land identified in Exhibit A-1; and

WHEREAS, Owners are willing to assist Western Nuclear, Inc. in its efforts to limit access to by-product material in ground water under said land,

NOW, THEREFORE, in exchange for good and valuable consideration, the sufficiency and receipt whereof being acknowledged, Owners for themselves, and their successors and assigns and all future owners of the land described in Exhibit A-1, agree that permitting, drilling, building, opening, or utilizing any new water wells in or upon the land identified in Exhibit A-1 will not be allowed except upon prior consent of Western Nuclear, Inc. or its successors.

FILE DATE: 10/10/2000 FILE TIME: 02:17 PAGE #: 0002 OF 0003
FREMONT COUNTY, WY, JULIE A FREESE - COUNTY CLERK DOC #: 1214580

Owners for themselves, their successors and assigns additionally hereby grant Western Nuclear, Inc. and its successors an access easement on, over and through the land described in Exhibit A-1 to drill or put in place monitoring wells and to collect samples of ground water and to take such corrective action as may be necessary or required under the provisions of the Uranium Mill Tailings Radiation Control Act, or as may be required by any federal or state agency having jurisdiction, in order to protect the public health and safety, and the environment.

Owners specifically agree that the provisions in the preceding paragraphs shall be a burden on the land described in Exhibit A-1 and shall run in favor of and provide benefit to the land described in Exhibit A-2 and Western Nuclear, Inc. and its successors owners and run in favor of and provide benefit to Western Nuclear, Inc. and its successor Licensees.

Done and signed this 20th day of Sept, 2000.

Beulah Peterson Walker By. Arliss C. Peterson P.O.A.

Beulah Peterson Walker a/k/a
Beulah M. Walker by Arliss C. Peterson
as her agent and attorney-in-fact pursuant to
the power of attorney recorded in the
Fremont County, Wyoming, real property
records in Book 807 at Page 230.

Arliss C. Peterson, Individually

STATE OF OREGON)
) ss.
COUNTY OF Jackson)

OFFICIAL SEAL
RUTH A. WOOTON
NOTARY PUBLIC-OREGON
COMMISSION NO. 058298
MY COMMISSION EXPIRES OCT. 22, 2000

This Restated Land Use Restrictive Covenant and Access Easement was acknowledged before me this 20th day of Sept, 2000 by Beulah Peterson Walker, a.k.a. Beulah M. Walker acting by and through Arliss C. Peterson as her agent and attorney-in-fact.

My commission expires: 10-22-00

Ruth A Wooton
Notary Public

STATE OF OREGON)
) ss.
COUNTY OF Jackson)

OFFICIAL SEAL
RUTH A. WOOTON
NOTARY PUBLIC-OREGON
COMMISSION NO. 058298
MY COMMISSION EXPIRES OCT. 22, 2000

This Restated Land Use Restrictive Covenant and Access Easement was acknowledged before me this 20th day of Sept, 2000, by Arliss C. Peterson.

My commission expires: 10-22-00

Ruth A Wooton
Notary Public

FILE DATE: 10/10/2000 FILE TIME: 02:17 PAGE #: 0003 OF 0003
FREMONT COUNTY, WY, JULIE A FREESE - COUNTY CLERK DOC #: 1214580

EXHIBIT A-1

The following described land in T29N, R92W, Fremont, County, Wyoming, is burdened by the Walker/Western Nuclear Restated Land Use Restrictive Covenant: NE1/4 of Section 14 located south of US Highway 287; NE1/4 NW1/4 of Section 14; and the S1/2 S1/2 of Section 11 (except the westerly 50 feet thereof), owned by Beulah Peterson Walker.

EXHIBIT A-2

The following described land in T29N, R92W, Fremont County, Wyoming is benefitted by the Walker/Western Nuclear Restated Land Use Restrictive Covenant: The SW 1/4 of Section 1 and the NW 1/4 of Section 12.

This page intentionally left blank

Claytor Quitclaim Deed

(ownership of property deeper than 7 feet)

This page intentionally left blank

Split Rock, WY

QUITCLAIM DEED

Claytor Livestock & Ranch, Co., a co-partnership, P.O. Box 370, Jeffrey City, Wyoming 82310, Grantor, for and in consideration of ten dollars and other good and valuable consideration, the receipt and sufficiency of which is acknowledged, conveys and quitclaims to Western Nuclear, Inc., a Delaware Corporation having its principle address at 200 Union Blvd., Lakewood, Colorado 80228, Grantee, all of Grantor's right title and interest, now held or hereafter acquired, in and to all the subsurface portion of the property described in Exhibit A lying deeper than seven feet below the surface, hereby releasing, reserving, however, unto the Grantor, its, successors and assigns the right to use, maintain, repair, and operate all existing water wells and related watering facilities located on said property for purposes of watering livestock.

The estate hereby granted shall be deemed the dominant estate, and Grantee, and its successors and assigns, acting through authorized agents or employees, are granted the right and a perpetual license to go upon and utilize the surface of said property for purposes of inspections; for purposes of installing, maintaining and utilizing such groundwater monitoring wells as may be required pursuant to the Uranium Mill Tailings Radiation Control Act, as amended; and for purposes of taking such corrective action as may be required the by United States Nuclear Regulatory Commission, or its successor regulatory agency or any other federal or state body having jurisdiction.

Dated this 13th day of Feb, A.D. ~~1999~~ 2000

Claytor Livestock & Ranch Co., a co-partnership
by [signature]
Lonnie J. Claytor, General Partner

State of Wyoming)
) ss
County of Fremont)

The foregoing instrument was acknowledge before me by Lonnie J. Claytor as General Partner of Claytor Livestock & Ranch Co., a co-partnership on this 13th day of February, ~~1999~~ 2000

Witness my hand and official seal.

Wallace Jamerman - Notary Public
County of Fremont
State of Wyoming
My Commission Expires April 2, 2002

[signature]
Notary Public

My commission expires April 2, 2002

Z.E.C.

Exhibit A to Claytor--Western Nuclear Quitclaim Deed

Township 29 North, Range 92 West

~ proposed Bdy is a little different

Section 12: SE¼ & S½SW¼ (240 acres, more or less)

Township 29 North, Range 91 West

Section 7: SW¼ & that portion of the NW¼ lying south of a line drawn from the West quarter corner of said section to the Northeast corner of said section (200 acres, more or less)

Shouldn't this be 320 Ac?

Split Rock, WY

QUITCLAIM DEED

Lonnie J. Claytor and Yvonne I Claytor, husband and wife P.O. Box 370, Jeffrey City, Wyoming 82310, Grantors, for and in consideration of ten dollars and other good and valuable consideration, the receipt and sufficiency of which is acknowledged, convey and quitclaim to Western Nuclear, Inc., a Delaware Corporation having its principle address at 200 Union Blvd., Lakewood, Colorado 80228, Grantee, all of Grantors' right title and interest, now held or hereafter acquired, in and to all the subsurface portion of the property described in Exhibit A lying deeper than seven feet below the surface, hereby releasing and waiving all rights under and by virtue of the homestead exemption laws of this state, reserving, however, unto the Grantors, their heirs, successors and assigns the right to use, maintain, repair, and operate all existing water wells and related watering facilities located on said property for purposes of watering livestock.

The estate hereby granted shall be deemed the dominant estate, and Grantee, and its successors and assigns, acting through authorized agents or employees, are granted the right and a perpetual license to go upon and utilize the surface of said property for purposes of inspections; for purposes of installing, maintaining and utilizing such groundwater monitoring wells as may be required pursuant to the Uranium Mill Tailings Radiation Control Act, as amended; and for purposes of taking such corrective action as may be required by the United States Nuclear Regulatory Commission, or its successor regulatory agency or any other federal or state body having jurisdiction.

Dated this 13th day of Feb, A.D. 1999

Lonnie J. Claytor — Lonnie J. Claytor

Yvonne I. Claytor — Yvonne I. Claytor

State of Wyoming)
) ss
County of Fremont)

The foregoing instrument was acknowledge before me by Lonnie J. Claytor and Yvonne I. Claytor on this 13th day of February, ~~1999~~ 2000

Witness my hand and official seal.

Wallace Jamerman - Notary Public
County of Fremont
State of Wyoming
My Commission Expires April 2, 2002

Wallace Jamerman
Notary Public

My commission expires April 2, 2002

Z.Z.C.
4IC

Exhibit A to Claytor--Western Nuclear Quitclaim Deed

<u>Township 29 North, Range 92 West</u>

Section 13: N½ (320 acres, more or less)

Pretransition Land Ownership and Restrictive Covenants Map

This page intentionally left blank

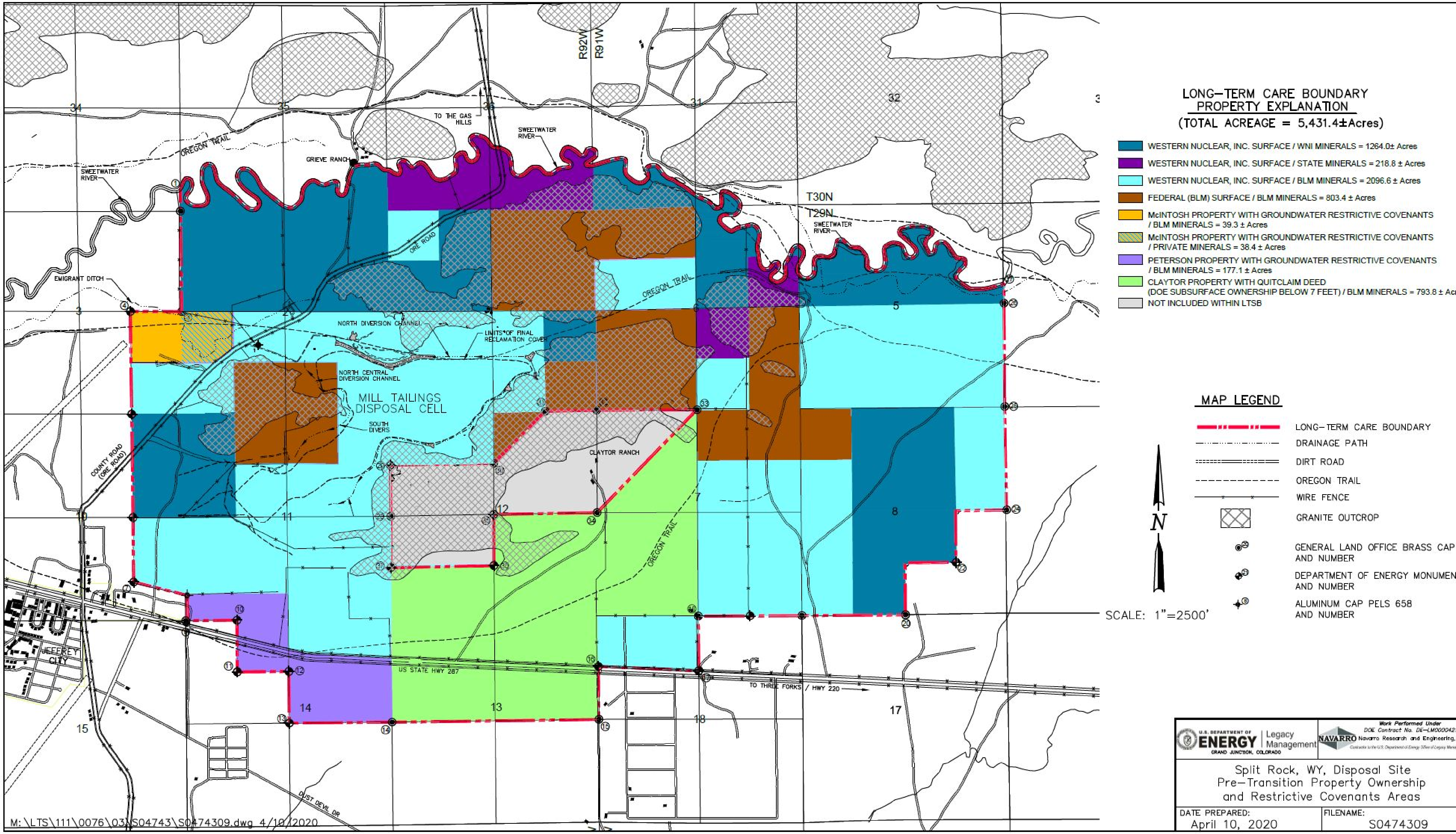


Figure A-1. Pretransition Property Ownership and Restrictive Covenants Areas for the Split Rock, Wyoming, Disposal Site

This page intentionally left blank

Appendix B

Chronology of Significant Pretransition Documents

This page intentionally left blank

Split Rock Chronology Documents

***Split Rock Tailing Reclamation Construction Completion Report*, Shepherd Miller, Inc., April 1999**. Details cell construction and how cell met design specifications. Includes photographs and as-built drawings and maps showing final site conditions. Two volumes; includes Appendixes A through Y.

Closure plan submitted by WNI via letter to NRC, from Lawrence J. Corte to John J. Surmeier, "RE: DOCKET NO. 40-1162, LICENSE NO. SUA-56," October 29, 1999. Provides a chronological explanation of steps taken to meet license conditions and requirements. Provides a status of the license and amendments at that time.

***Site Ground Water Characterization and Evaluation Report* (SGWCER), Shepherd Miller, 1999**. (Appears to have been submitted to NRC on December 31, 1999.) This report is the primary reference for groundwater at the site and served as the initial submittal for groundwater ACLs. Contains results of groundwater modeling and calculations to justify ACLs. Contains cross sections of the groundwater system at the time. Appendix H contains the spreadsheet modeling for the NWV flow system. Appendix I contains the baseline risk assessment for the site.

February 1, 2001, letter from Lawrence J. Corte (WNI) to Phillip Ting (NRC) attempting to expedite approval of WNI's Site Closure Plan for the Split Rock site. The letter includes several enclosures including the *Supplement to October 29, 1999, Split Rock Closure Report* dated January 14, 2000. The supplement includes results of uranium modeling for the SWV to estimate possible impacts to the Red Mule area. Several other letters, memos, and reference materials are also included in this submittal. A number of the enclosures address the use of institutional controls. One memo looks at the impacts of retardation of uranium with respect to the modeling transport in the SWV flow system. Another memo evaluates the impacts of a pumping well in the Jeffrey City area. Yet another addresses the "anomalous chemistry" of a well in the Jeffrey City area (SWAB-36). These enclosures all seem to address issues raised with review of the site closure report and groundwater characterization and evaluation report.

***Supplemental Groundwater Modeling Report for the Split Rock, Wyoming Site*, MFG Inc., March 2003.** This report provides updated modeling for the SWV to provide increased confidence in the proposed downgradient long-term care boundary for the site. The modeling focused on uranium and included the effects of uranium retardation.

Letter from Harley Shaver to Susan M. Frant (NRC) regarding institutional controls for private property within the Split Rock site long-term care boundary, dated March 27, 2003. Demonstrates a good faith effort was made to obtain properties within the boundary and describes the institutional controls that were established for these properties.

NRC Policy Issue Notation Vote, "**Subject: Efforts by Western Nuclear, Inc., to Acquire Off-Site Properties in Conjunction with Decommissioning its Uranium Recover Site and the Need for Institutional Controls, SECY-05-0200," dated October 28, 2005.** Commission agrees that WNI made a good-faith effort to acquire offsite properties and approves the use of institutional controls.

Draft Environmental Assessment for Amendment to Source Material License SUA-56 for Ground Water Alternate Concentration Limits**, Nuclear Regulatory Commission, April 2006.** This EA indicated the Sweetwater River was a Class II water—recreational fishing and wildlife habitat. The EA also had calculations for contaminant discharge to the river that concluded that concentrations 10 to 20 times higher than the maximum would still be protective. This language was removed from the final EA.

Environmental Assessment for Amendment to Source Materials License SUA-56 Ground Water Alternate Concentration Limits**, dated August 2006.** This is the "final" EA for ACLs. This EA acknowledged that the Sweetwater River was classified as a 2AB surface water that was protected for drinking water purposes. The EA indicated historic seepage rates from tailings were as high as 1400 gpm and that current rates at the time were 150 gpm. Long-term steady-state rates of 5 gpm were predicted in the next 30 years (by 2036).

Technical Evaluation Report (TER), Alternate Concentration Limits, Western Nuclear, Inc., Split Rock Site, Jeffrey City, Fremont County, Wyoming, **September 11, 2006**. NRC review of license amendment request for ACLs—lists all of the WNI submittals from the 1999 report to ACL approval. Submitted under cover letter from Gary S. Janosko to Lawrence J. Corte, "License Amendment No. 99 Approving Alternate Concentration Limits, Western Nuclear, Inc., Split Rock Site, Jeffrey City, Fremont County, Wyoming, SUA-56 (TAC L51881)," dated September 28, 2006.

Letter from Lawrence J. Corte, WNI, to Richard Chang, NRC, "Re: Western Nuclear Inc., Split Rock Uranium Mill Tailing Facility, Source Material License SUA-56, Proposed Amendments to License Condition 74," **dated December 1, 2008**. WNI letter requesting selenium ACL along with other license changes.

Letter from Louis Miller, Miller Geotechnical Consultants, to Richard Chang, NRC, "Re: License Amendment Request for Western Nuclear Inc., Split Rock Mill Site, Source Material License SUA-56 (TAC J00577)," dated February 7, 2009. Letter provides information requested by NRC to complete EA for license amendment (including selenium ACL).

Email from Lou Miller to Richard Chang and Stephen Cohen, "Subject: Split Rock Information," dated October 2, 2009. Provides calculations and backup information to demonstrate that proposed selenium ACL will result in aquatic standards being met in Sweetwater River under low flow conditions.

Environmental Assessment for Amendment to Source Material License SUA-56, Revised Groundwater Protection Standards, **Western Nuclear, Inc., Split Rock Uranium Mill Tailings Site, Jeffrey City, Fremont County, WY, January 2010**. EA establishing selenium ACL of 0.05 mg/L (and other miscellaneous license changes such as uranium trigger level for SWV well SWAB-32).

Technical Evaluation Report for Western Nuclear, Inc., Split Rock Mill Site, Jeffrey City, WY**, dated February 24, 2010.** Technical evaluation approving selenium ACL and other miscellaneous changes to license SUA-56.

***Long-Term Surveillance Plan for the Split Rock (UMTRCA Title II) Disposal Site, Jeffrey City, Wyoming*, LMS/SPR/S02613-0.0, April 2012.** Draft submitted to NRC raising the issue of downgradient nitrate ACL exceedances in the SWV.

Letter from Louis Miller (Worthington Miller Environmental, LLC) to J.C. Shepherd, NRC, "Re: Source Material License SuA-56; Western Nuclear, Inc., Split Rock Uranium Mill Tailings Facility; Long-Term Surveillance Plan," **dated February 6, 2013.** Letter describing establishment of LTSB for SWV. Acknowledges that nitrate exceeds ACL values established in license but indicates this was recognized previously and that it does not affect site protectiveness.

Letter from Christopher S. Pugsley to James Shepherd, dated July 29, 2013. Letter provides comments on DOE's draft LTSP. In particular, addresses why nitrate exceedance of ACL is actually in compliance. Indicates that WNI's approach is an "alternative" to the requirements of 10 CFR 40 Appendix A and is adequately protective of public health.

Letter from Andrew Persinko, NRC, to Lawrence J. Corte, WNI, "Subject: Ground Water Issues at the Split Rock Site and Request for Additional Information," **dated September 11, 2013.** Requests additional information regarding contaminant transport (particularly nitrate) in the SWV as recent observations were not consistent with model predictions.

Letter from Anthony J. Thompson (Thompson and Pugsley, PLLC) to Dominick Orlando, NRC, dated July 8, 2014. Technical memorandum from Thompson to NRC indicating that license conditions have been met and formally requesting license termination.

Letter from Dominick A. Orlando, NRC, to Lawrence J. Corte, WNI, "Subject: U.S. Nuclear Regulatory Commission Staff Acceptance Review of Western Nuclear Incorporated's (WNI's) Request for License Termination for WNI's Split Rock, Wyoming Site (Docket 040-1162)," dated January 7, 2015. Letter from NRC indicating that all approvals for license termination have not been obtained and that several required documents were not properly submitted to NRC (specifically approvals for ICs in lieu of obtaining ownership of property within the LTSB).

Assessment of Recent Groundwater and Surface Water Conditions. Report prepared by WNI and submitted to NRC May 22, 2015. Report provides an evaluation of recent groundwater conditions with results of previous modeling efforts.

Letter from Dominick A. Orlando, NRC, to Lawrence J. Corte, WNI, "Subject: Request for Additional Information Regarding Western Nuclear Incorporated Technical Memorandum Entitled Assessment of Recent Ground Water and Surface Water Conditions for the Split Rock Site in Jeffrey City, Wyoming (Docket 040-01162)," dated August 12, 2015. Request from NRC to WNI asking that they validate model predictions for both the NWV and SWV with the objective of verifying that the LTSB is appropriately located and protective.

Memo from Micheal Gard, AquiferTek, to Toby Wright, Wright Environmental Services Inc., "Subject: Analytical Modeling of Nitrate in Groundwater at the Western Nuclear Inc. Split Rock Site," dated October 4, 2016. Updated SWV modeling includes expanded site boundary with modeled concentrations at the Sweetwater River, higher nitrate source concentration.

Technical Memorandum to Lawrence Corte, WNI, from Toby Wright, Wright Environmental Services, "Subject: Proposed Long-Term Groundwater Monitoring Program," dated December 2, 2016. Provides a proposed long-term monitoring network for the site including wells and surface water locations and analytes.

Letter from Lawrence J. Corte, WNI, to Dominick Orlando, NRC, "RE: License Amendment Request for Western Nuclear Inc., Split Rock Mill Site, Source Material License SUA-56," dated October 25, 2016. WNI submittal to NRC for license amendment for change in nitrate ACL and expanded site boundary; includes predicted concentrations for all COCs based on 294:1 groundwater:source dilution factor.

Memorandum from Dominick A. Orlando, NRC to Stephen Koenick, NRC, "Subject: Meeting Summary—Technical Meeting to Discuss the Decommissioning of the Western Nuclear Incorporated site in Jeffrey City, Wyoming (Docket 040-01162)," dated June 22, 2017. Memorandum summarizing public meeting held May 24, 2017, on WNI license amendment request. Included discussion of expanded site boundary and ICs. Memo indicates that ICs appear to be adequate. Discussion about providing IC information to Wyoming State Engineer's Office in the event of a well requested in the restricted area.

Letter from Louis Miller, WNI, to Dominick Orlando, NRC, "RE: License Amendment Request for Western Nuclear Inc, Split Rock Mill Site, Source Material License SUA-56," dated June 21, 2017. Letter provides map with revised flow lines and predicted width of nitrate plume.

***Memorandum of Understanding Between the United States Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality to Establish a Process for the Completion of Decommissioning of Five Uranium Mill Tailing Sites and the Termination of the Associated Uranium Milling Licenses Located Within the State Of Wyoming,* dated September 30, 2018.** Licensing authority for the Split Rock Site transferred to the State of Wyoming (along with four other sites within the state).

Western Nuclear Inc., Split Rock Site, WYSUA-56, "Technical Approach Summary, License Amendment Request for Revised Selenium ACL in Northwest Valley," presentation dated April 24, 2019. Presents approach used to develop selenium ACL. Includes effects of mixing and dilution of plume from tailings seepage with upgradient NWV groundwater. Demonstrates that aquatic standard for selenium will likely be met in Sweetwater River.

Appendix C

Initial Site Inspection Checklist

This page intentionally left blank

Inspection Checklist: Split Rock Disposal Site

Date of This Revision:
Last Annual Inspection:
Inspectors:
Next Annual Inspection (Planned):

No.	Item	Issue	Action
1	Protocols	Inform regulators and interested parties of inspection.	Contact NRC and WDEQ 30 days before inspection.
2	Access	Access is from a gravel county road (labeled Ore Road on site map).	None.
3	Specific site surveillance features	See attached list.	Inspect and identify maintenance requirements.
4	Tailings impoundment	The surface of the tailings impoundment has been covered with rock mulch and graded to control wind and water erosion.	Inspect impoundment cover and note condition of rock mulch and look for evidence of displacement, degradation, settlement, or slumping.
5	Diversion channels	The storm water diversion channels have been armored with riprap for erosion protection and graded and sloped to convey runoff and control velocities.	Inspect channels and note evidence of sedimentation, vegetation, and debris build-up that may impact performance; look for hydraulic scour or bank cutting. Inspect riprap; note evidence of rock displacement or degradation.
6	Vegetation	The tailings impoundment has been covered with rock mulch; a vegetative cover was not used at this site (some vegetation has established, including deep-rooted plants). Growth of deep-rooted existed on the tailings impoundment at the time regulatory closure of the disposal site was approved.	No monitoring or control of vegetation (including deep-rooted plants) on the tailings impoundment will be performed under long-term management. Note condition of vegetation (abundance, diversity, extent). Note occurrence of listed noxious or invasive weeds; control as needed.
7	Site perimeter and balance of the site	Disturbed areas between the tailings impoundment and site ownership boundary have been contoured and revegetated. Site surveillance features are located in this area. Groundwater ICs (i.e., restrictive use covenants) are in place on the three privately held lands within the LTSB: McIntosh, Peterson, and Claytor (see LTSP, Appendix A, Figure A–1)	Inspect for intrusion or other activity or process that can affect protectiveness. Monitor the effectiveness of the groundwater ICs; verify awareness and compliance by land owners and state engineer's office.
8	Outlying area	Visually inspect for 0.25 mile beyond site boundary. Note adjacent land use. Look for changes and developments in the surrounding area that could negatively impact the site.	Note any changes or development in the surrounding area that could negatively impact site protectiveness.

Checklist of Site-Specific Surveillance Features: Split Rock Disposal Site

<table>
<tr><th>Feature</th><th colspan="2">Comment</th></tr>
<tr><td>Access road</td><td colspan="2">Gravel road; verify condition is adequate for vehicular access to the site.</td></tr>
<tr><td>Entrance gate</td><td colspan="2">Metal gate; verify condition (ensure functionality).</td></tr>
<tr><td>Entrance and perimeter signs</td><td colspan="2">Total: 38 (in process); verify condition (intact and legible).</td></tr>
<tr><td>Perimeter fence</td><td colspan="2">Barbed-wire stock fence (used for livestock management in many locations; maintenance performed by grazing leasee in accordance with agreement).</td></tr>
<tr><td>Boundary monuments</td><td colspan="2">Total: 33.</td></tr>
<tr><td>Site marker</td><td colspan="2">One (SM-1); near site entrance.</td></tr>
<tr><td rowspan="3">Monitor wells</td><td colspan="2">Total: 10.</td></tr>
<tr><th>NWV Flow Regime</th><th>SWV Flow Regime</th></tr>
<tr><td>
Well-5
WN-42A
WN-41B
WN-39B</td><td>SWAB-12R
SWAB-22
SWAB-29
SWAB-32
SWAB-1R
WN-21</td></tr>
</table>

Appendix D

Field Photograph Log

This page intentionally left blank

Field Photograph Log

Site: Purpose of Visit:
Date of Visit:

Photo File Name	Film Frame No.	Azimuth	Field Inspection Photo No.	Trip Report PL No.	Post on Web (Y/N)	Photo Caption

Lead Inspector:
Assistant Inspector:
Remarks:
Electronic File Location:

This page intentionally left blank

Appendix E

Summary of Pretransition Groundwater History and Conditions at the Split Rock, Wyoming, Disposal Site: Evaluation and Recommendations for Long-Term Monitoring

This page intentionally left blank

E1.0 Purpose

Extensive groundwater monitoring has been conducted at the Split Rock, Wyoming, UMTRCA Title II Disposal Site near Jeffrey City, Wyoming. Upon the concurrent acceptance of an LTSP and termination of WNI specific source material license (WYSUA-56) by WDEQ, the site is transferred to DOE for custody and long-term care and included under the NRC general license at 10 CFR 40.28. In order to develop the groundwater and surface water monitoring program presented in the draft LTSP submitted to NRC for concurrence, DOE performed a review of site documentation and an evaluation of historical (i.e., pretransition) groundwater and surface water monitoring data. The results of this review and evaluation are presented below.

The primary document upon which the groundwater remedy is based is the 1999 *Site Ground Water and Characterization and Evaluation* (SGWCE) report (SMI 1999b). This document is still the primary source of groundwater information about the site. It was submitted to support proposed ACLs and license termination. Much correspondence and documentation has taken place among the various parties since that time—the licensee, NRC, WDEQ, and DOE. NRC submitted requests for additional information to the licensee. The licensee followed up with supplements to the SGWCE or independent evaluations of particularly issues of importance. A common occurrence during the history of the site was that an unexpected condition was measured and reported to NRC and further clarification and explanation was requested from the licensee to demonstrate that this would not be a problem in the future (often an exceedance of a groundwater standard). The first exceedance was noted just a month after groundwater standards were first established in the site license. The intent of this appendix is to summarize the main issues pertinent to the current groundwater remedy and the interpretation of site monitoring results. This summary is to develop and justify the long-term monitoring strategy for the site and to provide a basic understanding of the site for future long-term stewards. A list of pertinent site-related documents is included as Appendix B. This list is not exhaustive but provides the framework for the long-term monitoring approach proposed herein.

E2.0 Background

E2.1 History

Uranium milling at the Split Rock site began in 1957 and continued through 1981, when the mill was placed on standby status. The mill remained in standby status until 1986 when it was placed in possession-only status. Decommissioning and demolition commenced in 1988 (SMI 1999b). Most of the ore for the mill came from open pit mine operations in the Gas Hills district, approximately 20 miles north of the mill site. Other ore supplies came from underground mining operations in the Crooks Gap area, approximately 12 miles south of the mill site (Merritt 1971). The Split Rock mill was an acid-leach, ion-exchange, and solvent-extraction operation that processed approximately 7.7 million tons of ore. The facility, originally designed to process 400 tons of ore per day, underwent two capacity upgrades, and, by 1967, the milling capacity had been increased to 1200 tons per day (SMI 1999b). After a series of expansions in the 1970s, the milling capacity was further increased to 1700 tons of ore per day.

During the milling period, process waste in the form of tailings solids and acidic liquids were discharged to the unlined tailings disposal areas. These tailings disposal areas or ponds were

designed in 1957 when the design philosophy was to eliminate process effluent through seepage, thereby maximizing solid tailings storage while decreasing water storage and handling requirements. Three primary tailings disposal areas, known as the Main, Old, and Alternate Tailings Impoundments, were used during the operational life of the mill (SMI 1999b). The final tailings impoundment was designed and constructed to combine these three former tailings disposal areas into one disposal cell. In 2007, reclamation of the Split Rock site was considered complete when NRC approved the reclamation of the final evaporation pond that had been used for groundwater corrective action.

E2.2 Groundwater Conditions and Use

The reclaimed tailings area at the Split Rock disposal site is at the head of a natural drainage that is bounded by steep granite outcrops located to the north and the south of the tailings impoundment (Figure E–1). Toward the outlet of this drainage, west of the tailings impoundment, an additional granite outcrop separates the drainage into two valleys that are referred to as the NWV and the SWV. Drainage from the NWV intersects the alluvial floodplain of the Sweetwater River, while drainage from the SWV intersects a plain of alluvial deposits in the regional Split Rock aquifer (SMI 1999b).

Seepage from the tailings impoundments has impacted the groundwater within the Split Rock Formation (regional aquifer) and the Sweetwater River alluvium (floodplain aquifer) in the area underlying and downgradient of the tailings impoundment. Concentrations of site-related contaminants are typically highest in groundwater at the mouths of both the NWV and SWV, immediately downgradient of the tailings impoundment. Contaminants, particularly uranium, are found at depth in the valleys but are mainly in shallow portions of the aquifers outside the valley mouths (SMI 1999b). The higher hydraulic conductivity and larger lateral gradient in the alluvial floodplain aquifer (as compared to the Split Rock Formation) has allowed for further migration of contaminants in this shallower zone downgradient of the NWV and SWV. The alluvium may also contain buried channel deposits of coarse-grained material that provides preferred pathways for shallow groundwater flow in the floodplain (SMI 1999b).

Drainage of the tailings historically input up to 1400 gpm into the underlying groundwater system. Since tailings and water disposal in the impoundments ceased in 1986, drainage into the underlying system has greatly diminished, and the elevated groundwater level (i.e., mound) in the immediate area of the impoundment has largely dissipated. In 1999, tailing seepage rates were estimated to be approximately 150 gpm and were expected to decline to a rate of 30 gpm within 30 years and eventually reach a long-term, steady-state rate of less than 5 gpm (SMI 1999b).

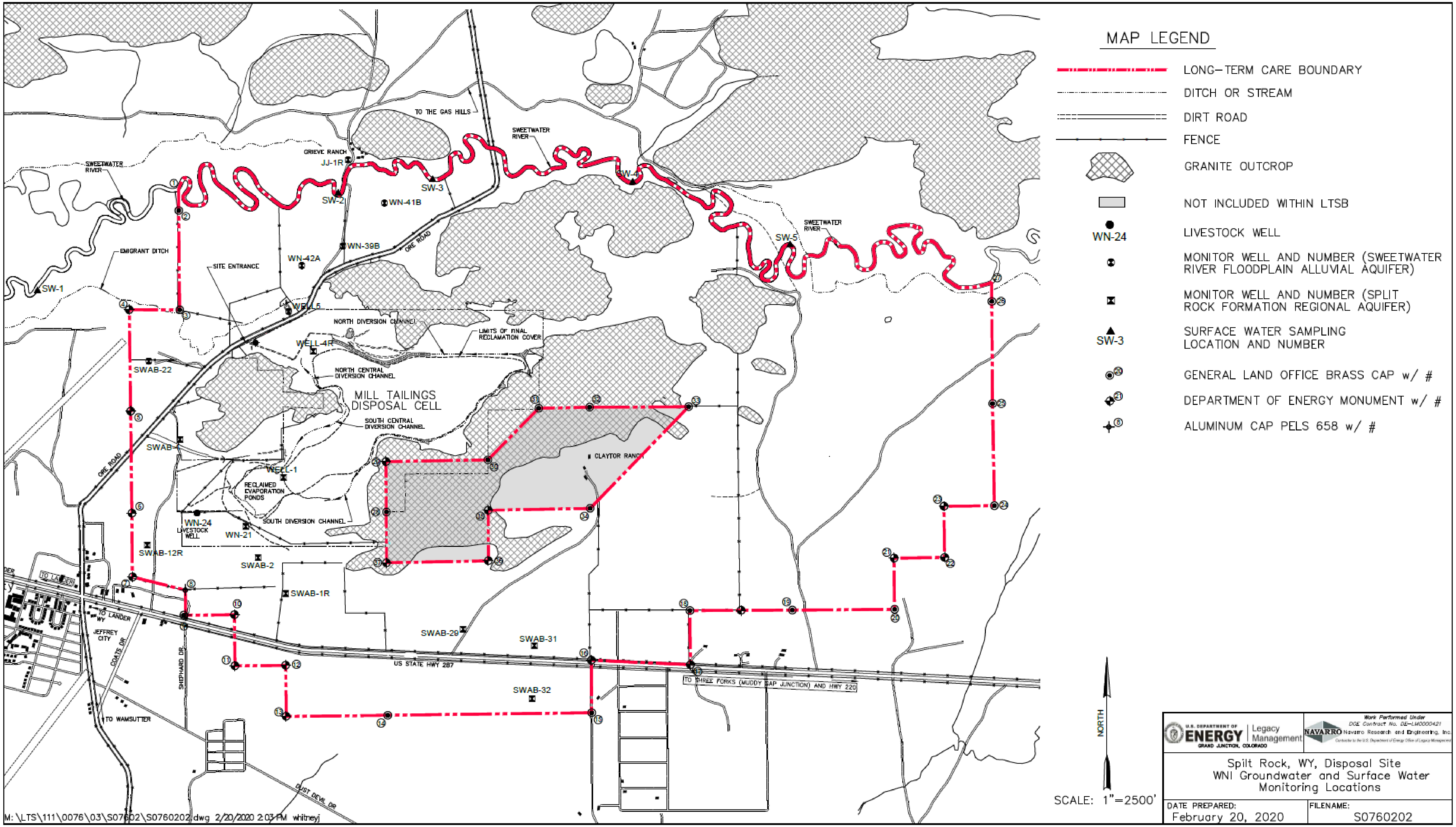


Figure E-1. Split Rock, Wyoming, Disposal Site WNI Groundwater and Surface Water Monitoring Locations

This page intentionally left blank

Horizontal groundwater flow gradients are out of the area of high elevation that surrounds the tailings impoundment and toward either the NWV or SWV. Groundwater underlying the tailings impoundment is primarily directed down the NWV (~90% of the flow), with the balance of the flow (~10%) directed down the SWV. This split in the flow is due to the presence of a granite outcrop located directly west of the tailings impoundment. Outside of either valley groundwater flowing from the tailings impoundment area merges with the east northeast trending regional groundwater flow of the Split Rock aquifer. An upward vertical gradient occurs in the groundwater of the regional Split Rock aquifer in this area due to the presence of the subsurface granite and discharges towards the Sweetwater River. This upward vertical gradient results in seepage from the tailings impoundments occurring primarily within the groundwater of the upper portion of the Split Rock aquifer in this area (SMI 1999b).

All groundwater flow exiting the NWV combines with the regional groundwater flow of the Split Rock aquifer that is entering the Sweetwater River floodplain alluvial aquifer. Most of the groundwater flow (~80%) exiting the SWV combines with the east-northeast trending regional groundwater flow of the Split Rock aquifer. This flow continues along the southern edge of the granite outcrops south of the impoundment before migrating beyond the site's eastern boundary. The balance (~20%) of the groundwater exiting the SWV flows to the north around the granite outcrops west of the impoundment where it joins the Split Rock aquifer that is merging with the east flowing groundwater of the floodplain alluvial aquifer. All groundwater in the immediate area of the tailings impoundment eventually discharges to the Sweetwater River. Groundwater exiting the NWV reaches the Sweetwater River before groundwater that exits the SWV, particularly the flow which travels to the south and joins with the east-northeast trending regional groundwater flow of the Split Rock aquifer (SMI 1999b). The groundwater flow patterns and affected aquifers are shown on Figure E–2 and Figure E–3, respectively.

Currently, groundwater near the site is used for drinking water and livestock watering. These uses will likely continue in the future (NRC 2006a). The Jeffrey City area is currently served by the Lucky Mc water supply system. In addition, one of the old townsite wells is used to supply a fill station for water hauling (WWDC 2013). A study of these systems was conducted in 2012 to evaluate the need for upgrading or optimizing them (WWDC 2013). At that time, the population of Jeffrey City was estimated to be about 50 (the 2010 census population estimate for Jeffrey City was 58). Total average city water usage was estimated at about 69 gpm, with higher usage rates in the summer and lower rates in the winter.

As part of the water supply system study, water quality was examined for the Lucky Mc and townsite wells. Both wells are completed in the Split Rock Formation. Total depth for the Lucky Mc well is reported to be 306 ft and the townsite well is 241 ft in depth. Adjusted for the difference in surface elevations, the wells are within 25 ft of the same depth. The screened intervals do not quite overlap. A comparison of water quality analyses for the two wells noted some differences, which were attributed to local variations in the geochemistry, thickness, permeability, recharge pathways, and geologic history of the many individual strata making up the aquifer. All constituents in both wells met applicable water quality standards. However, the townsite well had higher levels of gross alpha and uranium. The uranium concentration of 0.028 mg/L in the town site well was only slightly below the maximum contaminant level (MCL) of 0.030 mg/L.

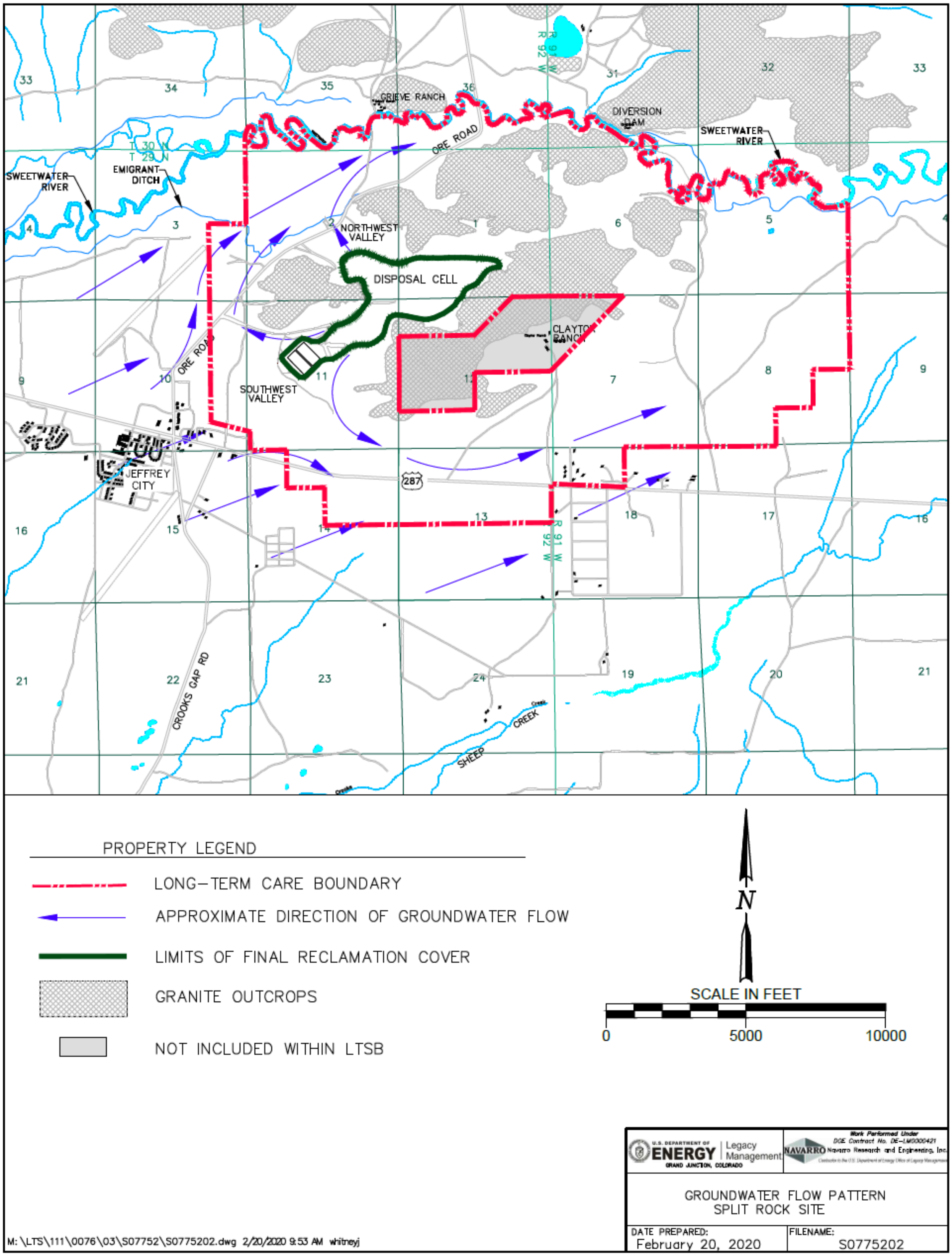
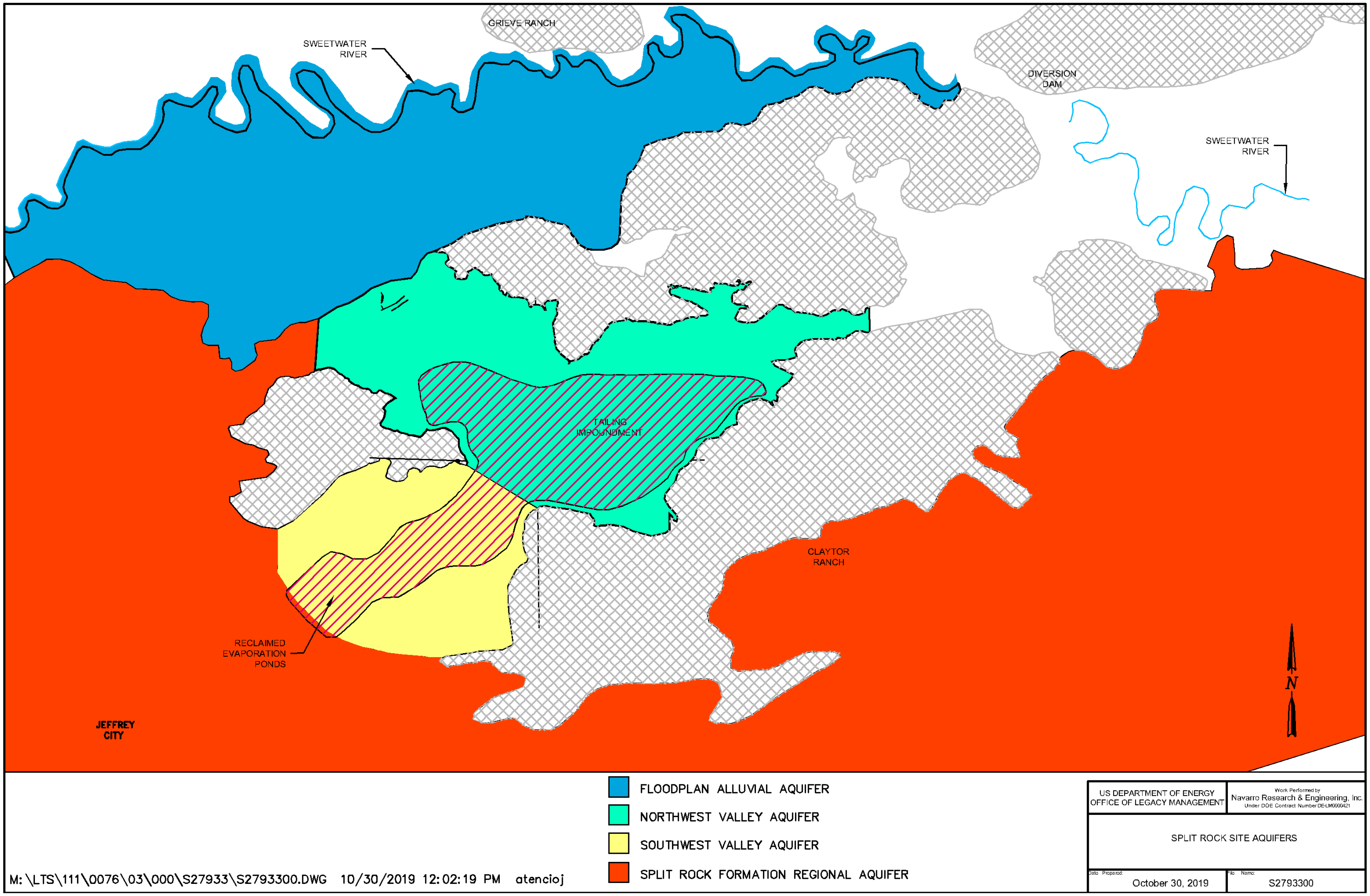


Figure E-2. Groundwater Flow Pattern, Split Rock, Wyoming, Disposal Site



DRAFT

Figure E-3. Split Rock, Wyoming, Disposal Site Aquifers

Continued usage of the municipal water system is not expected to be impacted by site-related contamination (WNI 2001). Current water usage rates are nearly an order of magnitude lower than peak rates. Population projections for the area do not indicate appreciable growth; the Wyoming Department of Administration and Information estimates a population of 73 by 2060 (WWDC 2013). Given the expected land and water use, site-related contamination is not expected to affect areas outside the long-term surveillance boundary (LTSB; also known as the long-term care boundary). Previously, a well within the LTSB (WN-24) was used for watering livestock, but the use of that well has been discontinued, and the well was decommissioned by WNI in accordance with State of Wyoming requirements prior to site transition to DOE. No future use of groundwater within the LTSB is anticipated.

Groundwater along both the northwest and southwest flowpaths ultimately discharges to the Sweetwater River, which is considered the POE for the site. The LTSB is anticipated to completely encompass these flowpaths. Modeling for the SWV has shown that residual groundwater contamination is expected to attenuate as it moves toward and discharges to the river. Mixing calculations have shown that even at low river flows, discharging groundwater will rapidly mix with river water, resulting in very dilute contaminant concentrations (SMI 1999b). Modeling has predicted that it will take hundreds, if not thousands, of years for contaminants in the SWV to reach the Sweetwater River.

Travel times for the NWV are shorter due to the higher hydraulic conductivities of the Sweetwater River alluvium compared to the Split Rock aquifer and, to a much lesser extent, the greater volume of water discharging to the NWV from the tailings area (SMI 1999b). Modeling provided in the groundwater characterization report (SMI 1999b) indicated that peak loading of uranium from the Sweetwater River alluvium to the river may have occurred in about 1996 and would have declined since that time, if uranium behaves like a conservative element (e.g., chloride). Monitoring of the Sweetwater River provides no indication that site-related constituents are significantly affecting river water quality (see Section E3.3).

E2.3 Groundwater Corrective Action

The formal groundwater CAP at the site began in 1990 when pumping was begun from four collection wells. The primary purpose of the system was to accelerate dewatering of the tailings impoundment. The system was designed to capture from 47.3 million gallons to 66 million gallons of water per year. Beginning in January 1990, the wells operated year-round. In February 1992, the pumping duration was reduced to about 6 months per year (April through October), with the required volume of captured water remaining the same as initially specified. Recovered groundwater was piped to an evaporation pond and to an evaporation misting system that sprayed water over the unreclaimed portion of the tailings impoundments (SMI 1999b). In addition to dewatering, the goal of the corrective action program was to return groundwater concentrations to groundwater protection standards, which were the higher of background or MCLs. These corrective action goals were incorporated into WNI's specific source materials license (SUA-56).

In 1999, WNI concluded that continued corrective action would not be effective in reducing contaminant concentrations in groundwater further and issued the SGWCE report (SMI 1999b) to support the selection of a corrective action alternative. While the groundwater CAP was effective in minimizing seepage from the tailings impoundment, based on the performance to

that point, it was determined that the continued operation of the system was unlikely to achieve the groundwater protection standards specified in SUA-56 for certain site constituents. Based on the presumed continued ineffectiveness of the active remediation system, WNI proposed that ACLs be determined for the site's POC that are protective of human health and the environment and which would result in compliance with groundwater protection standards (or established background concentrations, whichever was higher) at the LTSB (i.e., POE). The 1999 groundwater characterization and evaluation report submitted to NRC serves as the ACL application for the site.

Information provided in support of the ACL application (SMI 1999b) included a hazard assessment that evaluated the current and future environmental and human health risks associated with the establishment of ACLs as required by 10 CFR 40, Appendix A, Criterion 5B[6]. Site-related constituents were determined to be those that exceeded lowest background concentrations from samples collected within the tailings area. Constituents that exceeded a protective standard (or background, if higher) were designated as constituents of potential concern (COPCs). Constituents that exceeded protective standards downgradient of the tailings area based on data collected from January 1, 1996, through December 31, 1997, were determined to be the constituents of concern (COCs). Though some constituents in wells within the tailings area exceeded protective values, it was determined that concentrations beyond the tailings area would remain below protective values. Six constituents were identified as COCs: ammonia, manganese, molybdenum, nitrate, combined radium-226 and radium-228, and uranium. Only the COCs were considered in the subsequent corrective action evaluation.

Table E-1 provides the COPCs and COCs for the alluvial floodplain and Split Rock Formation regional aquifers. Maximum concentrations, background values, and groundwater protection standards used in the evaluation process are also provided. It should be noted that some of the maximum and background groundwater values could not be corroborated from existing data and that some of the groundwater protection standards subsequently changed. The values in Table E-1 are provided for historic context only.

Maximum groundwater concentrations from the tailings area from 1996 through 1997 were considered a conservative representation of the conditions at the time. The COCs for which ACLs were required included natural uranium, combined radium-226 and radium-228, ammonia, manganese, molybdenum, and nitrate. ACLs for these six COCs were proposed for both the NWV and SWV flow regimes. Uranium was the main focus because of its mobility and abundance. It was determined that if a remedy was protective for uranium, it would also be protective for other constituents.

Table E-1. Maximum Concentrations, Background Concentrations, and Groundwater Protection Standards from ACL Application for the Split Rock, Wyoming, Disposal Site

Constituent	Maximum Concentrations[a]		Background Concentrations[b]		Groundwater Protection Standard[c]
	Tailings Area	Beyond Tailings Area	Floodplain Alluvial Aquifer	Split Rock Formation Aquifer	
Aluminum (mg/L)	578	2.02	0.1	0.13	37 (RBC)
Ammonia (mg/L)	0.16	2.35	0.011	0.015	0.5 (RBC)
Antimony (mg/L)	0.017	0.01	0.005	0.005	0.006 (MCL)
Arsenic (mg/L)	2.64	0.058	0.024	0.1	0.05 (MCL)
Beryllium (mg/L)	0.084	<0.01	0.004	0.01	0.004 (MCL)
Cadmium (mg/L)	0.188	0.014	0.008	0.014	0.005 (MCL)
Fluoride (mg/L)	21.7	1.33	1.04	0.517	4 (MCL)
Lead (mg/L)	0.11	0.005	0.005	0.050	0.015[e]
Manganese (mg/L)	126	49.1	2.39	0.53	0.73 (RBC)
Molybdenum (mg/L)	0.55	0.22	0.1	0.1	0.18 (RBC)
Nickel (mg/L)	2.29	0.11	0.05	0.05	0.73 (RBC)
Nitrate (mg/L)	362	201	0.88	3.99	10 (MCL)
Radium-226 and -228 (pCi/L)	2950	13.5	4.7	5.3	10 pCi/L (MCL)
Selenium (mg/L)	0.119	0.061	0.005	0.011	0.05 (MCL)
Thallium (mg/L)	0.075	0.013	0.013	0.003	0.002 (MCL)
Thorium-230 (pCi/L)	732	5.5	5.5	1.8	15 (MCL)
Uranium (mg/L)	4.055	8.7	0.044	0.13[d]	0.11 (RBC)

Notes:
[a] Maximum concentrations observed between January 1, 1995, and December 31, 1997 (Table 17, SMI 1999b).
[b] Background concentrations obtained from Volume 1 of the SGWCE, Table 17 (SMI 1999b).
[c] Groundwater protection standards were those used to determine COCs (Table 3, SMI 1999b); some of these values subsequently changed.
[d] The background concentration for uranium was subsequently revised to 0.087 mg/L (NRC 2010b).
[e] EPA Action Level.

Abbreviations:
EPA = U.S. Environmental Protection Agency
pCi/L = picocuries per liter
RBC = risk-based concentration

E2.4 Groundwater Modeling and Development of ACLs

Flow and transport modeling of uranium and sulfate in the SWV was conducted as part of the corrective action assessment to evaluate different alternatives for the groundwater remedy. Of most relevance for this document is the modeling that was done to determine the "institutional controls" alternative (to Appendix A of 10 CFR 40), in which no further corrective action was conducted. Modeling of the NWV determined potential impacts to the Sweetwater River where contaminated groundwater would ultimately discharge. The SWV was modeled to determine the extent to which uranium exceeding the standard would migrate to establish an appropriate LTSB

for the site. Modeling for the SWV was also conducted to estimate impacts to the Sweetwater River, the eventual discharge point for the SWV groundwater contamination.

Uranium was used in the transport modeling because it was thought to be the most conservative and extensive COC (i.e., its transport would encompass the transport of all other COCs). Sulfate, another mobile COC, was modeled to confirm the assumptions and predictions made regarding uranium's mobility. In other words, by modeling uranium, and confirming the assumptions and predictions with sulfate, it was assumed that the mobility of these two constituents would represent the furthest extent of mobility of all other site-related hazardous constituents. The transport model used measured uranium and sulfate plume distributions from 1986 as the initial conditions, the 1996 distributions with depth at the mouth of each valley, and then the model was calibrated to measured 1996 plume distributions by varying the 1996 valley mouth concentrations, as needed (SMI 1999b). This initial modeling used a random walk particle tracking approach for contaminant concentrations and the limitation of quantifying concentrations at the plume front, where particles become sparse, was recognized (Section H.c.3.1 in SMI 1999b). However, this initial modeling was used more for evaluating different corrective actions than for quantifying concentrations at a POE. The flow and transport modeling in the SWV was later redone (MFG 2003) for a supplemental monitoring report in a more quantitative manner using state-of-the-art transport and calibration codes. This updated SWV transport model included uranium retardation. An equivalent update for the NWV and Sweetwater River alluvial floodplain has not been completed.

The above modeling was conducted in an effort to predict the downgradient behavior of site-related contaminants over time, both those concentrations associated with the legacy plume (which was acknowledged to have migrated some distance beyond the edge of the tailings area and the capture zone of the groundwater CAP) and those concentrations anticipated to be released from the tailings impoundment in the future under long-term surveillance. Modeling predictions were intended (and used) to establish a downgradient LTSB for the SWV that would be protective (i.e., one that assures concentrations of site-related constituents will be compliant with applicable groundwater protection standards or established background concentrations at the POE or site LTSB).

Under the "institutional controls" alternative, predicted loads to the river from the NWV were highest in 1996 and were predicted to drop off quickly within the first 20 years. However, these predicted loads were never measured directly. Loads to the river were predicted to reach steady-state levels within about 200 years. Predicted loads to the river from the SWV would not reach the river to the east until after 600 years and would be two orders of magnitude lower than loading from the NWV near the site (SMI 1999b).

The peak load of uranium discharge to the Sweetwater River from the NWV was estimated to be 4.6 pounds per day (lb/day) in 1996. The load was predicted to drop to 2.1 lb/day the first 5 years thereafter. Relatively rapid declines in uranium discharge were predicted for 20 years (through 2016) followed by slower declines over the next few hundred years until a steady-state loading of 0.15 lb/day is reached. The predicted worst-case loading rate to the river was estimated to result in a river uranium concentration of 0.38 mg/L at minimum 7-day low flow (2.1 cfs) conditions and the 2.1 lb/day loading equates to 0.19 mg/L uranium in the river. Likewise, the long-term steady-state loading of 0.15 lb/day equates to 0.013 mg/L uranium in the river under low flow conditions (2.1 cfs).

Uranium mass from the SWV was predicted to reach the river through the eastern flow path in the year 2496. The predicted load to the river in 2496 was 0.0009 lb/day. It increased to 0.08 lb/day by the end of the simulation period in 2996. These predicted loads were two orders of magnitude smaller than the peak river loading just north of the site. Thus, uranium loading to the river through this flow path will never exceed the peak loading predicted for the NWV flow path.

The COCs other than uranium were not modeled explicitly but were modeled implicitly. The behavior of other constituents were determined or calculated from relationships and observations that the licensee determined relative to uranium. The 1999 SGWCE report states: “Simulation of other constituents which migrate without retardation would transport in identical patterns to uranium. Reactive solutes would tend to lag behind uranium” (Section H.c.3.3, “General Chemical Transport,” SMI 1999b). The updated uranium transport model in MFG 2003 used a simple retardation for uranium using an equilibrium K_d approach. Although NRC had some issues with the modeling, their technical evaluation stated: “Although the staff finds that the models for uranium transport are likely oversimplified, all information WNI provided indicates that viable mechanisms exist for uranium retardation and/or removal, at this site” (Section 3.3, “Flow and Transport Modeling;” NRC 2006b).

In summary, groundwater modeling predicted the following: (1) that uranium and sulfate would mark the maximum extent of site-related contamination in both the Sweetwater River floodplain alluvial aquifer and in the regional Split Rock Formation aquifer; (2) that concentrations would be protective at the POE (i.e., the site’s LTSB), noting that the protective acute aquatic value in the river for uranium was 2.6 mg/L; (3) that groundwater within the site’s LTSB would ultimately discharge into the Sweetwater River; and (4) that if concentrations of site-related constituents at the POC stayed below the historical maximum concentrations observed, they would be protective at the POE (SMI 1999b).

Table E-2 reproduces Table 18 from the SGWCE (SMI 1999b) that shows maximum historical groundwater concentrations of COCs for the NWV and SWV for the wells indicated. For each COC, the highest concentration for the NWV and SWV was proposed as the ACL for each of the flow regimes. These values were subsequently approved (see Section E2.6) and remained the licensed values prior to site transition to DOE. Some of the maximum values reported in Table E-2 (as reproduced from SGWCE Table 18) do not agree with historical data received from WNI as presented in Section E3.3 (e.g., historical data for uranium for Well-5 exceeds the reported maximum concentration). In addition, current protective values for the Sweetwater River are different (mostly lower) than values used in the 1999 SGWCE report (SMI 1999b). Section E3.2 provides further discussion of these issues.

Table E-2. Maximum Historical Ground Water Concentrations for Proposed Point of Compliance and Other Wells

Constituent	Protective Aquatic Acute Values (mg/L)	NWV		SWV	
		Well-4/4R	Well-5[a]	WN-B	WN-21
Uranium	2.6	2.67	4.75 (1983)	3.4 (1982)	1.15
Radium-226	N/A	7.2	7.2 (1992)	19.9 (1993)	3.7
Manganese	1000	225 (1983)	0.25	35 (1982)	10.2
Molybdenum	16	0.6	0.66 (1982)	<0.1	<0.1
Ammonia	2.13[b]	0.61 (1996)	0.003	0.19	0.84 (1997)
Nitrate	100	317 (1995)	264	70.7 (1991)	35.6

Notes:
[a] Table 18 (SMI 1999b) incorrectly has this well labeled as WN-5; in text and in subsequent documentation, it is referred to as Well-5.
[b] Ambient water quality criteria is total ammonia reported as N.

Abbreviation:
N/A = not applicable

To demonstrate protectiveness of the proposed ACLs for the Sweetwater River (the POE for the NWV), the licensee performed worst-case mixing calculations that were included in the 1999 SGWCE report (SMI 1999b). It was assumed that groundwater discharged to the Sweetwater River that had concentrations equivalent to the ACLs (i.e., no attenuation between the POC and POE). It was further assumed that protective concentrations for the river were based on acute aquatic values rather than drinking water standards for which this section of the Sweetwater River is classified (i.e., a Wyoming Class 2AB surface water). Mixing assumed low flow conditions in the river. Table E-3 provides data used in the mixing calculations. Protective values were compared to calculated river concentrations. Calculated results were all lower than aquatic values used but not the drinking water standards in some cases (e.g., the uranium drinking water standard [MCL] is 0.03 mg/L, and the uranium protective aquatic value used is 2.6 mg/L). Table E-3 shows the factor of safety comparing calculated river concentrations with protective values.

Table E-3. Protective NWV Groundwater Concentrations Under Worst-case Conditions[a]

Constituent	Sweetwater River Background (mg/L)	Protective Aquatic Value (mg/L)	River Concentration with NWV GW at ACL values (mg/L)	Proposed NWV ACL concentrations (mg/L)	Factor of Safety[b]
Uranium	0.064	2.6	1.11	4.75	2.3
Radium-226	4 pCi/L	N/A	N/A	7.2 pCi/L	N/A
Manganese	0.4	1000	50.44	225	19.8
Molybdenum	0.1	16	0.22	0.66	71.2
Ammonia	0.45	2.13	0.49	0.61	4.4
Nitrate	0.95	100	71.37	317	1.4

Notes:

[a] Reproduced from Table 16 (SMI 1999b); assumes river at minimum low flow (942 gpm or 2.1 cfs) and 210 gpm (0.47 cfs) discharge from NWV to river; no attenuation between POC and river.

[b] Multiplier for the observed river concentration to equal the protective aquatic value (i.e., the factor by which the observed river concentration is below the protective aquatic value).

Abbreviations:

N/A = not applicable
pCi/L = picocuries per liter

WNI did indicate that under the ACL alternative, ICs would be required as an implementation measure for some privately held properties within the proposed LTSB. Different types of controls were identified that could be used included restrictive covenants, deed annotations, and water use classifications.

Two areas of elevated uranium in groundwater were identified during site characterization activities—one location west of the site boundary near the center of Section 10 (referred to as the SWAB-36 area after a former monitoring well) and one near the southern site boundary near well SWAB-32 (the former Red Mule subdivision area). Both areas were investigated in detail to determine if the elevated uranium could be the result of site-related activities. In both areas, wells with low uranium concentrations were located between the known site-related uranium plume and the areas of elevated uranium.

In the Red Mule area, uranium concentrations as high as 0.34 mg/L were observed in groundwater samples. Modeling assuming average retardation values for uranium showed that it would take at least 200 years (and possibly as many as 800 years) for the first particles of uranium to arrive at the Red Mule area from the tailings impoundment (WNI 2000). Even longer times would be required to achieve the observed concentrations. Geochemical differences were noted between tailings-related groundwater and Red Mule groundwater with respect to sulfate, chloride, and isotopic ratios (NRC 2006b). Additionally, subsurface investigations revealed the presence of elevated uranium in aquifer solids in the Red Mule area as compared to other locations (WNI 2002). Based on these lines of evidence, it was concluded that the uranium in the Red Mule area is naturally occurring. However, predictive modeling under the very conservative assumption of no retardation indicated that groundwater in this area could be impacted by site-related constituents in approximately 100 years (SMI 1999b). Uranium was estimated to range from 0.3 to 0.8 mg/L, manganese from 0.5 to 1.0 mg/L, and nitrate from 30 to 50 mg/L (WNI 2000).

It was speculated that the elevated uranium in the SWAB-36 area west of the site could have been derived from the tailings area through the operation of water supply wells that served Jeffrey City. During the peak of Jeffrey City's population in the 1970s, two municipal water systems served the area—the old townsite system (in the northwestern quarter of Section 15) and the Lucky Mc system (about a half mile west of the townsite). Wells in both systems were completed upgradient of the millsite and in the regional Split Rock aquifer.

The licensee examined the potential that operation of the townsite wells could pull contamination from the site to the SWAB-36 area. At its peak during mill operation, water usage rates were about 600 gpm for a population of approximately 4000 (SMI 2000). It was assumed that groundwater could have been continuously extracted from the townsite area at a rate of 600 gpm. Modeling showed it would take 1500 years for the first particle of site-related contamination to reach the SWAB-36 area and it was concluded that operation of the water supply wells could not have produced the observed uranium concentrations (SMI 2000). A similar hypothetical scenario was examined for a pumping well located at the SWAB-36 area. Using conservative assumptions, it was determined that it would take about 200 years of continual pumping (at 600 gpm) for a mobile constituent to move from the SWV and reach that well. It was therefore concluded that the elevated uranium located west of the site was probably not site-derived and was likely naturally occurring as in the Red Mule area.

E2.5 Institutional Controls

Three parcels of privately held land lie within the site's LTSB. In order to ensure protectiveness from site-related groundwater contamination on these three parcels of private land, and after unsuccessful attempts to acquire the land, WNI obtained ICs on these properties as an "alternate approach" to 10 CFR 40 Appendix A requirements. These ICs consist of a groundwater restrictive covenant on two of the three parcels (the McIntosh and Peterson properties) and a quitclaim deed that conveys ownership of the subsurface greater than 7 ft in depth (i.e., the shallowest depth at which groundwater could be encountered) on the third parcel (the Claytor property). These three ICs are tied to the land and, therefore, were transferred to DOE to provide long-term protection from contaminated groundwater. NRC determined that these ICs were durable and enforceable (NRC 2016). These ICs are presented in Appendix A of this LTSP.

NRC Commission Paper SECY-05-0200 summarizes options considered and efforts made to ensure protectiveness from site-related groundwater contamination through the use of ICs at the three privately held properties within the LTSB. A summary of the development of these ICs is described below.

2003 to 2006:

- Commission agreed with staff that WNI should try to purchase properties but approved the use of ICs within the LTSB to prevent direct human exposure to site-derived contaminants for the duration of the 1000-year performance period (SECY-02-0183 and its associated Staff Requirements Memorandum)—November 2002.
- WNI documented attempts to acquire land in a March 2003 letter.
- WNI made a good faith effort to obtain the land. DOE agreed that a good effort had been made by WNI; with NRC approval (and concurrence by DOE), WNI imposed ICs instead of acquiring all parcels.

- NRC considered having WNI put an alternate water supply in place. DOE informed NRC they did not think this was a good idea. DOE indicated it did not want to provide an alternate water supply system nor maintain such a system under long-term management (WNI 2004), and, as a result, the idea of putting in an alternate supply was abandoned.
- One well (WN-24) within the site boundary was being used for ranching purposes. WNI demonstrated no risks from this use via ingestion of beef or irrigated pasture (WNI 2004). The IC allows for agricultural, stock, or other ranching purposes; use of that well was discontinued due to concerns over groundwater contamination (the rancher had no objection as this portion of the site was no longer used for ranching purposes). The livestock well (WN-24) was decommissioned by WNI prior to site transition in accordance with State of Wyoming requirements.
- One property (the Claytor Ranch) within the LTSB (donut hole) is privately owned and has no ICs, even though domestic use of groundwater occurs on this property. There is no IC for this property because it is in the “shadow” of the granite outcrops and is not in the predicted flow path of the NWV plume. Therefore, it should be isolated from any site-related contamination.
- NRC approval letter for ACLs, dated September 28, 2006, indicated that acceptable ICs were in place. The 2006 Environmental Assessment (EA) approved the use of ACLs with ICs (NRC 2006a).
- Three different properties with an IC in place lie within the LTSB. Two of these ICs (for the McIntosh and Peterson properties) restrict groundwater from being used for human consumption or any other domestic purpose, although provisions are provided for groundwater to be used for livestock, agriculture, and other ranching purposes on portions of these privately held lands to which the ICs apply. The third IC (for the Claytor property) conveyed ownership of all subsurface property below a depth of seven feet (i.e., the depth of groundwater) to WNI, which was then transferred in fee to DOE, to ensure groundwater is not used. All three IC s carry with the land. DOE plans to maintain these groundwater ICs under long-term care.
- After recognizing that specific approval of the ICs by NRC had not occurred (outside of the ACL approval, which determined the need for ICs), NRC subsequently determined that the ICs were durable and enforceable (NRC 2016).

E2.6 Incorporation of ACLs and Trigger Levels in WNI’s License

In 2006, in response to WNI’s ACL application submittal (and supplemental information), NRC prepared an EA for amendment of WNI’s source materials license SUA-56 (NRC 2006a). In the EA, NRC recognized that the ACLs being established must be as low as reasonably achievable (ALARA) in accordance with requirements set forth in regulations at Criterion 5B (6) of Appendix A in 10 CFR 40. NRC also noted in the EA that “current groundwater constituent concentrations are ALARA” and issued a subsequent finding of no significant impact (FONSI) approving the establishment of ACLs. ACLs were established for ammonia, manganese, molybdenum, nitrate, combined radium-226 and -228, and uranium for both the NWV and SWV flow regimes. ACL values are provided in Table E-4.

Table E-4. ACLs for the Split Rock Site[a] (August 2006 EA)

Constituent	ACL Values NWV	ACL Values SWV
Uranium (mg/L)	4.8	3.4
Radium-226 and -228 (pCi/L)	7.2	19.9
Manganese (mg/L)	225	35
Molybdenum (mg/L)	0.66	0.22
Ammonia[b] (mg/L)	0.61	0.84
Nitrate[c] (mg/L)	317	70.7

Notes:
[a] Source: NRC 2006a.
[b] Though not specified, it is assumed that this is unionized ammonia based on subsequent monitoring reports (calculated as 2.5% of total ammonia—assumes pH is about 8).
[c] Though not specified, it is assumed this is nitrate reported as N.

Abbreviation:
pCi/L = picocuries per liter

While not explicitly stated in site documentation reviewed for this evaluation, it is assumed that the ACL values to be met at the POCs were set to evaluate the legacy plumes and future performance of the tailings impoundment (i.e., concentrations of site-related constituents will be compliant with the higher of either the applicable groundwater protection standards or established background concentrations at the long-term care boundary, or POE). As long as ACL values are maintained at the POCs, concentrations of site-related constituents will remain protective at the POE and the impoundment will be judged to be performing acceptably.

NRC stated in the EA that "WNI demonstrated that the ACLs would result in levels that meet water quality standards at the POE or are consistent with NRC-approved background concentrations." They further stated that "ICs would allow natural processes (i.e., advection, dispersion, retardation) to attenuate, disperse, and dilute site-derived constituents to meet protective standards at the POEs" (NRC 2006a). NRC recognized in this EA that the Sweetwater River was classified as Class 2AB surface waters and that these waters are protected for drinking water use as well as aquatic life and various other purposes (NRC 2006a). The Class 2AB standards are more stringent than the aquatic values used in the ACL application discussed above (Table E-3). Surface water monitoring data was cited in the EA as indicating impacts to the Sweetwater River from discharge of site-related groundwater were minimal. It was also noted that the highest concentration of uranium observed in the river since 2004 was 0.013 mg/L, which was below the drinking water standard of 0.03 mg/L (NRC 2006a). However, it should be noted that the highest concentration of uranium measured in the river was 0.022 mg/L in September 2012. See Figure E-39 for a time-concentration plot of uranium in the Sweetwater River.

NRC concluded that "WNI demonstrated that the ACLs would result in levels that meet water quality standards at the POE or are consistent with NRC-approved background concentrations" (NRC 2006a). No additional analysis was performed to demonstrate that the stricter drinking water standards would be met in the Sweetwater River, as opposed to the aquatic values (Table E-3). The primary rationale for protectiveness in the river appears to be that maximum contaminant loading to the river occurred in about 1996, based on uranium transport modeling

with particle tracking (SMI 1999b), and was the result of maximum groundwater flow rates and liquid levels in the tailings impoundments in 1986. Subsequent decreases in both groundwater flow rates and concentrations (which are expected to continue until steady state is reached) have resulted in significantly less loading to the river. Based on monitoring data, NRC concluded that there appears to be little or no impact to the river.

In approving the ACLs, NRC also established a set of trigger levels for both groundwater and surface water. It appears that the trigger levels were established to account for uncertainties in the modeling conducted by the licensee. Trigger levels were established for each constituent with an ACL: ammonia, manganese, molybdenum, nitrate, combined radium-226 and -228, and uranium (values are provided in Section E3.0). Trigger levels established in NRC's 2006 EA are reported to correspond to the higher of either background, MCLs, or U.S. Environmental Protection Agency (EPA) risk-based concentrations (where MCLs are not available). In the EA, the use of ICs and triggers levels were cited as mitigative measures that would help prevent exposure to contaminated groundwater and ensure protectiveness in the future (NRC 2006a). It was noted that exceedances of trigger levels would require a response action by the licensee.

According to WNI's license SUA-56, compliance with these trigger levels was applicable at the POE. Specific POE wells to which the groundwater trigger levels applied were not designated in the license for either the Split Rock (regional) aquifer or the floodplain (alluvial) aquifer. It is assumed that they applied at the well closest to the POE for each flow regime. The Sweetwater River is the point of discharge for both NWV and SWV flow regimes and serves as the POE where the surface water trigger levels are presumed to apply. NRC's EA indicates that "certain actions be taken in the event that surface water concentrations of ACL parameters exceed the trigger values at the downstream LTSB" (NRC 2006a). This implies that exceedances adjacent to the site but upstream of the LTSB might be acceptable. However, Wyoming surface water quality regulations indicate that values for human health are not to be exceeded in streams to which they apply. Although these trigger levels were a license condition for WNI, there appears to have been no other regulatory basis for their application. It should be noted that the Split Rock site is the only site that DOE is aware of where trigger levels were established and included as part of the licensee's monitoring program.

Following NRC's approval of ACLs (and the establishment of trigger levels) for the Split Rock site, the groundwater CAP was terminated in 2006 after removing approximately 375 million gallons of groundwater.

In 2008, concentrations of selenium at the NWV POC (Well-5) were noted to exceed the groundwater protection standard of 0.013 mg/L that had been established for the site. As a result, NRC directed WNI to address the selenium exceedance. In 2009, WNI responded by submitting a license amendment request proposing the establishment an ACL for selenium at the site equal to the EPA 40 CFR 141 MCL for drinking water (0.05 mg/L). As part of the regulatory process, NRC completed an EA in 2010 for the establishment of the selenium ACL (NRC 2010a). The licensee demonstrated that meeting the MCL at the point of discharge at the Sweetwater River would result in a concentration of 0.003 mg/L of selenium in the river at 4-day low flows—meeting the chronic aquatic standard of 0.005 mg/L (Miller 2009). The assumptions used to calculate the concentration of selenium in the river were similar to those discussed above for establishing ACLs. However, for this calculation, the low flow value for the Sweetwater River was assumed to be 2300 gpm (instead of 942 gpm; 10-year low flow instead of worst-case) and

steady state flow rate for the NWV was assumed to be 100 gpm (as opposed to 210 gpm in earlier calculations). The reduced flows for the NWV are consistent with decreases in seepage of fluids from the source area and were a better approximation of actual seepage at the time those calculations were performed.

In addition to the selenium exceedance, SWV well SWAB-31 (the downgradient-most well in the SWV flow regime) was also observed to have exceeded the uranium trigger level of 0.03 mg/L (which corresponds to the MCL for uranium) established by NRC in the 2006 EA. Because background uranium in the Split Rock regional aquifer was higher than the MCL, it was determined that the background level would be a more appropriate trigger level for the SWV flow regime. Subsequently, the background SWV uranium concentration of 0.087 mg/L was included in a license amendment as the revised trigger (assumed to have been applicable at well SWAB-31). Due to the localized elevated naturally-occurring concentrations of uranium in the former Red Mule subdivision (as previously discussed in Section E2.4 of this appendix) a uranium trigger level of 0.3 mg/L was established for well SWAB-32. In addition to addressing WNI's proposed selenium ACL for the SWV flow regime, the 2010 EA also addressed WNI's license amendment request to modify the uranium trigger level for groundwater (NRC 2010a). The EA was published in the *Federal Register* on February 5, 2010; a FONSI was also issued in January 2010 regarding this recent license amendment request. In February 2010, NRC approved the license amendment request and issued a technical evaluation report and amended license to WNI (NRC 2010b). The amended license (SUA-56, Amendment No. 105, February 24, 2010) contained the updated selenium standard and uranium trigger levels for the site.

In a concurrent action, NRC also approved WNI's license amendment request to establish groundwater protection standards at the site for several other constituents (aluminum 37 mg/L, antimony 0.006 mg/L, arsenic 0.05 mg/L, fluoride 4 mg/L, and thallium 0.002 mg/L), to modify the standard for beryllium (from 0.05 mg/L to 0.01 mg/L), to delete chromium from the list of required monitoring constituents, and to increase the trigger level for uranium in groundwater to 0.044 mg/L for the Sweetwater River floodplain alluvial aquifer (to reflect established background concentrations) (NRC 2010b). Table E-5 presents the trigger levels included in the most recent NRC license for the Split Rock site.

Table E-5. Final Trigger Levels for the Split Rock Site

Constituent	Surface Water Trigger Values (mg/L)	Split Rock Aquifer Trigger Values (mg/L)	Floodplain Alluvium Trigger values (mg/L)
Uranium	0.03	0.087/0.3[a]	0.044
Radium-226 and -228	5 pCi/L	5.0 pCi/L	5.0 pCi/L
Manganese	0.05	0.73	2.39
Molybdenum	0.18	0.18	0.18
Ammonia[b]	0.5	0.5	0.5
Nitrate[c]	10	10	10

Notes:
[a] SWAB-32 trigger value.
[b] Though not specified, it is assumed that this is unionized ammonia based on subsequent monitoring reports (calculated as 2.5% of total ammonia—assumes pH is about 8).
[c] Though not specified, it is assumed this is nitrate reported as N.

Abbreviation:
pCi/L = picocuries per liter

E2.7 Nitrate ACL Revision and change in SWV boundary

DOE prepared a draft LTSP for the Split Rock site and submitted it to NRC in 2012. In the LTSP, DOE noted that nitrate had exceeded the ACL established in the license at two wells. Concentrations of nitrate in well SWAB-2 were found to have consistently been reported in excess of the ACL value since before the nitrate ACL was proposed in 1999; more recently (since 2009) the nitrate ACL has also been exceeded in replacement well SWAB-1R. The LTSP noted that this condition therefore violated Criterion 5B (1) of Appendix A of 10 CFR 40, which states, "Hazardous constituents entering the ground water from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period." As described under Criterion 5B (5), these specified concentration limits are background values MCLs, or ACLs. DOE's intent with its draft LTSP was to confirm that it would not be receiving a site that was considered to be out of compliance with NRC requirements.

As a result of issues raised by DOE, NRC required additional information from the licensee. Of greatest concern was understanding why nitrate concentrations in the wells were higher than predicted and whether the LTSB for the SWV was adequately protective.

Subsequent discussions were held among the various parties to determine how to resolve this issue.

The licensee indicated that downgradient exceedances of the nitrate ACL were known and accounted for in previous modeling and the establishment of the LTSB.

It was recognized that an elevated pulse of contamination had moved beyond the POC in the SWV and that the groundwater remediation system was having no effect on the contamination that had migrated beyond the system's extraction wells (Thompson 2005; NRC 2006a). Indeed, it had been established that significant amounts of hazardous constituents from the tailings seepage had become associated with the aquifer solids and would slowly remobilize into the groundwater over time and that at least some of this secondary source term was downgradient of the edge of the reclaimed tailings (SMI 1999b). Additionally, at least some of the nitrate in the downgradient wells was likely derived from degradation of ammonia, which was used in the milling process, as opposed to downgradient migration of a nitrate plume. As ammonia degraded to nitrate, concentrations of nitrate increased. Therefore, it was not unexpected that downgradient nitrate concentrations were higher than the upgradient nitrate concentrations.

The licensee pointed to historical correspondence between the licensee and NRC indicating that they were aware of the elevated contaminant concentrations downgradient of the POC in the legacy plume. In addition, site groundwater modeling and the associated determination of the LTSB considered these historical nitrate concentrations above the ACL downgradient of the POC. The groundwater modeling indicated that concentrations of nitrate (and all other hazardous constituents) will not exceed background values at the LTSB, and, therefore, protection of human health and the environment would be ensured at the POE. Further protection appears to have been the intent of the establishment of trigger levels and an exceedance would be an indicator that a groundwater protection standard could potentially be exceeded at the POE.

NRC acknowledged this historical information but indicated that it did not resolve the fact that the site was out of compliance with the regulations. It was determined that the solution was to increase the nitrate ACL and expand the LTSB on the eastern downgradient portion of the site to contain the predicted extent of the SWV plume to its discharge point in the Sweetwater River. NRC requested additional information regarding the modeling, indicating that the licensee had not adequately compared model predictions with observations in an August 12, 2015, letter. The licensee indicated that the model was not intended to provide accurate predictions at any given well location but was supposed to provide a more general sense of plume behavior. Additional analytical modeling was subsequently conducted, assuming a constant source of 500 mg/L nitrate (as N) over a 1000-year period. The modeled concentration at the river in 1000 years was 1.7 mg/L nitrate as N, with a source to groundwater ratio of 294:1. This ratio was conservatively applied to other constituents to demonstrate that concentrations would be acceptable (WNI 2016). The results of these calculations are presented in the Table E-6.

Table E-6. Measured and Estimated POE Concentrations for SWV Groundwater

	Max. Measured in WN-21	Max. Measured in SWAB-2	Max. Measured in SWAB-1/1R	[1]Estimated GW Conc. at LTSB with 294:1	Protective Value	[2]Factor of Safety	[3]Split Rock Formation Background	Units	Basis for Protective Value
Nitrate (NO_3+NO_2-N)	35.6	343	153	1.7	10	9	3.99	mg/L	MCLG
Uranium (Unat)	1.618	3.033	3.517	0.012	0.03	3	0.1264	mg/L	MCL
Ammonia (NH_3-N free)	0.5933	0.2159	0.0069	0.002	0.7	347	0.7	mg/L	Upper Split Rock Fm. Background
Manganese (Mn)	10.21	11.1	0.18	0.038	0.2	5	0.53	mg/L	WDEQ Class II
Molybdenum (Mo)	<0.1	<0.1	<0.1	<0.0003	0.004	>13	0.100	mg/L	EPA Health Assessment Level
Radium-226+228	4.7	10.6	1.6	0.036	5	139	5.30	pCi/L	MCL
Sulfate (SO_4)	1,053	2,630	1,940	8.9	250	28	133	mg/L	MCLG

[1] Using maximum concentration ever measured from WN-21 (POC well), SWAB-2 and SWAB-1/1R
[2] Factor of Safety = Estimated GW Concentration at LTSB ÷ Protective Value, does not account for constituent dilution in river
[3] Table F-5-15 Background Upper Prediction Limits for Split Rock Formation Groundwater, Appendix F to 1999 Ground Water Protection Plan (WNI, 1999)

In an October 25, 2016, letter (WNI 2016), after additional evaluation and discussions among the parties involved, the licensee proposed a license amendment to increase the nitrate ACL and extend the LTSB. While these revisions to the license were being reviewed, the State of Wyoming was granted Agreement State status by NRC and assumed licensing authority over the Split Rock site. The State adopted the existing NRC license requirements and conditions (including the trigger levels) into their license (WYSUA-56) upon transfer of authority for the site. WDEQ reviewed the license amendment request and subsequently concurred with the revised nitrate ACL and expanded LTSB. These were incorporated into the State-issued specific license on April 5, 2019.

E2.8 Selenium ACL Revision

As noted above, the MCL under the Safe Drinking Water Act (0.05 mg/L) was adopted as the selenium standard in 2010. At the time, DOE commented that the standard might not be high enough to avoid future exceedances (DOE 2009). Subsequently, the MCL for selenium was exceeded in well WN-42A during the August 2018 sampling round (result was 0.074 mg/L selenium). WNI proposed an approach to revise the selenium ACL in a presentation to WDEQ and DOE on April 24, 2019, and subsequently proposed a license amendment to increase the selenium ACL for the NWV on May 1, 2019 (WNI 2019). This selenium ACL revision was approved by WDEQ in December 2019 (WDEQ 2019b).

WNI revised their modeling approach in their proposal to increase the selenium ACL in the NWV. They used a low flow event and State of Wyoming surface water acute and chronic standards applicable to Class 2AB surface waters (0.02 mg/L and 0.005 mg/L, respectively, for which portion of the Sweetwater River that borders the site is designated) (WDEQ 2018). The ACL was assumed to represent the source concentration at POC. The original approach for the ACLs did not account for any attenuation between the source area and the point of discharge in the Sweetwater River. The revised approach assumed mixing of some source concentration with background groundwater in the floodplain aquifer (30% source, 70% floodplain aquifer) as the plume migrates from the NWV across the floodplain prior to discharging into the river. It was assumed there was no attenuation of source contamination other than mixing with NWV groundwater of the floodplain aquifer. Estimates of the amount of groundwater that would mix with NWV source area water were based on uranium monitoring data and changes in the concentration and distribution of uranium in groundwater over time. Groundwater then discharged to the Sweetwater River and mixed with river water of various flows. The revised selenium ACL for the NWV was calculated such that the selenium concentration in the river would result in compliance with the acute and chronic values for class 2AB surface waters. The lowest compliant selenium concentration was the ACL that would result in compliance with the chronic value (0.005 mg/L), which was 0.3 mg/L selenium and proposed as the ACL for the NWV. This concentration was determined by WDEQ to be conservative and protective. It is unlikely to be exceeded as it is higher than historic values observed at the source area well by about an order of magnitude.

E2.9 Pre-termination Licensed Values and Monitoring Requirements of License WYSUA-56

DOE has developed its long-term monitoring approach based, in part, on a consideration of WNI's licensed standards and monitoring requirements prior to site transfer. Those requirements, along with historical data for the site, are summarized here. Table E-7 lists the licensed constituents and their standards prior to site transition to DOE. Historical concentrations are provided for reference. Chloride, sulfate, total dissolved solids (TDS), and pH are also specified as constituents for monitoring, but no standards or other levels for comparison are provided.

Table E–7. Historical Concentrations (Source Areas and POCs), Current Standards, and Licensed Values for Hazardous Constituents at the Split Rock, Wyoming, Disposal Site

Constituent	Maximum Historical Concentrations Northwest Flow Regime[a]		Maximum Historical Concentrations Southwest Flow Regime[a]		Water Quality Standard or Health Advisory	Current Standard in License (basis)[b]	
	Source Area (Well-4R)	POC (Well-5)	Source Area (Well-1)	POC (WN-21)		Northwest Flow Regime	Southwest Flow Regime
Aluminum (mg/L)	8.3	0.2	3.81	0.1	0.05 to 0.2 (SDWR)	37 (RBC)	37 (RBC)
Ammonia (mg/L)	0.845	0.061	2.40	2.64	30 (Lifetime HA)	0.61 (ACL)	0.84 (ACL)
Antimony (mg/L)	0.05	0.05	0.05	0.05	0.006 (MCL)	0.006 (MCL)	0.006 (MCL)
Arsenic (mg/L)	0.01	0.053	0.01	0.01	0.01 (MCL)	0.05 (background)	0.05 (background)
Beryllium (mg/L)	0.01	0.01	0.01	0.01	0.004 (MCL)	0.01 (background)	0.01 (background)
Cadmium (mg/L)	0.024	0.017	0.028	0.01	0.005 (MCL)	0.01 (background)	0.01 (background)
Fluoride (mg/L)	9.1	0.22	7.4	0.35	4 (MCL)	4 (MCL)	4 (MCL)
Lead (mg/L)	0.05	0.18	0.19	0.05	0.015 (action level)	0.05 (background)	0.05 (background)
Manganese (mg/L)	148	0.63	157	10.21	0.05 (SDWR)	225 (ACL)	35 (ACL)
Molybdenum (mg/L)	0.1	0.66	0.21	0.1	0.1 (40 CFR 192)	0.66 (ACL)	0.22 (ACL)
Nickel (mg/L)	0.56	0.29	0.99	0.05	0.1 (Lifetime HA)	0.05 (background)	0.05 (background)
Nitrate-N (mg/L)	264	172	86.1	35.6	10 (MCL)	317 (ACL)	500 (ACL)
Radium-226 and -228 (pCi/L)	5.25	4.83	13.4	3.9	5 (MCL)	7.2 (ACL)	19.9 (ACL)
Selenium (mg/L)	0.34	0.039	0.06	0.0086	0.05 (MCL)	0.3 (MCL)	0.05 (MCL)
Thallium (mg/L)	0.001	0.1	0.1	0.001	0.002 (MCL)	0.002 (MCL)	0.002 (MCL)
Thorium-230 (pCi/L)	1.8	15.6	8.9	30	15 (MCL)	0.95	0.95
Uranium (mg/L)	1.863	17.64	13.38	2.927	0.03 (MCL)	4.8 (ACL)	3.4 (ACL)

Notes:
[a] Maximum historical concentrations and background concentrations based on data obtained from licensee and monitoring reports.
[b] Standards obtained from WNI's Radioactive Material License (WYSUA-56), Amendment No. 111, License Condition 74B&C.
[c] The background concentration for uranium was revised to the value included in the *Site Ground Water Characterization and Evaluation* (NRC 2010b).

Abbreviations:
HA = health advisory;
pCi/L = picocuries per liter
RBC = risk-based concentration
SDWR = secondary drinking water regulation

Table E–8 and E–9 summarize the monitoring requirements and standards (including established ACLs and trigger levels) presented in WNI’s source materials license WYSUA-56 Amendment No. 112. The analytes monitored are considered the COCs for the site (see previous discussion in Section E2.3 on how COCs were determined for the site).

Table E–8. Groundwater and Surface Water Monitoring Requirements from WNI’s License WYSUA-56 for the Split Rock, Wyoming, Disposal Site

Groundwater and Surface Water Monitoring Requirements		
Wells	**Analytes**	**Frequency**
NWV: JJ-1R, WN-39B, WN-41B, WN-42A **SWV**: SWAB-1, SWAB-2, SWAB-4, SWAB-12, SWAB-22, SWAB-29, SWAB-31, SWAB-32	Uranium, sulfate	Semi-annually
NWV: JJ-1R, WN-39B, WN-41B, WN-42A **SWV:** SWAB-1, SWAB-2, SWAB-4, SWAB-12, SWAB-22, SWAB-29, SWAB-31, SWAB-32	Aluminum, ammonia, antimony, arsenic, beryllium, cadmium, chloride, fluoride, lead, manganese, molybdenum, nickel, nitrate, pH, combined radium-226 and -228, selenium, sulfate, thallium, thorium-230, TDS, uranium	Annually
NWV: WELL-4R, Well-5 **SWV:** WELL-1, WN-21	Aluminum, ammonia, antimony, arsenic, beryllium, cadmium, chloride, fluoride, lead, manganese, molybdenum, nickel, nitrate, pH, combined radium-226 and -228, selenium, sulfate, thallium, thorium-230, TDS, uranium	Semi-annually
Surface Water Locations	**Analytes**	**Frequency**
1) upstream of the proposed LTCB near the western boundary of Section 3, township 29 N and range 92 W; **2)** in a sharp meander directly upstream of well JJ-1R (SR-A); **3)** approximately 3,000 river feet downstream of SR-A in riffle section (SR-B); **4)** in tight meander downstream of Site, approximately 1600 river feet upstream of diversion dam, in Section 31, township 30 N and range 91W; **5)** downstream of proposed LTSB in Section 5, township 29 N and range 91 W.	Uranium, sulfate	Semi-annually
	Aluminum, ammonia, antimony, arsenic, beryllium, cadmium, chloride, fluoride, lead, manganese, molybdenum, nickel, nitrate, pH, combined radium-226 and -228, selenium, sulfate, thallium, thorium-230, TDS, uranium	Annually

Note:
Information obtained from Conditions 24 and 74 of WNI’s source material license WYSUA-56 Amendment 112.

Table E–9. Trigger Levels for Groundwater and Surface Water from WNI's License WYSUA-56 for the Split Rock, Wyoming, Disposal Site

Analyte	Surface Water Trigger Levels (POE; LTSB[a])	Split Rock Aquifer Trigger Levels (POE; LTSB)	Floodplain Aquifer Trigger Levels (POE; LTSB)
Ammonia	0.5 mg/L[a]	0.5 mg/L	0.5 mg/L
Manganese	0.05 mg/L	0.73 mg/L	2.39 mg/L
Molybdenum	0.18 mg/L	0.18 mg/L	0.18 mg/L
Natural Uranium	0.03 mg/L[b]	0.087 mg/L (0.3 mg/L[c])	0.044 mg/L
Nitrate	10 mg/L	10 mg/L	10 mg/L
Radium-226 and -228	5.0 pCi/L	5.0 pCi/L	5.0 pCi/L

Notes:
Information obtained from Condition 74 of WNI's source material license WYSUA-56 Amendment 112.
[a] EPA groundwater risk-based concentration.
[b] EPA MCL for drinking water.
[c] Applicable at well SWAB-32.

Abbreviation:
pCi/L = picocuries per liter.

Note: WNI's source material license (WYSUA-56) required compliance with trigger levels at the POE. The POE for groundwater is understood to be the site's LTSB; no specific wells are designated in WNI's source material license. The POE for surface water is understood to be the Sweetwater River. Trigger levels appear to have been established to be used as a "trigger" for raising concern should these concentrations be reached at the POE. This approach is presumed to have been taken because of the recognition that a pulse of groundwater contamination had migrated beyond the POC and beyond the capture zone of WNI's groundwater CAP. Therefore, it is understood that trigger levels were established as a safeguard for monitoring the natural attenuation of the legacy plume, whereas the ACLs were established for monitoring the performance of the disposal cell.

E3.0 Determination of Long-Term Monitoring Requirements

Long-term groundwater and surface water monitoring will be performed to monitor cell performance and ensure that site-related concentrations remain below either established background concentrations or applicable water quality standards at the POE (i.e., LTSB), as predicted. Wyoming Class 2AB surface water standards are applicable to the Sweetwater River, and Wyoming Class I standards for domestic use are applicable to groundwater. The intent of the long-term monitoring program proposed here will also be to confirm through observation that no unexpected changes in site conditions occur (including degradation of cell performance and changes in behavior of the legacy plume), that existing downward contaminant trends continue, and that protectiveness at the POE is maintained under long-term management.

In preparation of DOE's LTSP for the Split Rock disposal site, DOE reviewed historical site documentation, WNI's monitoring requirements (as described in their source materials license WYSUA-56), and historical monitoring data for both groundwater and surface water at the site. This evaluation provided the basis for the long-term monitoring program included in the LTSP. This review was conducted to support three main objectives: (1) the selection of hazardous constituents and indicator parameters, (2) the selection of appropriate groundwater and surface water monitoring locations to include in the long-term monitoring program, and (3) the selection of the set of measures against which monitoring results are compared. The results of this evaluation are discussed below along with a description of the recommended long-term monitoring program.

E3.1 Regulatory Considerations

Requirements for UMTRCA disposal sites were modeled after those established for Resource Conservation and Recovery Act (RCRA) sites under the Solid Waste Disposal Act (SWDA). Different sets of standards apply to UMTRCA (and RCRA) sites prior to and after the "closure period." These differences are also reflected in NRC's regulations for Title II sites. 10 CFR 40, Appendix A, Criterion 5, indicates that the groundwater protection standards imposed by EPA in 40 CFR Subparts D and E apply "during operations and prior to the end of closure." These standards include meeting background, MCLs, or ACLs. Once compliance has been achieved, a period of stability or compliance monitoring is required before the "postclosure" period begins. Under the SWDA (264.96), if the groundwater protection standard has not been exceeded for a period of 3 consecutive years, then the corrective action can be completed. NRC's guidance for license termination (NRC 2003) refers to a "1-year stability ground-water monitoring period."

Standards that apply to UMTRCA Title II sites after closure are more qualitative. NRC's regulations indicate that disposal sites should be closed in a manner that will "control, minimize, or eliminate post-closure escape of nonradiological hazardous constituents, leachate, contaminated rainwater, or waste decomposition products to the ground or surface waters or to the atmosphere" (10 CFR 40, Appendix A, Criterion 6(7)). These requirements are consistent with the 264.111 closure performance standards adopted in 40 CFR 192, Subpart D.

There is an important difference in activities that may be conducted during the postclosure period at RCRA sites compared to UMTRCA Title II sites. RCRA requires a period of postclosure care and monitoring, which is generally about 30 years. If groundwater protection standards are exceeded during the postclosure monitoring period, groundwater corrective action may be undertaken to bring the site back into compliance.

At most Title II sites, DOE assumes responsibility for the site after closure of the disposal cell but before the postclosure monitoring period would be considered complete under SWDA. However, under the Atomic Energy Act, Section 104, (f)2, DOE, as the long-term custodian, is only authorized to conduct monitoring, maintenance, and emergency measures. Other actions, such as corrective action, can only be undertaken by DOE under long-term management if expressly authorized by Congress. Therefore, DOE is limited in its ability to respond to postclosure changes in site conditions, particularly with respect to groundwater. The long-term monitoring program conducted at the site must factor in these constraints.

Discussions between NRC and DOE in recent years have led to an understanding that onsite standards that were in place prior to specific license termination, particularly ACLs, do not apply after closure (10 CFR 40, Appendix A, Criterion 5). Rather, it is up to DOE to determine the appropriate long-term monitoring requirements and comply with water quality standards (or established background concentrations, whichever is higher) that apply at the LTSB (i.e., the POE). However, once particular standards or requirements are included in an LTSP, those become conditions of DOE's general license. DOE must comply with the requirements of the LTSP or obtain concurrence from NRC that those requirements can be eliminated or revised. It is up to DOE to determine appropriate requirements for long-term care during the development and preparation of the LTSP.

E3.2 Long-Term Monitoring Approach and Limitations

This section describes the overall approach to long-term groundwater and surface water monitoring at the Split Rock site. As summarized above, the licensee was required to meet licensed standards at the POC wells (ACLs or groundwater protection standards) and trigger levels at the POE (presumed to be the well closest to the site boundary). The premise of this approach was that if the appropriate standards are maintained at the POC wells, protectiveness will be maintained at the POE (in this case, the Sweetwater River). Exceedances of licensed values required action on the part of the licensee. Since the termination of the groundwater CAP, those actions have involved further groundwater evaluations and increasing the licensed value (i.e., ACLs or groundwater quality protection standards) due to the exceedance of one or more of those values.

This approach will generally be adopted in the LTSP, though with some qualifications. The licensed standards in Tables E-7 and E-9 will be used to evaluate monitoring data and verify site protectiveness. ACLs used by the licensee, prior to site transition to DOE, will not be used as formal compliance standards under long-term management but instead will be used only as guidelines for comparison. Except for uranium in the NWV (as discussed in more detail below), the ACLs are generally useful as an indicator of maximum historical contaminant concentrations and protectiveness at the POE. If the disposal cell is performing as anticipated and seepage is declining over time as predicted, exceedances of maximum historical concentrations would not be expected. However, if such an exceedance should occur at the POC or any other downgradient groundwater or surface water monitoring location, no specific action will be taken on DOE's part other than notification to NRC and conducting confirmatory sampling. Similarly, the licensee's trigger levels will also be used by DOE as comparison values for evaluating groundwater quality near the site boundary but are not adopted as formal compliance standards. While it is likely that both sets of these pretransition licensed values will continue to be met under DOE's long-term management of the site, exceedances may not be wholly unexpected. Likewise, while it is probable that surface water quality standards will be maintained under the long-term surveillance program, modeling provided by the licensee suggest that compliance with the uranium standard in the Sweetwater River cannot be guaranteed.

SWV

With the extension of the boundary in the direction of the SWV flow path, contaminated groundwater exceeding standards, which are not enforceable onsite under long-term management (per 10 CFR 40, Appendix A, Criterion 5), should be fully contained within the LTSB. Groundwater from the SWV flow regime ultimately discharges to the Sweetwater River (i.e., the POE).

It is estimated that it will take hundreds of years for existing site-related contamination to travel to the Sweetwater River along the SWV flowpath. Well SWAB-29 has shown no evidence of site-related contamination and is downgradient of the wells with the highest levels of uranium and nitrate contamination (SWAB-1R). Changes in concentrations of COC measured from SWAB-1R and SWAB-29 should provide an indication of the progress of plume migration and attenuation during long-term management. Eventual detection of site-related contamination at SWAB-29 (and even later at SWAB-31, located downgradient of SWAB-29) is to be expected based on modeling conducted by the licensee. However, concentrations are expected to remain below levels observed at upgradient wells as constituents attenuate with distance and time. The main monitoring objectives for the SWV will be to ensure that constituent concentrations remain within expected bounds, particularly for well SWAB-29, and concentrations exceeding WNI's protective levels stay within the LTSB.

Uranium is the best indicator of site-related contamination, but its interpretation is complicated by the fact that it occurs in naturally elevated concentrations in the Split Rock aquifer and the Jeffrey City area. The challenge for long-term monitoring at the Split Rock site is to distinguish what changes in uranium concentration might signal a "problem" at the site from those that can be expected based on past site observations. Elevated uranium was recognized in the SWV when NRC established the trigger levels for this flow regime. A level of 0.3 mg/L uranium was established for SWAB-32 (directly upgradient of the former Red Mule Subdivision), and a general trigger level for the Split Rock aquifer was established at 0.087 mg/L (background concentration). Uranium concentrations in this range in the SWV will generally not be cause for concern under the long-term monitoring program.

NWV

Groundwater in the NWV flow regime travels much more quickly than in the SWV, and groundwater from the site has already reached the Sweetwater River. There has been no indication that site-related groundwater contamination migrates beneath the Sweetwater River, as evident from historical measured concentrations of COCs from well JJ-1R located on the north side of the Sweetwater River (see Section E3.3 and E3.4 below). Figure E-5 (cross section with uranium concentrations from SMI 1999b) shows the distribution of uranium in the subsurface in 1996. This represents the timeframe in which the licensee reports that the maximum mass loading of uranium to the Sweetwater River occurred. Seepage rates of tailings fluid to the NWV have declined since that time as evidenced by drops in water levels. However, a significant reservoir of uranium-contaminated groundwater was present. This source of uranium persists today as evidenced by the concentrations at Well-5 (POC), which have remained around 1.5 mg/L for the last 10 years. Similarly, well WN-42A (downgradient of Well-5) has had consistent concentrations of about 1 mg/L for the last 15 years. Concentrations at well WN39-B (downgradient of Well-42A) are above the uranium standard but have been declining since 2013. Farthest downgradient well WN-41B has shown no indication of site-related contamination. However, the screened interval for this well is at 92.4 to 112.4 ft below the ground surface; historical data show much higher uranium concentrations at this location in shallower elevations near the water table (around 0.7 mg/L as shown in Figure E-4).

The main long-term monitoring objectives for the NWV are to verify cell performance and assure protectiveness from COCs at the POE (the Sweetwater River). The uranium ACL is not useful for either of these objectives. The uranium ACL for the NWV was set at 4.75 mg/L for the

POC well (Well-5; rounded to 4.8 mg/L in the license). The calculations establishing the uranium ACL (Table 16, SMI 1999b) assume a protective aquatic value for uranium in the river of 2.6 mg/L. The conservative assumptions used in the ACL calculations indicate that discharge to the river of groundwater meeting the uranium ACL would produce a river concentration of 1.11 mg/L under low flow conditions. The ACL was therefore considered protective. However, since that time (i.e., post-ACL application submittal and during the NRC approval process), it was acknowledged that based on the State of Wyoming's 2AB surface water classification of the Sweetwater River at the site, the drinking water standard of 0.03 mg/L is the applicable surface water standard (NRC 2006a). The ACL for uranium was not revisited considering the more stringent uranium standard. NRC instead used river monitoring data to demonstrate that impacts of groundwater discharge to the river were minimal, citing a maximum surface water uranium concentration since 2004 of 0.013 mg/L as being well below the MCL of 0.03 mg/L. In addition, to account for modeling uncertainty and ensure protection of the Sweetwater River, NRC required surface water monitoring as a license condition and established surface water trigger values (including 0.044 mg/L for uranium) to be met at the LTSB. There have been no exceedances of the trigger level or the surface water standard since establishment of the uranium ACL.

According to WNI, the ACL for uranium (4.75 mg/L) is based on the maximum concentration observed in the POC well (Well-5) in 1983. However, based on historical monitoring data for this well, a one-time spike in uranium of greater than 17 mg/L was observed in late 1982 (DOE's data obtained from WNI). Additionally, between 1988 and 1993, uranium concentrations observed at this location were routinely in excess of 8 mg/L—nearly double the ACL (again, according to data received from WNI). As noted above, it is likely that a significant amount of residual uranium is present in the source area for the NWV and tied up in solid phase components. This uranium could be mobilized, as has been the case at other DOE sites, through excessive precipitation and flooding or through other disturbances of the land (e.g., excavation or construction activities). An exceedance of the ACL is therefore considered to be possible and does not automatically indicate a failure or malfunction of the disposal cell.

Surface water monitoring results obtained from WNI and entered into DOE's data management system show that results have been below the uranium drinking water standard. The highest reported concentration for uranium was 0.022 mg/L at surface water sampling location SW-3 (where the NWV plume likely discharges) in September 2012. However, WNI used a background surface water uranium concentration of 0.0643 mg/L based on a 95 UPL of monitoring data (k=1) (SMI 1999b). Assuming this was from a representative background monitoring location, it is possible that the uranium surface water standard (0.03 mg/L) could be exceeded in the Sweetwater River, even in the absence of site-related groundwater discharge.

As noted above, maximum uranium loading to the river was predicted with modeling to have occurred around 1996 and decreased since that time. It appears that this, along with stream monitoring data, is the main argument used to justify that the uranium ACL is protective and that exceedances of the uranium standard in the river will not be expected in the future under long-term management. The depiction of the uranium distribution in the NWV (Figure E-5) has been used by the licensee in numerous reports and presentations to show past site conditions. However, it is not clear what a more current snapshot might look like and what impacts to the river could be expected in the future.

Some of the initial modeling conducted by the licensee made the conservative assumption of no uranium retardation in estimating impacts to the Sweetwater River. Under such a scenario, much of the uranium-contaminated groundwater may have already migrated through the NWV and future impacts would be expected to decline in comparison. A comparison of model predictions of long-term source concentrations for the NWV with more recent observations indicates that current values are higher than anticipated. This suggests that a no retardation model may not be realistic for uranium, and, in fact, uranium retardation was included when the SWV was remodeled (MFG 2003). If high concentration portions of the uranium plume have not yet reached the Sweetwater River, it is possible that river concentrations could exceed the uranium standard in the future.

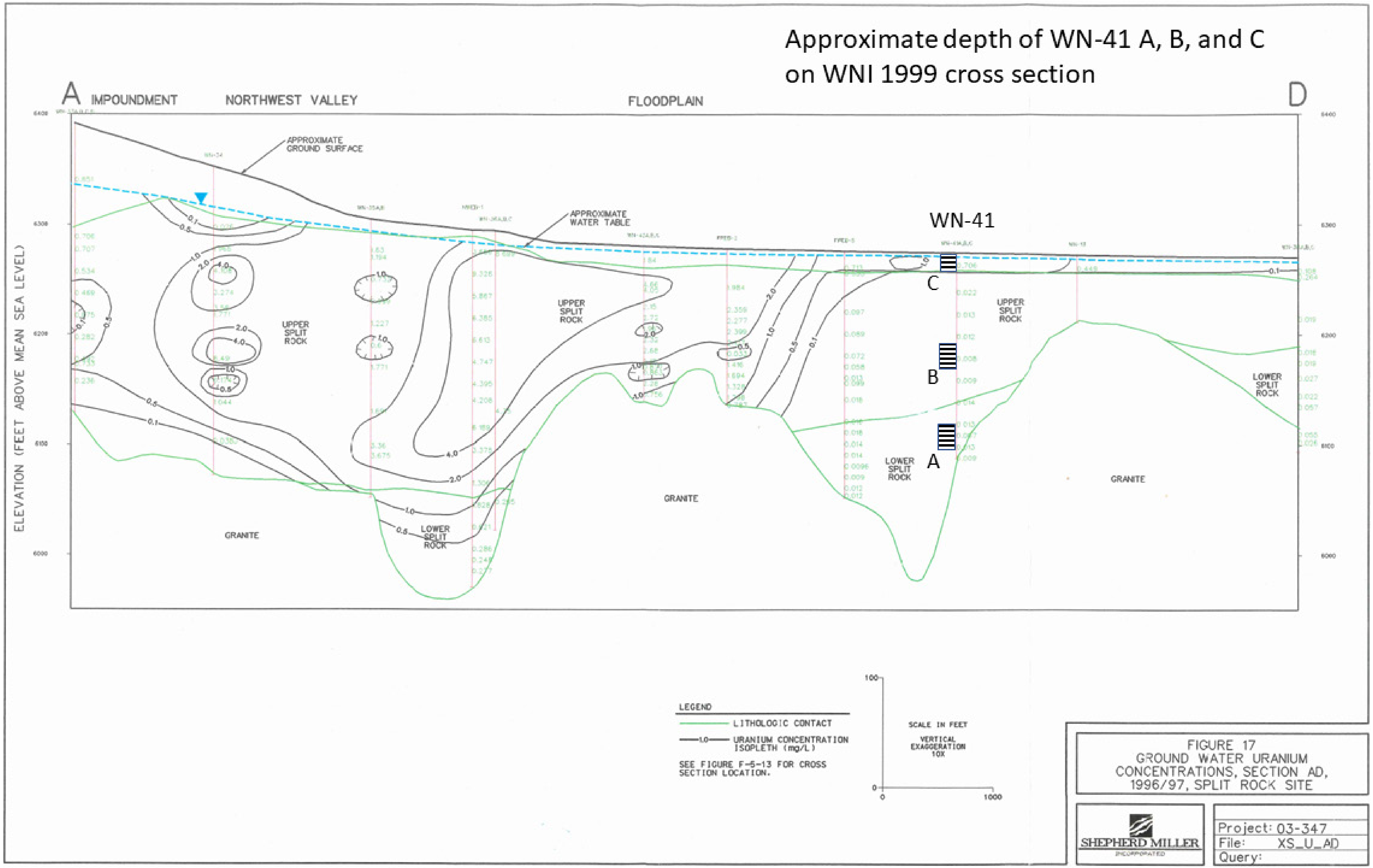


Figure E-4. Split Rock, Wyoming, Disposal Site cross section with approximate depth of WN-41 A, B, and C (SMI 1999b)

This page intentionally left blank

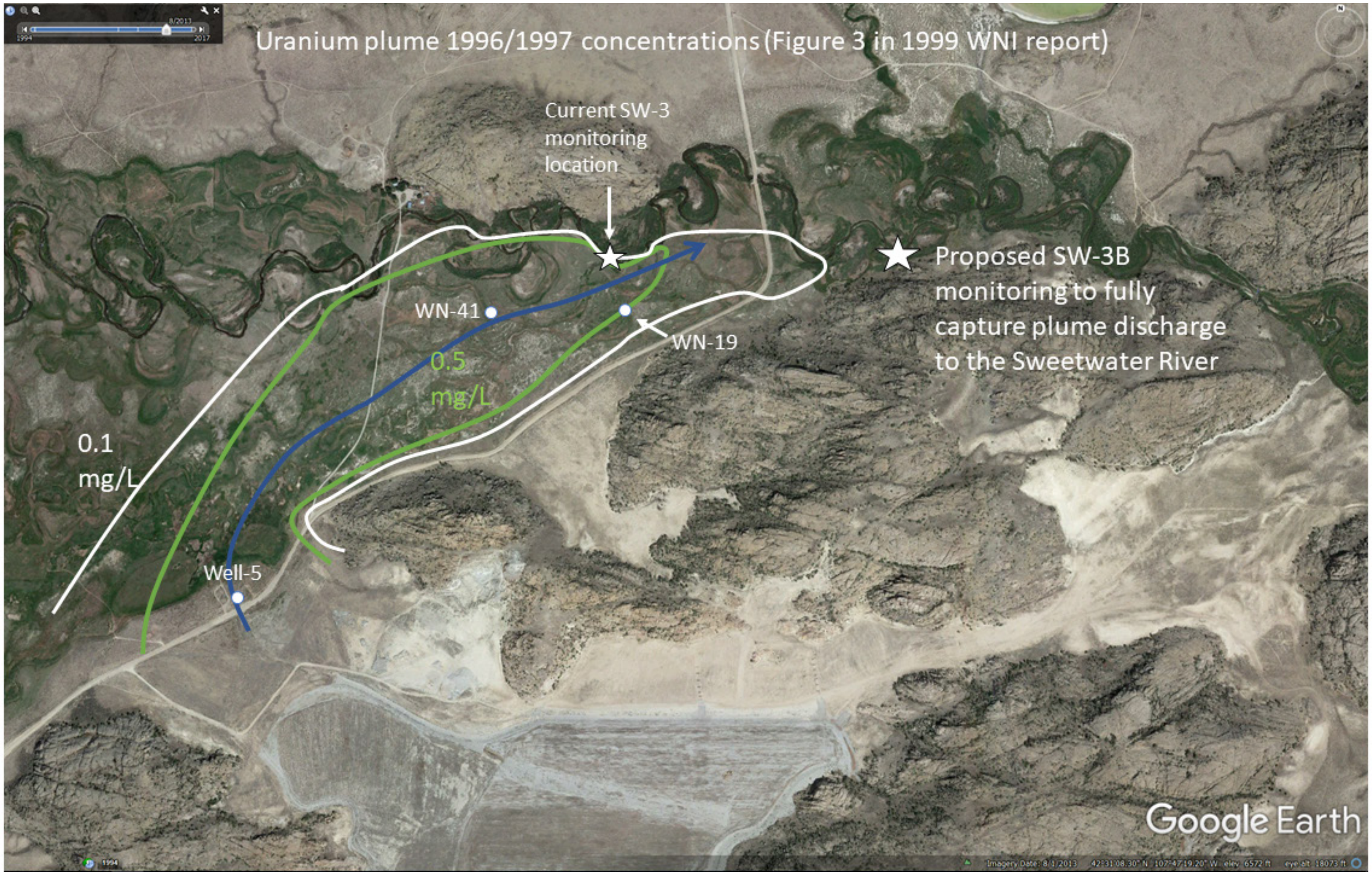


Figure E-5. Split Rock, Wyoming, Disposal Site Uranium plume 1996/1997 concentrations (Figure 3 in SMI 1999b)

DRAFT

Considering the above, exceedances of the uranium ACL and the uranium standard in the Sweetwater River are possible under long-term management. Therefore, any such exceedances will not be automatic cause for concern or action on DOE's part—other than notifying NRC (and WDEQ) and conducting confirmatory sampling. Use of the uranium trigger level at well WN-41B would also not assure that the surface water standard is met, given the depth at which that well is screened. DOE will also monitor wells in the NWV to look for significant contaminant increases that could signal unexpected increases in tailings seepage and possible malfunction of the impoundment system. POC well Well-5 will monitor the source area. Wells WN-42A, WN-39B, and WN-41B will all be important for observing and geochemical changes along the NWV flowpath, though well depths may not be optimum for identifying potential impacts to the river. Modeling and monitoring results do suggest that surface water quality will be maintained under average flow conditions (44 cfs in Table H-c-3 in SMI 1999b), despite modeling uncertainties.

E3.3 Selection of Hazardous Constituents and Indicator Parameters

Criterion 5B (3) of Appendix A in 10 CFR 40 allows NRC, on a site-specific basis, to exclude a detected constituent from the set of hazardous constituents required to be monitored "if it finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment." This includes a consideration of several factors including site characteristics, land and water uses, and potential effects that groundwater might have on surface water or other media with which it may come in contact. However, it is noted that Criterion 5A through 5D only "apply during operations and prior to the end of closure," and, therefore, Criterion 5B requirements are not applicable under long-term management.

Table E–3 lists the hazardous constituents required to be monitored in accordance with Condition 24 (surface water) and Condition 74 (groundwater) of WNI's source materials license (WYSUA-56, Amendment No. 112). Of these constituents, all but six were determined in WNI's site groundwater characterization and evaluation report (SMI 1999b) to not exceed background or protective values (MCLs or risk-based concentrations) beyond the POC at present (as of 1999) or in the future based on modeling predictions, though these values could be exceeded in the tailings area.

A look at measured data since the 1999 SGWCE report confirms this conclusion. Several constituents have never been detected in concentrations exceeding applicable protective standards or established background or have only exceeded these levels in the tailings wells (Well-1 for the SWV and Well-4R for the NWV; Figures E-6 through E-42). These constituents include aluminum, antimony, arsenic, beryllium, cadmium, fluoride, lead, nickel, thallium, and thorium-230. With rare exceptions (e.g., cadmium in Well-5 in 1999), protective standards for these constituents have consistently been met in all wells outside the source areas. WNI has demonstrated that these constituents have been constant or trending downward over the last 10 years. Based on their very limited distribution and low concentrations, DOE believes that these constituents are not capable of posing a substantial present or potential hazard to human health or the environment. In addition, these constituents are unlikely to be good indicators of cell performance or monitoring natural attenuation of the legacy plume, and therefore, DOE proposes that they be eliminated from the long-term monitoring requirements.

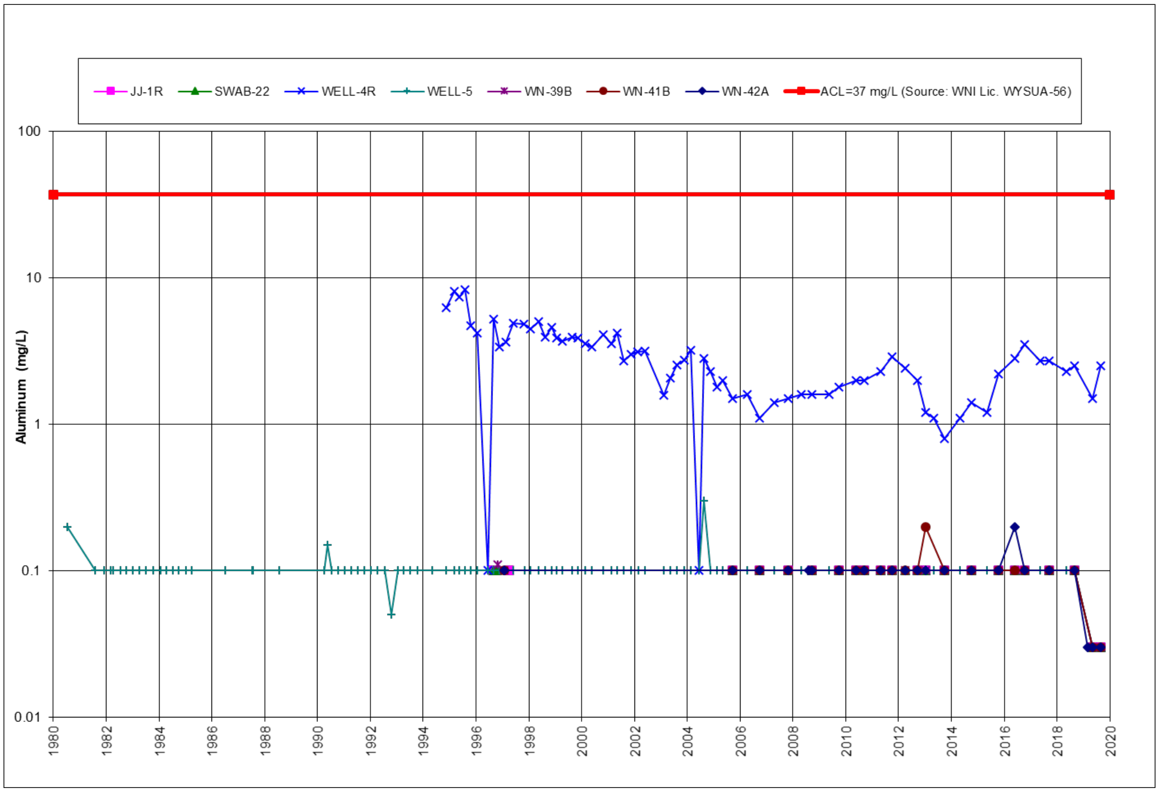


Figure E-6. Time-Concentration Plot for Aluminum in NWV Wells

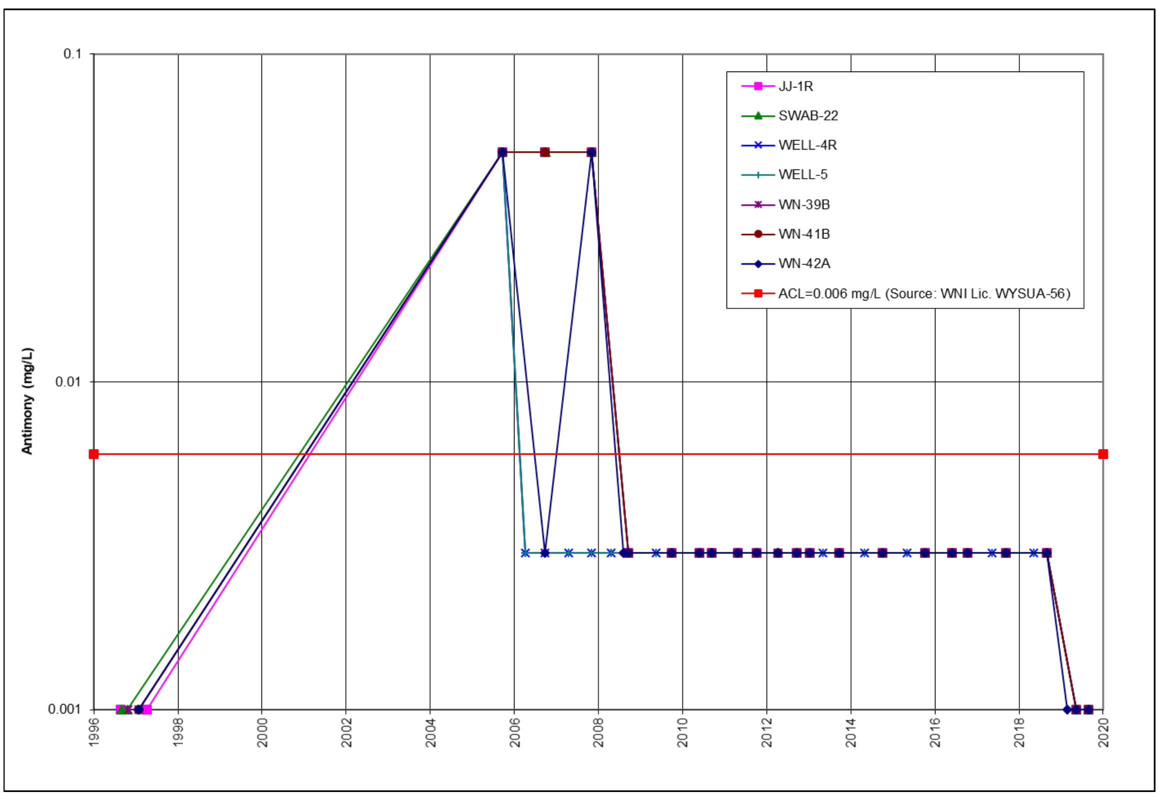


Figure E-7. Time-Concentration Plot for Antimony in NWV Wells

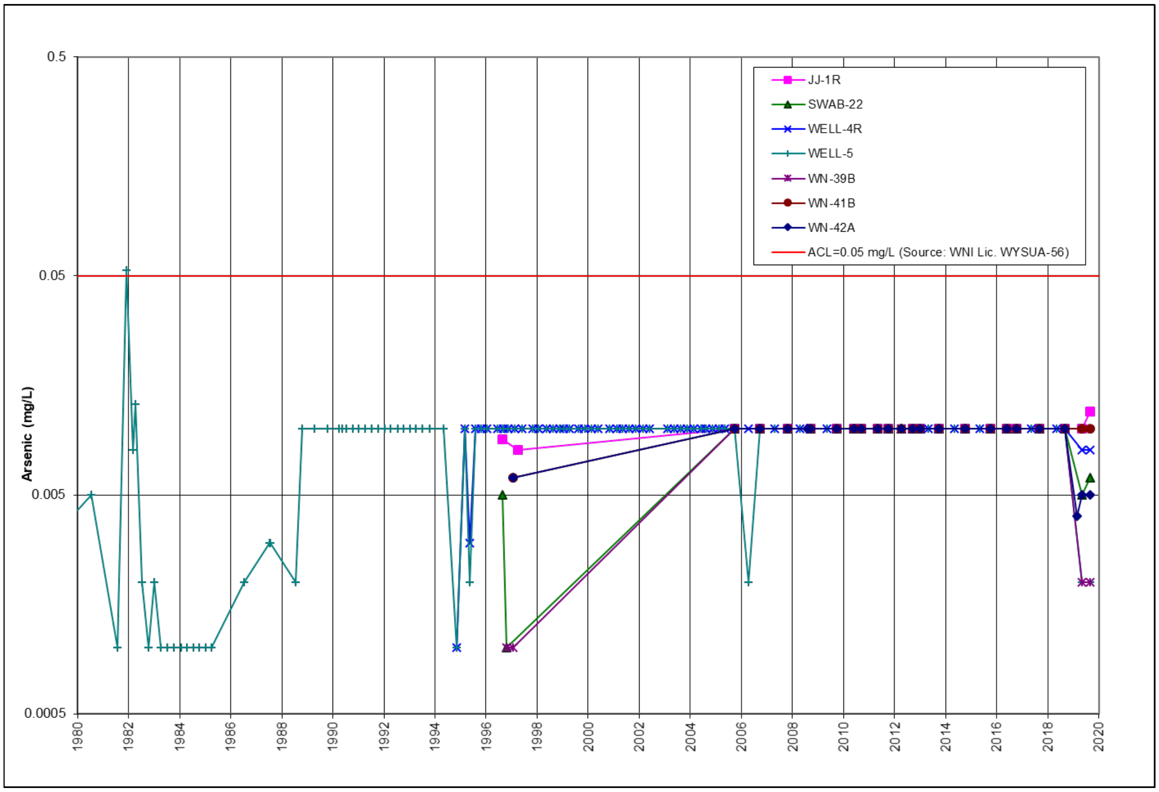


Figure E-8. Time-Concentration Plot for Arsenic in NWV Wells

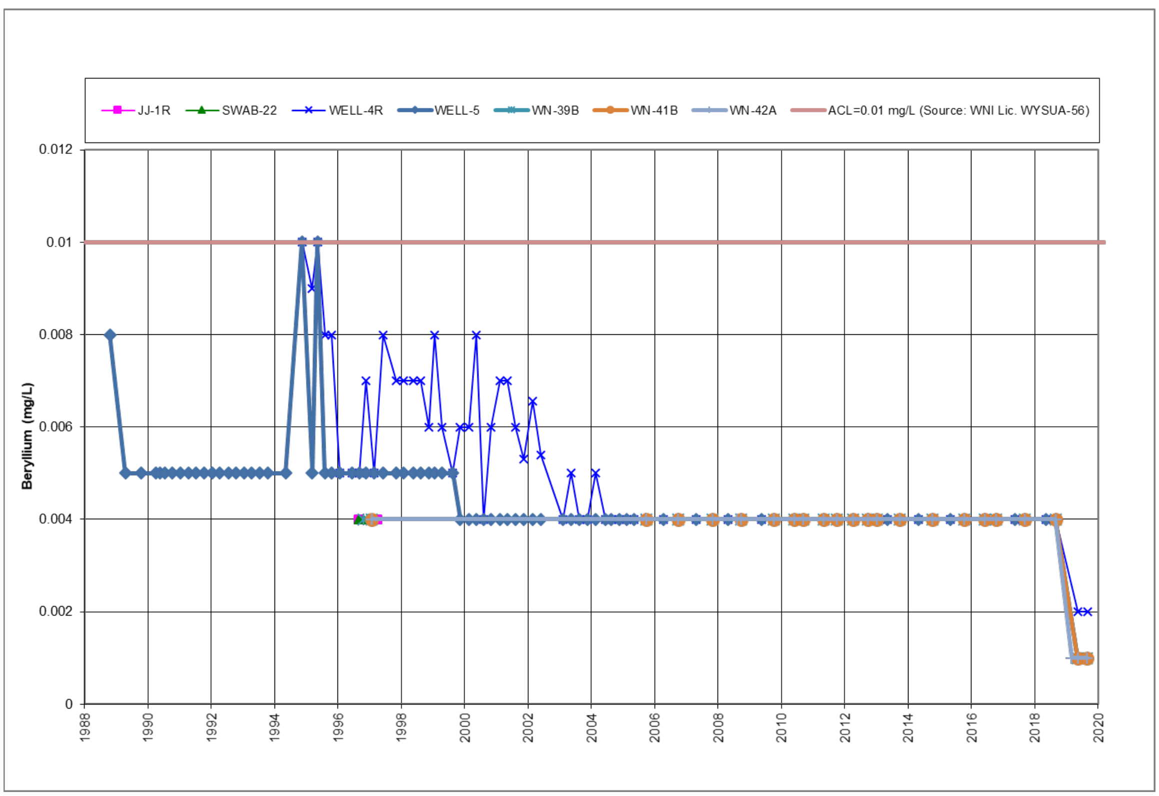


Figure E-9. Time-Concentration Plot for Beryllium in NWV Wells

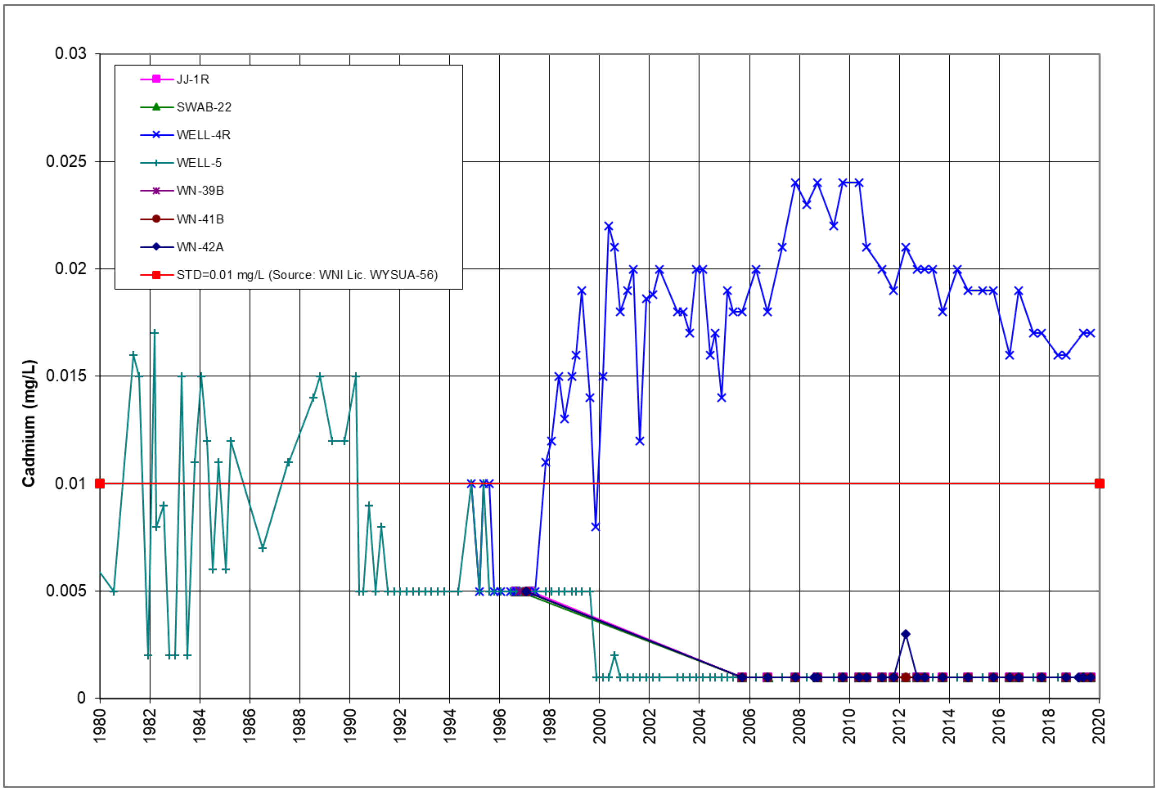


Figure E-10. Time-Concentration Plot for Cadmium in NWV Wells

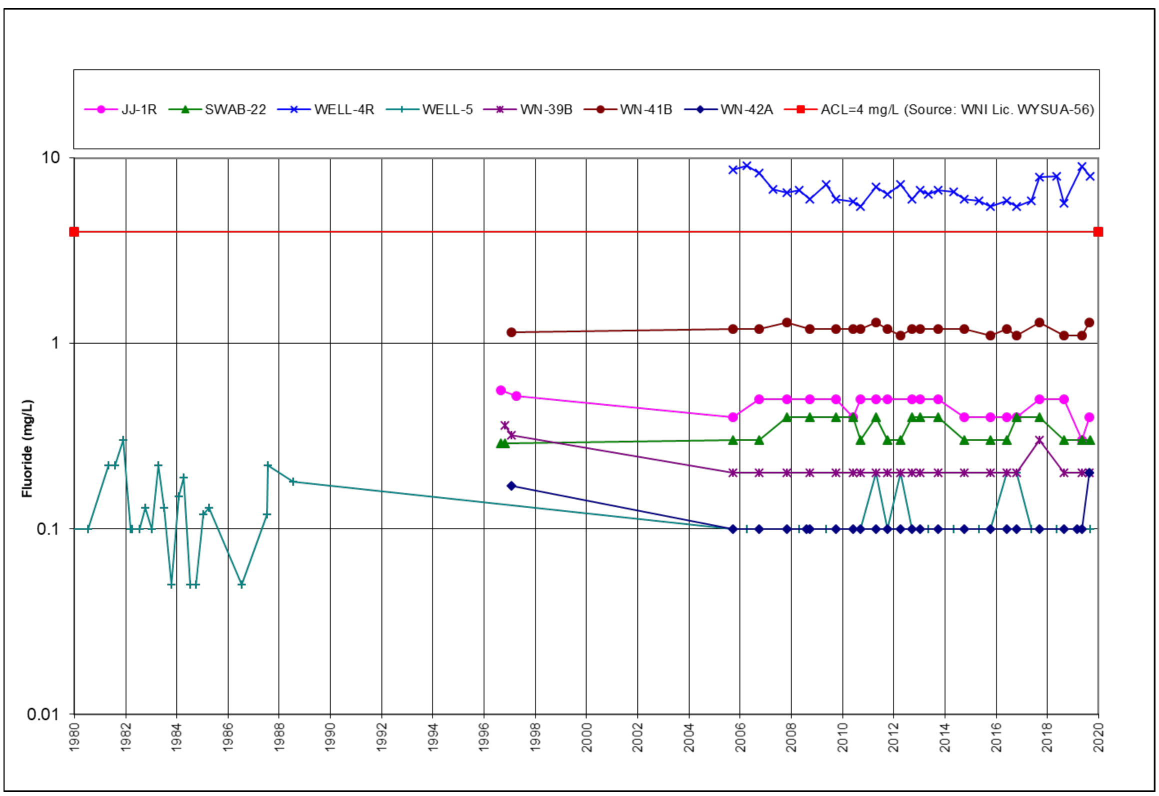


Figure E-11. Time-Concentration Plot for Fluoride in NWV Wells

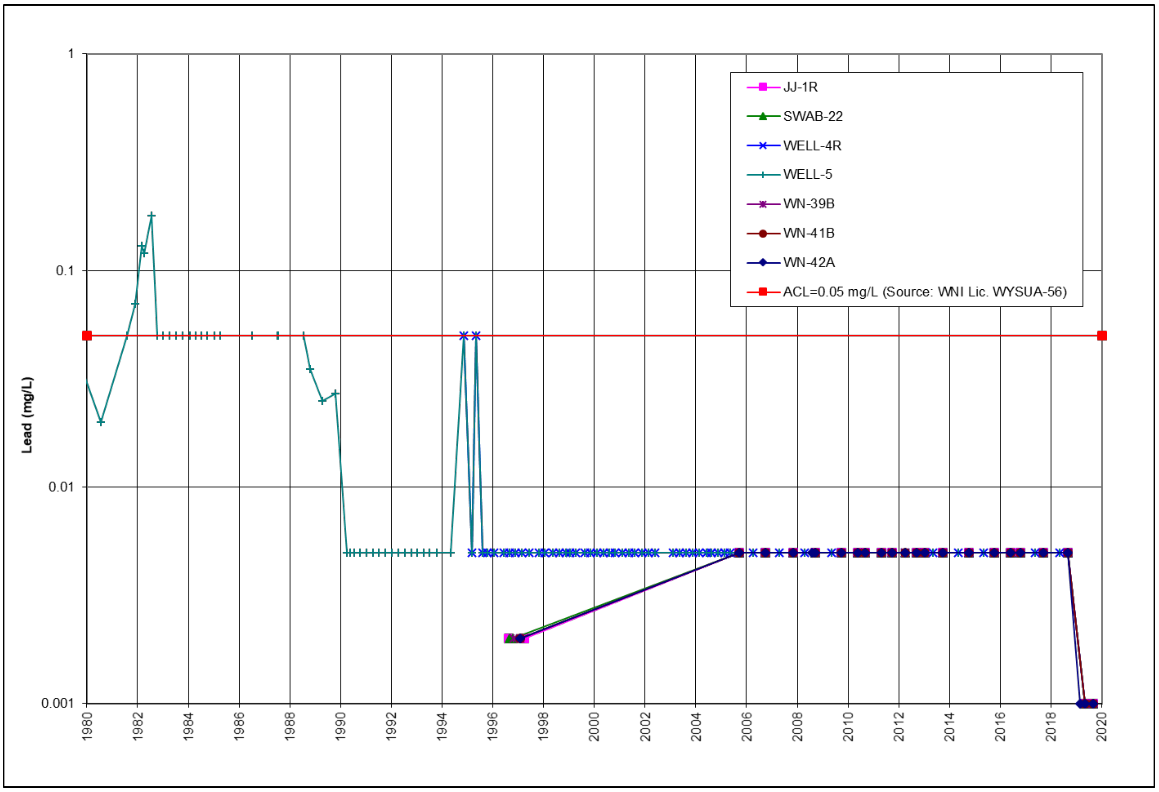


Figure E-12. Time-Concentration Plot for Lead in NWV Wells

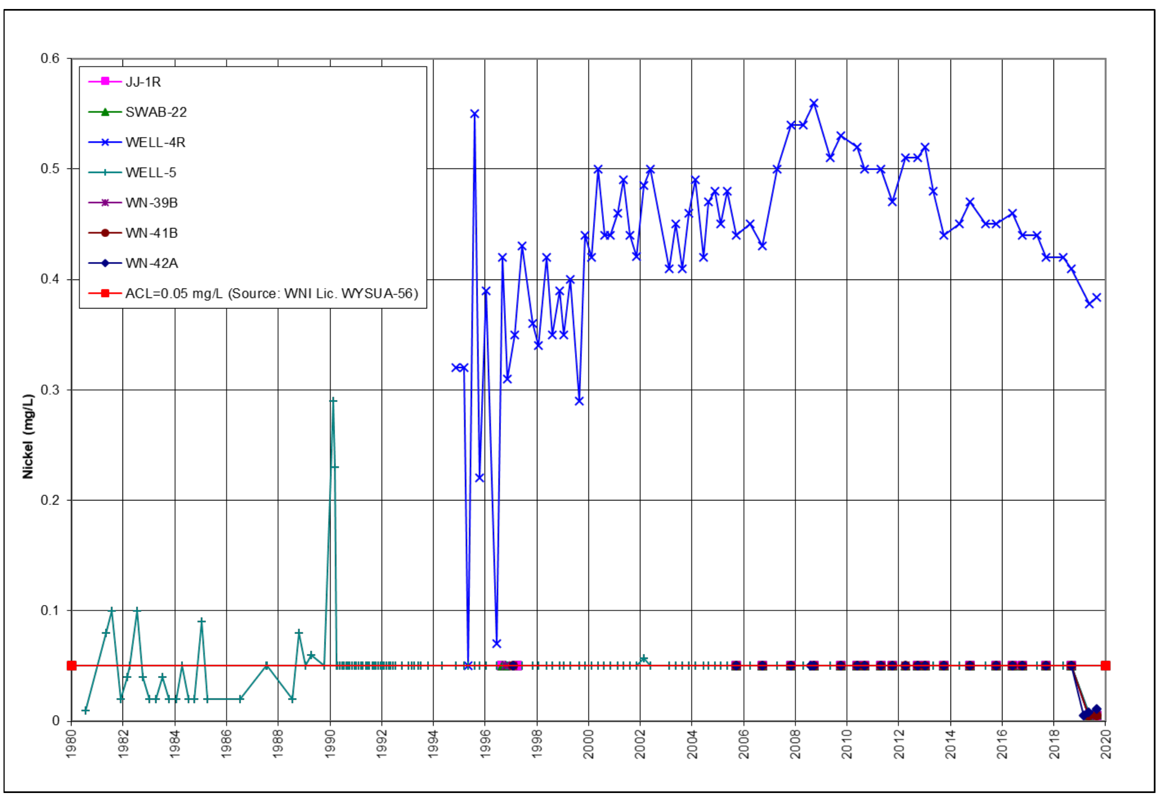


Figure E-13. Time-Concentration Plot for Nickel in NWV Wells

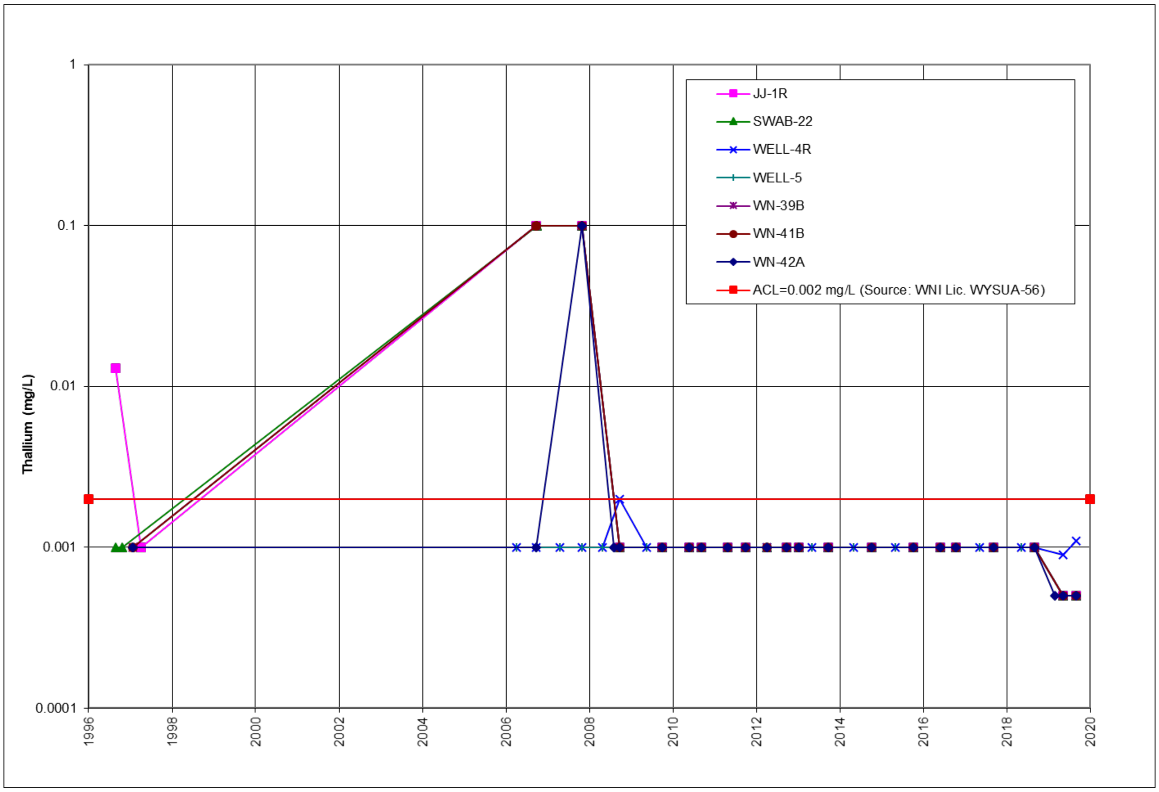


Figure E-14. Time-Concentration Plot for Thallium in NWV Wells

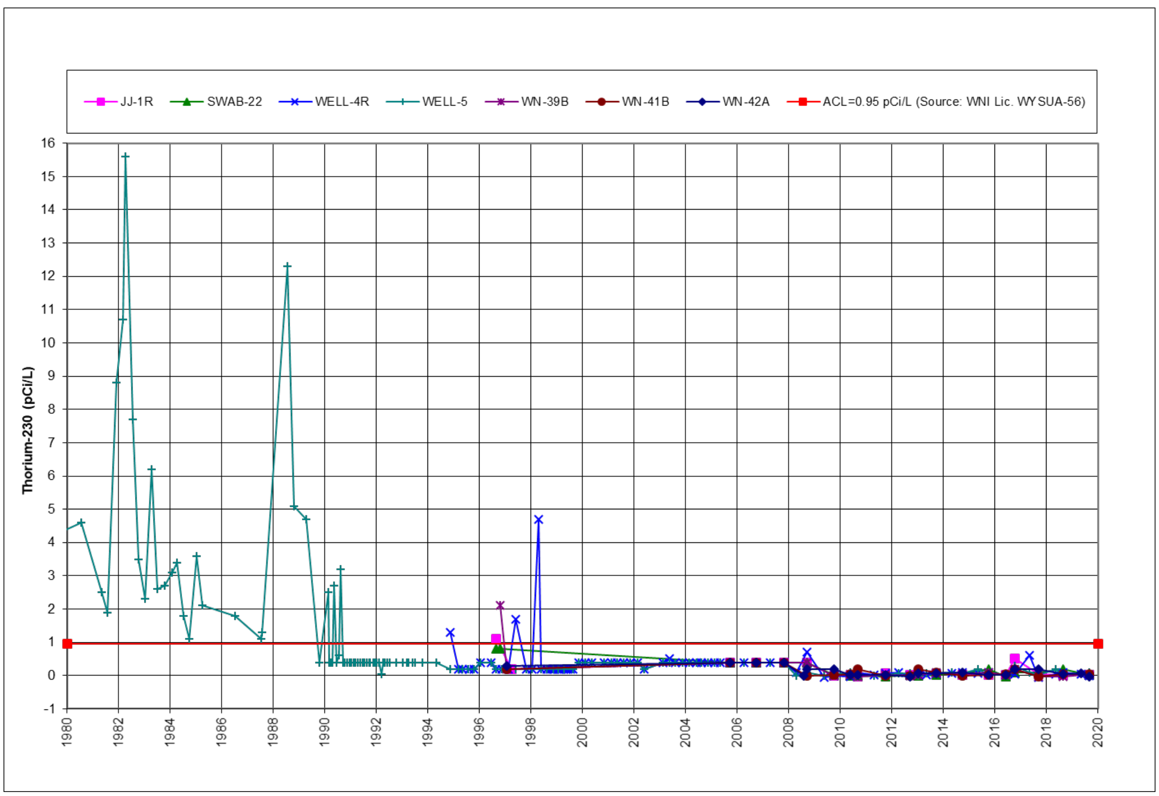


Figure E-15. Time-Concentration Plot for Thorium-230 in NWV Wells

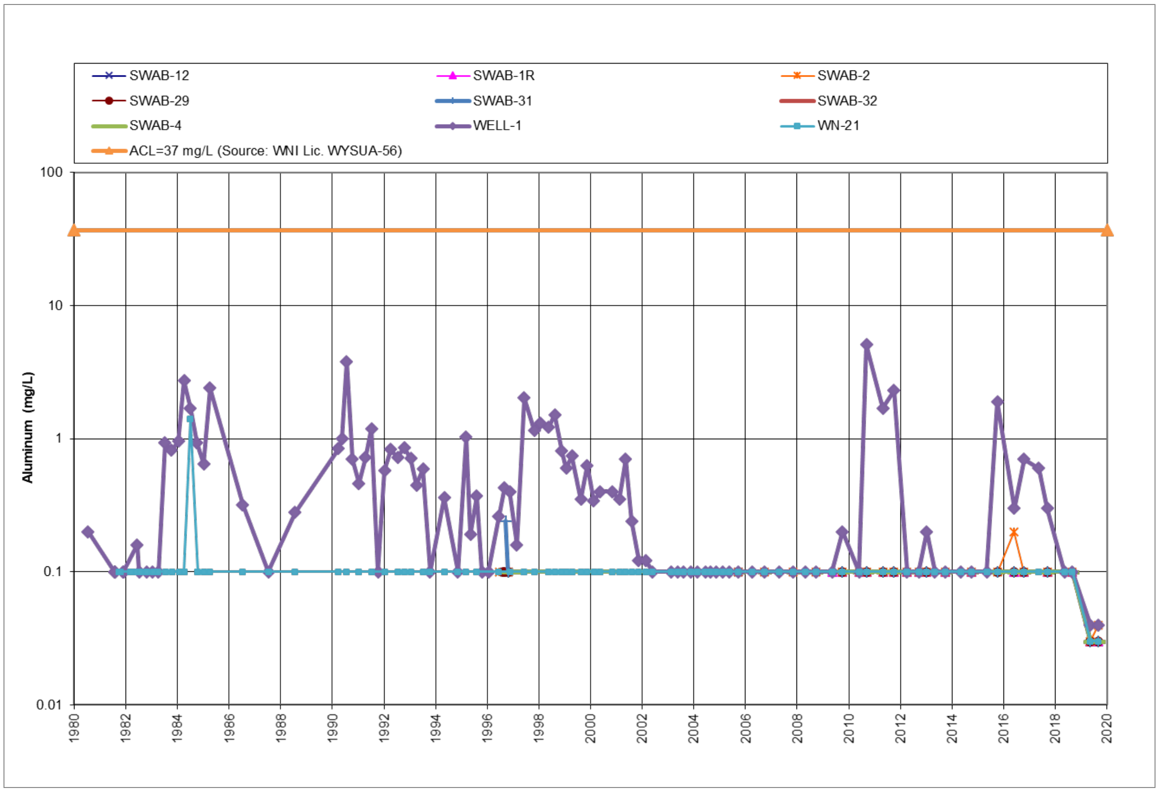


Figure E-16. Time-Concentration Plot of Aluminum for SWV Wells

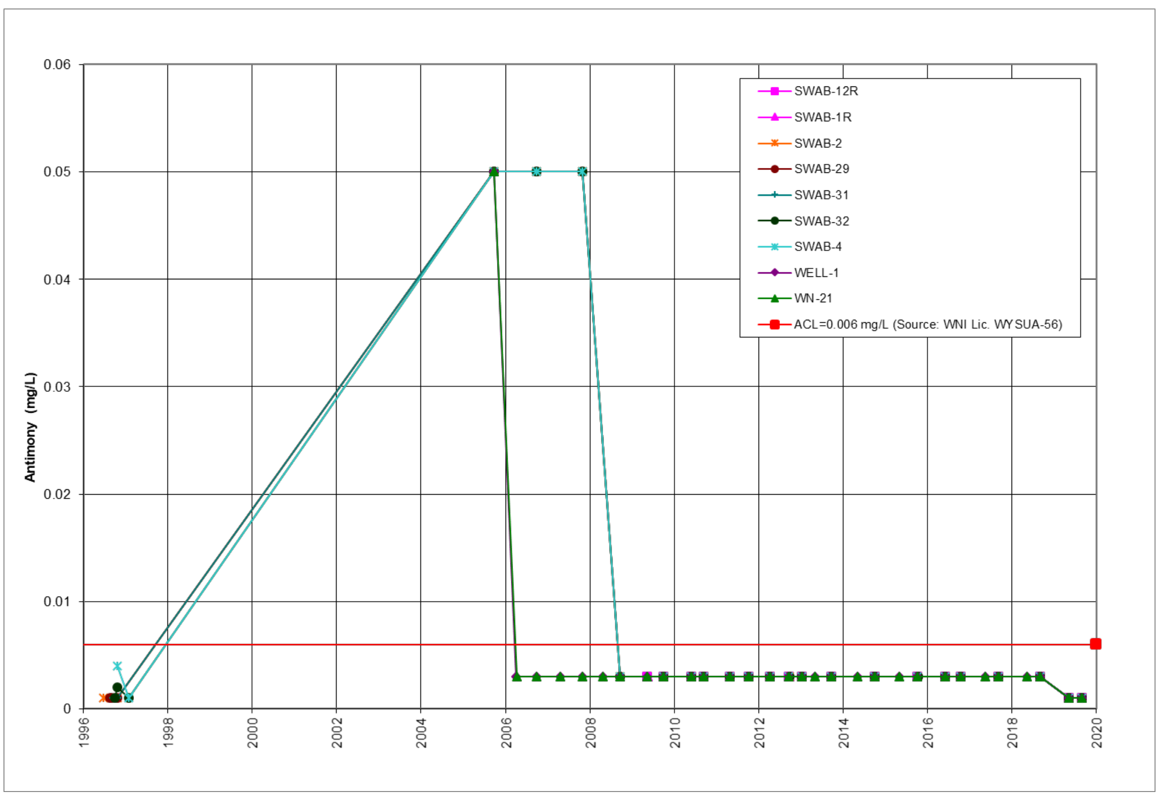


Figure E-17. Time-Concentration Plot for Antimony for SWV Wells

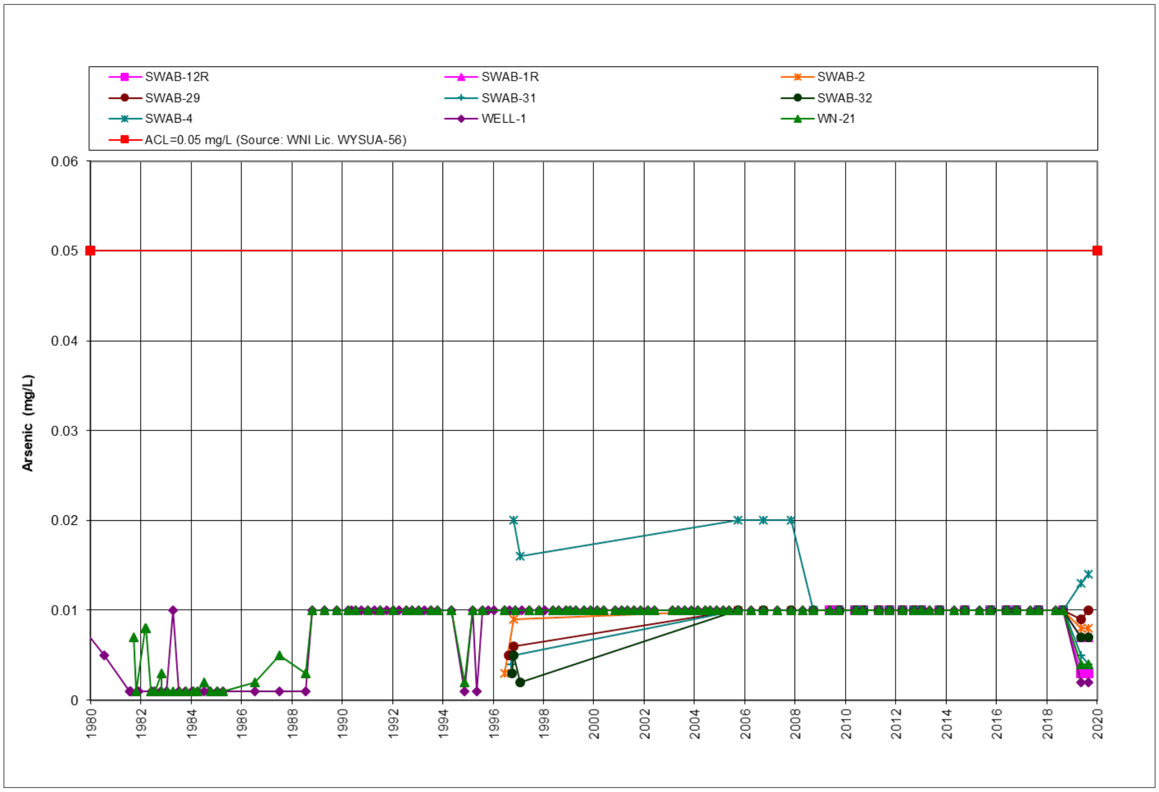


Figure E-18. Time-Concentration Plot of Arsenic for SWV Wells

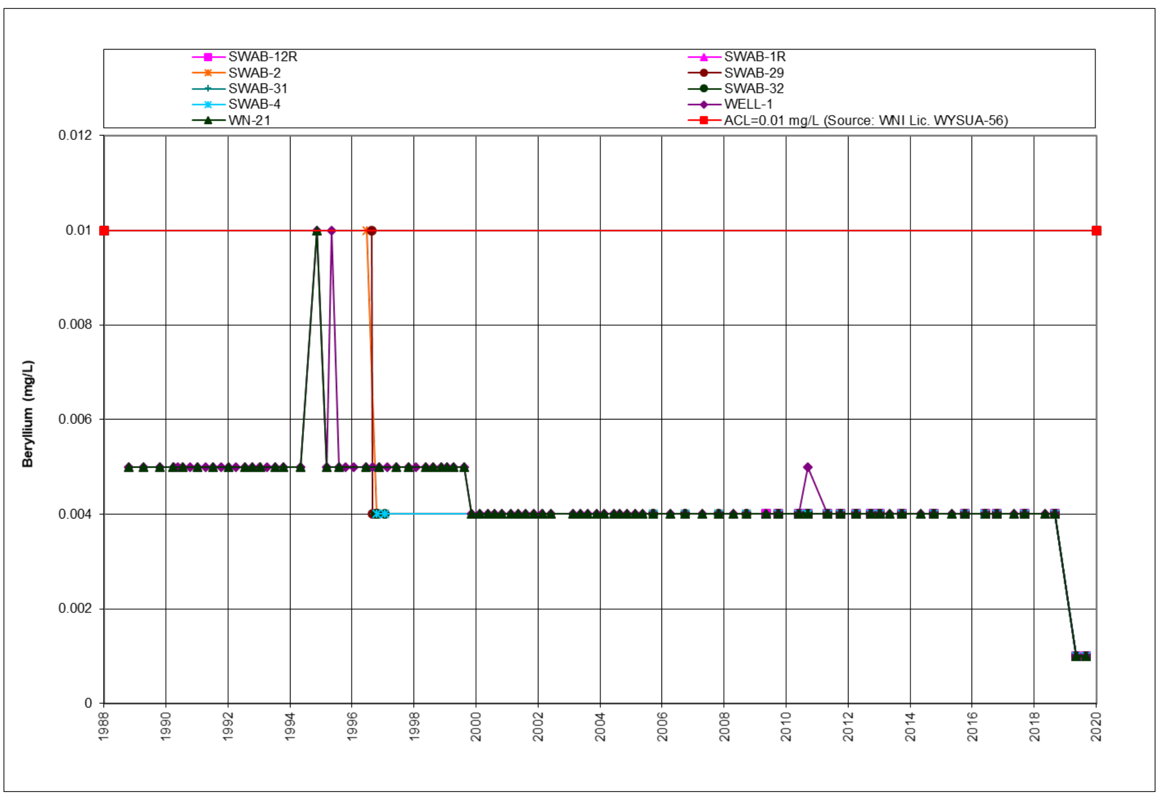


Figure E-19. Time-Concentration Plot of Beryllium for SWV Wells

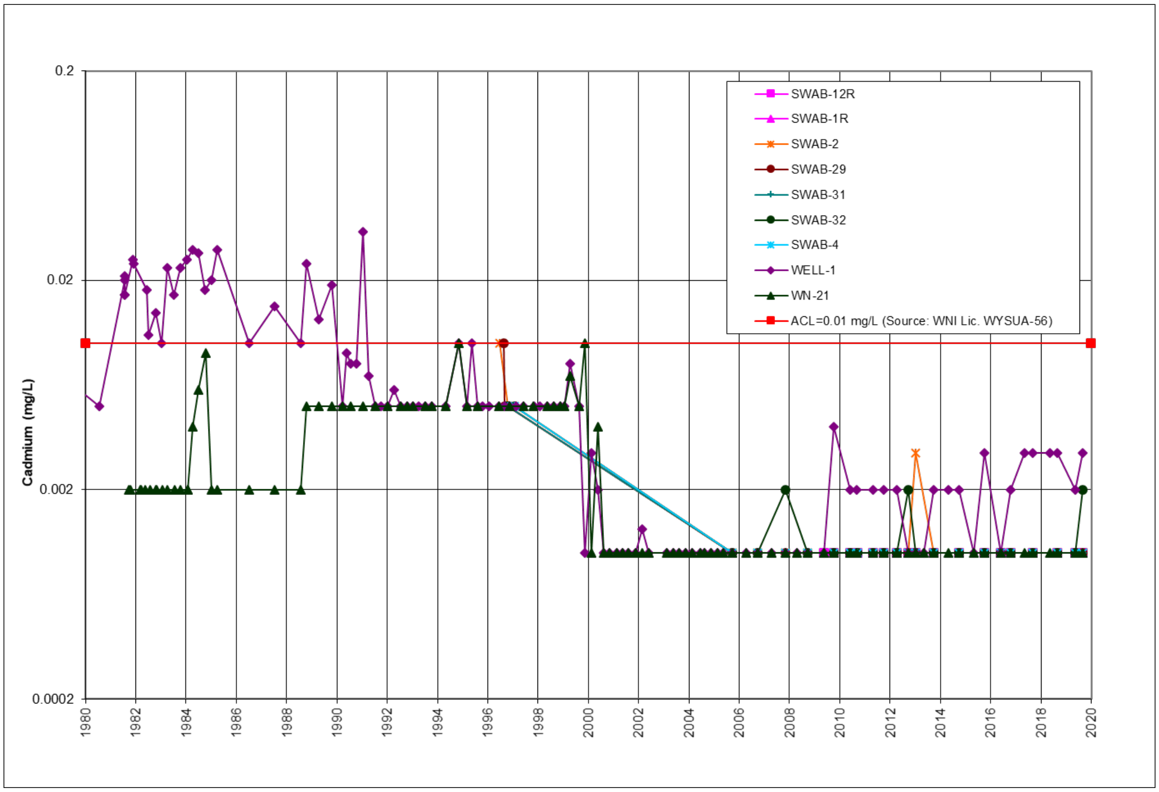


Figure E-20. Time-Concentration Plot of Cadmium for SWV Wells

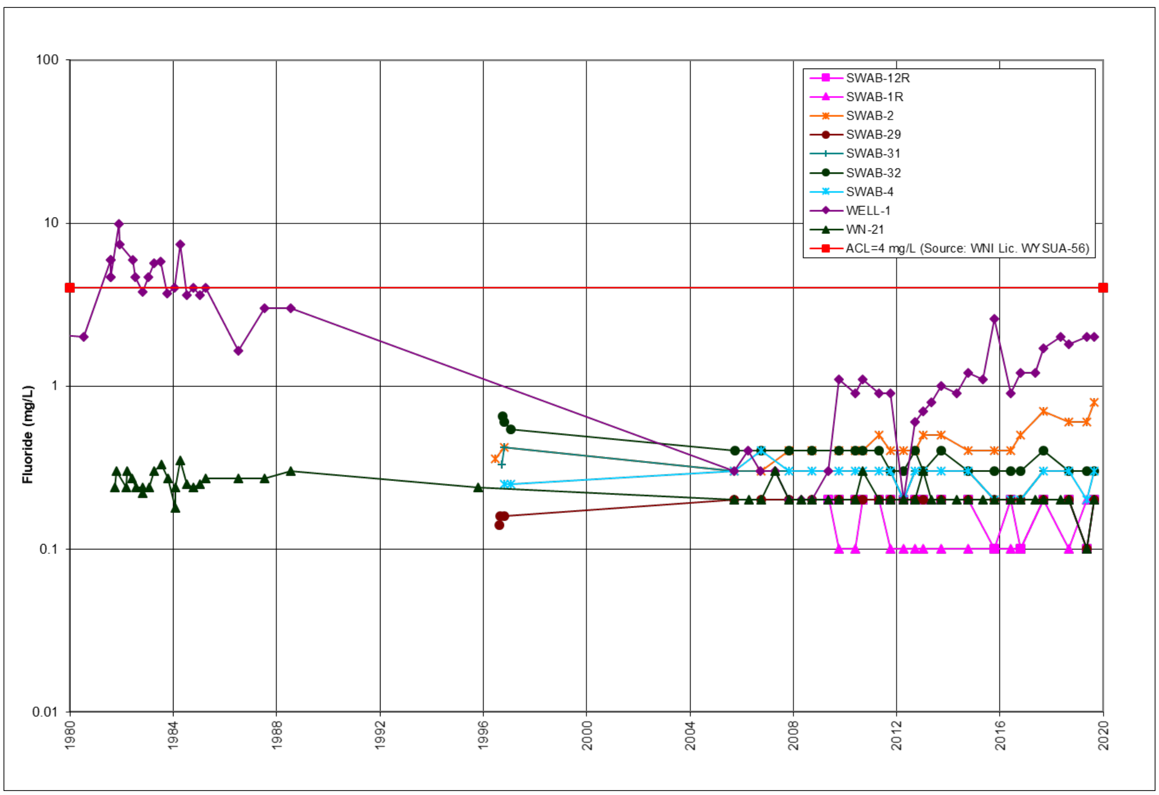


Figure E-21. Time-Concentration Plot of Fluoride for SWV Wells

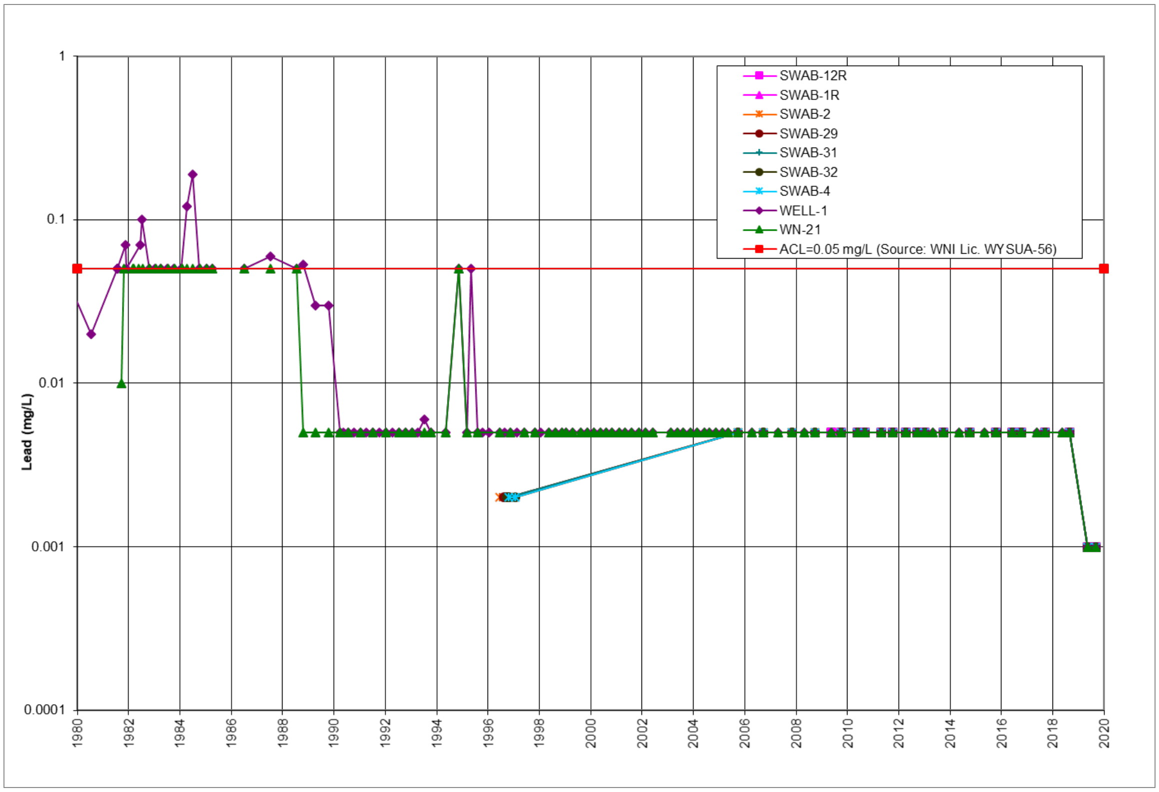


Figure E-22. Time-Concentration Plot of Lead for SWV Wells

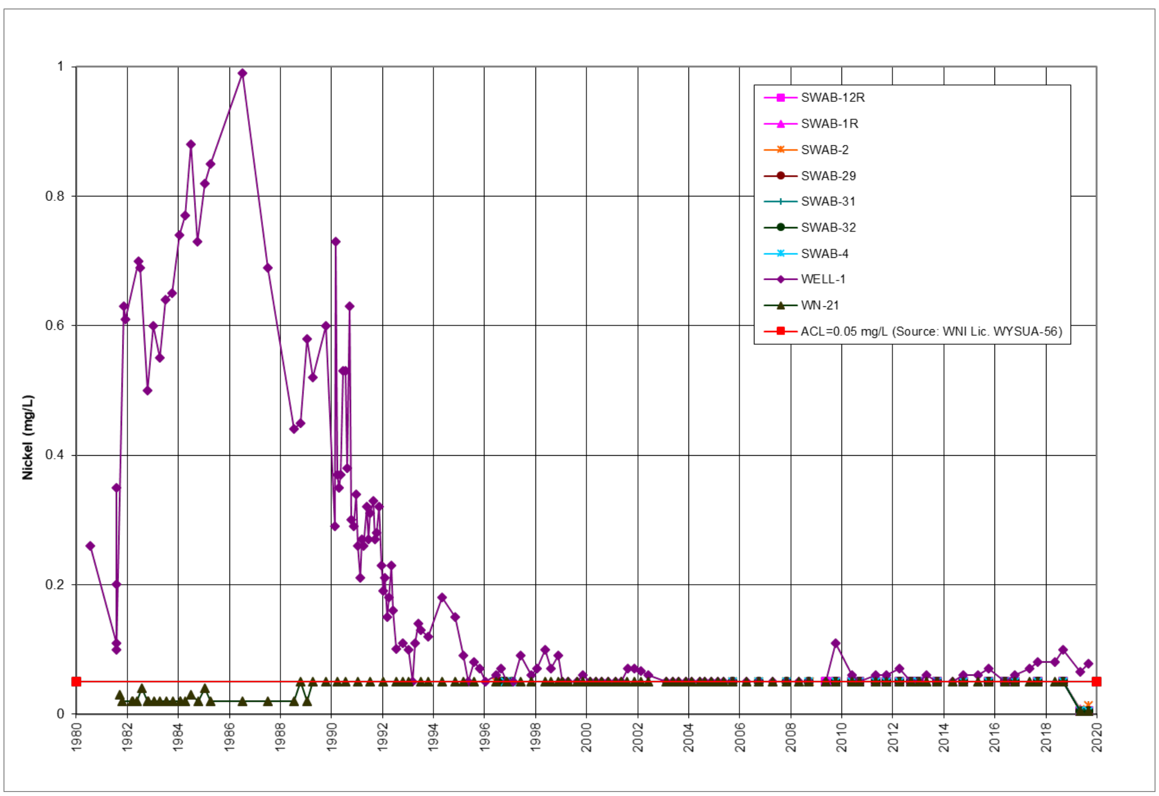


Figure E-23. Time-Concentration Plot of Nickel for SWV Wells

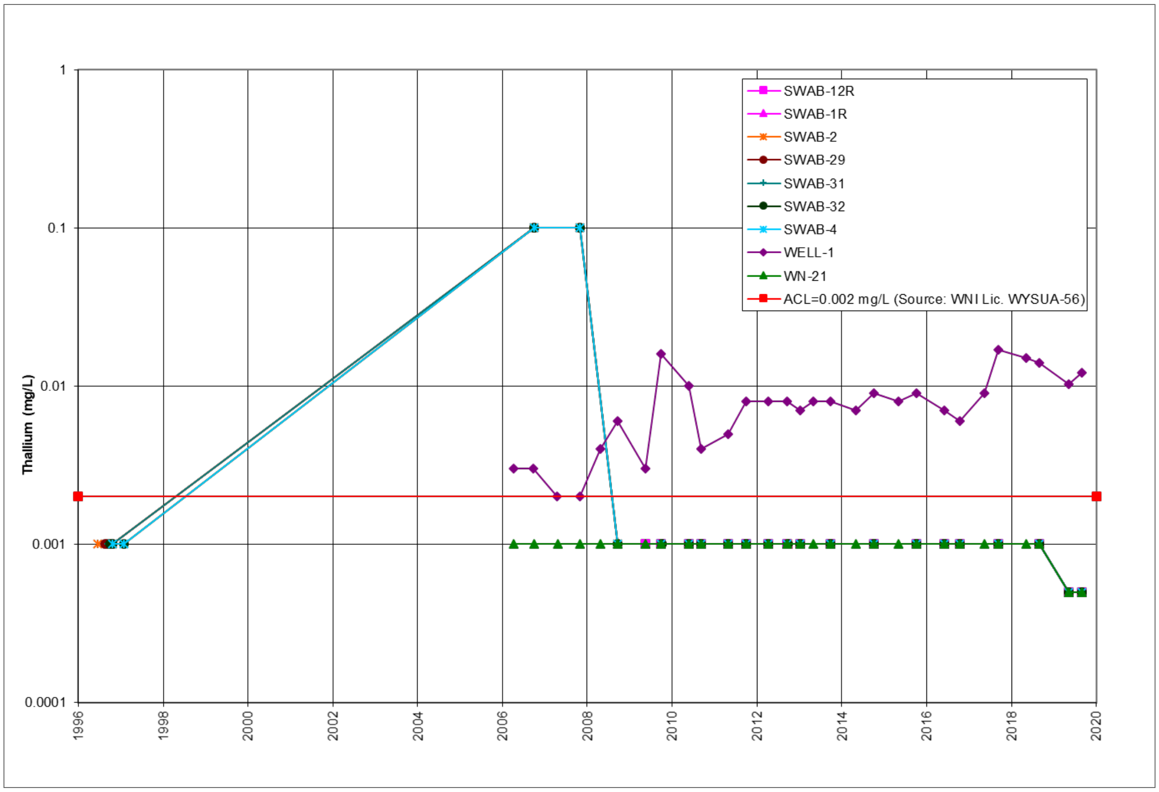


Figure E-24. Time-Concentration Plot of Thallium for SWV Wells

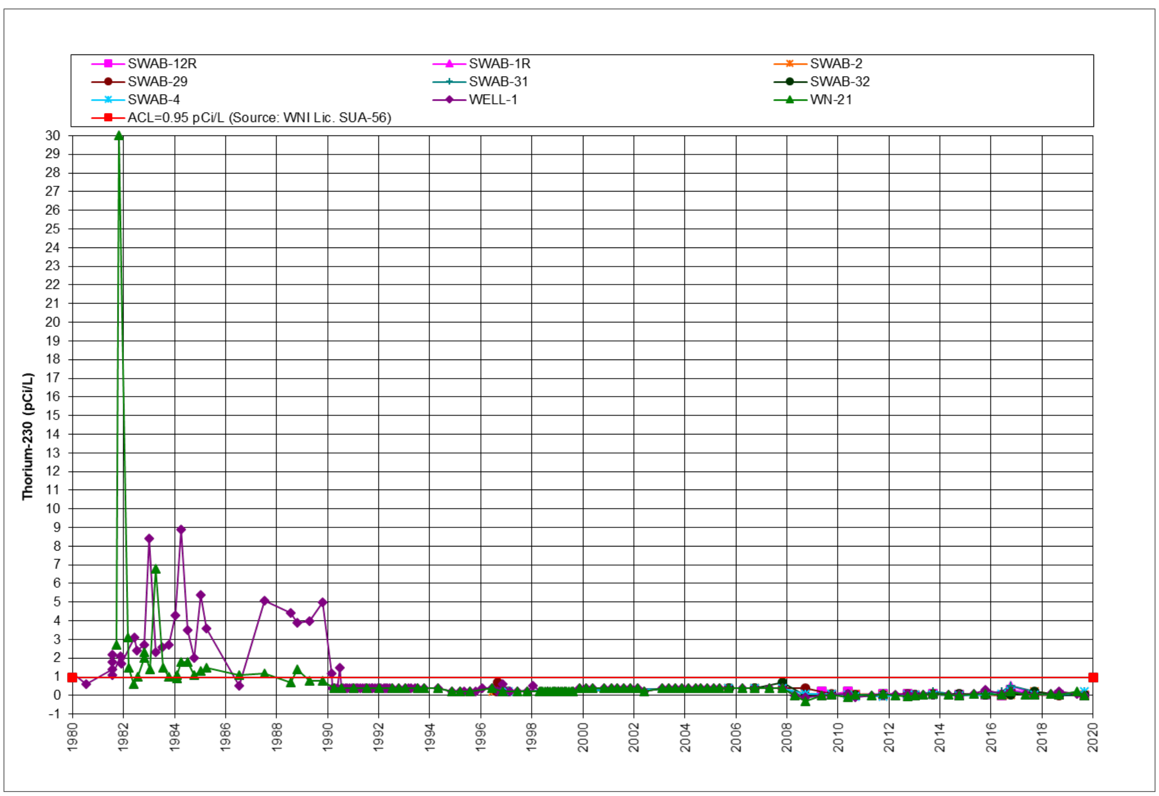


Figure E-25. Time-Concentration Plot of Thorium-230 for SWV Wells

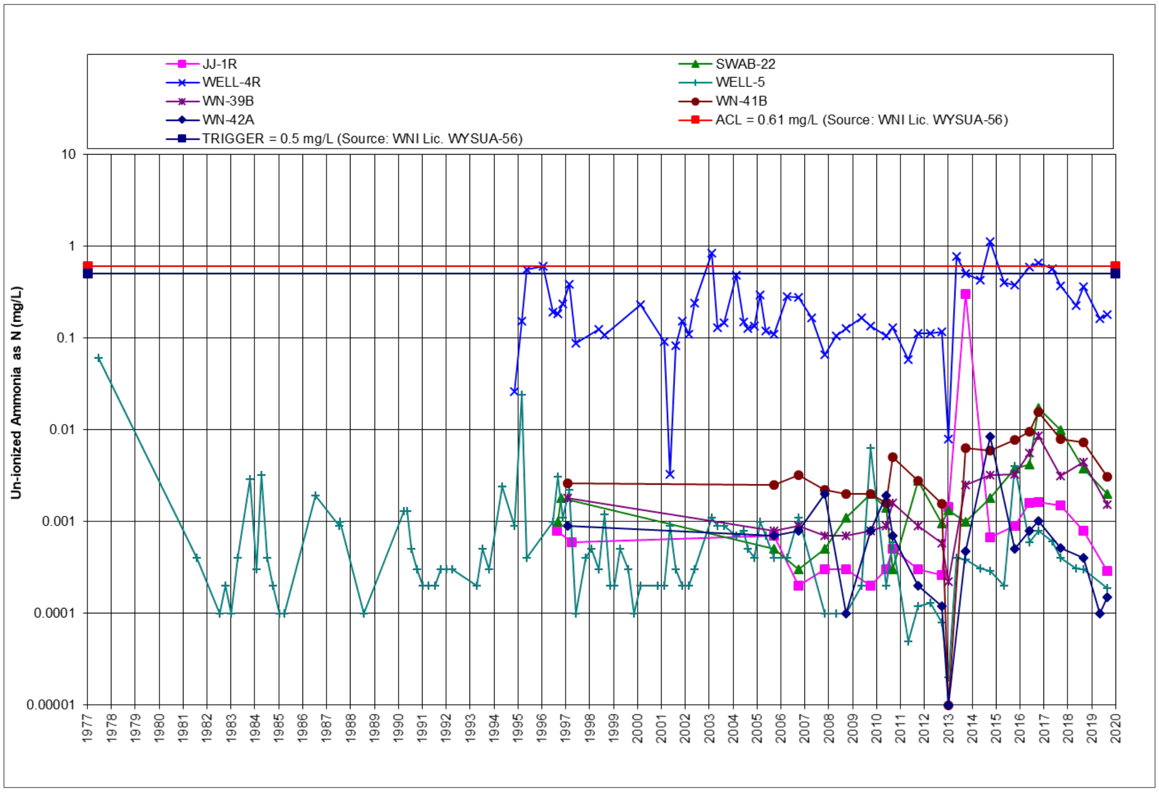


Figure E-26. Time-Concentration Plot for Ammonia (Un-ionized as N) in NWV Wells

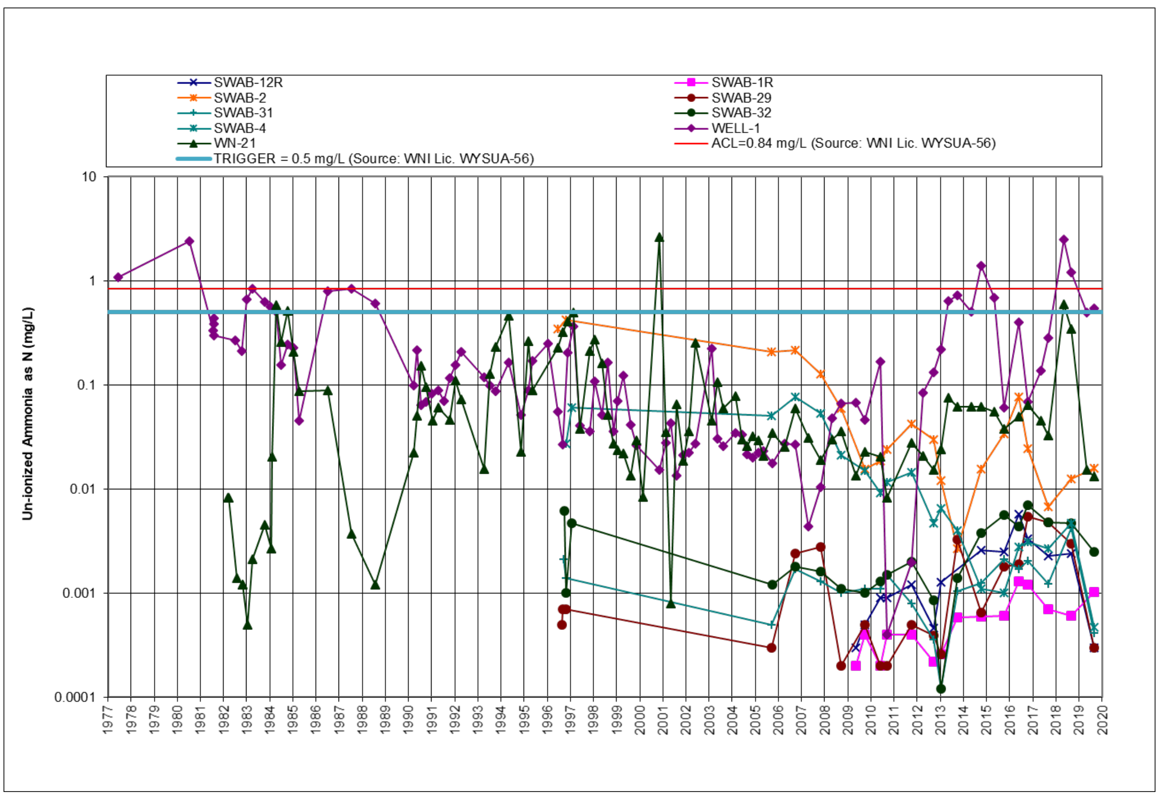


Figure E-27. Time-Concentration Plot of Ammonia (Un-ionized as N) for SWV Wells

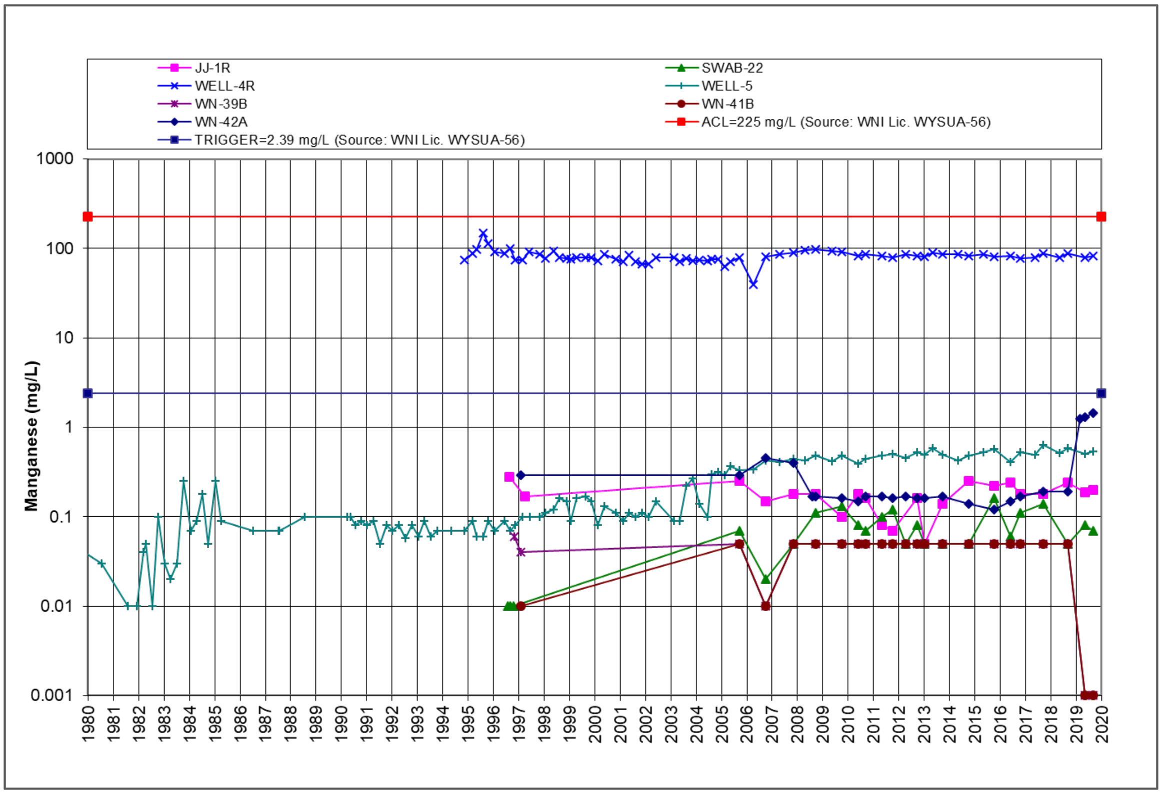


Figure E-28. Time-Concentration Plot for Manganese in NWV Wells

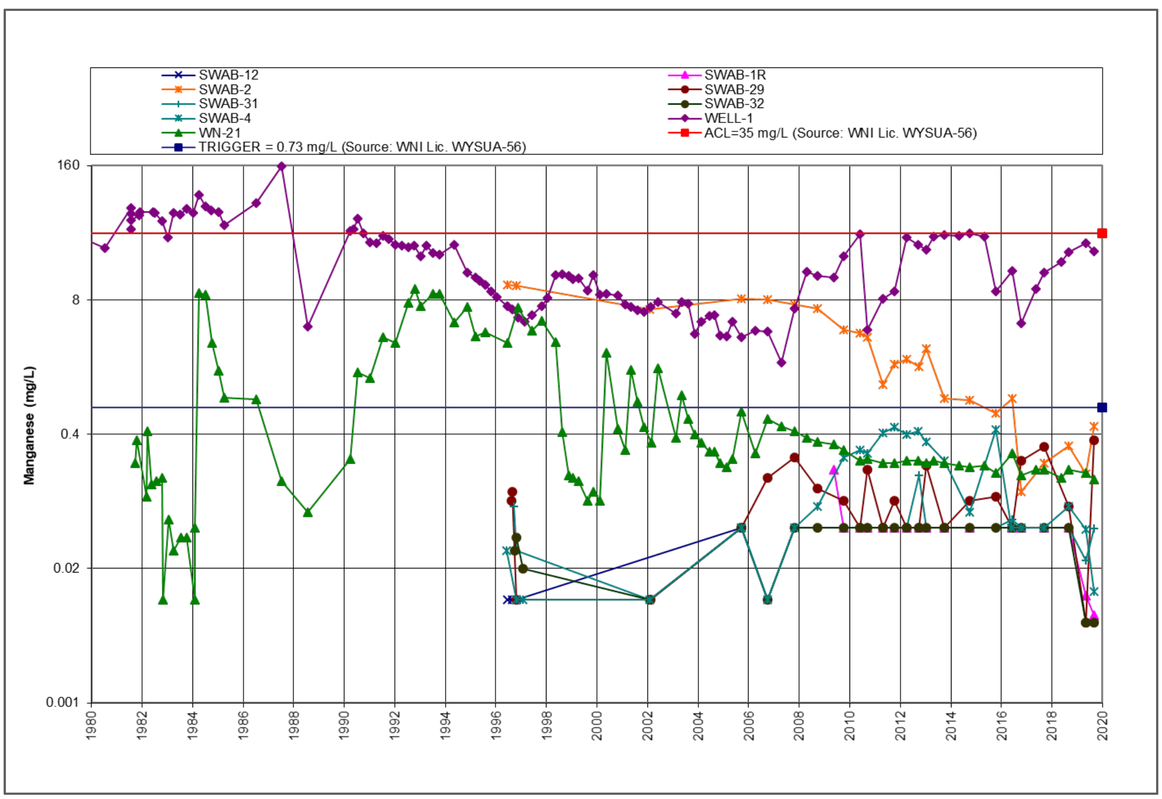


Figure E-29. Time-Concentration Plot of Manganese for SWV Wells

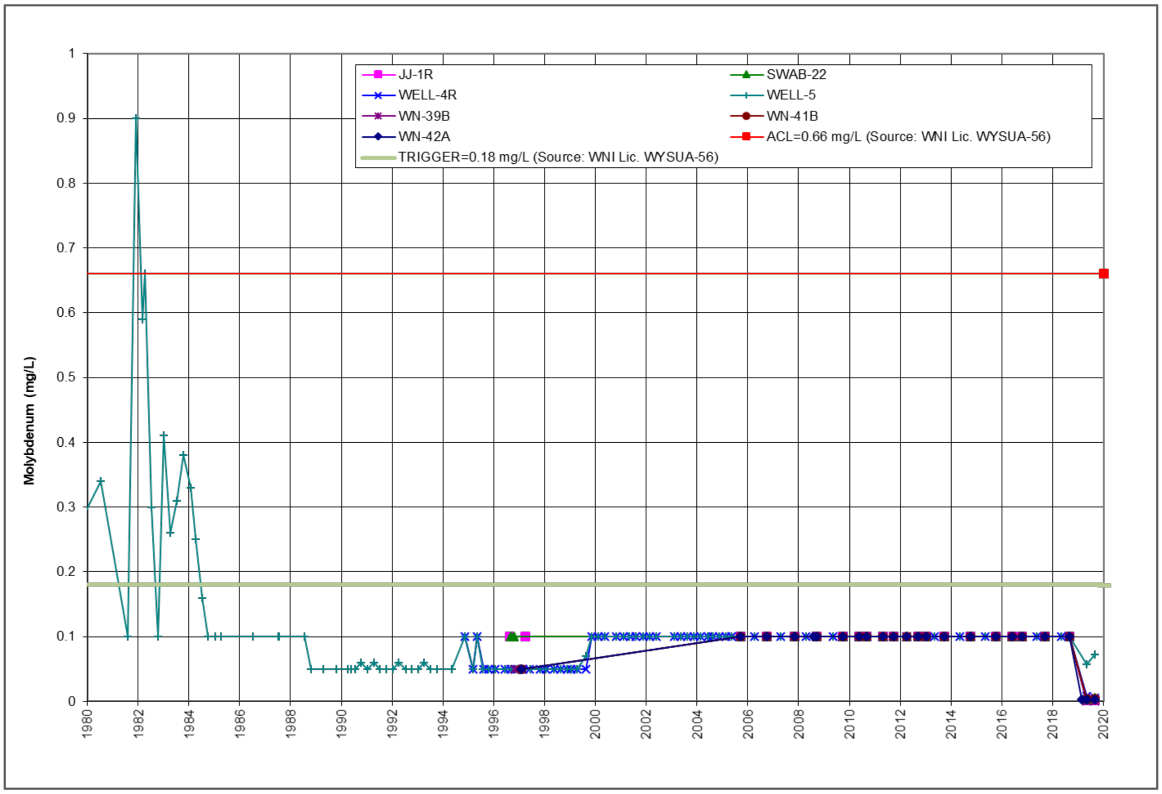


Figure E-30. Time-Concentration Plot of Molybdenum in NWV Wells

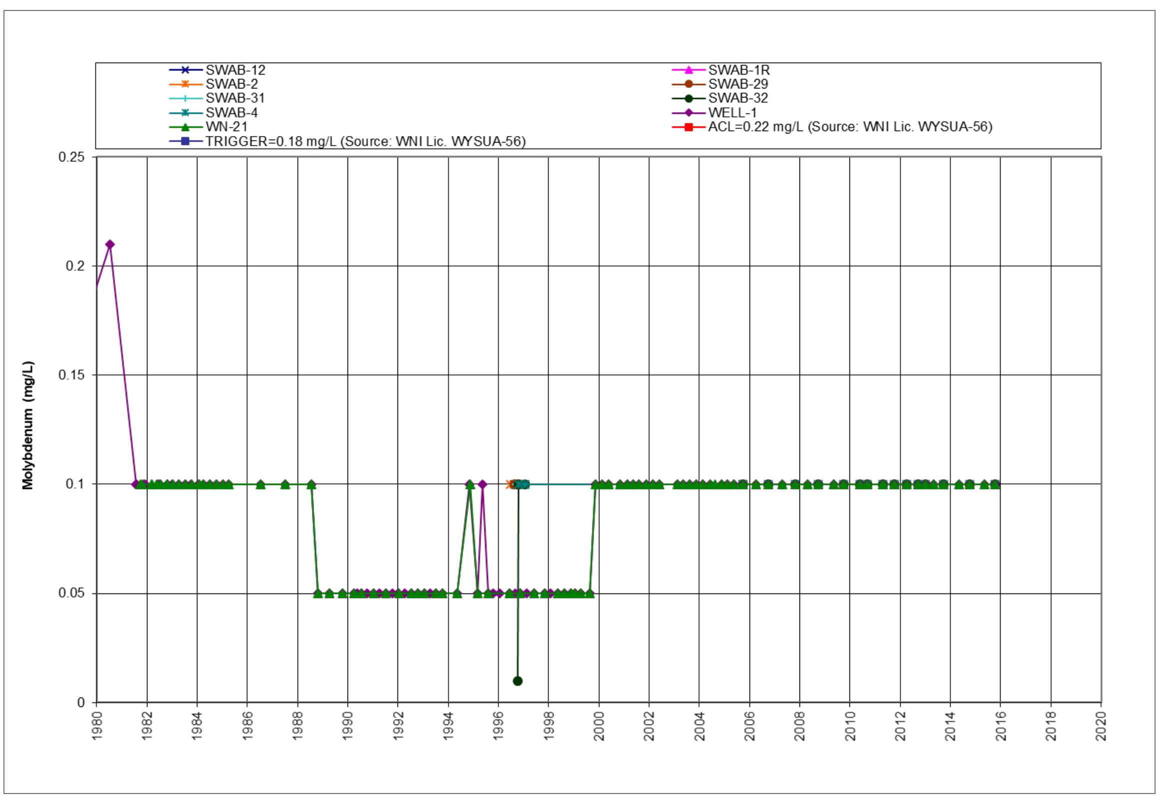


Figure E-31. Time-Concentration Plot of Molybdenum for SWV Wells

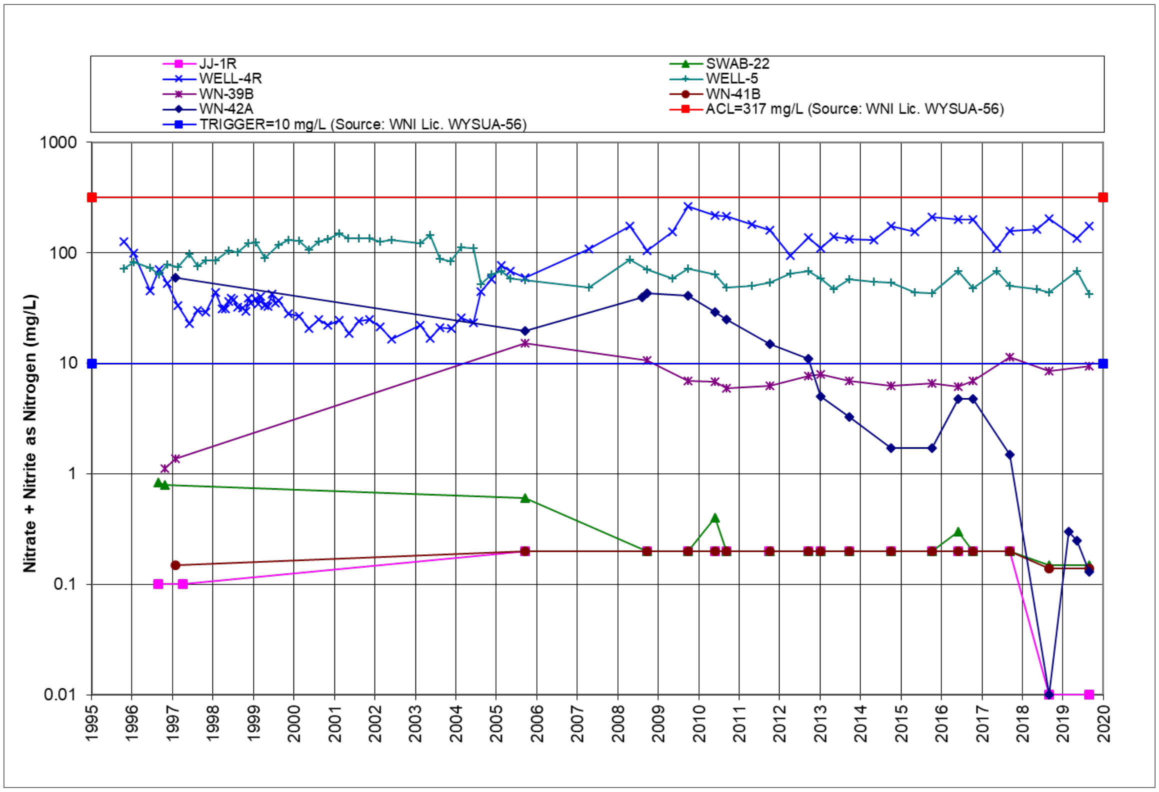


Figure E-32. Time-Concentration Plot of Nitrate (Total as N) in NWV Wells

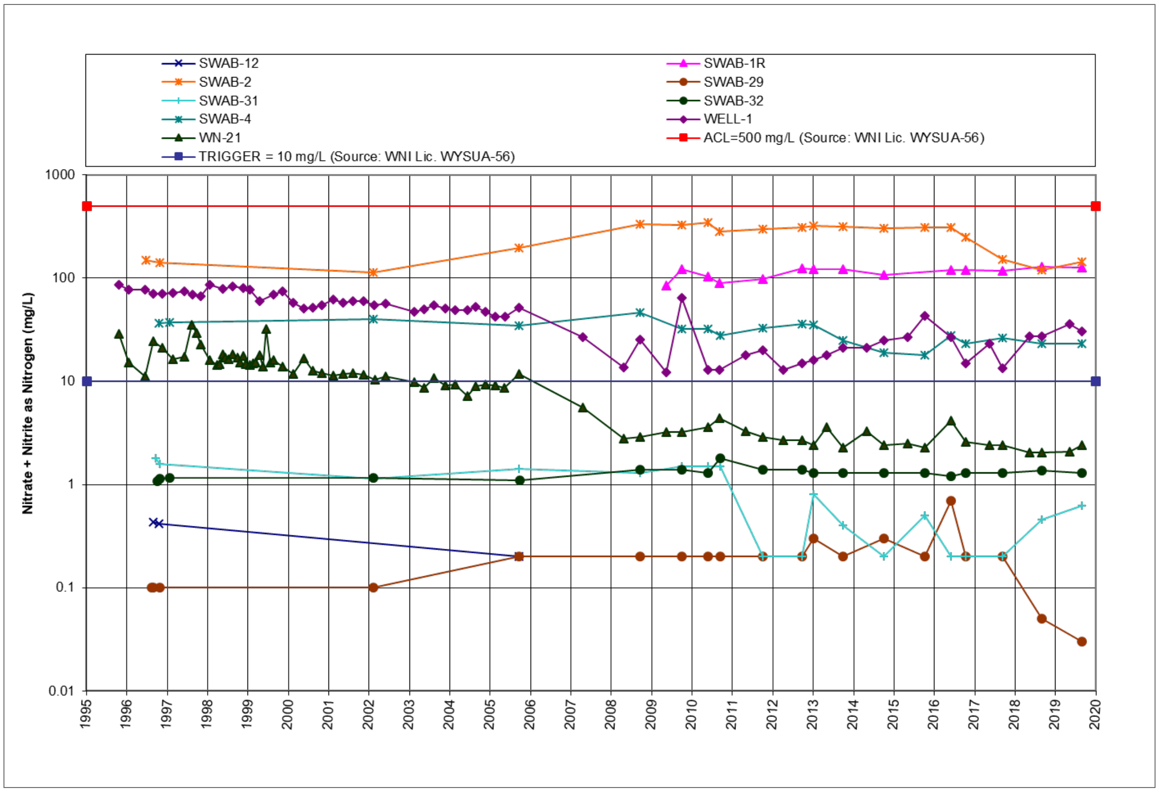


Figure E-33. Time-Concentration Plot of Nitrate (total as N) for SWV Wells

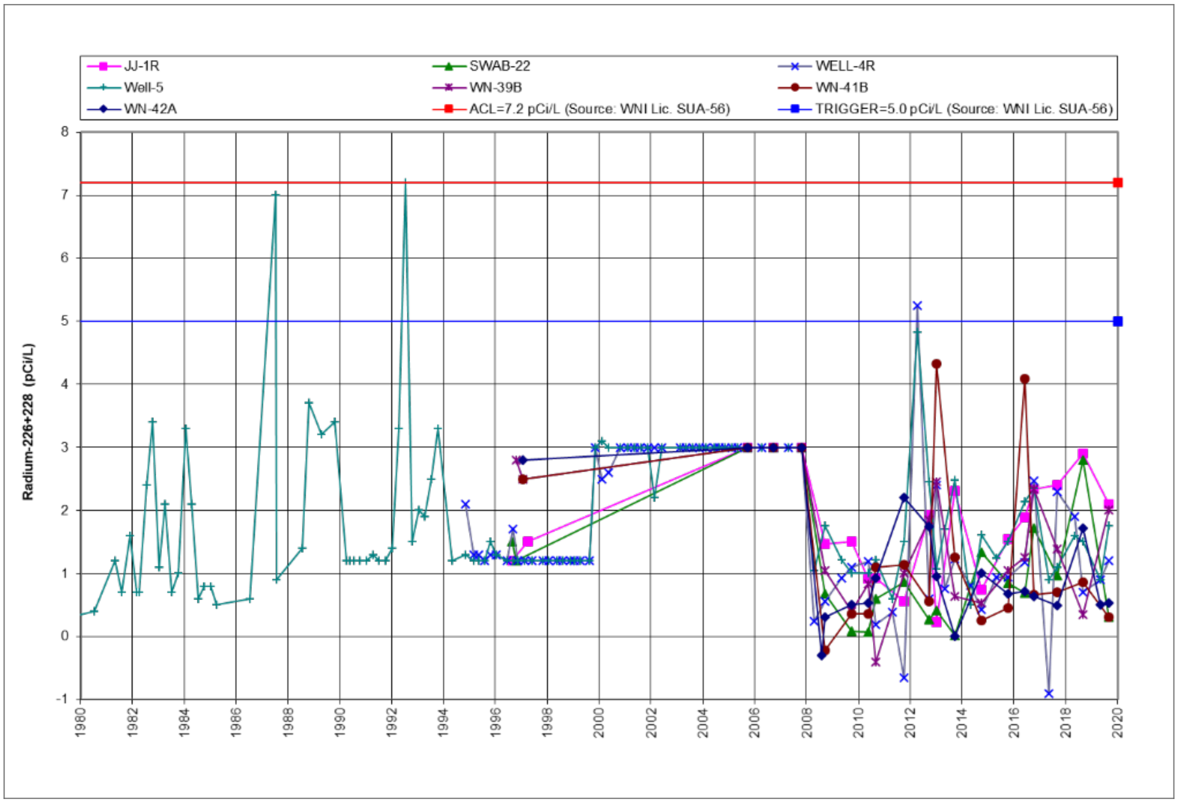


Figure E-34. Time-Concentration Plot for Radium-226 and -228 in NWV Wells

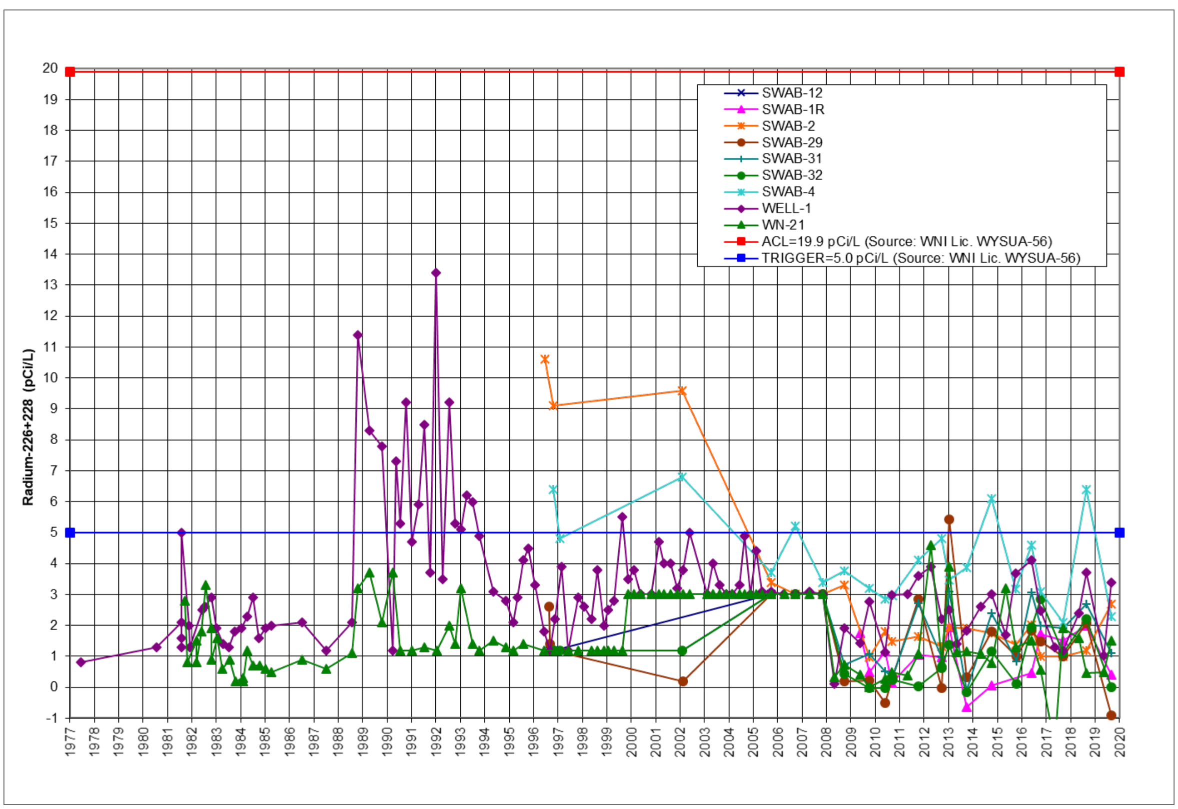


Figure E-35. Time-Concentration Plot of Radium-226 and -228 for SWV Wells

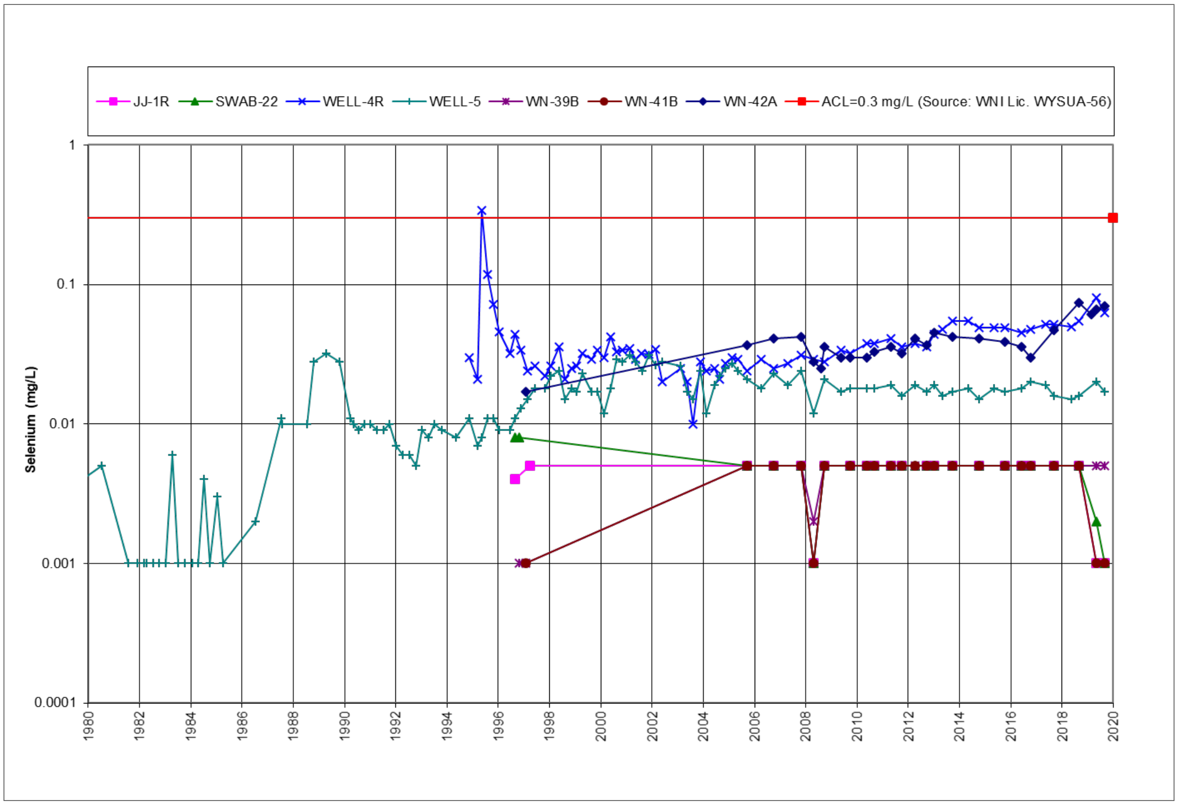


Figure E-36. Time-Concentration Plot of Selenium in NWV Wells

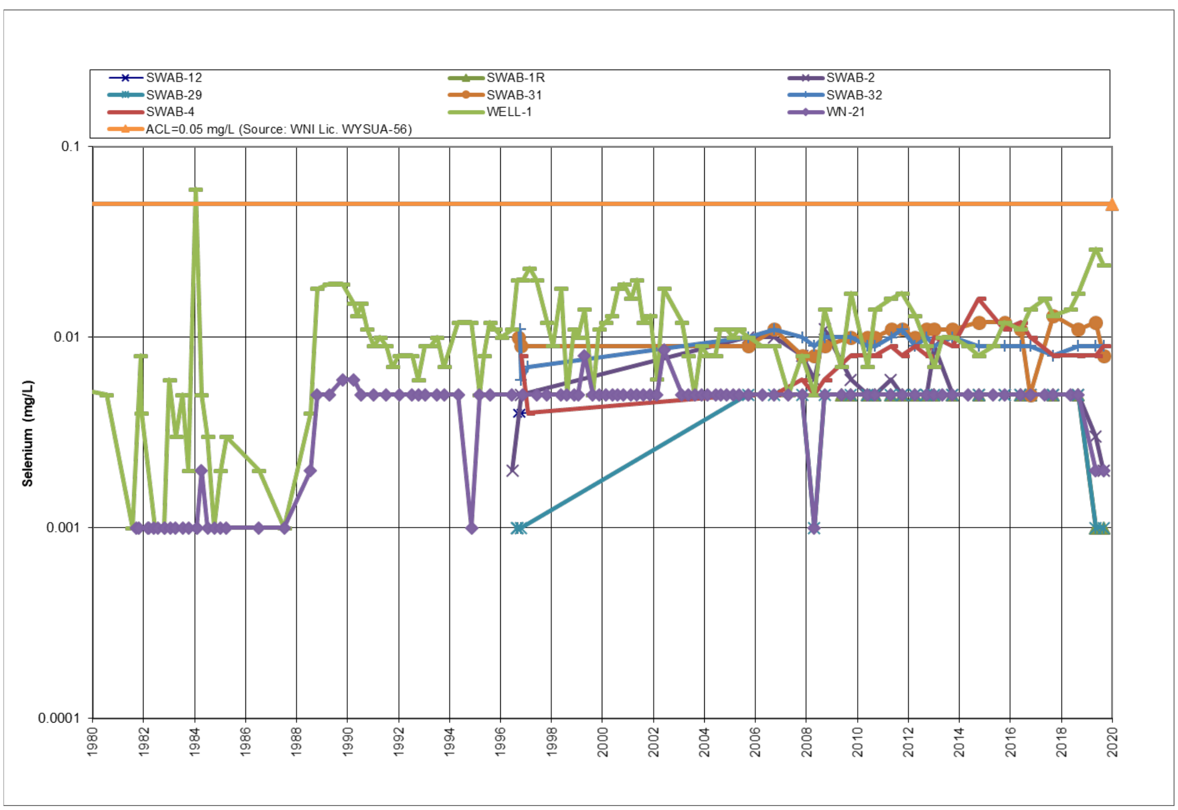


Figure E-37. Time-Concentration Plot of Selenium for SWV Wells

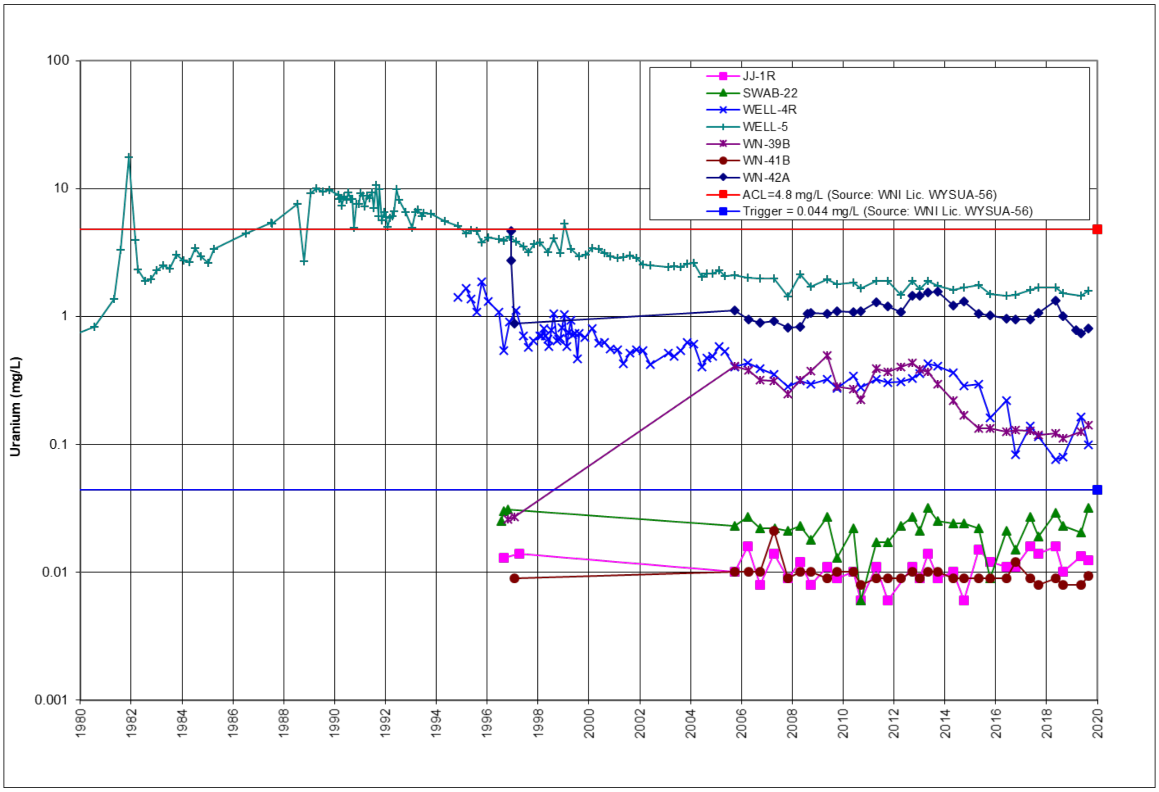


Figure E-38. Time-Concentration Plot of Uranium for NWV Wells

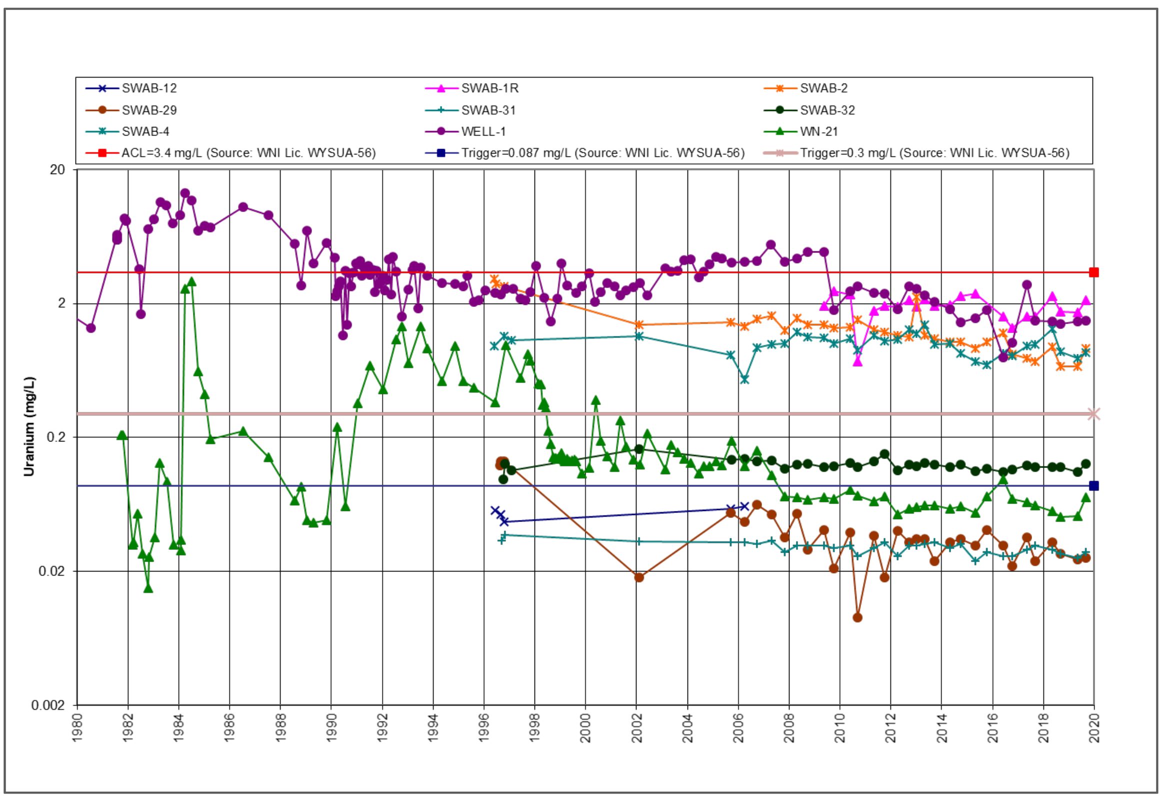


Figure E-39. Time-Concentration Plot of Uranium for SWV Wells

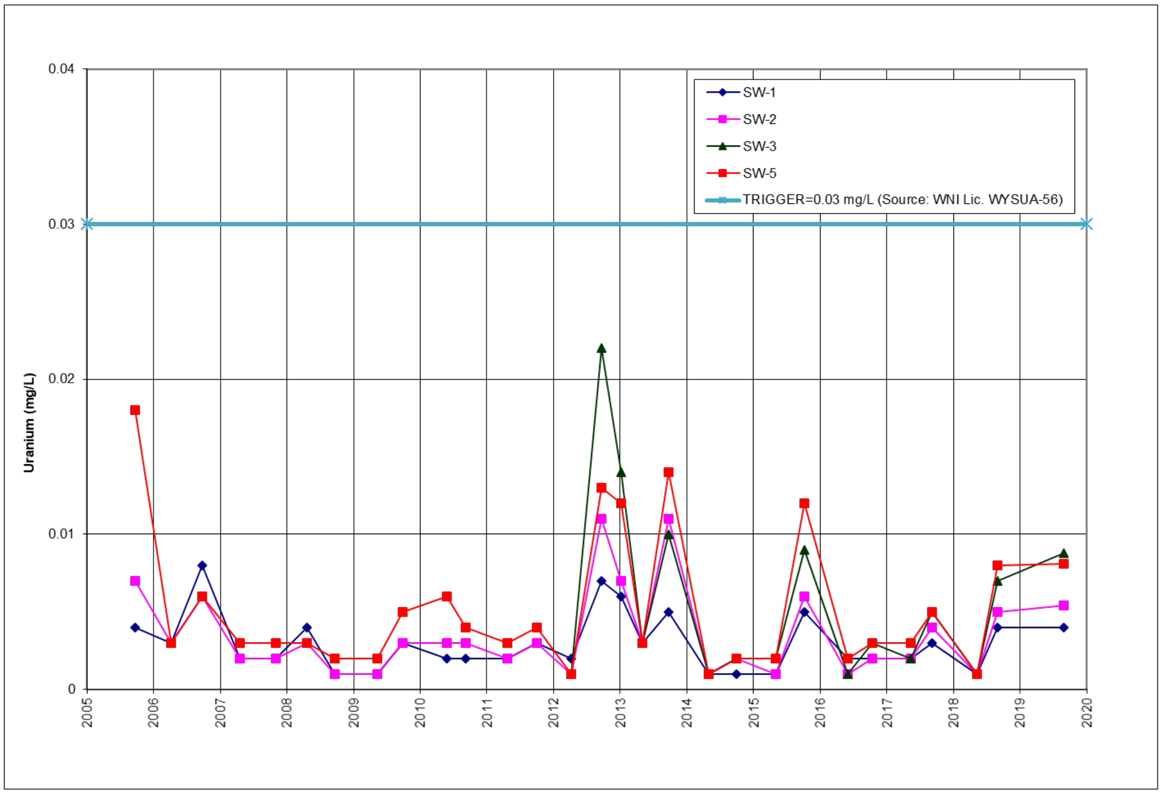


Figure E-40. Time-Concentration Plot of Uranium in the Sweetwater River.

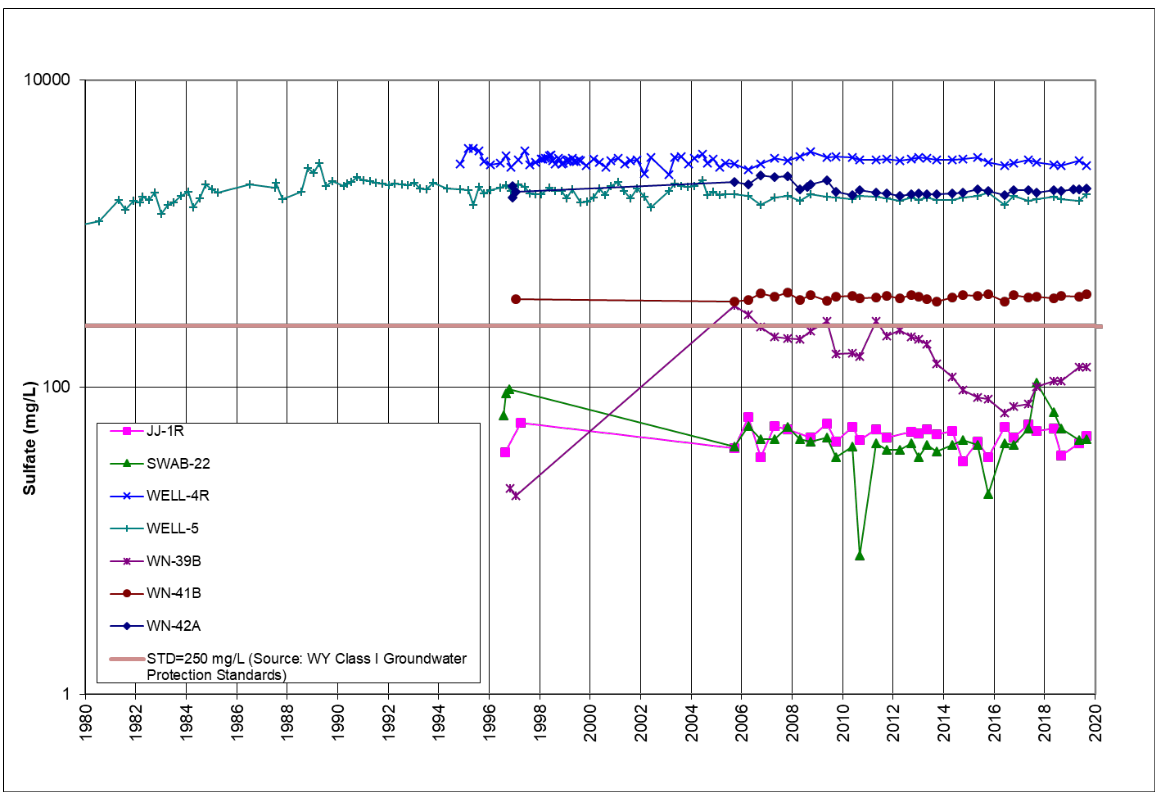


Figure E-41. Time-Concentration Plot of Sulfate for NWV Wells

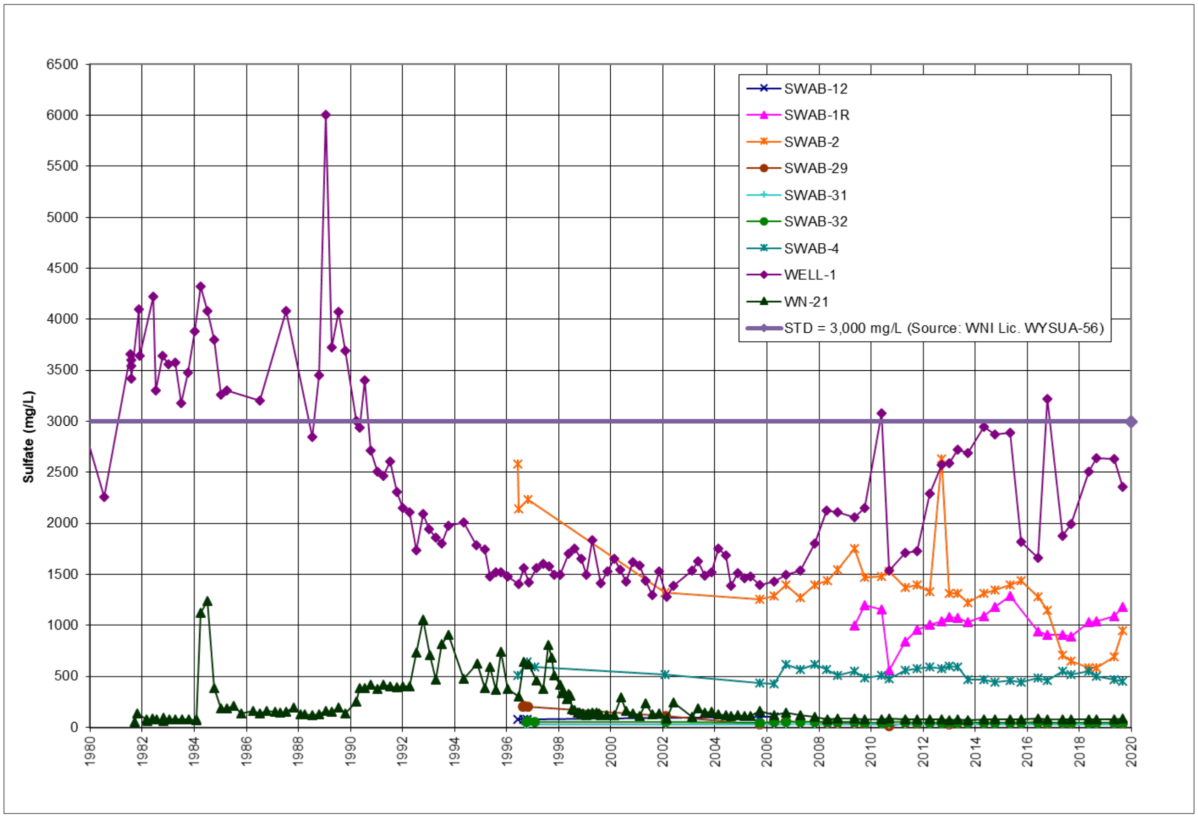


Figure E-42. Time-Concentration Plot of Sulfate for SWV Wells

The seven remaining hazardous constituents—ammonia, manganese, molybdenum, nitrate, combined radium-226 and -228, selenium, and uranium—were those previously identified as COCs and for which ACLs were established. Although not originally considered a COC, an ACL for selenium was subsequently established (see Section E2.7). Of these remaining COCs, WNI estimated that only manganese, uranium, and nitrate had the potential to be transported as far as the former Red Mule subdivision area (WNI 2000). The Red Mule subdivision was in an area that is now within the southeastern portion of the LTSB and protected by ICs (i.e., a groundwater restrictive covenant).

Each of these seven remaining hazardous constituents (COCs) with ACLs—ammonia, manganese, molybdenum, nitrate, combined radium-226 and -228, selenium, and uranium—are discussed separately below and evaluated for inclusion in the long-term monitoring program (including selenium for which an ACL was also established). Although not considered a hazardous constituent, sulfate is discussed separately below and included in the long-term monitoring program. TDS and chloride are being proposed for elimination from the long-term monitoring program.

Ammonia: Ammonia data have been difficult to interpret based on the various ways it can be reported (total as nitrate, "unionized ammonia," "free ammonia"). According to the licensee, the ACL for ammonia is based on "unionized" or "free" ammonia. At the time of the ACL application, aquatic standards for ammonia in surface water were commonly based on only the unionized fraction (EPA 1998). Since that time, the federal EPA ambient water quality criterion (AWQC) for protection of aquatic life was changed to reflect "total ammonia (as N)"

(EPA 1999), and these standards have been adopted as surface water standards by the State of Wyoming (Chapter 1, Wyoming Surface Water Quality Standards).

Groundwater trigger levels established in NRC's 2006 EA are reported to correspond to established background values, MCLs, or EPA risk-based concentrations (where MCLs are not available). The ammonia trigger level of 0.5 mg/L apparently corresponds to the State of Wyoming's groundwater standard for domestic use (most of these State standards correspond to EPA's drinking water MCLs). However, the Wyoming standards are reported as total ammonia as N (Chapter 8, Quality Standards for Wyoming Groundwaters). EPA has a lifetime health advisory for ammonia in drinking water of 30 mg/L (presumably total as N; EPA 2009).

Although ammonia was used in the processing of uranium, it has mainly been detected in the tailings wells (Well-1 and Well-4R) at the Split Rock site. Concentrations in the SWV have declined appreciably, while those in the NWV have fluctuated within a relatively consistent range. There have been only occasional exceedances of the ACL and the EPA benchmark, most notably in the tailings wells. Well SWAB-2 has also displayed elevated levels of ammonia but from the onset has continued to decline until reaching concentrations in recent years that are below both the ACL and the EPA benchmark. Because this decline is accompanied by a corresponding increase in nitrate, it is likely the result of degradation of ammonia to nitrate. Because ammonia degrades to nitrate and also because of the confusion over the ammonia standards, DOE proposes that ammonia be excluded as an analyte in the long-term monitoring program and that nitrate be used as a surrogate.

Manganese: High levels of manganese have been observed historically in tailings wells (Well-1 in SWV and Well-4R in NWV); concentrations also reached the ACL in Well-1 as recently as the fall of 2014. Within a 1000-year timeframe, future concentrations are predicted to increase in the area of the former Red Mule subdivision (located directly east of SWAB-31 and within the LTSB) to levels that would be considered only marginally protective (WNI 2000). However, concentrations are anticipated to remain below background in this area for the next 200 years. Manganese will not be capable of posing a substantial present or potential hazards to human health or the environment. DOE therefore proposes to eliminate manganese as an analyte in the long-term monitoring program.

Molybdenum: Molybdenum has rarely been detected over the last decade and only at levels close to the detection limit, though the detection limit used was often the same as the molybdenum standard in 40 CFR 192. However, based on the lack of significant detections, it is unlikely that molybdenum will pose substantial present or potential hazards to human health or the environment. DOE therefore proposes to exclude molybdenum as an analyte in the long-term monitoring program.

Nitrate: Nitrate concentrations have been reported in excess of the ACL in wells SWAB-2 and SWAB-1R since their installation in 1996 and 2009, respectively (see Section E2.6). Ammonia also degrades to nitrate (see above recommendation to exclude ammonia from the long-term monitoring program). DOE therefore proposes to retain nitrate as an analyte in the long-term monitoring program.

Combined Radium-226 and -228: The combined radium-226 and -228 standard has occasionally been exceeded in the past, but radium levels have appeared to be rather stable over the last several years. Radium does not appear to be capable of posing a substantial present or potential hazard to human health or the environment and is not a good indicator of cell performance. DOE therefore proposes to eliminate the analysis of combined radium-226 and -228 in the long-term monitoring program.

Selenium: An ACL of 0.05 mg/L was established for selenium in 2010 after the site-specific standard of 0.013 mg/L was exceeded at the NWV POC (Well-5) and the downgradient well WN-42A. The subsequent NRC approved selenium ACL is the same as EPA's primary drinking water standard (MCL) under the SDWA (0.05 mg/L, see Section E2.7). Until recently, that standard had not been exceeded in any site well except in the two tailings wells (in 1995 at the NWV Well-4R and in 1984 at the SWV Well-1). However, the 0.05 mg/L ACL was exceeded at well WN-42A in 2018, leading to an increase of the NWV selenium ACL to 0.3 mg/L. Although selenium is not considered to be an important indicator of either disposal cell performance or legacy plume migration, it will be retained for monitoring in light of the unexpected increases observed recently.

Uranium: As discussed above, uranium is the best indicator of site-related contamination and will be retained as an analyte in the long-term monitoring program. The uranium ACLs, particularly for the NWV, have little meaning for the long-term monitoring program. More important will be the observation of relative trends within and between wells and surface water concentrations in the Sweetwater River.

Sulfate: Sulfate is not considered a hazardous constituent. However, sulfate was used in the flow and transport modeling conducted in support of the ACL application (to confirm the assumptions and predictions made regarding uranium's mobility). Sulfate is also a good indicator of cell performance and will be useful in monitoring the natural attenuation of the legacy plume (i.e., model validation). DOE therefore proposes to retain sulfate in the long-term monitoring program.

E3.4 Selection of Groundwater and Surface Water Monitoring Locations

Each monitoring location specified in WNI's source material license SUA-56 (Amendment No. 105, February 24, 2010) (Figure E–1) was evaluated to determine whether it would add value to the proposed long-term groundwater monitoring program presented in the LTSP. The evaluation considered the requirement for establishment of POC and POE locations (as discussed in NRC's guidance and standard review plan for Title II uranium mill ACL applications [NRC 1996]) as well as the need to monitor both future cell performance and attenuation of the legacy contaminate plume. The SGWCE report for the site (SMI 1999b) indicated that site-related contamination tended to stay at shallow depths after leaving the valley mouths for both the NWV and SWV groundwater flow regimes. However, many of the wells in WNI's pretransition monitoring network were screened at depth and were the only wells available for use in certain areas of the site. Therefore, wells were selected based mainly on their lateral location relative to the existing plumes. It is recognized that the depths may not be optimal for tracking plume movement or estimating the quality of groundwater discharge to the river.

E3.4.1 NWV Groundwater Flow

As discussed above, uranium discharge to the river was estimated to be at its maximum in 1996 (in response to maximum tailings pond levels in 1986). Seepage rates from the tailings pile have been declining since 1986 (SMI 1999b). Contaminated groundwater flowing out of the NWV joins and mixes with clean (i.e., background) groundwater from the alluvial floodplain aquifer. Further attenuation is expected as groundwater travels downgradient to the Sweetwater River. If maximum uranium discharge (loading) to the river coincided with maximum plume concentrations as well, concentrations along the entire NWV flowpath should be declining or leveling off. However, if maximum concentrations have not yet reached the river, some locations could experience increases as the peak concentrations pass through.

- Well-5 was designated the POC well for the NWV because it is downgradient of the tailings impoundment (approximately 1200 ft). Well-5 was also determined to be downgradient of any secondary source term (i.e., tailings seepage that had migrated beyond the impoundment and become associated with the aquifer solids and which would slowly remobilize into the groundwater over time [SMI 1999b]). Well-5 is screened over a broad portion of the aquifer and is in the center of the flow path for the NWV flow regime. Well-5 is recommended for retention in the long-term monitoring network as the POC for the NWV. If the conceptual model for the site holds true, concentrations at this location should continue to decline and eventually level off as steady-state conditions are reached.
- Well-4R is located approximately 1200 ft upgradient of the WNI POC (Well-5) on the edge of the portion of the tailing impoundment that extends into the NWV. Well-4R is labeled in the 1999 groundwater characterization and evaluation report as a "tailings and source area well (above POC)" (SMI 1999b, Figure 7). The depth, completion interval, formation information, and so on are unknown for Well-4R because no construction or lithologic logs were available from the licensee. The concentration for many of the site-related hazardous constituents at Well-4R is higher than any of the other wells in this flow regime, and the pH is also lower. This data is not surprising considering the proximity of the well to the tailings impoundment. It appears that Well-4R is strongly influenced by the seepage from the tailings impoundment. Well-4R is recommended for elimination from the long-term monitoring network as the interpretation of monitoring data from this location is ambiguous.
- Well WN-41B is the farthest downgradient location for monitoring site-related constituents in groundwater exiting the NWV (i.e., the monitoring point closest to the POE for this groundwater flow regime). The POE for this flow regime is understood to be the Sweetwater River, although the POE is not specifically designated in WNI's license. Well WN-41B is located approximately 1000 ft upgradient of the Sweetwater River. Well WN-41B is recommended for retention in the long-term monitoring network because it is the farthest downgradient groundwater monitoring point for the NWV flow regime and is the well best suited of those remaining onsite for demonstrating that site-related contamination exiting the NWV has not reached the POE at concentrations above applicable standards. It should be noted that the well screen for well WN-41B is likely too deep (92.4–112.4 ft below ground surface) and may not be representative of groundwater discharging to the river.
  Well WN-41B is retained for long-term monitoring.
- Well WN-42A represents the area where flow from tailings seepage mixes with clean (i.e., background) floodplain alluvial aquifer groundwater. Based on the conceptual model for the site, concentrations should be decreasing here in response to decreased tailings seepage over time; however, concentrations of some site-related constituents (e.g., uranium)

appear to have leveled off at approximately 1 mg/L over the past 15 years. Well WN-42A is retained for long-term monitoring.

- WN-39B is a farther downgradient location on the NWV flowpath from well WN-42A. Concentrations should be lower than for farther upgradient wells as contamination attenuates with distance. If maximum contaminant concentrations have passed this point, concentrations should be declining or leveling off over time. Well WN-39B is retained for long-term monitoring.
- Well JJ-1R is located directly north of the Sweetwater River and historical groundwater monitoring data shows no indication of site-related contamination at this location. The Split Rock tailings impoundment lies approximately 4000 ft south of the Sweetwater River. Contaminated groundwater in the area of the impoundment flows out of the NWV and into the floodplain alluvial aquifer which discharges to the Sweetwater River. As demonstrated by 15 years of historical data, there is no indication that site-related contamination will migrate north of the river, and, therefore, continued monitoring of Well JJ-1R will not provide any additional benefit. Concentrations at well WN-41B (the first well south of the river) can also be used to assess whether there is any cause for concern for areas further to the north. Well JJ-1R is therefore recommended for elimination from the long-term monitoring network.
- **Surface Water Monitoring:** There are concentrations of site-related constituents in groundwater exiting the NWV discharge to the Sweetwater River (Figure E-5), although no evidence of concentrations above applicable standards has been reported in surface water samples collected from the river. Likely, this is because of dilution (i.e., at minimum low flow, groundwater discharge is only estimated to account for approximately 20% of river flow). Surface water monitoring of the Sweetwater River was conducted by WNI for 5 years at five locations across the site: an upstream location (SW-1), a downstream location (SW-5), and three midstream locations (SW-2, SW-3, and SW-4) (Figure E-1). Monitoring of SW-1 provides information on upstream water quality. This monitoring provides adequate baseline data. WNI's surface water monitoring location SW-3 will be replaced with a new surface water monitoring location, SW-3B, which is approximately one half a mile downstream from SW-3. This change will increase the likelihood that impacts from the entire width of the NWV plume are being monitored (Figure E-5). Since concentrations of site-related constituents discharge to the Sweetwater River, it is recommended that monitoring of location SW-1, SW-3B, and SW-5 be retained under the long-term monitoring program to monitor concentrations of site-related constituents in the river. Long-term monitoring results will be compared against any applicable surface water standards.

E3.4.2 SWV Groundwater Flow

Groundwater contamination from the site is not estimated to reach the river until year 2496 along the SWV flowpath. Contamination is therefore still migrating in that direction. It is not necessary to monitor the most distal parts of the boundary at this time. The emphasis is on monitoring the most upgradient wells. There should be declining concentrations in the wells closest to the cell as the main part of the plume has passed. Maximum uranium contamination (0.1 mg/L) is predicted to reach the Red Mule area in 150 to 200 years. This is higher than Split Rock formation background (0.087 mg/L) and less than background for well SWAB-32 (0.3 mg/L).

The remaining portion (10%) of the groundwater underlying the tailings impoundment that does not flow out of the NWV flows out the SWV (Figure E–2). Approximately 80% of the groundwater exiting the SWV (or 8% of the total underlying the impoundment) flows to the south and east around the granite outcrops where it combines with the east-northeast trending regional groundwater flow of the Split Rock aquifer. This flow continues along the southern edge of the granite outcrops south of the impoundment and then beyond the site's eastern boundary, where it ultimately enters the Sweetwater River floodplain alluvial aquifer. The balance (20%) of the groundwater exiting the SWV (or 2% of the total underlying the impoundment) is diverted to the north around the granite outcrops west of the impoundment, where it joins the east-northeast trending regional groundwater flow of the Split Rock aquifer that is merging with the east flowing groundwater of the Sweetwater River floodplain alluvial aquifer. All groundwater exiting the SWV eventually discharges to the Sweetwater River.

SWV Flow to the South

- As with Well-4R in the NWV, Well-1 is located upgradient of the designated POC (approximately 1500 ft) on the edge of the portion of the tailing impoundment that extends into the SWV. Well-1 is also directly upgradient of the remediated groundwater corrective action evaporation ponds. Again, no construction or lithologic logs are available for this well, so the depth, completion interval, formation information, and so on are unknown. The concentration for some of the site-related hazardous constituents is also higher at this well than any of the other wells in this flow regime, and the pH is again lower. This data is also not surprising considering the proximity of this well to the tailings impoundment, and it again appears that this location is strongly influence by the seepage from the tailings impoundment; however, the influence is not as strongly as Well-4R in the NWV (likely a result of the lower volume of tailings impoundment impacted groundwater that exits the SWV as compared to the NWV). Interpretation of monitoring results from Well-1 is ambiguous (as it is with Well-4R in the NWV). It is therefore recommended that Well-1 be eliminated from the long-term monitoring network.
- Well WN-21 was designated the POC well for the SWV because it is directly downgradient of the tailings impoundment (approximately 1500 ft) and peak concentrations. It was also determined to be downgradient of any secondary source term (i.e., tailings seepage that had migrated beyond the impoundment and become associated with the aquifer solids and which would then slowly remobilize into the groundwater over time [SMI 1999b]). Well WN-21 is in the center of the groundwater flow path for this flow regime. Well WN-21 is recommended for retention in the long-term monitoring network as the POC for the SWV.
- Well SWAB-2 is located approximately 1000 ft downgradient of the SWV POC (well WN-21), midway between the POC and well SWAB-1R. It appears that peak concentrations have passed SWAB-2 and that constituents there are now on the decline. Therefore, it shows a similar pattern to the POC well and is therefore somewhat redundant. It is therefore recommended that SWAB-2 be eliminated from the long-term monitoring network.
- Well SWAB-1 was located approximately 1000 ft downgradient of well SWAB-2. As a response action to NRC, well SWAB-1R was installed in May 2009 as a replacement well for well SWAB-1, which had been found to be dry at the time of sampling for several of the previous years. Well SWAB-1R was installed at the same location as the original well SWAB-1 but was completed 15 ft deeper in depth (well screen depths: SWAB-1 was 17.5 to 27.5 ft whereas SWAB-1R is from 17.4 to 42.8 ft). Initial monitoring results from

the replacement well reported an increase in the uranium concentration (from 0.62 mg/L in SWAB-1 to 1.91 mg/L in SWAB-1R) and the sulfate concentration (from 428 mg/L in SWAB-1 to 1000 mg/L in SWAB-1R). While concentrations for these constituents have fluctuated since that time, they have remained closer to the higher observed levels and appear to represent the leading edge of the uranium and sulfate plumes. The next downgradient well, SWAB-29, shows no evidence of site-related contamination. Therefore, the relationship between SWAB-1R and SWAB-29 will be important in monitoring plume movement. SWAB-1R is retained in the long-term monitoring network.

- Wells SWAB-31 and SWAB-32 are the farthest downgradient locations for monitoring site-related constituents in groundwater exiting the SWV. It is predicted to take a very long time before site-related constituents arrive at this area. Well SWAB-32 is in a known (or suspected) area of higher uranium concentrations that are reported to be naturally occurring. It would be difficult to attribute any observed increase in uranium concentrations to contamination migration or mobilization that is associated with the tailings impoundment. However, modeling of nitrate indicates that it could come close to the southern site boundary. Therefore, well SWAB-32 will be retained to ensure the nitrate plume stays within the site boundary as predicted. Well SWAB-31 be eliminated from the long-term monitoring network.

SWV Divergent Flow to the North

- Well SWAB-12 was used historically to monitor the west-southwest edge of the LTSB. The monitoring data to date have shown no evidence of site-related contamination; however, the monitoring history of this well is also not extensive. SWAB-12 was located approximately 300 ft inside the LTSB. As with well SWAB-1R, well SWAB-12R was installed in response to NRC in May 2009 as a replacement well for well SWAB-12, which had been found to be dry at the time of sampling for several of the previous years. Well SWAB-12R was also installed at the same location as the original well SWAB-12 but was again completed 15 ft deeper in depth (well screen depths: SWAB-12 was 9.0 to 19.4 ft whereas SWAB-12R is from 8.7 to 34.1 ft). Monitoring results from the replacement well have reported a slight decrease in both uranium and sulfate concentrations. Well SWAB-12R is also approximately 2500 ft from POC well WN-21. Data from this monitoring location demonstrates that any site-related hazardous constituents exiting the SWV have not reached the POE and Jeffrey City. Well SWAB-12R also demonstrates that groundwater in the regional Split Rock aquifer continues its east-northeast flow and thereby assures continued containment of any site-related contamination within the LTSB. Well SWAB-12R therefore is recommended for retention in the long-term monitoring network.
- Well SWAB-4 is approximately 3000 ft downgradient of the tailings impoundment and provides an early detection point for monitoring any site-related contamination exiting the SWV that is diverted north to merge with the east-northeast trending regional flow entering the Sweetwater River alluvial floodplain. For most of the contaminants that have an ACL or other groundwater protection standard, the concentration in well SWAB-4 is consistently higher than at the next downgradient well (SWAB-22, near the western edge of the LTSB). Although monitoring data from well SWAB-4 are somewhat limited, it appears that concentrations have been relatively stable over the last several years. The higher concentrations at SWAB-4 are likely the result of two processes. First, regional flow from the west should keep contamination near the granite outcrop; an upward vertical gradient occurs in the groundwater of the regional aquifer due to the presence of the granite

formations, which results in seepage from the tailings impoundments occurring primarily in the upper portion of the aquifer in this area. Second, the contamination has likely decreased due to natural attenuation if it were to reach as far west as well SWAB-22. Monitoring and modeling have demonstrated that any contamination in the vicinity of well SWAB-4 will remain within the western edge of the LTSB. Contamination that persists beyond SWAB-4 would also be detected at downgradient monitoring points in the Sweetwater River alluvial floodplain, although natural attenuation may occur first. Additional data from well SWAB-4 would provide little useful information, and therefore this well is recommended for elimination from the long-term monitoring network.

- Well SWAB-22 has been used historically to monitor the west-northwest edge of the LTSB. The monitoring data to date have shown no evidence of site-related contamination; however, the monitoring history of this well is not extensive. SWAB-22 is approximately 400 ft inside the LTSB, 2000 ft downgradient of well SWAB-4, and approximately 5000 ft downgradient of the tailings impoundment. Well SWAB-22 demonstrates that any site-related hazardous constituents exiting the SWV have not reached the POE (LTSB) and the McIntosh property (where groundwater restrictive covenants have been instituted as a precaution). Data from well SWAB-22 also demonstrate that groundwater exiting the NWV that is diverted north around the granite outcrop and merges with groundwater in the regional Split Rock aquifer (and then with the Sweetwater River floodplain aquifer) continues its east-northeast flow and thereby assures continued containment of any site-related contamination within the LTSB. Well SWAB-22 therefore is recommended for retention in the long-term monitoring network.

E3.5 Summary of Recommended Long-term Monitoring Requirements

Based on conclusions reached from the evaluation of WNI's pretransition groundwater and surface water monitoring program (and its historical results), the review of site documents, and the information provided above, a recommended long-term monitoring program is proposed for incorporation into the site LTSP. Table E–10 and Table E–11 summarize DOE's proposed long-term monitoring requirements for the Split Rock disposal site.

The frequency of monitoring is recommended to be reduced from semiannual to annual for the first 5 years of long-term monitoring to provide a baseline for DOE monitoring. It is recommended that monitoring frequency be reduced to once every 3 years after that time.

Following the establishment of a post-transition baseline (5 years), the long-term monitoring program will be reevaluated after every four monitoring events (i.e., every 12 years) to determine if the long-term monitoring program can be discontinued entirely. The first evaluation will be performed 17 years following the year in which the site transition occurred. Reevaluations of the long-term monitoring program will be conducted periodically, based on site conditions, but at least once every 12 years. Monitoring evaluations and recommended modifications to the long-term program will be submitted to NRC for concurrence prior to implementation.

Table E-7. Long-Term Groundwater and Surface Water Monitoring Network

Monitoring Location	Rationale	Observations
NWV Flow Regime		
Well-5	POC well. Should be stable or show decline in concentrations over time as seepage rates decrease.	Uranium has declined from peak concentrations in early 1990s. Fairly stable over last several years.
WN-42A	Well is located where seepage from tailings meets the floodplain alluvial aquifer. Should have lower concentrations than POC well due to mixing with uncontaminated alluvial groundwater. As tailings seepage rates decline, concentrations here should similarly decline.	Lower concentrations of uranium than POC well (factor of 2 or less); appeared to trend upward for about a decade followed by declining concentrations; slight increase in last few sampling rounds.
WN-39B	Downgradient of WN-42A in the floodplain alluvial aquifer flowpath. Should see decreasing concentrations if the plume has passed through this area.	Concentrations of uranium consistently lower than WN-42A. Recent concentrations nearly an order of magnitude lower. Uranium at 3 to 4 times the drinking water standard.
WN-41B	Well location closest to the river; best available location remaining to indicate concentrations discharging to river. If plume has already passed this location, concentrations should be steady or declining. If not, could see some concentrations increases.	Uranium concentrations very low (low end of background); no evidence of site-related effects. There is concern over well screen depth (i.e., screen too deep to monitor plume because plume rises as it approaches discharging to the river).
SW-1	Upstream/background surface water location. Monitors surface water quality entering portion of the river where the NWV plume discharges.	Fluctuations of background uranium over time.
SW-3B	Surface water location at downstream edge of predicted NWV plume discharge point. Monitors actual POE.	Uranium fluctuations mirror background; concentrations slightly higher than background but below current uranium standard.
SW-5	Historical downstream-most surface water location. Monitors river water quality as it nears leaving the site.	Currently, no evidence of site-related contamination above applicable water quality standards.
SWV Flow Regime		
WN-21	POC well; should be stable or show continuing decreases in concentrations over time.	Highest concentrations in early years of monitoring. Nitrate and sulfate have declined to below benchmarks. Uranium in background range.
SWAB-12R	Well at southwest corner of site; between site and Jeffrey City. Provides early warning should Jeffrey City significantly increase pumping of groundwater.	Currently, no evidence of site-related contamination.
SWAB-1R	Currently has highest uranium and nitrate concentrations—concentrations of uranium and nitrate both exceed standards. Could see possible nitrate increase if plume has not completely passed. Long-term expect to see stable or decreasing concentrations of both uranium and nitrate.	Concentrations for both nitrate and uranium have been relatively steady. Uranium concentrations greater than background. No clear decreasing trend for uranium or nitrate—fluctuations within historical range.
SWAB-29	Downgradient-most location in the SWV flow regime. Location will be used to track plume movement. Should eventually see site-related contamination as plume migrates downgradient.	Currently, no evidence of site-related contamination.
SWAB-32	Well at southern border of site; location will confirm SWV plume stays within LTSB; should continue to have concentrations in background range.	Nitrate and uranium at background levels. Stable—no evidence of site-related contamination, though has naturally elevated uranium (up to 0.3 mg/L).
SWAB-22	Demonstrates that the predicted small portion of the plume exiting the SWV that intercepts the NE trending regional aquifer remains on site.	No evidence of site-related contamination. Lies directly upgradient of the McIntosh IC area.

Table E-8. Long-Term Monitoring Plan for the Split Rock, Wyoming, Disposal Site

Groundwater Monitoring[a]		
Wells*	**Analytes**	**Frequency**
NWV Flow Regime: Well-5 (POC well), WN-41B (furthest downgradient well), WN-42A, WN-39B **SWV Flow Regime**: WN-21 (POC well), SWAB-12R, SWAB-29, SWAB-1R, SWAB-32, SWAB-22	Nitrate, sulfate, selenium, uranium (and standard field measurements: pH, temperature, conductivity, alkalinity, dissolved oxygen, and turbidity).	Annually for 5 years; reduce to every 3 years thereafter.
Surface Water Monitoring[b]		
Location	**Analytes**	**Frequency**
Sweetwater River: SW-3B (downstream edge of predicted NWV plume discharge point), SW-1 (upstream, background), SW-5 (downstream-most location historically, represents concentrations leaving the site)	Nitrate, sulfate, selenium, uranium (and standard field measurements: pH, temperature, conductivity, alkalinity, dissolved oxygen, and turbidity); note river flow rate(s) from the Sweetwater Station gaging station during each sampling event.	Annually for 5 years; reduce to every 3 years thereafter.

Notes:

[a] Site-related constituent monitored in groundwater will be compared to Wyoming Class I Groundwater Protection Standards for domestic use.

[b] Site-related constituents being monitored in surface water will be compared to the Human Health Values for Fish and Drinking Water that are applicable to Wyoming Class 2AB surface waters (Section 18, Chapter 1 of the WDEQ Water Quality Rules and Regulations).

* Note: Water level measurements will be taken at each well prior to sampling. Wells not otherwise designated are considered trend wells for their respective flow regime. The designations for both the groundwater monitoring wells and the surface water monitoring location were adopted from WNI's historical names used for these monitoring locations to maintain continuity.

Table E-9. Alternate Concentration Limits and Groundwater/Surface Water Protection Standards for Long-Term Monitoring at the Split Rock, Wyoming, Disposal Site

Analyte[a]	ACL[b] NWV (POC; Well-5)	ACL[b] SWV (POC; Well WN-21)	Wyoming Groundwater Standard (Domestic Use)[c]	Surface Water Standard[d]
Nitrate (total as N)	317 mg/L	500 mg/L	10 mg/L	10 mg/L
Sulfate	N/A	N/A	250 mg/L	N/A
Selenium	0.3 mg/L	0.05 mg/L	0.05 mg/L	0.005 mg/L
Uranium (natural)	4.8 mg/L	3.4 mg/L	N/A	0.03 mg/L

Notes:
[a] Uranium processing-related indicator COCs.
[b] ACLs were established by WNI and approved by NRC prior to site transition to DOE but apply only “during operations and prior to the end of closure” (10 CFR 40, Appendix A, Criterion 5) and, therefore, are not considered enforceable groundwater protection standards onsite under long-term management (i.e., ACLs will be used for comparison to measured results as a possible indication of cell performance and maintaining compliance with protection standards applicable at the POE; DOE will take no action if an ACL is exceeded, other than reporting it to NRC).
[c] Standards are Wyoming Class I Groundwater Protection Standards for domestic use and applicable at the POE.
[d] Standards are Human Health Values for Fish and Drinking Water that are applicable to Wyoming Class 2AB surface waters, which the portion of the Sweetwater River that defines the site’s northern boundary (and POE) is designated. Compliance with the chronic standards is required.

Abbreviation:
N/A = not applicable

Because the Sweetwater River and the Split Rock Aquifer are both potential drinking water sources, drinking water standards are the most relevant values to use to assure site protectiveness. For nitrate, selenium, and uranium, those values are 10 mg/L (as N), 0.05 mg/L, and 0.03 mg/L, respectively. If a drinking water standard is exceeded at a boundary well (SWAB-32, SWAB-12R, SWAB-22, WN-41B) DOE will notify NRC and WDEQ and conduct confirmatory sampling. The exception is that SWAB-32 would need to exceed 0.3 mg/L for uranium for notification and sampling to occur. Results of confirmatory sampling will be provided to NRC and WDEQ.

If a surface water standard is exceeded in the river, NRC and WDEQ will be notified. Confirmation sampling will only be conducted if river levels are comparable or lower than at the time of the original sampling. This will require professional judgement and depend on actual river flows and the magnitude of the exceedance. Results of confirmatory sampling will be provided to NRC and WDEQ. No further response will be required on the part of DOE. If noncompliance were to occur, it is DOE’s understanding that LQD would actively advocate a solution with Wyoming Water Quality Division, which would not impact DOE.

The ACLs are generally being used as an indicator of disposal cell performance. If an ACL is exceeded, NRC will be notified, but no further action is needed until the next scheduled site inspection. The well(s) exceeding the ACL will be sampled during each annual inspection until the concentration(s) drops back below the ACL. If an exceedance persists for 3 consecutive rounds of sampling, this could be signal a cell performance issue. DOE will determine the need for additional sampling or investigation in consultation with NRC. However, under UMTRCA, DOE, as the long-term custodian, is only “authorized to carry out monitoring, maintenance, and emergency measures” and no other actions “unless expressly authorized by Congress” (see UMTRCA, Section 104[f][2]). Therefore, potential response actions are limited. Results of the

groundwater and surface water monitoring program will be included in the annual inspection and monitoring report.

Appendix F

NRC Acceptance Documentation

This page intentionally left blank