Mark Gordon, Governor

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

DEQ

Todd Parfitt, Director

Lizette Roldan-Otero
U.S. Nuclear Regulatory Commission
Division of Material Safety, State, Tribal, and Rulemaking Programs
Office of Nuclear Material Safety and Safeguards

RE: Final Completion Review Report Submittal

Dear Ms. Roldan-Otero

Please find the attached revised Completion Review Report (CRR) in response to comments received the NRC by letter dated July 8, 2020. The LQD is appreciative of the comments received and hopes the NRC finds the responses adequate. In addition to the CRR an additional letter is attached documenting how we answered each of NRC concerns, and a copy of the last inspection report is included. The LQD would encourage the NRC to trust the established Agreement State Program. The Agreement State Program is strong and the NRC should place confidence in its Integrated Materials Performance Evaluation Program when evaluating CRR submittals. As stated in SA-900 (guidance for reviewing CRR) the NRC should not duplicate the State's review or conduct an independent detailed technical review of the proposed license termination or of any of the specific documentation submitted by the Agreement State licensee. Rather, NRC staff should examine whether the CRR has documented the State staff's basis in summary form for its conclusion that all applicable standards and requirements have been met.

Deviation from this scope when reviewing CRRs undermines the State's ability to administer their programs and demonstrates lack of trust in Agreement State Partners. Please let us know if you have any questions or concerns with the supplied material. We look forward to continuing to work with the NRC as a partner as we move to license termination for the Western Nuclear Split Rock Site.

Sincerely,

Ryan Schierman 9-01-2020

Ryan Schierman
Uranium Recovery Program Manager

Enclosures (3)
Cc: Kyle Wendtland- LQD Adminstrator
Emily Werner-LQD Record

Wyoming Department of Environmental Quality
Land Quality Division
Uranium Recovery Program

COMPLETION REVIEW REPORT

Date: September 1, 2020
License Number: WYSUA-0056
NRC Docket No: 40-1162
Facility: Western Nuclear, Inc. (WNI) Split Rock Uranium Mill Disposal Site
Location: Jeffrey City, Fremont County, Wyoming
Licensed Area Being Terminated: 5,428.34 acres (LTCB)
Manager: Ryan Schierman, Uranium Recovery Program Manager.
Technical Reviewers: Ryan Schierman WDEQ, David Adams, CHP, WDEQ, Reid Brown, WDEQ, Alan Thompson WDEQ

PURPOSE

This purpose of this report is to document the Wyoming Department of Environmental Quality (WDEQ) Land Quality Divisions (LQD) Staff's basis for proposing license termination of the Western Nuclear Inc. (WNI) Split Rock Uranium Mill source and 11e.(2) byproduct material license under Section 274(c)(4) of the Atomic Energy Act of 1954, as amended. The report was prepared using the United State Nuclear Regulatory Commission's (NRC) guidance for Agreement State licenses entitled *Termination of Uranium Mill Licenses in Agreement States, Procedure, SA*-900 (NRC, 2010). Much of the technical review for this project was completed by the NRC prior to Wyoming's Agreement with the NRC. As such, the WDEQ/LQD entered into a Memorandum of Understanding (MOU) with the NRC to clearly identify the remaining regulatory decisions necessary prior to termination of the license (NRC, 2018). Decisions made prior to Wyoming becoming an Agreement State will be referenced in this report according to the existing MOU.

The WNI Split Rock is a conventional uranium mill and tailings site which has been decommissioning and reclaimed under WDEQ Agreement State authority, derived from Title II of the uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). UMTRCA requires that prior to termination of the license, the NRC shall make a determination that the licensee has complied with all applicable standards and requirements. Under the Agreement State program, the State of Wyoming is responsible for approval of the remediation plans for the WNI Split Rock Site and for site inspections to ensure that the actual remedial actions have been completed pursuant to the approved plans.

This report documents WDEQ/LQD basis for its conclusion that decommissioning and reclamation have been acceptably completed at the Split Rock Site. The applicable standards for uranium mill reclamation is 10 C.F.R. 40 Appendix A which has been incorporated by reference in Uranium Recovery Regulations (Rules of Wyoming Department of Environmental Quality, Uranium Recovery, Ch. 4 Licensing Requirements for Source and Byproduct Material). The State's regulations are consistent with and compatible with NRC regulations, as required by the State's Agreement State status with the NRC.

All applicable standards and requirements, with appropriate references to related sections of the CRR are identified below in Table 1. The WDEQ/LQD has performed a complete review of the Split Rock site for compliance with all applicable standards and requirements. Additionally, Table 1 also contains the appropriate decision document that demonstrates how the site meets the applicable standards. In many instances as shown in Table 1 the decision document was completed by the NRC.

Table 1 Applicable Standards and Requirements Related to Topics Discussed in the CRR.

Applicable Standards/Requirements			CRR Section	Decision Document
10 CFR Part 40 Appendix A	Criterion 1. Tailings Isolation		Section 1, History, Section 2 Surface Remedial Actions	NRC 2000, NRC 2007
	Criterion 4.			
		(a) Erosion Potential	Section 2 Surface Water Hydrology and Erosion Protection	NRC 2007, NRC 2000, NRC 2010a
		(b) Wind Protection	Section 2 Surface Remedial Actions	NRC 2000, NRC 2007
		(c) Flatness of slopes	Section 2 Surface Remedial Actions	NRC 2000, NRC 2007
		(d) Self-sustaining vegetative cover or rock cover	Section 2 Surface Remedial Actions	NRC 2000, NRC 2007
		(e) Seismic Design	Section 2 Surface Remedial Actions	NRC 1996
	Criterion 5 Groundwater cleanup criteria		Section 4 Groundwater Remedial Action	NRC 2006A, LQD 2019a, LQD 2019b, NRC 2007, NRC 2000

	Criterion 6			
		(2) radon flux	Section 3 Radiation Cleanup and Control	NRC 1999b
		(3) radon measurement and limit	Section 3 Radiation Cleanup and Control	NRC 1999b
		(6) radiation cleanup and control	Section 3 Radiation Cleanup and Control	NRC 1988, NRC1990, NRC 1996 NRC 1999, NRC 1999b,
		(7) closure and post-closure impacts	Section 3 Radiation Cleanup and Control	NRC 1988, NRC1990, NRC 1996 NRC 1999, NRC 1999b,
	Criteria 13 groundwater cleanup criteria		Section 4 Groundwater Remedial Action	NRC 1988, NRC1990, NRC 1996 NRC 1999, NRC 1999b,

*10 CFR 40 Appendix A incorporated by reference in URP Chapter 4 Licensing Requirements for Source and Byproduct Material

1. A brief description of the licensee's activities associated with decommissioning, tailings remediation, and/or groundwater cleanup.

HISTORY

The Split Rock uranium mill was owned and operated by Western Nuclear Incorporated (WNI) in Fremont County, Wyoming. The Split Rock disposal site is located approximately 2 miles northeast of Jeffrey City and about 58 miles southeast of Lander Wyoming. The site lies in the high plains of central Wyoming. The site elevation ranges from a low of about 6,300 feet (ft) to a high of 6,800 feet. Topographically, the disposal cell itself lies at the base of a saddle between two of the granite peaks located on site. The Sweetwater river lies along the northern boundary of the site

Milling at the Split Rock uranium mill commenced in 1957 under Atomic Energy Commission (AEC) license R-205, and continued until 1981. The mill then went on standby status until 1986 when the license was converted to possession only and amended to allow WNI to complete the disposal of the tailings at the site. Most of the ore which fed the mill originated in open pit mines at the Gas Hills Mining District. The milling processes incorporated sulfuric acid leaching, liquid ion-exchange, solvent extraction and concentration, drying, and packaging. At peak capacity, the mill could process 1,700 tons of ore per day. The primary constituents in the tailing's solutions were chloride and sulfate as well as trace metals from the ore. As a result of these operations, approximately 7.7 million tons of tailings were produced and discharged as slurry to three separate tailings piles, designated Old, Alternate, and New.

On August 8, 1986 WNI license was amended (amendment 32) for possession only and active tailings disposal was terminated. In November of 1987, WNI submitted the Mill Decommission Plan (MDP) to the NRC. The MDP was approved and incorporated into the license via Amendment No. 57 on August 18,1988. Mill decommissioning began on September 14, 1989 with the unsalvageable materials buried in approved burial sites within the tailings area. Mill decommissioning was completed in October, 1989 when WNI submitted the Mill Decommissioning Completion Report to the NRC. Review and approval of the Mill Decommissioning Completion Report was documented in a memorandum for NRC Docket File 40-1162 dated July 26, 1992. In May of 1999, the NRC deleted all License Conditions relating to mill decommissioning from WNI's license via license amendment 87.

Reclamation activities associated with contaminated soils from operations and windblown tailings was originally included in the Tailings Remediation Plan (TRP) submitted to the NRC in 1987. This was later modified, and in December of 1995, WNI submitted a final Radiological verification Program to the NRC. The NRC approved the Radiological Verification Program through Amendment No. 78 on June 24, 1996. Clean up of the site soils was completed in 1997 and on November 19, 1997 the NRC approved WNI's request to terminated soil clean up via license Amendment 83.

The tailings disposal areas designated as Old, Alternate, and New were designed in 1957 with the design philosophy to eliminate process effluent through seepage thereby maximizing solid tailings storage while decreasing water storage and handling requirements. A total of approximately 7.7 million tons of tailings and billions of gallons of process effluent were deposited into these tailings' disposal areas. Tailings reclamation construction was completed, with the exception of the groundwater corrective action program (CAP) ponds in 1998. The Tailings Reclamation Plan Completion Report was submitted to the NRC on April 21, 1999. This work was approved by the NRC via license amendment 92 in September 2000 which deleted all surface tailings reclamation requirements with the exception of the requirement to reclaim the CAP ponds.

Groundwater corrective action at the site began in 1990 with the extraction of contaminated groundwater in the area directly downgradient of the tailing's 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 groundwater. In 1999 this cleanup goal was determined to be unachievable and alternate concentration limits

(ACLs) were applied for and subsequently approved by in 2006 by the NRC. The groundwater CAP was terminated in 2006 after extracting approximately 375 million gallons of contaminated groundwater. Additional information regarding groundwater corrective action is provided below.

In 2008, WNI reported an exceedance of the groundwater protection standards for selenium to the 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 the 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 LTCB. As an Agreement State, Wyoming approved the nitrate ACL in 2019. In 2018, WNI reported an exceedance of 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 the LQD approved this revised ACL in 2019.

COMPATIBILITY AND ADEQUACY

The NRC Agreement State program includes periodic performance evaluations of the state program to determine if the program remains compatible and adequate. The WDEQ entered into an Agreement with the NRC on September 31, 2018 after the determination of compatibility and adequacy was determined. The LQD had an Integrated Material Performance Evaluation Program (IMPEP) in March of 2020 and was found satisfactory for all six performance indicators. The Management Review Board agreed that the Wyoming Agreement State Program be found adequate to protect public health and safety, and compatible with the NRC's program. The applicable regulatory requirements for uranium mill reclamation is found in Wyoming Uranium Recovery Regulations Chapter 4 Licensing Requirements for Source and Byproduct Material. This state regulation is consistent and compatible with the federal equivalent of 10 C.F.R. 40.

2. Documentation that the completed surface remedial actions were performed in accordance with license requirements and regulations

SURFACE REMEDIAL ACTIONS

Geotechnical Stability

WNI submitted a Construction Completion Report (CCR) for the Split Rock site on April 21, 1999 to the NRC (Shepherd Miller 1999a). The NRC reviewed the contents of the CCR and concluded that the geotechnical engineering aspects of construction were performed in accordance with the specifications identified in the reclamation plan and in accordance with 10 CFR Part 40, Appendix A. These findings were incorporated by the NRC into the WNI Split Rock source materials license through the deletion of License Conditions (LC) 27 and 75 by

letter dated September 20, 2000 (NRC, 2000). Specific areas of review regarding geotechnical engineering and stability of the tailing's impoundment included:

- Appropriate tests and inspections were performed assuring that the proper material type was placed in each phase of tailings impoundment construction. Compaction and placement were routinely inspected during construction, as well as soil moisture.
- Laboratory and field testing by the licensee were conducted in accordance with acceptable test procedures by qualified personnel.
- Materials testing and inspections occurred at the required frequencies.
- The radon barrier was inspected at the required frequency during construction
- The materials used and placement of the radon barrier resulted in the desired thickness and density.
- As-built drawings were consistent with the NRC-approved design.
- Final slope, elevation, and compactions operations of the various cover layers were adequately inspected and final conditions were consistent with those stated in the reclamation plan.

As part of NRC review of the site reclamation plan the NRC staff 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). Therefore, the site meets Criterion 4(e) of Appendix A to 10 CFR 40.

Surface Water Hydrology and Erosion Protection

NRC staff reviewed the surface water hydrology and erosion protection aspects of remedial actions at the Split Rock site to ensure that they were constructed in accordance with applicable construction specifications as stipulated in the reclamation plan.

The reclamation design included erosion protection in several specific areas, including top slopes, side slopes, diversion channels, and rock toes at the outlets of the diversion channels. The riprap for the top and side slopes of the cell was designed to prevent long-term erosion and gullying of the cell cover. The riprap toes were placed to prevent erosion and migration of gullies.

The NRC staff reviewed each of these features and determined that testing, placement, and riprap configurations complied with specifications in the reclamation plan. Based on NRC staff observations and review of onsite records during remedial actions, as well as assessment of the verification results presented in the CR, the NRC staff concluded that the required durability and gradation tests were performed during the remedial action. The riprap is of adequate quality and has been acceptably placed. The NRC staff concludes that reclamation activities at the Split Rock site have been completed in accordance with 10 CFR Part 40 Appendix A with respect to erosion protection.

The WDEQ agrees with the assessment but it should be noted as documented below that ponds used in the Corrective Action Plan (CAP) were not fully reclaimed until 2007. Therefore, the statements from NRC above do not extend to the ponds used in the CAP.

Ponds used in the Groundwater Corrective Action Plan

Parallel to the reclamation of the tailings and the review of the construction, a groundwater Corrective Action Plan (CAP) was implemented onsite, beginning in 1990 and concluding in 2006. The CAP consisted of pumping contaminated groundwater into a pair of evaporation ponds onsite. These ponds were left in place subsequent to the conclusion of the CAP and a final cover system was placed over the ponds. WNI submitted a CCR for the pond cover on July 10, 2007 (Tetra Tech, 2007). The NRC reviewed the CCR and determined that the ponds had been adequately reclaimed, amending the license to remove LC 74.G (NRC, 2007). As part of the assessment of the geotechnical engineering and erosion dispersion protection of the pond covers, the NRC reviewed WNI's CRR, verifying:

Geotechnical

- WNI performed the appropriate tests and inspections to ensure that the proper material was used for construction;
- WNI conducted laboratory and field testing in accordance with acceptable test procedures;
- The frequencies of material testing and inspection complied with the approved technical specifications; and
- As-built drawings adequately documented that the completed remedial action was consistent with the NRC-approved design.

Erosion/Dispersion Protection

- WNI performed tests (gradation and durability) and inspections to ensure the proper selection of erosion protection materials. The thickness of the rock layers was verified to ensure compliance with the specification;
- WNI conducted laboratory and field testing in accordance with specified test procedures; and
- Testing frequencies for the rock mulch used for erosion protection complied with the frequencies specified in the reclamation plan.

During the inspection of the ponds it was noted that there were thin spots between the actual cover and the key trench at the tailing's impoundment. The NRC added a license condition that required repair of all erosion protection thin spots (NRC, 2007). The licensee mitigated these spots. The NRC review of the mitigative measures is documented through the deletion of License Condition 74(G) through License Amendment 105 (NRC, 2010a). With the deletion of the license conditions, the NRC confirmed that the reclamation of the CAP ponds as adequate.

Conclusion

The NRC review of the licensee CCR states that WNI has successfully completed the surface portion of decommissioning and reclamation at the Split Rock site. With the approval of the final evaporation pond reclamation, the NRC staff has concluded that the surface reclamation of the Western Nuclear Split Rock site is complete (NRC, 2007). The LQD agrees with this assessment

and the LQD has determined that the surface reclamation meets 10 CFR 40 Appendix A requirements based on previous NRC approvals.

3. Documentation that the completed site decommissioning actions were performed in accordance with the license requirements and regulations. This documentation should include a discussion of results of radiation survey and confirmatory soil samples that indicated that the subject meets unrestricted release requirements.

RADIATION CLEANUP AND CONTROL

Facilities

Mill decommissioning began in 1989 according to the mill decommissioning plan approved on August 18, 1988, via Amendment No. 47 of the licensee's source material license (NRC, 1988). Unsalvageable materials were buried in approved burial sites within the tailings area. Mill decommissioning was completed in 1989 and the Mill Decommissioning Completion Report was sent to the NRC on October 31,1989 (WNI,1989). NRC reviewed the completion report and concluded that the licensee had performed and documented decommissioning activities in accordance with requirements of the license (a memorandum dated July 26,1990 (NRC,1990)). In May of 1999, the NRC deleted all License Conditions relating to mill decommissioning from WNI's source material license (NRC, 1999). No physical structures remain on site.

Windblown/ Soil Cleanup

As part of site reclamation activities and in compliance with the requirements of 10 CFR Part 40, Appendix A, areas surrounding the tailings impoundments were surveyed for radiological contamination resulting from windblown materials. The initial plan to address soil cleanup issues was included in the original tailing remediation plan submitted in 1987 (WNI, 1987). The plan was later modified, and in December of 1995 WNI submitted a proposed final Radiological Verification Program to the NRC (Shepherd Miller, 1995). The NRC approved the Radiological Verification Program and it was incorporated into WNI License via Amendment 78 on June 24, 1996 (NRC, 1996).

Site soil scoping surveys began in late 1995 and WNI submitted the scoping survey results to the NRC in February of 1996 (Shepherd Miller,1996). Due to larger volumes of soil clean up compared to what was initially anticipated, revisions to surface cover designs for the tailings cell were submitted on several occasions to accommodate the additional volumes of materials requiring disposal.

Clean up of the site soils was completed in 1997 and on November 19, 1997 the NRC approved WNI's request to terminate soil cleanup via license amendment No. 83 (NRC, 1997). WNI submitted a Radiological Verification Program Completion Report to the NRC on December of 1995 (Shepherd Miller, 1995). The NRC performed a site inspection of the Radiological Verification Program clean up and performed confirmatory testing of site soils on May 12 through 14, 1998 (NRC, 1998). The NRC reviewed the completion report as documented in a letter to the licensee on May 21, 1999. The NRC concluded that the radiological aspects of soil cleanup were performed in accordance with WNI's approved Reclamation Plan, and that radiological cleanup and control verification data demonstrate compliance with the criteria in 10

CFR Part 40. The NRC staff determined that the Completion Report information provided reasonable assurance that the Split Rock mill site area, beyond the disposal cell (to be deeded to the Federal Government), is suitable for unrestricted release. The approval was formalized through the deletion of License Condition No. 33 which related to all requirements regarding soil clean up and radiological verification (NRC, 1999).

Tailings Cover/Radon Flux

WNI submitted a CCR for the Split Rock site on April 21, 1999 to the NRC (Shepherd Miller 1999a). The report detailed the final reclamation cover as 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 sacrificial clay layer that was used to establish the final desired subgrade on top of the tailings. The radon barrier thickness varies from 6 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. soil/rock matrix) or just a 4-inch thick rock layer. The median stone diameter (D_{50}) of the granite 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 tailing's 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 layers were 4-inches and 12-inches thick respectively (Shepherd Miller, 1999a). All materials for the borrow soil layer were surveyed to assure that the material was less than 18μR/hr in areas not affected by shine and 30μR/hr in areas affected by shine.

As detailed in the CCR, the radon flux of the final reclamation cover was measured as 0.88 pCi m^{-2} s^{-1} averaged over 320 locations. The NRC reviewed the contents of the CCR and concluded that the licensee had demonstrated compliance with 10 CFR 40, Appendix A, Criterion 6(2) requirements. The acceptance of the radon flux measurements was documented through Amendment 91 to the source material license, with the deletion of LC 75A(3) by letter dated September 29, 1999 (NRC, 1999b).

In review of the CCR the NRC also reviewed the geotechnical engineering aspects of the reclamation of the tailings cover against the applicable construction specification in the approved reclamation plan. Items reviewed included descriptions of construction operations, as-built drawings, laboratory and field testing data, construction inspection reports, and quality assurances summaries. The review was based on visual observations of the reclamation and a review of testing and records made during on-site inspection. During NRC staff review the following was noted:

1. Appropriate tests (gradation and Atterberg limits) and inspections were performed by the licensee to assure that the proper material type was placed in each phase of construction. Placement and compaction of constriction materials were routinely inspected by the licensee to assure that the moisture and density requirements were met and that the soil moisture was uniform throughout the compacted lifts. The loose thickness of the lifts was verified periodically by the licensee to ensure compliance with specification requirements for each particular type of material.

2. Laboratory and field testing by the licensee was conducted in accordance with acceptable test procedures and by trained qualified personnel. Records indicating acceptable calibration of measuring and testing equipment are provided in the CR.
3. The CR shows that the frequencies of material testing and inspection comply with the frequencies specified in the NRC Staff Technical Position on Testing and Inspection Plans
4. The radon barrier layer was continually inspected by the licensee to assure that the specified lift thickness and compaction levels were achieved
5. The material type, placement, and compaction methods specified for the radon barrier layer resulted in the desired density of the barrier.
6. As-built drawings adequately document that the completed remedial action is consistent with the NRC -approved design.
7. Final slope, elevation, and compaction operations of the various cover layers were adequately inspected to ensure that the final conditions were consistent with those stated in the reclamation plan.

Based on the NRC observations, NRC staff concluded that the geotechnical engineering aspect of construction were performed in accordance with the specifications identified in the reclamation plan and ins accordance with 10 CFR Part 40 Appendix A (NRC 2000).

Additionally, by letter dated July 10, 2007 WNI submitted a CCR to the NRC for review that documented construction activities for the reclamation of the former groundwater corrective action program CAP ponds. NRC staff reviewed the submittal, including as-built drawings, material quantities and the construction quality assurance tests. NRC staff determined that the CCR adequately documented the closure and construction of the final cover system on the CAP ponds. Additionally the NRC staff inspected the final construction and determined that the construction was adequate (NRC 2007). More specifically the NRC determined that:

1. WNI performed the appropriate tests and inspections to ensure that the proper material was used for construction
2. WNI conducted laboratory and field testing in accordance with acceptable test procedures
3. The frequencies of material testing and inspection complied with the approved technical specifications
4. As-built drawings adequately documented that the completed remedial action was consistent with the NRC-approved design.

The LQD has reviewed NRC determinations and concurs with the decisions made by the NRC. Reclamation of the tailings cover including the covers for ponds used as part of the CAP meet the requirement of 10 CFR 40 Appendix A.

4. Documentation that the completed groundwater corrective actions, if necessary, were performed in accordance with license requirements and regulations.

Groundwater Remedial Actions

Background

Groundwater flow and contaminant transport of site-derived constituents primarily involves the Upper and Lower Split Rock saturated units, collectively called the Split Rock Aquifer, and the Sweetwater River Alluvium, called the floodplain aquifer. The Floodplain Aquifer is hydrologically connected to the underlying Split Rock aquifer, and was formed where the Sweetwater River cut and meandered across the Split Rock Formation. Most residents of Jeffrey City derive their water supply from the town wells drilled into the Split Rock Aquifer. The Jeffrey City municipal wells presently supply approximately 379 (Lpm) (100 gpm), though pumping only occurs periodically to fill the storage tanks. These wells are located west and upgradient of the site and therefore, unaffected by site-derived contamination.

Groundwater downgradient of the WNI Split Rock site has been negatively affected by the unlined tailings impoundment. From 1957 to 1981, the mill processed ore and discharged tailings and acidic liquids into the impoundment. The liquids quickly entered the unsaturated zone as the tailings design utilized seepage to eliminate liquids in the impoundment. Over time, these liquids migrated downgradient into the groundwater.

The site groundwater hydrology includes two main drainage pathways. Two valleys naturally exist around the tailings which are surrounded by granite outcroppings, preventing groundwater flow through them in the first aquifer. One drainage exits the tailings area to the northwest and is referred to as the Northwest (NW) Valley, while the other drains to the southwest and is called the Southwest (SW) Valley. Contaminants have entered both of these drainage pathways. Historically, up to 1,400 gpm of tailings seepage entered the drainage pathways. Since 1986, when liquids and tailings disposal ceased, this number has slowed and is expected to reach long-term steady-state rate of less than 5 gpm. The two drainage pathways have caused this infiltration to split into two distinct groundwater flow paths, both of which eventually head northeast towards the Sweetwater River after going around the granite outcroppings. Areas with higher granite basement elevations beneath the Sweetwater River Floodplain causes groundwater to discharge from the Split Rock Aquifer into the Floodplain Aquifer. A significant lateral constriction in the Split Rock Aquifer and the Sweetwater River Alluvium occurs northeast of the site and at the point where the river passes through the granite outcrop at the Three Crossings Diversion Dam.

Groundwater Remediation

Groundwater remediation began in 1990 and continued until 2006. This program removed approximately 47.3 to 66 million gallons of water per year from the aquifer and sent this water to evaporation ponds as part of the Groundwater Corrective Action Program (CAP). In total, WNI removed 375.3 million gallons of contaminated groundwater under the CAP. Further CAP work has been investigated and a summary of the costs and benefits of further action may be found in *Environmental Assessment for Amendment to Source Materials License SUA-56 Groundwater Alternate Concentration Limits* (NRC, 2006a). In this document, the NRC concluded that further remediation of groundwater would be ineffective and not viable. The licensee proposed to develop Alternate Concentration Limits (ACLs) for the contaminated groundwater.

Alternate Concentration Limits (ACL)

WNI originally proposed distinct Alternate Concentration Limits (ACL) for the NW and SW valleys, respectively, that were protective at the point of exposure (POE) at the site boundary. These ACLs are listed in Table 1. The ACLs for the site groundwater's contaminants of concern were originally accepted by the NRC in August of 2006 and a finding of no significant impact (FONSI) was warranted in the Environmental Assessment (EA) (NRC 2006a). The NRC found that:

- Potential access to the seepage-impacted groundwater was prevented by including impacted aquifers within the Long-Term Care Boundary (LTCB), by property acquisition and the use of Institutional Controls (ICs), (mitigation measures), and by the establishment of groundwater and surface water trigger values;
- Discharges to the Sweetwater River were not sufficient to impact human health and the environment;
- Groundwater fate and transport modeling conducted by WNI indicated that revising the groundwater standards to ACLs would cause no degradation to the use of groundwater or surface water outside the LTCB, as a result of mill-related activities;
- Only potable groundwater use was impacted within the LTCB; groundwater may still be used for livestock watering and irrigation; and.
- An acceptable compliance groundwater monitoring program should be implemented to adequately monitor the future movements of the groundwater plume to assure that no significant environmental impacts will occur and that the ACLs will not be exceeded.

Table 1: 2006 EA ACL Concentrations

Contaminant	NW Valley	SW Valley
Manganese (mg/L)	225	35
Molybdenum (mg/L)	0.66	0.22
Ammonia (mg/L)	0.61	0.84
Radium-226 & Radium-228 (pCi/L)	7.2	19.9
Natural Uranium (mg/L)	4.8	3.4
Nitrate (mg/L)	317	70.7

However, subsequent to the FONSI, the ACL for nitrate was exceeded in September 2009 at well SWAB-2. The well is located downgradient of the point of compliance well (POC). The concentration at well SWAB-2 was 330 mg/L (WNI, 2009). This situation remains today, with the latest sampling event, for the 2nd half of 2019, showing a nitrate concentration of 144 mg/L at well SWAB-2 (WNI,2019). The POC well remains below the 2006 ACL of 70.7 mg/L.

By letter dated October 25, 2016 (WNI 2016a) WNI submitted a request to the NRC to amend LC 74 with regards to the nitrate Alternate Concentration Limit (ACL) for the Southwest Valley. The request proposed a new ACL for the SW valley for nitrate at 500 mg/L, and to expand their

proposed LTCB. The request was supplemented by letters dated December 9, 2016 (WNI 2016b), and then in response to questions posed by the Department of Energy (DOE) on May 24, 2017 (WNI, 2017). The NRC was unable to conclude its review of the WNI submittal prior to Wyoming becoming an Agreement State.

The LQD approved the proposed ACL for nitrate in the SW Valley on April 5, 2019. The review of the ACL was documented in the State Decision Document (SDD) included in Appendix A (LQD, 2019a). The ACL is based on a value that, although not observed or expected, when assumed at the POC, will result in a concentration that is protective of downgradient waters, human health, and the environment at the Point of Exposure (POE). To demonstrate this fact, WNI produced a model to show that nitrate concentrations would, even in a 1000-year window, not exceed the Environmental Protection Agency MCL or the Water Quality Divisions (WQD) class of use concentration of 10mg/L for domestic use at the POE. After reviewing the assumptions and inputs, the LQD concluded that the 500 mg/L ACL for nitrate was appropriate and would not result in significant impacts to downgradient waters outside the LTCB. Therefore the 500 mg/L ACL for nitrate in the SW valley was approved (LQD, 2019b).

Contrary to the original NRC ACL decision, well WN-42A exceeded the selenium ACL of 0.05 mg/L, with a concentration of 0.074 mg/L during the second half of 2018 (WNI, 2018). In February 2019, the licensee took another sample and confirmed that the well did indeed exceed the approved ACL. To address the exceedance, WNI submitted a request to the LQD to amend its original ACL application (WNI, 2019b). Per the request, the selenium ACL would be increased from 0.05 mg/L to a new value of 0.30 mg/L. The LQD approved the licensee request on December 11, 2019 (LQD, 2019c). Documentation of the approval can be found in Appendix B which contains the State Decision Document. Ultimately the LQD found that increasing the ACL to 0.30 mg/L at the POC would maintain the chronic standard of 0.005 mg/L at the Sweetwater River. Additionally, since fee title to the surface and subsurface estates will be transferred to the Federal government and institutional controls are in place on the property within the LTCB to prevent human exposure the LQD determined that there a no impacts to human health or the environment as a result of selenium concentrations within the LTCB.

Additionally, since the surface above the groundwater flow path from the NW Valley is owned by WNI and is within the current LTCB. The current institutional controls on the property will ensure that there are no impacts to human health or to individuals drinking groundwater contaminated with selenium above the MCL.

As a result of decisions by the NRC and the LQD the current ACL for the site is contained in Table 2.

Table 2: Current ACL Concentrations

Contaminant	NW Valley	SW Valley
Aluminum (mg/L)	37	37
Antimony (mg/L)	0.006	0.006
Arsenic (mg/L)	0.05	0.05

Beryllium (mg/L)	0.01	0.01
Cadmium (mg/L)	0.01	0.01
Fluoride (mg/L)	4.0	4.0
Lead (mg/L)	0.05	0.05
Nickel (mg/L)	0.05	0.05
Thallium (mg/L)	0.002	0.002
Th-230 (pCi/L)	0.95	0.95
Selenium (mg/L)	0.3	0.05
Manganese (mg/L)	225	35
Molybdenum (mg/L)	0.66	0.22
Ammonia (mg/L)	0.61	0.84
Radium-226 and Radium -228 (pCi/L)	7.2	19.9
Natural Uranium (mg/L)	4.8	3.4
Nitrate (mg/L)	317	500

Conclusions

The LQD agrees with this assessment, and furthermore believes that the same assessment of alternatives applied to the ACL in the August 2006 EA (NRC, 2006a) would apply to a new ACL for nitrate for the SW Valley, and to selenium in the NW valley. The LQD concludes that the current ACLs are protective, and meet the requirements in 10 CFR 40 Appendix A.

5. Discussion of results of State's site closure inspections.

SITE CLOSURE INSPECTION

On May 23-24, 2000, the NRC completed an inspection at the Split Rock Site. Technical reviewers in the disciplines of Health Physics, Geotechnical Engineering, Surface Water Hydrology and Erosion Control, and Hydrogeology were present. Representatives from the U.S. Department of Energy and the Wyoming Department of Environmental Quality were also present (NRC, 2000b). The technical reviewers from the NRC concluded during their inspection that the reclamation activities at the Split Rock site had been completed in accordance with 10 CFR Part 40 Appendix A with respect to erosion protection and geotechnical engineering. Additionally, as part of the review and inspection of the CCR the NRC concluded that the radon flux measurements taken by WNI meet the requirements of Criterion 6(2) of 10 CFR Part 40.

The NRC performed a site inspection of the Radiological Verification Program clean up and as well as confirmatory testing of the site soils on May 12 through 14, 1998 (NRC, 1998). Following a series of questions by the NRC regarding details of the completion report, the NRC approved the report on May 21, 1999 (NRC, 1999). The NRC deleted License Condition No. 33 which related to all requirements regarding soil clean up and radiological verification, and released relevant site areas for unrestricted surface use.

The LQD performed an inspection on August 19, 2020 in preparation of recommending termination of the license to the NRC as part of the Completion Review Report (CRR). The purpose of the inspection focused on whether reclaimed features at the site continued to meet

their design objectives, and whether the site was ready for transfer to the DOE. The LQD noted that the tailings impoundment is in good condition with no observable leaks or erosions. On inspection an erosion feature that deposited sand into a diversion channel was observed. After discussion with the licensee and review of the efforts to mitigate the erosion feature the LQD concurs with the licensee determination that the integrity of the diversion channel and the tailings cell were maintained and the features continue to meet their design objective (LQD 2020). As a result of the inspection the LQD continues to have assurances that the licensee has met the requirements in 10 CFR 40 Appendix A. As the site continues to transfer to the DOE, infrastructure such as wells not needed for long-term care and monitoring, signage around the site, and the monument at the entrance of the site will need additional work prior to final termination of the license. Many of these activities are dependent on approval and finalization of the Long Term Care Surveillance Plan (LTSP). Upon approval of the LTSP and after the licensee is able to make the necessary changes the LQD will verify the site is acceptable for transfer to the DOE.

6. **Documentation that release of this portion of the site will not negatively impact the remainder of the site to be closed at a later date, if it is a partial license termination case. Such documentation could be a statement from the appropriate State regulatory agency, which confirms that the impact has been evaluated and included the bases for the State's conclusion.**

SITE TERMINATION

WNI has chosen to perform a complete license termination of the entire site at once, without any partial or phased license termination. Therefore, the department has not been required to consider any such case to evaluate the relative impact of partial termination on the remainder of the site.

The LQD is prepared to terminate the specific license after it has received notification from the NRC that: (1) all applicable standards and requirements have been met, (2) the NRC has accepted the LTSP, and (3) the long-term care funds have been transferred to the appropriate custodial agency.

For consideration within the LTSP the LQD has the following recommendations,

Long Term Care Boundary

The primary purpose of the Long-Term Care Boundary (LTCB) is to remove the drinking water exposure pathway on private or government-owned properties within the LTCB and protect groundwater and surface water beyond the LTCB for the 1000-yr compliance period. In 2006 the NRC evaluated and approved WNI's ACL application along with a proposed LTCB (NRC, 2006b).

A revision to the Nitrate ACL necessitated an expansion of the previously accepted LTCB such that the drinking exposure pathway within the LTSB could remain protective (WNI 2016a). The extension of the LTCB, although specifically completed for the nitrate plume, would improve the confidence of previous ACL decisions made by the NRC for constituents in the SW Valley. The expansion included an additional 1,560 acres of which the majority is owned by WNI. The small portion of lands within this expanded LTCB for which WNI does not own the surface and subsurface estates are either Federally owned lands essentially identical to the other Federally owned lands within the LTCB proposed in 2006, or have effective and durable administrative land use restrictions previously acquired by WNI that are identical to those already reviewed and approved by the NRC in License Amendment No. 99 (NRC, 2006b). Therefore, the controls on access to and use of groundwater to control potential future human and livestock or wildlife exposure via the drinking water pathway within this expanded LTCB are identical to those already reviewed by the NRC under WNI previous submittals and are found to be acceptable to the WDEQ for the long-term isolation of the material.

Institutional Controls

Federal land ownership and stewardship are the primary forms of institutional control (IC) which serve to ensure long-term protectiveness at the Split Rock, Wyoming, disposal site. Other durable, legally enforceable institutional controls have been deemed by the NRC Commission as acceptable form of land management for a long-term custodian. For the Split Rock site, the lands within the LTCB are owned by WNI or the federal government with the exception of three properties that are privately owned within the LTCB. Fee title to the surface and subsurface estates for all WNI lands within the proposed LTCB will be transferred to the Federal Government. Although WNI's good faith effort to purchase the other private property within the proposed LTCB were not successful, WNI was able to acquire both durable and enforceable ICs over these three properties. These ICs were necessary because the groundwater within the LTCB was considered unsuitable for human consumption or domestic use. These ICs are fully and presently vested property rights which transfer with the chain of title, and constitute durable and enforceable property rights that include fully vested restrictive covenants, such restrictive covenants presently enforceable by WNI and shall also be fully vested in the DOE as the subsequent title holder which shall enable the DOE to fully facilitate enforcement of these restrictive covenants inherent in the chain of title as a matter of law that excludes access to groundwater for consumption or domestic use within the LTCB. The groundwater use restriction was accomplished by securing all rights and interests to the subsurface portions of the affected property . The IC's prohibit human consumption of groundwater thereby preventing risk to human health. Two of the IC's prohibit any wells for water for human consumption and the other IC secures ownership of the property that lies below a depth of seven feet. All the IC's give the DOE the right to enter upon the property and perform testing and remediation work. ICs have been established for the following lands:

- Township 29 North Range 92 West NW1/4 SW1/4, Section 2

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

- Township 29 North Range 92 West NE1/4, Section 14
  Township 29 North Range 92 West NE1/4 NW1/4, Section 14
  Township 29 North Range 92 West S1/2 S1/2, Section 11 (except the westerly 50 feet thereof).

- Township 29 North, Range 92 West SE1/4 & S1/2SW1/4, Section 12
  Township 29 North, Range 92 West SW1/4 Section 7 & portion of the NW1/4 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).

The proposed use of ICs by WNI constitutes an alternative to the provisions of 10 CFR Part 40, Appendix A. Use of IC would restrict consumption of contaminated groundwater, preventing exposure, and thereby preventing risk to human health from site derived contaminants. In Staff Requirements Memorandum (SRM) dated November 19, 2002, the NRC Commission agreed that WNI should make a good-faith effort to purchase the properties, noting, that if this goal was not achievable, WNI would have to provide both durable and enforceable ICs (NRC, 2005). In SECY 05-0200 it states that the NRC staff and the DOE's Office of Legacy Management have concluded that WNI completed a good-faith effort to purchase the property within the LTCB (NRC, 2005). On December 19, 2002 the Commission approved the use of ICs to prevent human exposures to site derived contaminants for the duration of the 1000-yr performance period (NRC, 2002).

On September 28, 2006 in NRC's approval of License Amendment No. 99 for groundwater ACL the following statement was made "*that based on the modeling predictions and mitigative measures (ie., ICs, monitoring, and trigger values, the NRC staff finds that the ACLs with ICs are protective of human health and the environment*" (NRC 2006b). The LQD agrees with NRC's assessment. However, as NRC has stated in the approval Amendment No. 99, monitoring of groundwater and surface water to track groundwater contamination and assess model predictions is warranted and the LQD would recommend surface and groundwater sampling and IC verification be continued once the license is terminated. The LQD agrees that the use of institutional controls as discussed above will ensure the long-term isolation of the Split Rock Site.

Long Term Monitoring Plan

In the DOE draft LTSP (DOE, 2012) the DOE recommends a monitoring program for Long-Term Monitoring Requirements. The LQD agrees that a long-term monitoring program for the Split Rock site is appropriate in order to ensure protectiveness to human health and environment. However, the proposed long-term monitoring program presented in the DOE's draft LTSP should be updated to reflect current conditions, considering the expansion of the LTCB and the

two ACLs approved by the LQD. In 2016 WNI proposed a long-term monitoring program based on the expanded LTCB included in the nitrate ACL (WNI, 2016). The LQD has reviewed WNI proposed long-term monitoring program, and based on discussions with DOE and the NRC has proposed the following recommendation for consideration by the DOE and the NRC. The proposal is solely a recommendation as ultimately the NRC approves the DOE's LTSP which dictates the monitoring that will occur post termination. As the LQD understands the process the CRR is a recommendation for NRC to exercise its authority to terminate the license. The CRR does not govern activities post termination. Once a long-term monitoring program is agreed to the LQD will instruct the licensee to plug and abandon wells not necessary for the monitoring.

Proposed 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 Field Measurements • pH • temperature • conductivity • alkalinity • dissolved oxygen • turbidity • water level measurements	Annually for 5 years; reduce to every 3 years thereafter
Surface Water Monitoring[b]		
Location	**Analytes**	**Frequency**
Sweetwater River: SW-B (downstream edge of predicted NWV plume discharge point), SW-1 (upstream background)	• Nitrate, • sulfate, • selenium, • uranium Field Measurements • pH • temperature • conductivity • alkalinity • dissolved oxygen • turbidity	Annually for 5 years; reduces to every 3 years thereafter

	Flow Rater from the Sweetwater gaging station during each sampling event	

[a] Site related constituent monitored in groundwater should be compared to Wyoming Class 1 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).

In addition to the long-term monitoring program the LQD recommends additional monitoring as discussed in the 2012 Draft LTSP. It indicated that DOE will verify awareness of the ICs by the current land owners, and confirm that groundwater is not being used for domestic purposes. The DOE will confirm that no drinking water wells have been established within the LTCB. Lastly once every 10 years DOE will check the records at the Wyoming State Engineer Office to determine if there have been significant changes in water demand in the vicinity of the site. With additional measures to ensure ICs remain protective along with a robust long-term monitoring plan the LQD recommends termination of the license in preparation for long term monitoring by the DOE.

Conclusion

Based on the information presented in this CRR, the LQD recommends that NRC terminate Source Material License SUA-56 WNI Split Rock. With institutional controls, and a long-term monitoring program the site will remain protective of human health and the environment.

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Appendix A
State Decision Document
Nitrate ACL Amendment

Wyoming Department of Environmental Quality
Land Quality Division
Uranium Recovery Program

STATE DECISION DOCUMENT
TECHNICAL REVIEW OF WESTERN NUCLEAR INC SPLIT ROCK URANIUM MILL ALTERNATE CONCENTRATION LIMIT FOR NITRATE IN GROUNDWATER IN THE SOUTHWEST VALLEY

LICENSE AMENDMENT REQUEST

By letter dated October 25, 2016 (ML16328A402), Western Nuclear Incorporated (WNI) submitted a request to the U.S. Nuclear Regulatory Commission to amend License Condition (LC) 74 with regards to the nitrate Alternate Concentration Limit (ACL) for the Southwest Valley. The request was supplemented by letter dated December 9, 2016 (ML16349A144), and then again on June 21, 2017 (ML17177A107) in response to questions posed by the Department of Energy (DOE) on May 24, 2017 (ML17145A425). The NRC was unable to conclude its review of WNI submittal prior to Wyoming becoming an Agreement State, therefore the Wyoming Department of Environmental Quality Land Quality Division (LQD) reviewed the request.

The ACL, represented by LC 74(c) would be changed from its current value of 70.7 mg/L to a new value of 500 mg/L. WNI has requested this change to reflect groundwater monitoring results which show that current concentrations of nitrate at wells downgradient of the Point of Compliance (POC) well, WN-21, currently exceed the original proposed ACL of 70.7 mg/L. The ACL requested, 500 mg/L, is shown by WNI to be protective of downgradient waters, human health, and the environment beyond the Long Term Surveillance Boundary (LTSB) over the time frame of 1000 years. This requested ACL is based upon institutional controls that result in the effective isolation of the material for the timeframe of concern (1000 years), not as a protective exposure value. The Point of Exposure (POE) to a member of the public or the environment is at the LTSB boundary.

Additionally WNI has requested to extend the LTSB to encompass additional lands from those currently approved as presented in a WNI letter to the LQD dated January 11, 2019. This extension provides for the revised SW Valley nitrate ACL such that the nitrate plume exists in isolation. WNI or the federal government owns a majority of the land within the proposed extended LTSB. The small portion of land not owned by WNI or the federal government has durable administrative land use restrictions, acquired by WNI, to disallow water well drilling. This effectively prevents exposures of humans, livestock, or wildlife to potentially contaminated groundwater.

HISTORY

The Split Rock uranium mill was owned and operated by Western Nuclear Incorporated (WNI) in Fremont County, Wyoming. The Split Rock disposal site is located approximately 2 miles northeast of Jeffrey City in Fremont County, Wyoming, and about 58 miles east southeast of

Lander, Wyoming. The site lies in the high plains of central Wyoming and encompasses approximately 5,398 acres. The site elevation ranges from a low of about 6,300 feet (ft) to a high of about 6,800 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.

Milling commenced in 1957 under AEC license R-205 and continued until 1981. The mill then went on standby status until 1986 when the license was converted to possession only and amended to allow WNI to complete the disposal of the tailings at the site. Most of the ore which fed the mill originated in open pit mines at the Gas Hills mining district. The milling processes incorporated sulfuric acid leaching, liquid ion-exchange, solvent extraction and concentration, drying, and packaging. At peak capacity, the mill could process 1,700 tons of ore per day. The primary constituent in the tailings solution was chloride and sulfate as well as trace metals from ore. As a result of these operations, approximately 7.7 million tons of tailings were produced and discharged as slurry into three separate tailings piles, designated Old, Alternate, and New. Between 1988 and 2007 the mill and mill buildings were dismantled and the tailings were reclaimed in place. All tailings and other contaminated materials were encapsulated in the three impoundments.

GROUNDWATER REMEDIAL ACTIONS

Background

Ground water flow and contaminant transport of site-derived constituents primarily involves the Upper and Lower Split Rock saturated units, collectively called the Split Rock aquifer, and the Sweetwater River Alluvium, called the floodplain aquifer. The floodplain aquifer is hydrologically connected to the underlying Split Rock aquifer and was formed where the Sweetwater River cut and meandered across the Split Rock formation. Most residents of Jeffrey City derive their water supply from the town wells drilled into the Split Rock aquifer. The Jeffrey City municipal wells presently supply approximately 379 (Lpm) (100 gpm), though pumping only occurs periodically to fill the storage tanks. These wells are located west of the site and are, therefore, upgradient of the site and unaffected by site-derived contamination.

Groundwater below the WNI Split Rock site has been negatively affected by the notably unlined tailings impoundment. From 1957 to 1981, the mill processed ore and discharged tailings and acidic liquids into the impoundment. The liquids quickly entered the unsaturated zone as the tailings design utilized seepage to eliminate liquids in the impoundment. Over time, these liquids migrated into the groundwater.

The site groundwater hydrology consists of two main drainage pathways. Two valleys naturally exist around the tailings which are surrounded by granite outcroppings, preventing groundwater flow through them in the first aquifer. One exits the tailings area to the northwest and is referred to as the Northwest (NW) Valley, while the other drains to the southwest and is called the Southwest (SW) Valley. Contaminants have entered both of these drainage pathways. Historically, up to 1,400 gallons per minute of tailings seepage entered the drainage pathways. Since 1986, when liquids and tailings disposal was ceased, this number has slowed and is

expected to reach long-term steady-state rate of less than 5 gpm. The two drainage pathways have caused this infiltration to split into two distinct groundwater flow paths, both of which eventually head northeast towards the Sweetwater River after going around the granite outcroppings. Areas with higher granite basement elevations beneath the Sweetwater River floodplain causes ground water to discharge from the Split Rock aquifer into the floodplain aquifer. A significant lateral constriction in the Split Rock aquifer and the Sweetwater River alluvium occurs near wells northeast of the site and at the point where the river passes through the granite outcrop at the Three Crossings Diversion Dam.

The Sweetwater River is the primary discharge point for the regional groundwater flow. Near the site, the river is classified by the state as Class 2 AB surface waters, Class 2 AB waters are those known to support game fish populations or spawning and nursery areas at least seasonally. Unless otherwise shown, these waters are presumed to exhibit sufficient water quality and quantity to support to support drinking water supplies and are protected for that use. Class 2 AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, primary contact recreation, wildlife, industry, agriculture, and scenic value uses.

WNI proposed distinct ACLs for the NW Valley and SW Valley, respectively. These ACLs, with the exception of nitrate in SW Valley, are protective at the POE at the site boundary. The ACLs for the site groundwater contaminants of concern were originally accepted by the NRC in August of 2006 and a finding of no significant impact (FONSI) was warranted in the Environmental Assessment (EA) (ML062130387). The ACLs from that submittal are listed in Table 1.The NRC found that:

- Potential access to the seepage-impacted ground water is prevented by including impacted aquifers within the LTSB, property acquisition and the use of ICs (mitigation measures), and the establishment of ground water and surface water trigger values.
- Discharges to the Sweetwater River are not sufficient to impact human health and the environment.
- Ground water fate and transport modeling conducted by WNI indicates that revising the ground water standards to ACLs would cause no degradation to the use of ground water or surface water outside the LTSB, as a result of mill-related activities.
- Only potable ground water use is impacted within the LTSB; ground water may still be used for livestock watering and irrigation.
- An acceptable compliance ground water monitoring program will be implemented to adequately monitor the future movements of the ground water plume and assure that no significant environmental impacts will occur and that the ACLs will not be exceeded.

2006 EA ACL Concentrations		
Contaminant	NW Valley	SW Valley
Manganese (mg/L)	225	35
Molybdenum (mg/L)	0.66	0.22
Ammonia (mg/L)	0.61	0.84
Radium-226 & Radium-228 (pCi/L)	7.2	19.9
Natural Uranium (mg/L)	4.8	3.4
Nitrate (mg/L)	317	70.7

Table 1: 2006 NRC EA ACL Concentrations

However, subsequent to the FONSI, the ACL for nitrate in the SW Valley was exceeded at a well downgradient of the point of compliance (POC), well SWAB-2 at a concentration of 380 mg/L in September of 2009. The nitrate concentration is still, as of for the 2nd half of 2018, greater than the ACL, showing a nitrate concentration of 120 mg/L at well SWAB-2 and 129 mg/L at SWAB-1R (the POC well WN-21 remains below the current 70.7 mg/L ACL). WNI has since proposed a new ACL for the SW Valley for nitrate of 500 mg/L and proposed to expand their site long term surveillance boundary (LTSB).

TECHNICAL EVALUATION

The newly proposed ACL is not based on any sampling result for nitrate, the highest to date being 380 mg/L, but is instead proposed by WNI as a "conservative" value. This value is described as "conservative" because even at a steady-state source concentration of 500 mg/L, which to reiterate has never been observed, the 1000 year contamination plume modeled by WNI would not result in the Environmental Protection Agency's (EPA) Maximum Concentration Limit (MCL) of 10 mg/L for nitrate in drinking water, at the boundary of the LTSB. The 1000 year time frame was chosen as the statutory compliance period pursuant to 10 CFR 40 Appendix A, Criterion 6(1)(i). The quality of the drinking water at the LTSB would be maintained during the timeframe. The estimated concentration of nitrate in the groundwater at the LTSB (Sweetwater River) at the end of the 1000 year timeframe is a less than 2 mg/L increase above baseline groundwater nitrate.

The publically available ATRANS1 model, available from S.S. Papadopulos & Associates, Inc. (ML16328A407, ML16328A405, ML16328A406), was used to determine the downgradient effects of a nitrate ACL of 500 mg/L in the SW Valley. ATRANS1 solves three-dimensional advective-dispersive transport problems. This model assumes a constant source condition with a location at well SWAB-2, a well downgradient from the POC. The source term is defined in this model as a two-dimensional persistent 500 mg/L nitrate patch 2,000 feet wide by 350 feet deep, and uses dispersion alone to dilute the source term in a path 10,000 feet wide by 350 feet deep by 21,310 feet long (the shortest downgradient length from the source term point to the LTSB). In reality, dilution from incoming clean groundwater, chemical adsorption, and other processes would inhibit the existence of a constant source term for the entire 1000 year timeframe. A

decreasing source term would be more probable based on the above causes of dilution and as infiltration from the tailings slows over time. Therefore the use of this model is assumed to be conservative in its estimation of downgradient nitrate over the timeframe.

The LQD-URP ran the ATRANS1 model separately from the work of the licensee and identified the model to be most sensitive to the groundwater velocity parameter, v. The following equation defines the groundwater velocity, v.

$$v = \frac{-Ki}{n_e}$$

Where: K represents the hydraulic conductivity;

n_e is the effective porosity of the aquifer; and

i represents the hydraulic gradient, such that

$$i = \frac{\Delta h}{\Delta x}$$

Where Δh equals the difference in head between two wells; and

Δx is the difference in distance between the two wells.

In WNI's ATRANS1 model, v is 0.0407 feet per day, where K is 5 feet per day, i is 52 feet over 21310 feet (the difference in head over the distance between well SWAB-2 and the Sweetwater River), and n_e is 0.3. Using this groundwater velocity, along with the parameters listed in Table 2, ATRANS1 was ran. The estimated concentration at the river after 1000 years was 1.978 mg/L. This is well below the MCL of 10 mg/L. This value was validated using the one-dimensional Ogata-Banks solution for groundwater transport (USGS, 1961). Using the same inputs as those in ATRANS1 (as applicable), the Ogata-Banks solution resulted in a nitrate concentration of 2.39 mg/L at 1000 years at the Sweetwater River. The similarity in these solutions provides some confidence in the model.

Input	Symbol	Value Used	Units	Justification
Groundwater Velocity	v	0.0407	feet/day	Porosity of 0.3, hydraulic conductivity of 5 feet/day (Aquifertek, 2016)
Longitudinal dispersion	α_L	200	feet	Dispersion is greater than the actual estimated of 125 feet
Transverse dispersion	α_T	20	feet	Dispersion is greater than the actual estimated of 12.5 feet
Vertical dispersion	α_V	2.1	feet	Dispersion is greater than the actual estimated of 1.25 feet
Decay (no decay assumed)	λ	0	day^{-1}	Denitrification is likely over the 1000 years
Retardation factor	R_d	1		Flows with groundwater, no adsorption
Contamination thickness	T_C	350	feet	Conservative as there will be no vertical dilution
End time of model run	t	365000	days	Full 1000 years to be considered in 10 CFR 40 Appendix A Criterion 6(1)
Time between calculations	Δt	3650	days	10 years between calculations
Starting concentration of contamination	C_o	500	mg/L	Higher than the highest observed concentration of 380 mg/L
Width of contamination	y_o	2000	feet	Current width of estimated plume
Hydraulic head at SWAB-2	H_1	6292	feet	Measured
Hydraulic head at Sweetwater River	H_2	6240	feet	Measured
Model x distance	L	21310	feet	Distance from SWAB-2 to the Sweetwater River
Model y dimension	W	10000	feet	Unlimited lateral dispersion of plume
Aquifer thickness (Model z dimension)	T	350	feet	Conservative as there will be no vertical dilution

Table 2: ATRANS1 Model Inputs

To estimate the sensitivity of the velocity parameter, the model was run numerous times using various groundwater velocity inputs. The fitted curve in Figure 1 corresponds with the results of those runs. The time where 10 mg/L of nitrate is observed at the POE in the model, the Sweetwater river, varies according to the relationship:

$$t = 44.414v^{-0.998}$$

Where t is the time in years at which a concentration of 10 mg/L is observed at the river, and v is the groundwater velocity in feet/day

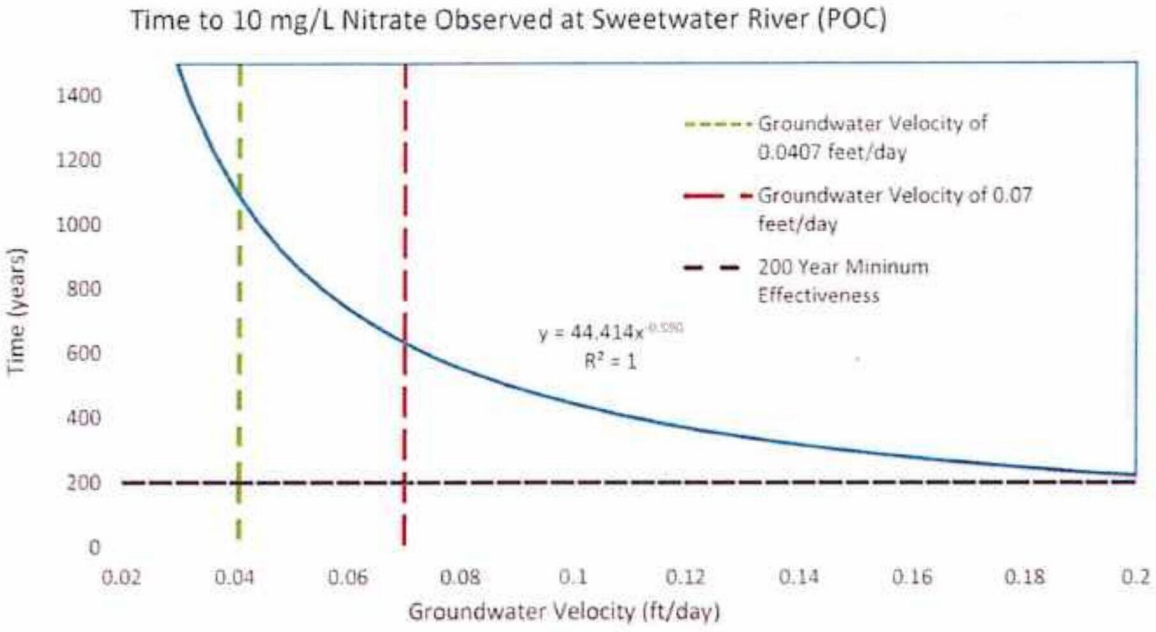

Figure 1: Influence of groundwater velocity on time before ACL results in nitrate MCL at the POE

Assuming the lower end porosity estimated in the 1999 WNI Split Rock Groundwater Protection Plan (GWPP) (0.25) and the geometric mean hydraulic conductivity (7.36 feet/day), a velocity of 0.072 feet per day is calculated. Assuming these values, the time at which 10 mg/L may be observed at the POE would be 615 years. However, the best estimate of porosity is likely higher than 0.3, as observed in the laboratory testing completed in the 1999 GWPP, and as estimated by WNI (Aquifertek, 2016). This testing estimated porosities greater than 0.35, and the 1999 model was run using an estimate of 0.35. The hydraulic conductivity of 5 feet per day is based on model calibrations using pump tests and evaluating hydraulic head at the wells in the southwest valley. This estimate therefore is considered the best estimate of hydraulic conductivity. Thus, the velocity used in the ATRANS1 model is likely conservative.

Other factors in the model are likely conservative, or demonstrably conservative. For instance, the model assumes a constant source term of 500 mg/L of nitrate to a depth of 350 feet for the 1000 year time period with no decay (denitrification). A 500 mg/L nitrate groundwater sample as never been observed, with the highest sample result to date being 380 mg/L, taken in 2008 at well SWAB-2. There would likely be some denitrification in the aquifer, and the source term is thought to most likely degrade in concentration over time as infiltration from the tailings slows. In fact, since the sample of 380 mg/L was observed at SWAB-2, subsequent samples have been lower, with upgradient sample location results, such as at WN-21, continuing to decline. Therefore, a more likely scenario would be a lower concentration nitrate plume, degrading over time, over a smaller vertical distance than modeled. Taking these considerations into account, it is unlikely a 10 mg/L plume would reach the river. Using the ATRANS1 model provided and the selected aquifer parameters however, it would occur beyond 600 years in the future. This falls

outside of the time of consideration mandated in 10 CFR 40 Appendix A, Criterion 6(1) which states that radiological controls "be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years". To the extent reasonably achievable, the nitrate plume will not exceed 10 mg/L in less than 1000 years, and in any case, will not reach the POE in less than 200 years.

The LTSB extension is necessary so that the nitrate plume, over the 1000 year timeframe, does not come into contact with humans, livestock, or wildlife via the drinking water pathway. Therefore, this amendment is also approved. The proposed LTSB provided by WNI is shown in addendum 1. The extension of the LTSB, although specifically completed for the nitrate plume, would improve the confidence of previous ACL decisions made by the NRC for constituents in the SW Valley. The evaluation of nitrate, which used very conservative assumptions, would equally be bounding for any other constituent of concern, and thus is protective of all previously approved ACLs.

ALTERNATIVES TO THE PROPOSED ACTION

Groundwater remediation began in 1990 and continued until 2006. This program removed approximately 6 million gallons to 66 million gallons of water per year, depending on evaporative capacity and well operability, from the aquifer and sent this water to evaporation ponds as part of the Ground Water Corrective Action Program (CAP). In total, WNI removed 460 million gallons of contaminated groundwater under the CAP. Further CAP work has been investigated and a summary of the costs and benefits of further action may be found in August 2006 Environmental Assessment for Amendment to Source Materials License SUA-56 Ground Water Alternate Concentration Limits (ML062130387). In this document, the NRC concluded that further remediation of groundwater would be ineffective and not viable.

WDEQ agrees with this assessment, and furthermore believes the same assessment of alternatives applied in the August 2006 EA (ML062130387) to the ACLs developed at that time would apply to a new ACL for nitrate for the SW valley.

EVALUATION OF THE PROPOSED ACTION

Consistent with 10 CFR 40, Appendix A, Criterion 5B(6), the revised ACL of 500 mg/L for nitrate within the SW Valley would not appear to pose a substantial present or potential hazard to human health or the environment if not exceeded at the SW Valley POC well WN-21, or any point downgradient based upon the institutional controls in place from the tailings pile to the Sweetwater River. Therefore, this amendment to increase the nitrate ACL in the SW valley from 70.7 mg/L to 500 mg/L is approved.

This finding is based on the staff's evaluation of the model and modeling files provided by WNI. The modeling files and the results of the model were found to be consistent with the assumptions, input parameters, and predictions described in the October 4th, 2016 technical memorandum (ML16328A404). Additionally, as part of its review, the staff calculated the

Ogata-Banks solution, which is a one-dimensional dispersion without chemical reactions analytical solution. Using this solution, predictions were nearly identical (2.39 mg/L) to the 1.978 mg/L estimated by WNI at the end of the 1000 year time period at the Sweetwater River, making the same conservative assumptions.

As stated in 10 CFR 40.28(b), "the general license in paragraph (a) of this section [for the Department of Energy's Long-Term Surveillance and Maintenance] becomes effective when the Commission terminates, or concurs in an Agreement State's termination of, the specific license and the site Long-Term Surveillance Plan (LTSP) meeting the requirements of this section has been accepted by the Commission." The DOE is required to submit the LTSP to the NRC which will include both a proposed long-term environmental monitoring program and the proposed LTSB as discussed in 10 CFR 40.28(1), (2), and (3). Upon review and approval of the LTSP, the LTSB and long-term monitoring program, pursuant to the general license in 10 CFR 40.28 becomes effective. While the groundwater monitoring wells proposed by WNI for the SW Valley would be considered protective for near-term monitoring in comparison to the 1000 year compliance period, the prolonged transport times for constituents to reach the LTSB reduce their effectiveness for determining potential health and safety impacts at the POE. Thus, groundwater monitoring may not be necessary in the SW Valley following license termination due to the proposed LTSB expansion, with potentially only surface water samples needing to be collected at the proposed Sweetwater River sampling points. Therefore, the LTSB extension as presented in addendum 1 and WNI's January 11th, 2019 letter to the LQD is also approved.

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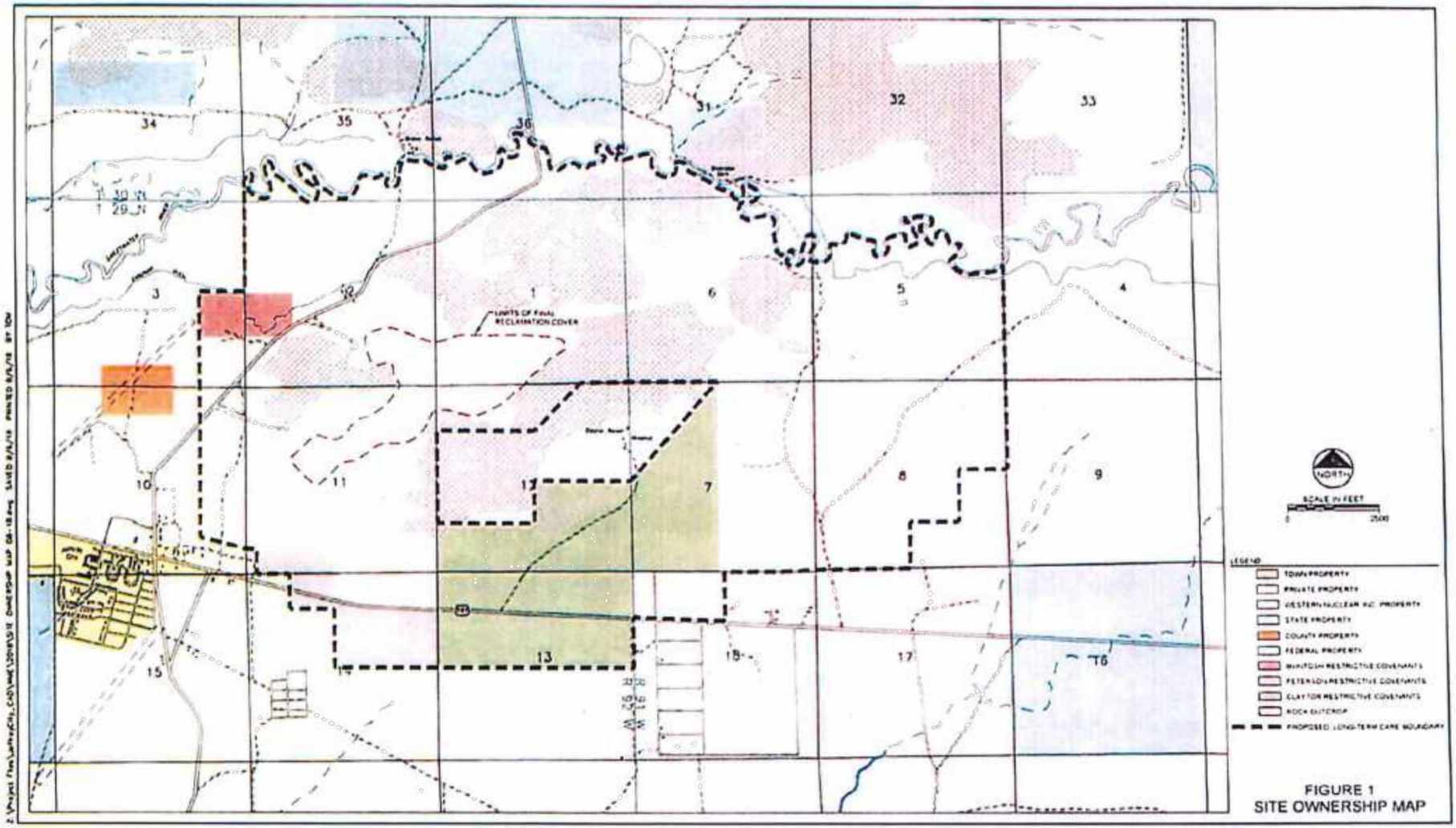

FIGURE 1
SITE OWNERSHIP MAP

Appendix B
State Decision Document
Selenium ACL Amendment

Wyoming Department of Environmental Quality
Land Quality Division
Uranium Recovery Program

STATE DECISION DOCUMENT
TECHNICAL REVIEW OF WESTERN NUCLEAR INC SPLIT ROCK URANIUM MILL ALTERNATE CONCENTRATION LIMIT FOR SELENIUM IN GROUNDWATER IN THE NORTHWEST VALLEY

LICENSE AMENDMENT REQUEST

By letter dated May 1st, 2019, Western Nuclear Incorporated (WNI) submitted a request to the Wyoming Department of Environmental Quality (WDEQ) Land Quality Division's (LQD) Uranium Recovery Program (URP) to amend License Condition (LC) 74 with regards to the selenium alternate concentration limit (ACL) for the Northwest Valley (LC 74(b)) for Point of Compliance (POC) well, WN-5, currently 0.05 mg/L. This request came in response to selenium being observed in a well (WN-42A) downgradient of the POC well at a concentration of 0.074 mg/L during the second half of 2018 (WNI, 2018). In February of 2019, another sample and a duplicate were taken from well WN-42A, which confirmed the exceedance, with concentrations of 0.061 mg/L and 0.063 mg/L, respectively (WNI, 2019).

Per the ACL request, the current selenium ACL in LC 74(b) would be changed from 0.05 mg/L to a new value of 0.30 mg/L. WNI has requested this change to reflect groundwater monitoring results which show that current concentrations of selenium at wells downgradient of the Point of Compliance (POC) well, WN-5, currently exceed the original ACL of 0.05 mg/L. The ACL requested, 0.30 mg/L, is shown by WNI to be protective of downgradient waters, human health, and the environment beyond the Long Term Surveillance Boundary (LTSB) over the time frame of 1000 years (WNI, 2019). The Point of Exposure (POE) to a member of the public or the environment is at the LTSB boundary (the Sweetwater River).

HISTORY

The Split Rock uranium mill was owned and operated by Western Nuclear Incorporated (WNI) in Fremont County, Wyoming. The Split Rock disposal site is located approximately 2 miles northeast of Jeffrey City in Fremont County, Wyoming, and about 58 miles east southeast of Lander, Wyoming. The site lies in the high plains of central Wyoming and encompasses approximately 5,398 acres. The site elevation ranges from a low of about 6,300 feet (ft) to a high of about 6,800 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.

Milling commenced in 1957 under AEC license R-205 and continued until 1981. The mill then went on standby status until 1986 when the license was converted to possession only and amended to allow WNI to complete the disposal of the tailings at the site. Most of the ore which fed the mill originated in open pit mines at the Gas Hills mining district. The milling processes incorporated sulfuric acid leaching, liquid ion-exchange, solvent extraction and concentration,

drying, and packaging. At peak capacity, the mill could process 1,700 tons of ore per day. The primary constituent in the tailings solution was chloride and sulfate as well as trace metals from ore. As a result of these operations, approximately 7.7 million tons of tailings were produced and discharged as slurry into three separate tailings piles, designated Old, Alternate, and New. Between 1988 and 2007 the mill and mill buildings were dismantled and the tailings were reclaimed in place. All tailings and other contaminated materials were encapsulated in the three impoundments.

GROUNDWATER REMEDIAL ACTIONS

Background

Ground water flow and contaminant transport of site-derived constituents primarily involves the Upper and Lower Split Rock saturated units, collectively called the Split Rock aquifer, and the Sweetwater River Alluvium, called the floodplain aquifer. The floodplain aquifer is hydrologically connected to the underlying Split Rock aquifer and was formed where the Sweetwater River cut and meandered across the Split Rock formation. Most residents of Jeffrey City derive their water supply from the town wells drilled into the Split Rock aquifer. The Jeffrey City municipal wells presently supply approximately 379 (Lpm) (100 gpm), though pumping only occurs periodically to fill the storage tanks. These wells are located west of the site and are, therefore, upgradient of the site and unaffected by site-derived contamination.

Groundwater below the WNI Split Rock site has been negatively affected by the notably unlined tailings impoundment. From 1957 to 1981, the mill processed ore and discharged tailings and acidic liquids into the impoundment. The liquids quickly entered the unsaturated zone as the tailings design utilized seepage to eliminate liquids in the impoundment. Over time, these liquids migrated into the groundwater.

The site groundwater hydrology consists of two main drainage pathways. Two valleys naturally exist around the tailings which are surrounded by granite outcroppings, preventing groundwater flow through them in the first aquifer. One exits the tailings area to the northwest and is referred to as the Northwest (NW) Valley, while the other drains to the northwest and is called the Southwest (SW) Valley. Contaminants have entered both of these drainage pathways. Historically, up to 1,400 gallons per minute of tailings seepage entered the drainage pathways. Since 1986, when liquids and tailings disposal was ceased, this number has slowed and is expected to reach long-term steady-state rate of less than 5 gpm. The two drainage pathways have caused this infiltration to split into two distinct groundwater flow paths, both of which eventually head northeast towards the Sweetwater River after going around the granite outcroppings. Areas with higher granite basement elevations beneath the Sweetwater River floodplain causes ground water to discharge from the Split Rock aquifer into the floodplain aquifer. A significant lateral constriction in the Split Rock aquifer and the Sweetwater River alluvium occurs near wells northeast of the site and at the point where the river passes through the granite outcrop at the Three Crossings Diversion Dam.

The Sweetwater River is the primary discharge point for the regional groundwater flow. Near the site, the river is classified by the state as Class 2 AB surface waters. Class 2 AB waters are those known to support game fish populations or spawning and nursery areas at least seasonally. Unless otherwise shown, these waters are presumed to exhibit sufficient water quality and quantity to support to support drinking water supplies and are protected for that use. Class 2 AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, primary contact recreation, wildlife, industry, agriculture, and scenic value uses.

WNI proposed distinct ACLs for the NW Valley and SW Valley, respectively. These ACLs, are protective at the POE at the site boundary, though the selenium ACL in the NW valley is being altered in this SDD to accommodate higher concentrations observed downgradient of the POC (WN-5) in well WN-42A. The ACLs for selenium has previously been altered from 0.013 mg/L to the current level of 0.05 mg/L accepted by the NRC in January of 2010 and a finding of no significant impact (FONSI) was warranted in the Environmental Assessment (EA) (ML092780275) for this change.

TECHNICAL EVALUATION

ALTERNATIVES TO THE PROPOSED ACTION

Groundwater remediation began in 1990 and continued until 2006. This program removed approximately 6 million gallons to 66 million gallons of water per year, depending on evaporative capacity and well operability, from the aquifer and sent this water to evaporation ponds as part of the Ground Water Corrective Action Program (CAP). In total, WNI removed 460 million gallons of contaminated groundwater under the CAP. Further CAP work has been investigated and a summary of the costs and benefits of further action may be found in August 2006 Environmental Assessment for Amendment to Source Materials License SUA-56 Ground Water Alternate Concentration Limits (ML062910216). In this document, the NRC concluded that further remediation of groundwater would be ineffective and not viable.

WDEQ agrees with this assessment, and furthermore believes the same assessment of alternatives applied in the August 2006 EA (ML062910216) to the ACLs developed at that time would apply to a new ACL for selenium for the NW valley.

EVALUATION OF THE PROPOSED ACTION

10 CFR 40 Appendix A requires that the State consider the list of factors in Criterion 5B(6) in making a determination that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the ACL is not exceeded. In this case, selenium is the constituent and the ACL is 0.3 mg/L. In 2010, the NRC determined that increasing the selenium ACL from 0.013 mg/L to 0.05 mg/L was acceptable. The 0.05 mg/L ACL was acceptable to the NRC in its determination (both in the EA and the TER) (ML092780275, ML092800206) because WNI demonstrated that the selenium levels would dilute to levels below which the WDEQ determined to be protective of aquatic life chronic standard in the Sweetwater River and, as the ACL was at the EPA's MCL for selenium, human health would also be

protected. The URP has determined, based on WNI's ACL application (WNI, 2019), that certain factors in Criterion 5B(6) must be re-examined in the consideration of increasing the ACL from 0.05 mg/L to 0.3 mg/L.

The analysis required by Criterion 5B(6) is completed through a hazard assessment, exposure assessment, corrective action assessment, and compliance monitoring, as needed. Because of the long regulatory history of ACLs with this site, much of the needed analysis has been completed previously and only a few changes have been identified by the URP as requiring update. In this SDD, WDEQ will assess WNI's ACL application for the following areas, regarding groundwater and surface water impacts:

(a) the quantity of groundwater, and surface water, available for dilution of selenium contaminated groundwater prior to "arrival" at the POE; and
(b) the cumulative impacts to human health, wildlife, and the environment of the ACL at the POE, the persistence and permanence of the adverse effects of selenium at the site and the POE.

Evaluation of Mass Flux and Transport of Selenium

The transport and mass flux analyses completed by WNI (WNI, 2019) shows dilution of selenium from a level of 0.3 mg/L in the groundwater at WN-42A to below the chronic standard for aquatic life at the Sweetwater River. WNI made a number of assumptions in their analyses. WNI assumes that selenium is associated with sulfate and uranium in determining the mass flux of selenium. This is an appropriate assumption because sulfate and uranium are associated with the tailings, as is the selenium. Generally, where the mass of uranium and sulfate have been located historically, the selenium should also be/have been present at some fairly consistent ratio. Therefore, by evaluating the distribution of uranium and sulfate in the groundwater, an estimation of how the selenium is distributed throughout the groundwater mass was calculated by WNI. WNI estimated that 61.6% of the selenium mass is concentrated in 30% of the flow from the NW Valley. The remaining 38.4% of the selenium mass is diluted in the remaining 70% of the flow. This estimate of mass distribution of selenium was completed using the uranium and sulfate mass distributions, as estimated from historical data, as approximate surrogates for the selenium mass as discussed in WNI's evaluation (WNI, 2019).

The flow rate of the groundwater from the NW Valley entering the Sweetwater River is assumed to be 99 gallons per minute (gpm). This flow rate is based on the flow rate estimated in 1999 Groundwater Protection Plan (GWPP), modified for the change in hydraulic head at the POC. This matches the predicted 100 gpm long-term groundwater flow estimated in the 1999 GWPP, and is a good estimate of long term groundwater flow from the NW Valley into the Sweetwater River.

WNI uses the biological based 4 day, 3 year Low Flow (4B3) discharge rate (8.32 cubic feet per second [cfs]) for chronic exposure of aquatic life at this section of the Sweetwater River. This was calculated using the United States Geological Survey (USGS) Surface Water Toolbox

(USGS, 2019) for Station ID 06638090 which is upstream of the Split Rock site by about 19 miles. This is the nearest station to the Split Rock site, and is likely the best data available for the flow rate of the Sweetwater River at the POE. This is appropriate for the discharge rate of the Sweetwater River at the POE which will mix with the inflowing groundwater and dilute the groundwater to below Wyoming' aquatic life chronic selenium standard of 0.005 mg/L. The 4B3 flow rate is standard for this purpose as discussed in EPA's Water Quality Standards Handbook, Chapter 5 (EPA, 2014). WNI assumes 30% of the groundwater flowing into the Sweetwater River from the NW Valley is contaminated at the proposed ACL of 0.3 mg/L, and the other 70% of groundwater flowing from the NW Valley is contaminated with selenium at 0.08 mg/L.

The highest selenium measurement to date at the tailings pile is 0.26 mg/L occurring at well S-1 in April of 1989, and in the NW Valley, 0.34 mg/L was observed from a sample taken at well 4R on May 9th, 2005. No measurement since that time however has resulted in a selenium concentration exceeding 0.2 mg/L. A vast majority of measurements taken onsite fall well below the 0.08 mg/L. In addition, WNI's analysis does not account for any attenuation or adsorption of selenium in the groundwater over the distance from the POC to the Sweetwater River. It would be likely that there is some adsorptive capacity for selenium in the flow path of the groundwater in the NW Valley.

Additionally, WNI has shown that during periods of very low flow, as defined by the acute 1B3 biologically based flow rate, the acute aquatic life standard is also not exceeded during these periods. 1B3 flow rates represents the lowest one-day average flow event expected to occur once every three years. In the event of a 1B3 type flow rate, calculated to be 5.43 cfs for the Sweetwater River at this location using the same location as that for the 4B3 discharge rate, the maximum concentration of selenium at the POE would be 0.0067 mg/L, well below the acute aquatic life standard for selenium in Chapter 1 of the WDEQ Water Quality rules of 0.02 mg/L. The LQD independently verified the 1B3 calculation and confirms that the methods used by the licensee is accurate.

Current institutional controls prevent groundwater human consumption of groundwater between the POC and the POE (the Sweetwater River). As such, there is no nexus for human exposure to the selenium concentrations in the groundwater except for at the river, where the chronic standard for aquatic life will be met. This level is an order of magnitude lower than the EPA's selenium MCL. Therefore, WDEQ accepts the proposed ACL as protective of aquatic life and human health.

Cumulative Effects

As selenium will also be present in the SW Valley flow path, WDEQ evaluated whether selenium in the SW Valley flow path could potentially impact the Sweetwater River cumulatively, such that the aquatic life chronic standard of 0.005 mg/L would be exceeded. Similar to WDEQ's technical evaluation report regarding the ACL for nitrate (WDEQ, 2019), the Ogata-Banks one dimensional transport equation (USGS, 1961) was used to estimate the concentration of selenium in groundwater which would enter the Sweetwater River over the time

period of interest (i.e. 1000 years). Assuming no retardation or attenuation of selenium, and assuming a constant source term of the ACL (all of which are very conservative) for selenium in the SW Valley, 0.05 mg/L, the Ogata-Banks transport equation showed that at 1000 years, the concentration of selenium in groundwater entering the Sweetwater River would be 0.0002 mg/L. This would have a diluting effect on the river selenium and would not likely be detectable above background in the groundwater or in the Sweetwater River.

Conclusion

The surface above the groundwater flow path from the NW valley is owned by WNI and within the current LTSB and therefore the current institutional controls on the property will not result in impacts to human health or to individuals drinking groundwater contaminated with selenium above the MCL. The chronic standard for aquatic life is likely to be maintained in the Sweetwater River at the POE, or at least is unlikely to be affected by selenium in the NW Valley flow path as long as the ACL is not exceeded at the POC. Selenium has been demonstrated by WNI to be diluted by groundwater and surface water in the Sweetwater River. As no previous monitoring, save for one measurement in 1995, has resulted in a selenium at or above the new ACL, this ACL is likely to be maintained in perpetuity without modification in the future. The WDEQ has therefore determined that in increasing the ACL from its current level of 0.05 mg/L to 0.3 mg/L, the ACL retains the protectiveness of the 0.05 mg/L ACL, and therefore approves the ACL.

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Appendix C
Proposed Long Term Care Boundary

RECORD OF SURVEY
WESTERN NUCLEAR, INC.
SPLIT ROCK SITE
2018 REVISED LONG TERM CARE AREA

LEGAL DESCRIPTION

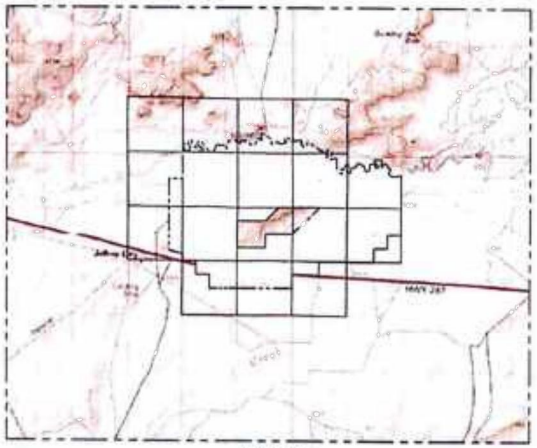
A tract of land in Sections 1-3, 10-14, Township 29 North, Range 92 West
Sections 5-8, and 18, Township 29 North, Range 91 West
Section 31, Township 30 North, Range 91 West
Sections 35 and 36, Township 30 North, Range 92 West
All of the 6th P.M., Fremont County, Wyoming

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°19'03"W, a distance of 555.49' more or less from the Southwest corner of said Section 35;
Thence proceed S00°19'03"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 2647.23' 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°53'13"W, 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°49'12"E, 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 1408.83' 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 1262.63' 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 5262.83' to Point 15, being the 1/4 corner common to said Section 18, T29N, R91W and said Section 13, T29N, R92W;
Thence N90°23'54"W, along the section line common to said Section 18 and Section 13, a distance of 1353.06' 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 2596.22' 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 3296.72' 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 2640.89' 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 2648.29' 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 5;
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°09'41"W, along the section line a distance of 2643.44' to Point 25, being the NE corner of said Section 8;
Thence N89°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 N89°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 N90°36'06"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 S88°58'03"E, a distance of 2639.91' to Point 30, being the EN1/16 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, T29W, R91W, a distance of 2561.48' 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 1[illegible] 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 10;
Thence N90°07'46"W, along the section line common to said Section 11 and Section 12 a distance of 1311.40' 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.



VICINITY MAP
NOT TO SCALE

CERTIFICATE OF SURVEYOR

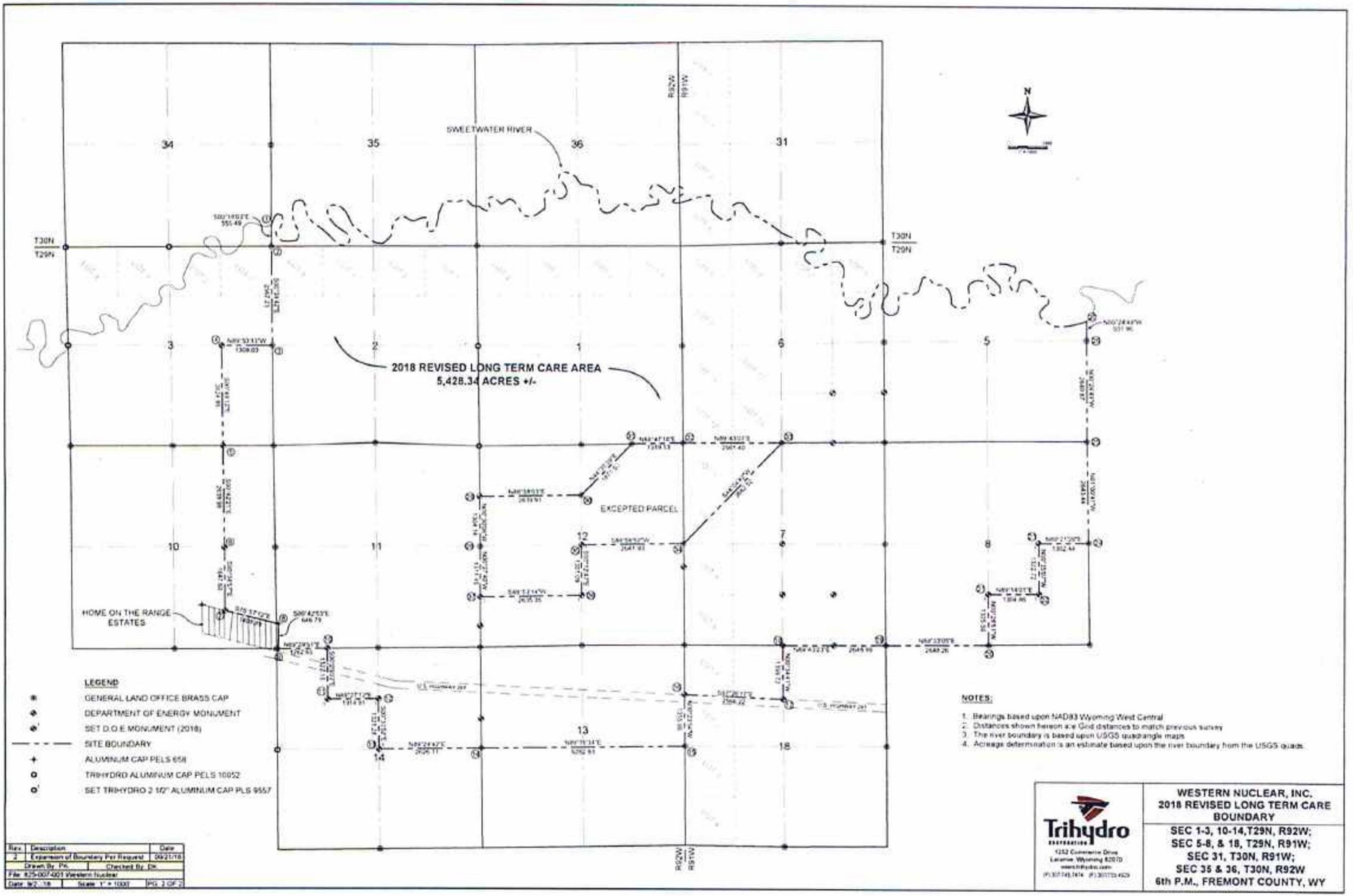
I, Paul F. Kenyon, professionally licensed surveyor in the State of Wyoming do hereby certify this plat was prepared from results of a survey made by me or under my direct supervision and is, to the best of my knowledge, information, and belief, a true and correct representation of said survey.

CLERK AND RECORDER'S CERTIFICATE

Rev.	Description	Date
2	Expansion of Boundary Per Request	09/21/18
Drawn By: PK	Checked By: DK	
File: 825-007-003 Western Nuclear		
Date: 9/21/18	Scale: 1" = 1000'	PG: 1 OF 2

Trihydro Corporation
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P) 307.745.7474 (F) 307.745.7729

WESTERN NUCLEAR, INC.
2018 REVISED LONG TERM CARE BOUNDARY
SEC 1-3, 10-14,T29N, R92W;
SEC 5-8, & 18, T29N, R91W;
SEC 31, T30N, R91W;
SEC 35 & 36, T30N, R92W
6th P.M., FREMONT COUNTY, WY



Rev	Description	Date
2	Expansion of Boundary Per Request	06/21/18
Drawn By: PK	Checked By: DK	
File: 825-007-001 Western Nuclear		
Date: 6/2...18	Scale: 1" = 1000'	PG. 2 OF 2

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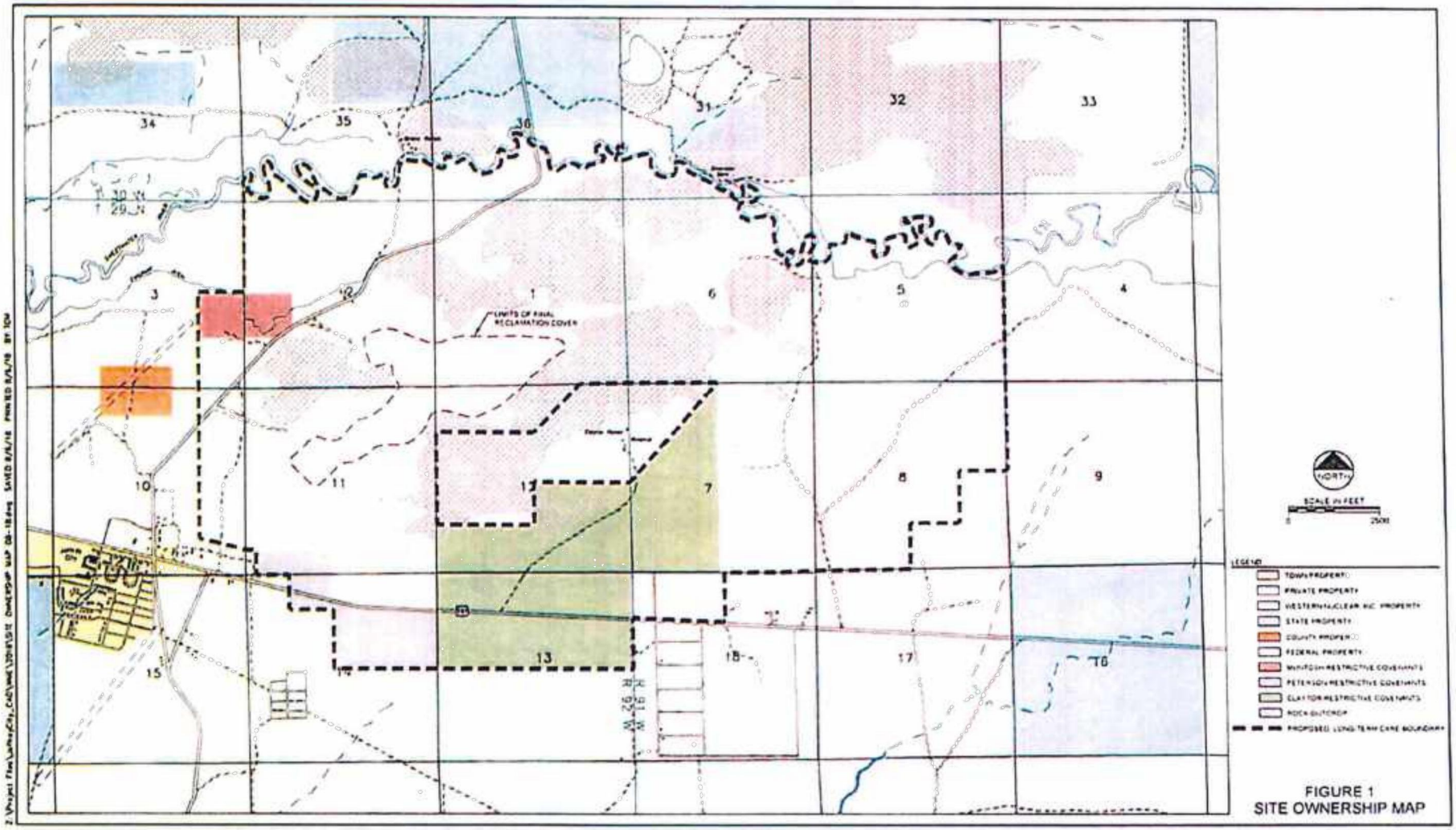

FIGURE 1
SITE OWNERSHIP MAP