September 28, 2006

Lawrence J. Corte, President
Western Nuclear, Inc.
2801 Youngfield, Suite 340
Golden, CO 80401

SUBJECT: LICENSE AMENDMENT NO. 99 APPROVING ALTERNATE CONCENTRATION LIMITS, WESTERN NUCLEAR, INC., SPLIT ROCK SITE, JEFFREY CITY, FREMONT COUNTY, WYOMING, SUA-56 (TAC L51881)

Dear Mr. Corte:

By letter dated October 29, 1999, Western Nuclear, Inc. (WNI) submitted to U.S. Nuclear Regulatory Commission (NRC) staff a request for alternate concentration limits (ACLs) at its Split Rock uranium mill tailings site near Jeffrey City, Fremont County, Wyoming. The October 1999 submittal was supplemented by multiple submittals from 2000 to 2006. NRC staff has reviewed WNI's application and supplements and is approving the requested ACLs.

NRC staff has enclosed License Amendment No. 99, which includes the ACLs, as well as trigger levels for ground water and surface water. Also, enclosed is a Technical Evaluation Report (TER) that documents NRC staff's review of the license amendment application and supplements. As described in the TER, NRC staff reviewed facility operations and the environmental setting, ground water flow and contaminant transport modeling, hazard and exposure assessments, monitoring, and mitigation.

If you have any questions, regarding this licensing action please contact Stephen J. Cohen, Project Manager, at 301-415-7182 or by e-mail at sjc7@nrc.gov.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

/RA Robert Pierson for/

Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 040-01162
License No.: SUA-56

Enclosure: License Amendment No. 99
Technical Evaluation Report

cc: M. Thiesse, Wyoming DEQ
J. Wagner, Wyoming DEQ

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

/RA/ Robert Pierson for

Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 040-01162
License No.: SUA-56

Enclosure: License Amendment No. 99
Technical Evaluation Report

cc: M. Thiesse, Wyoming DEQ
J. Wagner, Wyoming DEQ

CLOSES TAC L51881

DISTRIBUTION: FCFB r/f B. Spitzberg, RIV MMoriarty

ML062760520

OFC	FCFB	FCFB	OGC	FCFB	FCFB
NAME	SCohen	BGarrett	JHull-NLO as revised	Wvon Till	RPierson for GJanosko
DATE	09/18 /06	09/19 /06	09/28/06	09/28/06	09/ /06

OFFICIAL RECORD COPY

TECHNICAL EVALUATION REPORT
ALTERNATE CONCENTRATION LIMITS
WESTERN NUCLEAR, INC., SPLIT ROCK SITE
JEFFREY CITY, FREMONT COUNTY, WYOMING

Docket No.: 40-1162

License No.: SUA-56

DATE: September 11, 2006

FACILITY: Split Rock Site, Jeffrey City, Wyoming

TECHNICAL REVIEWERS: Stephen J. Cohen, William vonTill, Dick Codell, Elaine Brummett, Mark Thaggard

PROJECT MANAGER: Stephen J. Cohen

1.0 SUMMARY AND CONCLUSIONS

By letter dated October 29, 1999, Western Nuclear, Inc. (WNI) submitted, to U.S. Nuclear Regulatory Commission (NRC) staff, a Site Closure Plan (WNI, 1999) that requested amendments to WNI's Source Materials License SUA-56. This Site Closure Plan contained the Site Ground Water Characterization and Evaluation (SGWCE)(WNI, 1999) report and a number of proposed amendments regarding various aspects of site reclamation and decommissioning. One important proposed amendment was to revise ground water protection standards (GPSs) from background to alternate concentration limits (ACLs). WNI submitted supplements to its original application dated: (1) January 17, 2000 (WNI, 2000a); (2) February 22, 2000 (WNI, 2000b); (3) February 28, 2000 (WNI, 2000c); (4) February 1, 2001 (WNI, 2001); (5) May 28, 2002 (WNI, 2002a,b); (6) July 23, 2002 (WNI, 2002c); (7) September 9, 2002 (WNI, 2002d); (8) March 7, 2003 (WNI, 2003); (9) May 24, 2004 (WNI, 2004); (10) February 10, 2005 (WNI, 2005a); (11) March 3, 2005 (WNI, 2005b); (12) March 20, 2006 (Shaver, 2006); and (13) July 31, 2006 (MFG, 2006).

WNI proposed to institute ACLs and institutional controls (ICs) for offsite residential properties and an alternate water supply. ICs would be obtained either through agreements with property owners or property purchases. ICs would be a means of addressing contamination that already passed the current remediation system or would migrate away from the site after the corrective action program (CAP) remediation system is deactivated. To assess the impact of the proposed ACLs, WNI modeled ground water flow using MODFLOW 2000, and contaminant transport, using MT3D, in March 2003 (WNI, 2003). NRC concurred with this set of models on July 24, 2003.

WNI's proposed use of ICs constituted an alternative to the provisions of 10 CFR Part 40, Appendix A. 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). WNI finalized all IC arrangements in January 2006. In addition to the ICs, NRC is requiring a ground water and surface water monitoring network to track ground water contamination and assess model predictions. NRC staff also developed trigger values for surface water and ground water contaminants at the point of exposure (POE). These trigger values would require a licensee response if these values were exceeded.

NRC staff reviewed the hazard and exposure assessments, including pathways involving agricultural and livestock uses of ground water within the long-term surveillance boundary (LTSB). Currently, WNI has granted permission for agricultural and livestock watering uses on only one property within the LTSB -- the McIntosh property west of the site near well SWAB-22. Comparisons of ACL constituent concentrations in well SWAB-22 to Wyoming Department of Environmental Quality's (WDEQ's) Class II (Agriculture) and III (Livestock) standards, indicates that water quality is acceptable for agriculture and livestock watering (WDEQ, 2006). The McIntosh property will not likely be impacted by future contamination because it is on or slightly upgradient of the current contaminant plume; however, well SWAB-22 would provide sufficient warning if contamination migrates toward that property. Based on modeling predictions and mitigative measures (i.e., ICs, monitoring, and trigger values), NRC staff finds that the ACLs with ICs are protective of human health and the environment.

NRC staff has coordinated with the U.S. Department of Energy (DOE) – the future long-term care custodian – regarding this ACL license amendment request, in part by providing the DOE the opportunity to comment on the draft Environmental Assessment (EA) dated May 2, 2006. The DOE reviewed the draft EA and provided comments by letter dated June 8, 2006 (DOE, 2006), in which it did not express any objection to the proposed ACLs. NRC, therefore, finalized the EA on August 29, 2006 (NRC, 2006). The approved ACLs will be incorporated into the long-term surveillance plan (LTSP) to be submitted by DOE in the future.

2.0 BACKGROUND

2.1 Proposed Action

The proposed action is the establishment of ACLs for the following hazardous and nonhazardous constituents at the site: ammonia, manganese, molybdenum, nitrate, radium-226 & -228, and uranium. The licensee has also established ICs restricting domestic ground water use within the LTSB. Livestock and agricultural ground water uses would not be restricted within the LTSB. The license amendment would require the following actions:

1) Replace the current GPSs with ACLs for the aforementioned hazardous and nonhazardous constituents. Table 1 presents the proposed ACLs.
2) Establish the POE location at the LTSB, as presented on an LTSB map prepared by WNI (MFG, 2006).
3) Conduct surface water and ground water sampling at the point of compliance (POC), POE, and at selected wells between POE and POC (WNI, 2005b).
4) Purchase properties within the LTSB and prohibit domestic ground water use or establish ICs for those properties that cannot be purchased.
5) Establish surface water and ground water trigger limits at the POE or in ground water wells that would require licensee actions.

Table 1
Proposed ACL Concentrations

Contaminant	Northwest (NW) Valley	Southwest (SW) Valley	Current GPSs
Manganese (mg/L)	225	35	None
Molybdenum (mg/L)	0.66	0.22	None
Ammonia (mg/L)	0.61	0.84	None
Radium-226 & -228 (pCi/L)	7.2	19.9	5
Natural Uranium (mg/L)	4.8	3.4	0.16
Nitrate (mg/L)	317	70.7	None

Note: mg/L = milligrams per liter; pCi/L = picocuries per liter

The primary purpose of the proposed action is to remove the drinking water exposure pathway on private or government-owned properties within the LTSB and protect ground water and surface water beyond the LTSB for the 1000-yr compliance period. ACLs were determined for each proposed POC well, based on maximum historic concentrations seen in the valleys. WNI accomplished this by determining the maximum values for each of the six identified constituents that have been observed in either the proposed POC wells (Well 5 and Well WN-21) or the wells closest to the edge of the tailings. Through ground water flow and contaminant transport modeling, WNI demonstrated that the ACLs would result in residual downgradient contaminant concentrations that meet water quality standards at the POE or are consistent with NRC-approved background concentrations.

Human health and environmental protection would be accomplished through the institutional elimination of human ground water consumption within the LTSB and monitoring to detect conditions that may impact ground water and surface water quality beyond the LTSB. In anticipation of the ACL approval, WNI has obtained the necessary ICs, by purchasing or otherwise establishing, durable and enforceable restrictions on domestic ground water use on all properties within the proposed LTSB. ICs would allow natural ground water processes (i.e., advection, dispersion, retardation) to attenuate, disperse, and dilute site-derived constituents to meet protective standards at the POEs with no active treatment. POEs consist of the LTSB and the Sweetwater River for ecological and human exposures.

2.2 Split Rock Mill Operations

2.2.1 General Operations Description

Construction of the Split Rock mill started in 1956. The location of the mill site was originally selected in conjunction with the U.S. Atomic Energy Commission (AEC) and was approved, based on the following: (1) proximity to U.S. Highway 287; (2) favorable site for the future town; (3) centralized location between ore bodies to the north and south of the mill; and (4) favorable hydrogeologic conditions, which afforded rapid elimination of water in the tailings through seepage into the underlying aquifer. The mill was located approximately 3.2 kilometers (km) (or 2 miles (mi)) northeast of the company town of Jeffrey City, Wyoming, at the head of two alluvium filled valleys.

Chapter 2.0 of the SGWCE contains a detailed description of the milling process (WNI, 1999). The Split Rock mill was an acid-leach, ion-exchange, and solvent-extraction uranium ore processing mill. Ore was processed by a semi-autogenous grinder, leaching circuit using sulfuric acid and sodium chlorate, ion exchange and solvent extraction, stripping and precipitation using ammonium sulfate and anhydrous ammonia, and drying. Simplified schematics of the mill process from 1957 to 1965 and from 1965 to 1981 are shown in the SGWCE (WNI,1999).

The Split Rock Mill processed approximately 7 million metric tons (tonnes) (or 7.7 million short tons) of uranium ore from 1957 to 1981. The facility was designed originally to process 364 tonnes (400 tons) of ore per day. However, in 1961, because of heightened uranium demand, the milling capacity was increased to 768 tonnes (845 tons) per day. By 1967, milling capacity had increased to approximately 1091 tonnes (1200 tons) per day, to accommodate contracts with both private industry and the AEC. After a series of expansions in the 1970s, the mill was processing 1545 tonnes (1700 tons) of ore per day.

On June 19, 1981, WNI announced that the mill would be placed on standby, because of diminished demand and depressed uranium prices. The mill remained on standby until 1986, when the license was amended to terminate use of the tailings pond for disposal, and WNI was required to submit a Tailings Reclamation Plan to NRC. The mill was decontaminated and decommissioned in the summer of 1988. Mill components were dismantled and buried in the mill burial site, which is located primarily beneath the former mill site.

2.2.2 Waste Management

During the period of mill operation, process wastes in the form of tailings solids and acidic liquids were discharged to the tailings disposal area. Wastes not associated with milling (e.g., administration and mill-building sanitary wastes, paper products, etc.) were disposed of in the Sewage Lagoon or the Waste Trench located in the Southwest (SW) Valley. At one time, the Jeffrey City town landfill was sited in the SW Valley. Waste management practices are described in greater detail in Appendix F of the SGWCE.

2.2.2.1 Tailings Impoundments

The tailings impoundments were operated from 1958 until 1981 and consisted of three distinct areas referred to as the Main, Old, and Alternate Tailings Impoundments. WNI designed these ponds per the original AEC license (R-205). At that time, pond designs favored the elimination of process effluent through seepage. The Old Impoundment, was operated from 1958 to 1977 and originally occupied approximately 40.5 hectares (ha) (or 100 acres (ac)).

The Alternate Tailings Impoundment was constructed before 1977 and served as an additional tailings storage area. In 1977, tailings liquid overtopped and breached the Old Tailings Impoundment embankment. After the breach, the embankment was repaired, all tailings were returned to the impoundment, and a new compacted tailings embankment was constructed upstream of the existing embankment. This embankment created the Main Tailings Impoundment. The Old and Alternate Impoundments were not used after 1977. The 51.5-ha (127.2-ac) Main Tailings Impoundment consisted of new tailings (deposited after 1977) overlying portions of the old tailings (deposited before 1977).

By the end of operations, the three tailings disposal areas encompassed approximately 72.8 ha (180 ac) and contained approximately 7 million tonnes (7.7 million tons) of tailings. Approximately 4.8 million tonnes (5.3 million tons) of waste solids were discharged before 1977 in the Old and Alternate Tailings Impoundments, and the remaining 2.2 million tonnes (2.4 million tons) of waste solids were discharged to the Main Tailings Impoundment. The maximum thickness of tailings deposited in the impoundments is approximately 24.4 meters (m) (or 80 feet (ft)).

2.2.2.2 Waste Trench

The Waste Trench was located in the southwest portion of the site, south of the Old Tailings Impoundment and east of the Alternate Tailings Impoundment. The burial trench area occupied approximately 3.1 ha (7.7 ac). The bottom of the trench was above the maximum level of the ground water table.

In general, four major types of waste were placed in the waste trench, including:

- Carbon and wood fibers cleaned out of the ore pulp after leach

- Waste paper, bottles, rags, and miscellaneous trash
- Worn-out parts, equipment, and other materials
- Trash material in ore segregated on the ore pad and at the mill-feed shoot, which consisted of wood, wire cable, old tools, roof bolts, and so forth.

The trench was approximately 5.5-m (18-ft) wide by 4.3-m (14-ft) deep by 30.5-m (100-ft) long. Material in the trench was compacted by tracking it with a bulldozer. Once filled, the trench was covered with a minimum of 1.2 m (4 ft) of clean soil. The center of the trench was located approximately 61 m (200 ft) south and 61 m (200 ft) east of the toe of the southwest corner of the Old Tailings Impoundment (WNI, 1999).

2.2.2.3 Disposal of Spent Acid

During the 1960s and 1970s, WNI sold sulfuric acid produced at the site to several local petroleum refineries and agreed to dispose of the spent acid (WNI, 1999). From 1962 until the mill tailings impoundment overflowed in April 1977, spent acid was disposed of by the direct discharge of tanker trucks into the tailings impoundment. After the overflow, WNI no longer accepted spent acid for disposal.

2.2.2.4 Landfills

The Split Rock mill was decommissioned and demolished during the summer of 1988. Components were dismantled and buried in the mill site burial area. The mill site burial area was primarily located beneath the former mill site. Non-hazardous and non-radioactive solid wastes from the mill and the town of Jeffrey City were buried in a sanitary landfill southeast of the former mill building and northwest of the former seepage ponds. Procedures for the sanitary landfill operation were inspected and approved by the appropriate Wyoming State agencies.

2.3 Corrective Actions

2.3.1 SW Valley

Before 1983, no ground water corrective actions occurred in the SW Valley. From 1983 to 1986, essentially all ground water flow down the SW Valley was captured by wells WN-A, WN-B, and WN-C and returned to the tailings impoundment. From 1986 to December 1989, no water was extracted from the SW Valley wells pending approval of the current CAP. In January 1990, the CAP was initiated in the SW Valley. The CAP system was designed to reduce the mass of constituents in the ground water system by capturing the annual pumping volume objective (volume of extracted water required by NRC staff) of 179 to 250 million L (47.3 to 66 million gallons (gal.)) per year (average pumping rate of approximately 341 to 473 liters per minute (Lpm) (or 90 to 125 gal. per minute (gpm)).

Initially, the wells operated year-round, but in February 1992, pumping was reduced to approximately 6 months per year (April through October). In the SW Valley, the CAP consisted of ground water extraction from Well 9E and WN-B until April 1995, when Well 9E was removed from the CAP to facilitate surface reclamation. In 1997, the CAP was further modified by changing the aforementioned annual pumping volume objective to 22.7 to 56.8 million L (6 to 15 million gal) per year because surface reclamation reduced the area available for evaporation of extracted ground water, as part of the CAP.

Approximately one-half of the total CAP pumping is from the SW Valley, which equates to an annual rate of approximately 38 Lpm (10 gpm). At the current CAP pumping rate and duration, the CAP is removing only a fraction of the present annual ground water flow. Although constituent mass has been removed from the ground water, the CAP was not designed to reduce the source term or retrieve contamination that passed the SW Valley mouth prior to 1983.

2.3.2 NW Valley

Until 1986, all site-derived ground water flowing down the NW Valley was captured by ground water extraction from Well 2. Before 1977, pumping rates at Well 2 were as high as 5300 to 5490 Lpm (1400 to 1450 gpm). During 1981 to 1986, the pumping rate at Well 2 was reduced to 2460 Lpm (650 gpm). After the NRC staff approved the cessation of pumping from Well 2 in 1986, ground water began to migrate from the NW Valley into the Sweetwater River floodplain. In January 1990, the NRC CAP was initiated, which consisted of pumping Wells 4E and 5E in the NW Valley.

Similar to the SW Valley wells, the NW Valley wells operated year-round. In February 1992, pumping in the NW

Valley was reduced to approximately 6 months per year (April through October). In May 1997, pumping of Well 5E in the NW Valley stopped because of reduced evaporative capacity from surface-reclamation activities and low constituent-recovery efficiency from this well. As stated in Section 2.3.1, the total volume objective was reduced to 22.7 to 56.8 million L (6 to 15 million gal.) per year. In the NW Valley, at the current pumping rate (approximately 38 Lpm (10 gpm)) and duration, the remaining well (Well 4E) is removing a small fraction of the annual ground water flow from the NW Valley and, therefore, is no effectively reclaiming ground water. Additionally, the CAP is ineffective in remediating contaminants that have all ready migrated past the mouth of the valley beyond the area of CAP pumping influence.

3.0 TECHNICAL EVALUATION

3.1 Geology and Hydrogeology

WNI characterized the geology and hydrogeology at the site by sampling and analyzing soil and rock, ground water samples, and aquifer test data. WNI collected data over two sampling events, one in the mid 1996-1997 and one 2002. NRC staff determined that the resulting geologic and hydrogeologic conceptual model is supported by the data collected by WNI.

3.1.1 Geology

Geologic information was obtained from the SGWCE (WNI, 1999). The site is located approximately 3.2 km (2 mi) south of the crest of the Granite Mountains, in Fremont County, which form part of the boundary between the Wind River and Great Divide basins. Major structural features near the site are the Granite Mountains Uplift, north and south Granite Mountains fault system, and the Split Rock syncline. The Emigrant Trail fault is located within the site, although it has been dormant since sediment deposition and lithification (Miocene Epoch of 5 to 24 million years (MY) ago).

During the Miocene Epoch, the southern portion of the Granite Mountains began to subside into the Split Rock Syncline. Simultaneously, an enormous volume of tuffaceous strata was deposited across most of Wyoming. These deposits became what is known as the Split Rock Formation in central Wyoming.

During the early to middle Pliocene Epoch (3.5 to 5 MY ago), the Split Rock Syncline continued to sag, forming Moonstone Lake. In and adjacent to the lake, more than 305 m (1000 ft) of tuffaceous strata comprising the Moonstone Formation were deposited. Some of the beds in the Moonstone Formation were unusually rich in uranium and thorium and are believed to be source rocks for part of the uranium ore present in the Gas Hills and Crooks Gap uranium districts. Many zones are locally radioactive and contain more than 0.01 percent uranium. A regional uplift event began in the late Pliocene Epoch (2 to 3 MY ago), beginning the present cycle of erosion in most of central Wyoming.

Geologic units at the site are as follows:

- Sweetwater River Alluvium - Limited to Sweetwater River floodplain, up to 7.6 m (25 ft) thick. It is typically a fining upward sequence of gravel, sand, silt, and clay. Lower gravels typically contain well-rounded, pebbles 5 millimeters (mm) to 10 mm (0.2 to 0.4 inches (in.)) in diameter, with some up to 50 mm (2.0 in.) in diameter. Finer gravel and sand are dominantly quartz. Sands are typically poorly sorted. Silt- and clay-dominated zones are limited to the upper 1.5 to 3.0 m (5 to 10 ft) of the unit.

- Eolian Deposits - Limited in extent and discontinuous, up to 15.2 m (50 ft) thick. They occur as mostly stabilized sand dunes near granite outcrops and south of the mill site. Grains are pale yellow, fine to medium, quartz sand.

- Alluvium - Present in all but the granite outcrop and Sweetwater River floodplain areas. It is up to 5.5 m (18 ft) thick and occurs as terrace deposits and alluvial wash from uplands. Gravels, sands, and clays occur in both coarsening upward and fining upward sequences. Gravels contain pebbles up to 50 mm (2.0 in.) in diameter. Finer gravel and sand are dominantly quartz.

- Split Rock Formation
  Upper Split Rock Unit (USR) - Present in all but granite outcrop areas, up to 610 m (2000 ft) thick. It is typically a brown, poorly indurated, fine- to medium-grained, well-sorted, silty sandstone. Sand grains are dominantly quartz, with small amounts of magnetite. Interbeds of gravel, clay, and calcareous sandstone

are common.

Lower Split Rock Unit (LSR) - Present in lower valley areas between granite outcrops, up to 91.5 m (300 ft) thick. It is typically a poorly cemented clayey and sandy conglomerate or gravel composed of weathered granite granules and pebbles up to 35 mm (1.4 in.) in diameter. Interbeds of sandstone, siltstone, and claystone are common. Sandstones are similar to those found in the USR.

- White River Formation - Very limited in extent, up to 19.8 m (65 ft) thick. It occurs as isolated erosional remnants in structural low areas in the Precambrian surface beneath the Sweetwater River floodplain. Consists of yellow, light gray, light olive gray, and grayish orange interbedded sandstones, sandy claystones, and silty/clayey sandstones.

- Precambrian Granite - Underlies entire area, undetermined thickness -- the granite is composed primarily of clear to gray quartz, white potassium feldspar, and minor amounts of block hornblende. The granite is typically weathered in the uppermost 1.5 m (5 ft) and is yellowish brown in color.

3.1.2 Hydrogeology

Ground water flow and transport of site-derived constituents primarily involves the Sweetwater River Alluvium aquifer, called the floodplain aquifer, and the LSR and USR, collectively called the Split Rock aquifer. The floodplain aquifer is a shallow aquifer 4.6 to 9.1 m (15 to 30 ft) thick of river sediments that overlies and is hydraulically connected to the Split Rock aquifer. This shallow and highly permeable floodplain aquifer was formed where the river cut and meandered across the Split Rock Formation which fills the alluvial basins between the Green Mountains to the south and the Granite Hills.

The Split Rock Formation outcrops in a wedge-shaped pattern that begins west of Sweetwater Station (approximately 32.2 km (20 mi) west of the site) and extends east to the North Platte River (approximately 64.4 km (40 mi) east of the site), covering an area of approximately 3883 square km (km^2) (or 1500 square mi (mi^2)) (WNI, 1999). Its saturated thickness ranges from 152 to 915 m (500 to 3,000 ft) south of the Sweetwater River and from 61 to 183 m (200 to 600 ft) north of the river. Areas of greatest saturated thicknesses are along the axis of the Split Rock Syncline, directly south of the site. Table 2 summarizes the hydrogeologic characteristics of the aquifers at or near the site.

Table 2
Aquifer Hydrogeologic Properties

Unit	Transmissivity m^2/day (ft^2/day)	Storativity	Hydraulic Conductivity m/day (ft/day)
Upper Split Rock	217 (2337)	0.021	5.8 (19.0)
Lower Split Rock	107 (1153)	0.003	2.0 (6.6)
Floodplain	389 (4185)	0.21	76 (248)
Alluvial Deposits	66 (710)	0.005	3.0 (9.8)

Aquifers near the site are recharged from direct precipitation on the valley floor and from precipitation run-off from the surrounding granite hillsides. Approximately 1.5 centimeters (cm) (0.6 in.) per year of precipitation infiltrates the valley floor to deep recharge, whereas approximately 15 cm (6 in.) per year of runoff from the surrounding granite hillsides recharge the floodplain aquifer. Drainage of the tailings has also historically added approximately 5300 Lpm (1400 gpm) to the site ground water system. Since tailings and water disposal in the tailings impoundments ceased in 1986, tailings drainage and consolidation have greatly diminished, and the elevated ground water levels beneath the tailings caused by tailings drainage have largely dissipated (see Section 3.1.3).

Ground water at the site flows from high elevations surrounding the Main Tailings Impoundment, down the NW and SW Valleys, and then merges with regional flow. Ground water exiting the NW Valley merges with northeastward regional flow. Ground water exiting the SW Valley meets regional flow and diverges into two flow paths around the granite outcrops, one to the north and one to the southeast. Approximately 80 percent of the SW Valley ground water flows to the south and east around the granite outcrops, whereas the remaining 20 percent flows to the north, where it joins the regional flow in the Sweetwater River floodplain.

In the vicinity of the Split Rock Site, the regional flow gradient is approximately 0.003 to the east. Areas with structurally high granite 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 and floodplain aquifers occurs at the point where the river passes through the granite outcrop at the Three Crossings Diversion Dam. This constriction enhances ground water discharge from the floodplain aquifer into the Sweetwater River.

The Sweetwater River is the primary discharge point for the regional ground water flow, though it acts as a recharge mechanism to the floodplain aquifer during periods of seasonal high flow, typically from May to August. Near the site, the river is classified as Class 2AB surface waters. Class 2AB waters are those known to support game fish populations or spawning and nursery areas at least seasonally. Unless it is shown otherwise, these waters are presumed to exhibit sufficient water quality and quantity to support drinking water supplies and are protected for that use. Class 2AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, primary contact recreation, wildlife, industry, agriculture, and scenic value uses (WDEQ, 2006).

Currently, approximately 90 percent of the tailings seepage and ground water originating from under the Main Tailings Impoundment migrates down the NW Valley, while the remainder flows down the SW Valley. Future percentages are expected to be 100 percent and 0 percent, respectively, as the water table in the uppermost NW Valley falls below the lowest point in the bedrock saddle. However, sufficient basin area exists in the SW Valley below the bedrock saddle for ground water flow to continue in perpetuity from precipitation and resulting recharge.

3.2 Recent and Projected Conditions

3.2.1 NW and SW Valley Flow

In 1996, approximately 795 Lpm (210 gpm) of ground water was discharging from the NW Valley, 568 Lpm (150 gpm) from the Main Tailings Impoundment and 227 Lpm (60 gpm) from recharging precipitation. Discharge from the SW Valley was 197 Lpm (52 gpm), 78 Lpm (20 gpm) from the Main Tailings Impoundment seepage and 121 Lpm (32 gpm) from recharging precipitation. Estimates of future flow conditions indicate that the existing tailings seepage will decrease from 1996 rates to an average of approximately 30 gpm over the next 30 years due to construction of the compacted clay reclamation cover. Evidence of decreasing discharge was observed, as the NW Valley seepage pond went dry between 1986 and 1990. The long-term, steady-state tailings seepage rates will equilibrate with the reclaimed tailings area recharge (infiltration) rate (0.6 inches per year) resulting in tailings seepage rates of less than 5 gpm. Little seepage from the Main Tailings Impoundment would enter the SW Valley. However, areal recharge to the SW Valley will maintain long-term ground water flow out of this valley of approximately 32 gpm. The ground water flow from the NW Valley will equilibrate to approximately 85 gpm in the long term.

3.2.2 Surface Water

Several streams, lakes, and ponds, and numerous dry washes can be found within 16 km (10 mi) of the site. Approximately 1.6 km (1 mi) north of the site are the Sweetwater River (the only perennial stream in the site vicinity) and several floodplain lakes adjacent to the river. These lakes are north of the river and are essentially unconnected to the hydrologic systems south of the river (WNI, 1999). South of the site are several perennial streams that become intermittent in the lower reaches. Only a few of these streams are named (Crooks Creek, Sheep Creek, O'Brien Creek, and Pipeline Creek).

The Sweetwater River is a major surface drainage system in the Great Divide Basin. It is a tributary of the North Platte River, originates in the Wind River Mountains (west of the site), and flows generally from west to east, past the Split Rock site to the Pathfinder Reservoir, approximately 64.4 km (40 mi) east of the site. The Sweetwater River is used for fishing, irrigation, and stock watering through direct pumping or diversion ditches, thereby increasing the variability of its flow regime. Surface water users within 8 km (5 mi) of the site are the McIntosh, Grieves, Jamerman, and Welch ranches. Grieves Ranch is the closest to the site, located approximately 1.6 km (1 mi) northwest of the site, on the north bank of the Sweetwater River.

The lowest 7-day running average flow on record at the Sweetwater Station (closest station to the site) is 0.08 cubic meters per second (cms) (or 2.1 cubic feet per second (cfs)), and the average annual flow at the Sweetwater Station is 5.2 cms (185 cfs). The average peak daily flow is 41.3 cms (1459 cfs) (USGS, 2006). Interaction between the river and the local floodplain aquifer is dynamic as indicated by the large, seasonal water level changes in floodplain aquifer wells in response to river stage changes. A review of recent monitoring data indicates that the site may be contributing sulfate, total dissolved solids (TDS), and uranium (WNI, 2005c&d) to the Sweetwater River, as a result of this interaction. However, these increases are minimal and do not impact surface water use. For example, the maximum uranium surface water concentration since 2004 is 0.013 mg/L, which is well below the U.S. Environmental Protection Agency's (EPA's) maximum contaminant level (MCL) of 0.03 mg/L.

3.3 FLOW AND TRANSPORT MODELING

NRC staff reviewed WNI's original ground water flow and contaminant transport models provided in the SGWCE. However, because of NRC's concerns with the predictive capability of the contaminant transport model, WNI produced a second and final ground water modeling study in connection with its SGWCE (WNI, 2003). This study takes advantage of additional data collected since the previous study (WNI, 2002), more advanced inverse modeling tools to match history results for well heads and concentrations, and transient flow and transport models *in-lieu* of steady-state models. WNI also takes credit for uranium retardation based on observations of declining uranium concentrations downgradient of the tailings. WNI used these models within a framework of existing data on hydraulic heads and solute concentrations from a network of wells.

NRC staff reviewed the current models, previous models, and previously collected background information to assess plume migration. The final modeling study assumes transient conditions that predict a decline in infiltration because of the low permeability cover and the gradual decline in the existing hydraulic head. Compared to the previous steady-state models presented in the original amendment application (WNI, 1999), NRC staff concludes that modeling performed in the final study is inherently more reliable and should improve the predictions of the evolution of the downgradient uranium plume.

3.3.1 Retardation of Uranium

The staff was most concerned with the WNI's uranium retardation assumption. To support this assumption, WNI cited the decline in the uranium/sulfate ratio, as the plume progressed down the SW Valley. Assuming that sulfate is a conservative contaminant (migrates without retardation), then the decline in the uranium/sulfate ratio indicates that some external factor is causing uranium to disappear from solution, at least temporarily. Since the only model WNI contemplated for uranium transport is retardation, using the partition coefficient (Kd) approach with a linear isotherm, the inverse modeling of the uranium plume identified a small but positive Kd factor of 0.2 L/Kg, which translated to a retardation factor retardation factor (Rd) of about 2. This calibrated Kd value is at the lower end of the range of all experimentally measured data.

Despite WNI's modeling effort, the behavior of the uranium plume cannot necessarily be explained strictly as simple retardation, using an equilibrium Kd approach. If sulfate were conservative and uranium were retarded with a reversible equilibrium model, then the uranium and sulfate concentrations would not track each other as well as they do in Figures 5.5.1 through 5.5.5 of the 2003 modeling report (WNI, 2003). Complicating factors likely exist that account for the apparent decline in uranium concentration. Among the possible causes of the observed results are:

11. Precipitation or co-precipitation of uranyl minerals from solution - geochemical modeling studies the licensee conducted suggest that the ground water in parts of the plume may be saturated with respect to some uranyl-calcium-silicate minerals, and also uramphite (uranyl-ammonium-phosphate) although there is no direct evidence that these minerals are precipitating. Co-precipitation with hydrous ferric oxides is also a possibility, especially in portions of the plume where pyrite is oxidizing.

12. Reduction of uranyl species - uranium in the +4 state is much less soluble than in the +6 (uranyl) state. Approximately half of the tailings contained up to 0.7 percent pyrite by volume. Pyrite oxidation can remove oxygen from ground water, leading to the possibility of a reducing environment. Pyrite oxidation leads to the formation of hydrous ferric oxides (typically ferrihydrite) that also sorb and co-precipitate uranium and sorb other ions such as hydrogen ions. Even this behavior is complex, because as the amorphous ferrihydrate ages, it becomes more crystalline and less sorptive, and may actually release sorbed uranium and acid back into solution. Although reducing zones may exist, these are not likely extensive and enduring at or near this site.

13. Non-linear sorption and desorption - in most situations, it has been observed that uranium and other species do not follow the Kd linear isotherm model. At the very least, uranium sorption from some tests indicated a nonlinear relationship between Kd and uranium concentrations, with the highest values of Kd

associated with the lowest uranium concentrations. Often, rates of uranium adsorption are fast, but desorption is slow. Evidence of slow desorption of uranium exists in some data collected at this site, with release of only 10 percent of the uranium partitioned on to soils per pore volume of water flowing through it. Surface complexation is an alternative model of sorption behavior, and may explain better how the observed concentration of sorbed species usually “tails” off for long periods of time, whereas the Kd linear isotherm approach predicts none of this tailing behavior.

3.3.2 Anomalous Uranium Concentration Near Red Mule

High concentrations of uranium relative to other background wells have been observed in the Red Mule subdivision, raising suspicions that the uranium plume from the tailings disposal area has already reached monitoring wells near this subdivision. WNI argues that the observed concentrations in the Red Mule subdivision are naturally occurring, and were not caused by the tailings (WNI, 2002). The licensee points to several lines of evidence that the background uranium is naturally occurring:

1. Hydraulic modeling indicates that ground water velocities are too low to allow contaminants emanating from the tailings to have reached the Red Mule subdivision during approximately 50 years of operation and restoration.

2. Data from wells in the likely pathway of ground water flow indicate that the uranium plume is well up-gradient of Red Mule, and that wells between the edge of the plume and Red Mule have background levels of uranium.

3. The geochemical signature of waters in the Red Mule wells differs from that of the tailings water, specifically in levels of sulfate and chloride that would be at least as mobile as the uranium.

4. Ratios of stable isotopes in the Red Mule wells are significantly different from the tailings waters.

Uranium decay progeny Th-230 and Ra-226 are essentially in secular equilibrium with the uranium in the Red Mule wells, indicating that they have likely evolved in place from long-standing deposits. There would be a significant disequilibrium among these decay products had they been transported from the tailings, because thorium and radium are considerably less mobile than uranium in this environment.

3.3.3 Modeling Summary

Results of WNI’s flow and transport models indicate that uranium-contaminated ground water will remain within the LTSB for the entire 1000-year compliance period (see Figure 1). Although the staff finds that the models for uranium transport are likely oversimplified, all information WNI provided indicates that viable mechanisms exist for uranium retardation and/or removal, at this site. The licensee takes credit for retardation that is approximately a factor of 2. Measurements of adsorption and desorption Kds at this site are almost all greater than the value of 0.2 used by the licensee in its forecast of uranium transport. It is possible that mechanisms such as reduction, precipitation and co-precipitation are actually removing uranium from the system. Since the Kd linear isotherm model does not lead to an actual removal of uranium but only a retardation, it would not itself account for a decline in the peak uranium concentration eventually reaching the downgradient locations of concern (e.g., the Red Mule wells). The only question is how far the downgradient edge of the plume (defined by the licensee as 0.1 mg/L uranium) will extend.

Nevertheless, NRC staff concludes that mechanisms either retarding or removing uranium from solution are present, and that the licensee’s choice, in terms of a Kd is reasonable for its intended purpose. NRC staff also finds the evidence supports the licensee’s contention that uranium concentration in the Red Mule wells did not originate from the tailings plume. Furthermore, the licensee is conservative in not including levels of uranium from the Red Mule site in its definition of true background, although all evidence indicates that the plume has not reached those wells. On the basis of this review, the staff finds the latest modeling study discussed in the reference (WNI, 2003) adequately supports the extent of the long-term boundary (see Figure 2).

4.0 HAZARD AND EXPOSURE ASSESSMENTS

WNI performed a baseline risk assessment that included hazard and exposure assessments for human health and the environment [see Appendix I of SGWCE (WNI, 1999)]. These assessments were performed by evaluating both current and future risks associated with site-derived contamination.

4.1 Human Health Hazard Assessment

The hazard assessment is the process by which constituents of concern are identified through a systematic process and exposure pathways are defined. WNI used the following process to address NRC staff's requirements for hazard assessments:

1. All constituents listed in 10 CFR Part 40, Appendix A, and 40 CFR Part 192, except volatile and semi-volatile organics, were selected for consideration. Volatile and semi-volatile organics were eliminated because none was identified in site tailings or ground water [see Appendix F of the SGWCE (WNI, 1999)].

2. Additional constituents reasonably assumed to be derived from byproduct material that could adversely impact human health and the environment were included in the list.

3. Maximum ground water concentrations from the tailings impoundments for the period of January 1, 1996, through December 31, 1997 (Table 1-3-2 of SGWCE, Appendix I) (WNI, 1999), were compared to the lowest background concentration of the floodplain or Split Rock aquifers. Those constituents that were not detected in concentrations greater than the lowest background concentration were discarded and were not considered potentially hazardous for this site.

4. The remaining constituents were compared to protective standards [i.e., background, MCLs, or EPA, Region 3, Risk-Based Concentrations (RBCs) for those constituents with no MCLs)]. The higher of background, MCL, and RBC values were considered to be the values protective of human health.

5. Any constituent for which the maximum measured concentration in the tailings impoundments was greater than the larger of either: (a) the lowest ground water background value or (b) its respective MCL or RBC value, was considered a constituent of potential concern (COPC).

6. Existing COPC concentrations beyond the edge of tailings reclamation were compared to the protective standards, to assess human health risks at the time of the SGWCE.

7. All concentrations of COPCs above the protective standards beyond the edge of the tailings reclamation cover, at the time of the SGWCE, were considered to be the only constituents with the potential to exceed protective standards in the future. Therefore, these constituents of concern (COCs) were the focus of corrective action alternative development and evaluation.

Results of this evaluation indicated that the only COCs were the ACL parameters presented in Table 1. Pathways evaluated during this review include human and ecological exposures to contaminated floodplain soils, ecological exposures to contaminated surface water, consumption of vegetables watered using contaminated ground water, and consumption of beef from cows foraging on the aforementioned vegetables and also watered using contaminated ground water. Human consumption of contaminated ground water was not considered, since ICs would preclude such uses within the LTSB.

4.2 Exposure Assessment

4.2.1 Ecological Exposure Assessment

For ecological exposures to occur, concentrations of COCs within soil and surface water would need to be present in sufficient concentrations to impair ecological health. WNI addressed ecological exposures in its Environmental Assessment, included as Attachment I.b of Appendix I of the SGWCE. Types of analyses performed for this risk assessment include surface water sampling, sediment and soil sampling, soil toxicity tests, fish tissue analysis, and benthic macroinvertebrate studies. The analytical parameters for this study included the following:

ammonium	copper	manganese	radium-226 and -228	thorium-230
arsenic	fluoride	molybdenum	selenium	uranium-234, -235, and -238
cadmium	iron	nickel	silver	zinc
calcium	lead	nitrate	sodium	
chloride	magnesium	potassium	sulfate	

WNI also analyzed samples for water quality parameters including, pH and TDS. Soil toxicity tests were performed using the organisms *Ceriodaphnia dubia* and *Hyalella azteca* for sediments.

4.2.1.1 Sweetwater River Sampling

Based on the analysis of laboratory data, the portion of the Sweetwater River north of the site, has a high-quality ecosystem typical of cold-water prairie streams. Physical land use patterns within the vicinity of the river (e.g., cattle grazing, bridge crossings, and agricultural activities) have likely affected the river to a greater extent than have potential chemical influences derived from previous operations at the site. As stated previously, NRC's review of recent surface water analytical data indicates that the site contributes minor amounts of TDS, sulfate, and uranium.

Table 6-1 of the SGWCE, Appendix I, displays a matrix summarizing statistical differences in assessment endpoints between upstream reference and downstream experimental sampling locations. Although differences between certain reference and site sample ecological endpoints were identified, no single location was characterized as being simultaneously: a) chemically impacted, as demonstrated by sediment chemical analyses; b) ecologically impacted, as demonstrated by benthic invertebrate analyses; and c) toxicologically impacted, as demonstrated by laboratory bioassay analyses. WNI concluded, and NRC staff concurs, that site-derived contaminants are not adversely impacting ecological receptors.

4.2.1.2 Soil, Vegetation, Sediment, Surface Water, and Fish Tissue Sampling

Soil concentrations exceeded the reference concentrations at some locations; however, surface soil does not contain concentrations of site metals that would pose a risk to humans nor ecological receptors in the area. Thorium-230 was elevated at a single location within the NW Valley near the site. This location was within the area where cleanup and radiological verification were concluded or will be within the boundary of the reclamation cover system. Concentrations of manganese in vegetation from the NW Valley exceeded reference location vegetation concentrations.

Some differences between site samples and reference samples could be attributable to the variance among vegetation type, since each sample was a composite of the available vegetation. Comparison of all vegetation sample results to maximum tolerance levels (MTLs) (domestic animal dietary levels that do not produce unsafe residues in food) indicates that actual constituent concentrations in vegetation would not pose an unacceptable potential risk to wildlife, livestock, nor to humans potentially ingesting animal products.

Analytical results for Pond sampled in October 1995 indicated that the uranium concentration exceeded the Wyoming Livestock standard by 1.3 times. Subsequent sampling during 1996 indicated that the uranium concentration in the pond is typically much lower than the Wyoming standard. No adverse health impacts would be expected to occur if the maximum concentration in these waters was ingested by wildlife or livestock, and there would be no impact to humans who might consume meat from these livestock. Metals concentrations in fish tissue from the Sweetwater River are not present at levels that represent a potential for human health impacts from fish consumption. Also, wildlife potentially exposed to either soils and/or ground water within the LTSB would not be adversely impacted.

In summary, although some media near the site may have been impacted by previous site operations (e.g., vegetation, surface soils, and pond sediment), as shown by comparison with samples from unaffected reference locations, the concentrations in those media are too low to adversely impact humans or animals. Therefore, based on these results/data, no additional study of the site media is warranted.

4.2.2 Human Exposure to Contaminated Soils

The risks to human health from the shallow floodplain soils was calculated using the RESRAD computer code NRC had developed to evaluate residual radioactive contamination. Dose conversion factors assumed in the RESRAD modeling are adapted from the EPA Federal Guidance Report No. 11 (EPA, 1988). Dose represents the committed effective dose equivalent from an annual exposure estimated for a receptor.

Human exposure pathways quantitatively assessed for this scenario include:

- Direct irradiation from floodplain soils
- Ingestion of floodplain soils
- Inhalation of dust from floodplain soils

The maximum reported values for U-234, U-235, U-238, Ra-226, and Th-230, were conservatively used to represent total exposure risk to the floodplain soils. Input soil data [depth = 76 cm (30 in.)] were obtained from the shallow floodplain soil sampling events of 1996 and 1997 (see Appendix F of the SGWCE).

Results of the RESRAD model are presented in Table 3. In summary, the maximum dose is 0.5 millirem per year (mrem/yr) and occurs at time 0. Future doses would only decrease from this level. This dose is well below the NRC acceptable annual dose level, for the general public, from residual radioactivity, at decommissioned sites, of 25 mrem/yr (10 CFR 20.1402). No corrective actions are required for the floodplain soils.

Table 3
Summary of Exposure Dose for Radionuclides From Floodplain Soils Pathway

Radionuclide	Direct Gamma	Ingestion of Soil	Inhalation of Soil	Total
Ra-226 (mrem/yr)	3.63 E-1	1.08 E-2	4.21 E-5	
Th-230 (mrem/yr)	3.08 E-5	5.31 E-4	1.23 E-3	
U-234 (mrem/yr)	9.56 E-5	2.53 E-4	4.61 E-3	
U-235 (mrem/yr)	2.62 E-2	8.76 E-3	1.08 E-2	
U-238 (mrem/yr)	2.43 E-2	1.85 E-3	3.16 E-3	
Total by Pathway (mrem/yr)	4.14 E-1	2.44 E-2	1.99 E-2	4.59 E-1

4.2.3 Agricultural and Livestock Uses of Ground Water

NRC staff reviewed the safety issues regarding the use of ground water for agriculture (Class II use) and livestock watering (Class III use) within the LTSB. NRC staff compared current and expected concentrations of ACL contaminants to current WDEQ ground water protection standards. WNI is only allowing Class II and Class III ground water uses on the McIntosh property west of the site, which is near well SWAB-22. Table 4 is a comparison of ACL concentrations in this well with WDEQ's Class II and Class III standards.

Table 4
ACL Concentrations in SWAB-22 and WDEQ Standards

Contaminant	SWAB-22 Concentrations	Class II Standards	Class III Standards
Manganese (mg/L)	0.07	0.2	None
Molybdenum (mg/L)	<0.2	None	None
Ammonia (mg/L)	<0.05	None	None
Radium-226 & -228 (pCi/L)	<3.0	5	5
Natural Uranium (mg/L)	0.023	None	None
Sulfate (mg/l)[1]	41	200	3,000
Nitrate (mg/l)[2]	0.6	70.7	None

Sources: WNI, 2006 and WDEQ, Chapter 8, Water Quality Rules and Regulations
1. Not an ACL parameter; used as a conservation contaminant migration indicator.
2. Actual standard is for nitrite. Will compare nitrate + nitrite to determine compliance

A review of this table indicates that current ground water concentrations comply with WDEQ's Class II and III standards. This will likely remain the case over time because well SWAB-22 is either beyond or slightly upgradient of the plume. Because seepage from the impoundments is decreasing, contamination in excess of the standards is not likely to spread west and impact the McIntosh property.

The chemical toxicity of uranium was evaluated for cattle and native grasses as the most likely receptors to be found in the vicinity of the Split Rock site. Cattle were assumed to eat forage grown with contaminated irrigation water and drink contaminated ground water. The calculated daily uranium intake for cattle was 230 milligrams per kilogram (mg/kg), which is less than 6 percent of the dose found to cause health effects in previous studies on cattle (WNI, 2004). For native grasses, no adverse effects were identified at a concentration of 5000 mg/kg natural uranium in the plant, which far exceeds the potential 170 mg/kg natural uranium concentration expected at the site.

The dose assessment screening model chosen to estimate, for residents, their radiological impact from uranium contaminated water used for agriculture and other ranching purposes, is generally conservative. The model reflected consumption of beef and vegetables all raised on the contaminated site. The calculated potential dose of 6 mrem/yr is an overestimation caused by the conservative model assumptions. Considering the results of several types of analysis performed, significant impacts on human health are not likely from the agricultural nor livestock watering uses of the Split Rock contaminated ground water.

5.0 GROUND WATER MONITORING PROGRAM

As part of NRC's basis for approving the ACLs, a comprehensive ground water and surface water monitoring program would be implemented. The purpose of this program is to detect ground water or surface water contamination before it reaches potential receptors, to track the movement and concentrations of the ground water contaminant plume, and to account for uncertainty with the proposed ground water flow and transport models. Table 5 presents the monitoring program and Figure 2 presents the monitoring locations. The U.S. Department of Energy (DOE) would eventually undertake such a monitoring program after license termination.

Table 5
Surface Water and Ground Water Compliance Monitoring Network

Monitoring Wells/Sample location	Parameters
JJ-1R; SWAB-1; SWAB-2; SWAB-4; SWAB-12; SWAB-22; SWAB-29; SWAB-31; SWAB-32; WN-39B; WN-41B; WN-42A; Upstream SW-A; SW-B; SW-C; Downstream	Semiannual Sampling - uranium (natural); sulfate; water quality parameters pH and conductivity; and water levels. Annual Sampling - aluminum; ammonia; antimony; arsenic; beryllium; cadmium; chloride; fluoride; lead; manganese; molybdenum; nickel; nitrate; pH; radium-226 and -228; selenium; sulfate; thallium; thorium-230; total dissolved solids; uranium (natural); water quality parameters pH and conductivity; and water levels.
WELL 1; WELL 4R; WELL 5; WN-21	Semiannual Sampling - aluminum; ammonia; antimony; arsenic; beryllium; cadmium; chloride; fluoride; lead; manganese; molybdenum; nickel; nitrate; radium-226 and -228; selenium; sulfate; thallium; thorium-230; TDS; uranium (natural); water quality parameters pH and conductivity, and water levels.

6.0 MITIGATION MEASURES

Using ICs to restrict exposure to contaminated ground water would be implemented as part of the proposed action. The risk assessment for this action has concluded that the primary potential exposure pathway is through human ingestion of, or contact with, contaminated ground water. If the potential for ingestion or contact were restricted, the exposure pathway would be eliminated, thereby preventing risk to human health from radionuclides and heavy metals. Therefore, land acquisition and ICs effectively mitigate potential human health impacts of contamination remaining in the ground water as a result of the proposed action.

Approving this action would cause ground water contamination to migrate into waters not previously contaminated. The ICs, however, would restrict contaminated water from being consumed, thereby preventing exposure to humans. Additional active corrective action would not produce an incremental protection of human health and the environment relative to the costs. Use of ICs has been implemented in other ground water remediation programs such as underground storage tanks under the Resource Conservation and Recovery Act of 1976, as amended, and superfund sites under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended. EPA, the Department of Defense, and DOE all have guidance on the use of ICs as a means of reducing risk from ground water contamination.

NRC staff is also including surface water trigger concentrations for the ACL parameters in the license (Table 6). WNI's license conditions will require that certain actions (i.e., more stringent monitoring, active corrective actions) be taken if surface water concentrations of ACL parameters exceed the trigger values at the POE (see Figure 1). Trigger values are either background, Class 2AB surface water standards, MCLs, or RBCs, whichever are greater.

Table 6
Surface Water Trigger Values

Contaminant	Surface Water Trigger Value
Manganese (mg/L)	0.05
Molybdenum (mg/L)	0.18
Ammonia (mg/L)	0.5[1]
Radium-226 & -228 (pCi/L)	5.00
Natural Uranium (mg/L)	0.03[2]
Nitrate (mg/l)	10

1. EPA Ground Water RBC
2. Uranium MCL

NRC staff is also including ground water trigger concentrations for the ACL parameters in the license (Table 7). WNI's license conditions will require that certain actions (i.e., more stringent monitoring, active corrective actions) be taken if ground water concentrations of ACL parameters exceed the trigger values at the downstream LTSB. Trigger values are either background, MCLs, or EPA RBCs, where MCLs are not available.

Table 7
Ground Water Trigger Values

Contaminant	Split Rock Aquifer Trigger Value	Floodplain Aquifer Trigger Value
Manganese (mg/L)	0.73	2.39
Molybdenum (mg/L)	0.18	0.18
Ammonia (mg/L)	0.5	0.5
Radium-226 & -228 (pCi/L)	5.0	5.0
Natural Uranium (mg/L)	0.03/0.3[1]	0.03
Nitrate (mg/l)	10	10

1. SWAB-32 trigger value.

Because well SWAB-32 is located at the edge of a mineralized zone near the former Red Mule development, uranium concentrations currently exceed the uranium MCL trigger value. Therefore, a different trigger value of 0.3 mg/l will apply to well SWAB-32. The latest uranium concentration in this well is 0.136 mg/l. Contaminant transport modeling indicates that the uranium concentration could increase by 0.1 mg/l if contaminant ground water migrates to this well. Allowing for variations in contaminant concentrations, 0.3 mg/l is a reasonable trigger value for this well.

7.0 RECOMMENDED LICENSE AMENDMENT

74. The licensee shall implement a compliance monitoring program containing the following:

A. Sample wells JJ-1R, WN-39B, WN-41B, WN-42A, SWAB-1, SWAB-2, SWAB-4, SWAB-12, SWAB-22, SWAB-29, SWAB-31, and SWAB-32 semi-annually for uranium and sulfate and annually for aluminum, ammonia, antimony, arsenic, beryllium, cadmium, chloride, fluoride, lead, manganese, molybdenum, nickel, nitrate, pH, radium-226 and-228, selenium, sulfate, thallium, thorium-230,TDS, and uranium. Sample wells 1, 4R, 5, and 21 semi-annually for aluminum, ammonia, antimony, arsenic, beryllium, cadmium, chloride, fluoride, lead, manganese, molybdenum, nickel, nitrate, pH, radium-226 and-228, selenium, sulfate, thallium, thorium-230, TDS, and uranium. In addition, water levels shall be collected at all of the above wells for every sampling event.

B. Comply with the following ground-water protection standards at point of compliance Wells ~~No.~~ 4 and 21, with background being recognized in Well ~~No.~~ 15:

beryllium = 0.05 mg/l, cadmium = 0.01 mg/l, chromium = 0.05 mg/l, lead = 0.05 mg/l, nickel = 0.05 mg/l, selenium = 0.013 mg/l, and thorium-230 = 0.95 pCi/l.

C. Comply with the following alternate concentration limits in the northwest valley at point of compliance Well 4, with background being recognized in Well 15:

ammonia = 0.61 mg/l, manganese = 225 mg/l, molybdenum = 0.66 mg/l, nitrate = 317 mg/l, radium-226 and -228 = 7.2 pCi/l, and natural uranium = 4.8 mg/l.

Comply with the following alternate concentration limits in the southwest valley at point of compliance Well 21, with background being recognized in Well 15:

ammonia = 0.84 mg/l, manganese = 35 mg/l, molybdenum = 0.22 mg/l, nitrate = 70.7 mg/l, radium-226 and -228 = 19.9 pCi/l, and natural uranium = 3.4 mg/l.

D. Comply with the following ground water trigger levels at the point of exposure:

Trigger Levels for the Split Rock aquifer: ammonia = 0.5 mg/l, manganese = 0.73 mg/l, molybdenum = 0.18 mg/l, nitrate = 10 mg/l, radium-226 and -228 = 5.0 pCi/l, and natural uranium = 0.03 mg/l or 0.3 for SWAB-32.

Trigger Levels for floodplain aquifer: ammonia = 0.5 mg/l, manganese = 2.39 mg/l, molybdenum = 0.18 mg/l, nitrate = 10 mg/l, radium-226 and -228 = 5.0 pCi/l, and natural uranium = 0.03 mg/l.

E. Comply with the following surface water trigger levels at the point of exposure:

ammonia = 0.5 mg/l, manganese = 0.05 mg/l, molybdenum = 0.18 mg/l, nitrate = 10 mg/l, radium-226 and -228 = 5.0 pCi/l, and natural uranium = 0.03 mg/l.

~~C.~~ ~~Implement a corrective action plan program that shall recover and evaporate between 6 and 15 million gallons of contaminated water based upon minimizing recharge to the tailings. This program shall be constructed as described in the August 31, and September 28, 1989, submittals as modified by the licensee's April 3, 1990, January 13, 1992, September 23, 1993, April 18, 1997, May 20, 1998, and July 2, 1999, submittals. All monitoring requirements for the corrective action program shall be those specified in LC No. 74.A. The objective of the program shall be to return the concentrations of beryllium, cadmium, nickel, radium-226 and 228, selenium, thorium-230, and uranium to the concentration limits specified in Subsection 74B above. A final Corrective Action Program Plan, which includes a complete site characterization, must be received by NRC by October 31, 1999.~~

[Applicable Amendments: 25, 27, 36, 39, 40, 44, 48, 51, 56, 58, 61, 62, 67, 69A, 79, 89, 98]

~~D~~F. The licensee shall submit by December 15 of each year, a review of the corrective action program and its effect on the aquifer.

[Applicable Amendments: 25, 27, 36, 39, 40, 44, 48, 51, 56, 58, 61, 62, 67, 69A, 79]

~~E~~G. The licensee shall reclaim the groundwater corrective action evaporation ponds in accordance with their February 7, 1994, report titled, "Western Nuclear, Inc. Split Rock Mill, Addendum A (February 7, 1994) to Revision 5 to the June 30, 1987, Uranium Tailings Reclamation Plan," with the following exception:

1 The preliminary radon attenuation barrier design for the Winter Storage Ponds (Area 2C, 4, Drawing No. 91-225-E53 (Addendum A to Revision 5) consists of 6 inches of Cody Shale and 12 inches of Soil Borrow. This design is considered acceptable for estimating the surety amount. However, once the storage ponds are dismantled, the Licensee shall confirm the design and obtain NRC approval prior to placing the radon cover on the ponds. Reclamation to the Winter Storage Ponds shall be completed by the licensee within three years after cessation of use as determined by the NRC.

[Applicable Amendment: 92]

8.0 REFERENCES

MFG, Inc., 2006, "Map of Long-Term Surveillance Boundary", August 1, 2006 [ADAMS Accession No. ML0625503042].

Shaver, H.W., 2006, Letter to Gary Janosko transmitting the Deed and Title Policy Demonstrating Acquisition of Jamerman Property, March 20, 2006 [ADAMS Accession Number ML060930593].

U.S. Department of Energy, 2006, Letter to Mr. Gary Janosko Regarding Comments on the Draft Environmental Assessment for Ground Water Alternate Concentration Limits", June 28, 2006 [ADAMS Accession No. ML061640342].

U.S. Environmental Protection Agency, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion", Federal Guidance Report No. 11, EPA 520/1-88-020, September 1988.

U.S. Geological Survey, http://waterdata.usgs.gov/nwis/sw/, 2006.

U.S. Nuclear Regulatory Commission, SECY-02-0183, "Western Nuclear Inc.'s Proposed Use of Institutional Controls for Private Off-Site Properties including Residential Properties to which Contaminated Ground Water has not yet Migrated", October 11, 2002.

U.S. Nuclear Regulatory Commission, 2006, "Environmental Assessment for Amendment of Source Materials License SUA-56, Ground Water Alternate Concentration Limits", August 29, 2006 [ADAMS Accession No. ML062130387].

Western Nuclear, Inc., 1999, "Site Closure Plan" and "Site Ground Water Characterization and Evaluation", October

29, 1999 [ADAMS Accession Nos. ML003672392,ML003672396, ML003672400, ML003672396].

Western Nuclear, Inc., 2000a, Letter From Lawrence J. Corte to Thomas H. Essig Regarding the Site Closure Plan for Western Nuclear, Inc., January 17, 2000 [ADAMS Accession No. ML003676128].

Western Nuclear, Inc., 2000b, Letter From Harley W. Shaver to Thomas H. Essig regarding Site Closure Plan for Split Rock Site, February 27, 2000 [ADAMS Accession No. ML003686985].

Western Nuclear, Inc., 2000c, Letter From Anthony J. Thompson to Thomas H. Essig Regarding Site Closure Plan for Western Nuclear, Inc., Split Rock Site, February 28, 2000 [ADAMS Accession No. ML003687478].

Western Nuclear, Inc., 2001, Supplement to October 29, 1999, Split Rock Site Closure Report, February 1, 2001 [ADAMS Accession No. ML010380246].

Western Nuclear, Inc., 2002a, WNI Response to NRC Request of September 6, 2001, for Additional Information on Site Closure Plan for the Split Rock, Wyoming, Site, May 28, 2002 [ADAMS Accession No. ML021710273].

Western Nuclear, Inc., 2002b, Supplemental Data Collection, Program Trip Report, May 28, 2002 [ADAMS Accession No. ML021710422].

Western Nuclear, Inc., 2002c, WNI Response to NRC Request of September 6, 2001, for Additional Information on Site Closure Plan for the Split Rock, Wyoming, Site, July 23, 2002 [ADAMS Accession No. ML022110059].

Western Nuclear, Inc., 2002d, Letter From Lawrence J. Corte to Bill von Till Regarding Responses to Questions Raised on August 21, 2002, Telephone Conference, September 9, 2002 [ADAMS Accession No. ML022560163].

Western Nuclear, Inc., 2003, “Supplemental Ground Water Modeling Report,” March 7, 2003 [ADAMS Accession No. ML030760336].

Western Nuclear, Inc., 2004, Letter to Robert A. Nelson Regarding Risk Assessment of Ground Water for Agricultural Uses, May, 24, 2004 [ADAMS Accession No. ML041490156]

Western Nuclear, Inc., 2005a, Letter from Lawrence J. Corte to Gary Janosko Regarding Efforts to Purchase Properties within Long-Term Surveillance Boundary, February 10, 2005 [ADAMS Accession No. ML051220100].

Western Nuclear, Inc., 2005b, Response to Request for Additional Information, March 2, 2005 [ADAMS Accession No. ML050690064].

Western Nuclear, Inc., 2005c, “Ground Water Monitoring Report, Split Rock Mill Site, Ground Water and Surface Water Monitoring Results,” July 26, 2005 [ADAMS Accession No. ML052220552].

Western Nuclear, Inc., 2005d, “Ground Water Monitoring Report, Split Rock Mill Site, Ground Water and Surface Water Monitoring Results,” February 23, 2005 [ADAMS Accession No. ML050700396].

Western Nuclear, Inc., 2006b, “Ground Water Monitoring Report, Split Rock Mill Site, Ground Water and Surface Water Monitoring Results,” April 18, 2006 [ADAMS Accession No. ML061220275].

Wyoming Department of Environmental Quality, 2005, “Water Quality Rules and Regulations, Chapter 8, Wyoming Ground Water Quality Standards,” April 26, 2005.

Wyoming Department of Environmental Quality, 2006, “Water Quality Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards,” http://soswy.state.wy.us/Rule_Search_Main.asp.