environmental
properties management, LLC

CIMARRON FACILITY DECOMMISSIONING PLAN

Prepared by

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Project No. 84237 / 84242

December 2015

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Prepared for

CIMARRON ENVIRONMENTAL RESPONSE TRUST

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LIST OF ACRONYMS AND ABBREVIATIONS

ADU	ammonium diuranate
ALARA	As Low As Reasonably Achievable
amsl	above mean sea level
BTP	Branch Technical Position
cfs	cubic feet per second
cm	centimeter
COC	contaminant of concern
DCGL	Derived Concentration Goal Level
DEQ	Oklahoma Department of Environmental Quality
dpm	disintegrations per minute
EP Tox	Extraction Procedure for Toxicity
EPA	United States Environmental Protection Agency
EPM	Environmental Project Management LLC
ft	foot/feet
g	gram
in	inch/inches
in/yr	inches per year
kg	kilogram
km	kilometer
KMNC	Kerr-McGee Nuclear Corporation
LLRW	low-level radioactive waste
m	meter
MCL	Maximum Contaminant Level
mEq	Milliequivalent
mg/L	milligrams per liter
MPC	maximum permissible contamination
MOFF	Mixed Oxide Fuel Fabrication

LIST OF ACRONYMS AND ABBREVIATIONS

NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
OGS	Oklahoma Geological Survey
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
Plan	Final Decommissioning Plan
PVC	polyvinyl chloride
RAI	Request for Additional Information
RPP	Radiation Protection Program
RSO	Radiation Safety Officer
Site	Cimarron site
SNM	Special Nuclear Material
TCLP	Toxicity Characteristic Leaching Procedure
Trust	Cimarron Environmental Response Trust
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
UO	uranium oxide
UO_2	uranium dioxide
U_3O_8	uranium octaoxide
USGS	United States Geological Survey
yd	yard
yr	year
%	percent
μg/L	micrograms per liter

EXECUTIVE SUMMARY

Environmental Properties Management LLC (EPM), Trustee for the Cimarron Environmental Response Trust (the Trust), submits this Decommissioning Plan (the Plan) for the Cimarron site (the Site), located at 100 N. Highway 74, Guthrie, OK.

The Site consists of over 500 acres of rolling hills and 200 acres of floodplain at the intersection of Highways 74 and 33, approximately seven miles south of Crescent, OK (Figure 1-1). Grassland and temperate forest covers nearly all the property, and two ponds collect surface water from upland areas. Several miles of gravel road, a gravel parking area, and one office building remain on the property.

In the 1960s and early 1970s, Kerr-McGee Nuclear Corporation (KMNC) manufactured nuclear fuel under two Nuclear Regulatory Commission (NRC) licenses. Uranium fuel was produced under NRC Special Nuclear Material License SNM-928, and mixed oxide fuel was produced under NRC license SNM-1174. Waste was buried in three locations, and wastewater containing licensed material was stored in impoundments and discharged to the Cimarron River, in accordance with the regulatory requirements of that time.

Decommissioning of materials and equipment, buildings and structures, and surface and subsurface soils is complete. The Site was divided into 16 "Subareas" as shown in Figure 1-2, designated Subareas A through O (there are two uranium waste ponds, both designated Subarea O), to facilitate the decommissioning and final survey process for buildings and surface and subsurface soil. Final Status Survey Reports have been submitted for all these media for all 16 Subareas. All but three of the Subareas have been released from the NRC license.

Licensed material exceeds decommissioning criteria for unrestricted release in groundwater in several areas of the Site, which are further described in Section 2 of this Plan. The intent of the Plan is to reduce the concentration of uranium in groundwater to achieve unrestricted release of the Site and license termination. The Derived Concentration Goal Level (DCGL) for groundwater at the Site is 180 picoCuries per liter (pCi/L) total uranium, based on a Site-specific drinking water scenario, and incorporated in the license in License Condition 27(c).

Groundwater in several areas of the Site also contains two non-radiological contaminants of concern (COCs): nitrate and fluoride. For uranium and fluoride, the criteria to achieve an unrestricted release from the Oklahoma Department of Environmental Quality (DEQ) are the United States Environmental Protection Agency (EPA)-established Maximum Contaminant Levels (MCLs) for drinking water. The

MCLs are 30 micrograms per liter (µg/L) for uranium and 4 milligrams per liter (mg/L) for fluoride. Because nitrate is present at concentrations above the MCL due at least in part to the regional and Site use of agricultural fertilizer, DEQ has approved a "mean plus two standard deviations" value based on analysis of samples from monitoring wells located upgradient of processing or disposal activities. The DEQ remediation goal for nitrate is 22.9 mg/L.

In this Plan, the NRC-approved criterion for uranium in groundwater will be referred to as the DCGL. Remediation goals for uranium, nitrate, and fluoride will be referred to as "DEQ criteria" (or "DEQ criterion" if for a single chemical).

The primary objective of this Plan is to reduce the activity of uranium in groundwater to less than the DCGL to obtain release for unrestricted use, and termination of the license, by NRC. The secondary objective is to reduce the concentrations of all Site COCs to less than their DEQ criteria to obtain unrestricted release by DEQ. The extent to which the concentrations of COCs can be reduced will be determined by the funding available to the Trust. Post-remediation monitoring will demonstrate compliance with the criteria applicable to the above stated objectives.

Decommissioning activities will begin with the development of specifications and a request for bids from qualified vendors upon approval of this Plan by both NRC and DEQ. Upon completion of groundwater remediation, approximately two years of post-remediation groundwater monitoring and final status surveys for residual soils will be performed. Should groundwater monitoring and final status surveys demonstrate that the Site is releasable for unrestricted use, and that uranium, nitrate, and fluoride concentrations comply with DEQ criteria, demobilization will be performed over approximately one year following post-remediation monitoring.

This Decommissioning Plan is submitted as a License Amendment Request.

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1.0 FACILITY OPERATING HISTORY

EPM, Trustee for the Cimarron Environmental Response Trust (the Trust), submits this *Cimarron Facility Decommissioning Plan* (the Plan) for the Cimarron site (the Site), located at 100 N. Highway 74, Guthrie, Oklahoma.

The Site consists of over 500 acres of rolling hills and 200 acres of floodplain at the intersection of Highways 74 and 33, located approximately seven miles south of Crescent, Oklahoma (Figure 1-1) in Logan County. The street address of the facility is 100 North Highway 74, Guthrie, Oklahoma 73044. Grassland and temperate forest covers nearly all the property, and two ponds collect surface water from upland areas. Several miles of gravel roads, a gravel parking area, and one office building remain on the licensed Site.

In the 1960s and early 1970s, Kerr-McGee Nuclear Corporation (KMNC) manufactured nuclear fuel under two Nuclear Regulatory Commission (NRC) licenses. Uranium fuel was produced under NRC License SNM-928, and mixed oxide fuel was produced under NRC License SNM-1174. Waste was buried in three locations, and wastewater containing licensed material was stored in impoundments and discharged to the Cimarron River, in accordance with the regulatory requirements of that time.

Decommissioning of materials and equipment, buildings and structures, and surface and subsurface soils is complete. The Site was divided into 16 "Subareas" as shown in Figure 1-2, designated Subareas A through O (there are two areas, both of which contained uranium waste ponds, designated Subarea O) to facilitate the decommissioning and final survey process for buildings and surface and subsurface soil. Subareas A through E were considered unaffected areas, and were designated "Phase I" areas. Subareas F through I contained both unaffected and affected areas, and were designated "Phase II" areas. Subareas K through O contained affected areas, and were designated "Phase III" areas. Subareas I and K included the former processing buildings; final status surveys for these areas included surveys of the buildings in addition to surface and/or subsurface soil. All but three of the Subareas (F, G, and N) have been released from the NRC license.

1.1 LICENSE NUMBER / STATUS / AUTHORIZED ACTIVITIES

The Trust is decommissioning the Site in accordance with License SNM-928, Amendment 21. The license authorizes the possession of:

- $\leq$ 1,200 grams (g) of U-235 enriched to $\leq$ 5 weight percent (%)
- $\leq$ 10 g of U-235 enriched to > 5 weight %

- ≤ 2,000 kilograms (kg) of natural and depleted uranium source material
- ≤ 6,000 kg of thorium source material

This radioactive material can be in any chemical or physical form. The radioactive material at the Site consists only of environmental media (i.e., soil and groundwater) impacted by licensed material from past burials or releases of licensed material to the environment. There is no current inventory of licensed material at the Site; licensed material only enters the inventory as it is extracted from environmental media, or otherwise concentrated through chemical processing. Excluding uranium in groundwater, licensed material does not exceed decommissioning criteria for unrestricted release anywhere on the Site.

KMNC submitted an application for renewal of License SNM-928 on March 29, 1982. Sections of the application for license renewal addressing the processing of nuclear materials were deleted "for the standby period". License SNM-928 was renewed on March 31, 1983. Since the license was last renewed in 1983, 21 license amendments have been issued. A brief description of each follows.

- Amendment 1 was issued October 24, 1985. It transferred SNM-928 from KMNC to Sequoyah Fuels Corporation (SFC), and added letters dated March 28, 1984, September 28, 1984, and October 8, 1984 to License Condition 10, which address planned decommissioning activities.
- Amendment 2 was issued December 20, 1985. It added an August 6, 1985 letter to License Condition 10.
- Amendment 3 was issued April 16, 1986. It authorized the possession of up to 6,000 kg of thorium, which authorized SFC to package and dispose of thorium-impacted material being removed from a site near Cushing, Oklahoma, which was owned by Kerr-McGee Corporation (SFC's parent corporation), under License SNM-928.
- Amendment 4 was issued April 16, 1986. It increased the authorized quantity of U-235 enriched to ≤ 5 weight % to 6,000 g, and added letters dated August 6, 1985, November 19, 1985, and March 3, 1986 to License Condition 10.
- Amendment 5 was issued May 4, 1987. It added a letter dated February 19, 1987 to License Condition 10 and extended the deadline to complete decommissioning to December 31, 1988.
- Amendment 6 was issued October 26, 1988. It changed the licensee from SFC to Cimarron Corporation (Cimarron) and added a letter dated October 14, 1988 to License Condition 10.

- Amendment 7 was issued December 23, 1989. It added a letter dated November 17, 1988 to License Condition 10 and extended the deadline to complete decommissioning to June 30, 1990.
- Amendment 8 was issued January 5, 1990. It added a letter dated November 2, 1989 to License Condition 10 and added License Condition 21, dealing primarily with control of access to the Site.
- Amendment 9 was issued December 28, 1992. It added letters dated September 11, 1991 and June 24, 1992 to License Condition 10, extended the deadline for decommissioning to June 30, 1995, and added License Condition 22, which authorized the backfill of the excavated sanitary lagoons and several former burial trenches in the eastern portion of the Site.
- Amendment 10 was issued November 4, 1994. It decreased the authorized quantity of U-235 enriched to ≤ 5 weight % to 1,200 g, deleted License Condition 17 (prohibiting backfill of the excavated sanitary lagoons), and added License Condition 23 (authorizing burial of specified licensed material in an on-site disposal cell). It also included numerous significant changes related to decommissioning.
- Amendment 11 was issued July 26, 1995. It added License Condition 24, designating Karen Morgan as the Radiation Safety Officer (RSO).
- Amendment 12 was issued March 7, 1996. It corrected the name of the licensee, since Amendment 11 did not identify Cimarron Corporation as the licensee.
- Amendment 13 was issued April 13, 1996. It added License Condition 25, which released Phase I Areas (which included Subareas A through E) from the license.
- Amendment 14 was issued July 7, 1997. It made numerous revisions to License Condition 10. It also deleted License Conditions 11, 12, 13, 14, 15, 16, 20, & 21. All of these license conditions contained radiation safety requirements which were as of that license amendment addressed in Annex A, the Radiation Protection Program (RPP). It also added License Condition 26, requiring compliance with Annex A.
- Amendment 15 was issued July 29, 1999. It revised License Condition 10 to cite the Site Decommissioning Plan. It also added License Condition 27, which specified decommissioning criteria for unrestricted release, and incorporated a provision for changing the decommissioning plan and/or RPP with ALARA Committee approval. It also revised License Condition 26 to include updates to Annex A.
- Amendment 16 was issued April 17, 2000. It added License Condition 28, which released Subareas J and O from the license.

- Amendment 17 was issued April 9, 2001. It added License Condition 29, which released Subareas H, I, L, and M from the license.
- Amendment 18 was issued May 28, 2002. It added License Condition 30, which released Subarea K from the license.
- Amendment 19 was issued October 3, 2005. It deleted License Condition 22, which authorized the backfill of the sanitary lagoons. It also revised License Conditions 23 (retaining only remaining requirements related to the on-site disposal cell) and 27(e) (addressing the process for approving changes to the decommissioning plan and/or RPP).
- Amendment 20 was issued June 12, 2009. It deleted License Condition 24, which designated the Site RSO by name, and revised License Condition 27(e) (addressing the process for approving changes to the decommissioning plan and/or RPP).
- Amendment 21 was issued February 14, 2011. This amendment transferred the license from Cimarron Corporation to the Trust.

1.2 LICENSE HISTORY

The Cimarron facility was formerly operated by KMNC, a wholly owned subsidiary of Kerr-McGee Corporation. The Cimarron facility operated under two special nuclear material (SNM) licenses. License SNM-928 was issued for the production of uranium fuel, and License SNM-11742 was issued for the production of mixed oxide fuel. The principal operation under License SNM-928 involved the fabrication of enriched uranium reactor fuel pellets, and eventually fuel rods. A third license, License 35-12636-02, was issued for the possession of sealed sources (all cesium-137) for instrument calibration.

1.2.1 Mixed Oxide Fuel Production

Mixed oxide fuel was produced in the Mixed Oxide Fuel Fabrication (MOFF) facility from 1970 through 1975. Liquid uranyl nitrate and plutonium nitrate solutions were blended, co-precipitated, calcined, milled, pressed into pellets, and assembled in fuel pins. Due to the fact that the MOFF facility was decommissioned and released for unrestricted use in 1993, a more detailed description of the manufacturing process was not believed necessary. However, additional information concerning the processing is presented in *Report No. 6, Decontamination and Decommissioning of the Kerr-McGee Cimarron Plutonium Fuel Plant* (Cimarron Corporation, December 1988).

1.2.2 Uranium Fuel Production

Enriched uranium fuel was produced at the Uranium Plant from 1966 through 1975. Process facilities included a main production building; several one-story ancillary buildings, five process related collection ponds, two original sanitary lagoons, one new sanitary lagoon, a waste incinerator, several uncovered storage areas, and three burial grounds. The main production building was divided into six major areas: ceramic uranium dioxide (UO_2), pellet, scrap recycle and recovery, waste treatment, fabrication and the high enriched area. In addition, space was provided for auxiliary services such as administrative and laboratory services, maintenance, and warehousing. Figure 1-3 shows the location of the relevant features of the facility, including the former buildings, roads, burial sites, and impoundments.

The low enriched fuel fabrication process is described by the following steps in which uranium activity exceeds the license release criteria to include an appropriate "buffer zone":

- Uranium hexafluoride (UF_6) gas was received and stored on the Site for processing.
- The UF_6 was heated; the gaseous UF_6 was then passed through an ammonia solution, producing solid ammonium diuranate (ADU).
- ADU was calcined to produce uranium oxide (UO_2) powder.
- UO powder was ground to break up agglomerates, and then blended and pressed into pellets.
- The pellets were converted into ceramic-grade UO_2 in reduction furnaces.
- After sintering, the pellets were ground to a straight-sided right circular cylinder.
- The UO_2 removed by grinding was sent to the scrap purification system.

Highly enriched uranium processing was performed also at the Site within the main process building. This fuel fabrication process is described by the following steps:

- UF_6 was vaporized by heating cylinders with steam, reacted with a chemical to form solid uranium tetrafluoride (UF_4).
- The UF_4 was dried and placed in small muffle furnaces for conversion to UO_2 or uranium octaoxide (U_3O_8) metal oxides.
- Subsequent grinding and blending completed the oxide process.
- Uranium metal was made by blending UF_4 powder with calcium metal granules and heating.

- The uranium separated and was placed in an acid solution to remove the calcium and oxide slag.
- The metal and oxides were then packaged for shipment to fuel fabricators.

Additional operations at the facility included a solvent extraction process to recover uranium from the processing of scrap and from material that did not meet contract specifications.

1.2.3 Effluents

In general, the plant was designed to be slightly negatively pressurized at all times with the general plant air primarily discharging through roof vents. The exhaust systems for process equipment and operating areas provided effective control of airborne contaminants generated during processing. Special blowers, absolute filters, and exhaust ducts were utilized in areas of high airborne contamination potential. The main plant for uranium processing had 22 individual exhaust stacks which were routinely monitored for releases of radioactivity. The solvent extraction operation had a single exhaust stack which likewise was continuously sampled and periodically analyzed for radioactivity in the gaseous effluent. The contaminated waste incinerator had efficient stack gas cleaning equipment for controlling air emissions. In addition to the process buildings, there were other Site areas which were affected either directly or indirectly by operations. These areas included the sanitary lagoons, the waste settling ponds, the on-site disposal areas, selected drain lines, and the incinerator.

In converting UF_6 gas to a solid fuel, contaminated liquids were generated which required processing prior to discharge to impoundments. The liquid wastes produced via uranium processing were passed through an ion exchange system to recover the uranium. The treated effluent was monitored prior to being discharged to the Cimarron River from 1966 to 1971. From 1971 to 1975, the treated effluent was pumped to wastewater evaporation ponds. Contaminated sludge settled to the bottom of the ponds as the water evaporated.

Sanitary water and laundry water from the Uranium Plant operations were discharged to the East and West Sanitary Lagoons.

Radioactively contaminated solid wastes generated from the Uranium Plant activities were buried at a designated on-site radioactive waste disposal area (Burial Area #1) from 1966 to 1970.

1.2.4 Termination of Operations

In a letter dated September 2, 1976, KMNC notified NRC that the plant was being placed on standby. In January 1977, KMNC submitted a description of proposed standby activities, which consisted of decontamination and cleanup activities, and requested a license renewal. NRC renewed License SNM-928 on May 3, 1977. Between 1977 and 1981, five license amendments were issued, all related to possession limits for natural and depleted uranium and authorized quantities of U-235 at different enrichments.

KMNC submitted application for another renewal of License SNM-928 on March 29, 1982. Sections of the application for license renewal which addressed the processing of nuclear materials were deleted "for the standby period". License SNM-928 was renewed on March 31, 1983. A description of the license amendments issued since this last renewal are described in further detail in Section 1.1 above.

1.3 PREVIOUS DECOMMISSIONING ACTIVITIES

This section addresses the decommissioning of buildings, impoundments, and pipelines. Buildings decommissioned under License SNM-928 include Uranium Building #1, Uranium Tank Storage Building #2, Solvent Extraction Building #3, Uranium Warehouse Building #4, the UF_6 Receiving Room, and the Emergency Response Building. Figure 1-4 shows the locations of these buildings, as well as the layout of Uranium Building #1. Impoundments included the Plutonium Waste Pond, Plutonium Emergency Pond, Uranium Emergency Pond, Uranium Waste Pond #1, Uranium Waste Pond #2, the East and West Sanitary Lagoons, and the "New" Sanitary Lagoon. Figure 1-3 shows the locations of the former impoundments.

1.3.1 Decommissioning Criteria

Decommissioning criteria are stipulated in License Conditions 23 and 27. For soil and soil-like (volumetrically contaminated) material, License Condition 27 stipulates 10 pCi/g for natural uranium, 30 pCi/g for enriched uranium, and 35 pCi/g for depleted uranium as criteria for unrestricted release. License Condition 27 also states, "Soil and soil-like material with concentration exceeding the 1981 Branch Technical Position (BTP) Option 1 limits, but less than the Option 2 limits may be disposed in the onsite disposal cell in accordance with License Condition 23." License Condition 23 states, "The licensee is authorized to bury up to 14,000 cubic meters (m^3) (500,000 cubic feet) of soil contaminated with low-enriched uranium, in the 1981 BTP Option 2 concentration range, in the location described in the licensee's October 9, 1989, submittal to the NRC. The BTP Option 2

concentration range is up to 100 pCi/g for soluble uranium and up to 250 pCi/g for insoluble uranium."

For surfaces of buildings and equipment, License Condition 27 stipulates the following criteria:

- 5,000 disintegrations per minute (dpm) alpha/100 centimeter squared (cm^2) (15.5 in^2), averaged over 1 square meter (m^2) (10.8 ft^2);
- 5,000 dpm beta-gamma/100 cm^2 (15.5 in^2), averaged over 1 m^2 (10.8 ft^2);
- 15,000 dpm alpha/100 cm^2 (15.5 in^2), maximum over 1 m^2 (10.8 ft^2);
- 15,000 dpm beta-gamma/100 cm^2 (15.5 in^2), maximum over 1 m^2 (10.8 ft^2);
- 1,000 dpm alpha/100 cm^2 (15.5 in^2), removable;
- 1,000 dpm beta-gamma/100 cm^2 (15.5 in^2), removable

1.3.2 Decommissioning of Former Buildings

Uranium Building #1

Uranium Building #1 was a one-story sheet metal building which contained the offices, laboratory, and change rooms, plus the majority of the equipment utilized for uranium fuel processing. Decontamination and release of equipment and building surfaces were based on the release criteria now stipulated in License Condition 27(c), measuring both direct and removable alpha contamination. Process equipment was removed from the processing areas, surveyed, and either decontaminated or shipped off the Site to a licensed low-level radioactive waste (LLRW) disposal facility.

In 1977, the licensee initiated a procedure for characterizing and decontaminating Uranium Building #1 walls, floors, and ceiling surfaces. During initial characterization, all surfaces were surveyed with a portable gas proportional alpha detector. All areas yielding direct contamination measurements greater than 4,000 dpm/100 $(cm)^2$ alpha were marked. All floor surfaces and the bottom two meters (m) of each wall were completely surveyed. All hot spots greater than or equal to 15,000 dpm/100 cm^2 direct and 1,000 dpm/100 cm^2 smearable contamination were decontaminated. This general procedure was utilized to characterize and remediate all the rooms in Uranium Building #1.

Ceiling tiles were removed, vacuumed and surveyed. Ceiling tiles exceeding 2,000 dpm/100 cm^2 direct alpha or 500 dpm/100 cm^2 smearable alpha were disposed of at a licensed LLRW disposal facility. The ceiling, ceiling beams, rafters, conduit, piping and duct work were all surveyed.

The entire attic area was vacuumed and cleaned. A second survey of the attic was conducted. Any areas identified as greater than 5,000 dpm/100 cm^2 alpha were acid washed and re-surveyed. Areas which could not be cleaned to less than 5,000 dpm/100 cm^2 alpha were resurveyed to ensure that they were less than 15,000 dpm/100 cm^2 alpha maximum and less than 5,000 dpm/100 cm^2 alpha average.

A roof grid was set up for the different sections of the 55,000 square foot $(ft)^2$ roof; direct and removable contamination surveys were taken at grid intersects. Exterior wall panels were removed, surveyed for direct and removable contamination, and decontaminated if necessary. If wall panels were damaged or could not be decontaminated, replacement panels or panel sections from the Solvent Extraction Building were used to replace the exterior wall panels.

The concrete footings were decontaminated and surveyed and new foot plates were installed prior to replacement of individual wall panels. Concrete footings were decontaminated and surveyed and new foot plates were installed prior to replacement of individual wall panels. The concrete slab was surveyed, decontaminated as required, and most of the slab was removed. Releasable and decontaminated slabs of concrete removed from Uranium Building #1 were placed in the spillway of the pond in Subarea J, in Subarea F, and in Subarea G.

Contaminated soil under the concrete was removed. Soil containing licensed material in the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell. Soil containing licensed material exceeding the BTP Option 2 concentration range was shipped off-site to a licensed LLRW disposal facility. Floor drains and other drain lines were removed.

Additional details related to the decommissioning of Uranium Building #1 can be found in *Final Status Survey Report for Subarea "K"*, (Cimarron Corporation, February 2000). Decommissioning of Uranium Building #1, including the removal of contaminated soil underlying the building and drain lines extending beneath stockpiled soils, was completed in 1997. Uranium Building #1 was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

Uranium Tank Storage Building #2

This steel building was located just south of Uranium Building #1. Building #2 was used to house 44 tanks that were 10 inches in diameter and 20 feet tall. The tanks were used to store uranium nitrate scrap solutions of less than 5% enrichment. This solution was held for

subsequent reclamation by processing in the Solvent Extraction Building. The tanks were separated by concrete isolation barriers.

The concrete barriers and floor, as well as soil under and surrounding the building, were contaminated due to tank overflows, pipe leaks and pump leakage. The piping, tanks, and pumps were removed and were either decontaminated, surveyed and released, or shipped off the Site to a licensed LLRW disposal facility. The building was surveyed, dismantled, and/or disposed of as required based upon alpha survey results. The concrete divider in Building #2 was decontaminated by wet blasting and vacu-blasting. The concrete floor, footings and divider then was surveyed for both alpha and beta/gamma. The concrete floor, footings, and divider were released for unrestricted use and hauled to on-site drainage areas as rip-rap for erosion control.

Contaminated soils from beneath Building #2 were removed. Approximately 19,500 ft^3 of soil exceeding the BTP Option 2 concentration range were removed and shipped off the Site for disposal at a licensed LLRW facility. The Building #2 area was initially backfilled with soil containing uranium in the BTP Option 2 concentration range up to four feet below grade. This soil was removed in 1994 and stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

Additional details related to the decommissioning of Uranium Tank Storage Building #2 can be found in Final Status Survey Report for Subarea "K", (Cimarron Corporation, February 2000). Decommissioning of Uranium Tank Storage Building #2 was completed in 1994. Uranium Tank Storage Building #2 was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

Solvent Extraction Building #3

This metal building was dismantled in 1986. Some of the building siding was shipped off the Site as radioactive waste; some was decontaminated and used as replacement siding for Uranium Building #1. Equipment from this building was either decontaminated for unrestricted release or shipped off the Site to a licensed LLRW disposal facility. The concrete flooring from this building was surveyed for alpha only, decontaminated as necessary, released, and used for on-site erosion control. Contaminated soil in this area was excavated and segregated. Soil exceeding the BTP Option 2 concentration range were removed and shipped off the Site for disposal at a licensed LLRW facility. Soil containing uranium within the BTP Option 2 concentration range

was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

Additional details related to the decommissioning of the Solvent Extraction Building can be found in Final Status Survey Report for Subarea “K”, (Cimarron Corporation, February 2000). Decommissioning of the Solvent Extraction Building was completed in 1986. The Solvent Extraction Building was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

Uranium Warehouse Building #4

The warehouse is a sheet metal building which was never used to process radioactive materials. However, fuel assemblies were inspected and assembled for a short period of time within this building. Cimarron personnel requested permission from the NRC on December 28, 1979 to decontaminate the warehouse and use the building for coal liquefaction research and development.

Final release surveys were completed on the inside and outside surface of this building in 1980. The NRC gave approval on March 28, 1980 to use the Coal Building for non-nuclear purposes based upon these surveys. The survey conducted in 1980 was for alpha only. Additional surveys were conducted in the Coal Building in 1993 for both alpha and beta/gamma. These surveys revealed several small areas with elevated levels of beta activity in the concrete floor, which were decontaminated to unrestricted release criteria.

A portion of Uranium Warehouse Building #4 was used for coal liquefaction research and development. Although the process equipment was drained at the conclusion of testing, residual coal tar is still present in some of the process equipment. Another portion of Uranium Warehouse Building #4 was also used for titanium dioxide research and development. Although the process equipment was drained at the conclusion of testing, residual titanium tetrachloride is believed to be present in some of the process equipment.

Additional details related to the decommissioning of Uranium Warehouse Building #4 can be found in *Final Status Survey Report for Subarea “I”*, (Cimarron Corporation, June 1999). Decommissioning of this building was completed in 1994. Uranium Warehouse Building #4 is located in Subarea I, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001.

UF_6 Receiving Room

This metal building was located adjacent to the south wall of Uranium Building #1. It was within this building that the cylinders of UF_6, received from Atomic Energy Commission diffusion plants, were heated with steam to vaporize the UF_6 for processing into fuel. Decontamination and decommissioning activities were initiated for the Vaporizer Building in 1991. The inner wall was removed, surveyed, decontaminated as required, and replaced. The roof and all interior and exterior walls were surveyed for direct and smearable alpha contamination. Areas exceeding unrestricted release criteria were decontaminated to comply with these criteria. The concrete floor was surveyed, decontaminated, and released for on-site erosion control.

Soil from under this building containing uranium within the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

Additional details related to the decommissioning of the UF_6 Receiving Room can be found in *Final Status Survey Report for Subarea "K"*, (Cimarron Corporation, February 2000). Decommissioning of the UF_6 Receiving Room was completed in 1991. The UF_6 Receiving Room was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

Emergency Response Building

During operating years, this building housed medical personnel, records, and emergency decontamination showers. During decommissioning activities, this building was used to house the on-site soil counter and to store records and soil samples. No decommissioning was required for the Emergency Response Building. The Emergency Response Building is located in Subarea I, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001. This building was surveyed for unrestricted release. The building is currently being used as an office building for Trust personnel and contractors.

1.3.3 Decommissioning of Former Impoundments

Plutonium Waste Pond

This hypalon-lined evaporation pond was irregular in shape. In 1976, a system was installed to decant and filter water from the Plutonium Waste Pond to Uranium Pond #2. The water was pumped from the surface through the filtration system until approximately 70,000 gallons of

water remained, which were not processed because the radionuclide concentration was greater than 0.1 times the maximum permissible contamination (MPC) limit.

The remaining water contained radioactive particles in colloidal suspension. Treatment of the 70,000 gallons of water in the Plutonium Waste Pond involved decanting water, treating it with ferric sulfate and sodium hydroxide to precipitate an iron hydroxide flocculent, and discharging it to the Plutonium Emergency Pond. The water from the Plutonium Emergency Pond then was decanted to Uranium Pond #2. After all water from the Plutonium Emergency Pond was transferred to Uranium Pond #2, the ferric hydroxide ($Fe(OH)_3$) sludge was transferred to the Plutonium Waste Pond, and solidified with concrete. A total of 491 drums of solidified waste containing less than 1 g of plutonium (total) were shipped off the Site for disposal at a licensed LLRW disposal facility.

The Plutonium Waste Pond liner was surveyed for alpha contamination, rolled up, and left in place prior to backfilling. The liner was later removed in 1986 when the New Sanitary Lagoon was constructed.

The Plutonium Waste Pond is located in Subarea L, which was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

Plutonium Emergency Pond

This hypalon-lined evaporation pond was irregular in shape, with a capacity of approximately 250,000 gallons. In 1976, water from the Plutonium Emergency Pond was pumped to Uranium Pond #1 with no visible sludge remaining. The Plutonium Emergency Pond was left undisturbed until it was used for treatment of water from the Plutonium Waste Pond. Waste precipitate residue was removed from the Plutonium Emergency Pond and placed in the Plutonium Waste Pond.

The Plutonium Emergency Pond liner was surveyed for alpha contamination prior to being rolled up and left in place prior to backfilling. The Plutonium Emergency Pond is located in Subarea L, which was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

Uranium Emergency Pond

This unlined evaporation pond was irregular in shape, with a capacity of approximately 180,000 gallons. In 1976, water from the Uranium Emergency Pond was pumped to Uranium Pond #1,

with no visible sludge remaining. After being pumped dry and characterized, the Uranium Emergency Pond was left undisturbed (no additional remediation was performed) until written approval was received from the NRC to backfill five ponds. The Uranium Emergency Pond is located in Subarea L, which was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

Uranium Pond #1

This asphalt pitch, felt and pea-gravel-lined evaporation pond was rectangular in shape, with a capacity of approximately 1,150,000 gallons. Uranium Pond #1 was closed by crushing the asphalt liner into the pond. The underlying clay dike material and clean soil were used to fill in the depression (a depth of approximately 4 feet). This pond was backfilled in 1978 after confirmatory sampling by NRC.

The closure of Uranium Pond #1 began with the construction and installation of a dike across the south half of the pond. This enabled Waste Pond #1 to be consolidated into a much smaller area. Excess water was decanted to Uranium Pond #2. Sludge solidification consisted of mixing the sludge with approximately 15% cement. 865 drums of solidified waste containing 3,002 g of U-235 were shipped from Uranium Pond #1 to a commercial LLRW disposal facility.

Uranium Pond #1 is located in Subarea O, which was released for unrestricted use in Amendment 16, License Condition 28, issued April 17, 2000.

Uranium Pond #2

Uranium Pond #2 had a compacted clay bottom liner with poly rubber sidewalls anchored at the bottom and top of the dike. The pond was rectangular in shape, with a capacity of approximately 3,000,000 gallons. Sludge removal was not required because sludge had not been generated in this pond.

Uranium Pond #2 is located in Subarea O, which was released for unrestricted use in Amendment 16, License Condition 28, issued April 17, 2000.

East and West Sanitary Lagoons

These unlined ponds were rectangular in shape, and the capacity of each pond was approximately 500,000 gallons. The East and West Sanitary Lagoons received all liquid waste from the Uranium Plant from 1966 to 1970. In 1970, liquid waste from the Uranium Plant was diverted to other ponds located on the Site. From 1970 until 1985, the MOFF Plant septic tank, the Uranium

Plant septic tank, the Uranium Plant laundry, the MOFF Plant lab, the Uranium Plant lab, the Uranium Plant dock drain, and numerous floor drains in the Uranium Plant discharged into the East and West Sanitary Lagoons.

In 1986, residual water in the East and West Sanitary Lagoons was pumped to the New Sanitary Lagoon. Initial soil removal and packaging of contaminated soil from the East Sanitary Lagoon was completed in 1986. Initial soil removal and packaging of contaminated soil from the West Sanitary Lagoon was completed in 1987. Approximately 55,000 ft^3 of waste were shipped off the Site to a licensed LLRW disposal facility. Final clean-up and survey work was performed on both lagoons in 1990.

The East and West Sanitary Lagoons were located in Subarea H, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001.

"New" Sanitary Lagoon

The hypalon-lined New Sanitary Lagoon was installed by January, 1986. The New Sanitary Lagoon was located directly above the closed Plutonium Waste Pond and a portion of the closed Plutonium Emergency Pond. This lagoon replaced the East and West Sanitary Lagoons, which were being decommissioned. A French drain was installed under the New Sanitary Lagoon prior to construction to divert groundwater that may collect under this area. All liquids from the East and West Sanitary Lagoons were pumped to the New Sanitary Lagoon prior to the start of remediation on the East and West Sanitary Lagoons. Wastewater from the ion exchange system and Uranium Building #1 drains was also released to the New Sanitary Lagoon. The New Sanitary Lagoon was utilized from early 1986 to October 1992.

The rainwater which collected in the lagoon was land applied in accordance with Oklahoma State Department of Health requirements. The sediments were then dewatered, sampled, and analyzed for total uranium. All sediment was removed. Material containing uranium within the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

The liner surface was then surveyed in accordance with NUREG-5849. Any liner found to exceed free release criteria was either decontaminated or disposed in a licensed LLRW disposal facility. The liner was cut into sections for removal.

After removal of the liner, surface soil was surveyed at the surface and at 1 m with a micro-R meter. A 5m x 5m grid area was established, and any location yielding two times background was marked. At marked locations and grid intersects, soil samples 0-6 in below grade were collected for analysis. Samples were analyzed for total uranium. Areas that yielded uranium at concentrations exceeding the BTP Option 1 limit (30 picoCuries per gram [pCi/g] above background) were further characterized by sampling at a greater density. If required, these areas will be remediated. Soil containing uranium at concentrations exceeding the BTP Option 1 limit were packaged and shipped to a licensed LLRW disposal facility.

The "New" Sanitary Lagoon was located in Subarea L, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001.

1.3.4 Decommissioning of Former Pipelines

Figure 1-5 shows the locations of pipelines beneath and near the buildings. Figure 1-6 shows the locations of pipelines sitewide. Nearly all the pipelines indicated as "removed" on Figure 1-5 were excavated in 1985. Soil stockpiles containing uranium within the BTP Option 2 concentration range were located east of Uranium Building #1. Only those drain lines which were beneath Uranium Building #1 and extended east of Uranium Building #1 (beneath soil stockpiles) remained until 1997, when the last drain lines beneath the soil stockpile were removed as the soil was placed in the on-site BTP Option 2 Disposal Cell.

The process for removal and survey of drain lines was similar for all pipelines. Pipelines were removed by excavation of a trench following the pipeline. The trench was surveyed and sampled at 10-meter intervals. When scan readings indicated or soil samples yielded uranium concentrations exceeding the BTP Option 1 limit, additional measurements and samples were obtained between 10-m locations. Soil exceeding the BTP Option 1 limit was excavated and shipped to a licensed LLRW disposal facility. More detailed information on the decommissioning of each pipeline can be found in "*Radiological Characterization Report for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility*" (Chase Environmental Group, October 1994). The following describes the removal of pipelines and surveys of soil related to pipelines for which there was no evidence of leakage or release of licensed material. The removal, survey, and decommissioning of pipelines and releases from those pipelines is further discussed in Section 1.4, "Spills or Releases".

Drain Line from Uranium Pond #1 to the Cimarron River

This six-inch PVC pipe was installed for liquid effluent discharges from Uranium Pond #1 to the Cimarron River. Records indicate that liquid was only discharged two times from Uranium Pond #1 to the Cimarron River. The drain line was excavated and removed in 1985. Surveys of the trench yielded no areas with elevated uranium concentrations. A soil sampling program was conducted at 10-meter intervals, collecting soil samples at 6-inch intervals for the first foot, and at 1-foot intervals to 4 feet in depth. No samples exceeded BTP Option 1 limits.

Drain Line from Uranium Pond #1 to Uranium Pond #2

This 4-in PVC drain line was used for transfer of liquid from Uranium Pond #1 to Uranium Pond #2. Transferred liquid involved only slightly contaminated water. Uranium Pond #2 was used for evaporation purposes only, and did not discharge. This drain line was excavated and removed in 1985. A gamma survey was conducted after the pipe was removed, with measurements taken at the bottom, at the surface, and at 1 m above the surface of the excavated area. No contaminated soil was identified in the trench.

1.3.5 Decommissioning of Soil

Decommissioning of both soil and waste was based on criteria specified in the 1981 BTP, SECY 81-576, "Disposal or On Site Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) From Past Operations". The BTP criteria were first formally introduced into the license when the on-site burial of up to 14,000 m^3 (500,000 ft^3) of material within the BTP Option 2 concentration range was authorized in License Condition 23 of License Amendment 10. The use of the BTP Option 1 criteria as unrestricted release criteria were formally incorporated into the license in License Condition 27 when License Amendment 15 was issued July 29, 1999.

The Site was divided into 16 "Subareas", designated Subareas A through O (Subarea O is comprised of two areas which formerly contained two uranium waste ponds). Subareas A through E were considered unaffected areas, and were designated "Phase I" areas. Subareas F through I contained both unaffected and affected areas, and were designated "Phase II" areas. Subareas K through O contained affected areas, and were designated "Phase III" areas. A total of three final status survey plans were submitted to NRC, one addressing each "Phase" of Subareas. Subareas I and K included former processing buildings, and final status surveys for these areas included surveys of the buildings in addition to surface and/or subsurface soil.

Phase I Areas

The October 24, 1994 *Final Status Survey Plan for Unaffected Areas* was a single final status survey plan for Subareas A through E. The August 9, 1995 *Final Status Survey Report, Phase I Areas* (Chase Environmental Group, 1995) presented the results of the final status survey for all five areas. A March 1998 *Confirmatory Survey of the Phase I Unaffected Areas* (Oak Ridge Institute for Science and Education, 1998) concurred with the results of the final status survey. NRC released Subareas A through E from License SNM-928 in License Amendment 13, dated April 23, 1996.

Phase II Areas

The July 25, 1995 *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, 1995) was a single final status survey plan for Subareas F through J.

Final Status Survey Report for Phase II Subarea J (Cimarron Corporation, 1997) was submitted September 9, 1997. NRC released Subarea J from License SNM-928 in License Amendment 16, dated April 17, 2000.

Final Status Survey Report for Subarea H (Cimarron Corporation, 1998) was submitted November 16, 1998. *Final Status Survey Report, Subarea I* (Cimarron Corporation, 1999) was submitted June 29, 1999. NRC released Subareas H and I from License SNM-928 in License Amendment 17, dated April 9, 2001.

Final Status Survey Report, Subarea G (Cimarron Corporation, 1999) was submitted October 21, 1999. When license SNM-928 was transferred to the Trust, the February 16, 2011 license transfer order stated, “Final status surveys and confirmatory surveys have confirmed that Subareas G and N are releasable for unrestricted use, but NRC has determined that these areas should not be released until groundwater remediation is complete.”

Decommissioning and Final Survey Report for Cimarron Facility Contaminated Waste Burial Ground (Cimarron Corporation, 1991), submitted November 25, 1991, presented final status survey results for the excavated burial trenches in Subarea F prior to their backfilling, which NRC approved in License Amendment 9, dated December 28, 1992. *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Cimarron Corporation, 1998) presented final status survey results for concrete slabs which had been removed from buildings and structures in other areas and placed in Subarea F. *Final Status Survey Report, Subarea F* (Nextep Environmental, 2005) was submitted September 5, 2005, with additional information provided in the November 20,

2007 *Burial Area #1 Subsurface Soil Assessment* (Cimarron Corporation, 2007). ORAU issued a letter report on the analysis of seven confirmatory subsurface soil samples on March 6, 2013; all results were less than one-third of the criteria for unrestricted release. When license SNM-928 was transferred to the Trust, the February 16, 2011 license transfer order stated, "Because groundwater exceeds license criteria in Subarea F, this area cannot be released for unrestricted use until groundwater remediation is complete."

Phase III Areas

The June 24, 1998 *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, 1998) was a single final status survey plan for Subareas K through N. Two final status survey reports were submitted for Subarea O. *Final Status Survey Report for Phase III Subarea O Uranium Waste Ponds #1 and #2 (Subsurface)* (Cimarron Corporation, 1998) was submitted March 12, 1998. *Final Status Survey Report, Subarea O (Surface)* (Cimarron Corporation, 1999) was submitted February 9, 1999. NRC released the two Subarea O areas from License SNM-928 in License Amendment 16, dated April 17, 2000.

Two final status survey reports were submitted for Subarea L. *Final Status Survey Report for Subarea L (Subsurface)* (Cimarron Corporation, 1996) was submitted May 29, 1996. *Final Status Survey Report for Subarea L* (Cimarron Corporation, 1998) was submitted July 27, 1998.

Final Status Survey Report for Subarea M (Cimarron Corporation, 1998) was submitted December 31, 1998. NRC released Subareas L and M from License SNM-928 in License Amendment 17, dated April 9, 2001.

Final Status Survey Report for Subarea K (Cimarron Corporation, 2000) was submitted February 15, 2000. NRC released Subarea K from License SNM-928 in License Amendment 18, dated May 28, 2002.

Final Status Survey Report for Subarea N (Cimarron Corporation, 2002) was submitted January 31, 2002. NRC performed an inspection/confirmatory survey for Subarea N. An inspection report dated September 18, 2002 stated, "These confirmatory measurements were consistent with the licensee's determination that Sub-Area N of the Site meets the criteria established in NRC License SNM-928, License Condition 27 for unrestricted use." When license SNM-928 was transferred to the Trust, the February 16, 2011 license transfer order stated, "Final status surveys and confirmatory surveys have confirmed that Subareas G and N are releasable for unrestricted

use, but NRC has determined that these areas should not be released until groundwater remediation is complete."

Summary

As a result of all the above described final status surveys, confirmatory surveys, and license amendments, surface and subsurface soil has been demonstrated to comply with unrestricted release criteria in all Subareas. All Subareas except Subareas F, G, and N have been released for unrestricted use.

1.4 SPILLS OR RELEASES

Five categories of spills or releases of licensed material occurred at the Site. Some subsurface drain lines, including pipelines carrying wastewater to ponds, leaked wastewater in quantities that were too small to be detected during operations, but which yielded elevated scan or soil sample results upon excavation and removal of the pipeline. Beneath Uranium Building #1, soil was found to be contaminated as a result of leaking drain lines or by migration of licensed material through penetrations in the concrete floor, such as locations where cracks developed or where electrical conduit penetrated the floor. Soil removal and disposal (based on the uranium activity of the soil) was required in these cases. Figure 1-6 shows the locations of pipeline leaks, spills, and releases which were identified during their excavation and removal.

Uranium Ponds #1 and #2 were primarily evaporative ponds, but wastewater seeped through the pond liners and impacted the groundwater underlying the ponds. Movement of groundwater has resulted in migration of uranium, nitrate, and fluoride beyond the footprint of the impoundments, extending into the Western Alluvial Area. The extent of contaminant migration is addressed in Section 3.

Burial of wastes containing licensed material in trenches in the three burial areas that were used during operations resulted in the leaching of uranium and/or nitrate and fluoride into groundwater. Movement of groundwater has resulted in migration of licensed material beyond the burial trenches. The extent of contaminant migration is addressed in Section 3.

Finally, contaminated equipment was stored outside in a storage yard located east of Uranium Building #1. A water supply well (Well 1319) had been drilled in the storage yard, but had never been used to produce water for production operations. The well casing was cut off at grade, but had not been securely covered. Rainwater rinsed some of the material off of contaminated equipment and flowed down the well. This resulted in the contamination of groundwater in the Well 1319 Area. The extent of contaminant migration is addressed in Section 3.

1.4.1 Leaking Drain Lines Causing Soil Contamination

Main Drain Lines from Uranium Building #1 to Uranium Pond #1

Except for portions of this line underlying Uranium Building #1 and the soil stockpiles, this four-inch PVC line was excavated and removed in 1985. The excavated trench was surveyed, and 150 drums of soil that exceeded the BTP Option 1 limit due to a leak located south and east of Uranium Pond #1 were packaged and shipped to a licensed LLRW disposal facility.

Liquid Waste Line from Uranium Building to Emergency Ponds

This four-inch PVC line was excavated and removed in 1985. Surveys of the trench yielded several areas with elevated uranium concentrations, which were removed and shipped to a licensed LLRW disposal facility.

Drain Line from Closed Sanitary Lagoons to Cimarron River

This four-inch steel drain line was used for liquid effluent discharges from the Sanitary Lagoons to the Cimarron River. The drain line was excavated and removed in 1985. Surveys of the trench yielded several areas with elevated uranium concentrations, which were removed and shipped to a licensed LLRW disposal facility.

Uranium Building #1 Drain Lines

For those drain lines that were under Uranium Building #1, it was not possible to distinguish between soil that had been impacted by releases from drain lines and soil that had been impacted by releases through penetrations in the floor (e.g., electrical conduit, floor joints, etc.). Drain lines under the laboratory were removed in 1990. Drain lines under the Wet Ceramic area were removed in 1990 and 1991. This area was included in a 1991 confirmatory survey performed by Oak Ridge Institute for Science and Education (ORISE) prior to backfilling. Drain lines under the Scrap Area Floor were removed in 1990 and 1991. This area was included in an ORISE confirmatory review. Drain lines along the North wall of the Uranium Building were removed in 1991. Drain lines east of Uranium Building #1 were excavated and removed in 1992. In all areas beneath the processing areas of Uranium Building #1, soil underlying the concrete slab was surveyed. Soil containing uranium within the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell. Soil exceeding the BTP Option 2 limit was packaged and shipped to a licensed LLRW disposal facility.

Once the stockpile had been placed in the on-site BTP Option 2 Disposal Cell, the pipeline under the stockpile was excavated and removed in 1997. Material containing uranium within the BTP Option 2 concentration range was transferred to the on-site BTP Option 2 Disposal Cell.

1.4.2 Leaking Drain Lines Causing Groundwater Contamination

Leaking wastewater from drain lines resulted in the contamination of groundwater in four areas. In the Western Alluvial Area, uranium activity exceeds the Derived Concentration Goal Level (DCGL), and uranium, nitrate, and fluoride all exceed their Oklahoma Department of Environmental Quality (DEQ) criteria. A pipeline leak near Well 1350 resulted in a nitrate concentration below its DEQ criterion but above its MCL. A pipeline leak near Well 1355 resulted in a nitrate concentration below its DEQ criterion but above its MCL. West of the southern end of the 1206 drainageway, fluoride exceeds its DEQ criterion in Well 1348.

1.4.3 Groundwater Contamination from Leaking Ponds

Leaking wastewater from Uranium Pond #1 has resulted in both fluoride and nitrate exceeding their DEQ criteria, but uranium concentrations are below the MCL. Leaking wastewater from Uranium Pond #2 has resulted in both fluoride and nitrate exceeding their DEQ criteria, and while uranium concentrations are below the DCGL, they exceed the MCL.

1.4.4 Groundwater Contamination from Buried Waste

Burial Area #1 – Leachate from Burial Area #1 has resulted in uranium concentrations exceeding the DCGL, but nitrate and fluoride concentrations are below their criteria. Nitrate exceeds its MCL at two locations (1315R and 02W29). Both locations yield less than 15 mg/l nitrate.

Burial Area #2 – Leachate from Burial Area #2 has resulted in uranium concentrations that formerly exceeded the DCGL, but uranium concentrations have been below the DCGL since 1999. Uranium concentrations still exceed the MCL, and nitrate and fluoride concentrations are both below their MCL.

Burial Area #3 – Leachate from Burial Area #3 has resulted in uranium concentrations exceeding the DCGL, and nitrate concentrations exceeding its DEQ criterion. Fluoride concentrations have been below the MCL.

1.4.5 Rainwater Causing Contamination through Uncapped Well

Contaminated runoff from precipitation apparently flowed down the former uncapped water supply Well 1319. The potentiometric surface in this water well appears to have been in

Sandstone B, because the uranium concentration previously exceeded the DCGL, and the nitrate concentration exceeded its DEQ criterion, only in Sandstone B (described in Section 2.5). Groundwater extraction reduced the uranium concentration to less than the DCGL, but nitrate continues to exceed its DEQ criterion. Fluoride concentrations remain below the MCL.

Figure 1-6 shows the locations of the sources of spills and releases. The extent of contaminant migration in groundwater is addressed in Section 3.

1.5 PRIOR ON-SITE BURIALS

During operating years, licensed material was disposed of in burial trenches in three locations, in accordance with 10 CFR 20.302. Some of the material in these trenches exceeded decommissioning criteria and was removed. Soil containing low concentrations of licensed material has been buried onsite in a fourth area. The locations of these burial areas are shown on Figure 1-3.

1.5.1 Burial Area #1

This burial area, constructed in 1965, was opened in 1966 for disposal of radioactive material, including thorium-contaminated waste from the Kerr-McGee Corporation's Cushing, OK facility. Burial Area #1 was closed and capped in 1970. Records show that 1,303 kg of depleted uranium, 148 kg of enriched uranium, and 5,555 kg of natural thorium were buried in this area. An investigation was initiated in 1984. From 1986 through 1988, the trenches were excavated. Waste exceeding the BTP Option 2 limits was shipped for disposal at a licensed LLRW disposal facility. Waste shipment records indicate that approximately 65,000 ft^3 of waste were shipped for disposal. Approximately 16,000 ft^3 of contaminated soil within the BTP Option 2 concentration range were stockpiled east of Uranium Building #1 awaiting on-site disposal.

In 1988, Oak Ridge Associated Universities (ORAU) performed a confirmatory survey for Burial Area #1 and found eight (8) locations requiring further remediation. An additional 14,000 ft^3 of material were removed and stockpiled east of Uranium Building #1. Confirmatory soil sampling and surveys by ORAU were completed in December, 1991, with a final report issued in July, 1992. Burial Area #1 was released for backfilling with clean soil in Amendment #9, License Condition 22, issued December 28, 1992.

1.5.2 Burial Area #2

Burial Area #2 was utilized in the 1970's for the disposal of industrial solid waste generated during processing operations. Analysis of soil samples collected in May 1990 determined that licensed material was present in this buried waste. Remediation of Burial Area #2 began in 1991.

Remediation involved the location and excavation of all material exceeding BTP Option 1 and Option 2 soils from Burial Area #2. Material containing licensed material in the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell. Approximately 20,000 cubic feet of material exceeding the BTP Option 2 concentration range were packaged and shipped off-site for disposal in a licensed LLRW disposal facility. Industrial waste was also packaged and shipped off the Site for disposal in a licensed LLRW waste disposal facility. Excavations were backfilled with soils from unaffected areas, which were sampled and analyzed after placement.

NRC staff supervised a confirmatory sub-surface sampling effort for Burial Area #2 on October 30, 1996. Based upon the results of this confirmatory sampling effort, the NRC staff approved the backfilling of Burial Area #2. Burial Area #2 was backfilled with clean soil and final grading was completed in January 1997. Burial Area #2 was released for unrestricted use in Amendment17, License Condition 29, issued April 9, 2001.

1.5.3 Burial Area #3

This area was intended to be utilized for the disposal of non-radioactive solid waste materials. In 1990, soil sampling and gamma surveys indicated that radioactive materials were present in the buried waste. In-depth characterization completed in 1992 led to the removal of approximately 100 ft^3 of waste exceeding the BTP Option 2 concentration range. This waste was packaged and shipped to a licensed LLRW disposal facility.

Cimarron later excavated all non-native soil from the Burial Area #3 trenches. All industrial solid waste and non-native soils were spread in lifts approximately 6 in thick and were surveyed with both gamma scans and collection of soil samples. Material containing licensed material in the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell. Material and/or soil exceeding the BTP Option 2 concentration range were packaged and shipped off-site for disposal in a licensed LLRW disposal facility. Burial Area #3 was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

1.5.4 Burial Area #4

Burial Area #4 is an on-site disposal cell approved by NRC and DEQ for the on-site disposal of soil containing uranium in the BTP Option 2 concentration range. The lower bound of the BTP Option 2 concentration is 30 pCi/g total uranium. The upper bound varies from 100 pCi/g total

uranium for soluble uranium to 250 pCi/g total uranium for insoluble uranium. Cimarron performed tests to evaluate lung solubility as well as tests to determine environmental leachability, including the United States Environmental Protection Agency (EPA)-approved Extraction Procedure for Toxicity (EP Tox) and Toxicity Characteristic Leaching Procedure (TCLP), but was unable to obtain NRC approval for any calculated solubility. Consequently, Cimarron utilized the 100 pCi/g total uranium concentration as the upper bound for the BTP Option 2 concentration range, and shipped all soil exceeding 100 pCi/g total uranium off-site to a licensed disposal facility.

Soil containing uranium at concentrations between 30 pCi/g and 100 pCi/g total uranium was placed in four flat-topped stockpiles for final characterization. The North Stockpile (DAP-1) was located north of Uranium Building #1 and measured approximately 40 m by 25 m by 2 m thick. The East Stockpile (DAP-2) was located east of Uranium Building #1 and measured approximately 80 m by 30 m by two m thick. Stockpiles DAP-1 and DQP-2 were generated from soil generated during decommissioning activities prior to 1994. Stockpiles DAP-3 and DAP-4 were smaller stockpiles generated from 1994 through 1996.

For all stockpiles, soil samples were collected for on-site analysis from borings drilled on a 5-m grid and sampled at 0.5-m depth intervals. Soil that exceeded the BTP Option 2 criterion was removed and shipped for off-site for disposal at a licensed disposal facility. For Stockpiles DAP-3 and DAP-4, hot-spot averaging criteria contained in NUREG/CR-5849 was applied to the stockpile characterization data.

The disposal cell consisted of three trenches, referred to as Pits #1, #2, and #3. Pit #1 was excavated in 1994 and measured approximately 50 feet X 425 feet at its base. Placement of BTP Option 2 material was completed in February 1995. Pit #2 was excavated in 1995, and measured approximately 60 feet X 470 feet at its base. Placement of BTP Option 2 material was completed in September 1996. Pit #3 was excavated in 1997, and measured approximately 60 feet X 470 feet at its base. Placement of Option #2 material was completed in July 2000. Soil from stockpiles was placed in Pits #1 and #2, but Pit #3 was filled with soil excavated in the field as decommissioning operations in various areas were completed.

One-foot lift markers were placed at 50-foot intervals along the east and west walls of each excavated trench. One-foot lifts were placed in the trench, compacted, and measured to demonstrate compliance with compaction and moisture criteria. Characterization data from

Stockpiles DAP-1 through DAP-4 were used to characterize the soil placed in Pits #1 and #2. As Pit #3 was filled with soil from various areas during the completion of soil and waste decommissioning, each one-foot lift was sampled on a 5-m grid.

A total of approximately 452,000 ft^3 (16,740 yd^3) of BTP Option 2 soil was placed in the disposal trenches. The average concentration of uranium in the three pits varies from 35.7 to 45.0 pCi/g total uranium. The total quantity of uranium in the soil placed in Burial Area #4 is approximately 0.98 Curies.

After placement of waste, Pits #1 and #2 were covered with at least 4 feet of cover soil. Due to excess capacity, Pit #3 was covered with approximately 6 feet of cover soil. All cover soil came from areas of the Site not affected by previous operations. Several inches of topsoil was placed over the entire area, which was then seeded with a winter seed mix. Concrete cairns were placed at the corners of the disposal cell. Each cairn contains a brass marker with the words "Radioactive Disposal Area", lines indicating the boundaries of the pits, and the northing and easting coordinates of the cairn.

A notice was placed in the deed in accordance with License Condition 23(b). The deed notice states that "… notice is hereby provide that uranium-contaminated soil has been buried at the following location: [legal description of the location of Burial Area #4] … [coordinate location of Burial Area #4] … The total volume of uranium-contaminated soil in the containment cell is 452,186 ft^3, and the total quantity of uranium is 0.98 Curies. Markers are placed at the containment site." License Condition 23(b) states, "This notification is not to be considered a restriction on the sale or future use of the site."

License Condition 23(b) also required periodic inspection of the disposal area for subsidence, erosion, and status of the vegetative cover for at least 5 years. Inspections were performed for over five years. To date, there is no evidence of erosion, and despite two years of intense drought (2011 and 2012), the vegetative cover over the disposal cell remains dense and healthy.

* * * * *

2.0 FACILITY DESCRIPTION

2.1 SITE LOCATION AND DESCRIPTION

The Site consists of approximately 700 acres of property located in Logan County, Oklahoma (Figure 1-1). Its actual acreage varies based on the location of the Cimarron River, which forms the northern property line. Prior to 2015, the Site included property located west of Highway 74, and occupied over 800 acres. Approximately 117 acres west of the highway, and approximately 24 acres containing the former processing buildings were sold in 2015. Those two areas were located in portions of Subareas E, H, I, J, K, and L. These Subareas were released from License SNM-928 as described in Section 1. The 117-acre and 24-acre properties are no longer owned by the licensee, and for the purposes of this decommissioning plan are no longer considered part of the Site.

However, in the sale of the 24-acre property, the Trust retained the environmental liability associated with groundwater which does not require remediation under License SNM-928, but which contains concentrations of nitrate exceeding DEQ criteria. The concentration of nitrate in groundwater exceeds DEQ criteria in two areas: near the former uranium processing building (referred to as the Process Building Area), and in the northeast corner of the 24-acre property, north of Burial Area #2. Although these small areas do not require groundwater remediation for decommissioning purposes, the Trust will include plans for reducing the concentration of nitrate in these areas in this plan to eliminate the duplication of effort that would be required to develop a separate groundwater remediation plan for only these two small areas.

The city of Cedar Valley extends to approximately ½ mile east of the Site. Cimarron City extends to the northern bank of the Cimarron River. Crescent, Oklahoma is located approximately 6 miles north of the Site. Guthrie, Oklahoma is located approximately 9 miles east of the Site. Edmond, Oklahoma extends to approximately 11 miles southeast of the Site, and Oklahoma City extends to approximately 14 miles south of the Site. Figure 1-1 shows the location of the Site relative to these cities. Figure 2-1 presents an aerial image of the Site, as well as the topographic contours of the property. Figure 2-2 presents a topographic map of an area extending 2 miles around the Site, showing the locations of residences, other facilities, ponds, streams, lakes, the Cimarron River, and off-site water wells. Table 2-1 lists water wells located within 2 miles of the Site.

The Site consists of gently rolling hills, leading northward to the floodplain of the Cimarron River. Ground elevation varies from approximately 925 feet above mean sea level (amsl) at the northeastern property line to approximately 1,045 feet amsl near the southern property line. Two surface water

reservoirs are present on the Site. Unnamed ephemeral streams feed these reservoirs, which discharge to the floodplain of the Cimarron River. The only structure remaining on the licensed Site is the current office building (formerly the Emergency Response Building). Figure 1-3 presents the Site and site features.

2.2 POPULATION DISTRIBUTION

Cimarron City, which extends northward from the northern bank of the Cimarron River, had a 2010 population of 110; its population has been increasing at a rate of approximately 36% per decade. Crescent, Oklahoma, located approximately 6 miles north of the Site, had a 2010 population of 1,280; its population has been increasing at a rate of approximately 10% per decade. Guthrie, Oklahoma, located approximately 9 miles east of the Site, had a 2010 population of 10,200; its population has been increasing at a rate of approximately 3% per decade. Edmond, Oklahoma, located approximately 11 miles southeast of the Site, had a 2010 population of 81,400; its population has been increasing at a rate of approximately 19% per decade. Oklahoma City, Oklahoma, located approximately 14 miles south of the Site, had a 2010 population 580,000; its population has been increasing at a rate of approximately 15% per decade. Population increase data is taken from the website www.usa.com.

2.3 CURRENT / FUTURE LAND USE

The property owned by the Cimarron Trust currently lies fallow. Portions of the Site containing grasses that are beneficial for cattle feed are periodically mowed and baled. The bales are removed from the Site for use as cattle feed. Mowing of large portions of the Site is intended to minimize the fire hazard associated with tall prairie grass as well as to maintain access to groundwater monitoring wells. An office building (not continuously occupied) is maintained for periodic use by personnel when at the Site.

The area surrounding the Site is primarily used for farming and ranching. The 24-acre property near the office building is being developed for light industrial use and warehousing. A small commercial development with a service station/convenience store is located west of the southern portion of the Site. A golf course is located within one mile of the southeastern corner of the Site. Less than 100 people live within one mile of the Site. Figure 2-2 presents a topographic map of an area extending 2 miles around the Site, showing the locations of residences, other facilities, ponds, streams, lakes, the Cimarron River, and off-site water wells. Table 2-1 lists water wells located within 2 miles of the Site.

2.4 METEOROLOGY AND CLIMATOLOGY

Adams and Bergman (1995) summarized the precipitation for the Cimarron River from Freedom to Guthrie, Oklahoma. Their study showed that precipitation ranges from an average of 24 inches per year (in/yr) near Freedom, Oklahoma, in the northwest part of the Cimarron River floodplain in Oklahoma, to 32–42 in/yr at Guthrie, Oklahoma. Wet years between 1950 and 1991 were in 1973–1975, 1985–1987, and 1990–1991. The wettest months are May through September, while the winter months are generally the dry months. The period from 1973 to 1975 was 23 inches above the normal total for the three-year period (Carr and Marcher, 1977).

Precipitation data collected by the National Oceanic and Atmospheric Administration (NOAA) for Guthrie County, Oklahoma, from 1971 to 2000 indicates that the annual average precipitation is 36.05 inches. The minimum monthly average precipitation is 1.33 inches (January) and the maximum monthly average is 5.48 inches (May).

2.5 GEOLOGY AND SEISMOLOGY

The following two sections describe the regional and Site-specific geology. These two sections contain information summarized from *Conceptual Site Model (Revision – 01), Site, Crescent, Oklahoma* (ENSR International, 2006). More detailed descriptions of the geology and hydrogeology of localized areas of interest are provided in Section 2.7, "Groundwater Hydrology".

2.5.1 Regional Geology

The bedrock geology of Logan County is dominated by Permian-age clastic sedimentary rocks of the Garber-Wellington Formation as shown in Figure 2-3. These units dip to the west at 30 to 40 feet per mile. The Permian-age Garber Sandstone and underlying Wellington Formation, which comprise the Garber-Wellington Formation, include lenticular channel and sheet-flood sandstones interbedded with shales and mudstones. The combined thickness of the Garber Sandstone and the Wellington Formation is about 1,000 feet. Because the two formations are difficult to distinguish in drill core and in outcrop and have similar water bearing properties, they are often treated as a single mappable formation and grouped into a single hydrostratigrahic unit, the Garber-Wellington Aquifer (Wood and Burton, 1968).

Structurally, the Cimarron area is part of the Nemaha Uplift of Central Oklahoma. The Nemaha Uplift trends northward across Oklahoma and was formed during a period of uplift, faulting, and erosion that occurred between the Mississippian and Pennsylvanian Periods in the Oklahoma area. The Nemaha Uplift consists of north-northwest trending normal faults and anticlinal

structures that influenced early Pennsylvanian-age sedimentation in the Oklahoma region. By middle Pennsylvanian time, the Nemaha Uplift was not active. During the Permian, when the Garber-Wellington Formation was deposited, Central Oklahoma was part of the eastern shelf of a shallow marine sea. The sandstones and shales of the Garber-Wellington Formation were deposited as part of a westward-advancing marine delta fed by numerous streams flowing to the west and northwest. Thus, the sands of the Garber-Wellington Formation are often sinuous and discontinuous, and exhibit the rapid facies changes typical of a deltaic channel and overbank depositional system. Sand accounts for 35 to 75 percent of the Garber-Wellington Formation (Carr and Marcher, 1977).

There is no evidence of subsidence, karst terrain, or landsliding within several miles of the Site. Bank erosion is present along streams and the Cimarron River. Floodplain and upland erosion rates are typically insignificant due the heavy vegetation throughout the area, although agricultural fields are subject to sediment erosion during heavy precipitation events.

There are no man-made geologic features such as mines and quarries within several miles of the Site.

2.5.2 Site Geology

The stratigraphy of the Site is dominated by the Garber-Wellington Formation. The Garber Formation is exposed along the escarpment that borders the Cimarron River. The Wellington Formation is not exposed within the project area. A boring completed in 1969 near the plant site penetrated 2,078 feet of the Garber-Wellington Formation. Identified in this boring was 200 feet of Garber Formation sandstones underlain by 960 feet of Wellington Formation red shales. Beneath the Wellington Formation, the Stratford Formation was identified at a depth of 1,160 feet and consisted of red and gray shales with interbedded anhydrite.

Within the Site, the Garber Formation consists primarily of sandstone layers separated by relatively continuous siltstone and mudstone layers. The sandstone units frequently have interbedded, but discontinuous, red-brown shale and mudstone lenses. Lateral facies changes are common in the sandstones and represent shifting channel locations in the Garber delta. The Garber sandstones can be divided into three basic sandstone units separated by two relatively continuous and identifiable mudstone layers, as follows:

- Sandstone A is the uppermost sandstone unit, generally red-brown to tan in color and up to 35 feet in thickness. The bottom of this sandstone unit occurs at an elevation of approximately 950–970 feet amsl.
- Mudstone A is a red-brown to orange-brown, sometimes tan mudstone and claystone that separates Sandstones A and B. It ranges from 6 to 20 feet thick.
- Sandstone B is the second sandstone unit, underlying Mudstone A, and similar in color and sedimentary features to Sandstone A. It is found at elevations between 925 and 955 feet amsl and is up to 30 feet thick.
- Mudstone B consists of mudstone and claystone separating Sandstone B and Sandstone C. It is similar in color to Mudstone A and ranges from 6 to 14 feet thick.
- Sandstone C is the lowermost sandstone in the Garber-Wellington Formation, similar in color and sedimentary features to the overlying sandstones. This unit varies in thickness from 10 to 25 feet at the Site to at least 100 feet thick regionally.

Figure 2-4 presents a lithologic column describing these three zones, based on the boring log for Monitoring Well 1321. The three sandstone members of the Garber Formation at the Site are similar in lithology. They are fine to very fine-grained red-brown to tan sandstones with well-sorted sub-angular to rounded grains and contain variable amounts of silt. The silt content ranges from 10 to 50 percent and the sandstones with high silt content are difficult to distinguish from siltstone. The sand grains are mostly quartz with minor amounts of feldspar and occasional magnetite and mica. The inter-granular porosity varies with the silt content. The sandstones are weakly cemented and often friable. Cementing agents are calcite and hematite. Locally, thin intervals can be found that are well cemented with gypsum and barite. These intervals are often conglomeratic. The sandstones exhibit planar cross-stratification with thin, silty laminae. Conglomeratic intervals are common in most of the borings and they are observed to contain clasts of mudstone and occasionally sandstone in either a sandstone or mudstone matrix. These conglomeratic zones are up to 2.5 feet thick. Vugs found in these conglomerate zones are lined with calcite, gypsum, and barite. The sandstones of the Garber Formation were deposited in a fluvial deltaic environment, probably as channel sands.

The mudstone layers that separate the sandstones in the Garber Formation at the Site are mostly fine-grained, silty to shaly beds with a red-brown to orange-brown and tan color. The mudstones occasionally exhibit desiccation cracks. The mudstones are poorly consolidated. The mudstone layers are often encapsulated by thin, bluish-gray laminae that range in thickness from 0.1 to 4.0 inches. These “reduction zones” are common in red beds; at the Site the thickness of these

reduction zones is approximately proportional to the thickness of the mudstone layer. These continuous mudstone layers probably represent deltaic overbank deposits formed during flooding of the Garber delta.

A mineralogical analysis of the sandstones and mudstones of the Garber Formation was conducted by Auburn University using X-ray diffraction, grain-size determinations, and cation exchange capacity measurements. Quartz and feldspar were found to be the main clastic grains with kaolinite and montmorillonite as the clays in the fine-grained fractions. Illite, smectite, chlorite, hematite, and goethite were also among the minerals detected in the clay fractions according to USGS. Calcite, iron oxides, and iron hydroxides were identified as the main cementing agents. The clay fraction ranged from 6 to about 20 percent in the sandstones and from about 14 to 50 percent in the mudstones. The mudstones had a cation exchange capacity in the range of 6 to 22 milliequivalent (mEq)/100 g. The sandstones had a cation exchange capacity generally below 6 mEq/100 g. Exchangeable cations were generally calcium and magnesium for both the sandstones and the mudstones. Within the "reduction zones," minerals formed with metals in low oxidation states, including uranium, were identified.

The Cimarron River floodplain alluvium consists of sand and silt, developed by the erosion of the Garber Formation from the escarpment bordering the river on the south, as well as material transported to the floodplain from upstream within the river system. This alluvium formed gradually over time and contains many buried channels reflective of both transport of the alluvial materials northward toward the river from the escarpment and meandering of the main river channel. Near the present river channel, buried oxbow meanders can be expected. Near the escarpment, buried channels would be expected to be the continuation of present drainages incised into the escarpment sandstones. The alluvium is about 30 to 40 feet thick. Along the present escarpment face, there are local transition zones from the sandstones of the Garber Formation to the coarser alluvial materials. These transition zones can be clay-rich, as is the case with the transitional zone identified with borings in the Burial Area #1 area.

At the Site, upland areas are underlain by the sandstones and mudstones of the Garber Formation, which rolling hills on either side of ephemeral streams. Two ponds created by earthen dams constructed in the1960s contain water year-round, but the ephemeral streams which supply water to the ponds are dry in the hot, dry summers, and the water level in the ponds typically lowers during the summer.

The upland areas terminate where the floodplain of the Cimarron River exists. The river has carved a floodplain nearly one-half mile wide at the Site. The erosional escarpment is evident in the Western half of the Site, and rises over 30 feet above the floodplain in areas. To the east, the escarpment is present only as a shallow slope.

2.5.3 Seismology

In 1976, the NRC initiated several cooperative programs with state geological surveys to study areas of anomalously high seismicity east of the Rocky Mountains. The Oklahoma Geological Survey (OGS) participated in one of these surveys. A summary report on this study is documented in an Oklahoma Geological Survey Special Publication entitled *Seismicity and Tectonic Relationships of the Nemaha Uplift and Midcontinent Geophysical Anomaly* (OGS, 1983). This summary report was also published by NRC in 1983 as NUREG/CR-3117.

The Nemaha Ridge lies within one of the areas with a moderately high seismic risk classification. The Nemaha Uplift, approximately 415 miles long, extends from Oklahoma to Nebraska. OGS compiled data from over 20,000 wells to construct structure-contour maps, from which the following conclusions were drawn. Figure 2-5 shows the location of the Nemaha Ridge.

The structure-contour maps reveal a complex fault pattern associated with the Nemaha Uplift. This fault pattern is dominated by several discontinuous uplifts such as the Oklahoma City, Lovell, Garber, and Crescent Uplifts. These features form a fault zone that extends from Oklahoma City in a northwesterly direction. Near the Kingfisher-Garfield County line, the orientation of the fault zone becomes north-northeast and extends northward through Kansas and terminates in southeastern Nebraska. The southern end of the Nemaha Ridge is believed to be the Oklahoma City Uplift and its associated faults. Another fault zone, the McClain County Fault zone, intersects the Oklahoma City Uplift in southern Oklahoma County. This fault zone, which is composed of a number of sub-parallel faults and is thought to be temporally related to the Nemaha faults, trends south-southwest and terminates against the Paul's Valley Uplift in Garvin and southern McClain Counties (Oklahoma Geological Survey, 1983, p. 14-15).

There appears to be a 25-mile-wide and 90-mile-long zone that extends northeastward from near El Reno toward Perry. The El Reno-Perry trend appears to cut diagonally across the Nemaha Uplift structures at about a 30° angle. The southern end of this trend, the El Reno-Mustang area, appears to be more active than the middle and northern parts. The recent as well as the historic earthquake data seem to support this observation. It is not clear what the earthquake activity

between El Reno and Perry represents. It is not known whether the zone is the result of a coincidental plot of earthquake epicenters and (or) whether it is related to some unknown northeast-trending structure(s) (Oklahoma Geological Survey, 1983, p. 16-18).

Figure 2-6 presents the locations of faults and the locations and magnitudes of earthquakes noted in the Oklahoma Geological Survey (OGS) report in central Oklahoma. Five earthquakes were identified in Logan County from 1900 through 1981; all were of Modified Mercalli intensity 4 or less (from OGS, 1983, p. 17). According to the OGS website, in 2010, over one thousand earthquakes occurred in Oklahoma, and over 100 of these were felt. On November 5, 2011, magnitude (M) 4.7 and 5.6 earthquakes were recorded between Meeker and Prague, Oklahoma (approximately 42 miles east-southeast of Guthrie). The M5.6 quake was the largest quake to hit Oklahoma in modern times.

Based on rising concerns about increasing earthquake occurrences in Oklahoma, collaborative research by the United States Geological Survey (USGS) and the Oklahoma Geological Survey (OGS) is being performed to investigate this phenomenon and its potential relationship with induced seismicity resulting from human-induced fluid injections from oil and gas production activities. Holland (2013) opined that it is possible that the increased earthquake occurrences may be the result of fluid injection but is not definitive on the topic. In an area where both natural and induced seismic events occur it is very difficult to distinguish one potential cause from the other. To date, the induced seismicity phenomenon has not been specifically associated with seismic events in Logan County or in the vicinity of the site.

Table 2-2 presents a list of all recorded historical earthquakes having a magnitude of at least 3.0 in the State of Oklahoma through October 22, 2015. Table 2-2 provides evidence of the recent increase in low-magnitude seismic activity. From 1882 through 2010, a total of 147 earthquakes with a magnitude of at least 3.0 were recorded. Of those, 15 had a magnitude of at least 4.0, and one of them had a magnitude of at least 5.0. From 2011 through 2013, a total of 259 earthquakes with a magnitude of at least 3.0 were recorded. Of those, 11 had a magnitude of at least 4.0, and one of them had a magnitude of at least 5.0. In 2014 and 2015 (through October 22nd), 1,420 earthquakes with a magnitude of at least 3.0 were recorded. Of those, 49 had a magnitude of at least 4.0, and none had a magnitude of at least 5.0.

2.6 SURFACE WATER HYDROLOGY

2.6.1 Cimarron River

The Cimarron River is a gaining river over its entire course from Freedom to Guthrie, Oklahoma. In the vicinity of the Site and Guthrie, the flow is perennial. Base flow from the alluvial and terrace aquifers and from the Permian sandstone units that border the river is highest in the winter months due to the higher water tables in these aquifers, which result from decreased evapotranspiration. Base flow is lowest from late summer through early winter because water tables are at their low point during that time. Because the Cimarron River is fed mainly by base flow from groundwater aquifers, flow in the Cimarron River parallels this seasonal fluctuation in groundwater levels. River flow has not been directly measured at the Site because there are no stream gages within the Site boundary. From 1990 to 2003, the Guthrie gage, located approximately 10 miles east of the Site, recorded from 591 to 3,271 cubic feet per second (cfs) average annual flow rates (United States Geological Survey [USGS] water data website). Adams and Bergman (1955) reported a low-water median flow rate of approximately 100 cfs and a high-water median flow rate of 600 cfs.

Flood statistics for the Cimarron River have been compiled by the USGS (Tortorelli and McCabe, 2001). Peak flow ranges from a 2-year (yr) flood with a discharge of 26,700 cfs to a 500-yr flood with a discharge of 237,000 cfs. Floods most typically occur in this area in May-June or October, largely as a function of heavy rainfall in upstream portions of the watershed. The most recent significant flood was 20 years ago in 1986. The extent of flooding for the 100-yr flood includes the entire alluvial valley, but not the upland areas of the Site.

2.6.2 Other Surface Water Features

Surface water features at the Site and in the surrounding area are shown in Figure 2-7. Cottonwood Creek is located about seven miles south of the Site and flows northeast through Guthrie. Cottonwood Creek, like the Cimarron River, is a gaining stream and drains southern Logan and northern Oklahoma counties. On the north side of the Cimarron River, across from the Site, springs can be found at Indian Springs and small lakes are present at Crescent Springs. On the south side of the Cimarron River near the Site, Gar Creek to the east and Cox Creek to the west are named drainages that receive most of their flow from groundwater base flow. Most drainages within and near the Site are ephemeral in nature and flow only in response to heavy rainfall or from groundwater base flow when groundwater levels are relatively high (J.L. Grant and Associates, 1989).

Within the Site, two unnamed drainages have been dammed to form small reservoirs, referred to as Reservoir #2 and Reservoir #3, as shown in Figure 2-7 (Reservoir #1 was located west of Highway 74, and is no longer within the licensed site). Both reservoirs maintain a pool elevation of approximately 960 feet amsl. The maximum pool elevation in Reservoirs #2 is controlled by a spillway. When the Reservoir #2 pool elevation exceeds the elevation of the spillways (typically following heavy rainfall), water flows over the top of the spillway into the drainage below. The maximum pool elevation in Reservoir #3 is controlled by two 30-inch corrugated steel culverts. The pool elevation of both reservoirs is above the groundwater elevation in Sandstone B, and Sandstone A does not extend beneath the reservoirs. Both reservoirs represent recharge sources for groundwater in Sandstone B. The pond evaporation rate in this part of central Oklahoma is approximately 60 in/yr (J.L. Grant and Associates, 1989).

2.7 GROUNDWATER HYDROLOGY

Groundwater in the Permian-age Garber Formation is found in the Garber Sandstones and the underlying Wellington Formation in the Site area. Shallow groundwater, defined by Carr and Marcher (1977) as groundwater at depths of 200 feet or less, is generally fresh and mostly unconfined. Groundwater deeper than 200 feet can be artesian to semi-artesian. The base of fresh groundwater at the Site is at approximately 950 feet amsl and the thickness of the fresh water zones has been estimated at 150 feet (Carr and Marcher, 1977). Data from the Site shows that groundwater in Sandstone C, which is generally more saline than groundwater in Sandstones A and B, is usually at an elevation around 900 to 920 feet amsl. Thus, at the Site, the bottom of fresh water is somewhat lower than estimated by Carr and Marcher (1977) for this part of the Garber Formation and, conversely, the thickness of the fresh water zone is somewhat greater. Following Carr and Marcher (1977), the groundwater in Sandstone C at the Site, therefore, represents the top of the saline groundwater zone in the Garber Formation.

Recharge to shallow groundwater in the Permian-age Garber Formation near the Site has been estimated at 190 acre-feet per square mile, or about 10 percent of annual precipitation (Carr and Marcher, 1977). Adams and Bergman (1995) estimate a similar recharge of 8 percent of annual precipitation. A regional groundwater high is located south of the Site between the Cimarron River and Cottonwood Creek (Carr and Marcher, 1977). The maximum groundwater elevation on this high is around 1,050 feet amsl. Groundwater flows north toward the Cimarron River from this location.

The regional northward gradient from the groundwater high to the Cimarron River in the shallow sandstone unit is approximately 0.0021foot/foot. The gradient to the south to Cottonwood Creek is 0.0067 foot/foot. This groundwater high and the uplands at the Site are within a major recharge area for the Garber Formation.

This suggests that vertical groundwater flow in the area of recharge between Cottonwood Creek and the Cimarron River is downward. At the Cimarron River, regional groundwater flow in the fresh water zone of the Garber Formation is vertically upward to allow for discharge to the river, which act as a groundwater drain in this part of central Oklahoma (Carr and Marcher, 1977). The nature of vertical groundwater flow in the saline water zone of the Garber Formation at the Cimarron River is uncertain.

In summary, the Site is underlain by the Garber-Wellington Aquifer of Central Oklahoma. At the site, the Garber Formation can be divided into three separate water-bearing zones that parallel the geological division of the formation into Sandstones A, B, and C. The uppermost water-bearing zone in the Garber Formation is generally unconfined, although it can be locally semi-confined by mudstone and shale units. The two lower units in Sandstones B and C are confined to semi-confined, depending on the thickness and continuity of the overlying mudstone unit.

Groundwater flow in uppermost water-bearing unit is local in nature and flows from topographic highs, which also act as recharge areas, to topographic low areas such as the drainages. In the western portions of upland areas, groundwater in Sandstone A discharges through groundwater seeps into the escarpment that borders the Cimarron River floodplain. In the northeastern portion of the upland area (Burial Area #1), groundwater in Sandstone B flows eastward to the drainage, and northward to the alluvial sediments and the transition zone. In the deeper bedrock units groundwater flow is regionally controlled, with flow predominantly to the north towards the Cimarron River, with a component of upward flow as it ultimately discharges to the River.

The Site is within a recharge area for the upper fresh water zone of the Garber-Wellington Formation. Thus vertical hydraulic gradients are generally downward, except at major discharge areas such as the Cimarron River. However, the low permeability of the mudstone units results in flow predominantly horizontal in the water-bearing units, with a minor component of flow vertically across units. The Cimarron River is a gaining river and thus receives groundwater from its floodplain alluvium.

2.7.1 Saturated Zones

Groundwater occurs in both consolidated (Garber-Wellington Formation) and unconsolidated Quaternary (colluvium, terrace, and alluvium) deposits at the Site. Geologically, the Garber Formation Sandstones at the Site have been divided into Sandstones A, B, and C. The Garber and Wellington Formations have been grouped into the Garber-Wellington Formation by Carr and Marcher (1977). At the Site, the Garber-Wellington Formation can be further divided into water-bearing units because the mudstone layers that separate the three main sandstone units of the Garber Formation at the site act as semi-confining units. In the upper 200 feet at the Site, there are thus four main water-bearing units as follows:

- Sandstone A;
- Sandstone B;
- Sandstone C; and
- Cimarron River Alluvium and Terrace Deposits.

2.7.2 Monitoring Wells

There are 229 monitor wells at the Site, including those located on the 24-acre property for which the Trust retains responsibility for groundwater remediation. These wells are screened in each of the water bearing zones. Tables 2-3 through 2-7 provide a listing of all monitor wells present at the site, with selected installation and location information for each well.

2.7.3 Physical Parameters

Each of the water-bearing units at the Site has its own specific flow patterns and hydraulic properties.

For Sandstone A, slug tests completed by J.L. Grant and Associates (Grant, James, 1989) yielded a geometric mean hydraulic conductivity of 1.03×10^{-3} cm/s with a range from 2.41×10^{-4} cm/s to 5.7×10^{-3} cm/s. The geometric mean for transmissivity was 33.4 square feet/day (ft^2/d) with a range from 10.3 ft^2/d to 108 ft^2/d. For Sandstone C, the geometric mean hydraulic conductivity was 7.85×10^{-5} cm/s.

Aquifer tests in Burial Area #1 (BA1) included slug tests on many of the monitor wells and a pumping test. For Sandstone B, hydraulic conductivity estimates ranged from 9.97×10^{-4} cm/s to 2.39×10^{-5} cm/s. For the alluvial sediments of the Cimarron River floodplain, hydraulic conductivity estimates varied from values in the 10^{-2} cm/s to 10^{-3} cm/s range for the coarser

sediments (sandy alluvium) to values in the range of 10^{-3} to 10^{-5} cm/s for sediments high in clays and silts (transitional zone). Because the alluvial sediments have higher clay and silt content near the escarpment where Sandstone B is exposed, the slug tests in the alluvial sediments gave lower hydraulic conductivities nearer the escarpment.

In 2014, pneumatic slug tests were performed in select monitor wells in the western portion of the floodplain alluvium. A pumping test was conducted at GE-WA-01. Hydraulic conductivity values were calculated to range from 10^{-1} cm/s to 10^{-4} cm/s.

2.7.4 Groundwater Flow Directions and Velocities

The general groundwater flow direction at the Site is northward from the groundwater high south of the Site toward the Cimarron River. Within the Site, groundwater flow directions vary locally depending on depth within the Garber Formation.

Figures 2-8, 2-9, and 2-10 present potentiometric surface maps for the Site.

In those areas where Sandstone A is the uppermost water-bearing unit, the hydraulic gradient in Sandstone A mimics the local overlying topography. Groundwater in Sandstone A flows from the topographically higher areas to adjacent drainages and reflects local recharge from precipitation events. That is, the hydraulic gradients in Sandstone A are northwards towards the escarpment, with components of flow to the east and/or west towards the drainages in the vicinity. This same pattern is observed in water levels from Sandstone B where it is the uppermost water-bearing unit in BA1.

Flow in deeper Sandstones B and C is more regionally controlled. Generally, flow in Sandstones B and C is north to northwest toward the Cimarron River. Flow in the alluvium is generally northward toward the Cimarron River because the river is a gaining stream throughout its reach from Freedom to Guthrie.

Locally, groundwater flow directions are impacted by local geologic features. Based on the interpretation of subsurface data, the potential presence of a paleochannel in the transition zone in BA1 may provide a preferential pathway for groundwater flow in the otherwise lower permeability of the silts and clays. The presence of mudstones between sandstone units affects flow between the units. Similarly, interbedded layers of silts and clays in the sandy alluvial materials exert some influence on groundwater flow.

In addition to the horizontal groundwater flow, vertical components of hydraulic gradient depend on the localized groundwater recharge-discharge relationship. In the uplands and generally to the south, the vertical component of the gradient is expected to be downward, as this is an area of groundwater recharge. In the alluvium and near the Cimarron River, vertical gradients are expected to be upward, reflecting groundwater discharge to the River.

Because groundwater flow varies locally across the Site, a discussion of groundwater flow for specific areas of interest is presented in this section.

Burial Area #1

Groundwater in the vicinity of BA #1 (Figure 2-8) originates as precipitation that infiltrates into the shallow groundwater unit recharge zone in the area of the former disposal trenches and Sandstone B. Groundwater also enters Sandstone B area from upgradient. This groundwater then flows across a buried escarpment that acts as an interface between Sandstone B and the floodplain alluvium, and finally into and through the floodplain alluvium to the Cimarron River.

There is also flow in BA1 towards the drainage to the east. As shown in Figure 2-8, flow in Sandstone B west of the transitional zone is mostly northward, but further south it is more eastward towards the drainage. Between these two areas, the gradient is to the northeast along the interface with the transitional zone. Flow is driven by a relatively steep hydraulic gradient (0.10 foot/foot) in Sandstone B.

Based on relative elevations, groundwater discharges from Sandstone B into the southern portion of the drainage. However, to the north, the groundwater elevation is well below the streambed. Therefore, when water is flowing in the northern portion of the drainage, such as following precipitation events, groundwater may be locally recharged. The elevation of Reservoir #2 is above the groundwater in BA1. Any potential hydrologic effect that the reservoir has on groundwater is reflected in the measured groundwater levels. It is unlikely that fluctuations in the level of the reservoir would affect groundwater flow.

Once groundwater enters the transition zone of the floodplain alluvium, the hydraulic gradient decreases to around 0.023 foot/foot and flow is refracted to a more northwesterly direction. The decrease in hydraulic gradient is due in part to the much higher overall hydraulic conductivity in the floodplain alluvium compared to Sandstone B and lower permeability material in the transition zone (10^{-1} cm/s to 10^{-4} cm/s versus 10^{-4} cm/s to 10^{-5} cm/s in Sandstone B). The

refraction to the northwest of the groundwater flow path may also be due to a paleochannel in the transition zone and floodplain alluvial sediments.

Once groundwater passes through the transitional zone, it enters the sandy alluvial material where the hydraulic gradient is very flat (0.0007 foot/foot). The decrease in gradient is caused by the higher permeability of the sandy alluvium. Groundwater flow in the alluvium is northward, with discharge ultimately to the Cimarron River. Also in the alluvium, there is expected to be upward flow from the underlying bedrock as groundwater in the bedrock is discharging to the River.

There is no evidence of perched groundwater in this area. However, the presence of the mudstones may restrict vertical movement of groundwater in preference to horizontal flow in the sandstones. The presence of the mudstones indicates that vertical hydraulic conductivities across units are potentially smaller than horizontal conductivities within water-bearing units. Gradients within these lower permeability units are expected to be predominantly vertical. However, due to the low permeability of the mudstones, flow will be predominantly horizontal in the water-bearing units, with a minor component of flow vertically across units.

Based on measured hydraulic gradients and estimated hydraulic conductivities, groundwater velocities in these various units can be estimated. Average linear groundwater velocities were calculated using the hydraulic properties presented above and assuming porosity for the sandstone of 5%, 20% for the transition zone, and 33% for the alluvium. The calculated velocities are 0.6 ft/day for Sandstone B, 0.03 ft/day for the transition zone, and 0.3 ft/day for the alluvium. Velocities generated by the groundwater model are approximately 5 ft/day for the sandstone, 3 ft/day for the transition zone, and 4 ft/day for the alluvium.

Western Upland Area

As in BA1, groundwater in the Western Upland Area and the Western Alluvial Area (Figures 2-9 and 2-10) also originates as precipitation that infiltrates into the shallow groundwater unit recharge zones and flows into Sandstone A.

In the Western Upland Area, the drainage between the former Uranium Pond #1 and the former Sanitary Lagoons acts as a local drain for groundwater in Sandstone A. Groundwater flows toward this drainage from both the east and west, including Burial Area #3 and the former Sanitary Lagoons. The thick vegetation and groundwater seeps, such as those at the Western Alluvial Area, attest to groundwater base flow entering this drainage (thus becoming surface water) from Sandstone A.

Groundwater gradients steepen along the cliff faces of the drainage. Along the escarpment bordering the Cimarron River floodplain alluvium just north of the former Uranium Pond #1, groundwater flows north to northwest toward the floodplain in Sandstone A and discharges in numerous small seeps that are difficult to locate. Groundwater gradients in Sandstone A near the former Uranium Pond #1 are approximately 0.01 foot/foot toward the drainage to the northwest and about 0.02 foot/foot toward the north.

To the west of the drainage, groundwater flows northeastward towards the drainage near it, and more northerly to the alluvial floodplain at greater distances. At the western edge of the Upland Area, groundwater flow immediately east of Highway 74 is to the west.

Groundwater levels in Sandstone A range from approximately 988 feet amsl at the south end of the 1206 Area near Well 1353 to approximately 964 feet amsl near the escarpment (Well 1312). Groundwater in Sandstone A surfaces and flows into the drainage to the west of BA3 from small seeps that commingle with surface water in the drainage.

Groundwater in Sandstones B and C is present approximately 30 feet below the groundwater in Sandstone A. The deeper groundwater flows northwest toward the Cimarron River beneath the Western Upland Area.

The top of Sandstone B is exposed in the lower part of the escarpment north of the BA #3 Area. In Sandstone B, the groundwater gradient is toward the north-northwest at about 0.023 foot/foot. In Sandstone C, the gradient is also toward the north at about 0.013 foot/foot (J.L. Grant and Associates, 1989). Groundwater flow in Sandstones B and C is below the base of the escarpment in the Western Upland Area, thus Sandstones B and C do not discharge to seeps in the escarpment. These two water-bearing units are not intercepted by the drainages in the area of BA #3.

The relative groundwater elevations suggest there may be some perching of water in Sandstone A, especially to north, near the escarpment; that is, there may be some portions of Sandstone B that are unsaturated.

However, the presence of the mudstones between the water-bearing units is likely to restrict vertical movement of groundwater in preference to horizontal flow. Vertical hydraulic conductivities across units are expected to be significantly smaller than horizontal conductivities within water-bearing units.

Gradients within these lower permeability units are expected to be predominantly vertical. Due to the low permeability of the mudstones, flow will be predominantly horizontal in the water-bearing units, with a minor component of flow vertically across units. This is demonstrated by the appearance of the seeps, representing horizontal flow within Sandstone A. Seepage from Sandstone A into the drainage way does not infiltrate into Sandstone B, but commingles with surface water, flows along Mudstone A, and is discharged into the transition zone from which it discharges in to the alluvium.

Based on measured hydraulic gradients and estimated hydraulic conductivities, groundwater velocities can be estimated. Average linear groundwater velocities were calculated using the hydraulic properties presented above and assuming porosity for the sandstone of 5%. The calculated groundwater velocity is 1.2 ft/day for Sandstone A.

Western Alluvial Area

The water table in the Western Alluvial Area (Figure 2-10) is found in the alluvial floodplain of the Cimarron River. Groundwater flow in the Western Alluvial Area is generally northward toward the Cimarron River, as shown in the groundwater contour map in Figure 2-10. The hydraulic gradient is approximately 0.002 foot/foot. This is significantly lower than in the adjacent uplands, due to the increased permeability of the alluvial materials.

As in the BA1 area, there is expected to be upward flow from the underlying bedrock into the alluvial material as groundwater in the bedrock is discharging to the Cimarron River.

Average linear groundwater velocities were calculated using the hydraulic properties presented above and assuming porosity for the alluvium of 33%. The calculated groundwater velocity is 0.9 ft/day for the alluvium in the Western Alluvial Area. The groundwater flow velocity generated by the groundwater flow model is approximately 1.5 ft/day.

2.7.5 Unsaturated Zone

The unsaturated zones (vadose zones) exist within the uppermost soils in the upland, transitional, alluvial material at the Site. No vadose zone monitoring has been performed at the Site.

2.7.7 Groundwater Models

Groundwater flow models for the Western Alluvial Area and Burial Area #1 were initially developed by ENSR Corporation, and submitted to NRC in *Groundwater Flow Modeling Report*, (ENSR 2006). Those flow models were revised based on additional COC delineation and aquifer

testing, and submitted to NRC January 6, 2014. The groundwater flow models incorporate area-specific lithologic and hydraulic detail to describe groundwater gradients and flows, and assist in determining the locations and probable production of groundwater from groundwater extraction technologies such as groundwater recovery wells and groundwater extraction trenches.

Burial Area #1

The model area for BA #1 is shown on Figure 2-11. The northern boundary of the model domain is the Cimarron River and the southern boundary of the model is the extent of the transition zone. There are twelve layers in the model. This complex model layering system setup was described in the *2006 Groundwater Flow Modeling Report* (ENSR, 2006a). The BA1 model was updated with new geologic and hydrogeologic data, based on additional assessment performed in 2012 and 2013. The model was recalibrated to a more comprehensive round of groundwater levels collected in November 2013 (Burns & McDonnell, 2014). New boring data collected in the alluvium suggested the model layer elevations for the sandstone needed to be adjusted, therefore slight adjustments were made to the bedrock elevation in the model. Flow into the model domain is from recharge and general head boundaries and flow out of the model is to the Cimarron River. Figure 2-12 shows the simulated potentiometric surface.

Western Alluvial Area

The Western Alluvial Area (WAA) is located in the alluvial floodplain to the north of the upland area near the former BA #3 Area, the 1206 Seep Area, and the area of the former Sanitary Lagoons. Alluvial sediments in the WAA consist predominantly of sand with minor amount of clay and silt. The alluvium is underlain by Sandstone B near the escarpment and by Mudstone B and Sandstone C closer to the Cimarron River (ENSR CSM, 2006).

The model area for the WAA is shown on Figure 2-13. The northern boundary of the model domain is the Cimarron River and the southern boundary of the model is the extent of the transition zone. The model was recently expanded eastward to address remedial alternatives in the entire area of the nitrate plume as defined by the 10-mg/L isoconcentration contour; it therefore covers a larger area than the 2006 groundwater model. The WAA model domain includes two layers: Layer 1 represents the alluvium and Layer 2 represents the underlying bedrock. Flow into the model domain is from recharge and general head boundaries and groundwater flow out of the model is to the river. Figure 2-14 shows the simulated potentiometric surface.

Western Upland Areas

The Western Upland Area (WUA), which includes the former Uranium Pond #1, the 1206 Seep Area, and the former Sanitary Lagoons, is underlain primarily by Sandstone A. Sandstone B is exposed near the base of the drainage between the former Sanitary Lagoons and the former Uranium Pond #1 at the mouth of the drainage where it opens into the alluvial floodplain of the Cimarron River. In the vicinity of the BA #3 Area and the former Sanitary Lagoons, the upper part of Sandstone A is composed mostly of siltstone and shale, rather than sandstone (ENSR CSM, 2006).

As in the BA1 Area, groundwater in the Western Upland Area also originates as precipitation that infiltrates into the shallow groundwater unit recharge zones and flows into Sandstone A. In the Western Upland Area, the drainage between the former Uranium Pond #1 and the former Sanitary Lagoons acts as a local drain for groundwater in Sandstone A. Groundwater flows toward this drainage from both the east and west, including the BA #3 Area and the former Sanitary Lagoons. Groundwater gradients steepen along the cliff faces of the drainage. Along the escarpment bordering the Cimarron River floodplain alluvium just north of the former Uranium Pond #1, groundwater flows north to northwest toward the floodplain in Sandstone A and discharges in a myriad of small seeps that are difficult to locate (ENSR CSM, 2006).

A review of historical records indicates groundwater in the Western Uplands has shown impact from prior site operations. For the WUA, Uranium Pond #1, Uranium Pond #2, Well 1348 Areas no numerical modeling was conducted.

Well 1319 Area

The area is located upgradient of the alluvium and south of the WA area, in the Western uplands. Well 1319 was installed as a water supply well in the mid-1960s to a depth estimated at 173 feet, but was never used for water supply (Kerr-McGee, 2003). The geology at this location consists of alternating layers of sandstones and siltstones of the Garber Formation. Unlike the BA #1 Area, Sandstone A extends across the upland area in the western part of the Site. No numerical modeling was needed for the Well 1319 area.

2.7.8 Distribution Coefficients

The primary mechanisms controlling transport in groundwater at the Site are advection (within groundwater flow) and dispersion (spreading during transport). The numerical groundwater flow

models (ENSR, 2006 and Burns & McDonnell, 2014) demonstrate that the groundwater flow directions generally mirrors the contaminant plumes moving away from the source areas.

An important aspect of the site hydrogeology is the mobility of the contaminants in various strata under influence of groundwater flow. The distribution coefficient, also known partition coefficient, K_d, used to describe the decrease in concentration of contaminant in solution through interaction with the geologic material in a soil/rock-groundwater system. The K_d is defined as the ratio of concentration (or activity in the case of radionuclides) of a species sorbed, divided by its concentration (or activity) in solution under steady-state conditions. It is an empirical parameter and its use in a given situation implies that soil/rock-groundwater system under study is under equilibrium. K_d can also be determined by the direct proportionality to the fraction of organic carbon (f_{oc}) in the saturated soils and to organic carbon partition coefficient (k_{oc}) for the chemical. However, literature-derived K_d values are commonly used for calculations.

The primary chemicals of concern at the site are uranium, nitrate, and fluoride. The K_d values can vary across the site depending upon the geochemistry and soil type, which potentially results in a range values.

Uranium Kd Literature Values

Kd values for uranium have been shown to vary with pH, total dissolved carbonate, and dissolved calcium due to geochemical processes (Zachara *et al.* 2007 and EPA, 1999). Groundwater data (2011-05-06 Comprehensive Water Data tables) from the Site indicate average pH for all measurements is 7.2. Kd values reported by EPA (1999) range between 63 to 630,000 mL/g for a pH of 7. *Understanding Variation in Partition Coefficient, Kd* (EPA, 1999) also noted that the Kd for clays is much larger than the Kd for sands.

Previously reports used Kd values averaging 3 mL/g (*3/31/2004 Travel time estimate*). Using samples of soil and groundwater from the site, column tests were conducted by Hazen Research, Inc. (Johnson, Dennis and Kenney, Charles, June 2006). Kd values were calculated and reported in *Conceptual Site Model (Revision – 01)* (*ENSR 2006*).

Alluvial sand yielded a Kd of 0.5 mL/g, silt yielded a Kd of 2.0 ml/g, and clay yielded a Kd of 3.4 ml/g. All tests were conducted with groundwater from BA1, and it is acknowledged that the minor variations in groundwater geochemistry may impact Kd values. Consequently, more conservative values than those reported were agreed upon for use in retardation calculations.

Because none of the borings completed in the Transition Zones yielded all clay, but consisted of a mixture of clay, silt, and fine sand, the use of a uranium Kd value of 3.4 ml/g for all Transition Zone material was deemed overly conservative. Similarly, borings drilled in Sandstones A and B contained a high degree of silt. Based on these observations, it was decided that a Kd lower than that which had been reported for clay should be used for Sandstones A and B. A conservative value of 3.0 was selected for Sandstones A and B.

Clean sand yielded a uranium Kd of 0.5 during the Hazen tests. However, although borings in the floodplain do contain intervals of very “clean” sand, there is sufficient silt and/or clay to justify the use of a higher Kd value than had been reported for clean sand. A Kd of 2.0 was applied to alluvial areas.

Nitrate Kd Literature Values

Nitrate is highly mobile and has little potential for sorption to soil therefore Kd values for nitrate are expected to be very low. Krupka et al (2004) recommend for groundwater scenarios a Kd of 0 L/kg for nitrate with a possible range from 0 mL/g to 0.0006 mL/g. Therefore, nitrate is expected to be very mobile in groundwater. For retardation calculations, a very conservative value of 0.6 mL/g was used in retardation calculations.

Fluoride Kd Literature Values

A literature search for fluoride Kd values produced limited published information. Fluoride is usually transported through the water cycle complexed with aluminum. The Kd values were estimated between 16 mL/g to 1166 mL/g (Daniels and Das, 2007) suggesting fluoride transport in groundwater is very retarded under certain geochemical conditions. However, since fluoride concentrations only slightly exceed the MCL, it was decided that retardation calculations to estimate the time required for remediation would not be performed.

2.8 NATURAL RESOURCES

2.8.1 Natural Resources at or Near the Site

The mineral and water resources of Logan County are important to the overall development and progress of the county. Petroleum production is by far the most important mineral-related commercial activity. In 1993, petroleum production in Logan County amounted to about 1.1 million barrels of crude oil (valued at nearly $18.7 million) and about 12 billion cubic feet of natural gas (valued at $22.6 million). Due to these production levels, Logan County ranked near

the middle of the petroleum producing counties in Oklahoma (NRCS, 2006). Significant exploration and production activities have been performed in Logan County since early 2014.

Sand and gravel have been produced from a number of sites in the alluvial and terrace deposits of the county. Some of the sandstone and siltstone beds may locally be suitable for use as building and fill material.

Agriculture has a key role in the utilization of natural resources in the vicinity of the site. The native vegetation consists of mid and tall rangeland grasses. The main agricultural enterprises are cattle and wheat production. Cattle are grazed mainly on native grasses and some improved pasture and on the side slopes. Wheat and grain sorghum are grown on the summits and gently sloping side slopes. Wheat, grain sorghum, and alfalfa are grown on the wide flood plains.

2.8.2 Water Usability

Abundant quantities of good-quality ground water occur in Quaternary alluvial and terrace deposits as well as in the extremely important Garber-Wellington aquifer that underlies much of the southern part of the county. The Garber-Wellington aquifer covers permeable sandstone layers of both the entire Garber Sandstone section and the upper part of the underlying Wellington Formation. The saturated thickness of this aquifer ranges from about 500 to 700 feet.

Water wells in the Garber-Wellington aquifer commonly yield 25 to 100 gallons per minutes (GPM) of fresh water that contains only 200 to 500 mg/L of dissolved solids. The aquifer is recharged by precipitation and runoff that percolates down through the soil into the porous and permeable sandstones of the Garber Sandstone and the Wellington Formation. Groundwater then percolates slowly downward and/or laterally dips down (westward) within the sandstone layers. Groundwater is salty in the lower part of the Wellington Formation and farther west where the Garber Sandstone extends beneath Kingfisher County. Where the Garber Sandstone and the Wellington Formation crop out, ground water generally is found in any permeable sandstone bed at or below the ground-water surface. Farther west, where the relatively impermeable Hennessey Group overlies the Garber Sandstone, wells still must be drilled down into the water-bearing sands of the Garber-Wellington aquifer. Upon encountering a fresh-water sand, the water will be forced up the borehole several hundred feet under artesian pressure to the potentiometric surface, approximately 100 to 200 feet below the land surface. Since the Garber Sandstone and the Wellington Formation are more shaley to the north, the yield of the aquifer decreases northward

across the county. Fresh water still occurs in the sands (the same as it does farther south), but the sands are less abundant and the yields typically are 5 to 40 GPM. Water wells in alluvial and terrace deposits locally yield 25 to 50 GPM, while wells in the prolific Cimarron River terrace aquifer in the west-central part of the county yield 150 to 700 GPM. The water quality in most of these aquifers includes 300 to 1,000 mg/L of dissolved solids.

2.8.3 Economical Evaluation of Natural Resources

As defined in U.S. Geological Survey Circular 831, resources in the vicinity of the Site are inferred to be viable based on known historical oil and gas production. Inferred reserves are currently economic for oil and gas.

2.8.4 Mineral, Fuel, and Hydrocarbon Resources

No mineral, fuel, and hydrocarbon resources near and surrounding the site, if exploited, would affect the licensee's dose estimates. The only potential exposure pathway would occur if exploration and production (E&P) activities occurred in proximity to the remediation areas. Sundance Energy (current operator within the vicinity of the site) has established locations and drilled wells for Sections 11 and 12 in T16N-R4W, and in Section 7 in T16N-R3W. If another operator would want to drill in Sections 1 or 2 in T16N-R4W, it is likely that the interested party would potentially need to cross the Cimarron River and drill on high ground rather than in the floodplain. The pipeline that constructed across Section 12 carries production water for disposal and presents negligible naturally occurring radioactivity material (NORM) risk. As a result of these factors, the risk impact to dose estimates is very small.

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3.0 RADIOLOGICAL STATUS OF FACILITY

3.1 CONTAMINATED STRUCTURES

All formerly contaminated structures at the Site have been decommissioned and released for unrestricted use. Buildings that were formerly associated with licensed activities included:

- Uranium Building #1
- Uranium Tank Storage Building #2
- Solvent Extraction Building #3
- Uranium Warehouse Building #4
- UF_6 Receiving Room
- Emergency Response Building (now the Site Office)

A description of the decommissioning of these buildings is provided in Section 1.3.1, "Decommissioning of Former Buildings". All these buildings are or were located in Subareas I and K. Subarea I was released for unrestricted use in License Amendment 17, issued April 9, 2001. Subarea K was released for unrestricted use in License Amendment 18, issued May 28, 2002.

The Site Office (with adjacent storage containers) will be used to support continuing license activities, including:

- Storage of radiological instruments and check sources
- Storage of sampling equipment and supplies
- Storage, packaging, and shipping of samples
- Conducting groundwater treatability tests
- Storage of potentially contaminated material prior to shipment to a licensed disposal facility

Sampling activities and groundwater treatability testing conducted in the Site Office had the potential to contaminate the building and equipment. Both routine and post-activity radiological surveys were conducted in the Site Office; no detectable contamination was present after completion of sampling activities and groundwater treatability testing. This demonstrates that contamination does not exceed criteria for unrestricted release. The Site Office has remained releasable for unrestricted use.

3.2 CONTAMINATED SYSTEMS AND EQUIPMENT

A trash incinerator, located south of Burial Ground #3, was used to incinerate non-radioactive waste materials released from restricted areas during site operations. Uranium was present in the ash at

concentrations above background, due to concentration of the licensed material in the ash. Ash exceeding restricted release criteria was drummed and shipped to a licensed disposal facility. Soil samples collected from the area beneath the incinerator yielded uranium concentrations below the unrestricted release criteria. This area was included in the Final Status Survey Report for Subarea M. Subarea M was released for unrestricted use in License Condition 29 of Amendment 17 (issued April 2001).

All other radiologically contaminated systems and equipment associated with the former processing buildings were removed during the decommissioning of the buildings.

The radiological status of systems and equipment that becomes contaminated during groundwater decommissioning activities is addressed in Section 8, "Planned Decommissioning Activities".

3.3 SURFACE AND SUBSURFACE SOIL CONTAMINATION

The licensee has completed decommissioning and final status surveys for all soil and buildings currently present on the Site. Surface soil (including soil to three feet in depth where soil contamination was detected in the top six inches) in all sixteen Subareas of the Site has been demonstrated to comply with criteria for unrestricted release stipulated in License Condition 27(c) (30 pCi/g total uranium).

Where pipelines were removed, the excavated trench was surveyed, and wherever contamination was identified below the pipeline, soil was removed until subsurface soil complied with the 30 pCi/g total uranium criterion.

In Burial Area #1 and Burial Area #3, the former burial trenches were excavated, scanned, and sampled. Soil containing less than 30 pCi/g total uranium was returned to the trenches. Soil exceeding 30 pCi/g was removed.

Soil and/or waste exceeding one meter in depth in Burial Area #2 was sampled and excavated as necessary to comply with the volumetric averaging criteria stipulated in License Condition 27(c).

NRC's 1981 *Branch Technical Position on Disposal or On Site Storage of Residual Thorium and Uranium from Past Operations* (USNRC, October 1981) established criteria for uranium in soil. This Branch Technical Position (BTP) established four options for disposal or on-site storage. The first option (Option 1) is unrestricted use, and the Option 1 criteria were incorporated into License Condition 27(c) as unrestricted release criteria. The second option (Option 2) is on-site storage, with

a minimum of four feet of "clean" cover (the cover could be Option 1 soil). The activity limit for Option 2 varied based on the solubility of the uranium in the soil. Although the licensee demonstrated that the uranium in the soil had a very low solubility, the limit for totally soluble uranium (100 pCi/g total uranium) was incorporated into License Condition 27(e) as the limit for on-site disposal of uranium. The third and fourth options in the BTP require off-site disposal of higher activity licensed material; Option 3 pertains only to natural uranium, so all material exceeding the Option 2 limit was considered Option 4 material.

All excavated soil (and other buried material) which exceeded the Option 2 criterion (100 pCi/g total uranium) was packaged and shipped to an off-site licensed disposal facility. All excavated material which contained 30 – 100 pCi/g total uranium was placed in the on-site disposal trenches, now designated as Burial Area #4. Both surface and subsurface soil now comply with license criteria for unrestricted release Site-wide.

3.4 SURFACE WATER

All former impoundments which received or may have received licensed material at the Site have been decommissioned and released for unrestricted use. Impoundments that were or may have received licensed material included:

- Plutonium Waste Pond
- Plutonium Emergency Pond
- Uranium Emergency Pond
- Uranium Pond #1
- Uranium Pond #2
- East Sanitary Lagoon
- West Sanitary Lagoon
- "New" Sanitary Lagoon

A description of the decommissioning of these impoundments is provided in Section 1.3.2, "Decommissioning of Former Impoundments". These impoundments were located in Subareas H, L, and O. Both impoundment areas identified as Subarea O were released for unrestricted use in License Amendment 16, issued April 17, 2000. Subareas H and L were released for unrestricted use in License Amendment 17, issued April 9, 2001.

The two freshwater ponds (reservoirs) on the Site are located in Subarea B. Subarea B was released for unrestricted use in License Amendment 13, issued April 13, 1996.

The Cimarron River is located along the northern boundary of the Site. Annual environmental monitoring continues to demonstrate that the Cimarron River is not impacted by any of the contaminants of concern (COCs) associated with the Site.

3.5 GROUNDWATER

Groundwater is the only environmental medium for which decommissioning is required to obtain unrestricted release of the Site. This section lists the groundwater assessments that have been performed for the Site, and presents the current extent of impact for all COCs in groundwater at the Site.

The Derived Concentration Goal Level (DCGL) for the Site is 180 picoCuries per liter (pCi/L) total uranium, derived from a risk-based concentration, and stipulated in License Condition 27(c).

Groundwater in several areas of the Site also contains two non-radiological COCs: nitrate and fluoride. For uranium and fluoride, the criteria to achieve an unrestricted release from the Oklahoma Department of Environmental Quality (DEQ) are the United States Environmental Protection Agency (EPA)-established Maximum Contaminant Levels (MCLs) for drinking water. The MCLs are 30 µg/L for uranium and 4 mg/L for fluoride. Because nitrate is present at concentrations above the MCL due at least in part to the use of fertilizer, DEQ has designated a value of "mean plus two standard deviations" to be the remediation goal, based on analysis of samples from monitoring wells located upgradient of processing or disposal activities. The DEQ remediation goal for nitrate is 22.9 mg/L.

In this Plan, the NRC-approved criterion for uranium in groundwater will be referred to as the DCGL. Remediation goals for uranium, nitrate, and fluoride will be referred to as "DEQ criteria" (or "DEQ criterion" if for a single chemical).

3.5.1 Submittals Addressing Groundwater Assessment

Numerous groundwater assessment efforts have been performed at the Site. The following is a list of reports on groundwater assessment activities.

- April 17, 2002 Former Burial Area #1 Groundwater Assessment Work Plan (Cimarron Corporation, 2002)

- September 24, 2002 Tc-99 Site Impact Evaluation and Proposed Groundwater Assessment Work Plan (Chase Environmental Group, 2002)
- December 12, 2002 Well 1319 Area Groundwater Assessment Work Plan (Cimarron Corporation, 2002)
- January 29, 2003 Burial Area #1 Ground Assessment Report (Cimarron Corporation, 2003)
- December 30, 2003 Draft Tc-99 Groundwater Assessment Report (Chase Environmental Group, 2003)
- December 30, 2003 Assessment Report for Well 1319 Area (Cimarron Corporation)
- August 10, 2005 Site-Wide Groundwater Assessment Review (Cimarron Corporation)
- November 5, 2005 Refined Conceptual Site Model (ENSR International, 2005)
- October 19, 2006 Conceptual Site Model (Revision- 01) (ENSR International, 2006a)
- October 23, 2006 Groundwater Flow Modeling Report (ENSR International, 2006b)
- March 3, 2013 Pneumatic Slug Testing Memorandum (Burns & McDonnell, 2013a)
- March 15, 2013 Hydrogeological Pilot Test Report (Burns & McDonnell, 2013b)
- January 6, 2014 Groundwater Flow Modeling Report (Burns & McDonnell, 2014a)
- July 22, 2014 Hydrogeological Testing Memorandum (Burns & McDonnell, 2014b)
- May 8, 2015 Report on 2014 Design Investigation (Burns & McDonnell, 2015)

3.5.2 Submittals Addressing Groundwater Remediation

Numerous approaches to groundwater remediation efforts have been considered, and several proposed at different time, to address COCs in groundwater at the Site. The following is a list of submittals addressing groundwater remediation.

- October 22, 2003 Draft Work Plan – In Situ Bioremediation Treatment of Uranium in Groundwater in Burial Area #1 (ARCADIS, 2003)
- January 24, 2005 letter, proposing a Well 1319 Area post-decommissioning groundwater monitoring plan
- December 11, 2006 license amendment request which included Site Decommissioning Plan, Groundwater Decommissioning Amendment (ARCADIS, 2006). Rejected by NRC w/a request for additional information (RAI) March 27, 2007.
- August 31, 2007 letter requesting that NRC provide closure on Well 1319 Area groundwater remediation
- June 2, 2008 Groundwater Decommissioning Plan (ARCADIS, 2008)

- March 26, 2009 license amendment request included Groundwater Decommissioning Plan (ARCADIS, 2009)
- June 30, 2011 Evaluation of Potential Alternative Groundwater Remediation Technologies (Environmental Properties Management LLC, 2011)
- Treatability Study Report (Clean Harbors, 2013)
- Treatability Test Report (Kurion, Inc., 2015)

3.5.3 Current Extent of COCs in Groundwater

Figures 3-1 through 3-4 present the results of recent (2015) groundwater assessment for the Site. Figure 3-1 presents the extent of groundwater exceeding the DEQ Criterion for nitrate in the Western portion of the Site. Figure 3-2 presents the extent of groundwater exceeding the DEQ Criterion for fluoride in the Western portion of the Site. Figure 3-3 presents the extent of groundwater exceeding the DCGL and the DEQ Criterion for uranium in the Western portion of the Site. Figure 3-4 presents the extent of groundwater exceeding the DCGL and the DEQ Criterion for uranium in Burial Area #1.

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4.0 UNRESTRICTED RELEASE CRITERIA

Decommissioning Plan guidance contained in Appendix D of NUREG-1757 is based on the need to utilize a dose model to develop derived concentration goal levels (DCGLs) that will yield a site that is releasable for unrestricted use. However, unrestricted release criteria for building surfaces and equipment, surface and subsurface soil, and groundwater have already been established and specified in License Condition 27. Consequently, dose modeling was not performed to develop unrestricted release criteria. This section describes the criteria that are stipulated in License Condition 27.

4.1 UNRESTRICTED RELEASE CRITERIA FOR FACILITIES AND EQUIPMENT

License Condition 27(c) lists the unrestricted release criteria for facilities and equipment. This condition cites the August 1987 *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source or Special Nuclear Material"*. License Condition 27(c) states, "Buildings, equipment, and outdoor areas shall be surveyed in accordance with NUREG/CR-5849, 'Manual for Conducting Radiological Surveys in Support of License Termination.'" The criteria are:

- 5,000 dpm alpha/100 cm^2 (15.5 in^2), averaged over 1 m^2 (10.8 ft^2)
- 5,000 dpm beta-gamma/100 cm^2 (15.5 in^2), averaged over 1 m^2 (10.8 ft^2)
- 15,000 dpm alpha/100 cm^2 (15.5 in^2), maximum over 1 m^2 (10.8 ft^2)
- 15,000 dpm beta-gamma/100 cm^2 (15.5 in^2), maximum over 1 m^2 (10.8 ft^2)
- 1,000 dpm alpha/100 cm^2 (15.5 in^2), removable
- 1,000 dpm beta-gamma/100 cm^2 (15.5 in^2), removable

The exposure rate for surfaces of buildings and equipment is 1.3 pC/kg (5 μR/hr) above background at 1 m (3.3 ft.)

4.2 UNRESTRICTED RELEASE CRITERIA FOR SURFACE SOIL

License Condition 27(c) also lists the unrestricted release criteria for soils and soil-like material. This license condition states, "The licensee shall use … the October 23, 1981, BTP 'Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations' for soils or soil-like material." It also states, "… outdoor areas shall be surveyed in accordance with NUREG/CR-5849, 'Manual for Conducting Radiological Surveys in Support of License Termination'. Soils and soil-like materials with elevated activities exceeding the unrestricted use criteria shall be investigated to determine compliance with the averaging criteria in NUREG/CR-5849. These criteria address averaging

concentrations over any 100 m^2 (1070 ft^2) area and use the $(100/A)^{1/2}$ elevated area method." Unrestricted release criteria for soils and soil-like material are:

- Natural uranium 0.37 Bq/g (10 pCi/g) total uranium
- Enriched uranium 1.1 Bq/g (30 pCi/g) total uranium
- Depleted uranium 1.3 Bq/g (35 pCi/g) total uranium
- Natural thorium 0.37 Bq/g (10 pCi/g) total thorium
- 2.6 pC/kg (10 µR/hr) average above background at 1 m (3.3 ft.)
- 5.2 pC/kg (20 µR/hr) maximum above background at 1 m (3.3 ft.)

License Condition 23 lists post-closure monitoring and notification requirements for the onsite disposal cell. The onsite disposal cell has been closed and all post-closure monitoring and notification is complete. No additional material exceeding the BTP Option 1 (unrestricted release) criteria will be placed in the onsite disposal cell. All soil and soil-like material exceeding the unrestricted release criteria will be removed and shipped off-site to a licensed low-level radioactive waste disposal site.

4.3 UNRESTRICTED RELEASE CRITERIA FOR GROUNDWATER

The only radioactive elements of concern for groundwater are uranium and technetium-99. Uranium is present both as natural uranium and as licensed uranium in groundwater. In addition, nitrate and fluoride are the two non-radioactive contaminants for which groundwater remediation is required to obtain unrestricted release from DEQ.

4.3.1 Uranium

License Condition 27(b) cites the unrestricted release criterion for uranium in groundwater. This release criterion is referred to as a derived concentration goal level (DCGL). This DCGL is based on a site-specific risk assessment rather than a dose model, because the toxicity of purified uranium has a greater effect on human health than its radiological dose. A 1998 risk assessment established a risk-based limit of 0.11 mg/L for uranium in groundwater based on a drinking water scenario. A concentration of 0.11 mg/L is approximately equivalent to an activity of 180 pCi/L, assuming an average enrichment of approximately 3%.

To obtain unrestricted release from DEQ, uranium concentrations must comply with the MCL issued in the primary drinking water standards promulgated by the EPA. The MCL for uranium is 30 micrograms per liter (ug/L).

4.3.2 Technitium-99

Unrestricted release criteria for technetium-99 (Tc-99) are not stipulated in License SNM-928. The US Environmental Protection Agency (EPA) has promulgated a primary drinking water standard of 4 mrem/yr for beta photon emitters. NRC developed a Derived Concentration Limit (DCL) for Tc-99, based on this 4 mrem/yr dose limit, using the International Commission on Radiological Protection (ICRP) 1982 Publication 30, *Limits for Intakes of Radionuclides by Workers*. The NRC DCL for Tc-99 is 3,790 pCi/L. Tc-99 will not be accumulated in the groundwater remediation process. Hence, Tc-99 will not technically be “possessed”; consequently, the license does not authorize possession of Tc-99. However, post-remediation groundwater monitoring must demonstrate that Tc-99 concentrations in groundwater are less than 3,790 pCi/L to obtain unrestricted release from NRC.

EPA developed a Derived Concentration Limit (DCL) for Tc-99, based on the EPA MCL of 4 mrem/yr, using the ICRP 1959 Publication 2, *Permissible Dose for Internal Radiation*. The EPA DCL for Tc-99 is 900 pCi/L. Tc-99 concentrations in groundwater must be below 900 pCi/L to obtain unrestricted release from DEQ.

4.3.3 Nitrate

DEQ formalized the remediation goals for groundwater in a letter dated August 4, 2015. The concentration of nitrate in groundwater in the Process Building Area must be remediated to less than 52 mg/L. This is a risk-based concentration for a trespasser or an agricultural worker, which was deemed appropriate for a commercial operator obtaining drinking water from a public water supply.

The concentration of nitrate in groundwater in all other areas must be reduced to less than the DEQ Criterion of 22.9 mg/L. This represents the maximum nitrate concentration, at a 95% level of confidence, in groundwater collected from monitoring wells located upgradient of impacted areas.

4.3.4 Fluoride

The DEQ Criterion for fluoride in groundwater site-wide is also the MCL of 4 mg/L.

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5.0 ENVIRONMENTAL INFORMATION

5.1 INTRODUCTION

This section presents environmental information related to the decommissioning of the Site by reducing the concentration of COCs in groundwater to concentrations that provide for the release of the Site for unrestricted use and termination of license SNM-928. There are no regulatory deadlines or fixed dates for the initiation or completion of decommissioning activities.

The proposed action involves the extraction of groundwater from impacted areas, followed by removal of uranium by ion exchange and removal of nitrate by biodenitrification. A portion of the treated water will be re-injected into upland areas to flush contaminants to groundwater extraction components located in the floodplain. Most of the treated water will be discharged to the Cimarron River in accordance with an OPDES permit.

5.2 PURPOSE AND NEED FOR PROPOSED ACTIONS

The proposed actions are necessary to comp1ete the remaining decommissioning activities needed for NRC to release the Site for unrestricted use and to terminate Radioactive Materials License SNM-928. License termination is a separate action that requires an NRC finding that the Site meets the criteria for unrestricted release.

This section of the decommissioning plan follows the organization presented in NUREG-1748, Environmental Review Guidance for Licensing Actions Associated with NMSS Programs (USNRC, 2003). Several of the topics referenced in this document are fully presented elsewhere in this decommissioning plan, and are not duplicated herein to reduce duplication of effort and future potential conflicts between different sections of this decommissioning plan.

5.3 NEED FOR THE PROPOSED ACTION

Release of the Site for unrestricted use and termination of the radioactive materials license will result in the restoration of the Site such that it can be converted to beneficial use without the future risks associated from residual licensed material.

Decommissioning activities have been ongoing since 1976 when production activities were terminated. Many of the decommissioning activities were completed in accordance with the licensee’s operating license conditions, and the license was amended numerous times as described in Section 1.1. The facilities and remaining processing equipment were decontaminated, and waste and some soil were excavated and packaged for shipment and disposal under License Conditions 18 and

20 of SNM-928 through its 1983 renewal. After excavation of the sanitary lagoons and trenches of Burial Area #1, NRC authorized their backfill in License Condition 22 of Amendment 9, issues in December 1992.

The on-site burial of Option 2 material was authorized in License Condition 23 of Amendment 10, issued in November 1994.

Cimarron Corporation submitted its first decommissioning plan on April 19, 1995. Eight responses to NRC comments, clarifying statements made in the decommissioning plan or committing to specific requirements were submitted between 1996 and the issuance of Amendment 15 in July 1999. One of those submittals was the 1998 *Site Decommissioning Plan Groundwater Evaluation Report* (James L. Grant, July 1998), which stated that, based upon knowledge of groundwater impact at the time, it was believed that active groundwater remediation may not be required to achieve license termination for unrestricted use. NRC approved the use of the decommissioning plan (with the eight additional submittals) and stipulated unrestricted release criteria for groundwater, soil, surface contamination, and exposure rate, in License Condition 27 of this amendment. Since that time, it was determined that active groundwater remediation is required to reduce uranium concentrations in groundwater to unrestricted release criteria in an acceptable timeframe.

Achieving release of the Site for unrestricted use and license termination significantly reduces the potential for the site to become a legacy site with no financially solvent owner or licensee.

5.4 THE PROPOSED ACTION

The proposed action is to decommission the Site to achieve release for unrestricted use and termination of Radioactive Materials License SNM-928 by implementation of the groundwater remediation program proposed herein. This decommissioning plan is submitted in accordance with 10 CFR 70 38(g). This plan involves the extraction and treatment of impacted groundwater by ion exchange and/or biodenitrification. Treated water will be managed and then disposed of in one of two ways:

- A portion of the treated water will be reinjected into upland fractured sandstone to drive impacted groundwater to groundwater extractions systems
- Treated water not used for reinjection will be discharged to the Cimarron River in accordance with a discharge permit to be issued by DEQ

Influent and effluent concentrations will be monitored to maintain an inventory of U-235 adsorbed by the ion exchange resin. Resin bed(s) will be removed and replaced by fresh resin before the mass of U-235 in the site-wide inventory reaches 1,200 grams (the license possession limit for U-235). Spent resin will be processed, packaged, and shipped to a licensed disposal facility as LLRW. Biomass that accumulates in bioreactors without prior uranium treatment will be processed, packaged, and shipped to a licensed LLRW disposal facility. Biomass that accumulates in bioreactors with prior uranium treatment will be processed, packaged, and shipped to a municipal solid waste disposal facility.

Periodic groundwater sampling and analysis will provide the necessary data to monitor the progress of groundwater remediation, as well as to modify pumping rates to optimize groundwater remediation. Groundwater extraction, treatment, injection, and discharge will continue until COC concentrations in all wells are below the DEQ Criteria. When post-remediation monitoring demonstrates that uranium concentrations remain below the DCGL, and treatment for uranium is discontinued in all areas, the licensee will apply for termination of the license. It is anticipated that demonstration that residual dose is less than 25 mrem/yr will expedite the license termination process.

5.5 ALTERNATIVES TO THE PROPOSED ACTION

5.5.1 No Action Alternative

Two alternatives to the implementation of this decommissioning plan were considered: no action, and “passive” groundwater remediation by monitored natural attenuation. No action would mean:

- Concentrations of licensed material in groundwater would not be reduced to levels that would provide for unrestricted release of the Site
- License conditions currently in effect would be maintained
- Portions of the former Site in which the concentration of uranium in groundwater exceeds unrestricted release criteria would remain released from the license, and
- Portions of the Site which are releasable for unrestricted use would remain under license

There is no immediate threat to public health and safety because licensed material exceeding unrestricted release criteria is present only in groundwater at depths from five to thirty feet below grade in the Cimarron River floodplain, and at slightly greater depths in the upland areas. However, not remediating groundwater at the site does not resolve the regulatory requirement to maintain license controls.

Funding for decommissioning is limited to the amount available to the Trust. If groundwater is not remediated, funding may not be sufficient to maintain license controls indefinitely. Loss of control over residual licensed material could result in unacceptable exposure to licensed material in the future.

5.5.2 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is a process whereby natural processes such as dispersion and dilution reduce the concentration of contaminants in groundwater over time. Long-term monitoring of groundwater tracks the reduction in concentration. Should MNA be implemented at the site, license controls would remain in effect while periodic sampling and analysis of groundwater, followed by evaluation of the data, would enable the licensee to monitor the natural decline in concentration until groundwater concentrations are below unrestricted release criteria Site-wide.

As with the “No Action” alternative, funding for decommissioning is limited to the amount available to the Trust. If groundwater is not remediated, funding may not be sufficient to maintain license controls indefinitely. Loss of control over residual licensed material could result in unacceptable exposure to licensed material in the future.

5.6 AFFECTED ENVIRONMENT

5.6.1 Land Use

Approximately 117 acres of property located west of Highway 74 was released for unrestricted use and excluded from the license in License Condition 25. This property was purchased by a third party and is now used for grazing and ranching.

Approximately 24 acres of the property containing two of the former processing buildings was purchased by a third party conducting industrial/commercial operations in those facilities. The Subareas within which this property is located (Subareas H, I, K, and L) were released for unrestricted use in License Conditions 29 and 30.

Once decommissioning activities have been completed, the remainder of the property will be divested as required by the Trust Agreement.

Except for mowing and baling hay, the property was not used for activities other than decommissioning since operations ceased in 1975. The return of the Site to productive

agricultural or commercial/industrial activities will represent a return to beneficial use of the property. The Trust Agreement requires that the Trustee provide for the disposition of the property and termination of the Trust. Because the property will be releasable for unrestricted use, farming, grazing, commercial/industrial, or recreation will all represent beneficial use.

5.6.2 Transportation

Figure 1-1 shows that the site can be accessed directly from State Highway 33, State Highway 74, and a section line road that runs along the eastern edge of Section 12. All gates through which materials will be transported during construction and operation will open directly onto one of the two state highways. Both highways experience frequent traffic by freight trucks, farm equipment, and heavily loaded trucks carrying oilfield equipment, pipeline equipment, etc.

Trucks bringing equipment to the site for construction and installation of the groundwater remediation facilities will represent a marginal increase in traffic for a period of several months. Throughout the duration of remediation, trucks bringing resin to the site or taking waste material from the site will represent a minimal increase in truck traffic. Given that the marginal traffic impact from transporting material during construction is temporary and the long-term traffic impact during operation of the groundwater remediation systems is minimal, no traffic infrastructure improvements outside of the licensed area are proposed.

5.6.3 Geology and Soils

Section 2.5 describes the geology of the Site, as well as the area surrounding the site. The installation, operation, and demobilization of groundwater remediation systems will have no impact on the geology or the soil except for the reduction in concentration of COCs that desorb from soil particles during groundwater extraction. Therefore, the impact of remaining decommissioning activities to Site geology and soil will be a positive impact.

5.6.4 Water Resources

Decommissioning activities are designed to improve the quality of the shallow groundwater at the Site, which currently discharges to the Cimarron River. Groundwater will be extracted, treated, and discharged to the Cimarron River in accordance with an OPDES permit. Without this groundwater remediation effort, groundwater would otherwise migrate untreated to the river. Groundwater treatment will improve the quality of surface water. Treated water discharged to the river will be of drinking water quality. Consequently, decommissioning groundwater will result in a positive environmental impact.

Potable water is provided by Logan County Rural Water District #2. Decommissioning operations will require the use of additional water only for sanitation; this use will be minimal and is not expected to impact users of potable water provided by the Water District.

5.6.5 Ecological Resources

The US Fish and Wildlife Service (USFWS) lists 19 species of threatened or endangered animals, and one threatened plant, which are listed in and occur in the State of Oklahoma. Of those, four species of threatened or endangered animals occur in Logan County. These include:

- Whooping Crane (Grus Americana) - Endangered
- Piping Plover (Charadrius melodus) – Threatened
- Arkansas River Shiner (Notropis girardi) – Threatened
- Least Tern – (Sterna antillarum) – Endangered

An Oklahoma Ecological Services Field Office (OKESFO) online project review was performed in August 2015. As part of this process, a letter was submitted stating concurrence with the online assessment concluding that the proposed Project will have no effect or is not likely to adversely affect species protected under the Endangered Species Act. No issues were raised by the USFWS regarding the Bald & Golden Eagle Protection Act and the Migratory Bird Treaty Act. The concurrence from USFWS was received by email receipt and is provided in Appendix A. The 60-day review period expired on October 30, 2015 without further response from the USFWS; therefore, the Section 7 Consultation under the Endangered Species Act is complete for this Project.

BMCD submitted a wetland delineation report to the U.S. Army Corps of Engineers (USACE) regarding impacts to jurisdictional waters of the United States per Section 404 of the Clean Water Act. Based on review of this submittal and follow up discussions, it was determined by USACE that Nationwide Permit 12 would be required to construct the Project. Nationwide Permit 12 is specific to construction of utility line activities which result in less than ½ acre of loss of jurisdictional waters. A letter of authorization under Nationwide Permit 12 was received in November 2015. The letter of authorization and the general and regional terms of the permit are included in Appendix A.

5.6.6 Air Quality

Low concentrations of nitrogen will be released to the atmosphere during the denitrification process. The extraction and treatment of groundwater, and the subsequent injection and/or discharge of treated water will have no impact on air quality.

5.6.7 Noise

The extraction and treatment of groundwater, and the subsequent injection and/or discharge of treated water will not produce noise that can be heard from neighbors. Individuals working on site will not be exposed to sound levels that would require hearing protection. Consequently, decommissioning activities will have no noise impact.

5.6.8 Historical and Cultural Resources

US Department of the Interior's National Park Service (NPS) maintains a list of over 90,000 historic places. The following thirteen are located in Logan County:

- Guthrie, OK
  - Carnegie Library
  - Co-Operative Publishing Company Building
  - Guthrie Armory
  - Guthrie Historic District
  - Logan County Courthouse
  - Scottish Rite Temple
  - St. Joseph Convent and Academy
- Langston, OK
  - Langston University Cottage Row
  - Morris House
- Marshall, OK
  - Debo, Angie, House
  - Methodist Church of Marshall
- Mulhall, OK
  - Mulhall United Methodist Church
  - Oklahoma State Bank Building

None of these sites are located within approximately 9 miles from the Site. Several other historical and cultural resources were reviewed in March 2015. Appendix B contains a

memorandum summarizing this research. From this research, no specific cultural or historical sites were identified on the Project site. Therefore, decommissioning actions are not expected to impact any existing cultural or historical sites.

5.6.9 Visual/Scenic Resources

The Site has lain dormant for decades. The former process buildings have been removed or have been deteriorating, with no utilities provided or maintenance being performed. The nearly two acres of pavement had deteriorated, with vegetation reclaiming portions of it. Fencing had not been maintained west of Highway 74. Although a portion of the property has been mowed for hay production, much of the property has become overgrown, and cedar trees have become established in large areas. In an area where farming and ranching are the primary land uses, the Site represents unkempt property that is not being used productively.

The sale of portions of the Site has resulted in the repair of fences and gates west of Highway 74, and an improvement in the use of the property for agriculture. The sale of approximately 24 acres containing the former processing buildings has resulted in the renovation of the buildings, the repair of pavement, and improved fencing and gating of the Site. Landscaping on the property on which the industrial/commercial operations are being conducted has improved. These portions of the Site are significantly more appealing to the community as well as people driving past the facility on Highway 74.

Installation and operation of groundwater extraction, transfer, treatment, and injection or discharge will not impact the visual/scenic resource of the site. Completion of decommissioning activities and sale of the remaining property will result in improved maintenance of currently fallow land, improving the visual/scenic resource.

Consequently, decommissioning activities already completed have already had a positive impact on the visual/scenic resources of the Site, and completing decommissioning activities, with subsequent disposition of the property, will add to that positive impact.

5.6.10 Socioeconomic

During operation, the licensee employed approximately 175 to 200 workers at the Site. From 1975 to 1997, the licensee employed approximately 20 to 25 workers to perform decommissioning activities. As decommissioning progressed, the number of employees decreased. By the time the license was transferred to the Trust, there were no full-time workers at the site.

Proposed decommissioning activities will require only part-time support of operations and maintenance and health physics personnel. Decommissioning will therefore not impact employment.

Approximately 24 acres containing the former process buildings has been sold, and that property is now used for industrial/commercial operations. The beneficial re-use of these facilities has creating several jobs in addition to improving the security of the Site.

Approximately 117 acres of property west of Highway 74 has been sold, and is now used for ranching, expanding the operations of a local rancher.

Upon completion of decommissioning, the remaining approximately 700 acres of property will be sold. It is presumed that a significant portion of this property will be used for agriculture and ranching, and a portion may be used to expand the industrial/commercial operations as an expansion of existing operations.

5.6.11 Public and Occupational Health

Residual levels of radiation above the land surface are indistinguishable from background. Because impacted groundwater is not used for drinking water, irrigation, or any other activity, there is no current exposure to radioactive material or radioactivity.

Decommissioning activities will involve the concentration of uranium in anion resins, with subsequent packaging, transportation, and disposal at a licensed facility. Personnel will rarely be working in proximity to the anion resin beds (an average of less than eight hours per week), and the exposure rate at 30 cm from the resin beds has been estimated to be less than 30 μR/hr.

The treatment facility components have been designed, and operating procedures established, so that the exchange of anion resin, the process of mixing it with non-fissile material to yield a fissile-exempt material for shipping, and the packaging and loading of the fissile-exempt material for transportation and disposal are all conducted in accordance with the ALARA principle. It is not anticipated that any worker will receive a TEDE exceeding 100 mrem/yr.

5.6.12 Waste management

It is anticipated that each anion resin exchange will generate between 50 and 60 cubic feet of waste after blending with sufficient non-fissile material to yield a fissile-exempt waste. During the first year of operation, as many as thirteen exchanges may occur, yielding between 650 and

800 cubic feet of LLRW. As uranium concentrations decline, less anion resin exchanges will occur each successive year.

Nitrate treatment processes will produce biomass which must be disposed of offsite. Treatment Train 4 does not route water through uranium treatment vessels prior to nitrate treatment. Therefore, biomass waste produced by this train is expected to be shipped as LLRW to a licensed disposal facility. After blending with inert material for shipment, the expected volume of this material is approximately 2,500 cubic feet annually.

Treatment Trains 2 and 3 will route water through uranium treatment vessels prior to nitrate treatment. Therefore, biomass waste produced by these trains will not accumulate uranium, and will not require disposal as LLRW. Biomass from these trains will be shipped to a municipal solid waste disposal facility. No blending with inert material is expected for this material. Due to lower influent concentrations, generating less biomass, and less need for inert material, these two trains combined are expected to produce an approximate annual volume of 1,250 cubic feet.

Upon demobilization of the treatment facility equipment used in these processes, components that can be economically surveyed for unrestricted release will be surveyed. Material which cannot be economically surveyed, or which exceeds the exposure rate or surface contamination limits will be packaged accordingly and shipped as LLRW to a licensed facility. All equipment which can be economically surveyed and demonstrated to be releasable will be disposed of at a municipal solid waste or construction and demolition landfill.

The quantities of all wastes discussed above represent an insignificant fraction of the material that the respective disposal sites receive. Section 8 contains more information on the waste-producing processes discussed above.

5.7 ENVIRONMENTAL IMPACTS

5.7.1 Radiological Impacts

Radiological impacts may occur during operation of the groundwater remediation system as well as during dismantlement and removal. These potential radiological impacts will require mitigation.

Contamination Control

Day-to-day contamination control will be managed and monitored in accordance with the Radiation Protection Program (RPP). Rigorous implementation of the RPP will eliminate onsite and offsite radiological contamination impacts.

Airborne Contamination

Airborne radioactive contamination is unlikely because radioactively contaminated materials are either water, moist resin, or wet biomass. However, airborne radioactive contamination may be encountered in the form of a solid, liquid or particulates suspended in air. In accordance with the RPP, proper personnel practices and engineering controls will mitigate onsite and offsite impacts due to airborne radioactive contamination.

Discharge of Treated Water

During operation of the groundwater remediation system, discharge of treated water will be controlled and monitored in accordance with an OPDES permit. Treated water will contain concentrations of COCs that are less than their respective MCL, and will comply with OPDES permit limits. Compliance with permit limits will be confirmed by periodic sampling as stipulated in the OPDES permit.

Civil Engineering Controls

Civil engineering controls will be required if excavation activities are required during removal of the groundwater treatment system. Standard measures will be implemented to prevent impacts due to potential radioactivity in excavated materials. These measures may include:

- Diversion of surface water away from work areas.
- Covering un-active waste stockpiles.
- Use of silt fence and/or filter socks.
- Control and management of groundwater encountered in excavations.

Accidents

There is a slight potential for radiological accidents during the decommissioning activities resulting from the uncontrolled release of radioactive materials to the work area or environment.

These releases would most likely be associated with inadvertent mismanagement of contaminated liquids in the treatment tanks and pipes. Full-time monitoring, in accordance with the RPP, will

be conducted during removal of all systems. Draining of tanks and pipes before removal (or moving) will be sufficient to prevent uncontrolled release.

An uncontrolled release of radioactive material could also occur during a transportation accident. Strict adherence with NRC, Department of Transportation (DOT), and Oklahoma State waste packaging and shipping regulations will mitigate the potential for uncontrolled release due to a traffic accident.

A fire is another possible source of an uncontrolled release of radioactive materials. However, the majority of flammable or combustible materials (e.g. gasoline or diesel fuel) that will be present onsite will be radiologically unimpacted. Potentially contaminated combustibles may include dry active waste such as personnel protective clothing, rags and towels used for site cleanup and decontamination. The radioactivity contained in these materials would not be high enough to result in a significant release during such an incident.

5.7.2 Non-Radiological Impacts

Non-radiological impacts may occur during operation of the groundwater remediation system as well as during dismantlement and removal. These potential non-radiological impacts will require mitigation.

Fugitive Dust

Fugitive dust is particulate matter discharged into the atmosphere due to a construction activity such as dismantling of treatment components, stockpiling of soil, or packaging of waste. A written Dust Control Plan will be prepared and submitted in accordance with applicable County or State requirements.

Dust control requirements, summarized below, will be maintained throughout the duration of decommissioning activities:

- If needed (as determined by the Trustee PM or Activity Lead), unpaved areas subject to vehicle traffic will be stabilized by being kept wet, treated with a chemical dust suppressant, or covered.
- The speed of any vehicles and equipment traveling across unpaved areas will be no more than 15 miles per hour.

- Storage piles and disturbed areas not subject to vehicular traffic will be stabilized by being kept wet, treated with a chemical dust suppressant, or covered when material is not being added to or removed from the pile.
- If needed (as determined by the Trustee PM or Activity Lead), prior to any ground disturbance, including grading, excavating, and land clearing, sufficient water will be applied to the area to be disturbed to prevent dust emissions from crossing the boundary line.
- As necessary, construction vehicles leaving the site will be cleaned to prevent dust, silt, mud, and dirt from being released or tracked off site.
- When wind speeds are high enough to result in dust emissions crossing the property line, despite the application of dust mitigation measures, grading and earthmoving operations shall be suspended.
- If required by the Dust Control Plan, hand-held dust monitoring equipment, such as DataRAM, will be utilized.

Discharge of Treated Water

During operation of the groundwater remediation system, discharge of treated water will be controlled and monitored in accordance with an OPDES permit. Treated water will contain concentrations of COCs that are less than their respective MCL, and will comply with OPDES permit limits. Compliance with permit limits will be confirmed by periodic sampling as stipulated in the OPDES permit.

Civil Engineering Controls

If construction or demobilization activity results in a ground disturbance greater than one acre, a Storm Water Pollution Prevention Plan (SW3P) will be prepared and implemented in accordance with ODEQ requirements. The SW3P may include requirements for:

- Erosion and Sedimentation Control
- Stabilization
- Pollution Prevention

Accidents

A fire is a possible source of an uncontrolled release of toxic materials. Combustible materials such as gasoline or diesel fuel will be properly stored in accordance with applicable ordinances. A Fire Protection Plan will be developed and implemented in accordance with OSHA standards.

5.8 SUMMARY OF ENVIRONMENTAL IMPACTS

The decommissioning work to be completed to achieve release of the Site for unrestricted release and license termination will comply with the decommissioning criteria in 10 CFR 20, Subpart E. Implementation of the plan submitted herein will have essentially no impact on transportation in the vicinity of the Site, air quality, noise levels, historical and cultural resources, visual/scenic resources, members of the public or workers at the Site.

Implementation of the plan proposed herein will have a positive impact on the geology and soils, water resources, and the socioeconomic environment, and will result in the beneficial use of a site that has not been beneficially used since the early 1970's.

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6.0 REVISIONS TO THE LICENSE

6.1 INTRODUCTION AND BACKGROUND

License SNM-928 was transferred, along with the Cimarron Site, from Cimarron Corporation to the Cimarron Environmental Response Trust (the Trust) on February 14, 2011. As received, several license conditions reference documents which are no longer relevant to the decommissioning of the Site. Buildings, equipment, and soils have been decommissioned to comply with unrestricted release criteria stipulated in the license, and tie-downs which govern those aspects of decommissioning are no longer needed. License conditions should continue to list those documents that pertain to the completion of decommissioning activities. This Section proposes revisions to license conditions to more closely address current conditions and plans for the site.

6.2 LICENSE CONDITION 8 – POSSESSION LIMIT

License Condition 8(A) authorizes the licensee to possess up to 1,200 grams of "Uranium enriched to ≤ 5.0 wt. percent in U-235." License Condition 8(B) authorizes the licensee to possess up to 10 grams of "Uranium enriched to > 5.0 wt. percent in U-235". An asterisk in License Condition 8(B) refers to a note stating, "If during the decontamination of the facilities and equipment at the Cimarron Plant, uranium solutions or compounds are generated that have a U-235 isotopic content greater than 5.0 wt. percent, prompt action shall be taken to degrade these materials to below 5.0 wt. percent U-235.

License Condition 8(D) authorizes the possession of up to 6,000 kilograms of thorium. This license condition was added to SNM-928 to enable the licensee to possess thorium contaminated material that had been buried in Burial Area #1, and which was sent from a Cushing, OK site to package and ship for disposal. The last thorium contaminated material was shipped for disposal in 2004. There is no longer a need for a thorium possession limit.

EPM requests that License Condition 8 be amended to read,

A. Uranium enriched to ≤ 5.0 wt. percent in U-235	*A. Any compound*	*A. 1,200 grams of contained U-235*
B. Uranium enriched to > 5.0 wt. percent in U-235	*B. Any compound*	*B. 100 grams of contained U-235* [1]
C. Natural and depleted uranium source material	*C. Any compound*	*C. 2,000 kilograms of uranium*

D. Uranium enriched to ≤ 5.0 wt. percent in U-235	*D. Any compound as packaged waste in containers that meet the transportation requirements for fissile exempt material* [2]	*D. See note 2 below*

[1] *If during the decontamination of the facilities and equipment at the Cimarron Plant, uranium solutions or compounds are generated that have a U-235 isotopic content greater than 5.0 wt. percent, prompt action shall be taken to degrade these materials to below 5.0 wt. percent U-235.*

[2] *Special Nuclear Material packaged for transportation that meets the fissile exempt definition in 10 CFR 71.15(c) may be handled, stored, and transported for disposal without nuclear criticality safety controls, nuclear criticality monitoring systems, or mass-based limits, and is exempt from SNM security (physical protection) requirements of 10 CFR Part 73.*

Appendix C provides justification for the issuance of a new possession limit to License SNM-928 which would authorize the possession of packaged containers that meet all of the requirements for transportation as "fissile exempt" material in accordance with the transportation regulations.

6.3 LICENSE CONDITION 9 – DEFINITION OF THE LICENSED SITE

NRC has released significant portions of the property owned by the Trust. The Site has been divided into sixteen Subareas, labeled Subareas A through O (there are two areas, both of which contained uranium waste ponds, designated Subarea O). Figure 1-2 showed the locations of these Subareas.

The release of portions of the Site has been documented in License Conditions 25, 28, 29, and 30, all of which state that these areas are "… no longer licensed by NRC". This release has been granted to Subareas A, B, C, D, E, H, I, J, K, L, M, and O. Two portions of the property have been demonstrated to comply with the decommissioning criteria for unrestricted use (Subareas G and N), but NRC will not release them until a decommissioning plan providing for the remediation of groundwater has been submitted. The licensee has continued to exercise license controls over these areas of the Site, despite the fact that NRC has stated they are no longer under license.

Subsequent to the release of most of the Site, groundwater exceeding the release criteria for groundwater has been identified in some of the Subareas that had been released for unrestricted use. Portions of Subareas C, E, F, H, and M are underlain by groundwater exceeding the release criteria for uranium. Except for Subarea F, all these Subareas have been released from license.

The Subarea designations were created to address the decommissioning of buildings, soils, and waste management or disposal units (impoundments, lagoons, pipelines, and burial areas). Recent reports addressing the remaining aspects of site decommissioning have abandoned reference to these Subareas, since groundwater migration from historic sources extends across these artificial boundaries. There is little relationship between those areas which license SNM-928 identifies as “licensed” and “released from license” (as shown in Figure 5-1), and those areas which contain or will contain uranium exceeding decommissioning criteria.

The license should be amended so that only those areas which contain or will contain licensed material exceeding decommissioning criteria are “under license”. The licensee will then implement license controls in those areas for which such controls are justified in accordance with ALARA principles. This part of the license amendment request identifies those areas within which:

- Groundwater exceeds license criteria for unrestricted release,
- Groundwater exceeding license criteria will stored and treated during the groundwater remediation effort, and
- Contaminated media, such as treatment resins containing concentrated uranium, will be stored and/or packaged for shipment for disposal.

These areas are shown in Figure 6-1. EPM requests that License Conditions 25, 28, 29, and 30 be deleted, and that Item #9, “Authorized Place of Use” be amended to read, “That portion of the property owned by the Cimarron Environmental Response Trust depicted on Figure 6-1, “Property to Remain Under License SNM-928”, in *Cimarron Facility Decommissioning Plan,* submitted December 31, 2015.”

6.4 LICENSE CONDITION 10 – FINAL SURVEY AND ON SITE DISPOSAL

License Condition 10 lists 39 documents (there are 40 citations, but one date is listed twice). These documents primarily address final status surveys and the burial of soil in the on-site disposal cell. Other documents referenced in License Condition 10 include license amendment requests related to the authorization to possess specific quantities of radioactive material (since incorporated into Item 6 of the license), the site radiation safety officer, and responses to NRC comments related to groundwater assessment and remediation. This section briefly describes each document listed in License Condition 10 and provides justification to:

- Retain the document citation in License Condition 10
- Move the document citation to another License Condition, or

- Delete the document citation from the license.

November 19, 1985 – This letter from Kerr-McGee Corporation requested an amendment to the license to authorize possession of up to 6,000 kilograms of thorium, which would allow the excavation, packaging, and shipment of thorium from the Cushing site (which has been buried at the Cimarron site) for disposal at a licensed facility. License amendment No. 3, issued in April 1986, revised Item 6(D) to authorize possession of 6,000 kilograms (kg) of thorium. This authorization is still present in Item 6(D) of the current license. EPM requests that License Condition 10 be amended to delete the reference to this document.

March 3, 1986 – This letter from Sequoyah Fuels Corporation (predecessor to Cimarron Corporation) requested an amendment to the license to increase the authorized quantity of < 5 weight percent U-235 from 1,200 grams to 6,000 grams, to provide latitude for the licensee to accumulate sufficient material on site to load several trucks with contaminated material for transportation to a licensed disposal facility. License amendment No. 4, issued in April 1986, revised Item 6(A) to authorize possession of 6,000 grams of < 5 weight percent U-235. However, this authorization is again limited to 1,200 grams of < 5 weight percent in Item 6(A) of the current license. License amendments No. 5 through 9 only addressed changes to later license conditions, and the authorized amount is not listed in those amendments. It appears that when license amendment No. 10 was issued on November 4, 1994, NRC reverted the authorized quantity of < 5 weight percent U-235 back to the previous 1,200 grams. EPM requests that License Condition 10 be amended to delete this document, and that Item 6(A) maintain the authorized possession limit of up to 1,200 grams of <5 weight percent U-235.

September 4, 1987 – This letter from Sequoyah Fuels Corporation requested an amendment to the license to authorize the stockpiling of material designated as "Option 2 material" in the 1981 SECY 81-576, *Disposal or Onsite Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) From Past Operations* (hereafter referred to as "Option 2 material") on site so that other areas could be decommissioned for release while on-site burial of this material was under consideration. License amendment No. 10, issued in November 1994, added this letter as a tie-down to Condition 10 to authorize the stockpiling of Option 2 material. Disposal of Option 2 material is complete, and authorization to create soil stockpiles is no longer needed. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 2, 1989 – This submittal from Cimarron Corporation included results of the final release surveys of the MOFF facility. Subarea I, in which the MOFF plant is located, was released for

unrestricted use in License Amendment No. 17, issued April 9, 2001. EPM requests that License Condition 10 be amended to delete the reference to this document.

August 22, 1990 and September 14, 1990 – The August 1990 letter from Cimarron Corporation stated that the MOFF facility had been decommissioned, that decommissioning of the uranium plant was nearly complete, and that all major exhaust systems had been removed. Consequently, there were no longer effluents to monitor, and Cimarron planned to discontinue filing effluent monitoring reports as had been required per 10 CFR 70.59. In the September 14, 1990 letter, NRC stated, "Since the reports are required for licensees authorized possession or use of SNM for processing and fuel fabrication and your license authorizes possession or use of SNM subsequent to decontamination and decommissioning only, we have no objection to your discontinuation of the effluent release reports." Effluent release reports have not been submitted for over twenty years, and these tie-downs are no longer needed. EPM requests that License Condition 10 be amended to delete the references to these documents.

June 24, 1992 – This letter from Cimarron Corporation requested information from NRC, maintaining that NRC was causing "unnecessary delay and additional expense in decommissioning the Cimarron facilities because of indecision and non-responsiveness of the Commission." It is not clear why this letter is referenced in Condition 10. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 25, 1993 – This letter from Kerr-McGee Corporation responded to an NRC request for additional information dated January 8, 1993. This letter addressed subsidence, wind and water erosion, deed notice and location markers, all associated with the proposed on-site burial cell. It also contained a commitment to submit a radiological characterization report and complete the decommissioning of the site. On-site disposal of Option 2 material was approved by NRC in license amendment No. 10, issued November 4, 1994. Decommissioning of soil and burial in the on-site disposal cell is complete. The deed notice was filed and the corner markers (cairns) were installed. The post-closure monitoring of the cell for subsidence and/or erosion associated with the on-site disposal cell is complete. The radiological characterization report was submitted in 1994. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. The required 5-year monitoring period expired several years ago. There is no reason to maintain this tie-down in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 19, 1994 – This letter from Kerr-McGee Corporation requested NRC approval of a procedure entitled, "Onsite Disposal Plan". This procedure defined the responsibilities of various personnel, the characterization, transportation, and disposal of Option 2 material in the cell, the determination of total activity in the filled cell, the construction of run-on and run-off controls and the final cover, and the record of disposal. On-site disposal of Option 2 material was approved by NRC in license amendment No. 10, issued November 4, 1994. Decommissioning of soil and closure of the on-site disposal cell is complete. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

May 31, 1994 – This letter from Kerr-McGee Corporation responded to an NRC request for additional information dated April 19, 1994. The response addressed the final survey of Option 2 material in the on-site disposal cell, determination of the average concentration of material in the cell, Regulatory Guide 1.86 criteria, acceptance of a 100 pCi/g Option 2 limit for soil to be placed in the on-site disposal cell, hot spot averaging, the final survey of excavations, and the final survey of the disposal cell cap using the 1992 NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Determination*. Decommissioning of soil and closure of the on-site disposal cell is complete. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 20, 1994 – This letter from Kerr-McGee Corporation responded to an NRC request for additional information dated July 18, 1994. It addressed how to collect soil samples and determine the distribution coefficient (K_d) value for soil in the on-site disposal cell. Decommissioning of soil and closure of the on-site disposal cell is complete. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

September 21, 1994 – This letter from Cimarron Corporation responded to an NRC request for additional information dated August 12, 1994. It addressed hot spot averaging of soil in the on-site disposal cell, the analysis of quality control (QC) samples, NUREG/CR-5849 calculations, and calibration of the on-site soil counter, all associated with the placement of Option 2 material in the on-site disposal cell. Decommissioning of soil and closure of the on-site disposal cell is complete. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no

reason to maintain this tie-down in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 3, 1994 – This letter from Cimarron Corporation responded to an NRC question raised during a teleconference conducted November 1, 1994. It addressed exposure to workers placing soil in the on-site disposal cell. Decommissioning of soil and closure of the on-site disposal cell is complete. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 15, 1994 – This letter from Cimarron Corporation requested a license amendment to eliminate tie-downs related to Appendix A of a 1976 license renewal request, and Annex A of a 1982 license renewal request. Both Appendix A and Annex A were previous versions of the site Radiation Protection Plan. None of the referenced documents are relevant to the current license, decommissioning plan, or Radiation Protection Plan. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

December 16, 1994 – This letter from Cimarron Corporation requested a license amendment to designate Karen Morgan as radiation safety officer (RSO). Ms. Morgan has not been RSO for the Cimarron site since 2007. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 12, 1995 – This letter from Cimarron Corporation responded to an NRC request for additional information dated March 29, 1995. It addressed the analysis of samples from and hot-spot averaging used in the South Uranium Yard. Decommissioning and disposal of soils in the South Uranium Yard, which is part of Subarea K, is complete. Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

June 5, 1995 – This letter from Cimarron Corporation provided a resume for Karen Morgan to justify her designation as radiation safety officer (RSO). Ms. Morgan has not been RSO for the Cimarron site since 2007. License Condition 27(e)(3) of the current license (Amendment No. 21) states, "The Radiation Safety Officer shall be named in the licensee's Radiation Protection Plan", hence, neither the June 5, 1995 tie-down, nor a more up-to-date equivalent, needed be referenced in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 5, 1995 – This letter from Cimarron Corporation provided a response to an NRC telephone inquiry on hot spot averaging in the South Uranium Yard. Decommissioning and disposal of soils in the South Uranium Yard, which is part of Subarea K, is complete. Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 25, 1995 – This document is the *Final Status Survey Plan for Phase II Areas* (Cimarron Corporation, 1995). Subarea F is a Phase II area, and is the only area in which NRC has not yet agreed that soils are releasable for unrestricted use. In August 2005, Cimarron Corporation submitted a final status survey plan in accordance with this final status survey plan, and supplemented it with subsurface soil data in November 2007. In March 2013, Oak Ridge Associated Universities (ORAU) published the analytical results for confirmatory subsurface samples selected by NRC. All results were less than one-third the license criteria for unrestricted release. However, because this Phase II area remains under license, this tie-down should be retained in the license.

August 9, 1995 and November 13, 1995 – The August 9 document is the *Final Status Survey Report, Phase I Areas* (Chase Environmental Group, Inc., 1995). The November 13 letter responds to September 5, 1995 NRC comments on the final status survey report. All five of the Phase I areas (Subareas A through E) were released for unrestricted use in license amendment No. 13, issued April 23, 1996. Groundwater containing uranium exceeding NRC criteria for unrestricted release, as well as uranium and nitrate exceeding DEQ criteria, is present in portions of Subareas C, D, and E. The remediation of groundwater in these areas is addressed in the decommissioning plan submitted as part of this license amendment request. Portions of Subareas C, D, and E will be drawn back under the license; those areas that should be licensed will be defined in Section 6.3 of this license amendment request. However, the final status survey of soils described in Phase I areas is not relevant to the groundwater remediation plan proposed herein. Consequently, these submittals are no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the references to these documents.

January 23, 1996 – This letter from Cimarron Corporation requested a license amendment to recognize an organization change. The organizational change reported in this submittal is no longer relevant, and the license was transferred to a new licensee in February 2011. License amendment No. 21 sets forth the organizational requirements for the Trust, which are presented in the Radiation Protection Program. This tie-down does not reflect the current licensee's organization and is no

longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 25, 1996 (Listed twice) and June 10, 1996 – The April 25 letter from Cimarron Corporation proposed an Option 2 material disposal procedure change from stockpiling to direct transportation to the on-site disposal cell. The June 10 letter from NRC approved this procedural change. Decommissioning of soil and closure of the on-site disposal cell is complete. NRC has agreed that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. These tie-downs established requirements for work that has already been completed and are not relevant to current site conditions. EPM requests that License Condition 10 be amended to delete the references to these documents.

August 28, 1996 – This letter from Cimarron Corporation described hot-spot averaging procedures which were being used in the evaluation of material in stockpiles and the on-site disposal cell, and clarified that hot-spot averaging was not performed in the five waste water pond areas. Decommissioning of soil and closure of the on-site disposal cell is complete. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. This tie-down was established to control work that has already been completed, and is no longer relevant to current site conditions. EPM requests that License Condition 10 be amended to delete the reference to this document.

September 20, 1996 – This letter from Cimarron Corporation responded to an August 1996 NRC request for additional information, and revised the November 15, 1994 license amendment request. Cimarron Corporation was seeking to eliminate tie-downs related to Appendix A of a 1976 license renewal request, and Annex A of a 1982 license renewal request. During the ensuing two years, additional sections of the license were determined to be in need of revision. A new Radiation Protection Plan (RPP) was submitted in this license amendment request, which was to represent a new “Annex A” to the 1995 *Site Decommissioning Plan* (Cimarron Corporation, 1995). That RPP has been superseded several times, and other documents referenced in this submittal are no longer relevant to the license. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 20, 1996 – This letter from Cimarron Corporation proposed to perform a lung fluid solubility test to determine the biological solubility of uranium in site soils. The intent of this proposal was to determine if the Option 2 limit for soil for on-site disposal should be between the 100 picoCurie per gram (pCi/g) and the 250 pCi/g limits for totally soluble uranium and totally insoluble

uranium, respectively. The issue is now moot, since decommissioning of soil and closure of the on-site disposal cell is complete. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

January 2, 1997 – This letter from Cimarron Corporation responded to NRC's December 2, 1996 comments on Annex A, the RPP submitted in the September 20, 1996 license amendment request. The RPP has been superseded numerous times since this submittal, and the 1996 RPP is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

January 28, 1997 – This letter from Cimarron Corporation responded to NRC's October 31, 1996 comments on *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, Inc., 1995). Subarea F, which is the only area in which NRC has not yet agreed that soils are releasable for unrestricted use, is a Phase II area. Cimarron Corporation submitted a final status survey plan in accordance with this final status survey plan, in August 2005, and supplemented it with subsurface soil data in November 2007. Because this Phase II area is still under license, this tie-down should be retained in the license.

May 6, 1997 – This letter from Cimarron Corporation responded to NRC's February 25, 1997 comments on the site decommissioning plan. This response addressed volumetric averaging at Uranium Ponds 1 and 2, volumetric characterization of concrete in drainage and spillways, and the State's classification of groundwater. The first two issues were addressed in subsequent decommissioning efforts. The two areas containing Uranium Ponds 1 and 2, the two Subarea O parcels, were released for unrestricted use in Amendment No. 16, issued April 17, 2000. Both NRC and DEQ approved criteria for groundwater under an unrestricted use scenario in 1999. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

May 16, 1997 – This letter from Cimarron Corporation responded to NRC's March 5, 1997 comments on the RPP. The RPP has been superseded numerous times since this submittal, and the 1996 RPP is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

December 5, 1997 – This letter from Cimarron Corporation responded to NRC's October 3, 1997 Comments on the *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, Inc.,

1997). Final Status Survey Reports (FSSRs) for all Phase III areas have been submitted and approved by NRC. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 10, 1998 – This letter from Cimarron Corporation served as a letter of submittal for the June 24, 1997 *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, Inc., 1997). FSSRs for all Phase III areas have been submitted and approved by NRC. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

June 26, 1998 – This letter from Cimarron Corporation responded to NRC's February 9, 1998 comments on the June 24, 1997 *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, Inc., 1997). FSSRs for all Phase III areas have been submitted and approved by NRC. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 2, 1998 – This letter from Cimarron Corporation responded to NRC's July 1, 1998 conference call comments regarding the soil counter used to prepare the *Final Status Survey Report, Phase II Subarea J* (Cimarron Corporation, 1997). With the exception of Subarea F, the NRC has agreed that all Phase II soils are releasable for unrestricted use. A July 1, 1998 letter also addressed a similar soil counter comment on the Phase III Final Status Survey Plan (FSSP). FSSRs for all Phase III areas have since been submitted and approved by NRC. This tie-down regarding the traceability of the soil counter is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 15, 2000 – This document was the *Final Status Survey Report, Subarea K* (Cimarron Corporation, 2000). Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002 – This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 20, 2001 – This letter from Cimarron Corporation responded to NRC's January 9, 2001 comments on the *Final Status Survey Report, Subarea K* (Cimarron Corporation, 2000). Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 17, 2002 – This letter from Cimarron Corporation proposed a decommissioning schedule based on information available at that time. That schedule is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

May 10, 2002 – This letter from Cimarron Corporation revised the decommissioning schedule, revising the assumptions behind the April 17, 2002 schedule. That schedule is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

Only two of the 39 documents listed in License Condition 10 are still relevant to the licensing and decommissioning of the Cimarron site. Those documents are the July 25, 1995 *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, Inc., 1995) and the January 28, 1997 *Final Status Survey Report for Subarea F* (Cimarron Corporation, 1997). License Condition 27(a) references those documents that address all other aspects of site decommissioning. EPM requests that License Condition 10 be deleted and the references to the July 25, 1995 and January 28, 1997 submittals be added to License Condition 27(a).

6.5 LICENSE CONDITION 23 – ON SITE DISPOSAL

License Condition 23 authorized the licensee to bury up to 500,000 cubic feet of soil contaminated with low-enriched uranium in the location described in an October 9, 1989, submittal to the NRC. The licensee was required to monitor the disposal area for subsidence, erosion, and status of the vegetative cover for at least 5 years, and promptly repair any problems noted.

In accordance with License Condition 23, the disposal cell area was inspected and maintained. On September 19, 2002, notification was placed on the land title to declare that uranium-contaminated soil was buried on the site. The deed notice recorded the volume of soil, total uranium activity, and exact location of the buried soil. Cairns (permanent markers) consisting of concrete cylinders with brass markers were placed at the corners of the disposal cell. According to License Condition 23, the deed notice is not to be considered a restriction on the sale or future use of the site.

Although License Condition 23 required that the disposal cell be maintained for five years, it has now been maintained for over ten years, with no observable evidence of subsidence or erosion. A dense vegetative cover remains on the cell, which was sufficiently vigorous to withstand the severe drought conditions of 2011 – 2012. All the requirements of this license condition have been satisfied. EPM requests that this license condition be deleted from License SNM-928.

6.6 LICENSE CONDITION 26 – RADIATION PROTECTION PROGRAM

License Condition 26 requires the licensee to implement a version of the Radiation Protection Plan (RPP) that was submitted as Annex A to the 1996 site decommissioning plan. This license condition also lists a specific set of clarifications and revisions dated September 20, 1996, January 2, 1997, May 16, 1997, June 30, 1997, January 23, 1998, June 29, 1998, October 26, 1998, and December 11, 1998. The RPP has been revised on an annual basis, resulting in 15 subsequent revisions since the last submittal referenced in this license condition.

In addition, license amendment No. 15, issued August 20, 1999, added License Condition 27(e), which provides for licensee revision of the Site Decommissioning Plan and RPP without NRC approval, provided certain conditions are met. Periodic changes have been made to the RPP each year, and annual reports of all changes made under License Condition 27(e) have been submitted to NRC, usually with complete copies of the current RPP.

License SNM-928 was transferred to the Trust on February 14, 2011. The RPP was revised significantly to reflect changes in the licensee and the licensee's organization. The RPP has since been revised to reflect changing conditions and programs at the site; all revisions have been in accordance with License Condition 27(e).

<u>EPM requests that License Condition 26 be amended to read, "The Licensee shall conduct a radiation protection program in accordance with the Radiation Protection Plan (RPP) dated September 28, 2015, as amended in accordance with License Condition 27(e)."</u>

6.7 LICENSE CONDITION 27 - SITE DECOMMISSIONING

6.7.1 License Condition 27(a)

This license condition authorizes the licensee to remediate the site in accordance with the April 1995 site decommissioning plan, as supplemented by eight subsequent documents. Numerous additional submittals address subsequent commitments and work to decommission the Site, particularly addressing the characterization and remediation of Site groundwater. EPM believes this license condition needs to be amended incorporate the site characterization work that justifies the re-definition of the licensed area. The amended license condition should also incorporate the groundwater remediation plan submitted in this license amendment request to provide for the completion of decommissioning activities needed to achieve unrestricted release of the Site and termination of the license. This section addresses each of the documents referenced in License Condition 27(a) and explains why each should be deleted or retained from the license. It also

discusses several other submittals which EPM believes should be included in this license condition.

April 19, 1995 – This submittal was the *Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility*, (Chase Environmental Group, Inc., 1995). This document provided for the decommissioning of buildings, materials, and soil Site-wide. It also assumed that active groundwater remediation would not be required. Although the decommissioning of equipment, buildings, soils and all media other than groundwater is complete, this submittal documented the license history (to that time), the operations conducted under license, and other issues that must be included in a decommissioning plan. To avoid duplication of effort, EPM requests that this tie-down should be retained in License Condition 27(a).

July 25, 1995 – This submittal was the *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, Inc., 1995), which includes the final status survey plan for Subarea F. This submittal is not currently referenced in License Condition 27(a), but is referenced in License Condition 10. NRC concurs that surficial soil within Subarea F complies with its decommissioning criteria. However, Subarea F is the only area within which NRC has not yet formally concurred that subsurface soil complies with decommissioning criteria. EPM requests that, this reference should be retained in License Condition 27(a).

September 10, 1996 – This letter from Cimarron Corporation responded to NRC's July 11, 1996 comments on the April 1995 *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, Inc., 1995). NRC's comments primarily addressed the decommissioning and final status survey of areas which were subsequently released for unrestricted use. Except for groundwater, which has received substantial characterization since that time, and for which a remediation plan is submitted herein, all the work addressed in this submittal has been completed. This submittal is no longer relevant to the license. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

January 28, 1997 – This submittal was the *Final Status Survey Report for Subarea F* (Cimarron Corporation, 1997). This submittal is not currently referenced in License Condition 27(a), but is referenced in License Condition 10. NRC concurs that surficial soil within Subarea F complies with its decommissioning criteria. However, Subarea F is the only area within which NRC has

not yet formally concurred that subsurface soil complies with decommissioning criteria. EPM believes this reference should be retained in License Condition 27(a).

May 6, 1997 – This letter from Cimarron Corporation responded to NRC's February 25, 1997 comments on Cimarron's September 10, 1996 response letter. NRC's comments addressed volumetric averaging, final survey of paved areas, groundwater classification, and the characterization of concrete. Except for groundwater, which has received substantial characterization since that time, and for which a remediation plan is submitted herein, all the work addressed in this submittal has been completed. This submittal is no longer relevant to the license. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

August 26, 1997 – This letter from Cimarron Corporation responded to NRC's July 1, 1997 comments on open issues related to Cimarron's September 10, 1996 response letter. NRC's comments addressed volumetric averaging in Uranium Ponds #1 and #2 and the characterization of concrete. All the work addressed in this submittal has been completed. This submittal is no longer relevant to the license. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

March 10, 1998 – This submittal was *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Cimarron Corporation, 1998). This report presented the results of surveys of concrete rubble (primarily floor slabs and footers) which came from demolished buildings in Subarea K. NRC performed a confirmatory survey of the concrete rubble in Subarea F in June 2012, and in a letter dated September 7, 2012, NRC released the rubble for unrestricted use. EPM requests that NRC amend License Condition 27(a) to delete the reference to this document.

March 12, 1998 – This submittal was *Final Status Survey Report for Phase III Subarea O, Uranium Waste Ponds #1 and #2 (Subsurface)* (Cimarron Corporation, 1998). The two Subareas identified as Subarea O were released for unrestricted use in license amendment No. 16, issued April 17, 2000. This submittal is no longer relevant to the license. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

June 15, 1998 – This letter from Cimarron Corporation responded to NRC's May 20, 1998 comments on *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Cimarron Corporation, 1998). For the same reasons described in the above paragraph on the March 10,

1998 report, EPM requests that License Condition 27(a) be amended to delete the reference to this document.

October 6, 1998 – This letter from Cimarron Corporation responded to NRC's September 10, 1998 comments on residential inhalation dose from concrete rubble in Subarea F. For the same reasons described in the above paragraph on the March 10, 1998 report, EPM requests that License Condition 27(a) be amended to delete the reference to this document.

March 4, 1999 – This letter from Cimarron Corporation responded to NRC's January 19, 1999 comments on *Decommissioning Plan Groundwater Evaluation Report* (Cimarron Corporation, 1998), in which Cimarron stated that groundwater in Well 1315 (in Subarea F) exceeded the criteria for uranium. At that time, Cimarron personnel did not believe that groundwater exceeding release criteria extended beyond Well 1315, much less beyond the boundary of Subarea F. NRC required additional characterization of groundwater in Subareas F and C. Since that time, substantial characterization of groundwater, not only in Subareas F and C, but site-wide, has been performed, culminating in the submittal of *Conceptual Site Model (Revision – 01)* (ENSR, 2006). Consequently, Cimarron's response to NRC comments on the 1998 groundwater evaluation report are no longer relevant to the continued decommissioning of the site. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

License Condition 27(a) Summary – EPM requests that License Condition 27(a) be amended to read, "The licensee is authorized to remediate the Licensee facility in accordance with the "Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility at Crescent, Oklahoma", dated April 19, 1995, with supplemental correspondence dated July 25, 1995, January 28, 1997, and December 31, 2015.

6.7.2 License Condition 27(b)

License Condition 27(b) establishes the radiological release criterion for uranium in groundwater, establishes a monitoring requirement to demonstrate that groundwater complies with the criterion, requires that the licensee retain control of the property until groundwater release criteria are met, and acknowledges that DEQ may require monitoring of non-radiological components of groundwater.

At the time this license condition was incorporated into the license, it was believed that uranium exceeding the license release criterion was present in groundwater in only a very limited area. It was also believed that natural attenuation would reduce the concentration of uranium in

groundwater to less than the release criterion within a few years. Consequently, License Condition 27(b) required that ALL wells yield less than the groundwater release criteria for eight consecutive quarters.

Subsequent groundwater assessment has shown that groundwater exceeds license release criteria in several areas of the Site, and that natural attenuation processes alone will not reduce groundwater concentrations to less than release criteria for decades. The substantial groundwater assessment performed at the site has resulted in the installation of over 230 monitor wells at the site, many of which do not yield groundwater exceeding the release criterion for uranium.

The decommissioning plan submitted as part of this license amendment request includes a comprehensive groundwater remediation plan designed to reduce the concentration of both radiological and non-radiological chemicals of concern (COCs) to less than their respective release criteria. The groundwater remediation plan includes a post-remediation groundwater monitoring plan to demonstrate that portions of the site comply with groundwater release criteria as remediation is completed in various areas. The requirement to collect and analyze groundwater samples from ALL wells for eight quarters is no longer appropriate. Incorporation of this groundwater remediation plan into License Condition 27(a) will eliminate the need to specify groundwater monitoring requirements in License Condition 27(b).

License Condition 27(b) states that DEQ may require continued groundwater monitoring. Approval of the groundwater remediation plan by both NRC and DEQ is required before groundwater remediation can be initiated. The groundwater remediation plan contains post-remediation monitoring requirements for both radiological and non-radiological COCs. Consequently, there is no longer any need to state in the license condition that DEQ may require monitoring.

EPM requests that License Condition 27(b) be amended to read, "The release criteria for groundwater at the Cimarron site is 6.7 Bq/l (180 pCi/l) total uranium. Compliance with release criteria must be demonstrated as described in the post-remediation monitoring plan described in Section 8.8 of the December 31, 2015 *Site Decommissioning Plan*."

6.7.3 License Condition 27(c)

License Condition 27(c) includes one paragraph specifying survey methods for Waste Ponds 1 and 2 in Subarea O, and concrete rubble located in Phase II and Phase III subareas. The two

areas containing Waste Ponds 1 and 2 (the two Subarea O parcels) were released for unrestricted use in Amendment No. 16, issued April 17, 2000.

Concrete rubble is present in Subareas E, G, and F. Subarea E was released for unrestricted use in Amendment No. 13, issued April 13, 1996. In a letter dated March 1, 1999, NRC stated it had no further comments regarding the survey of the concrete rubble in Subarea F. In a letter dated March 12, 2002, NRC did not comment on the rubble in Subarea G, but stated that Subarea G would not be released until the licensee characterized Tc-99 contamination in groundwater in Subarea G, Waste Pond 1, Waste Pond 2, and Burial Area #1. The concrete rubble in Subareas E and F have been released for unrestricted use, and it is the Trustee's understanding that NRC has accepted the surveys conducted for the concrete rubble in Subarea G.

In a letter dated March 12, 2012, EPM submitted information regarding the characterization of Tc-99 site-wide, including Tc-99 in and downgradient from Subarea G. In a letter dated April 22, 2013, NRC stated, "… the NRC staff has concluded that Tc-99 will not have to be addressed in the groundwater remediation plan. However, the NRC staff requests that the post-remediation monitoring plan leading to license termination includes four calendar quarters of monitoring for Tc-99 to be collected … to confirm that previous concentrations have remained below NRC's DCL." Consequently, there is no need for further characterization of Tc-99 in groundwater in Subarea G, Waste Pond 1, Waste Pond 2, and Burial Area #1.

<u>EPM requests that the license be amended to remove this paragraph from License Condition 27(c).</u>

6.7.4 License Condition 27(d)

License Condition 27(d) reads, "Access gates to the Cimarron facility shall be locked and secured when no personnel are onsite and fences and locks will be maintained." This control of access was appropriate when the licensee maintained a crew of employees onsite during normal working hours, and before all but a few dozen acres of the property had been released for unrestricted use.

It is important to control access to areas where personnel have the potential to receive exposure to radiation or radioactive material which may exceed the allowable dose to a member of the public. This does not apply to most of the Site. Section 6.3 proposes a license amendment that defines the licensed site as the two areas where exposure to radiation or radioactive material requires access control, and the office building.

EPM retains contractors to perform site work. Activity leaders and work crews will be monitoring and maintaining groundwater remediation facilities, and performing decommissioning activities. The RPP require that personnel who may be exposed to radiation or radioactive material successfully complete radiation worker training, or be escorted by a worker who has successfully completed radiation worker training. The QAPP requires that personnel who are performing quality critical tasks successfully complete quality assurance training. All personnel performing work on the site successfully complete training on the procedures which apply to their activities. Such personnel are considered "Authorized Personnel".

EPM requests that that License Condition 27(d) be amended to read, "Access to licensed areas shall be restricted and secured when no licensee-authorized personnel are on site and fences and locks shall be maintained as appropriate."

* * * * *

7.0 ALARA ANALYSIS

7.1 DECOMMISSIONING GOAL

Section 1, "Facility Operating History", describes how the Cimarron Site was divided into subareas for the purpose of decommissioning and final status survey. Based solely on final status surveys and confirmatory surveys performed for equipment and building surfaces and surface and subsurface soil, all but three of the sixteen subareas (Subareas F, G, and N) have been released for unrestricted use. Even for Subareas F, G, and N, final status surveys and confirmatory surveys have shown that both surface and subsurface soil complies with the criteria for unrestricted release. The only environmental medium that remains to be decommissioned is groundwater.

License Condition 23(b) provides the unrestricted release criterion of 6.7 Bq/l (180 pCi/L) for uranium in groundwater. This release criterion is the concentration that yields a 25 mrem/yr total effective dose equivalent, based on a site-specific dose model and a drinking water scenario. However, DEQ policy requires that shallow groundwater undergoing remediation must be treated to comply with EPA drinking water standards. For uranium, this is 30 μg/L, which will vary from 30 – 40 pCi/L as the enrichment of the uranium in groundwater varies.

No unrestricted release criterion for technetium-99 (Tc-99) is stipulated in License SNM-928. EPA has promulgated a primary drinking water standard of 4 mrem/yr for beta photon emitters. As discussed in Section 4.3.2, NRC developed a derived concentration level of 3,790 pCi/L for Tc-99, based on the 4 mrem/yr dose limit.

It is anticipated that, after remediation is complete, residual dose will be significantly less than the 25 mrem/yr TEDE limit for unrestricted release. The decommissioning goal is to reduce the concentration of all radionuclides to levels that justify the release of the Cimarron Site for unrestricted use.

7.2 COST BENEFIT ANALYSIS

To terminate the site's license, EPM must demonstrate that the dose criterion in 10 CFR 20 Subpart E (25 mrem annual dose) or that the release criteria in License Conditions 27(b) and 27(c) have been met. As part of the decommissioning evaluation process specified in 10 CFR 20.1402, an ALARA analysis of the decommissioning effort must show that anticipated residual radioactivity levels are ALARA. 10 CFR 20.1402 states:

"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."

Demonstration of whether it is feasible to further reduce the levels of residual radioactivity to levels below those necessary to meet the dose criteria (i.e., to levels that are ALARA) is discussed in NUREG-1757. Per NUREG 1757 Volume 2, Appendix N, the following definition applies:

"'Reasonably achievable' is judged by considering the state of technology and the economics of improvements in relation to all the benefits from these improvements. (However, a comprehensive consideration of risks and benefits will include risks from nonradiological hazards. An action taken to reduce radiation risks should not result in a significantly larger risk from other hazards.) NRC Regulatory Guide 8.8, Revision 3 (1978)."

10 CFR 20.1402, 20.1403(a), 20.1403(e), and 20.1404(a)(3) contains specific requirements to demonstrate that residual radioactivity has been reduced to a level that is ALARA. NUREG-1757 Volume 2 Appendix N provides specific examples of an ALARA demonstration. ALARA for site closure for the Site can be demonstrated using the equation shown below.

$$\frac{Conc}{DCGL_W} = \frac{Cost_T}{\$2000 \; x \; P_D \; x \; DoseA \; x \; F \; x \; A} \; x \; \frac{r+\lambda}{1-e^{-(r\lambda)N}}$$

The residual radioactivity level that requires initiation of an ALARA assessment is the point when the concentration, *Conc*, reaches the $DCGL_W$ value (180 pCi/L). Thus, this ALARA assessment is applied after the concentration is reduced to the $DCGL_w$ value, i.e., site remediation standards have been met. Factors in this equation are defined below along the specific values used for this ALARA evaluation.

P_D = population density for the critical group scenario in people/m^2. For the Cimarron facility, the total plant area is approximately 700 acres. The sale of 24-acres of the site containing the TiO2 and MOFF buildings may lead an estimated 24 workers assigned to the site. This scenario provides a site population density of 2.78 E-04 people/m^2. Logan County estimates the population in 2013 to be 44,000. Logan County is

approximately 749 square miles (1,940 km^2). This scenario provides a population density value of 2.27 E-05 people/m^2. As a conservative selection, the higher value of 2.78 E-04 people/m^2 was selected.

A	=	area being evaluated in square meters (m^2). The total site area is approximately 700 acres, or 2.861 E06 m^2. The combined area of the western alluvial and Burial Area #1 is approximately 108 acres, or 4.37 E05 m^2. . For the purposes of the ALARA calculation, the area being evaluated is 4.37 E05 m^2.
$Dose_A$	=	annual dose to an average member of the critical group from residual radioactivity at the Derived Concentration Guideline Level ($DCGL_W$) results in 25 millirem/year.
F	=	effectiveness, or fraction of the residual radioactivity removed by the remediation action. The effectiveness was assumed to be 1 (complete removal).
$Conc$	=	average concentration of residual radioactivity in the area being evaluated in units of activity per unit area for buildings or activity per unit volume for soils. For the purposes of the ALARA calculation, the concentration of that will remain after decommissioning was assumed to be 180 pCi/L of total uranium in the groundwater.
$DCGL_W$	=	derived concentration guideline equivalent to the average concentration of residual radioactivity that would give a dose of 0.25 mSv/y (25 mrem/y) to the average member of the critical group, in the same units as "Conc". For the purposes of the ALARA calculation $DCGL_w$ is 180 pCi/L.
r	=	monetary discount rate in units per year. For durations exceeding 100 years, the NRC approved value is 0.03.
λ	=	radiological decay constant for the radionuclide in units per year. The radiological decay constant for uranium-234 is 2.77×10^{-6}. For the purpose of the ALARA calculation, the radiological decay constant for U-234 was selected as the most conservative value.
N	=	number of years over which the collective dose will be calculated, or 1,000 years.

For the ALARA analysis, $Cost_T$ can include all of the costs shown in the equation below.

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF.} + Cost_{WDose} + Cost_{PDose} + Cost_{other}$$

where

$Cost_R$	=	monetary cost of the remediation action (may include "mobilization" costs);
$Cost_{WD}$	=	monetary cost for transport and disposal of the waste generated by the action;
$Cost_{Acc}$	=	monetary cost of worker accidents during the remediation action;

$Cost_{TF}$	=	monetary cost of traffic fatalities during transporting of the waste;
$Cost_{WDose}$	=	monetary cost of dose received by workers performing the remediation action and transporting waste to the disposal facility;
$Cost_{PDose}$	=	monetary cost of the dose to the public from excavation, transport, and disposal of the waste; and
$Cost_{other}$	=	other costs as appropriate for the particular situation.

The process steps for the ALARA calculation are as follows:

1. Assume that the concentration (*Conc*) is equal to the $DCGL_w$.
2. Solve the ALARA equation to calculate the total monetary value of remediation at which *Conc* equals $DCGL_w$ (i.e., ratio of 1).
3. Compare the cost in the ALARA calculation to the NRC-adopted value of $2,000 per person-rem of averted dose.

Using the values and process steps described above, the ALARA equation gives:

$$\frac{180 pCi/L}{180 pCi/L} = \frac{\$Cost_r}{\$2000\ x\ \ 0.000278\ x\ 0.025\ x 1\ x\ (4.37 x 10^5)}\ x\ \frac{(0.03 + 2.77\ x 10^{-06})}{1 - e^{-(0.03 + 2.77 x 10^{-06}) * 1{,}000}}$$

The computed value of $Cost_r$ from the above equation is $202,250. This cost represents the net present worth of future remediation to be considered when the dose exposure has been reduced to 25 millirem per year by achieving 180 pCi/L. The decommissioning cost estimate is far in excess of the NRC approved limit of $2,000 per person-rem averted, thus no further remediation to achieve additional averted dose is justified when the concentration is reduced to 180 pCi/L.

The calculation of cost per man-rem avoided will be significantly greater than is presented in this analysis because of the following:

- A relatively high population density was assumed.
- Assumed area used only the footprint of the impacted area rather than the entire site.
- Removal efficiency was assumed to be 1.
- The collective dose is assumed at the highest future potential dose rate over 1,000 years.

Overall, the ALARA analysis shows that the site will meet the regulatory ALARA criteria upon achieving 180 pCi/L.

7.3 COST ESTIMATION

Various portions of the cost estimate provided in Section 16 were generated by personnel familiar with the equipment and supplies, labor, operating and maintenance, laboratory analysis, and miscellaneous expenses (e.g. overhead, license fees, insurance, taxes, etc.) associated with the construction, operation, monitoring, demobilization, and documentation required to complete decommissioning of the Cimarron Site.

The cost estimate provided in Section 16 complies with the applicable regulatory requirements of 10 CFR 70.38(g)(4)(v).

7.4 RESIDUAL DOSE IS ALARA

It is not realistic to project that EPM can staff and operate the groundwater remediation system to achieve a lower activity of uranium in the groundwater for a cost of $202,250 or less. It is concluded that achieving 180 pCi/L is ALARA, and continued spending to achieve lower groundwater uranium levels is not justified by ALARA.

* * * * *

8.0 PLANNED DECOMMISSIONING ACTIVITIES

Sections 1 through 3 of this decommissioning plan describe remediation activities performed to date at the Cimarron Site. Decontamination of former operating facilities and equipment is complete. Decommissioning of former impoundments, waste burials, pipelines, and soils is complete. The only decommissioning activities that remain are associated with the removal of contaminants from groundwater in areas where groundwater exceeds unrestricted release criteria.

Although the reduction of uranium concentrations to less than its unrestricted release criterion is all that is required to complete site decommissioning, additional groundwater remediation for all COCs must be performed to obtain unconditional release from DEQ. The groundwater remediation plan presented in this section is based on groundwater assessment and aquifer testing, groundwater flow modeling, and treatability tests. Construction and installation of the systems presented in this section will be performed in accordance with this remediation plan. In-process monitoring of groundwater and treatment may necessitate modification of this plan. Any modifications to this plan will be evaluated in accordance with License Condition 27(e) prior to implementing those modifications.

8.1 GROUNDWATER REMEDIATION OVERVIEW

This Section provides an overview of the groundwater remediation process. Sections 8.2 through 8.10 provide a more detailed description of the aspects of the remediation program introduced in this Section. Design drawings related to groundwater extraction, treated water injection, and discharge aspects of the remediation effort, bearing the prefix "BMCD", are located in Appendix D, and will be referenced in the detailed descriptions of those portions of the remediation program. Design drawings related to groundwater treatment, bearing the prefix "KUR", are located in Appendix E, and will be referenced in the detailed descriptions of groundwater treatment.

The index sheet (the first page) for the Kurion drawings lists numerous drawings in a gray font. These are "duplicate" drawings not included in the 60% design package. To minimize the review of essentially identical drawings, only drawings which are distinctly different were included in the 60% design drawing set. For instance, drawing KUR-ENVI01-001-DWG-G920 depicts the general arrangement of a single nitrate treatment train in Nitrate Train 2. Drawings KUR-ENVI-01-001-DWG-G930 and KUR-ENVI-01-001-DWG-G940 present the same general arrangement for each nitrate treatment train in Nitrate Trains 3 and 4, respectively. Since the only difference between those drawings is the nitrate train in which the arrangement is located, they were not included in the 60%

design package. These drawings will be produced in the full design package to provide for traceability between design and fabricated equipment, and installation in each area.

8.1.1 Groundwater Remediation Areas

To facilitate planning and communication, the Site has been broadly divided into three areas: Burial Area #1 (BA1), the Western Alluvial Area (WAA), and the Western Uplands Area (WUA). Each of these has been further subdivided to distinguish between the distinctive groundwater remediation infrastructure and approach that will be used to reduce COC concentrations in each specific area.

BA1 has been subdivided into the following:

- BA1 “U > DCGL”
    - Sandstone B (BA1-SSB)
    - Transition Zone (BA1-TZ)
    - Alluvium
- BA1 “U < DCGL”

The WAA has been subdivided into the following:

- WAA “U > DCGL”
- WAA “U < DCGL WEST”
- WAA “U < DCGL EAST”
- WAA “BLUFF”

The WUA has been subdivided into the following:

- Process Building Area (WU-PBA)
- Burial Area #2 (WU-BA2)
- WU 1206 drainage (WU-1206)
- Burial Area #3 (WU-BA3)
- Uranium Pond #1 (UP1)
- Uranium Pond #2 (UP2)
    - Sandstone A (UP2-SSA)
    - Sandstone B (UP2-SSB)

Sub-areas located in the Western Areas are shown on Figure 8-1. Subareas located in Burial Area #1 are shown on Figure 8-2. The boundaries of these areas are neither precise nor are they "fixed"; they were developed based on the estimated boundaries of COC concentration levels and geological features, as well as the estimated locations of contaminant sources. The remediation components depicted for each sub-area are designed to mitigate COC groundwater impacts within the corresponding boundaries of the sub-area. As the concentrations of COCs in groundwater decline, the shape and extent of these subdivided areas will likely vary. The distinguishing characteristic of each sub-area is not the shape, as defined in this Plan, but the remediation strategy and infrastructure proposed to address groundwater COC impacts.

8.1.2 Groundwater Extraction

Groundwater remediation in some sub-areas will be accomplished by recovering impacted groundwater through the installation and operation of extraction wells and trenches. A site-wide layout of the groundwater remediation system is presented on Drawing BMCD-GWREMED-C002. Partial site plans showing additional remediation system and site infrastructure details are provided in Drawings BMCD-GWREMED-C003 through BMCD-GWREMED-C006. The groundwater extraction infrastructure and operations are addressed in detail in Section 8.2, Groundwater Extraction.

Twenty-four (24) groundwater extraction wells (GE-WAA-01 through 24) will be installed in the WAA. One groundwater extraction well (GE-WU-01) will be installed in WU-PBA. Groundwater extraction trenches will be installed in WAA "U > DCGL" (GETR-WAA-01), and WU-1206 (GETR-WU-01). These groundwater extraction facilities will produce a nominal 458 gallons per minute (gpm), based on contaminated groundwater capture objectives and effective treatment facility operations.

Nine (9) groundwater extraction wells (GE-BA1-02 through 10) will be installed in BA1. Four of these wells (GE-BA1-02 through 05) are located within the BA1 "U>DCGL" area and five wells (GE-BA1-06 through 10) are located within the BA1 "U<DCGL" area. One groundwater extraction trench will be installed in BA1-TZ (GETR-BA1-01) and one in BA1-SSB (GETR-BA1-02). These groundwater extraction facilities will produce a nominal 100 gpm, based on contaminated groundwater capture objectives and effective treatment facility operation.

8.1.3 Groundwater Treatment

Groundwater produced by extraction systems will be treated to reduce the concentration of uranium to less than 30 µg/L, and the concentration of nitrate to less than 10 mg/L, prior to surface water discharge or aquifer injection. Treatment for fluoride is not anticipated, since the fluoride concentration in treatment system influent streams will be less than the MCL of 4 mg/L. This is attributed to the unavoidable dilution that results from extraction of groundwater in the floodplain. Two water treatment facilities will be constructed at the Site. Drawing BMCD-GWREMED-C002 shows the locations of both treatment facilities and Drawing BMCD-GWREMED-C006 presents partial site plans focused on the treatment facilities.

Treatment for uranium will consist of removal by ion exchange. A process flow diagram (PFD) and process and instrumentation diagrams (P&ID) for the Western Area uranium treatment systems are provided in Drawings KUR-ENVI01-001-P110 and KUR-ENVI01-001-P115, respectively. A PFD and P&ID for the Burial Area #1 uranium treatment system is provided in Drawings KUR-ENVI01-001-P210 and KUR-ENVI01-001-P215, respectively. Each uranium treatment train will contain lead, lag, and polishing resin vessels. The concentration of uranium in the influent and effluent lead vessel streams will be measured on a periodic basis to estimate uranium removal rate and the cumulative mass of uranium retained in the vessel. The lead vessel will be removed from service when it reaches its adsorption capacity. Lead ion exchange vessels are expected to reach the uranium adsorption capacities long before they approach the U-235 possession limit established by NRC license criteria.

Once the lead vessel reaches its adsorption capacity, the treatment train process flow will be reconfigured such that the lag vessel becomes the lead vessel, the polishing vessel becomes the lag vessel, and a vessel of fresh resin, becomes the polishing vessel. The use of lag and polishing vessels provides redundancy so the concentration of uranium in the effluent from the treatment train remains less than 30 µg/L; however, effluent uranium concentrations below laboratory detection limits are expected under typical operating conditions.

When the ion exchange resin in a lead vessel is taken from service, the spent material will be removed and blended with sufficient dry, dense material (e.g., barite, cement, etc.) to achieve the NRC and US Department of Transportation (DOT) fissile exempt criterion of 1 gram U-235 per 2 kilograms of non-fissile material. The mixture will be loaded into drums, sampled, and shipped to a licensed low-level radioactive waste (LLRW) facility for disposal.

Treatment for nitrate will be accomplished through a biodenitrification process facilitated by anaerobic bioreactors. The bioreactors will be inoculated with bacteria and amended with organic substrate and nutrients to promote biological denitrification reactions that convert nitrate to nitrogen gas, subsequently released to the atmosphere. The biodenitrification process will reduce the concentration of nitrate to less than 10 mg/L; however nitrate concentrations below laboratory detection limits may be achieved under typical operating conditions.

Each water treatment system will be bypassed or shut down once the COC groundwater concentration (uranium or nitrate) in the corresponding treatment train influent falls below the respective MCL. If groundwater extraction from a given remediation area must continue because in-process monitoring results for individual wells still yield COC concentrations above applicable remediation criteria (DCGL, MCLs, or ACLs), the treatment system influent will bypass treatment and be injected or discharged directly to the Cimarron River in accordance with an Oklahoma Pollution Discharge Elimination System (OPDES) permit.

The groundwater treatment systems, treatment processes, and operations are addressed in detail in Section 8.3, Groundwater Treatment.

8.1.4 Treated Water Injection

Treated water will be injected into select areas to flush contaminants in upland sandstone units to groundwater extraction trenches and wells located in down gradient areas underlain by transition zone and alluvial materials. Prior to injection, groundwater will be treated as necessary to reduce the concentration of uranium, nitrate, and fluoride below the respective MCL. Additional treatment will also be conducted, as required, to prevent mineral scaling and/or biological fouling of the injection system components (e.g., wells screens) and target formations. The locations of treated water injection trenches and wells are depicted on Drawings BMCD-GWREMED-C003 through BMCD-GWREMED-C005.

In the WU, five injection trenches (GWI-WU-01 and GWI-WU-02, GWI-UP1-01, GWI-UP2-01, and GWI-UP2-04) will be constructed in Sandstone A, the uppermost water-bearing unit. Two injection wells (GWI-UP2-02 and 03) will be installed in Sandstone B, the underlying water bearing unit. The estimated flow rate to be injected by gravity into each Sandstone A trench will vary based on total trench length and location. The anticipated range of injection rate for each trench is presented below:

- GWI-WU-01: 5 to 10 gpm

- GWI-WU-02: 4 to 15 gpm
- GWI-UP1-01: 20 to 40 gpm
- GWI-UP2-01: 30 to 60 gpm
- GWI-UP2-04: 20 to 40 gpm

Each of the UP2 Sandstone B injection wells are expected to accept a volumetric gravity flow rate of approximately 2 to 5 gpm.

In BA1, two injection trenches (GWI-BA1-01 and 02) will be completed in Sandstone B, the uppermost water-bearing unit. GWI-BA1-01 is expected to accept a gravity flow rate of approximately 4 to 10 gpm, and GWI-BA1-02 expected to accept approximately 2 to 5 gpm.

The groundwater injection infrastructure and operations are addressed in detail in Section 8.4, Treated Water Injection.

8.1.5 Treated Water Discharge

All treated water not used for injection will be discharged to the Cimarron River in accordance with an OPDES permit. Treated water will contain concentrations of COCs that are less than their respective MCL, and will comply with OPDES permit limits.

Approximately 350 to 740 gpm of treated water will be discharged from the Western Area (WA) Treatment Facility to the Cimarron River via Outfall 001. Approximately 70 to 100 gpm of treated water will be discharged from the BA1 Treatment Facility to the Cimarron River via Outfall 002. Maximum discharge rates for each of these outfalls could increase as pretreatment of extracted groundwater becomes unnecessary. Compliance with permit limits will be confirmed by periodic sampling as stipulated in the OPDES permit.

Locations of the treated water outfalls, located on the south bank of the Cimarron River, are depicted on Drawings BMCD-GWREMED-C003 and BMCD-GWREMED-C005. The treated water discharge infrastructure, monitoring, and operations are addressed in more detail in Section 8.5, Treated Water Discharge.

8.1.6 In-Process Monitoring

In-process monitoring consists of monitoring hydrological conditions, groundwater COC concentrations, groundwater treatment processes, and groundwater treatment effluent concentrations. In-process monitoring provides the information needed to:

- Optimize groundwater extraction and treated water injection rates to minimize the time needed to reduce COC concentrations to less than applicable criteria.
- Monitor the rate of decline of COC concentrations in remediation areas.
- Monitor the loading of uranium in ion exchange resin and the accumulation of biomass in bioreactors.
- Verify that treated water contains COC concentrations that comply with discharge and injection criteria.

In-process monitoring of groundwater treatment systems is described in more detail in Section 8.7. In-process monitoring of groundwater extraction, injection and remediation are described in more detail in Section 8.8.

8.1.7 Post-Remediation Monitoring

Post-remediation monitoring of groundwater will be performed to demonstrate compliance with the NRC decommissioning criterion of 180 pCi/L total uranium and 3,790 pCi/L Tc-99. Post-remediation monitoring for license compliance will be performed in BA1 when all in-process groundwater monitoring wells in this area yield uranium concentrations below 180 pCi/L for at least two consecutive months. Post-remediation monitoring for license compliance will be performed in the WAA "U > DCGL" when all in-process groundwater monitoring wells in this area yield uranium concentrations below 180 pCi/L for at least two consecutive months. It should be noted that based on currently available groundwater monitoring data, there are no exceedances of the 180 pCi/L criterion in the other WAA remediation sub-areas or any WUA sub-areas.

Following achievement of the NRC decommissioning criterion for groundwater in BA1 and the WAA "U > DCGL", post-remediation monitoring of groundwater will be performed to demonstrate compliance with the unrestricted release criteria stipulated in License Condition 27(b). Post-remediation monitoring for compliance with NRC criteria will be performed for the following areas:

- BA1
- WAA "U > DCGL"

The two above areas, plus the WU-BA3 area, are the only areas on site in which uranium has exceeded the DCGL within the past several years. Consequently, in-process monitoring

performed during remediation will already have generated data demonstrating that the following areas contain groundwater with uranium concentrations below the DCGL:

- WU-PBA
- WU-BA2
- WU-BA3
- WU-1206
- UP1 and WAA “BLUFF” WEST (as defined in Section 8.2.4)
- UP2 and WAA “BLUFF” EAST (as defined in Section 8.2.4)
- WAA “U < DCGL” WEST
- WAA “U < DCGL” EAST

Should groundwater remediation result in achieving compliance with DEQ criteria, post-remediation monitoring will be performed to demonstrate compliance with these criteria. Post-remediation groundwater monitoring is addressed in more detail in Section 8.8, Post-Remediation Groundwater Monitoring.

8.1.8 Demobilization

Demobilization of uranium or nitrate treatment systems, including treatment train skids and associated tanks, piping, and appurtenances, may be performed individually once COC concentrations in the influent stream associated with a particular treatment system no longer exceed the respective MCLs, and the use of the system for treatment of groundwater recovered from other areas is not required. Demobilization of uranium treatment systems dedicated to the WAA “U > DCGL” sub-area and BA1 will not occur until post-remediation monitoring confirms that DCGL groundwater criterion has been achieved. In addition, all uranium treatment systems will be demobilized prior to termination of the NRC license since the ion exchange treatment process cannot be conducted without the license.

Demobilization activities will include the removal of ion exchange resin processing/handling systems and other related equipment and facilities. All groundwater treatment systems and associated components that have a reasonable potential to concentrate or accumulate licensed material will be disposed of in accordance with NRC regulations prior to requesting NRC license termination.

Demobilization will include the release survey of materials and equipment, as well as the final status survey of the WAA treatment system building. Release surveys are addressed in Section 11, Health and Safety Program. Final status surveys are addressed in Section 15, Facility Radiation Surveys.

Demobilization of groundwater extraction and injection infrastructure will be performed in each area once post-remediation monitoring demonstrates compliance with DEQ criteria. Demobilization includes the plugging and abandonment of all monitoring wells, groundwater extraction and injection wells, and groundwater extraction trench sumps and laterals in accordance with Oklahoma Water Resources Board (OWRB) regulations

NRC license termination will be requested prior to demolition and demobilization of the well field facilities described above since these components may be used to achieve DEQ remediation criteria following achievement of NRC criteria.

Upon completion of groundwater remediation in all areas, the WA Treatment Facility building, the Well Field Control Building, the Office Building, and the utility services associated with these buildings, will remain on Site, to be included as assets in the disposition of the property.

8.2 GROUNDWATER EXTRACTION

This section presents the detailed design for the groundwater extraction infrastructure, equipment, and associated controls, as well as the rationale for the operation of the system. The locations of groundwater extraction wells and trenches are depicted on Drawings BMCD-GWREMED-C002 through Drawing BMCD-GWREMED-C005.

8.2.1 Groundwater Extraction Wells

Twenty-four (24) groundwater extraction wells (GE-WAA-01 through GE-WAA-024) will be screened within alluvial material in the WAA remediation sub-areas. Nine (9) groundwater extraction wells (GE-BA1-02 through GE-BA1-10) will be screened within alluvial material in BA1. One groundwater extraction well (GE-WU-01) will be installed within Sandstone B in the WU-PBA. Well construction details are provided on Drawing BMCD-GWREMED-M201.

Borings for extraction wells installed in the alluvium will be advanced using standard drilling methods to the base of the alluvium. The boring shall extend at least 0.5 feet into the sandstone or mudstone at the base of the alluvium if practical. A qualified health physics technician (HP tech) will monitor exposure rate during drilling; cores extracted during drilling activities will be

logged and scanned using a 2” by 2” NaI gamma scintillation detector. Subsurface lithology and scan results will be recorded by the field hydrogeologist on drilling log forms. The boring will then be reamed to a nominal 10” diameter.

The boring for GE-WU-01, located in the WU-PBA, will be advanced by air rotary or other standard drilling methods through Sandstone B. Following achievement of total depth, the boring shall be reamed to a nominal diameter of 10 inches. A qualified HP tech will monitor exposure rate during drilling. Drill cuttings will be logged and the lithology will be recorded by the field hydrogeologist on drilling log forms.

Groundwater extraction wells will be installed as described in SAP-110. The wells will be constructed, as detailed on Drawing BMCD-GWREMED-M201, using 6” poly-vinyl chloride (PVC) well casing with 6” PVC wire-wrapped screen. When possible, the well screen will extend from the base of the alluvium to unsaturated soil above the water table. In no case will the top of the well screen extend higher than 5 feet bgs. The annular filter pack will consist of 10-20 sand and the surface seal will be comprised of hydrated bentonite and a bentonite/cement grout, as necessary. All extraction wellheads will be constructed flush with the surrounding grade. Well installation details will be recorded by the field geologist on a Well Installation Diagram form.

Groundwater extraction wells shall be developed by alternating water removal, via air lift, surging, if practical, and stabilization periods that allow the water level to return to static elevation. Development will occur until the well produces clear water. Development pumps, surge blocks, and/or swabs may be used to enhance well development if the driller and field geologist agree that pumping and surging may be more effective in achieving development criteria and aquifer communication. Development will continue until the field geologist approves termination of development activities. Well development information shall be recorded on the well installation diagrams.

Drawing BMCD-GWREMED-M102 presents a typical groundwater extraction well installation. As shown on the drawing, each well will be equipped with a 4” electric submersible pump installed a minimum of 12 inches from the bottom of the well. Extraction well pump size information is provided on Drawing BMCD-GWREMED-M203. A water level transducer will be installed approximately 2 feet above the top of the pump and a pitless adapter will be installed in the well casing, approximately 2 feet below grade, for the connection of subgrade groundwater

discharge piping to the pump drop pipe. The pitless adapter also facilitates installation and removal of the pump from the well.

A 24" diameter by 24" deep steel well vault, set in a 48" diameter by 24" deep concrete pad will be installed over each extraction well. A capped 1" galvanized steel pipe shall extend through the concrete pad to approximately 5 feet above grade. A bolt shall be placed in the concrete pad to serve as a reference point for location and elevation, and a metal tag displaying the well identification will be fastened to the steel pipe. Groundwater extraction well construction information shall be recorded on well installation diagrams.

8.2.2 Groundwater Extraction Trenches

A total of four groundwater extraction trenches will be installed at the Site. These include the following:

- GETR-WU-01 – Installed in the WU-1206 sub-area
- GETR-WAA-01 – Installed in the WAA "U > DCGL" sub-area (within transition zone material)
- GETR-BA1-01 – Installed in the BA1-TZ portion of the BA1 "U > DCGL" sub-area
- GETR-BA1-02 – Installed in the BA1-SSB portion of the BA1 "U > DCGL" sub-area

Groundwater extraction trench subsurface profiles are depicted on Drawing BMCD-GWREMED-C101 and construction details are provided on Drawing BMCD-GWREMED-M201. Extraction trenches may be installed in a phased approach to allow for the temporary operation of shorter "pilot" trench segments. Data obtained from pilot trench operations may be used to optimize trench designs prior to full-scale construction.

Extraction Trench Excavation

Following completion of the sump boring(s), an access trench may be excavated at the surface, using standard earthwork equipment, both to provide a level working surface for the excavator, and to enable the excavator to reach the required maximum trenching depths (up to 30 feet bgs for some trenches).

In the WAA and BA1 transition zones, trenches GETR-WAA-01 and GETR-BA1-01 will be excavated to a minimum width of 2 feet using a tracked excavator. Excavation of these trenches will be accomplished using standard excavation and earthmoving construction equipment (e.g., track excavators and bulldozers). Excavations will extend to the base of the transition zone

material, generally located at the bedrock interface. Trenches will be over-excavated at sump locations to allow the sumps to extend deeper than the invert elevation of the lateral trench drain pipe. A high-density slurry will be used to maintain an open trench during excavation within the unconsolidated transition zone materials.

In the WU-1206 sub-area, trench GETR-WU-01 will be excavated to the base of Sandstone A, or to a depth of approximately 30 feet, whichever is shallower. Trench GETR-BA1-02, completed in the BA1-SSB, will be excavated to 30 feet bgs or the base of Sandstone B, whichever is shallower. Excavation of these trenches will be accomplished using standard excavation and earthmoving construction equipment, as well as excavator-mounted pneumatic hammers or other rock excavation equipment as needed to achieve the required depths. Following excavation, the bedrock walls of these trenches will be cleaned using a high-pressure water jet or other means to remove soil smearing, achieve scarification of the bedrock wall faces, and improve hydraulic connection between the trench and secondary porosity features in the formation.

Extraction Trench Construction

Following excavation of each trench, approximately 6 inches of granular bedding will be placed in the bottom of the trench. A lateral drain pipe and sump risers will be assembled, via butt fusion welding, and placed on the bedding along the bottom of the trench. Weights will be used as required to sink the piping through groundwater or trench slurry.

The lateral drain pipe will be constructed, as detailed on Drawing BMCD-GWREMED-M201, using 4”, machine-slotted, SDR-11 high-density polyethylene (HDPE) pipe with 0.06-inch openings. Prior to installation, the drain pipe will be fitted with a geotextile fabric to prevent infiltration of fines. Following piping placement, the trench will be backfilled with clean, free draining aggregate to the desired depth. A geotextile fabric will then be placed on top of the drainage layer before backfilling the trench to grade with clean, native soil previously excavated from the trench. Trench sumps will be constructed flush with the surrounding grade and trench construction details will be recorded by the field geologist or engineer using sump installation diagram forms and as as-built field sketches.

Groundwater extraction trenches shall be developed by alternating water removal, via air lift, surging, if practical, and stabilization periods that allow the water level to return to static elevation. Development will occur until the trench produces clear water. Development pumps, surge blocks, and/or swabs may be used to enhance trench development if field and project

management personnel agree that pumping and surging may be more effective in achieving development criteria and aquifer communication. Development will continue until the field geologist approves termination of development activities. Trench development information shall be recorded on the trench sump installation diagrams.

Drawing BMCD-GWREMED-M102 presents a typical groundwater extraction trench sump installation. As shown on the drawing, each sump will be equipped with a 4” electric submersible pump installed a minimum of 12 inches from the bottom of the sump casing. The pump inlet will be set below the invert elevation of the lateral trench drain pipe to allow for maximum trench dewatering, if necessary. Extraction sump pump size information is provided on Drawing BMCD-GWREMED-M203. A water level transducer will be installed approximately 2 feet above the top of the pump and a pitless adapter will be installed in the sump casing for the connection of subgrade groundwater discharge piping to the pump drop pipe. The pitless adapter also facilitates installation and removal of the pump from the sump.

A 24” diameter by 24” deep steel vault, set in a 48” diameter by 24” deep concrete pad will be installed over each trench sump. A capped 1” galvanized steel pipe shall extend through the concrete pad to approximately 5 feet above grade. A bolt shall be placed in the concrete pad to serve as a reference point for location and elevation, and a metal tag displaying the sump identification will be fastened to the steel pipe. Groundwater extraction sump construction information shall be recorded on sump installation diagrams.

8.2.3 Piping and Utilities

General locations of groundwater conveyance piping runs and other well field utilities associated with the groundwater extraction systems are depicted on Drawing BMCD-GWREMED-C002. Extraction well/trench groupings by trunk line, treatment influent tank, and treatment train are depicted on the Well Field and Water Treatment Line Diagram included as Figure 8-3. Mechanical details for extraction well and trench sump wellhead connections, controls, and instrumentation are provided on Drawing BMCD-GWREMED-M102.

WAA and WUA

Partial site plans depicting detailed layouts for groundwater conveyance, electrical power, instrumentation, and communications runs for the WAA and WUA are presented on Drawings BMCD-GWREMED-C003 and BMCD-GWREMED-C004. Drawing BMCD-GWREMED-C006 includes a partial plan dedicated to the WA Treatment Facility that receives groundwater

recovered from all WAA and WUA extraction wells and trenches. As shown on the drawings referenced above, individual groundwater discharge piping runs (i.e., branch lines) originating at extraction well and trench sump pumps connect to trunk lines that convey groundwater from the various remediation areas to one of the four groundwater influent tanks (TK-101 through TK-401) located at the WA Treatment Facility.

General groundwater extraction branch line configuration for the WAA and WUA, including branch-trunk line connections, is depicted on Drawing BMCD-GWREMED-P101. This drawing also shows the general arrangement of electrical power, instrumentation, and communication service runs for the WAA and WUA extraction components. General quantities and subsurface configurations for conduits associated with these utilities are shown on Drawings BMCD-GWREMED-C105 and BMCD-GWREMED-C106. As shown on these drawings, 480-volt alternating current (480 VAC) electrical power cables are routed to each groundwater extraction well/sump via dedicated conduits. Separate, dedicated conduits are also provided for the routing of 24-volt direct current (24 VDC) instrumentation and communication cables. Finally, dedicated conduits are provided for fiber optic communication cables, used for the transmission of signals between control systems located in the WA Treatment Facility, the WAA Remote Terminal Unit (RTU), and the Well Field Control Building.

General design information for the electrical power and control system serving WAA and WUA groundwater extraction pumps is provided on single-line diagrams presented on Drawings BMCD-GWREMED-E101 and BMCD-GWREMED-E102. Additional cable and conduit design details for WAA and WUA electrical service, instrumentation, control, and communication feeds are provided on Drawings BMCD-GWREMED-E107 through BMCD-GWREMED-E109. Finally, the WAA and WUA control system configuration is depicted on the communication system architecture diagrams provided on Drawings BMCD-GWREMED-E111 and BMCD-GWREMED-E112.

BA1

A partial site plan depicting the detailed layout for BA1 groundwater conveyance, electrical power, instrumentation, and communications runs is presented on Drawing BMCD-GWREMED-C005. Drawing BMCD-GWREMED-C006 includes a partial plan dedicated to the BA1 Treatment Facility that receives groundwater recovered from all BA1 extraction wells and trenches. As shown on the drawings referenced above, individual groundwater discharge piping runs (i.e., branch lines) originating at extraction well and trench sump pumps connect to a

common trunk line that conveys groundwater from the BA1 well field to the groundwater influent tank (TK-501) located at the treatment facility. Because extraction trench sump GETR-BA1-02 is equipped with a pneumatic submersible pump, a dedicated discharge line will connect this sump to tank TK-501.

General groundwater extraction branch line configuration for the BA1, including branch-trunk line connection, is depicted on Drawing BMCD-GWREMED-P102. This drawing also shows the general arrangement of electrical power, instrumentation, and communication services runs for BA1 extraction components. General quantities and subsurface configurations for conduits associated with these utilities are shown on Drawing BMCD-GWREMED-C106 (see Section F on the drawing). As shown on these drawings, 480 VAC electrical power cables are routed to each groundwater extraction well/sump via dedicated conduits. Separate, dedicated conduits are also provided for the routing of 24 VDC instrumentation and communication cables. Finally, dedicated conduits are provided for fiber optic communication cables, used for the transmission of signals between the BA1 and WA Treatment Facility control systems.

General design information for the electrical power and control system serving BA1 groundwater extraction pumps is provided on the single-line diagram presented on Drawing BMCD-GWREMED-E103. Additional cable and conduit design details for BA1 electrical service, instrumentation, and communication feeds are provided on Drawings BMCD-GWREMED-E107 and BMCD-GWREMED-E109. Finally, the BA1 control system configuration is depicted on the communication system architecture diagram provided on Drawing and BMCD-GWREMED-E112.

8.2.4 Groundwater Extraction Strategy by Area

A Well Field and Water Treatment Line Diagram, included as Figure 8-3, presents estimated flow rate and influent COC concentration characteristics for the groundwater extraction trunk lines associated with each remediation area. The notes provided on Figure 8-3 describe operational modifications that may be employed as influent COC concentrations in various groundwater extraction streams fall below the respective MCLs. Anticipated groundwater extraction flow rates for each extraction well and trench are summarized on Drawing BMCD-GWREMED-P203.

BA1

The BA1 treatment facility is designed to accommodate flow rates between 70 and 100 gpm. During remediation system design development, BA1 extraction well/trench locations and flow

rates were optimized using a particle tracking model. Appendix F includes the output from a particle tracking model demonstrating capture of the BA1 uranium groundwater plume exceeding the MCL. The extraction flow rates presented on Drawing BMCD-GWREMED-P203 for each BA1 extraction well and trench sump were used in the particle tracking model. Under the pumping scenario depicted in the model, groundwater is extracted from the BA1 “U > DCGL” area at a combined rate of approximately 80 gpm, and from the BA1 “U < DCGL” area at a rate of approximately 20 gpm. Under this scenario, only two extraction wells within the BA1 “U < DCGL” area are operating at any given time. During the initial phase of BA1 remediation, GE-BA1-06 through 08 will remain idle and the two most down gradient BA1 “U < DCGL” extraction wells (GE-BA1-09 and 10) will be operated to achieve capture of the down gradient extents of the uranium groundwater plume.

Uranium concentrations in groundwater in the vicinity of GE-BA1-10 should decrease to less than the MCL before groundwater in the vicinity of GE-BA1-09, both because the uranium concentration in groundwater near GE-BA1-10 is lower, and because GE-BA1-09 will be drawing groundwater from upgradient areas with even higher concentrations. Once in-process monitoring demonstrates uranium concentrations around GE-BA1-10 have remained below the MCL for at least two consecutive months, operation of extraction well GE-BA1-10 will be discontinued and operation of GE-BA1-08 will begin. Eventually, operation of GE-BA1-09 will be discontinued and GE-BA1-07 will begin. This sequence will continue as the BA1 “U < DCGL” plume retracts to the south.

Due to the transmissivity of the alluvial sediments and relatively low uranium concentrations in the BA1 “U < DCGL” area, remediation is expected to progress much faster in the alluvial area than in the BA1-TZ and BA1-SSB portions of the “U > DCGL”. For this reason, phased operation of the BA1 “U < DCGL” groundwater extraction wells was deemed an acceptable approach for optimizing BA1 remediation system efficiency and reducing the size and cost of the BA1 groundwater treatment facility.

It is anticipated that operation of the groundwater extraction wells and trenches in the BA1 “U > DCGL” area will continue until in-process monitoring indicates that uranium concentrations throughout BA1 have remained below the DCGL for at least two consecutive months.

WAA "U > DCGL", WU-PBA, and WU-1206

The WA treatment facility includes one influent tank (TK-101) and uranium treatment train dedicated to groundwater extracted from the WAA "U > DCGL", WU-PBA, and WU-1206 remediation sub-areas. This treatment train is designed to accommodate flow rates between 100 and 125 gpm. During remediation system design development, WAA "U > DCGL" extraction well/trench locations and flow rates were optimized utilizing a particle tracking model. Figure 8-4 presents the output from a particle tracking model demonstrating capture of the WAA uranium groundwater plume exceeding the DCGL. The extraction flow rates presented on Drawing BMCD-GWREMED-P203 for each WAA "U > DCGL" extraction well and trench sump were used in the particle tracking model. Under the pumping scenario depicted in the model, groundwater is extracted from the WAA "U > DCGL" area at a combined rate of approximately 105 gpm.

Initially, groundwater will be extracted from the WAA "U > DCGL" groundwater extraction trench (GETR-WAA-01) and groundwater extraction wells (GE-WAA-01 through 04). An estimated 5 gpm will be produced by the PBA extraction well (GE-WU-01), and approximately 10 gpm will be produced by the WU-1206 extraction trench (GETR-WU-01).

Nitrate is the only COC requiring remediation in the WU-PBA and remediation in this area is expected to reach completion quickly because of the relatively high concentration limit for this area (52 mg/L), and the low distribution coefficient for nitrate. Once in-process monitoring indicates that nitrate concentrations in the vicinity of GE-WU-01 have remained below the ACL for a minimum of at least two consecutive months, operation of GE-WU-01 will be discontinued.

The WU-1206 area in the vicinity of GETR-WU-01 requires remediation for uranium and fluoride. Remediation in this area is expected to reach completion quickly because concentrations for both uranium and fluoride are slightly more than two times their respective MCLs at monitoring well 1348. Once in-process monitoring indicates that uranium and fluoride concentrations in the vicinity of GETR-WU-01 are below the respective MCLs for at least two consecutive months, operation of GETR-WU-10 will be discontinued.

Achievement of the DCGL in the WAA "U > DCGL" area is anticipated to require more time than the WU-PBA and WU-1206 areas. All four WAA "U > DCGL" extraction wells will continue to operate until in-process monitoring indicates that uranium groundwater

concentrations throughout the WAA “U > DCGL” have remained below the DCGL for at least two consecutive months.

As shown on Figure 8-3, the initial estimated nitrate concentration in the combined treatment system influent for the WAA “U > DCGL”, WU-PBA, and WU-1206 treatment components exceeds the MCL of 10 mg/L. This exceedance is predominantly attributed to nitrate concentrations reported for three monitoring wells (T-62, T-65, and MWWA-09) located in areas that are not expected to contribute significantly to the combined volumetric flow rate extracted from the WAA “U > DCGL” area. In addition, well field operations (i.e., extraction well and trench flow rates) for this area can be managed to maintain nitrate concentrations in the treatment system influent that are below the MCL.

WAA “U < DCGL” WEST

The WA Treatment Facility includes uranium and nitrate treatment trains dedicated to groundwater extracted from the WAA “U < DCGL” WEST groundwater extraction components. This treatment train is designed to accommodate flow rates between 100 and 125 gpm. During remediation system design development, WAA “U < DCGL” WEST extraction well locations and flow rates were optimized using a particle tracking model. Figure 8-4 presents the output from a particle tracking model demonstrating capture of the WAA “U < DCGL” WEST uranium groundwater plume exceeding the MCL, and the nitrate groundwater plume exceeding the ACL. The extraction flow rates presented on Drawing BMCD-GWREMED-P203 for each WAA “U < DCGL” WEST extraction well were used in the particle tracking model. Under the pumping scenario depicted in the model, groundwater is extracted from the WAA “U < DCGL” WEST extraction wells (GE-WAA-05 through 08, and GE-WAA-21 and 22) at a combined rate of approximately 120 gpm.

Because of the low distribution coefficient for nitrate, the nitrate concentration in the “U < DCGL” WEST influent is expected decrease faster than the uranium concentration. Once in-process monitoring demonstrates nitrate concentrations in the treatment system influent have remained below the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended), the nitrate treatment system will be bypassed and nitrate treatment for the “U < DCGL” WEST influent stream will be discontinued. Although the influent nitrate concentration is expected to decline more rapidly, it is possible that the influent uranium concentration will fall below the MCL first. If this occurs, the uranium treatment system will be bypassed before nitrate treatment is discontinued.

WAA "U < DCGL" EAST

The WA Treatment Facility includes uranium and nitrate treatment trains dedicated to groundwater extracted from the WAA "U < DCGL" EAST groundwater extraction components. This treatment train is designed to accommodate flow rates between 100 and 125 gpm. During remediation system design development, WAA "U < DCGL" EAST extraction well locations and flow rates were optimized using a particle tracking model. Figure 8-4 presents the output from a particle tracking model demonstrating capture of the WAA "U < DCGL" EAST uranium groundwater plume exceeding the MCL, and the nitrate groundwater plume exceeding the ACL. The extraction flow rates presented on Drawing BMCD-GWREMED-P203 for each WAA "U < DCGL" EAST extraction well were used in the particle tracking model. Under the pumping scenario depicted in the model, groundwater is extracted from the WAA "U < DCGL" EAST extraction wells (GE-WAA-09 through 12, and GE-WAA-23 and 24) at a combined rate of approximately 116 gpm.

Because of the low distribution coefficient for nitrate, the nitrate concentration in the "U < DCGL" EAST influent is expected decrease faster than the uranium concentration. However, because the uranium concentration anticipated for the combined influent groundwater stream is much closer to the MCL than the nitrate concentration, it is probable that the influent uranium concentration will fall below the MCL before nitrate. Once in-process monitoring demonstrates uranium concentrations in the treatment system influent have remained below the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended), the uranium treatment system will be bypassed and uranium treatment for the "U < DCGL" EAST influent stream will be discontinued. If the influent nitrate concentration decreases below the MCL before uranium, the nitrate treatment system will be bypassed before uranium treatment is discontinued.

WAA "BLUFF"

Nitrate is the only COC requiring remediation in the WAA "BLUFF" remediation area. The WA Treatment Facility includes a nitrate treatment train dedicated to groundwater extracted from the WAA "BLUFF" groundwater extraction components. This treatment train is designed to accommodate flow rates between 100 and 125 gpm. During remediation system design development, extraction well locations and flow rates for this area were optimized using a particle tracking model. Figure 8-4 presents the output from a particle tracking model demonstrating capture of nitrate impacted groundwater within the WAA "BLUFF" area boundaries. The extraction flow rates presented on Drawing BMCD-GWREMED-P203 for each extraction well

were used in the particle tracking model. Under the pumping scenario depicted in the model, groundwater is extracted from the WAA "BLUFF" extraction wells (GE-WAA-13 through 20) at a combined rate of approximately 102 gpm.

Once in-process monitoring demonstrates nitrate concentrations in the WAA "BLUFF" treatment system influent have remained below the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended), the nitrate treatment system will be bypassed and treatment for the WAA "BLUFF" influent stream will be discontinued.

In addition to remediating groundwater in the WAA alluvium exceeding the nitrate MCL, the WAA "BLUFF" extraction system is designed to capture nitrate-impacted groundwater discharging from the upland sandstone units during treated water injection operations. Groundwater extraction wells GE-WAA-13 through 15 (i.e., WAA "BLUFF" WEST extraction wells) capture groundwater flushed from the UP1 area, and GE-WAA-16 through 20 (i.e., WAA "BLUFF" EAST extraction wells) capture groundwater flushed from the UP2 area. The "BLUFF" WEST extraction wells will continue to operate until UP1 water injection has ceased. The "BLUFF" EAST extraction wells will continue to operate until UP2 water injection has ceased.

Because the WAA "BLUFF" treatment train does not involve the removal of uranium via ion exchange, and the biodenitrification process can accommodate very low flow rates, it is not necessary to maintain any particular flow rate to the nitrate treatment system. This will permit the discontinuation of WAA "BLUFF" EAST or WEST well operations when monitoring data indicate that remediation in these areas can be discontinued. Also, it is unlikely that continuous operation of all WAA "BLUFF" extraction wells will be necessary to maintain capture of groundwater discharged from the upland sandstones during UP1 and UP2 water injection activities; consequently, the number of extraction wells, and flow rates for individual wells, operating at any given time may vary as evaluation of in-process monitoring data allows. Monitoring well water level data collecting during in-process monitoring activities will be used to verify hydraulic capture of the nitrate plume within the WAA "BLUFF" area until remediation is complete.

8.3 GROUNDWATER TREATMENT

As previously stated, two groundwater treatment facilities will be installed at the Site. The WA Treatment Facility will be constructed at the former location of Uranium Pond #1 and a smaller facility, the BA1 Treatment Facility, will be constructed at the southern end of Burial Area #1. The WA Treatment Facility will include a permanent building and will house the ion exchange resin process equipment used to handle and package spent resin generated by both the WA and BA1 Treatment Facilities. BA1 Treatment Facility equipment will be house in temporary, modular enclosures.

Drawing KUR-ENVI01-001-DWG-C113 (Kurion drawings are in Appendix E) includes a utility site plan for the WA Treatment Facility. Utilities required to support this facility include electric, potable water, propane, communications, and a septic sewerage. Connections to piping runs will be by pipes/hoses located above ground. Use of above ground connections will simplify demobilization.

Drawings KUR-ENVI01-001-DWG-G100 and KUR-ENVI01-001-DWG-G110 present plot plans and elevations for the WA Treatment Facility, respectively. The water treatment systems for each influent groundwater stream are comprised of uranium and nitrate treatment trains as shown on Drawing KUR-ENVI01-001-DWG-C110. Major WA Treatment Facility components include the following:

- One 5,000-gallon acid tank (TK-705)
- Four 12,000-gallon influent tanks (TK-101, TK-201, TK-301, and TK-401)
- Three uranium ion exchange (UIX) treatment trains (UIX Train 1, UIX Train 2, and UIX Train 3)
- Three biodenitrification systems (Nitrate Train 2, Nitrate Train 3, and Nitrate Train 4)
- One 33,000-gallon effluent tank (TK-701)

All three uranium treatment trains will be identical, each containing three 48” diameter resin vessels designed for flow rates varying from 100 to 125 gpm. The three biodenitrification systems are similar with the following differences based on the inlet nitrate concentration:

- Nitrate Train 2: Single bioreactor, no heating of inlet groundwater
- Nitrate Train 3: Single bioreactor, heating of inlet groundwater to achieve treatment rate
- Nitrate Train 4: Two bioreactors, heating of inlet groundwater to achieve treatment rate

Nitrate Trains 2 and 3 have equalization tanks as the interface with a uranium treatment train while Nitrate Train 4 is fed directly from Influent Tank TK-401 (inlet stream does not require treatment for uranium).

Drawing KUR-ENVI01-001-DWG-C220 includes site grading and utility plans for the BA1 Treatment Facility. As shown on the drawing, the uranium treatment system will require electric utility service and a fiber optic communication line (to facilitate communications between the BA1 and WA Treatment Facility and well field control systems).

Drawings KUR-ENVI01-001-DWG-G200 and KUR-ENVI01-001-DWG-G220 present plot plans and elevation for the BA1 Treatment Facility, respectively. The BA1 Treatment Facility will include a single uranium treatment train as shown on Drawing KUR-ENVI01-001-DWG-C210. Major BA1 Treatment Facility components include the following:

- One 1,000-gallon acid tank (TK-802)
- One 12,000-gallon influent tank (TK-501)
- Three 48" resin vessels designed for flow rates varying from 70 to 100 gpm
- One 12,000-gallon effluent tank (TK-801)

8.3.1 Uranium Treatment Systems

Drawing KUR-ENVI01-001-DWG-M110 shows the configuration of a typical UIX treatment train. The process elements of the BA1 uranium treatment train are identical to the WA treatment trains; however the BA1 systems are housed within a modular enclosure (see Drawing KUR-ENVI01-001-DWG-M510).

Each UIX train consists of a feed pump that transfers groundwater from an influent tank through lead (primary), lag (secondary), and polishing (tertiary) resin vessels. All resin vessels are the same size and configuration, and provide sampling ports for the collection of samples of influent to each resin vessel as well as effluent from the treatment train. Each resin vessel also provides a sampling port for the collection of samples of resin.

The same process will be implemented for each uranium treatment train. A pH meter in the influent tank will monitor the pH of the groundwater. A metering pump will inject sufficient hydrochloric acid into the influent line to reduce the pH to approximately 6.8 standard units. This will prevent scaling in the resin vessels without converting the uranyl carbonates to a form that the ion exchange resin would not adsorb efficiently.

A flowmeter will monitor the rate of flow through the resin vessels. Each resin vessel will contain approximately 50 cubic feet of chloride-form DOWEX 1® ion exchange resin, which will adsorb the uranium.

Sampling ports will be located between a pre-filter and the lead resin vessel, prior to the lag and polishing vessels, and at the effluent from the polishing vessel. Samples will initially be collected from each sampling port on a weekly basis, and analyzed for uranium concentration. The volume of groundwater (operating time multiplied by the volumetric flowrate) multiplied by the difference between the influent and effluent concentrations (mass of total uranium per volume of groundwater) will yield the mass of uranium contained in each resin vessel. The enrichment percentage (2% for groundwater in all areas except the WAA "U > DCGL" area) is used to determine the U-235 content with a vessel.

Current estimates are that no resin vessel will ever accumulate more than 500 grams of U-235, because as the uranium concentration of influent groundwater declines, the adsorption capacity of the resin declines. Consequently, a single resin vessel will be unable to adsorb sufficient uranium to exceed the U-235 possession limit of 1,200 g. Figure 8-6 presents the calculated U-235 loading for each uranium treatment train. Figure 8-6 also shows that the total mass of U-235 in all treatment trains combined is not expected to exceed 800 grams at any given time.

Exchange and replacement of the lead vessel will typically be triggered when the uranium concentration in the effluent from the lead vessel exceeds 80% of the uranium concentration in the influent. This trigger criterion will be evaluated and modified as appropriate during operations to maximize the utilization of the resin capacity and minimize the volume of solid waste generated for disposal.

When the resin in a lead vessel approaches its adsorption capacity, the lead vessel will be removed from the treatment train. The valve alignment will be changed such that the lag vessel will become the lead vessel, the polishing vessel will become the lag vessel, and a new vessel filled with fresh resin will become the polishing vessel. The spent resin will be processed as described in Section 8.6, Treatment Media Management, and disposed of as low level radioactive waste as described in Section 13, Radioactive Waste Management.

The valve arrangement around the three ion exchange vessels is the same for all four (4) of the UIX trains as shown on Drawings KUR-ENVI01-001-DWG-P115 and KUR-ENVI01-001-DWG-P215. Using the valve numbering for UIX Train 1 (KUR-ENVI01-001-DWG-P115, Sheet 1),

Table 8-1 shows the required valve position (OPEN or CLOSED) needed to enable use of a given UIX vessel position as the lead, lag, or polish function.

The ion exchange process is a function of both the rate of flow and the concentration of the species being removed. During a shutdown of the system (planned or upset condition such as loss of power), the lead vessel may establish a different chemical equilibrium, releasing some adsorbed species back into solution. In previous treatability studies, such a release of uranium was observed during a shutdown. The use of a lead, lag, and polish vessel configuration minimizes the potential to exceed the required effluent concentration upon re-start of the system. While not included in this plan, isolating the lead vessel, with return of the vessel discharge to the supply tank, will be considered based upon results of in-process monitoring. This option allows for re-establishing the pre-shutdown chemical equilibrium in the lead vessel and maximizing utilization of the vessel without affecting the other two (lag and polishing) vessels. This option can be implemented for all of the uranium treatment trains. The duration of the shutdown requiring implementation of these measures will be determined from in-process monitoring data.

Effluent from two of the WA uranium treatment trains (UIX Train 2 and UIX Train 3, as shown on Drawing KUR-ENVI01-001-DWG-P115, Sheets 2 and 3) will be routed to a nitrate treatment train as long as the nitrate concentration of the effluent exceeds 10 mg/L. When the nitrate concentration of the effluent from a uranium treatment train is less than 10 mg/L, the effluent will be pumped to the WA Treatment Facility effluent tank (TK-701).

8.3.2 Biodenitrification Systems

Each biodenitrification system is designed to accommodate flow rates varying from 100 to 125 gpm. With replacement of the feed pumps, the bioreactors would remain effective at much lower flow rates due to increased residence time for treatment by the biomass. Drawing KUR-ENV101-001-DWG-G904 (Sheets 1 and 2) shows a typical bioreactor, also known as a submerged fixed film bioreactor, which is comprised of a four-chamber tank. The fixed film media allows bacteria and microorganisms to grow and remain attached to the media. The microorganisms biologically convert the nitrate contaminants to nitrogen gas and biomass, utilizing a methanol organic nutrient source.

Each of the three (3) nitrate trains will include:

- Feed pumps
- Nutrient injection module

- Equipment to remove, dewater, and package the biomass that will accumulate in the bioreactor

The influent nitrate concentration varies depending on the groundwater extraction components feeding a specific WA Treatment Facility influent tank at a given time. Based on the results from the nitrate Treatability Study, the following configuration of bioreactors and heaters (to increase the groundwater temperature for a higher nitrate degradation rate) is planned for the three nitrate trains:

- Nitrate Treatment Train 2: Single bioreactor, no heating
- Nitrate Treatment Train 3: Single bioreactor, propane gas in-line heater
- Nitrate Treatment Train 4: Two bioreactors, propane gas in-line heater

Biological denitrification occurs when molecular oxygen (O_2) is not sufficient for bacterial respiration and bacteria utilize combined oxygen in nitrate (NO_3^-) as an oxygen source. In an anoxic process, bacteria obtain oxygen from nitrate. Nitrate is thereby converted to nitrite and then molecular nitrogen. Oxidation Reduction Potential (ORP) is monitored to control the anoxic conditions. As depicted in Figure 8-7, an anoxic process takes place, when ORP is -50 mV to +50 mV. Blowers and air diffusers provided with the bioreactors control the ORP and prevent the system from going septic or anaerobic. The blowers will only operate when the ORP of the water drops to levels below -100mV.

Nitrate treatment operations will begin by filling the bioreactors with groundwater. The initial nutrients needed will be determined and added, and a commercial biodenitrification microbial culture will be added to establish an initial microbial population capable of denitrifying the water. Groundwater will be recirculated within the bioreactor while nutrients are added as needed for biomass generation.

Once nitrate reduction of greater than 50% in the groundwater in the bioreactors is achieved, the operation is made continuous by starting a forward flow from the bioreactor feed tanks. Treated effluent from each bioreactor compartment gravity flows to system transfer pumps, from which it is pumped to dual media filters to ensure removal of the total suspended solids (TSS) carried over from the bioreactors.

After filtration, a small portion of the effluent will be routed to a backwash storage tank. This backwash water will be used to periodically backwash the dual media filters. The backwash

water, containing the particulates removed by the dual media filters, will be returned to the influent equalization tank and recycled through the bioreactor. The vast majority of the effluent will be transferred to TK-701.

Over time, bioreactors build up an excessive concentration of biomass or biological floc. To prevent overcrowding, excess biomass and other solids, in the form of sludge, will be removed from the bioreactors. Removing excess sludge helps to maintain a balance between food and biological floc. Also, by removing old sludge, which contains dead biomass along with adsorbed organics and minerals, space will be created for new, healthy bacteria to grow and flourish.

Sludge from bioreactors will be pumped and stored in a 3,000-gallon sloped-bottom sludge holding tank (TK-001, see Drawing KUR-ENVI01-001-DWG-M912) before processing with a centrifuge. The system will be equipped with automated level control that will feed the automated centrifuge as the tank fills up. TK-001 will be equipped with an automated aeration system designed to mix the sludge and keep it from going septic and producing odors.

The sludge holding tank will also be equipped with manual valves for decanting supernatant. The operator shall drain the supernatant to a centrate recycle tank, from which centrate will be pumped back to the bioreactor feed. The dewatered sludge will be ready for disposal.

Assuming a 125 gpm inlet flowrate and a 150 ppm nitrogen-nitrate concentration, it is estimated that 120 pounds of sludge will be produced each day. This is equivalent to 840 pounds per week. Assuming that the sludge initially has a 2% solids concentration and specific gravity of one, the estimated volumetric sludge production rate is 5,000 gallons per week. The estimated volumetric solid waste generation rate is approximately 0.5 cubic yard per week. The solid waste generation rate will be lower at reduced inlet nitrate concentrations.

In-line measurements provided in the nitrate treatment system include pH, ORP, and dissolved oxygen (DO) as shown on Drawing KUR-ENVI01-001-DWG-P921, Sheet 2). In addition to the in-line measurements, daily samples will be collected from each of the bioreactor chambers. The DO concentration will be checked with a hand-held meter to verify that the DO concentration is below operational limits. The bulk of the sample will be placed into an Imhoff cone to check the level of settlable solids. If the measured settled solids level is above the operational limit, removal of sludge from the chamber will be initiated. This removal process will be done without interrupting the operations for the remaining chambers in a bioreactor.

8.3.3 Western Area Groundwater Treatment

Figure 8-3, Well Field and Water Treatment Line Diagram, illustrates how water will be transferred from groundwater extraction wells and trenches to the water treatment facilities, and what treatment processes will be employed for each groundwater stream. This section describes the treatment planned for influent groundwater streams generated by each remediation area.

WAA "U > DCGL", WU-PBA, and WU-1206

The WA treatment facility includes one influent tank (TK-101) and uranium treatment train dedicated to groundwater produced by the WAA "U > DCGL", WU-PBA, and WU-1206 remediation areas. This treatment train is designed to accommodate flow rates between 100 and 125 gpm.

The WU-PBA and WU-1206 groundwater extraction components combine to produce an estimated 15 gpm. As shown on Figure 8-3, this combined groundwater stream is conveyed to Influent Tank TK-101 via WA Line 1. The four extraction wells and one extraction trench required for remediation of the WAA "U > DCGL" area are estimated to produce a total of 105 gpm, conveyed to TK-101via Line 2.

Based on historical data, groundwater conveyed to Influent Tank TK-101 is anticipated to initially contain uranium at a concentration that exceeds the DCGL, and fluoride at a concentration below the MCL. While the nitrate concentration in this stream could initially exceed the MCL, this will be prevented by managing well field operations (i.e., extraction well and trench flow rates) for the WAA "U > DCGL" area (see Section 8.2.4).

Groundwater discharged to Influent Tank TK-101 will be treated only for uranium, via UIX Train 1, prior to transfer to the WA Effluent Tank (TK-701). Based on historical data, the enrichment of the uranium in WAA "U > DCGL" groundwater is estimated at approximately 4%. Because WAA "U > DCGL" groundwater represents the vast majority of groundwater treated by UIX Train 1, it will initially be assumed that the enrichment of the influent groundwater is 4%. Isotopic analysis of ion exchange resin described in Section 8.6.3 will provide a more accurate value for enrichment, which will be used to monitor the U-235 content.

Treatment for uranium will continue until the concentration of uranium in TK-101 is less than the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended). At that time, the flow from TK-101 will bypass UIX Train 1, and flow directly to Effluent Tank TK-701.

WAA "U < DCGL" WEST

The WA Treatment Facility includes uranium and nitrate treatment trains dedicated to groundwater produced by the WAA "U < DCGL" WEST groundwater extraction components. This treatment train is designed to accommodate flow rates between 100 and 125 gpm. As shown on Figure 8-3, the six extraction wells required for remediation of the WAA "U < DCGL" WEST area are estimated to produce a total of 120 gpm, conveyed to TK-201via Line 3A.

Based on historical data, groundwater conveyed to Influent Tank TK-201 will initially contain uranium and nitrate at concentrations exceeding the respective MCLs, and fluoride at a concentration below the MCL. Groundwater from TK-201 will be treated for both uranium (via UIX Train 2) and nitrate (via Nitrate Train 2), prior to transfer to TK-701.

Based on historical data, the enrichment of the uranium in WAA "U < DCGL" WEST groundwater is estimated to be less than 2%. Based on this, it will initially be assumed that the enrichment of the UIX Train 2 influent groundwater is 2%. Isotopic analysis of resin described in Section 8.6.3 will provide a more accurate value for enrichment.

Treatment for nitrate will continue until the concentration of nitrate in TK-201 is less than the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended). At that time, the flow from TK-201 will bypass Nitrate Train 2, and flow directly to TK-701.

Removal of uranium will continue until the concentration of uranium in TK-201 is less than the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended). At that time, the flow from TK-201 will bypass UIX Train 2 and flow directly to Nitrate Train 2 or to TK-701.

WAA "U < DCGL" EAST

The WA Treatment Facility includes uranium and nitrate treatment trains dedicated to groundwater produced by the WAA "U < DCGL" EAST groundwater extraction components. This treatment train is designed to accommodate flow rates between 100 and 125 gpm. As shown on Figure 8-3, the six extraction wells required for remediation of the WAA "U < DCGL" EAST area are estimated to produce a total of 116 gpm, conveyed to TK-301 via Line 3B.

Based on historical data, groundwater conveyed to Influent Tank TK-301 will initially contain uranium and nitrate at concentrations exceeding the respective MCLs, and fluoride at a

concentration below the MCL. Groundwater from TK-301 will be treated for both uranium (via UIX Train 3) and nitrate (via Nitrate Train 3), prior to transfer to TK-701.

Based on historical data, the enrichment of the uranium in WAA "U < DCGL" EAST groundwater is estimated to be less than 2%. Based on this, it will initially be assumed that the enrichment of the UIX Train 3 influent groundwater is 2%. Isotopic analysis of resin described in Section 8.6.3 will provide a more accurate value for enrichment.

Treatment for nitrate will continue until the concentration of nitrate in TK-301 is less than the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended). At that time, the flow from TK-301 will bypass Nitrate Train 3, and flow directly to TK-701.

Removal of uranium will continue until the concentration of uranium in TK-301 is less than the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended). At that time, the flow from TK-301 will bypass UIX Train 3 and flow directly to Nitrate Train 3 or to TK-701.

WAA "BLUFF"

The WA Treatment Facility includes one nitrate treatment train dedicated to groundwater produced by the WAA "BLUFF" groundwater extraction components. This treatment train is designed to accommodate flow rates between 100 and 125 gpm. As shown on Figure 8-3, the eight extraction wells required for remediation of the WAA "BLUFF" area are estimated to produce a total of 102 gpm, conveyed to TK-401via Line 4.

Based on historical data, groundwater conveyed to Influent Tank TK-401 will initially contain nitrate at a concentration exceeding the MCL, and uranium and fluoride at concentrations below the respective MCLs. Groundwater from TK-401 will be treated only for nitrate (via Nitrate Train 4) prior to transfer to TK-701.

Treatment for nitrate for this stream will continue until the concentration of nitrate in TK-401 is less than the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended). At that time, the flow from Influent TK-401 will bypass Nitrate Train 4, and flow directly to TK-701.

8.3.4 Burial Area #1 Treatment System

The BA1 Treatment Facility includes one treatment train dedicated to groundwater produced by all BA1 groundwater extraction components. This treatment train is designed to accommodate flow rates between 70 and 100 gpm.

The four groundwater extraction wells in the BA1 "U > DCGL" area are estimated to produce a combined total of 40 gpm, discharging to TK-501 via Line 1 (see Figure 8-3). Only two of the five wells in the BA1 "U < DCGL" area will be operational at any given time, limiting groundwater production from these wells to a combined 20 gpm, also conveyed to TK-501 via Line 1. The two sumps installed in the BA1-TZ extraction trench (GETR-BA1-01) are estimated to produce a combined 32 gpm, conveyed to TK-501 via Line 1, while the BA1-SSB extraction trench (GETR-BA1-02) is expected to produce 10 gpm, conveyed to TK-501 via Line 2. The combined total flow rate for BA1 groundwater extraction components is approximately 100 gpm.

Based on historical data, groundwater conveyed to Influent Tank TK-501 will initially contain uranium at a concentration exceeding the DCGL, and nitrate and fluoride at concentrations below the respective MCLs. Groundwater from TK-501 will be treated only for uranium (via UIX Train 5), prior to transfer to the BA1 Effluent Tank (TK-801).

Based on historical data, the enrichment of the uranium in BA1 groundwater is estimated to be less than 2%. Based on this, it will initially be assumed that the enrichment of the UIX Train 2 influent groundwater is 2%. Isotopic analysis of resin described in Section 8.6.3 will provide a more accurate value for enrichment.

Removal of uranium will continue until the concentration of uranium in TK-501 is less than the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended). At that time, the flow from TK-501 will bypass UIX Train 5 and flow directly to TK-801.

8.4 TREATED WATER INJECTION

In several locations at the Site, treated groundwater will be injected into the Sandstone A and/or Sandstone B formations to enhance the hydraulic gradient and drive impacted groundwater to down gradient areas equipped with groundwater extraction components. Treated water will be delivered to the subsurface via gravity flow, and will propagate through the targeted formation under hydrostatic heads developed by raising the water level in trenches or wells above the static groundwater elevation. The injection wells and trenches will not be pressurized. Only water that has been treated

to reduce the concentrations of uranium, nitrate and fluoride to less than the respective MCLs will be injected.

This section presents the detailed design for the groundwater injection infrastructure, equipment, and associated controls, as well as the rationale for operation of the system. The locations of groundwater injection wells and trenches are depicted on Drawings BMCD-GWREMED-C002 through Drawing BMCD-GWREMED-C006.

8.4.1 Water Injection Trenches

A total of seven groundwater injection trenches will be installed at the site. These include the following:

- GWI-WU-01 – Installed in the WU-BA3 sub-area, within Sandstone A
- GWI-WU-02 – Installed in the WU-BA2 sub-area, within Sandstone A
- GWI-UP1-01 – Installed in the UP1 sub-area, within Sandstone A
- GWI-UP2-01 – Installed in the western portion of the UP2 sub-area, within Sandstone A
- GWI-UP2-04 – Installed in the eastern portion of the UP2 sub-area, within Sandstone A
- GWI-BA1-01 – Installed at the southern end of the BA1 "U > DCGL" sub-area, within Sandstone B
- GWI-BA1-02 – Installed on the eastern edge of the BA1 "U > DCGL" sub-area, within Sandstone B

Groundwater injection trench subsurface profiles are depicted on Drawings BMCD-GWREMED-C102 through BMCD-GWREMED-C104, and construction details are provided on Drawing BMCD-GWREMED-M202. Injection trenches may be installed in a phase approach to allow for the temporary operation of shorter "pilot" trench segments. Data obtained from pilot trench operations may be used to optimize trench designs prior to full-scale construction.

Prior to trenching, an access trench may be excavated at the surface, using a bulldozer, both to provide a level working surface for the excavator, and to enable the excavator to reach the required maximum trenching depths (up to 30 feet bgs). Trenches will be excavated to a minimum width of 2 feet using a tracked excavator. Due to the weathered nature of Sandstone A bedrock in the WUA, and Sandstone B bedrock in BA1, the use of standard excavation and earthmoving construction equipment (e.g., track excavators and bulldozers) should be suitable for the majority of injection trench excavation. This was confirmed during exploratory trenching

activities performed at site during the 2015 groundwater monitoring event. Excavations will extend to the base of the transition zone material, generally located at the bedrock interface. Excavator-mounted pneumatic hammers or other rock excavation equipment will be employed as necessary to achieve the required trench depths. The injection trench excavations are expected to remain open during construction, therefore high-density slurries or excavation shoring techniques are not anticipated to be necessary.

Following excavation of each injection trench, the bedrock walls and bottom of the trench will be cleaned using a high-pressure water jet or other means to remove soil smearing, achieve scarification of the bedrock wall faces, and improve overall communication with the bedrock formation. The trench will then be backfilled with clean, free draining aggregate to the desired depth. A geotextile fabric will be placed on top of the drainage layer before backfilling the trench to grade with clean, native soil previously excavated from the trench.

Delivery of treated groundwater to each injection trench, and monitoring of trench water levels, will be accomplished through the installation and operation of injection wells. At least one injection well will be installed within each injection trench. Injection well design elements, installation details, and operational procedures are detailed in Section 8.4.2, Water Injection Wells.

WU-BA3

Injection trench GWI-WU-01 will be excavated to a length of approximately 225 feet. The trench will be located east of the 1206 drainage and upgradient of the former Burial Area #3. One injection well will be installed in the approximate center of the trench. A cross-sectional depiction of the trench and well are shown on Drawing BMCD-GWREMED-C103. In this area, a depth of 25 feet should fully penetrate Sandstone A. The trench will be positioned and oriented to achieve maximum penetration and interconnection of the former Burial Area #3 waste disposal trenches. The majority of uranium impacts are likely to reside within the backfill of the former disposal trenches. In addition, the former disposal trenches are likely to provide a preferential flow path for injected water. Observations from test trenches conducted during field construction activities will be used to determine the final location and orientation of GWI-WU-01. A nominal 10 gpm of treated water will be injected into this trench.

WU-BA2

Injection trench GWI-WU-02 will be excavated to a length of approximately 175 feet. The trench will be located near the northern end of the former Burial Area #2. One injection well will be installed in the approximate center of the trench. A cross-sectional depiction of the trench and well are shown on Drawing BMCD-GWREMED-C103. In this sub-area, a depth of 20 feet should fully penetrate Sandstone A. The trench is positioned and oriented to flush residual uranium impacts from the former Burial Area #2 toward the GETR-WAA-01 extraction trench. A nominal 10 gpm of treated water will be injected into this trench.

UP1

Injection trench GWI-UP1-01 consists of a main north-south segment with four semi-perpendicular east-west lateral segments to achieve maximum communication with the Sandstone A formation, as well as interconnection of secondary porosity features. This design is intended to maximize injected water distribution over the relatively large UP1 remediation sub-area. This will aid in distributing the significant volume of treated water required for remediation of the Sandstone A formation underlying the former Uranium Pond #1. The total combined length of the five UP1 trench segments is approximately 1,050 feet. Three injection wells will be installed in the north-south segment to evenly distribute treated water throughout the trench system. A cross-sectional depiction of the north-south trench segment and wells are shown on Drawing BMCD-GWREMED-C103. In this sub-area, full penetration of Sandstone A would require trenching to depths greater than 25 feet bgs; however, a minimum Sandstone A penetration depth of 10 feet is planned for the UP1 injection trench system. A nominal 30 gpm of treated water will be injected into this trench.

UP2

Injection trench GWI-UP2-01 has a combined total length of approximately 900 feet. This trench system consists of a main east-west segment with two perpendicular north-south lateral sections to achieve maximum communication with the Sandstone A formation and interconnection of secondary porosity features. As with the UP1 remediation sub-area, the large extent and volume of Sandstone A requiring remediation in the UP2 sub-area, combined with the low permeability of the sandstone, justifies the construction of several trenches to maximize treated water distribution throughout the sub-area. A total of four injection wells will be installed in GWI-UP2-01 and a nominal 40 gpm of treated water will be injected into the trench.

Injection trench GWI-UP2-04 has a combined total length of approximately 475 feet. This trench system consists of three segments that combine to form a west-to-north arc designed to drive flow toward the northwest. This design is intended to maximize injected water distribution over the relatively large UP2 remediation sub-area. Two injection wells will be installed in GWI-UP2-04 and a nominal 30 gpm of treated water will be injected into the trench.

An impervious barrier, likely consisting of HDPE sheeting, will be installed on the down gradient walls of all UP2 main trench segments to minimize the flow of water to the south and southeast. The sheeting will be installed prior to placement of trench backfill material. Cross-sectional depictions of the main UP2 injection trench segments and wells are shown on Drawing BMCD-GWREMED-C102. In the UP2 sub-area, a depth of 25 feet should nearly penetrate Sandstone A.

BA1

Injection trench GWI-BA1-01 will be excavated to a length of approximately 175 feet. The trench will be located near the southern end of former Burial Area #1. One injection well will be installed in the approximate center of this trench. A cross-sectional depiction of the trench and well are shown on Drawing BMCD-GWREMED-C104. In this area, a depth of 25 feet should fully penetrate Sandstone B. The trench is positioned and oriented to achieve maximum penetration and interconnection of the former Burial Area #1 waste disposal trenches. The majority of uranium impacts are likely to reside within the backfill of the former disposal trenches. In addition, the former disposal trenches are likely to provide a preferential flow path for injected water. A nominal 10 gpm of treated water will be injected into this trench.

Injection trench GWI-BA1-02 will be excavated to a length of approximately 150 feet. The trench is located on the eastern edge of the BA1 "U > DCGL" remediation sub-area. One injection sump will be installed in the approximate center of this trench. A cross-sectional depiction of the trench and well are shown on Drawing BMCD-GWREMED-C104. In this sub-area, a depth of 20 feet will fully penetrate Sandstone B. This trench is positioned and oriented to drive residual uranium impacts in Sandstone B toward the BA1 alluvium for capture via groundwater extraction wells. A nominal 5 gpm of treated water will be injected into this trench.

8.4.2 Water Injection Wells

Fifteen (15) groundwater injection wells (as listed on Drawing BMCD-GWREMED-M202) will be screened in Sandstone A and B formations within WUA and BA1 remediation areas. All but two of the wells (GWI-UP-02 and 03) will be installed with injection trenches and screened

within the trench drainage layer. Injection wells GWI-UP-02 and 03 will be installed upgradient of an isolated zone of Sandstone B contamination characterized by nitrate and fluoride MCL exceedances. Injection well construction details are provided on Drawing BMCD-GWREMED-M201.

Injection wells located within injection trenches will be installed during trench construction (see Section 8.4.1). The wells will be installed by placing the well screen and casing in the excavated trench prior to backfill placement. The wells will be constructed, as detailed on Drawing BMCD-GWREMED-M202, using 6" PVC well casing with 6" PVC wire-wrapped screen. Injection well screens will extend no higher than 5 feet bgs. Injection trench drainage materials will be placed around the injection wells during backfilling and each well will be completed with a surface seal comprised of hydrated bentonite and a bentonite/cement grout, if necessary. All injection wellheads will be constructed flush with the surrounding grade. Well installation details will be recorded by the field hydrogeologist on a well installation diagram.

Borings for injection wells GWI-UP-02 and 03, installed in the Sandstone B formation, will be advanced by air rotary to the specified total depth. Following achievement of total depth, the boring shall be reamed by air rotary to a nominal diameter of 10 inches. A qualified HP tech will monitor exposure rate during drilling. Cuttings will be logged and lithology will be recorded by the field hydrogeologist on drilling log forms.

Groundwater injection wells GWI-UP-02 and 03 will be installed as described in SAP-110. The wells will be constructed, as detailed on Drawing BMCD-GWREMED-M202, using 6" PVC well casing with 6" PVC wire-wrapped screen. Injection well screens will extend no higher than 5 feet bgs. The annular filter pack for GWI-UP-02 and 03 will consist of 10-20 sand. For wells installed within injection trenches, a 10-20 sand filter pack will be used to fill the annular space as necessary; however, collapse of the trench drainage material is anticipated to provide an adequate well filter pack. The surface seal for each injection well will be comprised of hydrated bentonite and a bentonite/cement grout, as necessary. The wellheads will be constructed flush with the surrounding grade. Well installation details will be recorded by the field hydrogeologist on a well installation diagram.

Groundwater injection wells shall be developed by alternating water removal, via air lift, surging, if practical, and stabilization periods that allow the water level to return to static elevation. Development will occur until the well produces clear water. Development pumps, surge blocks,

and/or swabs may be used to enhance well development if the driller and field geologist agree that pumping and surging may be more effective in achieving development criteria and aquifer communication. Development will continue until the field geologist approves termination of development activities. Well development information shall be recorded on the well installation diagrams.

Drawing BMCD-GWREMED-M103 presents a typical groundwater injection well installation. As shown on the drawing, each well will be equipped with a pitless adapter, connected to the well casing approximately 2 feet below grade, for the connection of subgrade water conveyance piping to the injection drop pipe. The pitless adapter also facilitates installation and removal of the drop pipe from the well. A water level transducer will be installed approximately 2 feet above the injection drop pipe outlet. A 24” diameter by 24” deep steel well vault, set in a 48” diameter by 24” deep concrete pad will be installed over each well. A capped 1” galvanized steel pipe shall extend through the concrete pad to approximately 5 feet above grade. A bolt shall be placed in the concrete pad to serve as a reference point for location and elevation, and a metal tag displaying the well identification will be fastened to the steel pipe. Groundwater injection well construction information shall be recorded on well installation diagrams.

8.4.3 Water Injection Systems

Mechanical systems required for the distribution and metering of treated groundwater to injection wells will consist of feed tanks, chemical pretreatment systems, transfer pumps, manifold systems, control valves, instrumentation, and associated piping and appurtenances. The injection system serving the WUA injection wells and trenches will consist of a skid-mounted unit installed inside the WA Treatment Facility building. The system serving the BA1 injection trenches will consist of a self-contained unit housed in a modular enclosure and installed adjacent to the BA1 Treatment Facility. The location of the WUA injection system is depicted on several Kurion design drawings, including Drawing KUR-ENVI01-001-G100. The location of the BA1 injection system is depicted on Kurion Drawing KUR-ENVI01-001-G200 and Burns & McDonnell Drawing BMCD-GWREMED-C006.

A P&ID for the WUA water injection system is provided on Drawing BMCD-GWREMED-P103. As shown on the drawing, treated groundwater is supplied to an injection feed tank (TK-001) by the WA Effluent Tank (TK-701). An actuated valve (MOV-011) controls the flow of water to prevent overfilling of TK-001. Water will be pretreated in TK-001, as necessary, to prevent mineral scaling and fouling of the injection system piping, wells, trenches and subsurface

formation. Transfer pumps P-001 and P-002 convey water from TK-001 to the injection manifold system.

Actuated valves on the injection manifold control the flow of water to each injection trench/well based on water levels continuously monitored via transducers installed in injection wells. The pumping pressure and injection flow rate for each injection manifold line is also monitored by the control system and individual injection lines can be closed if abnormal flow rate, pressure, or water level values are detected. The general arrangement of the WUA injection system to be installed inside the WA Treatment Facility building is depicted on Drawing BMCD-GWREMED-M104. A total of 11 dedicated injection manifold lines will deliver treated groundwater to the 13 WUA injection wells. The following injection well pairs are served by a single manifold line: GWI-UP2-01A and 01B, GWI-UP2-01C and 01D, and GWI-UP2-04A and 04B. Dedicated injection piping runs are provided for all other WUA injection wells.

A P&ID for the BA1 water injection system is provided on Drawing BMCD-GWREMED-P104. As shown on the drawing, treated groundwater is supplied to an injection feed tank (TK-003) by the BA1 Effluent Tank (TK-801). The process rationale and control logic for the BA1 injection system are the same as those described above for the WUA injection system. The general arrangement of the BA1 injection system is depicted on Drawing BMCD-GWREMED-M105. The BA1 injection system enclosure will also house an air compressor and ancillary equipment to provide the compressed air supply required for operation of the GETR-BA1-02 pneumatic groundwater extraction pump.

8.4.4 Piping and Utilities

Locations of water conveyance piping runs and other well field utilities associated with the groundwater injection systems are depicted on Drawing BMCD-GWREMED-C002. Mechanical details for injection well wellhead piping connections and instrumentation are provided on Drawing BMCD-GWREMED-M103.

WUA

A partial site plan depicting detailed layouts for water conveyance piping and instrumentation conduits for the WUA injection components is presented on Drawing BMCD-GWREMED-C004. Drawing BMCD-GWREMED-C006 includes a partial plan dedicated to the WA Treatment Facility that will house the injection system delivering treated groundwater to all WUA injection wells and trenches. As shown on the drawings referenced above, multiple water injection piping

runs will convey treated groundwater from the WUA injection system to the various WU-BA2, WU-BA3, UP1, and UP2 injection components. A total of 11 dedicated injection piping runs will deliver treated groundwater to the 13 WUA injection wells. The following injection well pairs are served by a single injection piping run: GWI-UP2-01A and 01B, GWI-UP2-01C and 01D, and GWI-UP2-04A and 04B. Dedicated injection piping runs are provided for all other WUA injection wells.

The general groundwater injection water conveyance piping configuration for the WUA is depicted on Drawing BMCD-GWREMED-P103. This drawing also shows the general arrangement of instrumentation service runs for the WUA injection wells, and the general arrangement of electrical power, instrumentation, and communication services for the WUA injection system located in the WA Treatment Facility. General quantities and subsurface configurations for instrumentation conduits associated with the injection wells are shown on Drawings BMCD-GWREMED-C105 and BMCD-GWREMED-C106. As shown on these drawings, dedicated conduits are provided for the routing of 24 VDC instrumentation cables required for transmission of water level transducer signals.

General design information for the electrical power and control system serving the WUA groundwater injection system is provided on the single-line diagram presented on Drawing BMCD-GWREMED-E101. Additional cable and conduit design details for the WUA injection system electrical service, instrumentation, control, and communication feeds are provided on Drawings BMCD-GWREMED-E107 through BMCD-GWREMED-E109. Finally, the WUA control system configuration is depicted on the communication system architecture diagrams provided on Drawings BMCD-GWREMED-E111.

BA1

A partial site plan depicting detailed layouts for water conveyance piping and instrumentation conduits for the BA1 injection components is presented on Drawing BMCD-GWREMED-C005. Drawing BMCD-GWREMED-C006 includes a partial plan dedicated to the BA1 Treatment Facility layout that includes the injection system delivering treated groundwater to all BA1 injection wells and trenches. As shown on the drawings referenced above, individual water injection piping runs convey treated groundwater from the injection system to the two BA1 injection wells/trenches.

The general groundwater injection water conveyance piping configuration for the BA1 is depicted on Drawing BMCD-GWREMED-P104. This drawing also shows the general arrangement of instrumentation service runs for the BA1 injection wells, and the general arrangement of electrical power, instrumentation, and communication services for the BA1 injection system. General quantities and subsurface configurations for instrumentation conduits associated with the injection wells are shown on Drawing BMCD-GWREMED-C106. As shown on these drawings, dedicated conduits are provided for the routing of 24 VDC instrumentation cables required for transmission of water level transducer signals.

General design information for the electrical power and control system serving the BA1 groundwater injection system is provided on the single-line diagram presented on Drawing BMCD-GWREMED-E103. Additional cable and conduit design details for the WUA injection system electrical service, instrumentation, control, and communication feeds are provided on Drawings BMCD-GWREMED-E107 through BMCD-GWREMED-E109. Finally, the BA1 control system configuration is depicted on the communication system architecture diagrams provided on Drawings BMCD-GWREMED-E112.

8.4.4 Water Injection Strategy by Area

The anticipated groundwater injection flow rates for each injection well/trench are summarized on Drawing BMCD-GWREMED-P203. The strategies for treated water injection in applicable remediation areas and sub-areas are detailed below.

WUA Injection Systems

Treated water will be injected into the WU-BA2, WU-BA3, UP1, and UP2 sub-areas via both injection wells and injection trenches. Treated water will be injected into the Sandstone A formation within these remediation areas via the five injection trenches listed in Section 8.4.1, Injection Trenches. Trenches are considered the best technology for injection of treated water into Sandstone A due both to the low permeability of the sandstone and the presence of secondary porosity features (i.e., fractures and former excavations or re-worked areas). The WUA injection trenches will continue to operate until in-process monitoring indicates that COC groundwater concentrations within the targeted remediation area have remained below the respective MCLs (uranium and/or fluoride) and/or ACL (nitrate) for at least two consecutive months. Water delivery to each injection trench will only be permitted if the extraction component(s) responsible for capture of the injected water are operating and maintaining sufficient capture.

Treated water will be injected into the Sandstone B formation within UP2 via two injection wells (GWI-UP2-01 and GWI-UP2-02). Injection wells were selected for use in this application because the depth of Sandstone B in UP2 makes injection trench excavation unfeasible. In addition, the lateral extent of the relatively isolated area of impact requiring remediation in UP2 Sandstone B is compatible with injection wells. These wells will be screened to a total depth of approximately 70 feet and a nominal 5 gpm of treated water will be injected into each well. Water delivery to the injection wells will only be permitted if the extraction component(s) responsible for capture of the injected water are operating and maintaining sufficient capture.

BA1 Injection System

Treated water will be injected into the BA1-SSB portion of the BA1 "U > DCGL" area via two injection trenches (GWI-BA1-01 and 02). As with Sandstone A injection in the WUA areas, trenches are considered the best technology for the injection of treated water into the BA1 Sandstone B formation due both to the low permeability of the sandstone and the presence of secondary porosity features (i.e., fractures and former excavations or re-worked areas). The BA1 injection trenches will continue to operate until in-process monitoring indicates that uranium groundwater concentrations within the targeted remediation area have remained below the DCGL or MCL for at least two consecutive months. Water delivery to each injection trench will only be permitted if the extraction component(s) responsible for capture of the injected water are operating and maintaining sufficient capture.

8.5 TREATED WATER DISCHARGE

All treated water not utilized for injection will be discharged to the Cimarron River in accordance with an OPDES permit. The OPDES permit is anticipated to allow discharges from two constructed outfalls at the site: one for discharge of WA Treatment Facility effluent, and a second for discharge of BA1 Treatment Facility effluent. Locations of the two outfalls (WA Outfall and BA1 Outfall) are shown on Drawings BMCD-GWREMED-C002, BMCD-GWREMED-C003, and BMCD-GWREMED-C004. Outfall details are presented on BMCD-GWREMED-C107.

8.5.1 WA Outfall (Outfall 001)

Assuming all WUA and WAA groundwater extraction and injection systems operate at nominal capacity, approximately 328 gpm of treated water will be discharged to the Cimarron River through the WA Outfall (Outfall 001). With all groundwater extraction systems operating at nominal capacity and no injection occurring, the discharge rate increases to approximately 458 gpm. Finally, the discharge piping and outfall were designed to accommodate a maximum

discharge flow scenario characterized by all extraction systems operating at maximum capacity, bypassing treatment, with no injection. The flow rate associated with this scenario is approximately 727 gpm. The discharge pump for the WA Treatment Facility has been sized to maintain the maximum discharge flow rate (727 gpm) under 100-year flood conditions.

As previously stated, groundwater extracted from the WAA and WUA will be treated to reduce concentrations of uranium, nitrate, and fluoride below the respective MCLs prior to discharge. Samples of discharged water will be collected for analysis at a frequency stipulated in the OPDES permit; a weekly sampling frequency is anticipated.

As achievement of remediation goals demonstrated for remediation areas and operation of individual groundwater extraction and treatment systems are discontinued, the WA Treatment Facility discharge rate will decrease. Should this necessitate a discharge rate lower than the permitted value, a permit modification will be applied for and approved prior to reducing the flow rate.

8.5.2 BA1 Outfall (Outfall 002)

Assuming all BA1 groundwater extraction and injection systems operate at nominal capacity, approximately 85 gpm of treated water will be discharged to the Cimarron River through the BA1 Outfall (Outfall 002). With all groundwater extraction systems operating at nominal capacity and no injection occurring, the discharge rate increases to approximately 100 gpm. Finally, the discharge piping and outfall were designed to accommodate a maximum discharge flow scenario characterized by all extraction systems operating at maximum capacity, bypassing treatment, with no injection. The flow rate associated with this scenario is approximately 168 gpm. The discharge pump for the BA1 Treatment Facility has been sized to maintain the maximum discharge flow rate (168 gpm) under 100-year flood conditions.

As previously stated, groundwater extracted from BA1 will be treated to reduce concentrations of uranium below the MCL prior to discharge. Samples of discharged water will be collected for analysis at a frequency stipulated in the OPDES permit; a weekly sampling frequency is anticipated.

The BA1 Treatment Facility discharge rate is not expected to decrease over time; however, if a discharge rate lower than the permitted value is required, a permit modification will be applied for and approved prior to reducing the flow rate.

8.6 TREATMENT MEDIA MANAGEMENT

Section 8.3.1, Uranium Treatment Systems, describes the process whereby uranium is removed from groundwater by adsorption onto anion resin. This section describes the in-process monitoring that will be performed to monitor the mass of uranium adsorbed in the resin vessel, as well as the process whereby “spent” resin is removed from the treatment system, and processed and packaged for shipment as LLRW.

Section 8.3.2, Biodenitrification Systems, describes the process whereby nitrate is removed from groundwater through an anoxic reaction. This section describes the in-process processing and packaging of biomass that accumulates in the bioreactors. The influent to two of the three nitrate treatment train bioreactors will consist of groundwater that has already been treated for uranium. The influent should contain non-detectable concentrations of uranium. The biomass removed from the bioreactors in two treatment trains will be disposed of as solid waste. The influent to Nitrate Train 4 will consist of groundwater with a uranium concentration below the MCL. Treatability testing performed in 2015 indicates that the biomass removed from the bioreactor(s) in this treatment train may accumulate uranium in concentrations as high as several mg/kg. Each nitrate treatment train will include its own sludge tank and filter press, as well as the process whereby “spent” resin is removed from the treatment system, and processed and packaged for shipment as LLRW.

8.6.1 In-Process Monitoring

In-process monitoring of the groundwater treatment processes will include both chemical and radiological monitoring and data evaluation. Chemical monitoring will provide information needed to evaluate compliance with discharge criteria, to assess when influent concentrations are low enough that treatment is no longer needed, and to assess when ion exchange resin vessels require replacement/reconfiguration, or when accumulated biomass requires removal from denitrification bioreactors. Radiological monitoring of the treatment facilities and processes will consist of monitoring dose-rates to ensure compliance with regulatory exposure limits, as well as monitoring the mass and enrichment of uranium accumulated in each ion exchange resin and biomass to assess compliance with license-stipulated possession limits. In-process chemical monitoring is addressed in Section 8.6. Radiological monitoring is addressed in Section 8.6, Resin Management, Section 11, Radiation Protection Program, and Section 15, Facility Radiation Surveys.

Sampling ports will be located between the pre-filter and the lead resin vessel, prior to the lag and polishing vessels, and at the effluent from the polishing vessel. Drawing KUR-ENV101-001-

DWG-P115 and KUR-ENVI01-001-DWG-P215 shows the locations of the sampling ports in a uranium treatment train. Samples will initially be collected from each sampling port on a weekly basis, and analyzed for uranium concentration. The volume of groundwater (operating time multiplied by the volumetric flowrate) multiplied by the difference between the influent and effluent concentrations (mass of total uranium per volume of groundwater) will yield the mass of uranium contained in each resin vessel. The enrichment percentage (2% for groundwater in all areas except the WAA "U > DCGL" area) is used to determine the U-235 content with a vessel.

Current estimates are that no resin vessel will ever accumulate more than 500 grams of U-235, because as the uranium concentration of influent groundwater declines, the adsorption capacity of the resin declines. Consequently, a single resin vessel will not be able to adsorb sufficient uranium to contain 1,200 g of U-235. Figure 8-6 presents the calculated U-235 loading for each uranium treatment train. Figure 8-6 also shows that the total mass of U-235 in all treatment trains combined is not expected to exceed 800 grams.

Exchange and replacement of the lead vessel will typically be triggered when the uranium concentration in the effluent from the lead vessel exceeds 80% of the uranium concentration in the influent. This trigger criterion will be evaluated and modified as appropriate during operations to maximize the utilization of the resin capacity and minimize the volume of solid waste generated for disposal.

8.6.2 Resin Vessel Replacement

Once it is determined that the resin in the lead vessel is "spent", the system will be shut down, and the lead vessel will be removed from the treatment train. As explained in Section 8.3.1, the valve alignment will be changed such that the lag vessel will become the lead vessel, the polishing vessel will become the lag vessel, and a new vessel filled with fresh resin will become the polishing vessel. This replacement process ensures that there will always be three vessels in series with the final (polishing) vessel containing fresh anion resin.

8.6.3 Spent Resin Processing

Spent resin processing operations are shown on a Process Flow Diagram on Drawing KUR-ENVI01-001-DWG-P110. Spent resin processing involves the following steps:

The spent resin vessel is removed from a uranium treatment train. Spent resin vessels from BA1 are transported to the WA treatment facility for processing.

A sample of the spent resin will be extracted from the vessel via a sample port located on top of the vessel. A sample thief will be used to draw a composite sample through the entire thickness of the resin bed. The sample will be analyzed for both uranium concentration and isotopic activity. The concentration will be compared with the estimated uranium mass based on the analysis of influent and effluent samples. The isotopic activity results will be used to determine the quantity of non-fissile material that must be added to meet transportation and disposal criteria. The fissile exempt criterion (for transportation of the waste) is less than 1 gram of U-235 per 2 kilograms of non-fissile material. Another waste acceptance criterion (for receipt by the disposal facility) is a requirement that the waste contain less than 20% carbon.

After the quantity of non-fissile material needed has been determined, the ion exchange vessel will be moved to the vessel and solids processing area.

Spent resin is sluiced out of the vessel, and dewatered using a scrolling centrifuge. The water coming out of the scrolling centrifuge is routed back to an influent tank to be processed through the appropriate uranium treatment train. Solids (i.e., resin) from the centrifuge are moved by enclosed conveyor to a ribbon blender. The ribbon blender is sized to blend the contents of a resin vessel plus the non-fissile material needed to meet the transportation and waste acceptance criteria. The ribbon blender will yield a uniform final mixture that complies with the fissile exempt and waste acceptance criteria. If required, heat will be provided to dry the mixture enough to ensure that the packaged material contains no free liquid, and will not produce free liquid during transportation.

A sample is collected from the ribbon blender after mixing is complete to analyze for isotopic activity and total organic carbon. Analytical data will be the basis for shipping papers and manifests, as well as documentation that transportation and disposal criteria have been met.

Once a resin vessel has been emptied, the vessel remains in the Vessel and Solids Processing Area to be filled with fresh ion exchange media. A pre-determined quantity of new resin is sluiced into the vessel, using treated effluent. Because of the potential for residual contamination in a vessel, excess water is collected and routed to the appropriate influent tank, to be treated by a uranium treatment train. Once filled, the vessel is stored in the Vessel and Solids Handling Area until needed.

The Vessel and Solids Handling Area is located in the northeast corner of the WA treatment facility as shown on Drawing KUR-ENVI01-001-DWG-G100. The processing equipment is

based on commercial models selected for their processing function. Elevation views of the resin handling equipment is shown on Drawing KUR-ENVI01-001-DWG-G120, Sheet 1. Using a single station for both the removal of spent resin and the addition of fresh resin minimizes vessel movement.

8.6.4 Spent Resin Packaging and Storage

Initially, it is anticipated that spent resin will contain sufficient uranium that a dense particulate material such as barite may be used to reduce the U-235 concentration to less than the fissile exempt criterion. As the concentration of uranium in groundwater declines, and the adsorption capacity of the resin decreases, it is possible that spent resin may not contain enough uranium to require the addition of a dense particulate material; it may already meet the fissile exempt criterion. An absorbent material may be used to ensure that free liquid will not be present upon delivery to the licensed disposal facility. However, as noted in the previous section, the dense particulate material added to the resin to meet the waste acceptance criterion of 20% carbon, may be sufficient to ensure no free liquid remains in the waste.

The blended resin/non-fissile mixture will be transferred to 55-gallon drums equipped with a plastic liner. The liner allows for transfer of material in a way that does not expose the worker to direct contact with the material. Filled drums will be labeled and temporarily stored in a secure area pending confirmation analytical results and transportation. Disposal of processed resin is addressed in Section 13.1, Solid Radwaste Management.

8.6.5 Biomass Processing

When sufficient solids accumulate in the sludge holding tank that decanting of free liquid is not effective, the sludge will be sent through a centrifuge for dewatering. Treatability tests indicate that the discharge from the centrifuge will not contain free liquid, although the material will contain between 30 and 40 percent solids (by weight).

For the two nitrate treatment trains located downstream of a uranium treatment skid, sufficient uranium should not accumulate within the biomass to require disposal as LLRW. For Nitrate Train 4, which does not have a uranium treatment system upstream, treatability testing performed in 2015 indicates that the biomass removed from the bioreactor can accumulate uranium in concentrations as high as several mg/kg.

In-process monitoring will include the collection of biomass from the sludge holding tank for uranium analysis to determine the degree to which biomass accumulates uranium. Biomass

yielding total uranium activity greater than 2 pCi/g will be treated as LLRW. If needed, a small blender will be added to the system to blend additional mass or adsorbent material to comply with waste acceptance criteria. Depending on the concentration of uranium in the biomass, it may also be possible to increase the frequency at which biomass is removed from the bioreactor, resulting in insufficient time for accumulation of uranium to a level of concern.

8.6.6 Biomass Packaging and Storage

Discharge from the centrifuge (or the post-centrifuge blender if used in Nitrate Train 4) will be discharged into a plastic-lined 55-gallon drum. Absorbent material may be added to ensure that free liquid is not present and will not be generated during transportation. Drums designated as LLRW will be stored in the same radiologically controlled area as drums of spent resin. Drums designated as solid waste will be stored in a segregated area until loaded for disposal in a municipal landfill.

8.7 IN-PROCESS GROUNDWATER MONITORING

This section addresses the groundwater monitoring that will be performed to optimize the groundwater remediation process and determine when remediation can be discontinued and post-remediation monitoring can begin. In-process monitoring of the groundwater treatment process is addressed in Section 8.6.1. In-process monitoring of radiological conditions is addressed in Section 11, Radiation Safety Program.

8.7.1 Groundwater Extraction Monitoring

For BA1 and the WAA remediation areas, initial groundwater extraction rates were estimated through the development of a numerical groundwater flow model, utilizing a particle tracking method to optimize flow rates for plume capture while minimizing the required groundwater treatment capacity. For the WU-PBA, WU-1206, and UP2 sub-areas, initial groundwater extraction rates were estimated from injection tests and the productivity of monitoring wells during sampling events.

In-process monitoring of groundwater extraction systems will consist of recording, logging, and evaluating well field data including pumping rates and pressures, groundwater elevations in extraction trenches and wells, and pump run times. Well field instrumentation will provide real-time measurements for these data and the control system will store data records for future access, trending, and reporting. Groundwater elevations will also be periodically recorded in monitoring wells located in each remediation area containing groundwater extraction wells and/or trenches;

however, these measurements will be recorded manually. The data described above will be used to adjust groundwater extraction rates for individual wells and/or trenches to optimize COC removal rates, hydraulic capture of groundwater plumes, and operational efficiency. Individual pumping rates will also be adjusted to maintain the influent flow rates required for proper operation of the groundwater treatment systems.

Transducers will be installed in all groundwater extraction wells and trench sumps to monitor the drawdown achieved at the initial extraction rates. In addition, depth to groundwater will be measured in select monitoring wells to assess groundwater surface depression and hydraulic influence exerted by the various groundwater extraction components. In-process groundwater monitoring wells for each remediation sub-area are listed on Table 8-2. Figure 8-8 shows the locations of in-process monitoring wells in the Western Areas. Figure 8-9 shows the locations of in-process monitoring wells in Burial Area #1.

Depth to groundwater measurements will be recorded for in-process groundwater monitoring wells daily for the first week of operation, weekly for the second through fourth weeks, and monthly thereafter.

In-process groundwater elevation measurements may indicate a lack of drawdown and/or hydraulic capture in one or more areas, or excessive drawdown in other areas. Extraction rates will be adjusted as appropriate to optimize plume capture while maintaining influent flow rates to the treatment systems within the range specified for proper operation. In-process groundwater elevation data will also be used to maximize operational efficiency (e.g., minimize power consumption) and inform decisions regarding system modifications (e.g., shut down or cycling of individual extraction wells or trenches).

8.7.2 Treated Water Injection Monitoring

For the WU-BA2, WU-BA3, UP1, and UP2 remediation sub-areas, initial treated water injection rates were estimated from injection tests and the productivity of monitoring wells during sampling events. As previously stated, the injection of treated water into the bedrock aquifer units will be accomplished by gravity flow (i.e., the wells will not be pressurized). Injection rates will initially be adjusted to maintain water levels within injection wells and trenches at the desired elevations. Water level elevations will not be allowed to rise above 2 feet bgs.

In-process monitoring of groundwater injection systems will consist of recording, logging, and evaluating well field and injection process data including injection rates and pressures, injection

manifold valve positions, and groundwater elevations in injection wells. Well field and injection process instrumentation will provide real-time measurements for these data and the control system will store data records for future access, trending, and reporting. Groundwater elevations will also be periodically recorded in monitoring wells located in each remediation area containing groundwater injection wells and/or trenches; however, these measurements will be recorded manually. The data described above will be used to adjust groundwater injection rates to maximize the flushing of COCs from the targeted upland sandstone units.

Transducers will be installed in all treated water injection wells to monitor the potentiometric head maintained at the initial injection rates. In addition, depth to groundwater measurements will be recorded in select monitoring wells to assess the influence of injection efforts on hydraulic gradient (i.e., head propagation). In-process groundwater monitoring wells for each remediation sub-area are listed on Table 8-2. Figures 8-8 and 8-9 show the locations of in-process monitoring wells.

Depth to groundwater measurements will be recorded for in-process groundwater monitoring wells daily for the first week of operation, weekly for the second through fourth weeks, and monthly thereafter.

In-process groundwater elevation data will be used to maximize the driving head from areas of upland COC impact toward groundwater extraction features, while minimizing the potential for contaminant displacement to areas outside the boundaries of capture zones.

8.7.3 Groundwater Remediation Monitoring

Concentrations of groundwater COCs requiring remediation will be monitored to evaluate progress toward remediation goals and to determine when remediation within a given area or sub-area should be discontinued and post-remediation groundwater monitoring should begin. In-process monitoring wells used to evaluate remediation progress are the same as those previously specified for groundwater extraction and injection performance monitoring. Locations of the in-process monitoring wells are depicted on Figures 8-8 and 8-9. Table 8-2 lists the wells by remediation sub-area and identifies the COCs to be analyzed for groundwater samples collected from each well.

In-process monitoring of COC concentrations in groundwater will consist of the sampling and analysis of select monitoring wells in each subarea. Monitoring COC concentrations within each remediation sub-area will provide the information needed to adjust remediation process

parameters, primarily extraction and injection flow rates, assess progress toward remediation goals, evaluate when operation of specific wells or trenches can be discontinued, and determine when remediation in a specific area can cease and post-remediation monitoring can begin. Post-remediation groundwater monitoring is addressed in more detail in Section 8.8, Post-Remediation Groundwater Monitoring.

In-process groundwater monitoring will provide several years of data which can be used to evaluate the rate of decline of COC concentrations in groundwater, relationships between groundwater elevation and COC concentrations, and seasonal variations in both groundwater elevation. Section 8.1.7 states that at least two consecutive months of in-process monitoring data must show that all wells yield COC concentrations below their limits. However, these evaluations may indicate that the groundwater elevation or the rate of decline at the time may necessitate extending the duration of time in which treatment must continue.

Groundwater remediation monitoring samples will be collected immediately prior to startup of groundwater extraction and injection and monthly thereafter. In addition to evaluating remedial progress, in-process groundwater monitoring results will be used to assess the effectiveness of specific remediation components in each area. Based on the results, groundwater extraction and injection system operations will be adjusted to focus efforts on areas with higher levels of impact, maximizing COC mass recovery and concentration reduction, while remediation efforts in areas of lesser impact may be reduced. The data will also be used to maximize operational efficiency (e.g., minimize power consumption) and inform decisions regarding system modifications (e.g., shut down or cycling of individual extraction wells or trenches).

8.8 POST-REMEDIATION GROUNDWATER MONITORING

Post-remediation groundwater monitoring will be performed to demonstrate compliance with NRC-stipulated limits that must be met in order to request license termination. Post-remediation groundwater monitoring will also be performed to demonstrate compliance with criteria established by DEQ for release from further remediation with or without restrictions. This section describes the groundwater sampling and analysis that will be performed for either objective in each area requiring groundwater remediation.

Post-remediation monitoring can only be performed in a given area after all groundwater extraction and/or injection operations in that area have ceased operation. Following the discontinuation of remediation system operations, groundwater elevations and COC concentrations will equilibrate over

time. As groundwater elevations return to pre-remediation levels, sorbed-phase COCs in soils above the depressed groundwater surface maintained by extraction wells and trenches may be released into solution, resulting in a groundwater concentration increases (i.e., rebound). The proposed post-remediation monitoring program will allow groundwater sampling results to reflect potential COC concentration rebound that may occur following the cessation of remediation activities. If the concentration of a given COC rebounds above the remediation objective (i.e., DCGL, MCL, or ACL) in a post-remediation monitoring well, remediation will resume in that area. The post-remediation monitoring process will begin again when in-process monitoring indicates the remediation objective has been achieved.

Locations of the post-remediation monitoring wells are depicted on Figures 8-10 (Western Areas) and 8-11 (Burial Area #1). Table 8-3 lists the wells by remediation sub-area and identifies the COCs to be analyzed for groundwater samples collected from each well. The following subsections detail the post-remediation monitoring approach and criteria for each remediation area and/or sub-area.

8.8.1 Burial Area #1

Post-remediation groundwater monitoring for NRC license compliance in BA1 will consist of at least 12 consecutive quarters of groundwater sampling and analysis. Statistical evaluation of the data must demonstrate that there is a 95% confidence level that COC concentrations are less than 180 pCi/L total uranium and 3,790 pCi/L Tc-99.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria (in those areas which have achieved the DEQ remediation goal) will consist of at least 12 consecutive quarters of groundwater sampling and analysis. Statistical evaluation of the data must demonstrate that there is a 95% confidence level that COC concentrations are less than 30 µg/L total uranium and 900 pCi/L Tc-99. Nitrate and fluoride concentrations in groundwater have never exceeded the MCL in BA1; consequently, analysis for nitrate and fluoride will not be performed on post-remediation monitoring samples collected from BA1.

8.8.2 Western Alluvial Areas

WAA "U > DCGL" Area

Post-remediation groundwater monitoring for license compliance will consist of at least 12consecutive quarters of groundwater sampling and analysis. Statistical evaluation of the data must demonstrate that there is a 95% confidence level that COC concentrations are less than 180 pCi/L total uranium and 3,790 pCi/L Tc-99.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis. Statistical evaluation of the data must demonstrate that there is a 95% confidence level that COC concentrations are less than 30 µg/L total uranium and 10 mg/L nitrate. Fluoride concentrations in groundwater did not exceed the MCL in this area prior to groundwater remediation; consequently, analysis for fluoride will not be performed on post-remediation monitoring samples collected from the WAA “U > DCGL” area.

WAA “U < DCGL WEST Area

Post-remediation groundwater monitoring for license compliance will not be required for this area, because uranium and Tc-99 concentrations did not exceed license criteria prior to groundwater remediation.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis. Statistical evaluation of the data must demonstrate that there is a 95% confidence level that COC concentrations are less than 30 µg/L total uranium and 10 mg/L nitrate. Fluoride concentrations in groundwater did not exceed the MCL in this area prior to groundwater remediation; consequently, analysis for fluoride will not be performed on post-remediation monitoring samples collected from the WAA “U < DCGL” WEST area.

WAA “U < DCGL” EAST Area

Post-remediation groundwater monitoring for license compliance will not be required for this area, because uranium and Tc-99 concentrations did not exceed license criteria prior to groundwater remediation.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis. Statistical evaluation of the data must demonstrate that there is a 95% confidence level that COC concentrations are less than 30 µg/L total uranium and 10 mg/L nitrate. Fluoride concentrations in groundwater did not exceed the MCL in this area prior to groundwater remediation; consequently, analysis for fluoride will not be performed on post-remediation monitoring samples collected from the WAA “U < DCGL” WEST area.

WAA "BLUFF" Area

The groundwater extraction wells in the WAA "BLUFF" Area recover groundwater flushed from the UP2 Area, which formerly contained Tc-99 at concentrations above the NRC criterion of 3,790 pCi/L. This is the only area which has exceeded the EPA criterion of 900 pCi/L Tc-99 in the recent past. Consequently, post-remediation monitoring in this area must demonstrate that the lower EPA criterion has been achieved.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will therefore consist of at least 12 consecutive quarters of groundwater sampling and analysis. Statistical evaluation of the data must demonstrate that there is a 95% confidence level that COC concentrations are less than 30 µg/L total uranium, 10 mg/L nitrate, 4 mg/L fluoride, and 900 pCi/L Tc-99.

8.8.3 Western Upland Areas

WU-1206

Post-remediation groundwater monitoring for license compliance will not be required for this area, because uranium and Tc-99 concentrations did not exceed license criteria prior to groundwater remediation.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis, with all results yielding less than 30 µg/L total uranium, 10 mg/L nitrate, and 4 mg/L fluoride.

UP1

Post-remediation groundwater monitoring for license compliance will not be required for this area, because uranium and Tc-99 concentrations did not exceed license criteria prior to groundwater remediation.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis, with all results yielding less than 30 µg/L total uranium, 10 mg/L nitrate, and 4 mg/L fluoride.

WU-UP2

Post-remediation groundwater monitoring for license compliance will not be required for this area, because uranium and Tc-99 concentrations did not exceed license criteria prior to groundwater remediation.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis, with all results yielding less than 30 µg/L total uranium, 10 mg/L nitrate, 4 mg/L fluoride, and 900 pCi/L Tc-99.

WU-BA3

Post-remediation groundwater monitoring for license compliance in BA1 will consist of at least 12 consecutive quarters of groundwater sampling and analysis, with all results yielding less than 180 pCi/L total uranium.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis, with all results yielding less than 30 µg/L total uranium and 10 mg/L nitrate.

WU-PBA

Post-remediation groundwater monitoring for license compliance will not be required for this area, because uranium and Tc-99 concentrations did not exceed license criteria prior to groundwater remediation.

Post-remediation groundwater monitoring for compliance with DEQ-stipulated criteria will consist of at least 12 consecutive quarters of groundwater sampling and analysis, with all results yielding less than 30 µg/L total uranium and 52 mg/L nitrate. Fluoride concentrations in groundwater did not exceed the MCL in this area prior to groundwater remediation; consequently, analysis for fluoride will not be performed on post-remediation monitoring samples collected from the WU-PBA.

8.9 DEMOBILIZATION

Demobilization of remediation and water treatment equipment will be performed in phases as groundwater remediation goals and post-remediation monitoring criteria are achieved in various site areas. This section describes the decommissioning activities that will be employed during demobilization. As previously stated, the WA Treatment Facility Building, the Well Field Control Building, and the Office Building will remain onsite following the completion of groundwater

remediation activities. The WA Treatment Facility Building will be subject to a final status survey after all equipment and material used for the removal of uranium from groundwater (via ion exchange) have been removed. A release survey of the Well Field Control Building will not be required since this building will not house impacted groundwater or other radiological materials. The Office Building is located in an area that has been released for unrestricted use, and periodic surveys have demonstrated that the office building has not been impacted by activities performed by the licensee leading up to site decommissioning.

8.9.1 Sequence of Demobilization

The general sequence of groundwater remediation and treatment system shutdown, demobilization, and NRC license compliance is as follows:

- Operation of all WAA and WUA remediation and treatment systems is discontinued when in-process groundwater monitoring results indicate achievement of the uranium DCGL in the WAA "U > DCGL" sub-area for at least two consecutive months. Post-remediation groundwater monitoring begins in the WAA "U > DCGL" sub-area.
- Assuming post-remediation monitoring in WAA "U > DCGL" confirms achievement of the uranium DCGL, the uranium and nitrate treatment systems will be demobilized from the WA Treatment Facility. A final status survey for this facility will be completed. All WAA and WUA groundwater extraction and injection equipment and controls will remain.
- Operation of all BA1 remediation and treatment systems is discontinued when in-process groundwater monitoring results indicate achievement of the uranium DCGL in BA1. Post-remediation groundwater monitoring begins in BA1.
- Assuming post-remediation monitoring in BA1 confirms achievement of uranium DCGL, the BA1 Treatment Facility will be demobilized. A final status survey will be conducted in the area, if required.

The estimate presented in Section 16, Financial Assurance, does not include costs associated with groundwater remediation in the WAA or WUA areas following the shutdown described in #1 above, costs associated with groundwater remediation in BA1 following the shutdown described in #3 above, or costs associated with demobilization after license termination.

8.9.2 Uranium Treatment Units

Prior to demobilization of each uranium treatment train, the resin in all three vessels (lead, lag, and polishing) will be sampled and analyzed for uranium activity. Samples of fresh resin will be

analyzed for uranium concentration and activity to develop a background concentration for resin. Resin yielding total uranium activity less than 2 pCi/g above background will be disposed of as solid waste. Resin yielding total uranium activity greater than 2 pCi/g above background will be processed as described in Sections 8.6.3 and 8.6.4 and shipped for disposal as LLRW. Vessels in the WA Treatment Facility may also be transferred to the BA1 Treatment Facility if the concentration of uranium in the resin indicates it may still be able to adsorb uranium from BA1 groundwater.

Once all resin has been removed from the vessels, empty resin vessels and all process equipment that cannot be surveyed for unrestricted release will be packaged and shipped for disposal as LLRW. Empty resin vessels and all process equipment that can be surveyed for unrestricted release will be surveyed and either released, decontaminated for release (if practical), or packaged and shipped for disposal as LLRW.

8.9.3 Nitrate Treatment Units

Prior to demobilization of each nitrate treatment train, the biomass will be removed from the bioreactor and placed in containers. The biomass will be processed as described in Section 8.6.5, Biodenitrification Systems. The biomass in each container will be sampled and analyzed for uranium activity. Biomass yielding total uranium activity less than 2 pCi/g activity will be disposed of as solid waste. Biomass yielding total uranium activity greater than 2 pCi/g will be shipped for disposal as LLRW.

Once all biomass has been removed from the bioreactor, all process equipment that cannot be surveyed for unrestricted release will be packaged and shipped for disposal as LLRW. Empty vessels and all process equipment that can be surveyed for unrestricted release will be surveyed and either released, decontaminated for release (if practical), or packaged and shipped for disposal as LLRW.

8.9.4 Resin Processing System

The resin processing system will not be demobilized until all uranium treatment systems and biodenitrification skids have been demobilized. Once all processed resin or biomass has been removed from the system and disposed of as described in Sections 8.9.1 and 8.9.2, all process equipment that cannot be surveyed for unrestricted release will be packaged and shipped for disposal as LLRW. Process equipment that can be surveyed for unrestricted release will be

surveyed and either released, decontaminated for release (if practical), or packaged and shipped for disposal as LLRW.

8.9.5 Groundwater Extraction and Injection Infrastructure

Groundwater extraction and injection wells, trenches, piping, and other utilities and equipment will remain in place after NRC license termination to facilitate additional remediation activities required for the achievement of DEQ-stipulated criteria.

As previously stated, groundwater extraction and injection wells will be shut down during the post-remediation monitoring period for the area in which groundwater remediation is believed to be complete. Upon achievement of final remediation criteria, groundwater extraction and injection sumps and wells for each area will be removed, plugged, and abandoned. All groundwater extraction and injection wells will be plugged and abandoned in accordance with OWRB regulations.

Groundwater extraction and injection trenches will not be excavated or removed. The subsurface components including drain piping, gravel backfill, and geotextile will remain in place. Only the extraction trench sumps will be removed, plugged, and abandoned. Prior to abandonment, extraction trench sumps will be used as access points during the in-place plugging and abandonment of extraction trench drain pipes.

Ancillary demobilization and demolition activities such as power and control cable removal/reclamation, well control and cleanout vault removal and backfilling, well pad bollard removal, etc. will also be conducted once these facilities are no longer needed. Subsurface piping and conduits will be cut/capped, and abandoned in place. Final status surveys will not be required for well field groundwater piping and appurtenances because the piping will have conveyed groundwater containing very low uranium concentrations over the vast majority of its operational lifespan. Detailed depictions of subsurface well field piping, conduits, and structures are presented in Drawings BMCD-GWREMED-C105, BMCD-GWREMED-C106, BMCD-GWREMED-C108, BMCD-GWREMED-M102, and BMCD-GWREMED-M103.

Plugging reports for all well and sump abandonments will be filed with OWRB, and copies of plugging reports will be retained in the document repository.

8.9.6 Monitoring Wells

Like groundwater extraction and injection wells, monitoring wells will be removed by area once remediation in that area is complete and approval from both agencies has been obtained. The groundwater monitoring wells in each area will be removed, plugged, and abandoned in accordance with OWRB regulations. Plugging reports will be filed with OWRB, and copies of plugging reports will be retained in the document repository.

8.9.7 Utilities

Electric power lines, control wiring, and piping will be removed from each area in conjunction with the removal of groundwater extraction and/or injection infrastructure. Wire, cables, and piping will be run in trenches which are above the water table, and in soil that has been demonstrated to comply with decommissioning criteria (for unrestricted release). Wire and cables will be considered releasable for unrestricted use, and will be removed for recycling, salvaged, or disposition as solid waste.

Piping will have carried groundwater with concentrations of uranium that have declined over time until the water being pumped through the piping complies with drinking water standards. Accessible piping will be considered releasable for unrestricted use, and will be removed for recycling, salvaged, or disposition as solid waste. Subgrade piping will be cut, capped, and abandoned in place.

8.10 ONGOING REMEDIATION

Should additional remediation be required and sufficient funding is available to perform additional groundwater remediation, additional groundwater assessment will then be conducted, if needed. Remediation alternatives to achieve DEQ criteria will be evaluated. Subsequent remedial action will be based on the best use of available funding. Potential remedial alternatives could include continued groundwater extraction/injection without treatment or with nitrate treatment, monitored natural attenuation (MNA), in-situ bio-immobilization (ISBI), and/or institutional controls (e.g., deed restrictions).

* * * * *

9.0 SCHEDULE

9.1 PRE-CONSTRUCTION

Upon approval of this Plan by both NRC and DEQ, full design drawings and specifications for construction will be prepared. Following quality review of the design documents, bid documents will be prepared and submitted to qualified vendors. Bids will be evaluated, and EPM will propose award of contracts to NRC and DEQ. Upon approval of award selections, contracts will be executed.

It is assumed that agency review of the decommissioning plan and license amendment requests, issuance of requests for additional information (RAIs), responses to RAIs, and approval of this Decommissioning Plan is achieved by the end of the first quarter of 2017. Based on this assumption, contracts for construction and operation of the groundwater remediation and water treatment systems will be executed by the end of 2017.

The schedule presented in Figure 9-1 is based upon the execution of contracts before the end of 2017. A final schedule will be produced upon completion of the final design and receipt of bids.

9.2 CONSTRUCTION AND STARTUP

9.2.1 Groundwater Remediation Facilities

A six-month schedule for construction is aggressive. Installation of treated water injection trenches in the UP1 Area must be completed before the foundation for the Western Area Treatment Facility is poured. Excavation of treated water injection trenches and groundwater extraction trenches will begin immediately upon execution of contracts. Drilling and installation of groundwater extraction and treated water injection wells will also begin immediately. Installation of utility and piping from wells, trenches, and outfalls to treatment facilities will be performed as trench and well installation is completed. Electric utility (OG&E) work will be scheduled immediately or during pre-construction phases to ensure service is available when needed.

Procurement and assembly of groundwater remediation control systems will be performed off site. The control systems will be brought to the site and installed as the water treatment facilities are constructed.

Those monitoring wells located in the 24-acre property which are not needed to perform or monitor groundwater remediation will be plugged and abandoned during construction activities

while a drilling rig is located at the Site. Table 9-1 provides a list of monitoring wells that will be plugged and abandoned during construction.

9.2.2 Water Treatment Facilities

Fabrication and factory testing of uranium treatment skids and fabrication of bioreactors will begin immediately upon execution of contracts. Procurement of resin processing equipment and ancillary equipment needed for nitrate treatment system operation will begin immediately upon execution of contracts.

Site grading for both treatment facilities will begin when construction of the treated water injection trenches in the UP1 Area is complete. Grading and construction of foundations for the Western Area Treatment Facility, influent and effluent tanks, propane tanks, and Burial Area #1 treatment system containers will then be performed.

Construction of the Western Area Treatment Facility building will begin within two weeks after the foundation is poured. Uranium treatment skids, resin processing equipment, and supplies will be installed after the building is erected. Nitrate treatment trains may be installed while the Western Area Treatment Facility building is under construction, as access allows.

The site access road improvements will be constructed upon completion of the Western Area Treatment Facility construction. Utilities will be run to the treatment facilities and groundwater remediation system controls in preparation for startup.

9.2.3 Startup

Groundwater remediation system controls will be tested and flow rates set in accordance with final design requirements. Uranium treatment vessels will be filled with new resin, and groundwater from the influent tanks will be circulated through the treatment trains to adjust flow rates and pressures.

Groundwater will be recycled through bioreactors while innoculants and nutrients are injected. The groundwater will be recirculated through the bioreactors until a viable biological population is established as described in Section 8.3.

Treated water injection systems will be tested, and flow rates set in accordance with final design requirements.

Upon completion of startup activities, full-scale groundwater extraction, treatment, and injection and discharge will begin. It is assumed that full-scale groundwater remediation activities will begin in July 2018.

9.3 WESTERN AREA REMEDIATION

Groundwater extraction, treatment, and treated water injection and discharge will all begin in all the western areas upon completion of startup activities. In-process monitoring will be performed as described in Section 8. Groundwater extraction, treatment, and treated water injection and discharge will continue in the WAA "U > DCGL", WAA "BLUFF", WAA "U < DCGL" WEST, and WAA "U < DCGL" EAST areas as long as in-process monitoring wells in the WAA "U > DCGL" area yield uranium concentrations exceeding the DCGL.

Based upon remediation timeframe calculations, it is anticipated that final remediation criteria will be achieved in the Process Building Area near the end of 2018. Post-remediation monitoring could be performed, and the remaining Process Building Area wells plugged and abandoned. This work was not included in the schedule or cost estimate, so these wells would be available at license termination should DEQ desire to obtain data from some or all of these wells at license termination.

Based upon remediation timeframe calculations, it is anticipated that final remediation criteria will be achieved in Burial Area #2 near the middle of 2020. As with the Process Building Area, post-remediation monitoring could be performed, and the remaining Burial Area #2 wells plugged and abandoned. This work was not included in the schedule or cost estimate, so these wells would be available at license termination should DEQ desire to obtain data from some or all of these wells at license termination.

The Process Building Area and Burial Area #2 are the only areas which are expected to achieve final remediation goals before all wells in the WAA "U > DCGL" area yield uranium concentrations less than the DCGL area. This is projected to occur near the end of 2020. At that time, groundwater extraction, treatment, and treated water injection and discharge will be terminated in all western areas, so groundwater can return to static conditions during post-remediation monitoring.

Uranium and nitrate treatment trains will be drained, but will be maintained in case post-remediation monitoring indicates that additional treatment is needed. The resin processing system will continue to be used to process spent resin from the BA1 Treatment Facility for shipment to a LLRW disposal facility. Vessels containing fresh or partially-spent resin will be retained for use in the BA1 Treatment Facility.

Assuming that post-remediation groundwater monitoring demonstrates that license criteria have been met, and resumption of groundwater treatment is not required, post-remediation monitoring for the western areas is anticipated to be completed near the end of 2023.

9.4 BURIAL AREA #1 REMEDIATION

Groundwater extraction, treatment, and treated water injection and discharge will all begin in Burial Area #1 upon completion of startup activities. In-process monitoring will be performed as described in Section 8. Groundwater extraction, treatment, and treated water injection and discharge will continue as long as in-process monitoring wells in the BA1 "U >DCGL" area yield uranium concentrations exceeding the DCGL.

Based upon remediation timeframe calculations, it is anticipated that final remediation criteria will be achieved in Burial Area #1 near the end of 2026. At that time, groundwater extraction, treatment, and treated water injection and discharge will be terminated throughout Burial Area #1, so groundwater can return to static conditions during post-remediation monitoring. The uranium treatment train will be drained, but will be maintained in case post-remediation monitoring indicates that additional treatment is needed.

Assuming that post-remediation groundwater monitoring demonstrates that license criteria have been met, and resumption of groundwater treatment is not required, post-remediation monitoring for Burial Area #1 is anticipated to be completed near the end of 2029.

9.5 LICENSE TERMINATION ACTIVITIES

"License Termination Activities", as used in this plan, involve the decontamination, dismantling, and demobilization of groundwater treatment facilities, as well as the surveys and dose modeling that are required to demonstrate that the Site can be released for unrestricted use. License termination activities also include the responses to RAIs through the termination of the license.

9.5.1 Decontamination and Dismantling

When post-remediation groundwater monitoring demonstrates that groundwater in the WAA "U > DCGL" and BA1 "U > DCGL" Areas complies with the license release criteria, decontamination and dismantling (D&D) activities will commence. Anion resin and biomass will be removed from treatment systems. Anion resin and biomass that contains detectable concentrations of uranium will be processed, packaged, and shipped for disposal as LLRW. All other resin and biomass will be disposed of as solid waste.

Water treatment equipment, including resin and biomass processing equipment, will be surveyed as practical and either salvaged, disposed of as solid waste, or packaged and disposed of as LLRW. Instruments and sources used for radiation protection will be transferred to the Site office. All materials will be removed from both treatment areas except influent and effluent tanks and well field controls.

9.5.2 Residual Dose Model

A residual dose model will be prepared based on post-remediation groundwater monitoring data and soil data extracted from final status survey reports for Subareas F, H, M, and O. It is anticipated that the dose model will demonstrate that the residual dose is less than 25 mrem/yr.

9.5.3 Final Status Survey

A final status survey plan will be prepared and submitted for approval prior to termination of groundwater remediation. The final status survey will be performed after all treatment system equipment slated for removal has been demobilized. Submittal of the final status survey report is anticipated to occur approximately one year after demobilization is complete.

9.5.4 Request for License Termination

A request for termination of license SNM-928 will be submitted with the final status survey report. It is anticipated that agency review of the final status survey report, dose model, and license termination request, RAIs, and review of responses to RAIs achieve termination of the license approximately six months after submittal of the license termination request.

The license termination process is anticipated to require over a full year, extending to late 2030.

9.6 FINAL REMEDIATION

This section presents a preliminary schedule for work to be performed following termination of License SNM-928. It is presented in this Plan to provide assurance that subsequent groundwater remediation performed to achieve DEQ criteria for unrestricted release will not involve the use of a technology that could accumulate licensable quantities of uranium.

A meeting will be conducted with DEQ to determine if an updated groundwater assessment is needed and if so, to develop the scope of that assessment. Once the residual dose model and final status survey report are complete, groundwater assessment can be initiated. It is assumed that four quarters of groundwater data will be required, so that groundwater assessment will require a full year, ending early 2032.

Upon completion of the groundwater assessment, an evaluation of groundwater remediation alternatives will be performed. Alternatives will include:

- No further action
- Monitored natural attenuation
- In situ biological immobilization
- Pump and discharge without treatment
- Institutional controls

It is assumed that six months will be required to finalize the evaluation of alternatives, and another six months to obtain approval of a remediation strategy. The final groundwater remediation project would then begin late in 2032.

9.7 SCHEDULE CHANGES

The schedules provided in this section are presented as reasonable estimates. However, significant experience in groundwater remediation shows that the basis for cost and schedule estimates (e.g., groundwater flow models, distribution coefficients, and pore volume estimates) at best approximate highly complex and variable natural systems. Groundwater remediation often progresses more slowly than even the most sophisticated and well-calibrated numerical models would suggest. In addition, circumstances can change during decommissioning. The amount and distribution of precipitation and numerous other factors can significantly impact the schedules presented in this decommissioning plan. It is unlikely that decommissioning will precisely follow the schedule submitted herein.

The licensee will provide semi-annual schedule updates based primarily upon the following factors:

- The date of approval of the Decommissioning Plan
- Contract execution and the construction and startup of the groundwater remediation system
- Trends observed in in-process and post-remediation groundwater monitoring

The schedules presented herein do not comply with the two-year time frame for decommissioning specified in 10 CFR 70.38(g)(4)(vii). The schedules presented herein demonstrate the need for an alternative schedule in accordance with 10 CFR 70.38(g)(2). The licensee herein requests NRC approval of an alternative schedule.

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10.0 PROJECT MANAGEMENT AND ORGANIZATION

10.1 DECOMMISSIONING MANAGEMENT ORGANIZATION

Upon approval of the decommissioning plan, remediation activities will be broadly performed in four phases:

- Construction and startup of groundwater remediation facilities
- Groundwater remediation operations (for license termination)
- License termination
- Groundwater remediation operations (for site disposition)

A broad organization chart depicting the decommissioning management organization from construction, through operations, and to license termination is presented in Figure 10-1. The Trust Administrator is responsible for the management of Trust assets and provides the resources needed to complete the decommissioning of the site.

The Trustee Project Manager (Trustee PM) is responsible for overseeing the construction and operation of decommissioning systems, the implementation of the radiation safety, health and safety, quality assurance, and environmental compliance programs. The PM may maintain and implement the environmental compliance program, or may retain a third party to undertake that responsibility.

The Radiation Safety Officer (RSO) is responsible for the maintenance and implementation of the radiation protection program. The RSO reports to the Trustee PM, but also has a direct communication line to the Trust Administrator.

The Quality Assurance Coordinator (QAC) is responsible for the maintenance and implementation of the quality assurance program. The QAC reports to the Trustee PM, but also has a direct communication line to the Trust Administrator.

Project Managers and Activity Leaders (ALs) will direct various decommissioning activities. An engineering, procurement, and construction Lead (EPC Lead) will be responsible for the construction, installation, and startup of the groundwater remediation and water treatment systems. An AL will be responsible for operation of the groundwater extraction and injection system. An AL will be responsible for operation of the water treatment system. A PM or AL will be responsible for the development and implementation of all post-license termination groundwater assessment and remediation activities.

Individuals with responsibility at the levels described above (Trustee PM, RSO, QAC, and AL) are given authority to ensure that decommissioning activities are conducted in a safe manner. Routine activities will be performed in accordance with written procedures approved by the appropriate PM/AL and the QAC. Procedures involving work with radioactive material or in radiologically restricted areas will also require the approval of the RSO. Non-routine activities will be performed in accordance with activity plans approved by the PM, the AL, and the QAC. As with procedures, if an activity plan involves work with radioactive material or in radiologically restricted areas, it will also require the approval of the RSO.

10.2 DECOMMISSIONING TASK MANAGEMENT

10.2.1 Construction and Startup

The construction, installation, and startup of groundwater remediation will be managed as a project, directed by the Lead EPC Contractor. Figure 10-2 depicts the organization and reporting hierarchy of subcontractors and suppliers that will be engaged in the construction and installation of groundwater remediation and water treatment facilities.

The construction project will be broadly broken into two separate but interfaced projects:

- Groundwater extraction and treated water injection and discharge systems
- Water treatment facilities and systems

The EPC Lead will oversee the management of each of the two construction projects. The EPC Lead will oversee the procurement of subcontractors and materials related to utility infrastructure, permits, and project management facilities and systems. Each of the two separate projects will be managed by a Project Manager who is responsible for the fabrication of designed components, the procurement of materials, and the construction and installation of systems for each individual project.

Construction and installation of groundwater remediation infrastructure and water treatment systems will not involve working with radioactive material or work in radiologically restricted areas. Most groundwater extraction and injection wells and trenches, as well as most piping and utility runs and both water treatment facilities, will be constructed in areas that have already been released for unrestricted use. Both surface and subsurface soils have been demonstrated to comply with license criteria for unrestricted use.

The RSO will be responsible for the implementation of the radiation protection program as it relates to construction and decommissioning activities. The RSO will review for approval activity plans and procedures which involve the handling, processing, possession, transportation, or disposal of radioactive material. Health physics technicians will scan soils generated by drilling borings for well installations, trenches dug to run piping and/or utilities, soils generated by excavation of groundwater extraction and/or injection trenches, and soils excavated for water treatments system facilities, as directed by the RSO.

The QAC will direct observations and audits of procurement, construction, and radiation protection activities to ensure that is performed in accordance with:

- License requirements
- This decommissioning plan
- Radiation Protection Plan and procedures
- Quality Assurance Plan and procedures
- Health and Safety Plan and procedures
- Activity plans
- Any other task-specific work instructions governing the work

Upon completion of construction activities, the EPC Lead will be responsible for the compilation of documentation demonstrating compliance with design requirements. The RSO will be responsible for the compilation of documentation demonstrating compliance with license and regulatory requirements. The QAC will be responsible for the compilation of documents verifying that the quality requirements were inspected and complied with.

10.2.2 Groundwater Remediation Operations

Upon completion of startup activities, the decommissioning organization will transition from a project organization to an operations organization. Figure 10-3 presents an organization chart and reporting hierarchy for decommissioning operations.

The EPM Project Manager will be responsible for all decommissioning activities.

An AL will be responsible for operating and maintaining groundwater extraction and treated water injection and discharge as well as collection and analysis of in-process groundwater monitoring samples. An AL will be responsible for operating and maintaining groundwater treatment and resin and biomass processing and packaging, as well as collection and analysis of in-process water

treatment samples. An AL will be responsible for the transportation and disposal of wastes. A single AL may be responsible for one or more of these activities. Engineers or water treatment specialists will evaluate in-process groundwater and water treatment monitoring results to evaluate the need for modifications to systems or processes. Personnel filling these positions will report directly to the Project Manager.

The Radiation Safety Officer will be responsible for the implementation of the Radiation Protection Plan and implementing procedures. All health physics leads and technicians will report directly to the RSO. The RSO will report directly to the Project Manager, but will also have a direct line of communication with the Trust Administrator.

The Quality Assurance Coordinator (QAC) will be responsible for the implementation of the Quality Assurance Project Program and implementing procedures. Individuals utilized to perform audits and observations will report directly to the QAC. The QAC will report directly to the Project Manager, but will also have a direct line of communication with the Trust Administrator.

Environmental Compliance activities, consisting of compiling data, preparing discharge monitoring reports and other permit-required reports, may be performed or overseen by another AL, by personnel reporting to the QAC, or by the AL responsible for groundwater extraction and disposal.

Groundwater extraction and transfer operations, water treatment, resin and biomass processing and packaging, treated water injection and discharge, and in-process monitoring will be performed in accordance with operating procedures. Should the need for a non-routine activity arise, an activity plan will be prepared to provide work instructions covering that activity. Examples of non-routine activities that may be performed during remediation operations include:

- Modification of the groundwater extraction or injection infrastructure
- Demobilization of a uranium treatment or biodenitrification system
- Plugging and abandonment of monitoring wells and/or groundwater remediation infrastructure in discrete areas

10.2.3 License Termination

When post-remediation monitoring wells in all areas yield uranium concentrations less than the DCGL for eight consecutive quarters, license termination activities will begin. The

decommissioning organization will transition from an operations organization to a project organization. Figure 10-4 presents an organization chart and reporting hierarchy for license termination activities.

The Trustee Project Manager will be responsible for the performance of all decontamination and demobilization, the disposition of all wastes, the plugging and abandonment of portions of the groundwater remediation infrastructure, and the conduct of final status surveys. Groundwater remediation infrastructure will remain in place where the concentrations of COCs exceed the remediation goals stipulated in Section 4.3.

Activity Leaders will manage the decontamination of contaminated or potentially contaminated materials, the segregation of materials for disposal, the plugging and abandonment of wells and/or trenches, and the performance of final status surveys in the Western Treatment Facility. No groundwater treatment facilities will be left in Burial Area #1 after decommissioning criteria have been met.

Groundwater remediation infrastructure, including pump controls, influent tanks, and discharge infrastructure, will remain in place, pending continued use to meet DEQ remediation goals stipulated in Section 4.3.

The RSO will be responsible for the implementation of the radiation protection program, the calibration and qualification of instrumentation, and the evaluation of data demonstrating compliance with decommissioning criteria. The RSO will also be responsible for the development and implementation of a final status survey plan as well as the preparation of the final status survey plan and the final residual dose model.

The QAC will be responsible for audits and observations of decontamination, waste packaging and disposal, and final status survey activities.

10.2.4 Groundwater Remediation (for Site Disposition)

Upon termination of the license, there will be no radiation safety organization for ongoing activities. EPM will consult with DEQ regarding the work needed to finalize the approach to complete groundwater remediation. Project activities may include:

- Groundwater assessment
- Remedial technology evaluation

- Preparation and implementation of a plan to complete groundwater remediation

The EPM Project Manager will be responsible for all groundwater remediation activities.

Activity Leaders will be responsible for developing and implementing work plans needed to evaluate and implement groundwater assessment and remediation plans. Activity Leaders will report directly to the Project Manager.

The Quality Assurance Coordinator (QAC) will be responsible for the implementation of the Quality Assurance Project Program and implementing procedures. Individuals utilized to perform audits and observations will report directly to the QAC. The QAC will report directly to the Project Manager, but will also have a direct line of communication with the Trust Administrator.

10.3 DECOMMISSIONING MANAGEMENT POSITIONS AND QUALIFICATIONS

10.3.1 Trust Administrator

The Trust Administrator is responsible for the management of Trust assets and provides the resources needed to complete the decommissioning of the site. The Trust Administrator monitors and reports the financial status of the Trust accounts. The Trust Administrator is responsible for the preparation of periodic decommissioning funding cost estimates and annual budgets. The Trust Administrator is a permanent member of the site ALARA Committee.

The Trust Administrator reports directly to the President of the Trustee of the Cimarron Environmental Response Trust. The Trust Administrator must have experience managing organizations responsible for radiological decommissioning and environmental remediation, as well as overseeing the preparation of financial reports and cost estimates.

10.3.2 Trustee Project Manager

The Trustee Project Manager (Trustee PM) is responsible for overseeing the construction and operation of decommissioning systems, the implementation of the radiation safety, health and safety, quality assurance, and environmental compliance programs. The Trustee PM is responsible for ensuring that all personnel performing decommissioning activities, or working in radiation protection, health and safety, quality assurance, or environmental compliance functions receive training and have the skills and experience required to perform those functions. In conjunction with the Trust Administrator, the Trustee PM prepares decommissioning cost

estimates and annual budgets. The Trustee PM is a permanent member of the site ALARA Committee.

The Trustee PM reports directly to the Trust Administrator. The Trustee PM must have experience in the following areas:

- Complying with license and regulatory requirements
- Complying with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs
- Preparing and tracking work scopes and cost and schedule plans
- Managing radiological decommissioning projects
- Overseeing radiation protection, quality assurance, and environmental compliance programs
- Overseeing radiological characterization and final status surveys

10.3.3 Radiation Safety Officer

The Radiation Safety Officer (RSO) is responsible for the maintenance and implementation of the radiation protection program. The RSO is responsible for the review and revision of the Radiation Protection Plan and procedures, radiation exposure monitoring, dose reporting, the radiological instrument program, and all levels of radiation training. The RSO is responsible to ensure that all activities comply with license requirements, chair the site ALARA Committee, and manage the health physics staff. The RSO is given specific authority to implement and manage the licensee's radiation protection program, either directly or through qualified individuals who are designated in writing as having authority to exercise specific functions. All radiation protection personnel have stop work authority.

The RSO reports directly to the Trustee PM, but also has a direct communication line to the Trust Administrator. The RSO must have the following qualifications:

- Maintain certified health physicist (CHP) registration
- Experience managing radiation protection programs
- Background in license compliance
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs

- Experience in performing ALARA evaluations
- Overseeing radiological characterization and final status surveys
- Experience in decontamination and decommissioning projects

10.3.4 Quality Assurance Coordinator

The Quality Assurance Coordinator (QAC) is responsible for the maintenance and implementation of the quality assurance program. The QAC performs or schedules periodic and/or ad hoc audits and observations of all decommissioning and program management functions. All quality assurance personnel have stop work authority. The QAC is also responsible to perform periodic evaluations of the effectiveness of the quality assurance program and to ensure that all personnel performing quality-critical tasks have received the appropriate level of training on the site-specific quality assurance program. The QAC is a standing member of the site ALARA Committee.

The QAC reports to the Trustee PM, but also has a direct communication line to the Trust Administrator. The QAC is required to have the following qualifications:

- Experience in managing quality control / quality assurance programs
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs
- Familiarity with data verification and validation protocols

10.3.5 Project Manager

Project Managers (PMs) will be responsible for the preparation of plans, procurement of services and materials, and the performance of decommissioning projects. PMs will ensure that all personnel working on projects have received all the training needed and are qualified to perform the tasks for which they are responsible to perform. PMs are responsible for monitoring the schedule, cost, and quality of the project work.

Project Managers report directly to the Trustee PM. They are indirectly responsible to the RSO and QAC. Project Managers must meet the following qualifications:

- Experience managing environmental assessment and remediation projects
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs

- Experience in the preparation and tracking of work scopes and cost and schedule estimates
- Experience managing resources to perform work within schedule and budget, while maintaining quality and regulatory compliance

10.3.6 Activity Leader

Activity Leaders (ALs) will be responsible for the preparation of activity plans, procurement of services and materials, and the performance of decommissioning operations. ALs will ensure that all personnel working on projects are familiar with the activity plan under which the work is being performed, and that they have received all the training needed and are qualified to perform the tasks for which they are responsible to perform. ALs are responsible for monitoring the schedule, cost, and quality of the project work.

Activity Leaders report directly to the Trustee PM. They are indirectly responsible to the RSO and QAC. Activity Leaders must meet the following qualifications:

- Experience managing environmental assessment and remediation operations
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs
- Ability to prepare activity plans and manage work performed in accordance with activity plans
- Experience managing resources to perform work within schedule and budget, while maintaining quality and regulatory compliance

10.4 DECOMMISSIONING AND SAFETY COMMITTEES

The ALARA Committee ensures that procedures and engineering controls used are based upon sound radiation protection principles to achieve occupational doses and dose to members of the public that are ALARA. The ALARA Committee will meet at least once per quarter. The responsibilities of the ALARA Committee include:

- Ensuring that ALARA policy and regulatory compliance are integrated into all site work activities as appropriate
- Reviewing and approving ALARA goals for the Cimarron Site (if individual monitoring is required)

- Reviewing the effectiveness of the ALARA Program (if individual monitoring is required)
- Reviewing plans for new activities to ensure that ALARA principles have been considered
- Annual review of the RPP to ensure compliance and to incorporate any necessary changes
- Evaluate and approve changes to the Decommissioning Plan or the RPP in accordance with License Condition 27(e)

ALARA Committee meetings will include reports on the following aspects of decommissioning work:

- Radiological exposures
- Active activity plans
- Quality control / quality assurance performance issues
- Chemical concerns
- Health and safety performance and issues
- Radiological waste characterization and disposal

The ALARA Committee will be chaired by the RSO, and report directly to the Trust Administrator. The ALARA Committee will also have a direct line of communication with the President of the Trustee of the Cimarron Environmental Response Trust.

10.5 TRAINING

Radiation Safety Training requirements are tiered to provide an appropriate level of training based on the type of radiological work and individual will perform at the Cimarron Site. The Trustee shall not assume that radiation safety training has been adequately covered by prior employment or academic training.

Ancillary personnel (e.g., clerical, housekeeping, security, etc.) whose duties may require them to work in the vicinity of radioactive material (escorted or not) shall receive information about radiation hazards and the appropriate precautions.

A prospective evaluation of radiological conditions and potential doses to workers during the groundwater remediation process will be performed. Based on this evaluation, the RSO will determine the need for General or Site Specific Training or Radiation Worker Training.

Radiological orientation is provided for individuals performing routine activities that do not require access into Restricted Areas, including general office work, housekeeping, tours and inspections of

the property, annual environmental monitoring campaigns, and installation of new monitoring wells. Radiological Orientation is required prior to unescorted access to the Cimarron Site.

General or Site Specific Training is required for workers who require unescorted access to Restricted Areas. This training will include the principles and practices of radiation protection, the purpose and functions of protective and monitoring devices that will be used (if applicable), and protection for the embryo/fetus (if applicable).

Radiation Workers are individuals who in the course of employment are likely to receive an annual radiation dose greater than 100 mrem, or whose duties require them to routinely work in a Restricted Area or routinely handle radioactive material. Radiation Worker training will include:

- General or Site Specific Training
- Radioactivity measurements, monitoring techniques, and usage of monitoring instrumentation
- Basic calculations involved in using and measuring radioactivity
- Types of radiation, range and effects
- Regulatory and site specific dose limits to the general public and occupationally exposed persons
- Storage, transfer, or use of radiation and/or radioactive material
- Precautions or procedures to minimize exposure;
- Purposes and functions of protective devices employed;
- Regulatory and license requirements for the protection of personnel from exposure to radiation and/or radioactive material;
- Workers' responsibility to report promptly any condition which may lead to or cause a violation of regulatory or licenses requirements or unnecessary exposure to radiation or radioactive material
- Appropriate response to warnings in the event of any unusual occurrence or malfunction that may involve exposure to radiation and/or radioactive material
- Radiation exposure reports

All personnel performing decommissioning activities will receive training on the site-specific health and safety program, the quality assurance program, and the sampling and analysis plan, as appropriate. Personnel performing decommissioning activities will be task-qualified for the activities they will perform (e.g., trained on those procedures associated with groundwater sampling, documentation, and packaging and shipping if performing groundwater sampling). Personnel

performing activities under an activity plan will also be trained on the requirements of the activity plan.

Prior to performing a task the first time, supervisors will generate and the work crew will review a Pre-Task Safety Analysis identifying potential radiological and non-radiological hazards and measures that will be implemented to mitigate or minimize the hazard. Supervisors then meet with all personnel performing decommissioning activities on a daily basis. Issues identified the previous day will be identified and measures taken to improve safety, quality, or efficiency will be recorded. The Pre-Task Safety Analysis and the record of daily (e.g., tailgate) meetings will be documented on Form C-10E and maintained in the site files.

10.6 CONTRACTOR SUPPORT

All decommissioning tasks will be performed by contractors. The Trust Administrator and the Trustee PM will retain companies that will provide the resources for each position (e.g., RSO, QAC), project (e.g., construction, assessment), and operation (e.g., groundwater extraction, water treatment). All contractors must be qualified by evaluation by both the Trustee and the QAC. Contracts will require monthly reports on activities completed, cost and schedule status, activities to be performed during the next month(s), and issues identified and/or resolved during the reporting period.

All contractors will report directly to the Trustee PM. Contractor managers (e.g., RSO, QAC, EPC Lead, PMs, and ALs) will be responsible to ensure that their personnel receive training as described above, commensurate with the work they will perform. All contractor personnel will have stop work authority if conditions, procedures, or the working practices threaten the safety or quality of the work.

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11.0 RADIATION PROTECTION PROGRAM

This section discusses the Site radiation protection program (RPP) that will be implemented during decommissioning (extraction and treatment of uranium-impacted groundwater), specifically related to radiation safety controls and monitoring for workers. The licensee implemented a RPP that was approved by the NRC in Amendment 15 to the Site's license, SNM-928. Since NRC approval, the RPP has been revised in accordance with License Condition 27(e) numerous times, each time reflecting changing conditions at the site. Each year, evaluations performed by the ALARA Committee approving those changes, along with updated versions of the RPP, have been submitted to NRC, and have been reviewed during the numerous NRC inspections conducted since Amendment 15 established the change process.

To prepare for the extraction and treatment of uranium-impacted groundwater, several changes have been incorporated into the RPP. The sections "Radioactive Materials Control" and "Contamination Control" have been revised to monitor the extraction and treatment of groundwater containing low levels of licensed radioactive material to prevent the spread of contamination to other areas of the site, which would then require re-characterization and possible additional decommissioning. A section on material control and accountability has been added to the RPP to address radiological hazards associated with this processing. The quantity of special nuclear material being generated will be monitored to maintain compliance with the license possession limit of 1,200 grams of U-235, and to achieve the fissile exemption for all LLRW packaged for transportation and disposal. The section "Environmental Monitoring" addresses the sampling and analysis of environmental media until it is superseded by in-process (and subsequent post-remediation) monitoring.

Radiation protection (RP) procedures have been developed to provide consistent, effective performance of effluent monitoring, contamination control, and dose rate monitoring. RP procedures include the sampling and analysis of influents and effluents to monitor the accumulation of SNM in resins, the sampling of loaded resin and biomass for waste characterization, and the sampling, analysis, handling, storage, manifesting, transportation, and disposal of LLRW.

Operating procedures will address the removal and packaging of spent resin and biomass, replacement of resin, the operation and maintenance of groundwater extraction and injection systems, and the operation and maintenance of the water treatment system(s).

11.1 AIR SAMPLING PROGRAM

The air sampling program for the Cimarron Site is described in the RPP, which requires that air samples be collected whenever airborne radioactivity levels are expected to exceed 10 percent of the

Derived Air Concentration (DAC) as listed in Appendix B, Table 1 "Occupational Values" of 10 CFR 20. Considering the types of work activities described in this Decommissioning Plan, airborne suspension of licensed radioactive material is not anticipated to generate airborne radioactivity approaching 10% of a DAC. These activities include:

- Construction of water treatment and storage facilities, excavation of trenches for piping and/or utilities, and construction of new roads and improvement of existing roads will all take place in areas where soils have been demonstrated to comply with criteria for unrestricted release. Nearly all of these activities will occur in areas which have been released from License SNM-928. Installation of groundwater extraction and injection wells borings, as well as excavation of groundwater extraction trenches, will occur in two zones:
    - Unsaturated soils which comply with criteria for unrestricted release and will not generate airborne radioactivity during work activities.
    - Saturated soils where groundwater may exceed unrestricted release criteria, but do not have the potential for generating airborne radioactivity during work activities.
- Operation of the groundwater extraction and treatment systems are not expected to generate airborne radioactivity. Operation of treated water discharge and irrigation involves water that complies with drinking water criteria and cannot generate airborne radioactivity.
- Influent and effluent sampling involves the collection of liquid streams, where there is no potential for generation of airborne radioactivity. The same holds true for collection of in-process and post-remediation groundwater sampling.
- Removal and processing of treatment media (resin and biomass) involves the handling and packaging of moist material containing SNM. Due to the moisture of the treatment media, airborne radioactivity is not expected to be generated. Because the treatment media represents the only material for which a potential for exposure exists, the removal and processing of treatment media will be evaluated for potential airborne exposure.

General area (GA) air sampling, using low or high volume portable air samplers, will be performed throughout the resin unloading and packaging process for at least the first three resin exchanges. Following analysis of the air sample results from these resin exchanges, the RSO will determine the need and frequency of additional air sampling. Selection of air samplers is based on the following criteria:

- GA air sampling will be accomplished by using air samplers as discussed above. Sampling heads will be placed in the work zone so the air sample is representative of the air breathed by the individual worker.
- GA air samplers typically sample at a rate of approximately 3 - 25 liters per minute (LPM) for a low-volume sampler to 70 cubic feet per minute (CFM) for a high-volume sampler. Based on the nature of the low enriched uranium encountered, the detection capability of the air sampling equipment and associated radiological analysis (e.g., sample counting) will be evaluated to determine the total volume of air needed to detect 10% of the DAC. The enrichment of the uranium will be based on either the actual enrichment being collected on the resin or a conservative basis (i.e. 4%). This calculation will be documented in a site procedure or technical basis document. As the actual enrichment of recovered uranium in each area (i.e., WA or BA1), 10% DAC may be recalculated. Minimum collection times will be determined so adequate sensitivities are achieved for a given monitoring period.
- The need for air sampling will be prospectively determined based on the final process system design and potential for generation of airborne radioactivity. Due to the chemical and physical nature of the uranium-bearing media (e.g., water and moist ion exchange resin), minimal, if any, airborne radioactivity is expected to be generated. Engineering and physical controls incorporated into the process equipment design will also be considered in determining the need for air monitoring.
- The frequency of calibration of the flow meters on the air samplers will be based on manufacturers' recommendations (typically annually).
- Action levels will be developed that will include specific action levels (i.e., specific projected or actual airborne radioactive material concentration levels) for assigning respiratory protection, collecting bioassay samples, and stopping work.

Air samples will be counted on-site using existing laboratory bench top scalers (e.g., Ludlum Model 3030 or similar equipment). Minimum detectable activities (MDAs) based on various sample count times will be calculated and used to determine the sample volume needed to detect less than 10% DAC for 3% enriched uranium. This information will be documented and used to determine the minimum sampling time for lapel air samplers.

11.2 RESPIRATORY PROTECTION

The RPP states that the need for respiratory protection, for radiological work, is not envisioned at the Cimarron Site. However, if work activities are encountered that could potentially expose workers to

40 or more DAC-hours in a week, respiratory protection will be required. Respiratory protection will also be required for any areas where airborne radioactive material concentrations are expected to exceed 1 DAC. If either of these trigger levels are encountered, the RPP will be revised, and a respiratory protection procedure (or procedures) will be established that includes:

- Process controls, engineering controls, or procedures to control concentrations of radioactive materials in air
- Evaluations performed when it is not practical to apply engineering controls or procedures
- Considerations used to demonstrate respiratory protection equipment is appropriate
- Required medical screening and fit testing
- Use, maintenance, and storage of respiratory protection devices
- Respiratory protection training program
- Selection of respiratory protection equipment

11.3 INTERNAL EXPOSURE DETERMINATION

Based on anticipated radiological work involving extraction and treatment of groundwater at the Site, a bioassay program is not warranted. If radiological conditions change or evaluation of the final groundwater processing equipment design indicates that an individual worker could be exposed to 2% of the annual limit on intake (ALI) in a year, then bioassay will be performed. Bioassay will be performed, whenever a calculated intake of 40 DAC-hours occurred in any one incident based on air sampling data, accident conditions, equipment failure, external contamination, or other conditions. Bioassay sampling will also be performed whenever it is likely that an individual may have received an intake of 10 milligrams of uranium in any one week. In addition to the requirements set forth in the RPP, RP procedures include requirements for how worker intakes are determined:

- Using measurements of quantities of radionuclides excreted from, or retained in the human body.
- By measurements of the concentrations of airborne radioactive materials in the workplace.
- For an adult, a minor, and a declared pregnant woman using any combination of the measurements above, as may be necessary.

RP procedures also describe how worker intakes are converted into committed effective dose equivalent.

11.4 EXTERNAL EXPOSURE DETERMINATION

Individual monitoring for external exposure is not expected to be required during groundwater extraction and processing and related activities. Passive area radiation monitoring using thermoluminescent dosimeters (TLDs) or optically stimulated luminescent dosimeters (OSLDs) will be performed to demonstrate that individuals will not exceed the requirements for individual monitoring provided in the RPP. However, as discussed in the RPP, individual monitoring devices will be assigned if any of the following conditions are encountered or expected to be encountered:

- Any individual is likely to receive, from radiation sources external to the body, a dose in excess of 10 percent of the 10 CFR Part 20 occupational dose limits in a year.
- Any minor is likely to receive, in 1 year, from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem a lens dose equivalent in excess of 0.15 rem, or a shallow dose equivalent to the skin or the extremities that exceeds 0.5 rem.
- A declared pregnant woman is likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent that exceeds 0.1 rem.

In addition to the requirements set forth in the RPP, RP procedures describe the type, range, sensitivity, and accuracy of required of individual-monitoring devices. RP procedures also include a description of the action levels for worker's external exposure, and the technical bases and actions to be taken when they are exceeded.

Because non-uniform external radiation fields are not expected to be encountered at the Site, RP procedures do not address the use of extremity and whole body monitors in these situations. Additionally, procedures do not require audible-alarm dosimeters and pocket dosimeters due to low external dose rates that will be encountered during groundwater processing. Determining external dose from airborne radioactive material is not required as the only radionuclides encountered will be uranium isotopes. Area dosimeters and job-specific surveys will be conducted to determine the need for supplemental personnel monitoring.

11.5 SUMMATION OF INTERNAL AND EXTERNAL EXPOSURE

As provided in the RPP, internal and external doses are summed whenever positive doses are measured. Records of total effective dose equivalent and total organ dose equivalent for monitored workers are maintained by the Trust. RP procedures will be used to document the methodology for the summation of internal and external doses to workers and internal dose contribution from maternal intakes to the embryo/fetus of a declared pregnant worker. As provided in the RPP, RP procedures

require internal monitoring for any declared pregnant worker who is likely to receive during the entire pregnancy, a committed effective dose equivalent exceeding 0.1 rem.

As required by the RPP, RP procedure provide for the preparation, retention, and reporting of records for occupational radiation exposures.

11.6 CONTAMINATION CONTROL PROGRAM

As described in the RPP, the contamination control program is designed to prevent and/or minimize the spread of radioactive contamination to individuals, areas, and equipment. Control of radioactive surface contamination prevents or minimizes possible inhalation or ingestion of radioactivity by personnel, skin dose from small particles of radioactivity, and the spread to or build-up of radioactivity in the facility or environment from decommissioning operations. Controls to prevent the spread of contamination will be proposed by the Activity Leaders and approved by the RSO or designee prior to implementation. In addition, RP procedures provide for appropriate surveys to supplement personnel monitoring for workers during groundwater treatment operations and licensed activities and surveys will be performed to determine the baseline of background radiation levels and radioactivity from natural sources for areas where these activities will take place.

The RPP describes contamination action limits, and includes actions taken to decontaminate a person, place, or area, restrict access, or modify the type or frequency of radiological monitoring.

The contamination control program will control contamination in groundwater, resin, and biomass. Due to the low concentrations of licensed material in groundwater and biomass, contamination action levels should never be approached. Conservative action levels will be established for resin in lead vessels. Contamination surveys will be performed at appropriate frequencies and stop work levels will be established to prevent the spread of contamination to clean areas.

11.7 INSTRUMENTATION PROGRAM

The RPP lists the radiation protection instrumentation program at the Site. The RPP also addresses instrument calibration. Procedures provide implementing requirements for the program and a series of desk instructions provide guidance for using specific instruments, including the following information:

- Instrumentation storage, calibration, and maintenance facilities for instruments used in field surveys

- The method used to estimate the MDC or MDA (at the 95 percent confidence level) for each type of radiation to be detected
- Instrument calibration and quality assurance

Survey plans may be developed for the release of property or equipment associated with non-routine activities. Such surveys plans will include the methods used to estimate uncertainty bounds for each type of instrumental measurement.

11.8 NUCLEAR CRITICALITY SAFETY

The potential for a nuclear criticality event during the proposed decommissioning program at the Cimarron site is extremely unlikely because the concentration of uranium in material generated during decommissioning are low. Treatment of groundwater to remove the enriched uranium content will result in a more concentrated form of uranium on the ion-exchange resin. This step of the process will be evaluated by an analysis to demonstrate nuclear criticality safety. Nuclear criticality safety during decommissioning will be assured by the following:

11.8.1 Groundwater Handling and Storage

The highest concentration of uranium in the groundwater is in the BA1 area. During the 2013 treatability test, the highest measured uranium concentration from BA1 was 5,110 µg/L. At 2% enrichment, this is equivalent to 102 µg of fissile material per kg of non-fissile material. This is nearly 5,000 times less concentrated than the definition for fissile exempt material (500,000 µg of non-fissile per kg of fissile). This demonstrates that there is a large margin of safety for the handling and storage of untreated groundwater with respect to nuclear criticality safety. No special precautions will be required.

11.8.2 Groundwater Treatment by Ion-Exchange

Based on the information obtained during the groundwater treatment program, collection of enriched uranium on the ion-exchange resin will concentrate the U-235 to concentrations that may exceed the transportation definition for fissile exempt material but to less than a criticality safe mass limit since the enrichment of the uranium is less than 4% U-235. Calculations based on 2015 treatability tests indicate that the total U-235 content of all four uranium treatment trains will not exceed 1,200 grams. Process and administrative controls will monitor and control the accumulation of uranium in the groundwater treatment system to assure that the license possession limit of 1,200 grams of U-235 (≤5.0 wt. percent) is not exceeded.

11.8.3 Packaged Materials

All packaged materials that are stored on-site in preparation for shipment off-site for disposal will meet all transportation regulatory requirements for the shipment of enriched uranium. None of the processes to be conducted on-site are capable of extracting the enriched uranium from resin or biomass that has been prepared for shipment and disposal.

11.8.4 Responsibilities

The Trustee PM will assign responsibility for evaluating proposed changes to the groundwater treatment system and/or process to an individual with experience in nuclear criticality safety evaluation. This assigned individual will review and approve any changes made to the groundwater treatment system and will periodically conduct inspections of the system and operations to confirm that process and administrative controls assure that the license possession limits are not exceeded.

11.8.5 Training

All personnel responsible for the operation of the process systems will receive training on the potential for nuclear criticality and the need to comply with the controls established to maintain nuclear criticality safety during treatment and processing operations.

11.8.6 Nuclear Criticality Accident Monitoring System

Condition 19 of License SNM-928 provides an exemption from the provisions of 10 CFR 70.24, "Criticality accident requirements". Maintaining a site-wide possession limit of 1,200 grams of U-235 obviates the need for a criticality accident monitoring system.

11.9 HEALTH PHYSICS AUDITS, INSPECTIONS, AND RECORDKEEPING

The RPP addresses audits and surveillances of the RP program. The results of all audits and surveillances are reviewed by the ALARA Committee. Records of these audits and surveillances are maintained in accordance with the Quality Assurance Program Plan (QAPP).

As discussed in the RPP, surveillances are used to observe activities being performed. Surveillances may be initiated by the RSO or Quality Assurance Coordinator. The goal of surveillances is to determine whether or not an activity is being performed in accordance with applicable procedures, plans, accepted industry standards, etc. Surveillances are documented, as well as program changes resulting from findings or observations made during surveillances.

The QAPP describes the process used in evaluating and dealing with violations of NRC requirements or license commitments identified during audits.

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12.0 ENVIRONMENTAL MONITORING AND CONTROL

12.1 ENVIRONMENTAL ALARA EVALUATION PROGRAM

In accordance with License Condition 27(e) of NRC License No. SNM-926, the licensee has established an ALARA Committee. The RPP describes the composition of the ALARA committee that includes a designated ALARA Committee chairman. The ALARA committee will at a minimum consist of the following:

- One member with expertise in management who has managerial and financial responsibility for the decommissioning of the site.
- One member with expertise in decommissioning who is responsible for site decommissioning.
- The site Radiation Safety Officer who is responsible for ensuring conformance to radiation safety and environmental requirements.

License Condition 27(e) also specifies the evaluation the ALARA Committee must perform to determine if a change to tests, the Decommissioning Plan, or the Radiation Protection Plan require NRC approval. If not, the ALARA Committee can approve the change without NRC approval. The ALARA Committee sets ALARA dose goals for the Cimarron site.

This decommissioning plan restricts the concentration of licensed material in effluents generated during decommissioning to less than the MCL. A proposed change to the decommissioning process that could impact effluent concentrations would require the ALARA Committee to review the proposed change in accordance with License Condition 27(e). The change evaluation will be documented and maintained on site for review during regulatory inspections.

ALARA Committee meeting agenda and minutes, change evaluations and approvals of changes, and proposed and/or approved modifications of ALARA goals and processes, are distributed to all members of the ALARA Committee. Consequently, management remains fully informed of all ALARA issues associated with the decommissioning and release of the Site.

12.2 EFFLUENT MONITORING

The extent and concentration of both licensed material (i.e., uranium) and non-radiological contaminants of concern (i.e., nitrate and fluoride) have been established as described in Section 3.5.3 of this decommissioning plan.

Once groundwater remediation has begun, effluents will consist of extracted groundwater containing less than the MCL for each contaminant of concern (COC).

Effluents will be discharged to the Cimarron River via DEQ-permitted Outfalls 001 and 002. The locations of the two outfalls are shown on Drawing BMcD-GWREMED-C002 in Appendix D. Samples of the discharge will be collected from each outfall (prior to mixing with other surface water) and analyzed in accordance with the Oklahoma Pollutant Discharge Elimination System (OPDES) permit. The concentrations of these three COCs will be reported on a monthly basis.

Sample collection frequency, compositing, and analytical methods will be stipulated by the DEQ Water Quality Division as part of the OPDES permit. A procedure for discharge sampling will be prepared in accordance with the Site quality assurance program, and added to the DEQ-approved Sampling and Analysis Plan.

OPDES permits require monthly reporting of flow, COC concentrations, and other parameters stipulated in the permit, on a monthly discharge monitoring report. OPDES permits routinely require submittal of discharge monitoring reports within fifteen days of the end of each month, depending on the required turnaround time for different analytical methods.

The Quality Assurance Project Program (QAPP) established for the Site complies with Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination) – Effluent Streams and the Environment.* The QAPP has been reviewed during multiple NRC inspections, and will be revised in accordance with OPDES permit requirements, if appropriate.

12.3 EFFLUENT CONTROL

Releases of radioactive material to the environment can occur during groundwater through:

- A leak or leaks in well heads or piping
- A release of contaminated water from influent tanks
- Failure of an ion exchange vessel that has processed impacted groundwater

Piping conveying impacted groundwater is routed through areas containing impacted groundwater. A release from a leaking pipe would simply return the impacted water to its source.

Influent tanks are double-walled tanks with leak detection between the tank walls. Should the interior tank in an influent tank develop a leak, the leak detection sensor will trigger the control system to shut off all groundwater extraction pumps. As the treatment system continues to operate, the low level

sensor will then trigger a shut-down of the pumps transferring water to the treatment system. Even if both tanks fail simultaneously (and catastrophically), the maximum volume of impacted water that could be released would be a single volume of the influent tank.

Each uranium treatment train is installed within a shallow containment. If a resin vessel (or a connection to a resin vessel) develops a leak, a conductivity sensor will trigger a shut-down of the pumps transferring groundwater from the influent tank to the treatment train. The maximum volume of the release will therefore be the volume of water in the treatment train. Due to the fact that most of this water has already been in contact with the resin, the concentration of licensed material in the resin will be significantly less than that of the influent.

There is no release of impacted water to a sewer system, so the requirements of 10 CFR 20.2003 do not apply to this decommissioning operation.

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13.0 RADIOACTIVE WASTE MANAGEMENT

13.1 SOLID RADWASTE

Solid radwaste generated by groundwater remediation activities will fall into one of several categories: spent anion resin, biomass, and protective clothing, materials and equipment used for maintaining the systems and processing the groundwater, and the contaminated piping and equipment of the treatment systems. Biomass can be further divided into two categories. Biomass from Nitrate Train 4 is anticipated to contain sufficient uranium to require processing, packaging, and disposal as low level radioactive waste. Biomass from other treatment trains is not anticipated to contain detectable concentrations of uranium, and will not be treated as radwaste.

13.1.1 Spent Anion Resin

Spent anion resin will have adsorbed uranium, extracting it from the groundwater, and concentrating it in the resin. Anion resin beds will contain approximately 750 kg resin. As discussed in Section 8.6.1, data from 2015 treatability tests, in conjunction with anticipated influent concentrations, indicate that resin will not adsorb the high concentrations of uranium that were generated during 2013 treatability tests.

The highest anticipated concentration of uranium in a resin vessel will be in the first resin vessel in Burial Area #1 treatment train. This vessel is projected to accumulate approximately 24,000 g of uranium (32 g U per kg resin). At 2% enrichment, this yields 480 g of U-235 (0.64 g U-235 per kg resin). Although groundwater coming from the WAA "U > DCGL" area averages approximately 4% enrichment, the first vessel from this area is projected to contain approximately 7,000 g of uranium (9.3 g U per kg resin) due to a lower influent concentration. At 4% enrichment, this vessel would contain 280 g of U-235 (0.373 g U-235 per kg resin).

Although processed resin will contain less than 1 g of U-235 per 2 kg non-fissile material, the total uranium activity will significantly exceed the US Department of Transportation's (DOT's) 270 pCi/g threshold. At 2% enrichment, 32 g of uranium per kg of resin would yield over 30,000 pCi/g total uranium activity, designating the waste as DOT Class 7 radioactive material. The resin/additive mixture will be packaged in 55-gallon drums (or other containers as authorize by transportation regulations), and shipped for disposal as Class A fissile exempt low level radioactive waste in a licensed disposal facility.

13.1.2 Biomass from Nitrate Train 4

Treatability testing performed in 2015 indicates that the biomass removed from the bioreactor can accumulate uranium in concentrations as high as several µg/g, which is anticipated to yield less than 15 pCi/g uranium activity.

Like the spent resin, the biomass will be processed to reduce the carbon content to less than 20% carbon, and additional material may be added to absorb free liquid in the biomass. The resulting waste mixture will contain less than 10 pCi/g uranium.

This is a small fraction of the 270 pCi/g activity threshold that would trigger DOT Class 7 radioactive material requirements. Biomass will be packaged in 55-gallon drums (or other containers as authorize by transportation regulations), and shipped for disposal as "exempt" waste in a licensed disposal facility.

13.1.3 Potentially Contaminated Material

Theoretically, gloves, small diameter tubing, and other materials which may become contaminated during groundwater processing cannot absorb sufficient uranium to exceed surface contamination limits. However, since these cannot be surveyed practically to demonstrate this, they will be assumed to be contaminated, and segregated from other solid waste for disposal as radwaste. Potentially contaminated material will be packaged, shipped, and disposed of as Class A "exempt" waste in a licensed disposal facility.

13.1.4 Storage of Solid Radwaste

Spent anion resin, biomass from Nitrate Train 4, and potentially contaminated material will be stored in sealed 55-gallon drums (or other strong tight transportation container) in a secured area until sufficient material has been accumulated to comprise a full shipment for disposal. The location of the secured area is shown in Drawing KUR-ENVI01-001-DWG-C110.

13.2 LIQUID RADWASTE

Effluents from the groundwater treatment processes will either be injected into impacted areas, or discharged to the Cimarron River in accordance with an OPDES permit. All effluent will contain licensed material at concentrations below the MCL. Consequently, no liquid radioactive waste will be generated during decommissioning operations.

13.3 MIXED WASTE

There are no hazardous constituents in the groundwater, and neither pH adjustment (for both uranium and nitrate treatment) nor nutrient addition (for nitrate treatment) will result in the generation of hazardous waste. Consequently, no mixed waste will be generated during decommissioning operations.

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14.0 QUALITY ASSURANCE

The CERT Trustee is dedicated to promoting quality at every level of Cimarron Site work, and to fostering an environment that encourages continual quality improvement. A key characteristic of this environment is maintenance of a "no-fault" climate and reinforcement of the need to identify and correct nonconforming items, processes, and activities.

The Trust Administrator and Project Manager are ultimately responsible for the application, deployment, periodic evaluation, and documentation of the quality assurance (QA) program, and for implementing and assessing appropriate actions necessary to ensure:

- Products and services (including sample collection and analysis services) are compliant with license and regulatory requirements.
- Quality management systems and procedures are in place and operating effectively.
- Opportunities for improving the organization, quality, compliance and cost performance are identified and implemented.
- Timely evaluation of personnel resources, needs, skills and performance to stress the importance of, and identify opportunities for, continual quality improvement.
- Data used for decision making are of the quality needed to support Cimarron Site goals and assure compliance with nuclear and environmental compliance requirements.

All Cimarron Site Personnel, contractors, and subcontractors are responsible to:

- Maintain familiarity with the requirements of the Quality Assurance Program Plan (QAPP).
- Maintain a commitment to implementing QA program requirements in their work.
- Identify opportunities for quality improvement.
- Stop work when necessary to mitigate risks to safety, security, or quality.

14.1 ORGANIZATION

The Cimarron Site's organizational structure as it affects quality is summarized in the following role-specific responsibility descriptions:

14.1.1 Trust Administrator

The CERT Administrator has overall responsibility for Cimarron Site policies, quality assurance, and compliance at the Cimarron Site. The CERT Administrator is also responsible for financial administration of annual budgets, Trust accounts, and compliance with the Trust Agreement.

14.1.2 Trustee Project Manager

The Trustee Project Manager's (PM's) responsibilities include:

- Providing resources for, and planning and managing decommissioning and compliance activities at the Cimarron Site.
- The implementation and maintenance of the QAPP.
- Communicating to and ensuring compliance with all site personnel and contractors the requirements of the QAPP.
- Including quality assurance program requirements in contract and purchase order terms and conditions.

14.1.3 Quality Assurance Coordinator (QAC)

The Quality Assurance Coordinator (QAC) is responsible for the review, revision and maintenance of the quality assurance program. The QAC coordinates day-to-day activities with the Trustee PM, but reports directly to the CERT Administrator as necessary to assure implementation of the QAPP and resolve quality matters.

14.1.4 Subject Matter Expert (SME)

A subject matter expert (SME) is a knowledgeable and experienced individual who uses his or her knowledge of a specific discipline to judge what is important and useful.

14.1.5 All Cimarron Site Personnel

All Cimarron Site Personnel are encouraged to be diligent in the performance of work to maintain the level of quality required by plans, procedures, and instructions. Personnel are encouraged to be diligent and attentive to quality issues they may observe in the work of their peers, suppliers, contractors, and subcontractors, recognizing that a consistent and exemplary level of quality can only be obtained through vigilant attention to everyone's work.

All Cimarron Site Personnel are responsible to:

- Maintain familiarity with the requirements of the QA program.
- Maintain a commitment to implementing the QA program requirements in their work.
- Identify opportunities for quality improvement.
- Stop work when necessary to mitigate risks to safety, security, or quality.

14.2 QUALITY ASSURANCE PROGRAM

The EPM Cimarron Site quality assurance program meets the applicable requirements of the following:

- NRC Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination) - Effluent Streams and the Environment
- NRC License SNM-928

The QAPP is the governing document which defines the quality assurance program implemented at the Cimarron Site. The QAPP describes ***what*** will be done to ensure quality. Quality Assurance procedures implement the program; they describe ***how*** quality objectives will be identified and quality ensured in the performance of quality critical work.

The Trustee retains contractors for significant portions of the site work. The Cimarron Site QAPP is designed to ensure work is of sufficient quality to comply with site-specific quality requirements. The QAPP requires ensure that EPM verifies the qualifications of its contractors, effectively communicates the Cimarron Site's quality requirements to contractors, and monitors contractor and subcontractor performance and product quality.

The emphasis of this quality program is to provide quality management systems that ensure:

- An activity-specific plan is developed for each quality-critical activity.
- Activity-specific plans address quality assurance requirements.
- Vendors performing quality critical activities or generating quality critical data are qualified to provide the quality of data needed.
- Equipment and materials are suitably designed and maintained in a condition that qualifies it for its intended use.
- The effectiveness of the quality assurance program is periodically assessed.

14.3 DOCUMENT CONTROL

Documents such as the QAPP, the RPP, the Sampling and Analysis Plan, implementing procedures, and activity plans are maintained as controlled documents. Controlled documents are made available to internal users via electronic media, formatted as a .pdf file to prevent inadvertent change by users.

The Trustee PM and QAC authorize limited access to editable electronic versions of controlled documents.

Controlled copies are not normally distributed; end users are responsible to verify that printed copies are the latest revision. Since end users will likely rely on the revision number on the cover page of the electronic controlled document to verify their printed version, revision of individual pages within a document are not permitted.

14.4 CONTROL OF MEASURING AND TEST EQUIPMENT

Measuring and testing equipment (M&TE) requiring calibration must not be used unless the calibration is current. Activity plans require verification and documentation of calibration.

The Trustee delegates the responsibility for implementing calibration control of M&TE to a qualified contractor or vendor. When equipment is found to be in need of calibration or repair, it is taken out of service, visibly marked, and physically separated from in-service equipment. An equipment inventory identifies the current status of MT&E.

14.5 CORRECTIVE ACTION

The Site quality assurance program includes a corrective action process for non-conformances and incidents through the use of a deficiency reporting process. This process provides for the prompt identification of conditions adverse to quality, determination of their cause, and resolution of the specific conditions adverse to quality. A log of deficiencies and corrective actions is maintained to permit trending analysis if appropriate. The trend analysis can be used to identify timely corrective actions to prevent recurring problems and improve performance. Deficiency reporting and the corrective action process are controlled by procedure.

14.6 QUALITY ASSURANCE RECORDS

Quality records document the performance of quality-critical activities. Quality records relevant to license termination and site closure are maintained by the Trustee. Quality records also records of vendor qualification and personnel qualification, training, and exposure.

Redundant storage of records is required, and can include remote electronic storage. Records that do not need to be immediately accessible may be archived for storage at a remote location as determined by the Trustee PM or QAC. The adequacy of Cimarron Site records is subject to internal audit by the QAC.

14.7 AUDITS AND SURVEILLANCE

Audits and surveillances are planned and scheduled according to the type and status of work being performed. The results of audits and surveillances are documented. The QAC is responsible for ensuring that audit findings and observations are acted upon and closed out in a timely manner.

Managers take appropriate action to identify root causes, correct deficiencies, prevent recurrences, and determine impacts of audit findings in their area of responsibility. Follow-up actions are performed as necessary to ensure that appropriate corrective actions have been implemented in a timely manner and are effective.

14.8 PROGRAM CHANGES

Changes to the key elements of the Quality Assurance Program presented in this Decommissioning Plan will be submitted to the U.S. Nuclear Regulatory Commission for review and approval prior to implementation.

The NRC will be notified of any changes to the organizational elements within 30 days after the announcement of the change is made.

Editorial changes or personnel reassignments of a non-substantive nature do not require NRC notification.

14.9 GLOSSARY

Activity Plan: A working level document establishing the elements of a work activity important to quality, and also establishing the sequence of work necessary to successfully complete the work activity.

Activity Leader: The individual assigned by the Trustee Project Manager with overall responsibility to complete the work described in an Activity Plan.

Cimarron Environmental Response Trust (CERT): The Trust established as having overall responsibility for environmental liabilities at the Cimarron Site in accordance with the January 26, 2011 Settlement Agreement with the Department of Justice (DOJ), the Nuclear Regulatory Commission (NRC) and the State of Oklahoma. The CERT is represented by the CERT Administrator.

Cimarron Site Personnel: Any person performing remediation work at the Site.

Contractor: Any organization or individual contracted directly to the Trustee.

Controlled Document: Any document that the Trustee Project Manager or Quality Assurance Coordinator determines should be controlled to ensure that user possesses the most current revision of the document. This includes the QAPP and all implementing procedures.

Decisions Affecting License Termination or Site Closure: Decisions that support the Cimarron Site's characterization and remediation goals. This includes goals established in accordance with established requirements of the NRC and the State of Oklahoma.

Hold Point: A stopping point in a procedure or work plan requiring a signature or initials to verify that data has been recorded or that required actions are verified as complete before proceeding. Hold Points are used as a quality assurance measure in Activity Plans.

Quality Activity: Any activity that impacts the characterization or remediation of the site in order to achieve license termination or site closure, or that is otherwise required by the Trustee Project Manager or Quality Assurance Coordinator to be subject to the quality assurance program.

Quality Data: Data that directly or indirectly support decisions affecting license termination or site closure. Quality data collection and management are subject to the requirements of the QAPP.

Quality Assurance Program Plan (QAPP): The QAPP establishes the structure of the Quality Assurance Program, including implementing procedures, referenced procedures and plans, and quality requirements directly established in this Section.

Quality Assurance Program (QAP): The Cimarron Site's overall program for quality assurance, as described in the Quality Assurance Program Plan (QAPP).

Quality Assurance Records: Records of site activities or data.

Subcontractor: Any organization or individual retained by a contractor.

Subject Matter Expert: A knowledgeable and experienced individual in a specialized discipline.

Trustee: Environmental Properties Management (EPM), the Trustee identified in the January 26, 2011 Settlement Agreement with the Department of Justice (DOJ), the Nuclear Regulatory Commission (NRC) and the State of Oklahoma.

Trustee Project Manager: The employee of the Trustee assigned overall responsibility for the planning, scheduling, and performance of work at the Site.

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15.0 FACILITY RADIATION SURVEYS

15.1 RELEASE CRITERIA

License Condition 27 stipulates the criteria for unrestricted release for all impacted media at the Site. Unrestricted release criteria are presented in this section by each medium.

15.1.1 Facilities and Equipment

License Condition 27(c) lists the unrestricted release criteria for facilities and equipment. This condition cites the August 1987 *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source or Special Nuclear Material"*. License Condition 27(c) states, "Buildings, equipment, and outdoor areas shall be surveyed in accordance with NUREG/CR-5849, 'Manual for Conducting Radiological Surveys in Support of License Termination.'" The criteria are:

- 5,000 dpm alpha/100 cm^2 (15.5 in^2), averaged over 1 m^2 (10.8 ft^2)
- 5,000 dpm beta-gamma/100 cm^2 (15.5 in^2), averaged over 1 m^2 (10.8 ft^2)
- 15,000 dpm alpha/100 cm^2 (15.5 in^2), maximum over 1 m^2 (10.8 ft^2)
- 15,000 dpm beta-gamma/100 cm^2 (15.5 in^2), maximum over 1 m^2 (10.8 ft^2)
- 1,000 dpm alpha/100 cm^2 (15.5 in^2), removable
- 1,000 dpm beta-gamma/100 cm^2 (15.5 in^2), removable

The exposure rate for surfaces of buildings and equipment is 1.3 pC/kg (5 μR/hr) above background at 1 m (3.3 ft.)

15.1.2 Soils and Soil-Like Material

License Condition 27(c) also lists the unrestricted release criteria for soils and soil-like material. This license condition states, "The licensee shall use … the October 23, 1981, BTP 'Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations' for soils or soil-like material." It also states, "… outdoor areas shall be surveyed in accordance with NUREG/CR-5849, 'Manual for Conducting Radiological Surveys in Support of License Termination'. Soils and soil-like materials with elevated activities exceeding the unrestricted use criteria shall be investigated to determine compliance with the averaging criteria in NUREG/CR-5849. These criteria address averaging concentrations over any 100 m^2 (1070 ft^2) area and use the $(100/A)^{1/2}$ elevated area method." Unrestricted release criteria for soils and soil-like material are:

- Natural uranium 0.37 Bq/g (10 pCi/g) total uranium

- Enriched uranium 1.3 Bq/g (35 pCi/g) total uranium
- Depleted uranium 1.1 Bq/g (30 pCi/g) total uranium
- Natural thorium 0.37 Bq/g (10 pCi/g) total thorium
- 2.6 pC/kg (10 μR/hr) average above background at 1 m (3.3 ft.)
- 5.2 pC/kg (20 μR/hr) maximum above background at 1 m (3.3 ft.)

15.1.3 Groundwater

For groundwater, the only radioactive elements of concern are uranium and technetium-99. Uranium is present both as natural uranium and as licensed uranium in groundwater.

License Condition 27(b) cites the unrestricted release criterion for uranium in groundwater. It states, "The release criteria for groundwater at the Site is 6.7 Bq/L (180 pCi/L) total uranium. NRC will not terminate Radioactive Materials License SNM-928 until the licensee demonstrates that the total uranium concentrations in all wells have been below the groundwater release criteria for eight consecutive quarterly samples (the past 2 years). The Licensee will retain control of the property licensed under NRC Radioactive Material License SNM-928 until the groundwater release criteria are met."

This release criterion is referred to as a derived concentration goal level (DCGL). This DCGL is based on a site-specific risk assessment rather than a dose model, because the toxicity of purified uranium has a greater effect on human health than its radiological dose. A 1998 risk assessment established a risk-based limit of 0.11 mg/L for uranium in groundwater based on a drinking water scenario. A concentration of 0.11 mg/L is approximately equivalent to an activity of 180 pCi/L, assuming an average enrichment of approximately 3%. For groundwater, there is no average DCGL, nor is there any method for averaging uranium activity in groundwater.

Unrestricted release criteria for technetium-99 (Tc-99) are not stipulated in License SNM-928. The US Environmental Protection Agency (EPA) has promulgated a primary drinking water standard of 4 mrem/yr for beta photon emitters. NRC developed a Derived Concentration Limit (DCL) for Tc-99, based on this 4 mrem/yr dose limit, using the International Commission on Radiological Protection (ICRP) 1982 Publication 30, *Limits for Intakes of Radionuclides by Workers*. The NRC DCL for Tc-99 is 3,790 pCi/L. Tc-99 will not be accumulated in the groundwater remediation process. Hence, Tc-99 will not technically be "possessed"; consequently, the license does not authorize possession of Tc-99. However, post-remediation

groundwater monitoring must demonstrate that Tc-99 concentrations in groundwater are less than 3,790 pCi/L to obtain unrestricted release from NRC.

EPA developed a Derived Concentration Limit (DCL) for Tc-99, based on the EPA MCL of 4 mrem/yr, using the ICRP 1959 Publication 2, *Permissible Dose for Internal Radiation*. The EPA DCL for Tc-99 is 900 pCi/L. Tc-99 concentrations in groundwater must be below 900 pCi/L to obtain unrestricted release from DEQ.

15.2 CHARACTERIZATION SURVEYS

The former process buildings are located in Subareas I and K, which have been released for unrestricted use. Samples of environmental media, which are collected on an episodic basis throughout the Site, are brought to the Site office, which is located in Subarea I, for packaging and shipping. Two water treatability tests, which involved the processing of uranium-impacted groundwater, were conducted in the Site office. Water storage tanks, which held contaminated groundwater for the tests, were located near the Site office. To maintain confidence that none of these operations impacted the Site office (or surrounding property), each time such operations are conducted, building surfaces and equipment are surveyed after operations are completed. No evidence of impact from these operations has been observed.

Burial trenches located in Subareas F, L, and M were excavated and surveyed for release. NRC has released Subareas L and M from license SNM-928, and has performed confirmatory surveys for both surface and subsurface soil in Subarea F, finding no indication that the soils in this subarea would not be releasable for unrestricted use.

Concrete rubble located in Subareas F, G, and J has been surveyed for release. NRC has performed confirmatory surveys on the rubble and has released Subarea J from license SNM-928. NRC has agreed that the rubble in Subareas F and G are releasable for unrestricted use, but will not release these areas until groundwater is remediated.

Impoundments and lagoons were located in Subareas H, L, M, and O. These were excavated, and the residual soils were surveyed for release. NRC has released all four of these Subareas from License SNM-928.

The extent of licensed material in groundwater has been assessed, and the extent of groundwater exceeding the DCGL has been determined site-wide. No further characterization surveys are needed at the Site.

Figure 1-2 shows the locations of the various Subareas, and Figure 1-3 shows the locations of buildings, burial areas, and lagoons and impoundments. Figures 3-3 and 3-4 show the extent of uranium in groundwater exceeding the DCGL.

In a letter dated April 22, 2013, NRC noted that Tc-99 concentrations do not exceed the NRC DCL anywhere on site, although they exceed the EPA DCL at several locations. NRC stated, “As groundwater concentrations of Tc-99 have remained below the NRC’s DCL since 2004, the NRC staff has concluded that Tc-99 will not have to be addressed in the groundwater remediation plan. However,, the NRC staff requests that the post-remediation monitoring plan leading to license termination includes four calendar quarters of monitoring for Tc-99 to be collected … to confirm that pervious concentrations have remained below NRC’s DCL.” No further characterization surveys for Tc-99 are needed at the Site.

15.3 IN-PROCESS SURVEYS

During groundwater remediation activities and post-remediation activities, five types of in-process surveys will be performed at the Site. Groundwater sampling and off-site laboratory analysis will be performed to monitor progress in reducing the concentration of uranium in groundwater, and to demonstrate compliance with decommissioning criteria once the DCGL has been reached. Influent and effluent sampling and off-site laboratory analysis will be performed to monitor the quantity of uranium in the anion resin beds. Packages of spent resin and potentially contaminated material will be surveyed prior to shipment for disposal. Release surveys will be performed to release materials and equipment from radiologically restricted areas. Routine surveys of unrestricted areas will be performed to identify any areas that may become contaminated, or to demonstrate that unrestricted areas are not impacted above unrestricted release criteria.

15.3.1 In-Process Groundwater Monitoring

Section 8.7 presents the in-process groundwater monitoring program that will be used to monitor the concentration of uranium in groundwater. Section 8.8 presents the post-remediation groundwater monitoring program that will be implemented to demonstrate that groundwater remediation activities have reduced uranium concentrations sufficiently low to justify termination of license SNM-928.

Groundwater samples will be analyzed for uranium and/or nitrate and/or fluoride based on location and which COCs are present. For the purpose of this section, only isotopic analysis for uranium for comparison with the DCGL will be discussed.

The data quality objective for groundwater monitoring has been a 95% level of confidence that the actual concentration is less than the stipulated criteria. The laboratory must report the result as well as the uncertainty, defined as 2 standard deviations. Reported results plus 2 standard deviations must be less than 180 pCi/L for total uranium to assert that the actual activity is less than the activity limit.

GEL Laboratory (GEL) has provided Reporting Limits (RL – also called quantification limits) of 0.1 pCi/L for each isotope of uranium by the HASL 300 Method. This is less than 1% of the limit for total uranium. Consequently, this laboratory method is acceptable for analyzing uranium activity for this sampling effort.

15.3.2 Influent and Effluent Monitoring

Sections 8.3 and 8.6 describe the influent and effluent monitoring that will be performed to quantify the amount of uranium that has been adsorbed in each anion resin bed. Influent and effluent uranium concentrations will provide the data necessary to quantify the mass of uranium in each vessel. Isotopic analysis of the resin will provide the enrichment information needed to monitor the mass of U-235 in each vessel.

GEL Laboratory (GEL) has provided Reporting Limits (RL – also called quantification limits) of 0.1 pCi/L for each isotope of uranium by the HASL 300 Method. This is less than 1% of the DCGL for groundwater, and less than 6% of the U-235 activity that would be anticipated even if the average total uranium activity were as low as 50 pCi/L. Consequently, this laboratory method is acceptable both for demonstrating that groundwater complies with the DCGL, and for quantifying the amount of U-235 that accumulates in anion resin.

It is anticipated that the OPDES permit authorizing the discharge of treated water (the final effluent) will establish a limit of 30 μg/L total uranium. GEL has provided an RL of 0.2 μg/L for uranium by the EPA 200.8. This is less than 1% of the anticipated discharge limit. Consequently, this laboratory method is acceptable both for analyzing effluent for compliance with permit limits.

15.3.3 Shipping Package Surveys

Packages containing spent resin, groundwater samples bottles, and packages of potentially contaminated material will be surveyed for surface contamination and exposure rate readings will be measured at the exterior of the package. Surface contamination measurements will be made using an alpha/beta-gamma survey meter which measures counts per minute per 100 square

centimeters (cpm/100 cm^2). Smears will be collected from external surfaces of packages and counted in an on-site smear counter. Exposure rate measurements will be made at 30 cm from the package surface and on contact with the sides of the drum or package using a micro-R meter. All instruments used for shipping package surveys will have minimum detection limits that are less than 10% of the limits for unrestricted release specified in Section 15.1, above. Survey results will be documented and retained.

A Ludlum Model 2360 rate meter with a Ludlum Model 43-93 detector is typically used for surface contamination measurements. A Ludlum Model 3030E rate meter with a Ludlum Model 43-10-1 detector is typically used to count smears. A Ludlum Model 19 micro-R meter is typically used to measure exposure rate. Equivalent or substitute instruments may be used if sufficiently sensitive, upon approval by the RSO or designee. Source checks will be performed each day these instruments are used.

15.3.4 Release Surveys

Before material or equipment is removed from a radiologically restricted area, it will be surveyed for surface contamination. Surface contamination measurements will be made using an alpha/beta-gamma survey meter which measures counts per minute per 100 square centimeters (cpm/100 cm^2). All instruments used for release surveys will have minimum detection limits that are less than 10% of the limits for unrestricted release specified in Section 15.1, above. Release surveys are not documented.

A Ludlum Model 2360 rate meter with a Ludlum Model 43-93 detector is typically used for surface contamination measurements. Equivalent or substitute instruments may be used if sufficiently sensitive, upon approval by the RSO or designee. Source checks will be performed each day these instruments are used.

15.3.5 Routine Surveys

Routine surveys will be performed in the site office and other areas specified by the RSO and/or designee to demonstrate that these areas remain releasable for unrestricted use. Routine surveys will be performed on a weekly, monthly, or quarterly basis, based upon frequency of use and potential for contamination. Routine surveys may consist of surface contamination scans, small area (100 cm^2) smears, large area (up to 1 m^2) smears, and exposure rate measurements. All instruments used for routine surveys will have minimum detection limits that are less than 10% of

the limits for unrestricted release specified in Section 15.1, above. Survey results will be documented and retained.

A Ludlum Model 2360 rate meter with a Ludlum Model 43-93 detector is typically used for surface contamination measurements. A Ludlum Model 3030E rate meter with a Ludlum Model 43-10-1 detector is typically used to count smears. A Ludlum Model 19 micro-R meter is typically used to measure exposure rate. Equivalent or substitute instruments may be used if sufficiently sensitive, upon approval by the RSO or designee. Source checks will be performed each day these instruments are used.

15.4 FINAL STATUS SURVEY DESIGN

It is anticipated that, barring a release of radioactive material to the environment, all potentially contaminated equipment will have been demobilized from the site. It is assumed that by the time all monitoring wells yield uranium concentrations of less than 180 pCi/L, all the pre-treatment and discharge piping will be releasable for unrestricted use. Only the Western Area Treatment Facility will remain on site, as an asset to be transferred to a subsequent owner upon disposition of the property by the Trust.

Prior to the performance of a final status survey, a final status survey plan will be submitted to NRC (for approval) and DEQ. Although it is anticipated that only the Western Area Treatment Facility will require a final status survey, the final status survey plan will address the entire site. The final status survey plan will be prepared in accordance with the guidance presented in NUREG/CR-5849, “Manual for Conducting Radiological Surveys in Support of License Termination.”

15.5 FINAL STATUS SURVEY REPORT

Upon agency approval of the final status survey plan, the final status survey will be performed, and a final status survey report will be submitted to NRC and DEQ. Like the final status survey plan, the final status survey report will be prepared in accordance with the guidance presented in NUREG/CR-5849, “Manual for Conducting Radiological Surveys in Support of License Termination.”

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16.0 FINANCIAL ASSURANCE

16.1 COST ESTIMATE

Section 4.1 and Appendix A, Section A.3 of NUREG-1757, Volume 3, provides guidance on the preparation of a cost estimate for decommissioning funding purposes. These sections assume the existence of buildings and processing equipment that require decontamination, and make little provision for the decommissioning of environmental media. A cost estimate in general conformance with NUREG-1757, given the nature of the decommissioning activities and the current radiological status of the Site, is provided in Table 16-1: Decommissioning Cost Estimate. The estimated cost to complete decommissioning at the Cimarron site is $71,668,404.

This decommissioning cost estimate (DCE), prepared by Burns & McDonnell using inputs and parameters provided by EPM and others, presents a probable cost required to obtain license termination under the assumed conditions and parameters presented herein. The DCE includes administration, fees, capital construction, operations and maintenance, monitoring, and demobilization and license termination costs. The scope of work represented by each line item is described in the sub-sections below. The DCE is presented in calendar years based on the expected project schedule as presented in Section 9.

The DCE is based on the provisions set forth in the 60% Groundwater Remediation Design, as presented in 60% Design Drawings prepared by Kurion and Burns & McDonnell, and execution of the groundwater remediation and water treatment processes as presented in this Plan. Drawings and plans presented at a 60% design level of detail, and preliminary definition of operation and maintenance effort, limit the degree of accuracy in estimating the cost of decommissioning. Changes in scope and design, projected durations, and development of operating procedures based on a completed design will impact the DCE.

The DCE presented herein is based on the experience and judgment of a professional consultant combined with information from past projects, vendors, and published sources. Weather, cost and availability of labor, material and equipment, labor productivity, construction contractors' procedures and methods, unavoidable delays, construction contractors' methods of determining prices, economic conditions, government regulations and laws (including the interpretation thereof), competitive bidding or market conditions, and other factors may all impact the DCE, both positively and negatively. It is anticipated that a revised DCE will be produced when the final design and operating procedures have been developed, prior to construction, and periodically throughout the

decommissioning process, as in-process data provides better information on the rate at which groundwater remediation is progressing. All costs are estimated in 2015 dollars for direct comparison with the present day value of the Trust Accounts. Cost escalation is NOT included.

16.1.1 Administration & Fees

This section includes the estimated cost to administer the Trust, maintain the property, and reimburse regulatory agencies for oversight costs. Line 1 presents estimated administrative costs, which were provided by EPM to administer the Trust and maintain the property based on actual incurred costs in recent years and expected costs in future years. Line 2 presents estimated NRC fees for reimbursement of oversight costs. Line 3 presents estimated DEQ fees for reimbursement of oversight costs.

16.1.2 Capital Construction Costs

This section presents the estimated costs to install the treatment systems as detailed in Kurion and Burns & McDonnell 60% Design Drawings. A detailed compilation of capital construction costs is provided in Appendix G. The major components of the capital construction costs are also broken out on Table 16-1. These line items are described below:

Line 4a – Civil: This line includes costs for grading, foundations for tanks, buildings, and treatment units, roads, civil survey, installation of best management practices (BMPs) for erosion control, post-construction site restoration, and other site work generally related to providing essential access and utilities to the treatment facilities and managing disturbed areas.

Line 4b – Site Remediation Piping, Pumps, Wells, and Trenches: This line includes the cost of constructing all site piping, trenches, and wells related to both the injection and extraction systems. This line also includes the construction of the discharge piping and outfalls, stormwater piping, the Western Area injection system within the Western Area Treatment Facility, and the BA1 injection skid and enclosure.

Line 4c – Electrical and Controls: This line includes the proposed electrical construction scope for the entire project detailed in the drawings, including components and facilities associated with the enclosed treatment system installations, and those located across the Site. The cost of installing conduit in utility trenches is included in Line 4b since conduits will be installed in a common trench with other piping.

Line 4d – BA1 Treatment System: This line presents the cost for the BA1 Treatment System including enclosure, resin vessels (resin not included), influent and effluent tanks, climate control systems, pumps, and associated components and appurtenances.

Line 4e – WA Treatment Facility: This line presents the cost for the Western Area Treatment Facility including the pre-engineered metal building, heaters, heat pump, exhaust fans, climate control systems, vents, plumbing, electrical and lighting system, septic system, eyewash stations, and miscellaneous furnishings.

Line 4f – WA UIX Treatment Systems: This line includes the cost of three uranium ion exchange systems for the Western Area Treatment Facility, not including resin vessels).

Line 4g – WA UIX Resin Vessels: This line includes the cost of twelve uranium ion exchange resin vessels (resin not included).

Line 4h – WA Resin Processing Equipment: This line presents the cost of uranium ion exchange resin processing equipment including bulk resin bag unloader, ribbon blender, screw conveyor, drum dumper, and miscellaneous resin handling tanks and equipment.

Line 4i – WA Nitrate Treatment Train 2: This line presents the cost of the Nitrate Treatment Train 2 system including transfer pumps, one bioreactor, bioreactor blowers, chemical injection systems, two dual media filters, backwash tank and pumps, sludge dewatering system, and associated components and appurtenances. Heating of water is not required for this treatment system.

Line 4j – WA Nitrate Treatment Train 3: This line presents the cost of the Nitrate Treatment Train 3 system including transfer pumps, one bioreactor, bioreactor blowers, chemical injection systems, two dual media filters, backwash tank and pumps, sludge dewatering system, gas fired heater, and associated components and appurtenances.

Line 4k – WA Nitrate Treatment Train 4: This line presents the cost of the Nitrate Treatment Train 4 system including transfer pumps, two bioreactors, bioreactor blowers, chemical injection systems, two dual media filters, backwash tank and pumps, sludge dewatering system, gas fired heaters, and associated components and appurtenances.

Line 4l – WA Biomass Centrifuge: This line includes the cost of a centrifuge to dewater biomass waste from the bioreactors.

Line 4m – WA Process Tanks, Pumps, etc.: This line presents costs for process pumps, influent tanks, effluent tanks, and chemical tanks.

Line 4n – Direct Costs: This line provides the sum of all capital construction items listed above in Lines 4a through 4m.

Lines 4o through 4q: These lines add typical construction related costs including general conditions, construction management, engineering during construction, and bonds and permits.

Line 4r – Indirect Costs: This line presents the total of Lines 4o through 4q.

Line 4s – Capital Construction Subtotal: This line presents the total estimated capital construction cost.

16.1.3 Operations & Maintenance

This section includes the estimated costs to operate the treatment system and maintain the infrastructure.

Line 5 presents the estimated cost for license compliance activities, consisting of implementation of the radiation protection and quality assurance programs. In previous years, the cost for annual environmental monitoring was included in the cost of license compliance. Annual environmental monitoring will be replaced by the in-process monitoring program; this cost appears in separate line items (Lines 17 and 18) in Table 16-1.

Line 6 presents the estimated labor cost associated with operating and maintaining the remediation systems. Operating procedures have not yet been prepared; estimated labor hours and rates are subject to change depending on labor requirements of the operating procedures. The following assumptions apply to the indicated schedule increment:

- 2018: Assumes 100 hours per week in the first year for start-up and more time spent on adjustments to processes. (70 hrs. at $130/hr., 30 hrs. at $200/hr.). Operation and maintenance begins in July, assuming construction is completed during the first six months of 2018; thus, the annual operating cost is lower in 2018 than subsequent years.
- 2019 – 2020: Assumes that startup and modification of processes to increase efficiency are completed during 2018, resulting in an estimated 68 hours per week for operation and maintenance of all treatment trains. (40 hrs. at $85/hr., 20 hrs. at $199/hr., 8 hrs. at $210/hr.)

- 2021 – 2026: Following shutdown of all groundwater remediation and water treatment systems in the western areas, continuing operations only in Burial Area #1, the operation and maintenance labor effort is assumed to decrease to 52 hours per week. (40 hrs. at $85/hr., 8 hrs. at $199/hr., 4 hrs. at $210/hr.)
- 2027 – 2029: Assumes 12 hours per week for site maintenance and planning during the final 12-quarter monitoring period. (8 hrs. at $199/hr., 4 hrs. at $210/hr.)

Line 7 presents the estimated cost of electric service to the groundwater remediation and treatment facilities. This includes the electricity needed for treatment systems, well field remediation components and facilities, climate control systems, and incidental power usage. Current electricity rates provided by the Oklahoma Electric Cooperative were used to determine annual costs based on assumed loads ($0.34/ kilowatt hours [kWh] peak, $0.118 kWh off peak, and a $401.50 annual service charge). Loads were assumed for constant operation during the respective treatment periods (93% off peak, 7% peak). The following load assumptions apply to the indicated schedule increment:

- 2018: 780 kW for six months of operation of all trains.
- 2019 – 2020: 780 kW for twelve months of operation of all trains each year.
- 2021 – 2026: 75 kW for operation of BA1 treatment train, heating of building, and lighting of building.
- 2027 – 2029: 10 kW assumed for heating and lighting of building and operation of any other equipment needed during this period.

Line 8 includes the estimated cost of propane to heat the bioreactors, assuming a required load of 2.4 million British thermal units per hour (BTU/hr). This cost is based on a price quote from a local vendor to lease tanks and deliver propane to the site in liquid form. Propane will only be needed during the years in which nitrate treatment systems are operational (2018 – 2020). The propane requirement is 630 gallons per day (constant during operation) at $1.15 per gallon, delivered, plus an annual cost of $2,000 for tank rental (assumes 8 tanks). Nitrate treatment operations and propane consumption will begin in July 2018, assuming construction is completed during the first six months of 2018. Consequently, propane consumption for 2018 is half of that required for the subsequent two years.

Line 9 presents the estimated delivered cost of ion exchange resin required for uranium treatment systems. This cost is based on Dow Chemical Company's quote of $210 per cubic foot of resin

and a delivery cost of $1,013.50 per 202-cubic foot shipment. The following assumptions apply to the indicated schedule increment:

- 2018: 465 cubic feet of resin required to fill twelve vessels initially. One-half year of operation would require seven resin vessel change-outs, requiring an additional 271 cubic feet. Five shipments are required annually for this quantity of resin.
- 2019 – 2020: 504 cubic feet of resin and thirteen exchanges will be required each year while all uranium treatment trains are operational. Three shipments will be required each year for this quantity of resin.
- 2021 – 2026: 116 cubic feet of resin and three exchanges will be required each year while the BA1 uranium treatment train is operational. One shipment will be required each year for this quantity of resin.

Line 10 includes estimated delivered cost of the 6 molar hydrochloric acid chemical needed for pH adjustment of the uranium treatment process. This cost is based on a vendor quote of $300 per ton, delivered, and an assumed unit weight of 74.5 pounds per cubic foot (pcf). The following assumptions apply to the indicated schedule increment:

- 2018: Demand is 4,422 gallons per month, or 3,547 cubic feet for 6 months of operation of 12 uranium treatment vessels.
- 2019 – 2020: Demand is 4,422 gallons per month, or 7,094 cubic feet for 12 months of operation of 12 uranium treatment vessels, annually.
- 2021 – 2026: Demand is 1,106 gallons per month, or 1,774 cubic feet for 12 months of operation of 3 uranium treatment vessels, annually.

Line 11 presents estimated costs for barite needed to blend with spent uranium ion exchange resin and denitrification biomass prior to shipment for disposal as LLRW. This includes the delivered cost of barite to blend with spent resin and biomass (from Nitrate Treatment Train 4 only) prior to disposal. The barite cost is based on the estimated demand for resin blending and the $0.19/lb. unit cost of delivered barite. The following assumptions apply to the indicated schedule increment:

- 2018: Demand is 21,000 lb. for seven change outs of resin over six months. Demand for biomass blending is 3,960 lb/wk over 6 months, or 102,960 lb.

- 2019 – 2020: Demand is 39,000 lbs. for thirteen change outs of resin over twelve months. Demand for biomass blending is 3,960 lb/wk over 12 months, or 205,920 lb.
- 2021 – 2026: Demand is 9,000 lbs. for five change outs of resin over twelve months. No biomass is generated, so no blending is needed after 2020.

Line 12 shows estimated costs for off-site disposal of spent resin (blended with barite, see Line 11). This cost is based on quoted transportation and disposal prices from Energy Solutions. Transportation cost was estimated at $5,957.15 per shipment and the quoted disposal price was $150/cubic. One truck is capable of hauling (50) 55-gallon drums, each costing $110, delivered, delivered to the Site, per U-line Corporation® catalog. The following assumptions apply to the indicated schedule increment:

- 2018: After blending with barite for shipment, the waste generated during the first 6 months of operation fills (47) 55-gallon drums. One truck shipment is required.
- 2019 – 2020: After blending with barite for shipment, annual waste volume is contained in (93) 55-gallon drums. This assumes that all uranium treatment trains are operating, requiring 13 resin exchanges per full operating year. Two truck shipments are required annually.
- 2021 - 2026: After blending with barite for shipment, the waste generated during 2021 is contained in twenty-two 55-gallon drums. This assumes that only the BA1 uranium treatment train is operating, requiring three resin exchanges per year. One truck shipment is required.
- 2029: After blending with barite for shipment, the waste generated when all treatment systems are demobilized (the final three vessels) is contained in twenty-two 55-gallon drums. One truck shipment is required.

Line 13 presents the estimated cost of the methanol nutrient source required for the nitrate treatment bioreactors. Four bioreactors require an estimated 11 gallons per hour of nutrient addition. Assuming full-time, continuous operation of all bioreactors, nutrient costs are estimated to total $58,500 per month. Six months of full time operation are required in 2018 followed by 12 months of full time operation in 2019 and 2020.

Line 14 includes costs associated with bioreactor waste disposal from Nitrate Treatment Train 4. The biomass waste from the two bioreactors in this train will be treated as LLRW. The biomass will be blended with barite (the cost of the barite is included in Line 11) and packaged for

disposal at a licensed LLRW facility. This material is assumed to be disposed of at the Energy Solutions facility in Clive, Utah. The pricing for disposal and shipment described in Line 12 for LLRW material also applies to this material. The blended LLRW material volume produced will be six 55-gallon drums per week. The following assumptions apply to the indicated schedule increment:

- 2018: Six months of operation will produce 168 drums of LLRW biomass waste. It is assumed that four shipments will be made over this time period.
- 2019 – 2020: Each twelve months of operation will produce 336 drums of LLRW biomass waste. It is assumed that seven shipments will be made during each 12-month operating period.

- Line 15 includes costs associated with bioreactor waste disposal from the bioreactors of Nitrate Treatment Trains 2 and 3. Waste from these units will be packaged in 55-gallon drums and sent to a municipal solid waste landfill. Quotes were obtained from Waste Management Corporation to dispose of this material at the East Oak Landfill in Oklahoma City. The costs (per shipment) for this material, to be disposed of at the East Oak Landfill include a $50/drum tipping fee, a transportation charge of $450, and a mileage surcharge of $0.51 per mile (80 mile roundtrip). The following fees also apply to disposal: ODEQ State fee: $1.25 per ton; environmental fee: 13.25% of invoice; regulatory fee: 3.6% of invoice; profile fee (Waste Management): $50. Biomass from these treatment trains is produced at a rate of (3) 55-gallon drums per week. The following assumptions apply to the indicated schedule increment:

    - 2018: Six months of operation will produce 84 drums of non-LLRW biomass waste. It is assumed that shipments will occur every two months during this time.
    - 2019-2020: Twelve months of operation will produce 168 drums. It is assumed that shipments will occur every two months during this time.

Line 16 – Maintenance Allowance: An annual lump sum placeholder of $25,000 is assumed for maintenance of the treatment facilities. This amount is expected to cover such items as equipment repairs, building upkeep, etc.

16.1.4 Monitoring

The “Monitoring” category includes the costs to sample and analyze water samples as required to monitor treatment system performance, groundwater remediation progress, compliance with injection and discharge criteria, and compliance with decommissioning criteria.

Line 17 presents costs for in-process groundwater monitoring. Costs were estimated based on the monitoring locations and analytes listed in Table 8-2, assuming sample analytical unit costs of $35 for uranium (total concentration), $20 for nitrate, and $15 for fluoride. The in-process monitoring costs include labor and consumables, plus shipping costs, assuming all samples can be collected, packaged, manifested, and shipped by a three-man crew in one 40-hour week. The sampling interval for both areas is weekly for the first month, then monthly thereafter. The following assumptions apply to the indicated schedule increment:

- 2018: Six months of monitoring for all areas.
- 2019 – 2020: Twelve months of monitoring for all areas.
- 2021 – 2026: Twelve months of monitoring for BA1 only.

Line 18 presents costs for in-process treatment system monitoring as described in Section 8.6. Assumed costs were estimated based an analytical unit cost of $35 for uranium (total concentration), plus $20 for consumables (per sample) and $100 for shipping (per sampling event). The assumed costs for monitoring of nitrate treatment trains include one sample for each train at $20 each, and $100 shipping per sampling event. The sampling interval for in-process treatment monitoring is weekly for four weeks, then every two weeks during operation.

Also included in Line 17 are costs associated with discharge monitoring, which are required whenever treated water is being discharged. Monthly samples will be collected from two outfalls. Samples will be analyzed for uranium (concentration), nitrate, fluoride, oil and grease, pH, TDS, and TSS. The cost for analyzing each discharge sample is estimated at $150. Consumables and shipping are estimated to be $100 for each sampling event. The following assumptions apply to the indicated schedule increment:

- 2018: Six months of monitoring for all treatment trains (4 uranium trains, 4 nitrate trains).
- 2019 – 2020: Twelve months of monitoring per year for all trains (4 uranium trains, 4 nitrate trains).
- 2021 – 2026: Twelve months of monitoring for 1 uranium treatment train (BA1).

Line 19 presents costs for post-remediation groundwater monitoring as presented in Table 8-3. The assumed costs for BA1 post-remediation groundwater monitoring were estimated based an analytical unit cost of $175 for uranium (total concentration plus activity), plus $20 per well for

consumables and $100 shipping per sampling event. Assumed labor required for each event is 40 hours at $85/hr. The sampling interval is to be quarterly for three years. The following assumptions apply to the indicated schedule increment:

- 2021 – 2023: Four quarters of post-remediation monitoring per year for the Western Areas.
- 2027 – 2029: Four quarters of post-remediation monitoring per year for BA1.

16.1.5 Demobilization and License Termination

Line 20 presents estimated costs for plugging and abandoning existing monitoring wells. Only wells in the Process Building Area (10 wells) and in Burial Area #4 (6 wells) will be plugged and abandoned. This demobilization activity is assumed to occur during construction in the first 6 months of 2018.

Line 21 presents the estimated costs associated with “mothballing” the treatment systems following shutdown. This will consist of draining, emptying, cleaning, and lubricating equipment to allow the equipment to remain idle for an extended period of time. The estimated lump sum costs associated with this task are based on engineering judgment. The following assumptions apply to the indicated schedule increment:

- 2021: Includes the cost to mothball all WA treatment train equipment upon completion of treatment. Equipment will remain idle until post remediation monitoring is complete, at which time the equipment is assumed to be demobilized.
- 2027: Includes the cost to mothball BA1 treatment train equipment upon completion of treatment. Equipment will remain idle until post remediation monitoring is complete, at which time the equipment is assumed to be demobilized.

Line 22 presents estimated costs for demobilizing uranium treatment components. Components to be demobilized include tanks, pipes, valves, and controls associated with the uranium treatment systems within the BA1 treatment enclosure and the Western Area Treatment Facility. Demobilization includes the packaging and shipment of material that cannot be practically surveyed for disposal as LLRW, and disposal of all other material as solid waste. If some equipment is salvageable and demonstrated to be releasable for unrestricted use, the cost of demobilization may be reduced. System influent and effluent tanks will remain onsite. The following assumptions apply to the indicated schedule increment:

- 2023: Includes costs for planning, preparation, and mobilization.
- 2024: Includes costs to demobilize 3 uranium treatment trains in the Western Area Treatment Facility. The BA1 uranium treatment train will remain in operation as well as components of the Western Area Treatment Facility utilized for transfer and packaging of spent resin.
- 2029: Includes costs to demobilize BA1 uranium treatment train components and components of the Western Area Treatment Facility utilized to transfer and package spent resin.

Line 23 presents estimated costs for demobilizing nitrate treatment components. Components to be demobilized include tanks, pipes, valves, and controls associated with the nitrate treatment systems at the WA Treatment facility. System influent and effluent tanks will remain onsite. Demobilization includes the packaging and shipment of material that cannot be practically surveyed for disposal as LLRW, and disposal of all other material as solid waste. If some equipment is salvageable and demonstrated to be releasable for unrestricted use, the cost of demobilization may be reduced. The following assumptions apply to the indicated schedule increment:

- 2023: Includes costs for planning, preparation, and mobilization.
- 2024: Includes costs to demobilize 3 nitrate treatment trains at the Western Area Treatment Facility.

Line 24 presents the estimated cost to perform a final status survey. These costs will be incurred in 2029 following completion of demobilization activities.

Line 25 includes estimated costs to perform dose modeling and prepare for license termination. These costs will be incurred in 2030 following completion of the radiation release survey.

16.1.6 Contingency Factor

Line 27 applies a 25% contingency to the life-of-project subtotal provided on Line 26. Lines 26 and 27 are then added to yield the total decommissioning cost estimate on Line 28. The contingency factor is specified by NUREG-1757, Vol. 3.

16.2 CERTIFICATION STATEMENT

A certification statement is needed due to the licensed possession limits for U-235 and the applicable quantities specified in 10 CFR 70.25. Section A.2 of Appendix A, Volume 3 of NUREG-1757,

Consolidated Decommissioning Guidance, provides a Model Certification of Financial Assurance which must be submitted with a decommissioning funding plan. Certification is provided in Appendix H of this *Decommissioning Plan*.

16.3 FINANCIAL MECHANISM

16.3.1 Qualifications of the Trustee

The previous licensee, Cimarron Corporation, was a wholly owned subsidiary of Tronox Worldwide LLC (Tronox). Tronox and its wholly owned subsidiaries, (collectively, the Settlors) filed voluntary petitions for relief under Chapter 11 of the U.S. Bankruptcy Code on January 12, 2009. The Settlors, several Federal regulatory agencies, and multiple State regulatory agencies entered into a *Plan of Reorganization* and a *Consent Decree and Environmental Settlement Agreement* (Settlement Agreement) on February 14, 2011 (the Effective Date).

The Cimarron Environmental Response Trust (hereafter, the Trust) was established by an *Environmental Response Trust Agreement (Cimarron)* (the Trust Agreement), which was also executed on February 14, 2011. The Trust Agreement designated Environmental Properties Management LLC (EPM) as Trustee. The Trust Agreement defines the responsibility of the Trust and the Trustee.

Paragraph 2.1.4 of the Trust Agreement states, "On or before the Effective Date, with the approval of NRC and in accordance with the Atomic Energy Act, and applicable regulations in 10 C.F.R. Part 70, the Cimarron License shall be transferred to the Cimarron Trust, to be administered by Environmental Properties Management, LLC, not individually but solely in its representative capacity as Cimarron Trustee. The Cimarron Trustee, on behalf of the Cimarron Trust, shall oversee and shall receive communications relating to the transfer of the Cimarron License to the Cimarron Trust."

Paragraph 4.1.1 of the Trust Agreement states, "Environmental Properties Management, LLC, not individually but solely in its representative capacity, is appointed to serve as the Cimarron Trustee to administer the Cimarron Trust and the Cimarron Trust Accounts, in accordance with the Settlement Agreement and this Agreement, and the Cimarron Trustee hereby accepts such appointment and agrees to serve in such representative capacity, effective upon the Effective Date."

Paragraph 2.2.1 of the Trust Agreement states, "The exclusive purposes and functions of the Cimarron Trust are to: (i) act as successor to Debtors solely for the purpose of performing, managing, and funding implementation of all decommissioning and/or Site control and maintenance activities

pursuant to the terms and conditions of the Cimarron License, including the preparation and implementation of an NRC-approved decommissioning plan and groundwater remediation plan, and all Environmental Actions required under federal or state law; (ii) own the Cimarron Site; (iii) carry out administrative functions related to the performance of work by or on behalf of the Cimarron Site …".

EPM was therefore selected by NRC and DEQ, in consultation with other regulatory agencies, to function as Trustee for the Trust.

16.3.2 Level of Coverage

The Trust Agreement provided for the creation of and transfer of assets from the Settlors to the Trust. Paragraph 2.1.1 of the Trust Agreement states, "… Tronox Worldwide LLC hereby transfers, assigns, and delivers, by quitclaim deed and other appropriate instruments, to the Cimarron Trust … all of Settlors' right, title and interest in and to the Cimarron Trust Assets. Settlors shall retain no ownership or other residual interest whatsoever with respect to the Cimarron trust, the Cimarron Site."

Paragraph 2.1.2.1 of the Trust Agreement states, "On the Effective Date, the Settlors shall cause to be transferred to or at the direction of the Cimarron Trustee cash in the amount of $8,638,384.00 (the "Funding")."

Paragraph 2.1.2.2 of the Trust Agreement states, "On the Effective Date, the Settlors shall cancel the Cimarron LOC [Letter of Credit] and remit the funds from the Cimarron LOC to the Cimarron Standby Trust Fund already in existence, or to a new Cimarron Standby Trust Fund that may be established by the Cimarron Trustee in accordance with applicable NRC regulations." The Cimarron LOC was a letter of credit for $3,600,000.00. These funds were placed in a Standby Trust Fund; U.S. Bank is the Trustee for this Trust Fund.

Paragraph 2.1.5 of the Trust Agreement established and funded the Trust Accounts. It states, "Upon receipt of the Cimarron Site and The Funding and Consideration, the Cimarron Trustee shall create a segregated Cimarron Trust Federal Environmental Cost Account and a Cimarron Trust State Environmental Cost Account and a segregated Cimarron Standby Trust Fund within the Cimarron Trust. The purpose of the Cimarron Trust Environmental Cost Accounts and the Cimarron Standby Trust Fund shall be to provide funding for future Decommissioning Activities, Environmental Actions and certain future regulatory fees and oversight costs of NRC and the State of Oklahoma with respect to the Cimarron Site. Funding for the Cimarron Trust Environmental Cost

Accounts shall be held in trust for Environmental Actions with respect to the Cimarron Site and may not be used for any Owned or Non-Owned Site except as expressly provided in Section 2.4.3 below. The NRC shall be the sole beneficiary of the Cimarron Standby Trust Fund. The initial funding of the Cimarron Trust Federal Environmental Cost Account shall be a total of $6,588,381.00. The initial funding of the Cimarron Trust State Environmental Cost Account shall be a total of $746,114.00. The funding of the Cimarron Standby Trust Fund shall be the funds from the Cimarron LOC. The Cimarron Trustee shall also create a segregated Cimarron Trust Administrative Account in the amount of $1,303,889.00. The separate accounts are referred to in this Agreement individually as a "Cimarron Trust Account" and collectively as the "Cimarron Trust Accounts."

Paragraph 2.1.8 of the Trust Agreement states, "The Cimarron Trustee shall use the Cimarron Trust Federal Environmental Cost Account and the Cimarron Standby Trust to fund future decommissioning costs pursuant to the Atomic Energy Act of 1954, including the preparation and implementation of an NRC-approved decommissioning plan and groundwater remediation plan, and future regulatory fees of NRC with respect to the Cimarron Site. The Cimarron Trustee shall use the Cimarron Trust State Environmental Cost Account to fund Environmental Actions and certain oversight costs of the State of Oklahoma with respect to the Cimarron Site. To the extent any proposed decommissioning or Environmental Actions in the proposed budget entail overlapping work that qualifies for disbursements from both the Cimarron Trust Federal Environmental Cost Account and the Cimarron Trust State Environmental Cost Account, the Lead Agencies [U.S. NRC and DEQ] and the Cimarron Trustee shall determine an equitable allocation between both Environmental Cost Accounts for such proposed work. The Cimarron Trustee shall use the Cimarron Trust Administrative Account to fund the Cimarron Administrative Costs that have been approved by the Lead Agency and Non-Lead Agency."

Additional funding may be provided to the Trust by the Anadarko Litigation Trust. Subparagraph 55(e) of the Settlement Agreement states, "In settlement of claims of the United States and the State of Oklahoma … the United States and the State of Oklahoma [or the Cimarron Trustee (as described below)] shall receive allocations to the Cimarron Site of specified percentages of the Anadarko Litigation Proceeds as set forth in Subparagraph 124(v)."

Subparagraph 124(v) of the Settlement Agreement states, "The Cimarron Trust shall receive … a distribution of 1.75% of the Anadarko Litigation Proceeds, to be allocated as follows: (i) 1.5% for the United States' claim, and (ii) 0.25% for the State of Oklahoma's claim."

Subparagraph 124(cc)(ii) states, "The Cimarron Trust shall receive a distribution of 0.089% of the Anadarko Litigation Proceeds, to be deposited in the Cimarron Trust Administrative Account."

Paragraph 2.1.2.3 of the Trust Agreement states, "… the Anadarko Litigation Trust … shall transfer 1.75% of the Anadarko Litigation Proceeds to the Cimarron Environmental Trust Accounts (1.5% to the Cimarron Trust Federal Environmental Cost Account to be used to decommission and remediate the Cimarron Site, 0.25% to the Cimarron Trust State Environmental Cost Account to be used to conduct or finance Environmental Actions at the Cimarron Site) and 0.089% of the Anadarko Litigation Proceeds, to be deposited in the Cimarron Trust Administrative Account pursuant to the terms of the Plan of Reorganization, the Litigation Trust Agreement, and the Settlement Agreement."

Paragraph 4.2 of the Trust Agreement states, "The Cimarron Trustee shall have no obligations to perform any activities for which the relevant Environmental Cost Account lacks sufficient funds."

16.3.3 Monitoring and Maintenance Funding

The financial assurance coverage provided by the February 14, 2011 *Consent Decree and Environmental Settlement Agreement* (Settlement Agreement) and *Environmental Response Trust Agreement* (the Trust Agreement) for site control and maintenance consists of funds included in the Cimarron Federal Environmental Cost Account.

Paragraph 3.2.4 of the Trust Agreement states, "The Cimarron Trustee shall also notify the Deputy Director … no later than 180 days prior to the anticipated date, that all contractual and other projected obligations will have exhausted 25%, 50%, and 75% of the Cimarron Federal Environmental Cost Account. Upon notification that 75% of the Cimarron Federal Environmental Cost Account has been exhausted, the Cimarron Trustee shall cease remediation work and commence passive maintenance and monitoring only of the Site in order to provide for the protection of public health and safety using the remaining funds in the Cimarron Federal Environmental Cost Account to fund monitoring and maintenance until further order of the NRC; provided however, that no more than 5% of the remaining funds available in the Cimarron Federal Environmental Cost Account shall be spent in any six-month period without NRC approval. The assets of the Cimarron Standby Trust shall not be accessed by the Cimarron Trustee until further order of the NRC."

Subparagraph 55(e)(ii)(b) states, "The Standby Trustee for the Cimarron Standby Trust Fund is authorized, in consultation with the Cimarron Trustee and the approval of NRC, to transfer from time to time any or all of the assets of the Cimarron Standby Trust Fund to any of the Cimarron Trust Accounts in this Paragraph 55." NRC could therefore authorize the transfer of all or part of the funds

from the Standby Trust for decommissioning activities, or retain all or part of the funds for site monitoring and maintenance.

16.3.4 Trust Agreement

The financial assurance mechanism provided herein consists of several accounts held in Trust; both the amount and the authorized use of these accounts are described in the Trust Agreement. The wording of the Trust Agreement is not identical to the required wording presented in Appendix A of NUREG-1757, because the Trust was not established as a financial assurance mechanism. The Trust was established to create a licensable entity, and an administrative Trustee, to which License SNM-928 could be transferred to complete the decommissioning of the site.

Section A.4.3 of Appendix A to Volume 3 of NUREG-1757 requires that a decommissioning plan include the following documentation with the Trust Agreement:

- Schedule A – identifying the licensee name and address, site address, required funding, etc.
- Schedule B – listing the property used to establish the fund
- Schedule C – specifying compensation to be paid by the licensee to the Trustee
- Specimen certificate of events – example form to be used to document that decommissioning activities can be commenced
- Specimen certificate of resolution – example form to be used to authorize the performance of decommissioning activities
- Letter of acknowledgement – verifying the trustee's position and authority to enter into the Trust Agreement

The Trust Agreement was executed by NRC before a decommissioning plan and associated cost estimate could be prepared; the Trust Agreement does not include Schedules A, B, or C. The information that would be provided in Schedule A is presented in the Certification Statement.

Schedule B is intended to list the property (i.e., cash, securities, or other liquid assets) used to establish the Trust Fund (in this case, the Trust Accounts). This information is provided in the Trust Agreement, as described in Section 16.3.2, above.

Schedule C specifies the compensation to be paid by the licensee to the Trustee for its services. US Bank receives $5,000 per year, paid from the assets of the Standby Trust Fund, to function as Trustee

for the Standby Trust Fund. EPM submits a proposed budget on an annual basis, and is reimbursed for actual costs incurred within the budget approved by the NRC and DEQ as beneficiaries of the Trust. EPM does not charge a fee to function as Trustee.

No specimen certificate of events or certificate of resolution is included in the Trust Agreement. Paragraph 2.1.4.3 of the Trust Agreement states, "Upon NRC and ODEQ approval of the remediation plan, the Cimarron Trustee shall commence remediation of the Cimarron Site pursuant to the terms and conditions of the approved groundwater remediation plan and the Cimarron License." This paragraph provides both the triggering event (i.e., approval of the remediation plan) that would be presented in a Certificate of Events, and the authority of the Trustee to commence the decommissioning activities that would be presented in a Certificate of Resolution. Consequently, these documents are not needed.

* * * *

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18.0 LIST OF ACRONYMS AND ABBREVIATIONS

ADU	ammonium diuranate
ALARA	As Low As Reasonably Achievable
Amsl	above mean sea level
BA1	Burial Area #1
BA2	Burial Area #2
BA3	Burial Area #3
BA4	Burial Area #4
BTP	Branch Technical Position
cfs	cubic feet per second
cm	centimeter
COC	contaminant of concern
DCGL	Derived Concentration Goal Level
DEQ	Oklahoma Department of Environmental Quality
dpm	disintegrations per minute
EP Tox	Extraction Procedure for Toxicity
EPA	United States Environmental Protection Agency
EPM	Environmental Project Management LLC
Fe(OH)3	ferric hydroxide
ft	foot/feet
g	gram
GE	Groundwater Extraction
GETR	Groundwater Extraction Trench
GWI	Groundwater Injection
gpm	Gallons per minute
in	inch/inches
in/yr	inches per year
kg	kilogram
km	kilometer
KMNC	Kerr-McGee Nuclear Corporation
LLRW	low-level radioactive waste
m	Meter
MCL	Maximum Contaminant Level
mEq	Milliequivalent
mg/L	milligrams per liter
MPC	maximum permissible contamination
MOFF	Mixed Oxide Fuel Fabrication

NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
OGS	Oklahoma Geological Survey
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PBA	Process Building Area
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
Plan	Decommissioning Plan
PVC	polyvinyl chloride
RAI	Request for Additional Information
RPP	Radiation Protection Program
RSO	Radiation Safety Officer
Site	Cimarron site
SFC	Sequoyah Fuels Corporation
SNM	Special Nuclear Material
TCLP	Toxicity Characteristic Leaching Procedure
Trust	Cimarron Environmental Response Trust
UF4	uranium tetrafluoride
UF6	uranium hexafluoride
UO	uranium oxide
UO2	uranium dioxide
U3O8	uranium octaoxide
UP	Uranium Pond
USGS	United States Geological Survey
WA	Western Area
WAA	Western Alluvial Area
WU	Western Upland
yd	yard
yr	year
%	percent
µg/L	micrograms per liter

APPENDIX A - ECOLOGICAL RESOURCES DOCUMENTATION

APPENDIX B - HISTORICAL AND CULTURAL RESOURCE DOCUMENTATION

APPENDIX C - EXEMPTION OF PACKAGED FISSILE EXEMPT MATERIAL FROM U-235 POSSESSION LIMIT

APPENDIX D - BURNS & MCDONNELL GROUNDWATER REMEDIATION DESIGN DRAWINGS

APPENDIX E - KURION WATER TREATMENT FACILITIES DESIGN DRAWINGS

APPENDIX F - GROUNDWATER FLOW MODEL

APPENDIX G - COST ESTIMATE DETAIL

Note:

The first six pages of this appendix contains cost estimate information for the construction and operation of water treatment systems prepared by Kurion, Inc.

The last sixteen pages of this appendix contains cost estimate information for the construction and operation of groundwater remediation systems prepared by Burns & McDonnell Engineering Company.

Table 16-1 (in the “Tables” section) combines some of this information, such as civil construction, portions of which are contained in each of the two companies’ cost estimates.

APPENDIX H - CERTIFICATION STATEMENT