8.0 PLANNED DECOMMISSIONING ACTIVITIES

Sections 1 through 3 of this 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.

Reducing the concentration of uranium to less than 180 pCi/L is all that is required to complete site decommissioning and obtain unrestricted release from the NRC. However, the concentration of all COCs must be reduced to State Criteria to obtain release without restrictions from the DEQ. The groundwater remediation plan presented in this section is based on the results of groundwater assessment and aquifer testing, groundwater flow modeling, treatability tests conducted in 2013 and 2015, and a pilot test conducted in 2017 and 2018. Construction and installation of systems presented in this section will be performed in accordance with this remediation plan. Data obtained from in-process monitoring of groundwater and water treatment may indicate that modifications to the remediation infrastructure or process are needed. Any modifications will be evaluated in accordance with License Condition 27(e) prior to implementing those modifications.

Design drawings related to groundwater extraction, treated water injection, and discharge aspects of the remediation effort are provided in Appendix J, and will be referenced in the detailed descriptions of those portions of the remediation program. Appendix J has been subdivided into Appendices J-1 through J-6; the following is a description of the contents of each sub-appendix:

- Appendix J-1 – Index of drawings and symbols, notes, and legends that may appear throughout various Appendix J drawings.
- Appendix J-2 – Overall Site plans
- Appendix J-3 – Extraction system details
- Appendix J-4 – Injection system details
- Appendix J-5 – Electrical system details
- Appendix J-6 – Well field details

Design drawings related to groundwater treatment are in Appendix K and will be referenced in the detailed descriptions of groundwater treatment. Appendix K has been subdivided into Appendices K-1 through K-7; the following is a description of the contents of each sub-appendix:

- Appendix K-1 – Index of drawings and symbols that may appear throughout various Appendix K drawings.
- Appendix K-2 – Western Area Treatment Facility
- Appendix K-3 – Western Area Process Overview and Uranium Ion Exchange System
- Appendix K-4 – Spent Resin Handling
- Appendix K-5 – Biodenitrification System and Solids Handling
- Appendix K-6 – Secured Storage Facility
- Appendix K-7 – Burial Area #1 Treatment Facility

8.1 GROUNDWATER REMEDIATION OVERVIEW

This Section provides an overview of the groundwater remediation process. Sections 8.2 through 8.10 provide more detailed descriptions of the aspects of the remediation program introduced in this Section.

8.1.1 Groundwater Remediation Basis of Design

To facilitate planning and communication, the Site has been broadly divided into three areas: BA1, the WAA, and the WU. Several "remediation areas" are located within each one of these broad portions of the Site, with one small area (1206-NORTH) that doesn't fit into any of the three. Each remediation area will have area-specific groundwater remediation infrastructure to reduce COC concentrations based on the COC concentrations and the hydrogeological environment within that remediation area.

BA1 has been subdivided into the following remediation areas:

- BA1-A (the area in which uranium exceeds the NRC Criterion in Sandstone B and the Transition Zone)
- BA1-B (the area in which uranium exceeds the NRC Criterion in alluvial material)
- BA1-C (the area in which uranium exceeds the NRC Criterion in alluvial material)

The WAA has been subdivided into the following remediation areas:

- WAA U>DCGL (the area in which uranium exceeds the NRC Criterion in alluvial material)
- WAA-WEST (one of three areas in which uranium is less than the NRC Criterion in alluvial material)

- WAA-EAST (one of three areas in which uranium is less than the NRC Criterion in alluvial material)
- WAA-BLUFF (one of three areas in which uranium is less than the NRC Criterion in alluvial material)

The WU has been subdivided into the following remediation areas:

- WU-UP1 (the area surrounding and including the former Uranium Pond #1)
- WU-UP2-SSA (the Sandstone A portion of the area surrounding and including the former Uranium Pond #2)
- WU-UP2-SSB (the Sandstone B portion of the area surrounding and including the former Uranium Pond #2)
- WU-PBA (the Process Building Area)
- WU-BA3 (the area surrounding former Burial Area #3)
- WU-1348 (the area downgradient from a former pipeline leak near Monitor Well 1348)

The 1206 Drainage consists of a western branch, an eastern branch, and a confluence area. The 1206 Drainage is cut through Sandstone A and is not hydrologically considered an upland area. The confluence comprises a transition zone between the WU and the WAA. Groundwater extraction for remediation will only be conducted in the northern confluence (transition zone) and this area will be referred to as:

- 1206-NORTH

Remediation areas located in the Western Areas (WA) are shown on Figure 8-1 and remediation areas located in BA1 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 zones of hydraulic influence (groundwater extraction and water injection), geological features, and the estimated locations of contaminant sources. The remediation components depicted for each remediation area are designed to mitigate COC groundwater impacts within the corresponding boundaries of the remediation area. The distinguishing characteristic of each remediation area is not the shape, as defined in this Plan, but the remediation strategy and infrastructure proposed to address groundwater impacts.

The starting point for developing a basis of design is to define existing site conditions (e.g., hydrogeologic environment, nature and extent of contamination, etc.) and identify the remediation goals. A Basis of Design documents the development of a plan to achieve those goals based on the evaluation of available data. The Basis of Design is included as Appendix L.

8.1.2 Groundwater Remediation Process

Groundwater remediation in some remediation areas will be accomplished by recovering impacted groundwater through the installation and operation of extraction wells and/or trenches. The groundwater extraction infrastructure and operations are addressed in detail in Section 8.2, Groundwater Extraction.

Groundwater produced by extraction systems will be treated to reduce the concentration of uranium and nitrate to less than discharge permit limits. Treatment for uranium will consist of removal by ion exchange. Treatment for nitrate will be accomplished through a biodenitrification process facilitated by anoxic bioreactors. Treatment for fluoride is not anticipated because the concentration of fluoride in treatment system influents will be less than the discharge permit limit of 10 mg/L. Groundwater treatment is addressed in detail in Section 8.3, Groundwater Treatment.

Treated water will be injected into select areas to flush contaminants in upland sandstone units and transition zone units to groundwater extraction trenches and wells located in downgradient areas. The injection of treated water will be performed in accordance with the DEQ UIC program. Injection of treated water is addressed in detail in Section 8.4, Treated Water Injection.

All treated water not used for injection will be discharged to the Cimarron River in accordance with OPDES permit OK100510 (Appendix H). The concentrations of COCs in treated water will not exceed OPDES permit limits. Treated water discharge infrastructure, monitoring, and operations are addressed in more detail in Section 8.5, Treated Water Discharge.

8.1.3 In-Process Monitoring

The four categories of in-process monitoring that will be implemented throughout groundwater remediation are: groundwater extraction monitoring, water treatment monitoring, treated water injection and discharge monitoring, and groundwater remediation monitoring. In-process monitoring is described in more detail in Section 8.6, In-Process Monitoring.

8.1.4 Treatment Waste Management

Groundwater treatment will generate two primary types of waste: spent ion exchange resin removed from the uranium treatment system, and biomass removed from the nitrate treatment system. In-process monitoring will provide the data needed to determine when spent resin in the ion exchange system requires replacement. Biomass from the biodenitrification system is continuously separated from the treated effluent and transferred to the solids handling system for further water removal and subsequent packaging for disposal. The management and disposal of these waste streams is addressed in more detail in Section 8.7, Treatment Waste Management.

8.1.5 Post-Remediation Monitoring

Post-remediation monitoring of groundwater will be performed to demonstrate compliance with the NRC Criteria of 180 pCi/L total uranium, and 3,790 pCi/L for Tc-99. Post-remediation monitoring for all areas may begin when all in-process groundwater monitor wells in BA1 yield uranium concentrations below 180 pCi/L for at least three consecutive months. However, remediation may continue beyond the 3-month period to further reduce COC concentrations prior to initiating post-remediation monitoring. The U-235 enrichment in groundwater will decline as the concentration of licensed material in groundwater declines. During post-remediation monitoring, isotopic mass concentrations will be converted to activity concentrations based on the U-235 enrichment calculated for each location. Activity concentrations will be evaluated against the NRC Criterion. Post-remediation groundwater monitoring is addressed in more detail in Section 8.8, Post-Remediation Groundwater Monitoring.

8.1.6 Demobilization

Demobilization of uranium and nitrate treatment systems will occur after post-remediation monitoring confirms that license termination criteria have been achieved. All uranium treatment systems will be demobilized prior to requesting termination of the NRC license. Demobilization of groundwater extraction and injection infrastructure will be performed in each area if post-remediation monitoring demonstrates compliance with State Criteria, or upon approval by the DEQ.

Demobilization will include a final status survey of the WAA treatment system building. Release surveys and final status surveys are addressed in Section 13, Facility Radiation Surveys. Demobilization is addressed in more detail in Section 8.9, Demobilization.

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 State Criteria after license termination.

8.2 GROUNDWATER EXTRACTION

This section presents the 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 C002 through C005 (Appendix J-2).

8.2.1 Groundwater Extraction Wells

Fifteen groundwater extraction wells (GE-WAA-01 through GE-WAA-15) will be screened in alluvial material in the WAA remediation areas. Nine groundwater extraction wells (GE-BA1-02 through GE-BA1-09) 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. Extraction well construction details are provided on Drawing M201 (Appendix J-3).

In December 2016, groundwater samples were collected from discrete depth intervals at 10 locations in the alluvial aquifer. A direct-push rig with a Hydraulic Profiling Tool (HPT) yielded a hydraulic conductivity profile at each location. Evaluation of lab data and the HPT profiles indicated that uranium is not evenly distributed (vertically) throughout the saturated thickness of the aquifer. The results of this evaluation were documented in *Vertical Distribution of Uranium in Groundwater* (Burns & McDonnell, 2017).

In June 2017, DEQ notified EPM that extraction well screens should span the entire interval in which uranium concentrations exceed the MCL. Consequently, extraction well screens will be installed to span this interval, except that in no case will the top of the well screen extend higher than 5 ft below ground surface (bgs).

To accommodate this uneven vertical distribution of uranium in groundwater, the HPT will be advanced at the location of each alluvial groundwater extraction well prior to installation of the well. Groundwater samples will be collected at 2-ft intervals, beginning 1 ft below the top of observed saturation. Groundwater samples will be analyzed for uranium or nitrate to establish a vertical concentration profile for either COC, depending on which is the predominant COC at that location. Extraction well screen intervals will then be selected to span the zone of highest concentration, while also encompassing the saturated interval in which uranium concentrations exceed the MCL. This approach will maximize the mass of contaminant removed while minimizing both the recovery and treatment of uncontaminated groundwater and the time required to achieve remediation goals.

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 ft into the sandstone or mudstone at the base of the alluvium if practical. Subsurface lithology 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. Upon reaching total depth, the boring shall be reamed to a nominal diameter of at least 10 inches. Subsurface lithology will be recorded by the field hydrogeologist on drilling log forms.

The wells will be constructed as detailed on Drawing M201 (Appendix J-3), using 6" poly-vinyl chloride (PVC) well casing with 6" PVC wire-wrapped screen.

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.

The submersible pump installed in each well will include a shroud that draws water down from above the pump motor to the intake at the base of the pump. The flow of water past the motor will cool the motor. The top of the shroud will be located at the zone of maximum COC concentration in each groundwater extraction well, or approximately 3 ft below the average groundwater elevation for that location, whichever is deeper.

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.

A typical groundwater extraction well installation is depicted on Drawing M101 (Appendix J-3). 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 M203 (Appendix J-3). A water level transducer will be installed approximately 2 ft above the top of the pump and a pitless adapter will be installed in the well casing, approximately 2 ft 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-inch diameter by 24-inch deep steel vault, set in a 48-inch diameter by 24-inch deep concrete pad, will be installed over each extraction well. A capped 1-inch galvanized steel pipe shall extend through the concrete pad to approximately 5 ft 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.

After all groundwater extraction wells have been installed, groundwater samples will be collected for laboratory analysis. Extraction wells in the WAA will be analyzed for uranium, nitrate, and fluoride. Extraction wells in BA1 will be analyzed for uranium. The baseline data obtained from these groundwater samples will be compared to initial treatment system influent concentration estimates and used to assess influent concentration trends over the course of remedial operations. These results are expected to demonstrate that that the 95% upper confidence level (95% UCL) COC concentrations used to estimate initial treatment system influent concentrations are higher than actual COC groundwater concentrations.

8.2.2 Groundwater Extraction Trenches

The groundwater remediation system will include a total of four groundwater extraction trenches:

- GETR-BA1-01 was constructed during the Pilot Test. GETR-BA1-01 is approximately 184 ft long and will extract groundwater from the BA1 transition zone material.
- GETR-BA1-02 will be installed in BA1 transition zone material, west of GETR-BA1-01.
- GETR-WU-01 will be installed in the WU-1348 area. This extraction trench will be installed in Sandstone A.
- GETR-WAA-02 will be installed in transition zone material in the 1206-NORTH area.

Groundwater extraction trench subsurface profiles are depicted on Drawing C101 (Appendix J-3) and construction details are provided on Drawing M201 (Appendix J-3).

Extraction Trench Excavation

Stormwater management controls (BMPs) will be implemented in accordance with the site-specific SWPPP prepared for compliance with OPDES Stormwater Permit OKR10. Silt fence (or equivalent) will be installed around the downslope side(s) of "disturbed areas" until permanent vegetation is established. The stormwater permit and SWPPP are provided in Appendix B.

Bi-weekly inspection of BMPs will trigger improvement of BMP installation if evidence of sediment migration or damage to BMPs is noted in inspections. Additional inspections will be performed following precipitation events exceeding 0.5 inches.

Trench GETR-WU-02 will be located within the 100-year floodplain. Both excavated and imported material will be staged outside of the 100-year floodplain if remaining above grade overnight. Trench GETR-WU-02 will be excavated to a minimum width of 2 ft using a tracked excavator. Excavation of this trench will be accomplished using standard excavation and earthmoving construction equipment. Excavation will extend to the base of the transition zone material, generally located at the bedrock interface. The trench may be over-excavated to allow sumps and gravel backfill 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.

Trench GETR-WU-01 will be excavated to the base of Sandstone A, or to a depth of approximately 30 ft, whichever is shallower. Excavation of this trench 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 may be cleaned using a high-pressure water jet or other means to improve hydraulic connection between the trench and the formation.

Trench GETR-BA1-02 will be located within the 100-year floodplain. Both excavated and imported material will be staged outside of the 100-year floodplain if remaining above grade overnight. Excavation of this trench will be accomplished using standard excavation and earthmoving construction equipment. Excavation will extend to the base of the transition zone material, generally located at the bedrock interface. The trench may be over-excavated to allow sumps and gravel backfill 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.

For both GETR-WU-02 and GETR-BA1-01, frac tanks will be staged outside of the 100-year floodplain. Slurry will be mixed and stored in these frac tanks for use in trench excavation. A second disturbed area will be associated with each of these trenches both to stage frac tanks and to stage excavated soil that will be returned to the trench. BMPs will be installed on the downhill side of both disturbed areas in accordance with the requirements of the SWPPP.

A portion of the soil and/or rock excavated from the trenches will be replaced by specified gravel backfill and will not be returned to the excavation. This material will not be stockpiled within the disturbed area associated with the trench; it will be transported to a designated fill area. This area will also be treated as a disturbed area, with BMPs installed in accordance with the SWPPP until a vegetative cover is established.

The locations and sizes of spoil stockpiles will vary based on the length of the trench and the volume of material being stockpiled. All spoils excavated from the trenches that will be returned to the excavation will be stockpiled within the disturbed area associated with the trench, unless the disturbed area is within the 100-year floodplain. BMPs installed downslope from the disturbed area will protect areas downhill/downstream from the disturbed area from being impacted by stormwater-transported sediment.

The disturbed area associated with the construction of the three groundwater extraction trenches are as follows:

- GETR-WU-01 – Approximately 160 ft by 100 ft
- GETR-WU-02 – Approximately 275 ft by 75 ft (an additional disturbed area outside of the 100-year floodplain will be established for the staging of frac tanks and excavated soil that will be returned to the trench.)
- GETR-BA1-02 – Approximately 200 ft by 75 ft (an additional disturbed area outside of the 100-year floodplain will be established for the staging of frac tanks and excavated soil that will be returned to the trench.)

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 C101 (Appendix J-3). 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 on construction drawings.

The groundwater extraction trenches constructed in sandstone (GETR-WU-01) will not require development. For groundwater extraction trenches constructed in transition zone material (GETR-WU-02 and GETR-BA1-02), once the slurry is broken, the trench shall be developed by pumping the approximate volume of slurry in the trench into frac tanks. Trench development information shall be documented by the field geologist or engineer in a field log book.

Drawing M101 (Appendix J-3) 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 M203 (Appendix J-3). A water level transducer will be installed approximately 2 ft 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-inch diameter by 24-inch deep steel vault, set in a 48-inch diameter by 24-inch deep concrete pad, will be installed over each trench sump. A capped 1-inch galvanized steel pipe shall extend through the concrete pad to approximately 5 ft 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.

After all the groundwater extraction trenches have been installed, groundwater samples will be collected for laboratory analysis. Samples collected from extraction trenches GETR-WU-01 and GETR-WU-02 will be analyzed for uranium, nitrate, and fluoride and the sample collected from GETR-BA1-02 will be analyzed for uranium. The baseline data provided by these groundwater samples will be compared to initial treatment system influent concentration estimates and used to assess influent concentration trends over the course of remedial operations. These results are expected to demonstrate that that the 95% UCL COC concentrations used to estimate initial treatment system influent concentrations are higher than actual COC groundwater concentrations.

8.2.3 Piping and Utilities

General locations of groundwater conveyance piping and other well field utilities associated with the groundwater extraction systems are depicted on Drawing C002 (Appendix J-2). Extraction well/trench groupings by trunk line, treatment influent tank, and treatment train are depicted on Figure 8-3, the Well Field and Water Treatment Line Diagram. Mechanical details for extraction well and trench sump wellhead connections, controls, and instrumentation are provided on Drawing M101 (Appendix J-3).

WAA and WU

Partial site plans depicting detailed layouts for groundwater conveyance, discharge piping, water utility piping, electrical power, instrumentation, and communications runs for the WAA and WU are presented on Drawings C003 and C004 (Appendix J-2). Drawing C006 (Appendix J-2) includes a partial plan for the WATF that receives groundwater recovered from all WAA and WU extraction wells and trenches. As shown on the drawings referenced above, individual groundwater conveyance 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 the groundwater influent tank (TK-101) located at the WATF.

The general groundwater extraction branch line configuration for the WAA and WU, including branch-trunk line connections, is depicted on Drawing P101 (Appendix J-3). This drawing also shows the general arrangement of electrical power, instrumentation, and communication service runs for the WAA and WU extraction components. General quantities and subsurface configurations for conduits associated with these utilities are shown on Drawings C105 and C106 (Appendix J-6). 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 WATF and the Remote Terminal Unit cabinet located in the WAA (see Drawing C003, Appendix J-2).

General design information for the electrical power and control system serving WAA and WU groundwater extraction pumps is provided on single-line diagram presented on Drawing E101 (Appendix J-5). Additional cable and conduit design details for WAA and WU electrical service, instrumentation, control, and communication feeds are provided on Drawings E105 through E107 (Appendix J-5). Finally, the WAA and WU control system configuration is depicted on the communication system architecture diagrams provided on Drawings E109 and E110 (Appendix J-5).

BA1

A partial site plan depicting the detailed layout for BA1 groundwater conveyance, discharge piping, electrical power, instrumentation, and communications runs is presented on Drawing C005 (Appendix J-2). Drawing C006 (Appendix J-2) includes a partial plan for 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-201) located at the treatment facility.

The general groundwater extraction branch line configuration for the BA1, including branch-trunk line connection, is depicted on Drawing P102 (Appendix J-3). 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 C106 (Appendix J-6; see Section E 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 WATF 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 E102 (Appendix J-5). Additional cable and conduit design details for BA1 electrical service, instrumentation, and communication feeds are provided on Drawings E105 through E107 (Appendix J-5). Finally, the BA1 control system configuration is depicted on the communication system architecture diagram provided on Drawing and E110 (Appendix J-5).

8.2.4 Groundwater Extraction Strategy by Area

Groundwater extraction components located in the WA are shown on Figure 8-1 and extraction components located in BA1 are shown on Figure 8-2. Figure 8-3, the Well Field and Water Treatment Line Diagram, presents nominal flow rates for each remediation component and anticipated COC concentrations for the combined groundwater influent associated with each treatment system. Groundwater extraction flow rates for each extraction well and trench are also summarized on Drawing P205 (Appendix J-3).

The groundwater flow models were updated to evaluate changes in the revised groundwater remediation strategy and design. The modeling effort completed in 2016 included extensive model updates and calibration checks. The calibration of both models was confirmed using comprehensive groundwater elevation data collected in August 2016. The groundwater flow models were revised again in 2018 to incorporate the remediation components presented in this decommissioning plan. These revisions included:

- Well and trench locations revision;
- Pumping and injection rates were revision;
- Forward and reverse particle tracking analyses to depict capture zones and optimize operating scenarios to eliminate potential stagnation zones; and,
- One extraction well was eliminated in BA1.

No modifications were made to the groundwater flow models updated in 2016 other than the changes listed above. Groundwater flow modeling results are presented in Appendix M.

As discussed in the Basis of Design presented in Appendix L, several performance objectives and design criteria were considered in determining groundwater extraction component locations and pumping rates. Component locations were initially selected based on COC distribution (i.e., plume extent), with the objectives of capturing uranium impacts exceeding the NRC criterion and maximizing capture of COC concentrations exceeding State Criteria. Results from the 2017/2018 Pilot Test were then used to revise WA and BA1 extraction component locations, dimensions, and design parameters to maximize contaminant mass removal, minimize remediation duration, and optimize the overall design. Finally, the updated groundwater models (see above) were used to simulate and optimize the performance of extraction components located in alluvial areas (i.e., the WAA and BA1 alluvium). This included confirmation that remediation components will provide sufficient capture of injected water and groundwater contamination exceeding remediation criteria.

BA1

The technical memorandum *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1* (Burns & McDonnell, 2018c) depicted a complex stratigraphic layering within BA1 transition zone deposits. This technical memorandum demonstrated that the highly variable distribution and interconnection of higher-permeability deposits within the transition zone matrix makes three-dimensional groundwater flow modeling impractical for this area. However, that evaluation, in conjunction with results from pilot testing conducted from September 2017 through February 2018, provided sufficient data to support the re-location of extraction trench GETR-BA1-02 and to establish appropriate injection and extraction rates for BA1 injection and extraction trenches. As shown on Figure 8-2, the extraction of groundwater and injected water from the BA1-A area (including SSB and fine-grained transition zone materials) will be accomplished through the operation of extraction trenches GETR-BA1-01 and GETR-BA1-02.

A particle tracking analysis supported by the site groundwater flow model was conducted to optimize positions and flow rates for extraction wells located in the BA1 alluvium. Appendix L includes figures presenting the output of the particle tracking analysis and demonstrating capture of groundwater exceeding the NRC and State Criteria. Extraction flow rates presented on Drawing P203 P205 (Appendix J-3) for each BA1 extraction well were used in the particle tracking model. Under the pumping scenario depicted in the model, groundwater is extracted from the BA1-A and BA1-B areas (includes SSB, transition zone, and alluvium) at a combined rate of approximately 80 gpm, and from the BA1-C area (alluvium only) at a rate of approximately 20 gpm. Only two extraction wells within the BA1-C area will operate at any given time. During the initial phase of BA1 remediation, GE-BA1-05 through 07 will remain idle and the two most downgradient BA1-C extraction wells (GE-BA1-08 and 9) will be operated to achieve capture of the downgradient extent of groundwater exceeding the State Criterion.

Uranium concentrations in groundwater near GE-BA1-09 are expected to decrease to less than the State Criterion before groundwater near GE-BA1-08, both because the uranium concentration in groundwater near GE-BA1-09 is lower, and because GE-BA1-08 will be drawing groundwater from upgradient areas with higher uranium concentrations. Once in-process monitoring demonstrates that uranium concentrations near GE-BA1-09 have remained below the State Criterion for at least three consecutive months, operation of extraction well GE-BA1-09 will be discontinued and operation of GE-BA1-07 will begin. Eventually, operation of GE-BA1-08 will be discontinued and GE-BA1-06 will begin. This sequence will continue as the BA1-C plume retreats to the south.

Figure 8-4 presents the results of a BA1 particle tracking analysis conducted for that portion of the BA1-B plume that is in alluvial material. The particle tracking analysis demonstrates that particles placed at the boundary of the plume, defined by the 30 μg/L uranium concentration isopleth, are captured by operating extraction wells GE-BA1-02 through 04. The "Nominal Pumping Scenario" shows the capture of all plume boundary particles with the wells operating at the pumping rates shown in Figure 8-3 and Drawing P205 (Appendix J-3). Due to the spacing of particles at the plume boundary, gaps between particle flow lines appear midway between extraction wells, implying that constant-rate pumping from groundwater extraction components may create stagnation zones within the plume. If persistent stagnation zones were to develop within the flow field, groundwater within these zones may not be captured, resulting in incomplete remediation.

Following remediation system startup, a pumping optimization program will be implemented to address agency concerns that steady-state pumping conditions may create stagnation zones between extraction wells. The optimization program will be implemented for groundwater extraction wells GE-BA1-02 through GE-BA1-04 and will include alternating increases/decreases in pumping rates for adjacent extraction wells on a specified time schedule.

To demonstrate the effects of the optimization program on potential BA1 stagnation zones, the Nominal Pumping Scenario shown in Figure 8-4 was annotated by placing an additional particle in the middle of each apparent stagnation zone. Particle tracking analyses were then conducted using both the original plume boundary particles and the additional apparent stagnation zone particles. The model outputs for optimized BA1 pumping scenarios denoted "Operating Scenario 1" and "Operating Scenario 2" are presented on Figure 8-4. As shown on the figure, not only are all the plume boundary particles captured under both optimization scenarios, it is apparent from the stagnation zone particle paths (identified on the figure with green lines) that the pumping optimization program succeeds in eliminating the apparent stagnation zones. The stagnation zone particles report to different extraction components under each operating scenario, illustrating a change in groundwater flow direction within the apparent stagnation zone and complete groundwater capture. As the figure legend explains, the distance between arrows on the particle flow lines represents the distance the particle will travel in 60 days; therefore, the operational time required for each optimized pumping scenario to achieve complete capture of the apparent stagnation zones can be estimated using the model.

Operation of the groundwater extraction wells and trenches in the BA1-A area will continue until in-process monitoring indicates that uranium concentrations throughout BA1 have remained below the NRC Criterion for at least three consecutive months.

WAA U>DCGL, WU-PBA, WU-1348, and WAA-WEST

Since submission of the 2015 *Cimarron Facility Decommissioning Plan*, the decision was made to eliminate much of the infrastructure in the WAA-WEST area and install a single extraction well (GE-WAA-05) near Monitor Well T-97 (see Figure 8-1). The reduced remediation and water treatment infrastructure resulting from this decision enable longer operation of WA groundwater remediation facilities and greater total contaminant mass removal. Groundwater extracted from WAA U>DCGL, WU-PBA, WU-1348, and WAA-WEST extraction components will be delivered to the WATF as a single influent stream. Groundwater extracted from the 1206-NORTH area (discussed separately below) will be delivered in the same influent stream.

The nominal flow rates for groundwater extraction components in these areas are as follows:

- 99 gpm from WAA U>DCGL – extraction wells GE-WAA-01 through GE-WAA-04
- 5 gpm from WU-PBA – extraction well GE-WU-01
- 4 gpm from WU-1348 – extraction trench GETR-WU-01

- 10 gpm from WAA-WEST – extraction well GE-WAA-05

A particle tracking analysis supported by the site groundwater flow model was conducted to optimize the positions and flow rates of extraction wells located in the WAA U>DCGL area. Appendix L includes figures presenting the output of the particle tracking analysis and demonstrating capture of groundwater exceeding the NRC Criterion. Figure 8-5 presents the results of the particle tracking analysis for the WAA U>DCGL plume. The analysis demonstrates that particles placed at the boundary of the plume, defined by the 30 µg/L uranium concentration isopleth, are captured by the operation of extraction wells GE-WAA-01 through 04.

The "Nominal Pumping Scenario" shows the capture of all plume boundary particles with the wells operating at the pumping rates shown in Figure 8-3 and Drawing P205 (Appendix J-3). Due to the spacing of particles at the plume boundary, gaps between particle flow lines appear midway between extraction wells, implying that constant-rate pumping from groundwater extraction components may create stagnation zones within the plume. If persistent stagnation zones were to develop within the flow field, groundwater within these zones may not be captured, resulting in incomplete remediation.

Following remediation system startup, a pumping optimization program will be implemented to address agency concerns that steady-state pumping conditions may create stagnation zones between extraction wells. The optimization program will be implemented for groundwater extraction wells GE-WAA-01 through GE-WAA-04 and will include alternating increases/decreases in pumping rates for adjacent extraction wells on a specified time schedule.

To demonstrate the effects of pumping optimization on potential WAA U>DCGL stagnation zones, the Nominal Pumping Scenario in Figure 8-5 was annotated by placing a particle in the middle of each apparent stagnation zone. Particle tracking analyses were then conducted using both the original plume boundary particles and the additional apparent stagnation zone particles. The model outputs for optimized WAA U>DCGL scenarios denoted "Operating Scenario 1" and "Operating Scenario 2" are presented on Figure 8-5. As shown on the figure, not only are all the particles around the plume boundary captured under both scenarios, it is apparent from the stagnation zone particle paths (identified on the figure with green lines) that the pumping optimization program succeeds in eliminating the apparent stagnation zones. The stagnation zone particles report to different extraction components under each operating scenario, illustrating a change in groundwater flow direction within the apparent stagnation zone and complete groundwater capture. As the figure legend explains, the distance between arrows on the particle flow lines represents the distance the particle will travel in 60 days; therefore, the operational time required for each optimized pumping scenario to achieve complete capture of the apparent stagnation zones can be estimated using the model.

Operation of the groundwater extraction wells in the WAA U>DCGL area will continue until in-process monitoring indicates that uranium concentrations have remained below the NRC Criterion in BA1 for at least three consecutive months.

The WU-PBA area being addressed by GE-WU-01 requires remediation for uranium and nitrate. Operation of the groundwater extraction wells in the WU-PBA area will continue until in-process monitoring indicates that uranium and nitrate concentrations have remained below the State Criteria for at least three consecutive months.

The WU-1348 area being addressed by GETR-WU-01 requires remediation for uranium and fluoride. Operation of the groundwater extraction wells in the WU-1348 area will continue until in-process monitoring indicates that uranium and fluoride concentrations have remained below the State Criteria for at least three consecutive months.

Figure 3-3 shows a 30 µg/L concentration isopleth for uranium that extends south of Monitor Well 1348 to include the area surrounding Monitor Well 1353. The screen interval for Monitor Well 1353 is located within a zone of perched groundwater in Sandstone A. The screen interval for this well is also higher in elevation than the screen intervals associated with Monitor Wells 1348 and 1350. The groundwater elevation in this perched zone is sufficiently high that it was not used to contour groundwater elevations in Sandstone A. From 2013 through 2017, the concentration of uranium in groundwater samples collected from Monitor Well 1353 has varied from greater than 40 µg/L to less than 5 µµg/L. This wide variability caused the 95% UCL value for this location to exceed the maximum concentration, so the maximum concentration was used as the "representative value" for uranium at this location. Groundwater migrating from Monitor Well 1353 will either report to extraction trench GETR-WU-01 or to the 1206 Drainage. The decision was made to designate the area within which both uranium and fluoride exceed State Criteria as the WU-1348 Area.

The WAA-WEST area being addressed by GE-WAA-05 requires remediation for uranium. Operation of the groundwater extraction wells in the WAA-WEST area will continue until in-process monitoring indicates that uranium concentrations have remained below the State Criterion for at least three consecutive months.

Groundwater remediation may be terminated at any time after achieving the NRC Criterion for uranium in the WAA U>DCGL area, should this be necessary to maintain sufficient funding to achieve the NRC Criterion in BA1.

WAA-BLUFF and WAA-EAST

Since the submission of the December 2015 *Cimarron Facility Decommissioning Plan*, the decision was made to eliminate much of the infrastructure in the WAA-EAST area and install two extraction wells in an area of elevated uranium and nitrate concentration north of Monitor Wells T-59 through T-61. The reduced remediation and water treatment infrastructure resulting from this decision enable longer operation of WA groundwater remediation facilities and greater total contaminant mass removal. Groundwater extracted from both the WAA-BLUFF and WAA-EAST areas will be delivered to the WATF as a single influent stream.

The nominal flow rates for groundwater extraction components in these areas follow:

- 104 gpm from WAA-BLUFF – extraction wells GE-WAA-06 through GE-WAA-13
- 20 gpm from the WAA-EAST – extraction wells GE-WAA-14 and GE-WAA-15

The WAA-BLUFF extraction system will recover nitrate and fluoride impacted groundwater both already within the alluvium and groundwater discharging from WU-UP1 and WU-UP2 as treated water is injected into those areas. Groundwater extraction wells GE-WAA-06 through GE-WAA-08 are expected to capture groundwater flushed from the WU-UP1 area while GE-WAA-09 through GE-WAA-13 are expected to capture groundwater flushed from WU-UP2. WAA-BLUFF extraction wells will continue to operate until groundwater in their respective upland areas, as well as the areas surrounding the WAA-BLUFF extraction wells, complies with the State Criteria, or until flow from these wells is longer needed to maintain the minimum WATF influent flow rate, whichever comes first. For the purposes of this Plan it has been assumed that the WAA-BLUFF extraction wells will operate until WATF operations are discontinued.

The WAA-EAST area being addressed by GE-WAA-14 and GE-WAA-15 requires remediation for uranium and nitrate. Operation of the groundwater extraction wells in the WAA-EAST area will continue until in-process monitoring indicates that uranium and nitrate concentrations have remained below the State Criterion for at least three consecutive months, or until operation of the WATF is terminated, whichever comes first.

Once in-process monitoring demonstrates that 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 will be discontinued. Uranium treatment must precede treatment for nitrate, or the biomass generated during biodenitrification may accumulate sufficient uranium to require disposal as LLRW.

1206-NORTH

Uranium in groundwater exceeds the NRC Criterion within the 1206-NORTH area and the State Criteria for uranium, nitrate, and fluoride. Impacted groundwater in this area will be recovered by extraction trench GETR-WU-02 (see Figure 8-1). GETR-WU-02 will also capture seepage from the WU-BA3 area resulting from the injection of treated water in that area (see below). GETR-WU-02 will continue to operate until in-process monitoring indicates that uranium groundwater concentrations throughout the 1206-NORTH area have remained below the NRC Criterion for at least three consecutive months. Operation of GETR-WU-02 may continue until in-process monitoring indicates that uranium, nitrate, and fluoride concentrations have remained below State Criteria for at least three consecutive months. Operation of GETR-WU-02 will cease if operation of the WATF is terminated.

The 1206 Drainage is unique in that it is the only area in which excavation and disposition of sediment will be performed as a groundwater remediation strategy. As reported in the technical memorandum *1206 Drainage Sediment Assessment and Remedial Alternative Evaluation* (Burns & McDonnell, 2018), the west and east branches of the 1206 Drainage contain very small quantities of impacted sediment, and excavation and disposition of this sediment will expedite groundwater remediation in this area. Because the sediment contains concentrations of uranium that are near the EPA screening level for residential soil, the sediment will be mixed with excess spoils generated during injection trench excavation and placed in a soil laydown area. Following mixing and placement, the material will be covered with topsoil and vegetated.

To facilitate the transfer of seepage from WU-BA3 to GETR-WU-02, a slotted pipe will be installed in the east branch of the 1206 drainage to convey the seepage directly to the transition zone material in which GETR-WU-02 is constructed. The same non-reactive gravel used in the construction of injection and extraction trenches will be used as backfill to maintain the integrity of the drainage channel and protect the slotted pipe. The extent of sediment excavation and the installation of the slotted pipe and gravel backfill are shown on Drawing C004 (Appendix J-2).

GETR-WU-02 is projected to produce 8 gpm from the 1206-NORTH area. This water will be combined with groundwater from the WAA U>DCGL, WAA-WEST, WU-PBA, and WU-1348 areas.

8.3 GROUNDWATER TREATMENT

As previously stated and shown on Drawing C002 (Appendix J-2), two groundwater treatment facilities will be installed at the Site. The WATF will be constructed southeast of the former location of UP1 and a smaller facility, the BA1 Treatment Facility, will be constructed at the southern end of BA1. The WATF will include a permanent building housing uranium and nitrate treatment systems as well as the ion exchange resin processing equipment needed to process and package spent resin generated in both WA and BA1 uranium treatment systems. The WATF will also include a separate "secure storage" building (the Secure Storage Facility) for storing drums of LLRW prior to shipment. The location of the Secure Storage Facility, relative to the WATF treatment building is shown on Drawing C006 (Appendix J-2).

The BA1 treatment system will be housed in a modular enclosure. This treatment facility will only contain equipment needed to treat groundwater for uranium. Excluding acid for water treatment, all materials required for treatment system operation will be supplied from the WATF, and all waste generated in BA1 will be transferred to the WATF for storage and/or disposal.

Drawing C-113 (Appendix K-1) includes a utility site plan for the WATF. Utilities required to support this facility include electric, potable water, communications, and septic sewerage. Connections to utilities will be predominately underground with access provided where appropriate.

Drawings C-110 and C-130 (Appendix K-1) present the site layout and facility elevations for the WATF, respectively. The WATF water treatment systems are comprised of uranium ion exchange and nitrate biodenitrification treatment trains as shown on the Process Flow Diagrams, P-110 and P-100 (Appendix K-5). Major WATF components include the following:

- One (1) 5,000-gallon, double-walled acid tank (TK-103)
- One (1) 15,000-gallon, double-walled influent tank (TK-101)
- Two (2) uranium ion exchange (UIX) treatment trains (UIX Trains 1 and 2)
- One (1) 15,000-gallon, single-walled buffer tank located between the UIX and biodenitrification systems (TK-1000)
- A biodenitrification system containing:
    - Two (2) 14,500-gallon, single-walled Stage 1 moving bed biofilm reactor (MBBR) tanks (TK-1050A and TK-1050B)
    - One (1) 14,500-gallon, single-walled Stage 2 MBBR tank (TK-1100)
    - One (1) 12,500-gallon, single-walled flocculation tank (TK-1150)
- One (1) drum filter (F-1200)
- One (1) 6,000-gallon, double-walled methanol tank (TK-2000)
- One (1) 15,000-gallon, single-walled effluent tank (TK-102)

Both uranium treatment trains will be identical, each containing three 48" diameter resin vessels designed for flow rates varying from 100 to 125 gpm, for a total maximum flow rate of 250 gpm. The biodenitrification system will accommodate a flow rate of up to 250 gpm.

Drawing C-220 (Appendix K-7) shows the site grading and utility plan 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 WATF control systems).

Drawings G-200 and G-220 (Appendix K-7) present general arrangement plan and sections for the BA1 Treatment Facility, respectively. The BA1 Treatment Facility will include a single uranium treatment train as shown on Process Flow Diagram Drawing P-210 (Appendix K-7). Major BA1 Treatment Facility components include the following:

- One (1) 1,000-gallon, double-walled acid tank (TK-203)
- One (1) 12,000-gallon, double-walled influent tank (TK-201)

- One (1) UIX treatment train
- One 12,000-gallon, single-walled effluent tank (TK-202)

The uranium treatment train will contain three 48" diameter resin vessels designed for flow rates varying from 70 to 100.

In both areas, connections from the influent tank to the treatment process, and from the treatment process to the effluent tank, will require above ground piping. Heat trace and insulation will be installed on this and other exterior process piping, as required, for freeze protection. The WATF building and the BA1 treatment system enclosure will be equipped with heating and ventilation to protect interior process components (piping and equipment) from freezing and overheating.

8.3.1 Uranium Treatment Facilities

In the WATF, topsoil will be removed from an area measuring approximately 250 ft by 320 ft and stockpiled in an area southeast of the area of construction. Concrete foundations will include:

- An approximately 115 ft by 160 ft foundation for the treatment building
- Two approximately 13 ft ring foundations for the 15,000-gallon influent and effluent tanks
- An approximately 32 ft by 32 ft foundation for the Secure Storage Facility
- An approximately 10 ft by 10 ft foundation for the 5,000-gallon acid storage tank
- An approximately 8 ft by 20 ft foundation for the 6,000-gallon methanol storage tank

A Truegrid® permeable paving system will surround the concrete foundations, creating a total area of approximately 250 ft by 320 ft, as shown on Drawing C-110 (Appendix K-1). As depicted on Drawing C-111 (Appendix K-1), approximately 10,400 cubic yards of clean borrow soil will be required to achieve the proposed final surface elevations. In addition, a drainage channel will be constructed along the southern and eastern perimeter of the paving system to collect and convey stormwater run-on and runoff to the existing drainage channel north of the road (see Drawing C-112 in Appendix K-1). Following construction of the facility, the topsoil will be spread over disturbed soil and in the surrounding area, and vegetation will be established.

In BA1, topsoil will be removed from an area measuring approximately 150 ft by 175 ft and stockpiled in an area west of the area of construction. Concrete foundations will include:

- An approximately 47 ft by 11 ft foundation for the uranium treatment enclosure and 1,000-gallon acid storage tank
- Two approximately 13 ft ring foundations for the 12,000-gallon influent and effluent tanks

A Truegrid® permeable paving system will surround the concrete foundations, creating a total area of approximately 75 ft by 80 ft, as shown on Drawing C-210 (Appendix K-7). Additionally, a gravel "pavement" will surround the Truegrid® permeable paving, creating a total "paved" area of approximately 150 ft by 175 ft, as shown on Drawing C-210 (Appendix K-7). The civil design provides for similar quantities of cut and fill, such that excess spoils will be limited. Following construction of the facility, topsoil will be spread over disturbed soil in the surrounding area, and vegetation will be established. Topographic stormwater diversion will be constructed to divert stormwater from the gravel-paved area.

In both areas, storm water management controls will be installed downslope from the construction area, in accordance with the site-specific SWPPP, as described in Section 5.6.4, Water Resources. BMPs will remain in place until permanent vegetation is established. Bi-weekly and post-precipitation inspections of BMPs will trigger improvement of BMPs if needed. Additional inspections will be performed following precipitation events exceeding 0.5 inches.

8.3.2 Uranium Treatment Systems

Drawing M-110 (Appendix K-3) shows the configuration of a typical UIX treatment train. The components 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 M-210, Appendix K-7).

Each UIX train includes a feed pump that transfers groundwater from an influent tank through lead (primary), lag (secondary), and polishing (tertiary) resin vessels. All resin vessels are of the same size and configuration and include ports for the collection of water samples at the influent of each resin vessel and the effluent of the treatment train.

Each uranium treatment train will include a pH meter at the inlet to monitor the pH of the influent groundwater stream. A metering pump will inject hydrochloric acid into the influent line to maintain a pH of 6.8 – 7.0 standard units. Maintaining this pH range will prevent scaling in the resin vessels without converting the uranyl carbonates to a form that the ion exchange resin would not adsorb efficiently.

The rate of groundwater flow through the resin vessels will be measured by a flowmeter. Each resin vessel will contain approximately 50 ft^3 of anion exchange resin that will exchange the chlorine ions for uranyl carbonate, removing the uranium from the groundwater.

Hydrochloric acid (36 wt. %) and ion exchange resin are the only "consumable" items used within the uranium treatment systems. The following summarizes the predicted usage of these consumables for the BA1 and WATF systems:

Burial Area #1

- Hydrochloric Acid: Usage is anticipated to be approximately 8 gallons/day, supplied from the 1,000-gallon, doubled walled tank located next to the treatment enclosure. The tank will be refilled approximately every 3 months by a chemical delivery truck.
- Resin: Usage is anticipated to be approximately 121 cubic feet per year (cu ft/yr) (approximately 2.5 vessels per year). Fresh resin will be loaded into vessels in the WATF building and transported to BA1. Resin will be delivered to the WATF in drums on pallets by a delivery truck once every 4-5-months.

Western Area Treatment Facility

- Hydrochloric Acid: Usage is anticipated to be approximately 40 gallons/day, supplied from the 5,000-gallon, doubled walled tank located next to the treatment enclosure. The tank will be refilled approximately every 3 months by a chemical delivery truck to the WATF.
- Resin: Usage is anticipated to be approximately 255 cu ft/yr (just over 5 vessels per year for both trains combined). Fresh resin will be loaded into vessels in the WATF building. Resin is expected to be delivered in drums on pallets by a delivery truck once every 4-5-months.

Because the adsorption capacity of the ion exchange resin declines as the uranium concentration in influent groundwater declines, current estimates indicate that no resin vessel will ever accumulate more than 500 grams of U-235. Consequently, a single resin vessel will be unable to adsorb sufficient uranium to exceed the U-235 possession limit of 1,200 grams. Figure 8-6 presents the calculated U-235 loading for each uranium treatment train. 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 ion exchange resin vessel will 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 utilization of the resin capacity and minimize the volume of solid waste generated for disposal.

Once a resin vessel exchange is triggered, the lead vessel will be removed from the treatment train. The valve alignment (OPEN/CLOSED) will be changed such that the lag vessel will become the lead vessel, the polishing vessel will become the lag vessel, and a vessel filled with fresh resin will become the polishing vessel. Spent resin will be processed as described in Section 8.7, Treatment Waste Management, and stored and disposed of as LLRW as described in Section 13, Radioactive Waste Management.

The UIX vessel and valve configuration depicted on Drawings P-115 (Appendix K-3) and P-215 (Appendix K-7) is the same for all three of the UIX treatment trains. Using the valve numbering for UIX Train 1 (P-115, Sheet 1), Table 8-1 shows the required valve position (OPEN or CLOSED) needed to enable use of a given UIX vessel as the lead, lag, or polish vessel.

The time required for effluent from the lead ion exchange vessel to reach the triggering concentration (80% of the influent concentration) is a function of both the rate of flow and the concentration of the uranium. During a system shutdown (planned or resulting from an 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 restart of the system. Temporarily isolating the lead vessel to return the vessel discharge from that vessel to the influent 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. Another option is to remove the lead vessel from service and process the resin as though it is spent. Either of these options can be implemented for any uranium treatment train. In-process monitoring data will provide the information needed to determine the duration of the shutdown requiring implementation of these measures.

Effluent from the two WA uranium treatment trains (UIX Train 1 and UIX Train 2) will be combined and routed to the Nitrate Treatment System Buffer Tank shown on Drawing P-200 (Appendix K-5). Should the nitrate concentration in the blended WATF influent decline to less than 10 mg/L, the effluent from the uranium treatment system will be pumped directly to the WATF effluent tank (TK-102), bypassing the nitrate treatment system.

8.3.3 Biodenitrification Systems

The nitrate treatment (biodenitrification) system is designed to accommodate the combined flow rate of 250 gpm from the two WATF uranium treatment trains (UIX Train 1 and UIX Train 2). The biological denitrification design is based on a MBBR system operated under anoxic conditions. The MBBR is followed by a filtration system which separates suspended solids (biomass) from the treated water. Separated solids are sent to a solids handling system described further in Section 8.7.4. All nitrate treatment system components, except the methanol feed tank, are located within the WATF Building as shown on Drawings G-140 and G-141 (Appendix K-5). An overview of the biodenitrification treatment process follows.

Communities of microorganisms that grow on surfaces are called biofilms. Microorganisms in a biofilm are more resilient to process disturbances than the types of biological communities developed by other treatment processes. In the MBBR technology, the biofilm grows within engineered carriers designed to provide high internal surface area. Because the microorganisms are well protected, they remain in the system longer than suspended-growth microorganisms. This makes the process more tolerant of variations and disturbances. A large protected surface area makes it possible to utilize a more compact treatment system. The process is also easy to maintain and the amount of active biomass is self-regulating, dependent on the incoming nitrate load and the hydraulic retention time (HRT). A chemical oxygen demand (COD) concentration greater than 50 mg/l should be maintained within the system and a HRT greater than 30 minutes is required to maintain biofilm on the media. These should be the only criteria needed to maintain biofilm development within the system.

The biofilm carriers are kept in the reactor by a sieve(s) assembly at the outlet of the reactor. Anoxic reactors require the use of flat panel sieves. The sieve design provides structural strength while maintaining high flow capacity. Treated water passes through the outlet sieves to the solids separation equipment.

For anoxic processes, the MBBR carriers are kept in complete mix conditions, meaning the mixers keep them uniformly suspended throughout the tank. The media will occupy 45% fill of the working volume of the tank. This gives the design flexibility because the media fill can be increased up to 55% of the working volume. Additional media (10% more fill) can be added to increase the surface area, should greater nitrate removal be needed.

The denitrification process involves the biological reduction of nitrate (and/or nitrite) to N_2O, NO, and N_2. Since N_2O, NO, and N_2 are all gaseous, they can easily be lost to the environment. In the absence of dissolved oxygen, the bacteria use nitrate (and nitrite) to respire, while consuming the available carbon. Entrainment of air does not have a significant impact on the performance of anoxic systems in open top tanks. The reactors in the system are also open top for ease of media loading, less expensive fabrication, and minimal risk to the system.

The Biodenitrification Process Flow Diagram is shown on Drawing P100 (Appendix K-5). The nitrate treatment process is comprised of the following major components:

- 15,000-gallon Buffer Tank TK-1000: This tank receives the effluent from the uranium treatment systems, as well as internal recycle streams from the nitrate treatment and solids handling processes.
- 14,500-gallon MBBR Reactors 1A and 1B (TK-1050A and TK-1050B): These tanks, equipped with mixers, provide first-stage biodenitrification.
- 14,500-gallon MMBR Second Stage Reactor TK-1100: This tank, equipped with a mixer, provides second-stage biodenitrification to meet effluent treatment criteria.
- Chemical addition systems for methanol, phosphoric acid, and micronutrients.
- 1,250-gallon Flocculation Tank TK-1150: This tank, equipped with a mixer, incorporates a polymer to assist in the filtration process, separating biomass from treated water.
- Drum Filter F-1200: This is a pre-engineered unit that separates suspended solids from treated water pumped from the flocculation tank. The solids generated by the drum filter are periodically discharged to the Solids Handling System.

Because there will not be sufficient organic matter in the influent stream to sustain the nitrate-degrading microorganisms, an external carbon source (methanol) will be fed into the MBBR as an electron donor to support denitrification. Methanol demand is a function of the measured level of nitrate fed to the reactor, the target effluent nitrate level, dissolved oxygen (DO) and flow rate. The current design includes the equipment required for automatic methanol dosing, namely: an influent flowmeter and nitrate analyzers for influent and effluent flows. The process will also require addition of ortho-P (as a nutrient) to provide optimal conditions for bacterial growth. The design includes the equipment required for automatic dosing of the appropriate amount of ortho-P (as phosphoric acid). Provisions to feed a micronutrient blend are included since the uranium ion exchange system may remove trace metals needed for microbial growth. The design incorporates the flexibility to dose the MBBR chemicals automatically or manually. The following is a summary of the chemical usage for the biodenitrification treatment process, based on a 250-gpm flow with an influent nitrate concentration of 100 mg/L NO_3-N:

- Methanol: Usage is anticipated to be approximately 140 gallons/day, supplied from an 8,000-gallon, double-walled tank located outside the WATF building. The tank will be refilled once every 2 months by a chemical delivery truck.
- Phosphoric Acid: Usage is anticipated to be approximately 2 gallons/day, supplied from a 55-gallon drum located within the WATF building on a feed pump station equipped with secondary containment. The drum will be replaced once a month with a new drum delivered to the WATF building by truck. Interim storage is not expected to be more than 1-2 weeks. Phosphoric acid will be stored in a designated area with appropriate controls to limit interaction with other chemicals.
- Micronutrients: Micronutrients consist of primarily metal compounds in a liquid solution which maintain a healthy biomass. The micronutrients which will be injected into the influent to the bioreactors consist of ferric sulfate, manganese sulfate, cobalt sulfate, boric acid, nickel chloride, sodium selenite, zinc sulfate, coper sulfate, and sodium molybdate. Usage is anticipated to be less than a half-gallon/day, supplied from a 55-gallon drum located within the WATF building on a feed pump station equipped with secondary containment. The drum will be replaced once every 6 months with a new drum delivered to the WATF building by truck. Interim storage is not expected to be more than 1-2 weeks. Micronutrients will be stored in a designated area with appropriate controls to limit interaction with other chemicals.
- Emulsion Polymer (for Flocculation Tank): Usage is anticipated to be just over one gallon/day, supplied from a 55-gallon drum located within the WATF building on a feed pump station equipped with secondary containment. The drum will be replaced once every 2 months with a new drum delivered to the WATF building by truck. Interim storage is not expected to be more than 1-2 weeks. Emulsion polymer will be stored in a designated area with appropriate controls to limit interaction with other chemicals.

Once the initial microorganism culture is established, normal operation of the biodenitrification system is expected to occur as described in the following paragraph. Component sizes and discussed instrumentation are also shown on P&ID Drawings P200, P201, P203, P204, P206, P207, and P210 (Appendix K-5).

Water from the uranium treatment system is transferred to a 15,000-gallon buffer tank, providing approximately 60 minutes of retention time based on the incoming flow. The motive force for this transfer is provided by the uranium treatment system. This tank also receives internal recycle streams from the nitrate treatment system, including sludge thickener overflow, filter press filtrate, and effluent recycle (which may occur in the case of plant shutdown or detection of off-spec effluent). The tank will normally be maintained at a fluid level of 50% or less of capacity to provide buffering of these intermittent streams. A transfer pump controlled by a variable frequency drive (VFD) will forward flow to the MBBR tanks based on the fluid level in the buffer tank or a pre-set flow rate. The buffer tank will be equipped with a level sensor; in the event of high levels, the flow to the uranium treatment system will be reduced or stopped.

The flow through the first- and second-stage reactors into the drum filter is by gravity. In the reactors, microorganisms will remove oxygen from nitrate molecules, converting the nitrate into nitrogen gas that will be released to the atmosphere. This process requires anoxic conditions, where there is an absence of dissolved oxygen. Mechanical mixers will maintain suspension of the MBBR media in the reactors to ensure that there is effective contact between the microbial film on the MBBR media and the substrate in the water.

A two-stage reactor system (with the first stage comprised of two bioreactors) was selected based on a design flow rate of 250 gpm and inlet nitrate concentration of 100 mg/L. The bioreactors can be built off-site, transported, and then installed in the WATF building. Piping and valving is provided to enable reactors to be taken off-line as the inlet nitrate concentration decreases (which requires less biofilm to achieve the treated effluent nitrate target of less than 10 mg/L). The configurations identified for a 250-gpm system as nitrate concentration declines are:

- Two first-stage reactors followed by the second-stage reactor: Inlet nitrate concentration between 100 and 66 mg/L
- One first-stage reactor followed by the second-stage reactor: Inlet nitrate concentration between 66 and 27 mg/L
- Second-stage reactor only: Inlet nitrate concentration less than 27 mg/L

A high-level switch provided in each of the first MBBR tanks will stop forward flow to the MBBRs if alarmed. If the nitrate concentration measured in the effluent (via effluent nitrate probe) is above the permitted limit (10 mg/L), the effluent from the treated water sump will be directed back to the buffer tank, and troubleshooting will commence. Once the effluent nitrate concentration returns to less than 10 mg/L, recycle will stop and forward flow will resume. These start/stop conditions are not expected to occur once the system is acclimated and operating in a steady state conditions; however, these provisions have been developed in the event the system or components experiences a malfunction or other unexpected loss of performance.

The effluent from the MBBR system, containing the sloughed and detached biomass to be removed from the system along with any inert TSS transported with the influent groundwater, will flow by gravity to the flocculation tank. Polymer will be dosed into the tank, based on the influent flow rate, and a mixer will agitate the water to encourage flocculation of the biosolids. Flocculation should occur almost instantaneously. If polymer dosing and/or mixing fails, filtration will still occur, but it will be less effective.

The water will flow by gravity from the flocculation tank to the drum filter. The self-contained Hydrotech drum filter package unit is sized for the peak flow and peak solids load. The drum filter unit consists of filter panels mounted on a drum installed within a covered tank. The filter unit is equipped with an integral backwash strainer and pump, piping and associated nozzles, and the required instrumentation and controls. The package also includes nozzles for chemical cleaning of the filter media if required. A chemical cleaning trolley, including a fully mounted magnetic driven pump, chemical storage container, and controls is included for periodic cleaning of the filter panels.

Influent flows by gravity from the flocculation tank into the center of the drum. Solids are separated from the water by a microscreen cloth mounted on the drum. A 40-micron cloth was chosen for this project because the solids will primarily consist of biomass, which is typically larger than 40 microns. Any particle with a sphericity greater than 0.95 and larger than 40 microns will be captured by the filter.

The buildup of captured solids increases the head loss across the drum filter causing the inlet water level to rise. At a pre-determined level, a backwash cycle is initiated, which involves rotating the drum, placing clean filter elements into the flow path, and cleaning the filter elements with high-pressure jets. The backwash water is collected in a trough in the center of the drum and flows away by gravity. After the backwash cycle, the rotation of the drum and the backwash pump are stopped. Filtration is continuous even during the backwash cycle. The clean filtrate that leaves the drum filter gravity flows to the treated wastewater sump from which it is pumped to Effluent Tank TK-102 for discharge or injection.

If the drum filter unit were to stop functioning, meaning the drum ceased to rotate and/or the backwash pump did not work, some of the water would pass through the filter, and the excess would overflow into the backwash sump. From there, it would be routed through the solids handling system and recycled to the buffer tank.

The drum filter backwash water will flow by gravity to a sump/pump station. The volume of backwash water from the drum filter is anticipated to range from 1% – 3% of the influent flow. Under normal conditions, this is an intermittent flow. If the backwash sump level alarms high, the forward flow to the MBBR will be shut off. This is not expected to happen, but provisions are included for safety.

8.3.4 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. This section describes the treatment planned for influent groundwater streams generated by each WA remediation area. The WATF includes one influent tank (TK-101) that will receive groundwater from two trunk lines, TL-01 and TL-02. The trunk lines will transfer groundwater from different remediation areas to TK-101.

TK-101 will serve as the influent tank for UIX Treatment Trains 1 and 2. Based on an evaluation presented to the NRC and the DEQ in August 2017, the enrichment of the uranium in this groundwater is estimated (at the 95% UCL) to be approximately 2.6%. This enrichment value will initially be used to calculate the estimated content of U-235 accumulating in the ion exchange resin. Results from the isotopic analysis of samples of the ion exchange resin, as described in Section 8.6.3, will provide a more accurate enrichment value than can be calculated from groundwater data. Following collection and analysis of the first resin samples, the enrichment value based on groundwater data will be replaced by more accurate values derived from isotopic laboratory analytical results. Enrichment values obtained from each batch of processed resin will be used to estimate the content of U-235 accumulating in the ion exchange resin through the next batch of ion exchange resin for that treatment train.

WAA U>DCGL, WAA-WEST, WU-PBA, 1206-NORTH, and WU-1348

Trunk Line TL-01 will transfer groundwater produced by the WAA U > DCGL, WAA-WEST, WU-PBA, 1206-NORTH, and WU-1348 remediation areas to TK-101.

As shown on Figure 8-3, the four extraction wells (GE-WAA-01 through GE-WAA-04) required for remediation of the WAA U>DCGL area combine to produce an estimated total of 99 gpm; the single extraction well for the WAA-WEST area (GE-WAA-05) is estimated to produce 10 gpm; and the WU-PBA, 1206-NORTH, and WU-1348 groundwater extraction components (GE-WU-01, GETR-WU-01, and GETR-WU-01, respectively) combine to produce an estimated flow rate of 17 gpm. Consequently, the total estimated flow through this trunk line is 116 gpm.

Based on historical data, groundwater conveyed to Influent Tank TK-101 from these components is anticipated to initially contain uranium at a concentration that exceeds the NRC Criterion, nitrate that exceeds the State Criteria, and fluoride at a concentration below the OPDES permit discharge limit.

WAA-BLUFF and WAA-EAST

Trunk Line TL-02 will transfer groundwater produced by the WAA-BLUFF and WAA-EAST remediation areas to TK-101. 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 104 gpm. The two extraction wells installed in the WAA-EAST area are estimated to produce a total of 20 gpm. Together, these components will deliver approximately 124 gpm to TK-101.

Based on historical data, groundwater conveyed to Influent Tank TK-101 from these components will initially contain concentrations of nitrate and fluoride exceeding State Criteria.

Treatment for uranium will continue until the concentration of both uranium and nitrate in TK-101 are less than their respective MCL for a minimum of two consecutive months. At that time, the flow from TK-101 will bypass both UIX and nitrate treatment, and flow directly to Effluent Tank TK-102. Treatment for nitrate may be bypassed if the nitrate concentration in Influent Tank TK-101 is less than 10 mg/L, whether or not uranium treatment is required.

8.3.5 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.

Only three of the five wells in the BA1-B area will be operational at any given time, limiting groundwater production from these wells to a combined 66 gpm, via Trunk Line TL-03 (see Figure 8-3). Only two of the three wells in the BA1-C area will be operational at any given time, limiting groundwater production from these wells to a combined 20 gpm, via Trunk Line TL-03. The two trenches installed in BA1-A (GETR-BA1-01 and GETR-BA1-02) are estimated to produce a combined 14 gpm, via Trunk Line TL-03. 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 NRC Criterion, and background concentrations of nitrate and fluoride. Groundwater from TK-201 will be treated only for uranium prior to transfer to the BA1 Effluent Tank (TK-202).

Based on historical data, the enrichment of the uranium in BA1 groundwater is estimated to be 1.3% at the 95% UCL. This enrichment value will initially be used to calculate the estimated content of U-235 accumulating in the ion exchange resin. Results from the isotopic analysis of ion exchange resin samples, as described in Section 8.6.3, will provide a more accurate enrichment value than can be calculated from groundwater data. Following collection and analysis of the first resin samples, the enrichment value based on groundwater data will be replaced by more accurate values derived from isotopic laboratory analytical results. The enrichment values for each batch of ion exchange resin will be used to estimate the content of U-235 accumulating in the next batch of ion exchange resin.

Removal of uranium will continue until the concentration of uranium in TK-201 is less than 30 μg/L for two consecutive months. At that time, influent groundwater discharging to TK-201 will bypass UIX treatment and be routed directly to TK-202.

8.3.6 Start-Up and Commissioning

The skid-based approach for the uranium treatment systems will enable acceptance testing at the fabrication shop including, but not limited to: verification of pump flow rate using the end valve to adjust system back pressure, pipe pressure testing, and verification of monitoring and control components, sampling methods, fit-up of vessels with piping, and ease of access for manually operated components. Once accepted at the fabrication shop, the skids will be transported to the Site for installation and connected via field-installed piping, power, and communication cables.

Commissioning is expected to be limited primarily to integrated checks of hydraulic performance and control and communication systems. For the WATF, the UIX system start-up requires coordination with the nitrate treatment system since the UIX system is upstream of the biodenitrification system. For BA1, start-up activities should be able to commence as soon as leak testing of field piping connections is complete.

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 downgradient areas where it will be captured by 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 their respective MCLs will be injected.

Pilot tests conducted from September 2017 through February 2018 demonstrated that injection trenches constructed in BA1-A, WU-UP1, and WU-UP2 remediation areas, within Sandstone A, are capable of delivering more treated water per square foot of saturated trench surface than had been estimated based on borehole packer test results and the groundwater flow model. In response to NRC comments regarding the orientation and dimensions of injection trenches in WU-UP1, this trench network was modified following a field assessment of the lineation of joints evident in Sandstone A outcrops. The WU-UP2 trench network configuration was also reviewed following the bedrock lineament investigation but no design modifications were warranted.

The injection pilot tests conducted in WU-UP1 and WU-UP2 provided sufficient information to not only confirm the efficacy of the modified WU-UP1 trench network configuration, but to develop updated, and significantly higher, achievable water infiltration rate estimates for the WU-UP1 and WU-UP2 injection trench networks. Based on these higher infiltration rate estimates and other data obtained from the pilot tests, WU-UP1 and WU-UP2 injection trench network optimization measures, including the shortening and/or elimination of several trench segments, were implemented. Design implications resulting from the pilot test program are detailed in Section 8.0 of the Remediation Pilot Test Report.

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 C002, C004 and C005 (Appendix J-2).

8.4.1 Water Injection Trenches

A total of six more treated water injection trenches will be installed at the Site. These include the following:

- GWI-WU-01 – This trench will be approximately 225 ft long. It will be installed in Sandstone A in the WU-BA3 area.
- GWI-UP1-03 – This trench will be approximately 125 ft long. It will be installed in Sandstone A in the WU-UP1 area.
- GWI-UP1-04 – This trench will be approximately 125 ft long. It will be installed in Sandstone A in the WU-UP1 area.
- GWI-UP2-01 – This trench will be approximately 475 ft long. Approximately 175 ft of this trench was constructed during the 2017/2018 Pilot Test, so approximately 300 ft of this trench will be constructed during the full-scale program. It will be installed in Sandstone A in the western portion of the WU-UP2 area.
- GWI-UP2-04 – This trench will be approximately 310 ft long. It will be installed in Sandstone A in the eastern portion of the WU-UP2 area.
- GWI-BA1-02 – This trench will be approximately 110 ft long. It will be installed in Sandstone B in the BA1-A area.
- GWI-BA1-03 – This trench will be approximately 100 ft long. It will be installed in Sandstone B in the BA1-A area.

The following three treated water injection trenches were installed during the 2017/2018 Pilot Test:

- GWI-UP1-01 – This trench is approximately 185 ft long. It was installed in Sandstone A in the WU-UP1 area.
- GWI-UP1-02 – This trench is approximately 210 ft long. It was installed in Sandstone A in the WU-UP1 area.

- GWI-BA1-01 – This trench is approximately 175 ft long. It was installed in Sandstone B at the southern end of the BA1-A area.

Groundwater injection trench subsurface profiles are depicted on Drawings C102 through C104, and construction details are provided on Drawing M202 (Appendix J-4).

Prior to trenching, the top four to six inches of soil (topsoil) will be stripped from the trench area and stockpiled nearby. BMPs will be installed around the topsoil stockpile. 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 ft bgs). This soil will be stockpiled separately, also near the trench, and BMPs will be installed around the downslope sides of the stockpile.

Trenches will be excavated to a minimum width of 2 ft using a tracked excavator. Due to the weathered nature of Sandstone A bedrock in the WU, and Sandstone B bedrock in BA1, the use of standard excavation and earthmoving construction equipment (e.g., track excavators and bulldozers) is suitable for injection trench excavation. This was confirmed during exploratory trenching activities performed at site during the 2017/2018 Pilot Test. Excavations will extend to the base of the transition zone material, generally located at the bedrock interface. Soil excavated from the extraction trench will be stockpiled with the soil that was removed for the access trench.

License Condition 27(c) stipulates the use of volumetric averaging in Subarea O in accordance with *Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soils* (NRC, 1997). This volumetric averaging of uranium in subsurface soil was used in the WU-UP1 and WU-UP2 Areas to demonstrate that the areas were releasable for unrestricted use. Review of the final status survey data for subsurface soil in these areas indicated that subsurface soil "at depth" contains uranium with an average concentration above the 30 pCi/g limit for uranium in soil elsewhere on site. In WU-UP1, the average concentration of uranium in soil exceeds 30 pCi/g from 6 ft in depth to the top of rock (auger refusal), typically at 9 to 10 ft below grade. In WU-UP2, the average concentration of uranium in soil exceeds 30 pCi/g from 5 ft. in depth to the top of rock (auger refusal), also typically 9 to 10 ft below grade. Within the footprint of the former ponds, soil excavated from the subject depth intervals will be stockpiled separately from other excavated soil; BMPs will be installed around the downslope sides of these potentially impacted soil stockpiles, and the stockpiles will be covered to prevent migration via stormwater runoff. These potentially impacted soils will be returned to the same depth intervals when the trench is backfilled.

Excavator-mounted pneumatic hammers or other rock excavation equipment will be employed, if necessary, to achieve the required trench depths. Injection trench excavations are expected to remain open during construction; high-density slurries or excavation shoring techniques are not anticipated to be necessary.

Excavated rock will be stockpiled separately; that portion of the excavated rock that is displaced by specified gravel fill will be transported to the dry detention basin shown on Drawing C001 (Appendix J-2). BMPs will be installed around the excavated rock that is not displaced by specified gravel fill.

Trenches GWI-BA1-02 and GWI-BA1-03 are in the 100-year floodplain. Both excavated and staged material will be staged outside of the 100-year floodplain if remaining above grade overnight. Only material which will be placed back in the trench the same day will be staged near the trench.

Following excavation of each injection trench, the bedrock walls and bottom of the trench may 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 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.

The disturbed area associated with the construction of GWI-WU-01 is anticipated to be approximately 270 ft by 50 ft. The disturbed area associated with the construction of GWI-UP1-03 and GWI-UP1-04 will be managed as a single disturbed area. The disturbed area associated with the construction of GWI-UP2-01 is anticipated to be approximately 350 ft by 50 ft. The disturbed area associated with the construction of GWI-UP2-04 is anticipated to be approximately

350 ft by 50 ft. The disturbed area associated with the construction of GWI-BA1-02 and GWI-BA1-03 will be managed as a single disturbed area.

Stormwater management controls will be implemented in accordance with the site-specific SWPPP prepared for compliance with OPDES Stormwater Permit OKR10. BMPs include the installation of silt fence (or other equivalent measures) around the downslope side(s) of disturbed areas until permanent vegetation is established. Bi-weekly inspection of BMPs will trigger improvement of BMP installation if evidence of migration is noted in inspections. Additional inspections will be performed following precipitation events exceeding 0.5 inches.

WU-BA3

Injection trench GWI-WU-01 will be excavated to a length of approximately 225 ft. The trench will be located east of the 1206 Drainage and upgradient of the former BA3. 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 C103 (Appendix J-4). In this area, a depth of 25 ft should fully penetrate Sandstone A. The trench will be positioned and oriented to achieve maximum penetration and interconnection of the former BA3 waste disposal trenches. Uranium impact is 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 8 gpm of treated water will be injected into this trench.

WU-UP1

Injection trenches GWI-UP1-01 and GWI-UP1-02 were installed during the 2017/2018 Pilot Test. These trenches consisted of north-south and northeast-southwest trending segments to achieve maximum communication with the Sandstone A formation, as well as interconnection of secondary porosity features. The orientation and dimensions of for remaining injection trenches to be installed in WU-UP1 (GWI-UP1-03 and GWI-UP1-04) were developed based on the results of the Pilot Test. The WU-UP1 injection trench network is intended to maximize injected water distribution over the relatively large WU-UP1 remediation area, aiding distribution of the significant volume of treated water required for remediation of the Sandstone A formation underlying the former WU-UP1. The total combined length of the four WU-UP1 trench segments is approximately 650 ft.

One injection well will be installed in GWI-UP1-03 and another will be installed in GWI-UP1-04. These wells will provide even distribution of treated water throughout each of the trenches. A cross-sectional depiction of the GWI-UP1-03 and GWI-UP1-04 and the associated wells are shown on Drawing C103 (Appendix J-4). In this area, full penetration of Sandstone A would require trenching to depths greater than 25 ft bgs; a minimum Sandstone A penetration depth of 10 ft is required for the WU-UP1 injection trench system. Nominal 7 gpm of treated water will be injected into each these trenches (GWI-UP1-03 and GWI-UP1-04) and a nominal 44 gpm will be injected into the WU-UP1 injection trench network.

WU-UP2

175-ft injection trench GWI-UP2-01 was constructed during the 2017/2018 Pilot Test; approximately 300 additional ft of GWI-UP2-01 will be constructed during the full-scale program. This trench is oriented east-west to achieve maximum communication with the Sandstone A formation and interconnection of secondary porosity features. One additional injection well will be installed in GWI-UP2-01 and a nominal 35 gpm of treated water will be injected into the trench.

Injection trench GWI-UP2-04 will have a total length of approximately 310 ft. This trench system consists of two segments designed to drive flow to the north-northwest. This design is intended to maximize injected water distribution over the relatively large WU-UP2 remediation area. Two injection wells will be installed in GWI-UP2-04 and a nominal 21 gpm of treated water will be injected into the trench.

An impervious barrier consisting of geosynthetic clay liner will be installed on the upgradient walls of the WU-UP2 injection trenches to minimize the flow of water to the south and southeast. The liner will be installed prior to placement of trench backfill material. Cross-sectional depictions of the WU-UP2 injection trenches and wells are shown on Drawing C102 (Appendix J-4). In the WU-UP2 area, a depth of 25 ft should nearly penetrate Sandstone A.

BURIAL AREA #1

Injection trench GWI-BA1-01 was constructed during the 2017/2018 Pilot Test. This injection trench is approximately 175 ft long and averages approximately 20 ft in depth. One injection well was installed in the approximate center of this trench, essentially penetrating Sandstone B. The trench is positioned and oriented to achieve maximum penetration and interconnection of the former BA1 waste disposal trenches. A nominal 10 gpm of treated water will be injected into this trench.

Injection trenches GWI-BA1-02 and GWI-BA1-03 will be excavated as shown on Drawing C104 (Appendix J-4). Both injection trenches will essentially penetrate Sandstone B. Both trenches are positioned to drive residual uranium in Sandstone B toward the transition zone for capture via groundwater extraction trenches, and toward the BA1-B area for capture via groundwater extraction wells. A nominal 4 gpm of treated water will be injected into each trench.

8.4.2 Water Injection Wells

Fourteen groundwater injection wells listed on Drawing M202 (Appendix J-4) will be screened in Sandstone A and B formations within WU and BA1 remediation areas (four were installed during the 2017/2018 Pilot Test). All but two of the wells (GWI-UP-02 and GWI-UP2-03) will be installed within injection trenches and screened within the trench drainage layer. Injection wells GWI-UP-02 and GWI-UP-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 M202 (Appendix J-4).

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 M202 (Appendix J-4), using 6" PVC well casing with 6" PVC wire-wrapped screen. Injection well screens will extend no higher than 5 ft 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 GWI-UP-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 at least 10 inches. Cuttings will be logged and lithology will be recorded by the field hydrogeologist on drilling log forms.

Groundwater injection wells GWI-UP-02 and GWI-UP2-03 will be constructed, as detailed on Drawing M202 (Appendix J-4), using 6-inch PVC well casing with 6-inch PVC wire-wrapped screen. Injection well screens will extend no higher than 5 ft bgs. The annular filter pack for GWI-UP-02 and GWI-UP-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.

Drawing M102 (Appendix J-4) 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 ft 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 ft above the injection drop pipe outlet. A 24-inch diameter by 24-inch deep steel well vault, set in a 48-inch diameter by 24-inch deep concrete pad will be installed over each well. A capped 1-inch galvanized steel pipe shall extend through the concrete pad to approximately 5 ft 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 WU injection wells and trenches will consist of a self-contained unit housed in a modular enclosure and installed adjacent to the WATF 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 WU injection system is depicted on several design drawings, including Drawing C-110 (Appendix K-1) and Drawing C006 (Appendix J-2). The location of the BA1 injection system is depicted on Drawing C-210 (Appendix K-7) and Drawing C006 (Appendix J-2).

A P&ID for the WU water injection system is provided on Drawing P103 (Appendix J-4). As shown on the drawing, treated groundwater is supplied to an injection feed tank (TK-001) from the WA Effluent Tank (TK-102). An actuated valve (MOV-012) 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 WU injection system to be installed adjacent to the WATF building is depicted on Drawing M103 (Appendix J-4). A total of 11 dedicated injection manifold lines will deliver treated groundwater to the 11 WU injection wells.

A P&ID for the BA1 water injection system is provided on Drawing P104 (Appendix J-4). As shown on the drawing, treated groundwater is supplied to an injection feed tank (TK-003) by the BA1 Effluent Tank (TK-201). The process rationale and control logic for the BA1 injection system are the same as those described above for the WU injection system. The general arrangement of the BA1 injection system is depicted on Drawing BMCD-GWREMED-M104.

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 C002 (Appendix J-2). Mechanical details for injection well wellhead piping connections and instrumentation are provided on Drawing M102 (Appendix J-4).

WU

A partial site plan depicting detailed layouts for water conveyance piping and instrumentation conduits for the WU injection components is presented on Drawing C004 (Appendix J-2). Drawing C006 (Appendix J-2) includes a partial plan for the WATF where the injection system delivering treated groundwater to all WU injection wells and trenches is located. As shown on the drawings referenced above, multiple water injection piping runs will convey treated groundwater from the WU injection system to WU-BA3, WU-UP1, and WU-UP2 injection components. A total of 11 dedicated injection piping runs will deliver treated groundwater to the 11 WU injection wells.

The general groundwater injection water conveyance piping configuration for the WU is depicted on Drawing P103 (Appendix J-4). This drawing also shows the general arrangement of instrumentation service runs for the WU injection wells, and the general arrangement of electrical power, instrumentation, and communication services for the WU injection system located in the WATF. General quantities and subsurface configurations for instrumentation conduits associated with the injection wells are shown on Drawings C105 and C106 (Appendix J-6). As shown on these drawings, dedicated conduits are provided for the routing of 24-volt direct current instrumentation cables required for transmission of water level transducer signals.

General design information for the electrical power and control system serving the WU groundwater injection system is provided on the single-line diagram presented on Drawing E101 (Appendix J-5). Additional cable and conduit design details for the WU injection system electrical service, instrumentation, control, and communication feeds are provided on Drawings E105 through E107 (Appendix J-5). Finally, the WU control system configuration is depicted on the communication system architecture diagrams provided on Drawings E109 and E110 (Appendix J-5).

Burial Area #1

A partial site plan depicting detailed layouts for water conveyance piping and instrumentation conduits for the BA1 injection components is presented on Drawing C005 (Appendix J-2). Drawing C006 (Appendix J-2) includes a partial plan for 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 three BA1 injection wells/trenches.

The general groundwater injection water conveyance piping configuration for the BA1 is depicted on Drawing P104 (Appendix J-4). 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 C106 (Appendix J-6). 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 E102. Additional cable and conduit design details for the BA1 injection system electrical service, instrumentation, control, and communication feeds are provided on Drawings E105 through E107 (Appendix J-5). Finally, the BA1 control system configuration is depicted on the communication system architecture diagrams provided on Drawings E109 and E110 (Appendix J-5).

8.4.5 Water Injection Strategy by Area

The anticipated groundwater injection flow rates for each injection well/trench are summarized on Drawing P203 (Appendix J-3). The strategies for treated water injection in applicable remediation areas and areas are detailed below.

WU Injection Systems

Treated water will be injected into the WU-BA3, WU-UP1, and WU-UP2 areas via both injection wells and injection trenches. Treated water will be injected into the Sandstone A formation within these remediation areas via the seven 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 WU injection trenches will continue to operate until in-process monitoring indicates that COC groundwater concentrations within the targeted remediation area have remained below their respective State Criteria for at least three 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 WU-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 the WU-UP2 area makes injection trench excavation unfeasible. In addition, the lateral extent of the relatively isolated area of impact requiring remediation in Sandstone B in the WU-UP2 area is compatible with injection wells.

These wells will be screened to a total depth of approximately 70 ft 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-A area via three injection trenches (GWI-BA1-01 through GWI-BA1-03). As with Sandstone A injection in the WU 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 in all monitor wells in BA1 have remained below the NRC Criterion for at least three 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.

All injection of treated water will be performed in accordance with the requirements of the DEQ's UIC Program. A UIC permit was not required for the injection of treated water because the water being injected into the shallow subsurface contains lower concentrations of COCs than the formation into which it is being injected contains. However, monthly reports of the quantity and quality of water injected in each location will be submitted to DEQ.

8.5 TREATED WATER DISCHARGE

All treated water not utilized for injection will be discharged to the Cimarron River in accordance with OPDES permit OK0100510. The OPDES permit authorizes the discharge of treated water from two constructed outfalls at the site: one for discharge of WATF effluent, and a second for discharge of BA1 Treatment Facility effluent. Locations of the two outfalls (Outfall 001 and Outfall 002) are shown on Drawings C002, C003, and C005 (Appendix J-2). Outfall details are presented on C107 (Appendix J-6). Table 8-3c lists the analytes, analytical methods, and frequency of sampling required by the OPDES permit. Permit limits for both outfalls are maximum values of 30 µg/L uranium, 10 mg/L fluoride, and 10 mg/L nitrate. The pH of discharged water must be between 6.5 and 9 standard units. Discharge monitoring results must be reported on Discharge Monitoring Report forms on a monthly basis.

8.5.1 Outfall 001

Assuming all WA groundwater extraction systems operate at nominal capacity and no treated water is injected, a maximum of 250 gpm of treated water would be discharged to the Cimarron River through Outfall 001. The discharge pump for the WATF has been sized to maintain the maximum discharge flow rate (250 gpm) under 100-year flood conditions.

As previously stated, groundwater extracted from the WAA and WU will be treated to reduce concentrations of uranium, nitrate, and fluoride to less than stipulated permit limits prior to discharge. Samples of discharged water will be collected for analysis twice monthly, as stipulated in the OPDES permit.

8.5.2 Outfall 002

Assuming all BA1 groundwater extraction and injection systems operate at nominal capacity and no treated water is injected, a maximum of 100 gpm of treated water would be discharged to the Cimarron River through Outfall 002. The discharge pump for the BA1 Treatment Facility has been sized to maintain the maximum discharge flow rate (100 gpm) under 100-year flood conditions.

Groundwater extracted from BA1 will be treated to reduce the concentration of uranium to less than the stipulated permit limit. Samples of discharged water will be collected for analysis twice monthly, as stipulated in the OPDES permit.

8.6 IN-PROCESS MONITORING

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

8.6.1 Groundwater Extraction Monitoring

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. Transducers will be installed in all groundwater extraction wells and trench sumps to monitor the drawdown achieved at the initial extraction rates. This well field instrumentation will provide real-time measurements and the control system will store the data.

In-process groundwater monitor wells for each remediation area are listed on Table 8-2. Figure 8-8 shows the locations of in-process monitor wells in the western remediation areas. Figure 8-9 shows the locations of in-process monitor wells in BA1.

Groundwater elevations will also be measured manually in those monitor wells scheduled to be sampled on a quarterly basis (see Table 8-2). Groundwater elevation measurements will be recorded daily for the first week, weekly for the second through the fourth week, and after two and three months of operation. After the first three months of operation, groundwater elevation will be recorded on a quarterly basis for all monitor wells which remain on site. This will provide the data needed to assess drawdown and hydraulic influence throughout the plumes targeted for remediation.

The data and assessments described above will be used to adjust groundwater extraction rates for individual wells and/or trenches to optimize COC removal rates, 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.

In-process groundwater elevation measurements will also provide feedback on the capacity for injection wells and trenches to deliver treated water to Sandstones A and B. Injection rates may be adjusted as appropriate to maintain plume capture.

In both the WAA U>DCGL and BA1-B areas, the "groundwater extraction" issue of greatest concern is the potential to create stagnation zones between extraction wells, in which COC concentrations decline very slowly or not at all. In-process groundwater monitoring will provide the data needed to confirm that the concentration of uranium declines in these apparent stagnation zones at approximately the same rate as in other monitor wells located at similar distances from extraction wells.

In the WAA-BLUFF area, the "groundwater extraction" issue of greatest concern is the potential inability of extraction wells to effectively capture the impacted water being driven to the alluvium by the injection of treated water in WU-UP1 and WU-UP2 areas. Groundwater elevation data will be measured in Monitor Wells T-85 through T-88, and in monitor wells spaced between Extraction Wells GE-WAA-06 through GE-WAA-13. If the groundwater elevations in the second set of wells is lower than the groundwater elevation in currently-downgradient Monitor Wells T-85 through T-88, groundwater must be moving toward the bluff, and not away from the bluff through the line of extraction wells.

8.6.2 Water Treatment Monitoring

In-process monitoring of the groundwater treatment processes will provide information needed to monitor the effectiveness of the treatment systems, determine when ion exchange resin vessels require replacement/reconfiguration, to maintain compliance with license possession limits, to determine when accumulated biomass requires removal from denitrification bioreactors, to determine when influent concentrations decline to the point that treatment is no longer needed, to document compliance with disposal requirements for spent resin, and to evaluate compliance with discharge and injection criteria.

Table 8-3c presents the in-process monitoring program that will be implemented to monitor and operate the water treatment systems. Table 8-3a presents the critical continuous in-line monitoring inputs. Table 8-3b presents the samples collected and analyses that will be requested on a weekly basis. Table 8-3c presents the samples collected and analyses that will be requested on a bimonthly basis to monitor (and report compliance with) discharge permit parameters and underground injection control program requirements. Table 8-3d presents the samples collected and the analysis used to monitor and characterize spent resin for disposal (upon each changeout).

Uranium Treatment Monitoring

Pumping rates, pressures, and float switches will be continuously monitored to maintain a nominal flow of no more than 250 gpm to each uranium treatment skid in the WATF, and no more than 100 gpm to the uranium treatment skid in BA1.

The pH of the influent coming from TK-101 and TK-201 will be continuously monitored and electronically transmitted to the treatment control system. Speed controllers on the pumps which control the rate of acid addition will automatically adjust the pH of the influent to each ion exchange skid. The pH of influent water entering the ion exchange skids will be continuously monitored prior to the in-line mixer where acid is added for pH adjustment (see Drawing P-215, Appendix K-7, which is representative of each UIX treatment skid). After the mixer, the pH is continuously monitored to verify that the influent to the ion exchange vessels is 6.8 – 7.0 standard units. A sample port is in the process line both upstream and downstream of the in-line mixer to enable secondary check of the pH. Table 8-3a identifies the in-line sensors that provide data to control the treatment system.

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. See Drawing P-215 (Appendix K-7) for the specific location of sample ports; the configuration of this UIX treatment system is representative of all UIX treatment systems. Samples will 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 U-235 enrichment is used to determine the U-235 content with a vessel. The data obtained through the first two changeouts of each treatment train may indicate that the frequency of sampling may be reduced to every two weeks instead of weekly. Table 8-3b shows the locations from which samples will be collected.

Exchange and replacement of the lead vessel will 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.

Calculations indicate 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 grams 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.

Nitrate Treatment Monitoring

The design includes provision for addition of a nitrate source (such as sodium nitrate solution) into the MBBR system to establish the initial microorganism culture. This start-up period is expected to take four to eight weeks depending on the specific commercial denitrification microorganism culture selected and the rate at which nitrate and other nutrients are added.

During the start-up and throughout normal operation, nitrate is continuously monitored via a probe immersed in a sample sink (see Drawing P200 in Appendix K-5). A slip stream from the process continuously overflows into the area sump. The currently identified probe, which is not suitable for placement in the process pipe, provides feedback to the control system to adjust the feed rate of methanol addition. A similar arrangement is used after the drum filter to check that the treatment goal for nitrate has been met (see Drawing P207 in Appendix K-5). Should measurement indicate the effluent goal has not been met, the flow is directed back to the Buffer Tank for re-processing instead of sending the flow to the Effluent Tank. Table 8-3a identifies the in-line sensors that provide data to control the treatment system.

Samples of influent to the uranium treatment system, influent to the biodenitrification system, and effluent from the biodenitrification system, will be collected on a weekly basis, and analyzed for nitrate/nitrite. Evaluation of the data obtained over time may justify reducing the frequency of sampling to once every two weeks. Table 8-3b shows the locations from which samples will be collected.

Sample points are provided at multiple locations along the biodenitrification treatment process as shown on the various P&ID drawings provided in Appendix K5.

An external source of water and nitrate will be used to establish a sufficient biomass; uranium treatment will not begin until this inoculation is complete. In-process monitoring of the ion exchange systems will begin when uranium treatment begins.

Radiological Monitoring

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. Radiological monitoring is addressed Section 11, Radiation Protection Program, and Section 15, Facility Radiation Surveys.

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 grams 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.

8.6.3 Treated Water Injection and Discharge Monitoring

Injection System Monitoring

For the WU-BA3, WU-UP1, and WU-UP2 remediation areas, initial treated water injection rates were estimated from injection tests and the results of packer tests conducted during previous investigation activities. 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 ft 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 monitor 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-process groundwater monitor wells for each remediation area are listed on Table 8-2 and Figures 8-8 and 8-9 show the locations of in-process monitor wells.

Groundwater elevations will also be measured manually in those monitor wells scheduled to be sampled on a quarterly basis (see Table 8-2). Groundwater elevation measurements will be recorded daily for the first week, weekly for the second through the fourth week, and after two and three months of operation. After the first three months of operation, depth to groundwater measurements will be recorded on a quarterly basis for all monitor wells on-site.

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.

Discharge Monitoring

The flow rate to each outfall will be recorded, and samples of treated water being discharged via each outfall will be collected for laboratory analysis, on a bi-weekly basis. Discharge monitoring reports will report this data to DEQ on a monthly basis in accordance with the OPDES discharge permit. Parameters and locations for in-process discharge monitoring are presented in Table -3c.

8.6.4 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 area should be discontinued and post-remediation groundwater monitoring should begin. In-process monitor 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 monitor wells are depicted on Figures 8-8 and 8-9. Table 8-2 lists the wells by remediation 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 monitor wells in each subarea. Monitoring COC concentrations within each remediation 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. Section 8.1.7 states that post-remediation monitoring will begin when at least three consecutive months of in-process monitoring data shows that all wells yield uranium concentrations below 180 pCi/L. However, evaluation of in-process monitoring data may indicate that treatment should continue to reduce the risk of exceeding those criteria during post-remediation monitoring.

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 may 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).

Groundwater remediation monitoring samples will be collected immediately prior to startup of groundwater extraction and injection. The quarterly analysis of specific COCs for groundwater samples collected at specific locations will be discontinued once the concentration of that COC is below the corresponding State Criterion for four consecutive quarters. For example, groundwater from Monitor Well T-63 will be analyzed for uranium, nitrate, and fluoride each quarter. Should the concentration of fluoride be the first to drop below its State Criterion for four consecutive quarters, analysis for fluoride will be discontinued; analysis for uranium and nitrate would continue until one of these constituents has dropped below the respective State Criterion.

The same procedures will apply for the analysis of COCs in groundwater collected from monitor wells on an annual basis, except that annual analysis will be discontinued once the COC concentration is below the corresponding State Criterion for two consecutive years.

8.7 TREATMENT WASTE MANAGEMENT

Section 8.3.2, Uranium Treatment Systems, describes the process whereby uranium is removed from groundwater by adsorption onto organic 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 8.3.3, 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 is generated in the bioreactors. The influent to the biodenitrification system will consist of groundwater that has already been treated for uranium. The influent should contain non-detectable concentrations of uranium. The biomass filtered from the effluent of biodenitrification system will be processed and packaged for disposal as solid industrial waste.

8.7.1 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 8.3.2, 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.

8.7.2 Spent Resin Processing

Unless noted otherwise, all drawings cited within this section are provided in Appendix K-4. Spent resin processing operations are shown on P&ID Drawing P-125. 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 WATF 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 isotopic uranium mass concentration.
- The ion exchange vessel will be moved to the Spent Resin Handling Area (see Drawing G-120).
- Spent resin will be sluiced out of the vessel and dewatered using a scrolling centrifuge. The water discharged from the scrolling centrifuge will then be routed back to the WATF influent tank TK-101.
- Solids (i.e., dewatered resin) from the centrifuge will be transferred by enclosed conveyor to a ribbon blender. The ribbon blender is sized to blend the contents of a resin vessel plus the maximum amount of inert material (absorbent) that may be needed to meet the transportation and waste acceptance criteria. The ribbon blender will produce 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.

The absorbent is the only consumable material used in the Spent Resin Handling System. Current calculations indicate that the WATF uranium concentration is such that the resin capacity is not great enough to reach the fissile exception limit for transportation. For BA1, the initial four to five resin vessels are projected to require early replacement to remain below the fissile limit; however, the design has the flexibility to incorporate the blending of additional adsorbent material, thereby enabling greater utilization of a vessel. A specific adsorbent material has not been identified; however, the material selected will be approved by the LLRW disposal facility. Absorbent is currently estimated to be added to the resin at a volumetric ratio of 1:10 (absorbent volume to resin volume).

Absorbent will be stored in a hopper with a volume equivalent to the super sack (~37 ft^3) in which the absorbent will be delivered to the WATF. Usage is anticipated to be approximately one super sack per year, delivered by truck to the WATF. Absorbent may be delivered in containers other than super sacks to mitigate the potential for the absorbent to adsorb moisture from the air during the extended period (months) between vessel change out.

Once a resin vessel has been emptied, the vessel will remain in the Spent Resin Handling Area to be filled with fresh ion exchange media. A pre-determined quantity of new, fresh resin will be added to TK-301 utilizing a drum lifter to assist in positioning the drum to the elevated tank (see Drawing G-120, Appendix K-4). Using treated effluent, the resin is sluiced into the vessel; the resin is retained within the vessel by internal screens located on the outlet line from the vessel (the same screens that maintain the resin in the vessel during normal operation). The operation is continued until visual observations into TK-301 show that the tank no longer contains resin (e.g. the resin has been added and retained in the vessel).

Because of the potential for residual contamination in a vessel, excess water will be collected and routed to influent tank TK-101 for processing. Once filled, the vessel will be stored in a designated area in the Spent Resin Handling Area until needed.

The Spent Resin Handling Area will be in the northeast corner of the WATF as shown on Drawing G-120. The processing equipment is based on commercial models selected for their processing function. Elevation views of the resin handling equipment is shown on Drawing G-121. Using a single station for both the removal of spent resin and the addition of fresh resin minimizes vessel movement.

8.7.3 Spent Resin Packaging and Storage

Initially, it is anticipated that spent resin from BA1 may contain sufficient uranium to exceed the fissile exception criterion. As the concentration of uranium in groundwater declines, and the observed adsorption capacity of the resin decreases, spent resin will not contain enough uranium to require the addition of a more absorbent than will be needed to ensure that free liquid will not be present upon delivery to the licensed disposal facility. The spent resin without the addition of absorbent will meet the fissile exception criterion.

The blended resin/absorbent mixture will be transferred from the hopper to 55-gallon drums equipped with a plastic liner. The liner provides contamination control and allows for transfer of material in a way that minimizes the potential for airborne suspension of particulates and does not expose the worker to direct contact with the material.

A sample collected from each drum will be analyzed for isotopic concentration. The collection of multiple samples from a single batch provides the data needed to assess the homogeneity of the mixture. Analytical data will be the basis for shipping papers and manifests and will provide the data needed to document that transportation and disposal criteria have been met. Table 8-3d presents the sample identification and analytical method for samples of processed resin.

Filled drums will be labeled and placed in a designated area, separate from drums of waste for which data has been received and manifests have been generated, within the Secured Storage Facility located east of the WATF Building (see Drawing C-110, Appendix K-1) pending receipt of analytical results. The Secured Storage Facility is a Metal Building with a single roll-up door that will have removable bollards to additionally restrict access to the interior of the facility (see Drawings A-170 [Appendix K-6] and KC-110 [Appendix K-1], respectively).

Disposal of processed resin is addressed in Section 13.1, Solid Radioactive Waste. The yearly quantity of spent resin (including absorbent) projected to be generated is about 513 ft^3 (BA1 ~166 ft^3; WATF ~347 ft^3), or approximately seventy 55-gallon drums per year.

8.7.4 Biomass Solids Processing

Unless otherwise noted, drawings referenced in this section are in Appendix K-5. The drum filter within the biodenitrification system described in Section 8.3.3 will wash solids off the filter into a backwash sump. From the backwash sump, the water will be pumped to a sludge thickener tank, TK-1250 (see Drawings P210 and P211). Coagulant and polymer will be added in line with a static mixer. This will condition the solids as they enter the thickener. The chemical dosing of the coagulant and polymer will turn on and off with the backwash sump pump. If either chemical dosing system fails due to equipment malfunction or lack of chemical, the dewatering process will continue but will be less efficient.

An air sparging system in the thickener will operate intermittently. This will both prevent the wastewater from becoming septic and reduce the potential for odors. The thickener has a capacity of three days' sludge production to enable the system to continue working throughout the weekend without dependence upon an operator. The overflow from the thickener will flow by gravity to the Area Sump, from where it will be routed back to the buffer tank in front of the MBBRs. A scraper at the bottom of the thickener will move the sludge toward the center, from where it will be pumped to the filter press.

At the beginning of each filter press cycle, before sludge is pumped to the filter press, perlite will be mixed with water in TK-2300 to create a slurry. The slurry will be pumped into the filter press, creating a pre-coat layer on the cloth filter of each plate. The pre-coat minimizes the potential for blinding of the filter press cloths, resulting in more efficient dewatering and dryer sludge cake. Pre-coat also enhances the release of the sludge cake from the filter cloth. The filtrate during this step will be recycled to the perlite feed tank.

The valves will then pump sludge from the bottom of the thickener. Solids will be captured between the plates; the filtrate will discharge to the Area Sump. At the end of each press cycle, compressed air will be blown through the filter press to remove most of the remaining water. The plates of the filter press will be separated, and the filter cake will be dropped into a sludge cart (or equivalent) for transfer to the disposal container. Each filter press cycle takes two to four hours.

The perlite precoat will increase solids capture as well as help produce drier sludge cake. If the perlite system does not work, the filter press cycle can be delayed for maintenance. If the filter press fails due to mechanical reasons, the water in the press will go to the Area Sump, and the ample storage time in the thickener should be sufficient to perform the required maintenance. Again, this is not expected to occur frequently, but the provision is in place to ensure the smooth operation of the plant.

The following is a summary of the chemical usage for the biomass solids process, based on a 250 gpm flow rate and an inlet nitrate concentration of 100 mg/L NO_3-N:

- Emulsion Polymer (for Thickener Tank): Usage is anticipated to be less than one tenth of a gallon/day, supplied by a drum, which will be replaced every 6-months by delivery to the WATF by truck. Storage of replacement drums of polymer is not expected to be more than 1-2 weeks and will be in a designated area with appropriate controls to limit any interaction with other chemicals.

- Ferric chloride (for Thickener Tank): Usage is anticipated to be approximately 12-gallons/day, fed from a 320-gallon double-walled tote, which will be co-located with its feed pump on a skid within the WATF near TK-1250. The tote is expected to be refilled once a month via chemical tote delivered by truck. The new tote will be stacked on the empty supply tote to gravity fill it.
- Perlite (for filter press): Usage is anticipated to be about 60 pounds (lbs)/cycle. Perlite will be received on pallets as dry material in bags that can be handled by an operator. Delivery frequency will be approximately monthly, with a storage location to be determined within the WATF for the perlite pallets.

8.7.5 Biomass Packaging and Storage

The sludge cart will be emptied into a disposal container that complies with transportation requirements. Solids remaining in the sludge cart may be washed out with a hose and drained into the Area Sump to prevent biogrowth on the cart. The performance criterion for the sludge dewatering process is "no free liquids", (based on the paint filter test) for landfill disposal.

The biomass solid will be disposed as non-hazardous industrial waste at an industrial waste landfill. Daily sludge production is anticipated to be approximately 450 lb (dry solids), or approximately 1 ton of wet cake (at 20% solids content). The filter press has a volume of 30 ft^3, which is adequate to dewater the amount of sludge produced each day in a single cycle. Additional cycles can be run within a day if sludge accumulates in the thickener over several days.

The disposal container is anticipated to be removed on a weekly basis. This is both a function of the biomass solids generation rate and requirements of an industrial waste landfill operator. As nitrate concentrations decline, waste generation will decline.

8.8 POST-REMEDIATION GROUNDWATER MONITORING

Post-remediation groundwater monitoring will be performed to demonstrate compliance with NRC Criteria required for license termination. Post-remediation groundwater monitoring may also demonstrate compliance with State Criteria for specific COCs in specific remediation areas. This section describes the groundwater sampling and analysis that will be performed in each area requiring groundwater remediation.

In areas where drawdown due to extraction is significant (i.e., extraction trenches in transition zone material), COCs sorbed to unsaturated soil above the drawdown cone may be released into solution, increasing COC concentrations in the groundwater (i.e., rebound). Groundwater extraction and injection will be shut down prior to initiating post-remediation monitoring. Twelve quarters of post-remediation monitoring is more than sufficient to identify rebound if it occurs after the cessation of pumping and injection.

If the uranium concentration rebounds above the NRC Criterion in a post-remediation monitoring well, remediation will resume in that remediation area. If the concentration of a given COC rebounds above other remediation objectives (i.e., State Criteria) in a post-remediation monitoring well, remediation may or may not resume in that area. If remediation is resumed in a remediation area, post-remediation monitoring would then start over when resumed in-process monitoring indicates the remediation objective has been achieved.

Post-remediation groundwater monitoring will consist of at least 12 consecutive quarters of groundwater sampling and analysis for each remediation area. To demonstrate compliance with NRC Criteria within any remediation area, the concentration of uranium must be less than 180 pCi/L in every post-remediation monitoring well for 12 consecutive quarters. To demonstrate compliance with State Criteria within any remediation area, the concentrations of uranium, nitrate, and fluoride must be less than the State Criteria in every post-remediation monitoring well for 12 consecutive quarters. Additionally, post-remediation monitoring will include sampling and analysis for Tc-99. Tc-99 concentrations already comply with its NRC Criterion, but post-remediation monitoring will be performed to determine if Tc-99 concentrations are below the EPA-stipulated criterion of 900 pCi/L.

Locations of post-remediation monitor wells are depicted on Figures 8-10 (WA) and 8-11 (BA1). Table 8-4 lists the wells by remediation 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 various portions of the site.

8.8.1 Western Alluvial Areas

WAA U>DCGL Area

Uranium, nitrate, and fluoride are the COCs for which groundwater samples will be analyzed in this remediation area. Analysis of groundwater samples for Tc-99 will not be performed in this area because Tc-99 did not exceed 900 pCi/L prior to groundwater remediation.

It is anticipated that in-process remediation monitoring will have demonstrated that groundwater outside of the centerline of the uranium plume complies with NRC Criterion for uranium prior to the conclusion of remedial operations in this area. Post-remediation monitor wells are located between extraction wells, where the potential for stagnation zones is greatest.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands.

WAA-WEST Area

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium concentrations did not exceed its NRC Criterion, and Tc-99 did not exceed 900 pCi/L prior to groundwater remediation.

Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area prior to groundwater remediation. Uranium has never exceeded 30 µg/L in Monitor Well T-97, and nitrate has never exceeded 10 mg/L in Monitor Well T-98. Consequently, samples from Monitor Well T-97 will be analyzed only for nitrate, and samples from Monitor Well T-98 will be analyzed only for uranium.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands.

WAA-EAST Area

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed their NRC Criteria.

Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation. Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area. Post-remediation groundwater samples will be analyzed for uranium and nitrate.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands

WAA-BLUFF Area

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed their NRC Criteria.

Analysis for uranium will not be performed in this area because uranium concentrations in groundwater did not exceed 30 µg/L prior to groundwater remediation. Although Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation, samples will be analyzed for Tc-99 because groundwater discharging to the alluvium from UP1 and UP2 areas has yielded Tc-99 concentrations above 900 pCi/L.

Post-remediation groundwater samples will be analyzed for nitrate, fluoride, and Tc-99. Post-remediation monitor wells are located between extraction wells, where the potential for stagnation zones is greatest.

8.8.2 Western Upland Areas

WU-UP1

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed NRC Criteria prior to groundwater remediation. Analysis for uranium will not be performed in this area because uranium concentrations in groundwater did not exceed 30 µg/L in this area prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for nitrate, fluoride, and Tc-99.

WU-UP2-SSA

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed their NRC Criteria prior to groundwater remediation. Post-remediation groundwater samples will be analyzed for uranium, nitrate, fluoride, and Tc-99.

WU-UP2-SSB

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed their NRC Criteria prior to groundwater remediation. Analysis for uranium will not be performed in this area because uranium concentrations in groundwater did not exceed 30 µg/L in this area prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for nitrate, fluoride, and Tc-99.

WU-BA3

Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation.

Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area prior to groundwater remediation. Analysis for nitrate will not be performed for Monitor Wells 1356 and 1360 because nitrate concentrations in groundwater did not exceed 10 mg/L in these wells prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for uranium for all wells, and nitrate for Monitor Well 1351.

WU-PBA

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed their NRC Criteria prior to groundwater remediation. Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation. Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for uranium and nitrate.

WU-1348

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

Analysis for nitrate will not be performed in this area because nitrate concentrations in groundwater did not exceed 10 mg/L in this area prior to groundwater remediation. Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for uranium and fluoride.

8.8.3 1206-NORTH

The 1206-NORTH area is unique in that it is the only area on site in which uranium exceeds the NRC Criterion, all COCs exceed State Criteria, and Tc-99 has exceeded 900 pCi/L. Post-remediation groundwater samples will be analyzed for uranium, nitrate, fluoride, and Tc-99.

8.8.4 Burial Area #1

Uranium is the only COC for which groundwater samples will be analyzed in BA1. Analysis of groundwater samples for Tc-99 will not be performed in this area because Tc-99 has never been identified in groundwater in BA1. Analysis for nitrate fluoride will not be performed in this area because nitrate and fluoride concentrations in groundwater have never exceeded the MCL in BA1.

It is anticipated that in-process remediation monitoring will have demonstrated that groundwater outside of the centerline of the uranium plume complies with NRC Criterion for uranium prior to discontinuing remedial operations in this area. Post-remediation monitoring locations were selected to demonstrate compliance with the NRC Criterion at locations selected as described below.

In BA1-A, post-remediation monitor wells in SSB are located where uranium concentrations are currently elevated. In the transition zone, post-remediation monitor wells are located where drawdown near extraction trenches (and the potential for rebound) is greatest.

In BA1-B and BA1-C post-remediation monitor wells are located between extraction wells, where the potential for stagnation zones is greatest, along with several locations where current uranium concentrations are relatively high.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands. Sampling of post-remediation Monitor Wells 02W17, 02W43, and 1415 may be discontinued once uranium concentrations are below the NRC Criteria for 12 consecutive quarters (including in-process monitoring results).

8.9 DEMOBILIZATION

Demobilization of remediation and water treatment equipment will not be performed until post-remediation monitoring demonstrates that the NRC Criterion has been achieved in the WAA U>DCGL, WU-BA3, BA1-A, and BA1-B remediation areas. The WATF Building and secure storage facility will remain on Site following the completion of groundwater remediation activities. The WATF Building and the secure storage facility will be subject to a final status survey after all equipment and material used for uranium treatment and spent resin processing, and all packaged LLRW have been removed.

8.9.1 Sequence of Demobilization

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

Once post-remediation monitoring in the WAA U>DCGL, WU-BA3, 1206-NORTH, BA1-A, and BA1-B remediation areas confirms achievement of the NRC Criterion, all treatment systems will be demobilized from the WATF and the BA1 treatment facility. A final status survey for this facility will be completed. All WAA and WU groundwater extraction and injection equipment and controls will remain.

The estimate presented in Section 16, Financial Assurance, does not include costs associated with groundwater remediation that may continue without treatment (if influent concentrations no longer require treatment), or costs associated with removal of injection or extraction components or monitor wells that remain 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 WATF 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 8.7.4, Biomass Solids Processing. Processed biomass will be disposed of in an industrial waste disposal facility in accordance with OPDES permit OK0100510.

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 Oklahoma Water Resources Board (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 C105, C106, and C108 (Appendix J-6), M101 (Appendix J-3), and M102 (Appendix J-4). 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 Monitor wells

Like groundwater extraction and injection wells, monitor wells will be removed by area once remediation in that area is complete and approval from both agencies has been obtained. The groundwater monitor 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 to achieve State Criteria for groundwater, and sufficient funding is available to perform additional remediation, additional groundwater assessment will then be conducted, if needed. Remediation alternatives to achieve State Criteria will be evaluated and subsequent remedial action will be considered based on the best use of available funding. Potential remedial alternatives could include continued groundwater extraction/injection without treatment or with nitrate treatment, MNA, institutional controls (e.g., deed restrictions), or some combination of these.

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