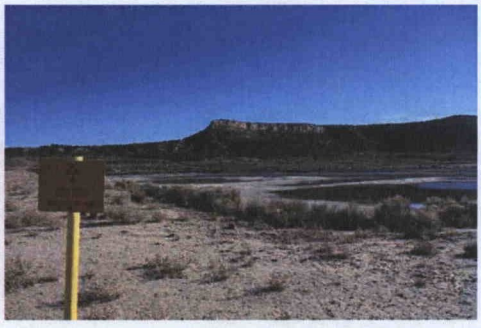
FIFTH FIVE-YEAR REVIEW REPORT FOR UNITED NUCLEAR CORPORATION CHURCH ROCK SUPERFUND SITE MCKINLEY COUNTY, NEW MEXICO

September 2018



Prepared by

U.S. Environmental Protection Agency
Region 6
Dallas, Texas

FIFTH FIVE-YEAR REVIEW REPORT
UNITED NUCLEAR CORPORATION SUPERFUND SITE
EPA ID#: NMD030443303
MCKINLEY COUNTY, NEW MEXICO

This memorandum documents the U.S. Environmental Protection Agency's (EPA) performance, determinations, and approval of the United Nuclear Corporation (UNC) Superfund Site (Site) Fifth Five-Year Review (FYR) under Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S. Code Section 9621(c), as provided in the attached Fifth FYR Report. The Site is located in McKinley County, New Mexico.

Summary of the Fifth Five-Year Review Report

The Site was listed on the National Priorities List (NPL) on September 9, 1983. The Remedial Investigation and the Feasibility Study were completed in August 1988. The Record of Decision ("ROD") for the Site's first operable unit[1] ("OU1") was signed on September 30, 1988. Site cleanu under the OU1 ROD was completed and documented in the Preliminary Close-out Report; which was signed on September 28, 1998.

This is the Fifth FYR of the Site. The purpose of a five-year review is to evaluate the implementation and performance of a remedy in order to determine if the remedy is or will be protective of human health and the environment. The triggering action for this review was the signing of the Fourth FYR report on September 27, 2013.

The Site is located 17 miles northeast of Gallup and on the southern border of the Navajo Nation. The Site is comprised of the former ore processing mill facilities and a byproduct material (tailings) disposal area (hereinafter the Tailings Disposal Area or TDA). The Tailings Disposal Area is comprised of three covered tailings containment cells and two covered borrow pits.

At the Site, there are two agencies with overlapping jurisdiction—EPA and the U.S. Nuclear Regulatory Commission (NRC). As stated in a 1988 Memorandum of Understanding (MOU) between EPA and NRC, NRC assumed the role of lead regulatory agency for the Tailings Disposal Area reclamation and for the surface area closure activities at the Site. At the same time, acting under the 1988 OU1 ROD, EPA developed and implemented its own Site action requirements for ground water contamination outside of the Tailings Disposal Area, in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

To summarize, until recently, NRC generally addressed the surface of the Site and the TDA, while EPA addressed ground water and reviewed and commented on NRC action. On September 29, 2013, however, EPA issued another Site ROD, calling for the disposal of waste from the Northeast Church Rock Mine Site (NECR Site), at the United Nuclear Corporation Superfund Site, which is separate from the NECR Site. EPA refers to this waste disposal action as Operable Unit 2 (OU2) or the Surface Soil Operable Unit. To complete the OU2 remedy, EPA will be coordinating with NRC. In fact, EPA's implementation of the OU2 remedy is contingent on the NRC approval of a license amendment for the Site Tailings Disposal Area.

UNC is the primary responsible party for both the United Nuclear Corporation Site and the NECR Site. In September 1997, UNC became a wholly-owned indirect subsidiary of the General Electric Company (GE).

[1] Operable unit means a discrete action that comprises an incremental step toward comprehensively addressing Superfund site problems. The cleanup of a Superfund site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. 40 CFR § 300.5. In September 1983, the ROD was not referred to as the OU1 ROD, because it was not until 2013 that EPA decided to have more than one operable unit at the Site.

Collectively these parties are referred to in this FYR as "UNC/GE." UNC/GE have been working cooperatively with EPA at the Site under an EPA administrative order for OU1. Under a separate administrative order on consent, UNC/GE have been developing a Remedial Design for the implementation of the remedy under the OU2 ROD.

The recommendations from the 2013 FYR, along with a description of the actions that have been taken in response to those recommendations, and a description of the outcome of those actions are presented in Section 3.0 of this 2018 FYR.

Environmental Indicators

Human Exposure Status: Current Human Exposure Controlled
Contaminated Ground Water Status: Contaminated Ground Water Migration Not Under Control.
Site-Wide Ready for Reuse: No

Actions Needed

The following actions should be taken for the remedy to be protective in the long term:

- Determine if changes in Applicable or Relevant and Appropriate Requirements (ARARs), MCLs in particular, warrant a change in Remediation Goals for the remedy to remain protective.
- Evaluate the current extraction pumping in Zone 3 to determine whether it is effective at controlling contaminant migration from the Site. In particular, the upgradient well series (*i.e.,* RW-series) should be evaluated to determine whether it is drawing in background water (*i.e.,* water that came from contaminated mine discharge, but that was not contaminated by tailings from the UNC mill) from the west.
- Continue efforts to minimize northward advancement of the Zone 3 ground water that has been impacted by contaminants that seeped from Site tailings. These efforts should forestall contamination of aquifers underlying Navajo land where drinking water wells may be installed in the future. As part of these efforts, where practicable, extraction of contaminated ground water from Zone 3 should be continued in the northernmost extraction wells. These northern wells are located at the leading edge of the ground water that has been impacted by contaminants that seeped from Site tailings. Evaluate expanded use of Natural Attenuation.
- Renew efforts with stakeholders (*e.g.,* the Navajo Nation and local residents) to establish Institutional Controls (ICs) that will restrict the use of contaminated ground water on Navajo, Tribal Trust, and Indian Allotment lands (and unrestricted fee lands, if any) in all three hydrostratigraphic units.

Determination

I have determined that the remedy for the Site is currently protective in the short term. This five-year review report specifies the actions that need to be taken for the remedy to be protective in the long term

for Ronald D Cumfield

Carl E. Edlund, P.E.
Director, Superfund Division
U.S. Environmental Protection Agency Region 6

9/18/18
Date

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CONCURRENCES

FIFTH FIVE-YEAR REVIEW REPORT
UNITED NUCLEAR CORPORATON CHURCH ROCK SUPERFUND SITE
EPA ID#: NMD030443303
MCKINLEY COUNTY, NEW MEXICO

Janet Brooks
Remedial Project Manager — Date: 9/4/2018

Blake Atkins
Chief, LA/OK/NM Remedial Section — Date: 9/5/18

John C. Meyer
Chief, Superfund Remedial Branch — Date: 9/7/18

James E. Costello
Practice Group Leader, Office of Regional Counsel — Date: 9/11/18

Mark A. Peycke
Chief, Superfund Branch, Office of Regional Counsel — Date: 09/12/18

Pamela Phillips
Deputy Director, Superfund Division — Date: 9/18/18

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ISSUES/RECOMMENDATIONS

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 1	**Issue Category: Other**			
	Issue: MCLs for certain contaminants of concern on the Site have changed, and these changed MCLs are applicable or relevant and appropriate requirements (ARARs) for the Site. EPA's policy regarding newly promulgated or modified environmental requirements that are promulgated or modified after a ROD is signed is that EPA will not reopen the remedy selection decision made in the ROD unless the new or modified requirement calls into question the protectiveness of the selected remedy. EPA believes that it is necessary to "freeze ARARs" when the ROD is signed. To do otherwise would disrupt CERCLA cleanups, whether the remedy is in design, construction, or in remedial action. Each of these stages represents significant time and financial investments in a particular remedy.			
	Recommendation: Determine if the changes in MCLs warrant a change in Remediation Goals for the remedy to remain protective.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	EPA	EPA/State	6/30/2020
OU(s): 1	**Issue Category: Remedy Performance**			
	Issue: The effectiveness of the Zone 3 O&M activities in controlling contaminant migration from the Site needs to be assessed and adjusted accordingly since mine discharge water may be drawing into the Zone 3 pumping wells.			
	Recommendation: Evaluate the current extraction pumping in Zone 3, to determine whether it is effective at controlling contaminant migration from the Site. In particular, the upgradient well series (i.e., RW-series) should be evaluated to determine whether it is drawing in background water (i.e., water that was contaminated mine discharge, but that was not contaminated by tailings from the UNC mill) from the west.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA/State	1/31/2019

OU(s): 1	Issue Category: Remedy Performance			
	Issue: Current pumping will reach a point where an extraction well will not be able to withdraw water from the Zone 3 hydrostratigraphic unit. At this point in time, the Zone 3 contaminated water will still migrate northward toward the Navajo Reservation.			
	Recommendation: Continue efforts to minimize northward advancement of the Zone 3 ground water that has been impacted by contaminants that seeped from Site tailings. These efforts should forestall contamination of aquifers underlying Navajo land where drinking water wells may be installed in the future. As part of these efforts, where practicable, extraction of contaminated ground water from Zone 3 should be continued in the northernmost extraction wells. These northern wells are located at the leading edge of the ground water that has been impacted by contaminants that seeped from Site tailings. Evaluate expanded use of Natural attenuation.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA/State	1/31/2019
OU(s): 1	**Issue Category: Institutional Controls**			
	Issue: Although no Navajo are currently using ground water that is contaminated with contaminants of concern (COCs) from the Site, there is a potential for water supply wells to be installed in areas that may become impacted with hazardous substances.			
	Recommendation: Renew efforts with stakeholders (e.g., the Navajo Nation and local residents) to establish Institutional Controls (ICs) that will restrict the use of contaminated ground water on Navajo, Tribal Trust, and Indian Allotment lands (and unrestricted fee lands, if any) in all three hydrostratigraphic units.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA/State	6/30/2019

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LIST OF ABBREVIATIONS & ACRONYMS

AOC	Administrative Order on Consent
amsl	Above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
BTVs	Background Threshold Values
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of Concern
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
FYR	Five-Year Review
gpm	Gallons per minute
GE	General Electric Company
GWPS	Ground Water Protection Standards
ICs	Institutional Controls
License	NRC's Source Materials License SUA-1475
mg/L	Milligrams per Liter
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MNA	Monitored Natural Attenuation
MOU	Memorandum of Understanding
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NECR	Northeast Church Rock Mine Site
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
NNEPA	Navajo Nation Environmental Protection Agency
NPL	National Priorities List
NRC	United States Nuclear Regulatory Commission
OU1	Ground Water Operable Unit
OU2	Surface Soil Operable Unit
O&M	Operation and Maintenance
PRP	Potentially Responsible Party
Quivira	Quivira Mine Site
pCi/L	pico Curies per Liter
RAO	Remedial Action Objectives
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SWA	Southwest Alluvium
SWSFS	Site-Wide Supplemental Feasibility Study
TBC	To be considered
TDA	Tailings Disposal Area
TDS	Total Dissolved Solids
TI	Technical impracticability
TTL	Treatment Technology Action Level
TTHM	Total Trihalomethane
UAO	Unilateral Administrative Order
UMTRCA	Uranium Mill Tailings Radiation Control Act
UNC	United Nuclear Corporation
UPL95	Upper prediction limits at 95 percent confidence

I. INTRODUCTION

The Site was listed on the National Priorities List (NPL) on September 9, 1983. The Remedial Investigation and the Feasibility Study were completed in August 1988. The Record of Decision ("ROD") for the Site's first operable unit[2] ("OU1") was signed on September 30, 1988. Site cleanup under the OU1 ROD was completed and documented in the Preliminary Close-out Report; which was signed on September 28, 1998.

The purpose of a five-year review is to evaluate the implementation and performance of a remedy in order to determine if the remedy is or will be protective of human health and the environment.The methods, findings, and conclusions of reviews are documented in five-year review reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The EPA is preparing this five-year review pursuant CERCLA Section 121, consistent with the NCP (40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the Fifth FYR for the Site. The triggering action for this statutory review is the completion date of the previous FYR on 09/17/2013. The FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure.

The Site consists of two OUs, but only OU1, which addresses the ground water remedy, is discussed in the data review and technical assessment sections of this FYR. OU2 is a surface soil operable unit that is currently in the remedial design phase. As such, only a brief summary of the current activities for OU2 are presented.

The Site FYR was led by Ms. Janet Brooks, of the EPA, with support from Mr. Steve Jetter and Mr. Angelo Ortelli, of the New Mexico Environment Department (NMED), Ground Water Quality Bureau, Superfund Oversight Section. Participants for the Site inspection included Mr. Ricky Spitz, Project Manager and Contractor on the UNC Church Rock Project (see Appendix A for the Site Inspection Checklist). Participants in the interviews included members of the Coyote Canyon and Pinedale Chapter Houses of the Navajo Nation. The UNC, the potentially responsible party (PRP), has been a wholly owned indirect subsidiary corporation of the General Electric Company (GE). UNC/GE was notified of the initiation of the five-year review. The Navajo Nation Environmental Protection Agency (NNEPA) was also notified of the initiation of the five-year review. The review began on 9/17/2017.

Site Background

The Site is located 17 miles northeast of Gallup, New Mexico and on the southern border of the Navajo Nation (Figure 1). The Site includes a former ore processing mill and TDA, which cover about 25 and 100 acres, respectively (Figure 2). Two former uranium mines are located within one mile of the Site. To the northwest of the Site is the NECR uranium mine site, which supplied the uranium ore to the Site. To the north of the Site is the Quivira Mine Site (Quivira) that was operated by Rio Algom (formerly Kerr-McGee and Quivira). The Quivira mine consists of Church Rock 1 and Church Rock 1E mine sites.

The Site was granted a radioactive materials license by the State of New Mexico in May 1977, and operated from June 1977 to May 1982 (see Appendix B for the Site Chronology). The mill was designed to process 4,000 tons of ore per day from the nearby NECR mine and extracted the uranium using conventional crushing, grinding, and acid-leach solvent extraction methods. The milling of uranium ore produced an acid slurry of ground waste rock and fluid (tailings) that was pumped to the tailings impoundments. An estimated 3.5 million tons of tailings were

[2] Operable unit means a discrete action that comprises an incremental step toward comprehensively addressing Superfund site problems. The cleanup of a Superfund site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. 40 CFR § 300.5. In September 1983, the ROD was not referred to as the OU1 ROD, because it was not until 2013 that EPA decided to have more than one operable unit at the Site.

disposed in the tailings impoundments. These tailings impoundments were subdivided by dikes into three cells; identified as the South Cell, Central Cell, and North Cell (Figure 2) (EPA, 1988). Details of the site operational history have been summarized in N.A. Water Systems (2008d), and Site Annual Reports (*e.g.*, Chester Engineers, 2017). Uranium milling activities ceased in 1982. The TDA achieved interim closure status in accordance with UNC's NRC Source Material License SUA-1475 (License) for radioactive material. Currently, activities at the Site are limited to O&M of the ground water remedial program and maintenance of the interim tailings cover.

There are three types of ground water on the Site. Two types are manmade (anthropogenic) and have been defined in the 1988 ROD and subsequent Site documents. The two types of manmade water were: 1) the mine water discharged from the NECR and Quivira mines; and 2) the UNC mill water that was used to process the ore and slurried into the TDA. The third type of ground water was natural water already in the ground and not from the mines or mill. The water that existed in the ground before mining is called "natural ground water" in the rest of this report.

The Site has three hydrostratigraphic units[3] of interest in the ground water OU: the Southwest Alluvium (SWA), and the Zone 1 and Zone 3 sandstone units from the upper Gallup Formation. Detailed descriptions of these hydrostratigraphic units are provided in the Site-Wide Supplemental Feasibility Study (SWSFS) Parts I and II (Chester Engineers, 2011).

Based on more than 30 years of site data, the hydrostratigraphic units were not saturated in the Site vicinity prior to the discharge of mine water to the Pipeline Arroyo (see Figure 2). From approximately 1969 to 1986, large volumes of ground water were pumped from the nearby NECR and Quivira mines to dewater the underground workings. The average rate of mine water discharge was approximately 3,000 gallons per minute (gpm). This water was discharged to the local Pipeline Arroyo, which runs through the Site. A portion of the mine discharge water infiltrated into the subsurface and significantly saturated the near-surface alluvium and Zone 1 and Zone 3 sandstones. As designated in the ROD (EPA, 1988c), this infiltrated water represents the "background" ground water conditions for the Site. This "background" phrase has also been referred to as "post-mining/pre-tailings" background water quality in various Site documents.

Ground water in the SWA flows to the southwest along Pipeline Arroyo. Ground water in Zones 1 and 3 flows to the north to northeast. The source of the water in all three hydrostratigraphic zones (above 6700 ft above mean seal level (amsl) in the case of Zone 1 and 3) is from mine discharge water infiltration. Water levels in all three zones reached their highest levels between 1977 and 1986 and have been steadily declining since the mine water discharge ceased in 1986.

Acidic tailings liquids were stored in the TDA, beginning in 1977, in accordance with the NRC License and standard mill procedures at that time. Seepage from the tailings impacted the "background water" (i.e., the portion of the mine discharge water that had infiltrated into the subsurface during the mining era and significantly saturated the near-surface alluvium and Zone 1 and Zone 3 sandstones). Seepage impacts have been observed in the alluvium to the west and southwest of the tailings impoundment in the SWA and in Zone 3 and Zone 1 to the north, northeast and east of the impoundment (see, e.g., EPA, 1988c; and see Figure 3). The term "seepage-impacted water" is defined as the acidic water that seeped from the UNC mill tailing impoundments, which contains the COCs as identified in the 1988 ROD. The seepage-impacted water is distinctly different from the water that infiltrated from the mine discharge waters which constitute the "background water," and it is also distinctly different from the natural ground water that exists in Section 36 in Zone 3 and Zone 1 at about elevation 6700 ft amsl.

[3] A hydrostratigraphic unit is a section of a geologic formation that exhibits similar hydraulic properties. In this report, the term "hydrostratigraphic unit" will be used instead of the term "aquifer", which is commonly used for water supply.

The surrounding lands include the Navajo Nation, Tribal Trust Land, Indian Allotment Land, and UNC-owned property. To the northwest and adjacent to the Site is the former NECR mine, an underground uranium mine which was also operated by UNC. The NECR mine is currently subject to EPA response actions directed by EPA Region 9. Under the removal action at NECR and under the UNC OU2 ROD, EPA has called for approximately one million cubic yards of contaminated mine waste from the NECR mine to be disposed at the TDA at the United Nuclear Superfund Site. EPA's implementation of the OU2 remedy is contingent on the NRC approval of a license amendment for the Site TDA which comprises three covered tailing cells and two covered borrow pits. The surrounding lands are sparsely populated and the primary land use near the site is grazing for sheep, cattle, and horses.

FIFTH FIVE-YEAR REVIEW SUMMARY FORM

Site Name: United Nuclear Corporation Church Rock Superfund Site		
EPA ID: NMD030443303		
Region: 6	**State:** NM	**City/County:** Gallup/McKinley County
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion? (yes for OU1) but no for OU2 as reflected below.** No	
Lead agency: EPA		
Author name (Federal or State Project Manager): Janet Brooks, Remedial Project Manager		
Author affiliation: EPA Region 6		
Review period: 9/17/2017 - 9/17/2018		
Date of site inspection: 10/31/2017		
Type of review: Statutory		
Review number: 5		
Triggering action date: 9/17/2013		
Due date *(five years after triggering action date)*: 9/17/2018		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

EPA listed the Site on the NPL of Superfund sites in September 1983 and conducted a Site Remedial Investigation (RI) and Feasibility Study (FS) from 1984 through 1988. The RI report concluded that because of the disposal of mill tailings, acidic tailings fluid containing radioactive and other chemical constituent contaminants seeped downward beneath the TDA and impacted three water bearing zones of the underlying ground water, including the SWA, and Zone 1 and Zone 3 of the Upper Gallup Sandstone Formation.

Contaminants of Concern
The OU1 COCs and cleanup levels identified in the 1988 ROD (see Table 1) were established based on the following:

- Post-mining/pre-tailings background levels were established for iron, manganese, sulfate, nitrate, and total dissolved solids (TDS). By "background" EPA means the subsurface water that originated from the mine water discharge and infiltrated the hydrostratigraphic units at the Site. This background water is distinctly different from the acidic water that seeped from the tailings impoundments. Background concentration levels of a contaminant in ground water are generally used as a benchmark for measuring whether cleanup methods are successful.

- EPA MCLs were selected as the cleanup levels for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, radium-226, radium-228, gross alpha and thorium-230. The 1988 ROD noted that the thorium-230 level is based on the gross alpha MCL.

- New Mexico Water Quality Control Commission (NMWQCC) standards were selected as the cleanup levels for aluminum, cobalt, copper, molybdenum, nickel, zinc, chloride, and uranium-238. NMWQCC standards and MCLs were the same for barium, cadmium, chromium, lead, mercury and silver.

- Health based criteria were calculated using Reference Doses for antimony, beryllium, thallium, and vanadium. A Reference Dose means an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure for an acute duration (24 hours or less) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Resources impacted by the contamination include the SWA and Zone 3 and Zone 1 ground water hydrostratigraphic units. Nearby residents and livestock are not exposed to Site-related ground water contamination at present because there are no domestic or livestock wells within close proximity to the Site. The UNC production well on the Site is accessible only by Site management. Exposure to surface soils and tailings through direct contact is controlled through requirements in the NRC License SUA-1475. Air emissions are also controlled through the requirements of NRC License SUA-1475

Response Actions

Prior to the 1988 ROD, UNC undertook several actions under its NRC License. During that time, UNC/GE also assisted in the development of the EPA Remedial Investigation and Feasibility Study (RI/FS). UNC also undertook actions as required by the New Mexico Environmental Improvement Division (now NMED) to address ground water concerns. UNC neutralized the acidic mill tailings by adding ammonia and lime to raise the pH levels in the TDA. UNC also investigated the impact of the tailings seepage on ground water. UNC began ground

water remediation in 1982. UNC installed and operated wells to extract tailings seepage. UNC extracted neutralized water and discharged the neutralized water into the tailings disposal cells for evaporation.

Implementation of the processes for reclamation and ground water remediation under the NRC License began in 1986, when the NRC assumed mill site licensing responsibility from the State. UNC submitted a draft reclamation plan to NRC in 1987, and the final plan was approved in March 1991.

Selected Remedy

The remedy selected in EPA's 1988 ROD for OU1—the ground water operable unit—is the subject of this FYR Report and includes the following six elements:

1. Implementation of a monitoring program to detect any increases in the areal extent, or concentration of ground water contamination outside the tailings disposal area.
2. Operation of existing seepage extraction systems in the Upper Gallup aquifers.
3. Containment and removal of contaminated ground water in Zone 3 of the Upper Gallup Sandstone utilizing existing and additional wells.
4. Containment and removal of contaminated ground water in SWA utilizing existing and additional wells.
5. Evaporation of ground water removed from aquifers using evaporation ponds supplemented with mist or spray systems to enhance the rate of evaporation.
6. Implementation of a performance monitoring and evaluation program to determine water level and contaminant reductions in each aquifer, and the extent and duration of pumping actually required outside the tailings disposal area.

Based on the RI/FS, the RAOs established in the 1988 ROD for OU1, ground water remedy, included:

- Containment of down-gradient contaminant migration within each target area.
- Restoration of ground water down-gradient of the TDA, to the maximum extent practicable, to meet the cleanup criteria.
- Restoration of ground water at the TDA to a level that allows attainment of cleanup criteria at its boundary.

The goal of the selected remedy for OU1 at the Site was to restore ground water outside the TDA to federal and state standards, health based criteria, or background levels, to the maximum extent practicable, and to the extent necessary to adequately protect public health and the environment. However, as stated in Appendix A of the 1988 ROD, it was recognized that cleanup levels may not be reached within a reasonable time period due to the hydrogeologic characteristics of the aquifers.

The 1988 ROD identified remediation goals for the twenty-eight contaminants detected in Site ground water during the remedial investigation. Of the 28 remediation goals, 19 are ARARs, four are health-based criteria and five are background levels that were based on the mine water discharge (*i.e.*, hydrostratigraphic water that originated from mine water discharge, but which had not been impacted by contamination seeping from mill tailings), which is also reffered to as "background water" or "post-mining/pre-tailings background water" in this FYR report. Table 2 lists the Site contaminants identified in the 1988 ROD that exceed the established cleanup levels and the hydrostratigraphic units in which they were exceeded.

Operable Unit 1

The 1988 ROD did not provide a clear evaluation of the post-mining/pre-tailings background water quality in establishing the Site cleanup standards. The COCs or cleanup levels for the Site were not specifically identified in the 1988 ROD. UNC addressed cleanup levels in the UNC SWSFS Part I investigation report that included: 1) a thorough review and update of the Site COCs based on screening with current federal MCLs, health based criteria, background water quality; and 2) an update and recommendation for revision of the Site cleanup levels.

Parts I and II of the SWSFS have been reviewed and accepted by the EPA but have not yet modified the COC list and monitoring program.

The NRC has approved several revisions to License standards including changes to the COCs, and monitoring programs recommended by UNC. EPA has discussed those revisions with the NRC but has not modified the cleanup levels or remedy set forth in the 1988 ROD to be consistent with NRC revisions. Such consistency, where appropriate, would help to integrate and coordinate the ground water and source control/surface reclamation activities to achieve comprehensive reclamation and remediation of the Site. This sort of integration and coordination is called for in the MOU between the EPA and the NRC.

The EPA plans to revise the background water levels, as appropriate, to make them a more accurate reflection of the water that existed post-mining/pre-tailings now that the SWFS Parts I and II are complete. The SWFS Parts I and II include a thorough and comprehensive review of the existing cleanup levels, an evaluation of newly promulgated standards as potential new ARARs, and more recent health based toxicological information and background water quality data. Since the 2013 FYR was completed, UNC has completed a working draft of Part III of the SWSFS, including an analysis of remedial alternatives. A summary of this work is presented and discussed in Section 3.0.

Operable Unit 2

EPA has not yet implemented the remedy for OU2, the Surface Soil Operable Unit, which is still in the Remedial Design phase. EPA entered into a settlement agreement with UNC and GE and under that agreement, UNC/GE agreed to develop a Remedial Design for the implementation of the remedy selected in the ROD. The Remedial Design is subject to EPA's approval. The settlement agreement was documented in a 2015 EPA administrative order on consent (AOC). Under the AOC, UNC/GE completed the Preliminary Design (30%) in late 2016, and UNC/GE submitted a Draft Pre-Final Design (95%) to EPA for review and comment in October 2017. The OU2 remedy selected in EPA's 2013 ROD for OU2—the surface soil remedy—addresses contaminated surface and subsurface soil from the nearby NECR mine. **The Selected Remedy described in the 2013 ROD does not address contaminated ground water at the Site which is being remediated under the separate 1988 ROD for OU1, as described above.**

Status of Implementation

The 1988 MOU between EPA Region 6 and Region IV of the NRC indicated that these two regions understood that NRC would exercise its authority over surface reclamation and source control. The 1988 ROD stated that, "...Upon approval of a final reclamation plan, both ground water and source control/surface reclamation remedial actions will be integrated and coordinated to achieve comprehensive reclamation and remediation of the Site" (1988 ROD, p. 41).

Source control measures regulated by the NRC were constructed primarily to effectively minimize infiltration, seepage, and mobilization of contaminants from the tailings. The source control measures implemented in the NRC license included regrading and recontouring the tailings, placing a low permeability compacted soil cover over the regraded tailings, and constructing drainage swales on and around the reclaimed impoundments. The tailings impoundment covers consist of an interim cover of compacted soil, followed by the final cover of compacted soil and rock. The interim and final covers act as a radon barrier and for erosion protection.

OU1 – Ground Water Remedial Actions

UNC implemented the remedial systems at the Site as required by the 1988 ROD, which operated as intended for a period of time. As UNC has dewatered Site areas, extraction well efficiency declined and the wells were decommissioned in accordance with decommissioning criteria set forth in the NRC license. Currently, of the six elements identified in the 1988 ROD, elements 1, 3, and 6 remain active, elements 2 and 4 are inactive, and

element 5 is partially active – the evaporation ponds are in use but the spray systems are inactive. (*See supra* p. 5 (*Selected Remedy*) for a numbered list of the OU1 ROD elements.) The tailings seepage mound has dissipated due to the pumping from the three hydrostratigraphic units (only Zone 3 is still pumping water) and minimal natural recharge from precipitation. Efforts to restore ground water quality outside the TDA to established standards, criteria, and background levels by UNC/GE has potentially reached the maximum extent practicable, according to the limited ability to pump from the Zone 3 wells. Operational results from the performance monitoring program gathered by UNC/GE indicate a significant reduction in the saturated thickness of water in all three hydrostratigraphic units which severely limits the ability to extract impacted ground water.

Historically, all the ground water produced from all extraction wells on the Site was placed into two five-acre ponds (Figure 2) where it evaporated. The water was then pumped through a spray evaporation system installed on the surface of the regraded and covered tailings. An evaporation mist system constructed on the interior berm, between the two evaporation ponds, was designed to enhance the disposal of the extracted water during the summer months. During the winter months, a small amount of water accumulates in the evaporation ponds from winter precipitation. The evaporation mist system ceased operation in 2001, when the rate of ground water extraction declined significantly (only Zone 3 has been pumped since 2001). Currently, due to the lack of a sufficient volume of water being pumped from the Zone 3 hydrostratigraphic unit, UNC/GE is supplementing the volume of water in the evaporation ponds with water pumped from the on-site production well. This water is needed to keep the evaporation liner saturated.

The SWA remedial system (see Figure 4) was temporarily shut down by EPA in 2001 to conduct a natural attenuation test. Since 2001, the SWA remedial system has remained idle, i.e., water has not been pumped from any of the SWA wells. Performance monitoring is ongoing. Monitored natural attenuation (MNA) has been effective in addressing the residual contaminant concentrations in the SWA.

The Zone 3 (see Figure 10) remedial system continued operating throughout this FYR period. The ground water extraction system for Zone 3 uses six wells along the seepage-impacted front that is designed to capture and slow migration of the ground water in Zone 3 that has been contaminated by water seeping from the disposal cells on the Site. UNC has adjusted the pumping regime along the NW-series extraction wells (see Figure 10) since 2009 to: (1) minimize the withdrawal of background water originated from the mine water discharge; (2) limit the tendency for seepage-impacted water from the disposal cells to be drawn westward or northward at the northern portion of Zone 3; and (3) improve the capture of seepage-impacted water from the pumping wells. The goal is to strike the best balance between containing the seepage-impacted water while minimizing its transport to the more thickly saturated, but non-seepage-impacted parts of Zone 3.

The Zone 1 (see Figure 15) remedial system was decommissioned by NRC in July 1999. Performance monitoring is ongoing.

Institutional Controls

ICs are non-engineered instruments such as administrative and legal controls that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy selected by EPA for a Superfund site. The 1988 ROD did not formally establish any ICs; however, certain enforcement documents, governmental controls, and informational controls are in place. Informational controls such as signs are posted near the TDA.

In 1989, EPA issued a unilateral administrative order (UAO) to UNC. The UAO required UNC to undertake the ground water remediation required by EPA's OU1 ROD. In addition, the NRC's Site Source Materials License No. SUA-1475 remains in effect. As part of the license, NRC requires that UNC manage the Site to prevent contaminant exposure, including exposure to those contaminants in the ground water.

There are currently no ICs restricting the use of ground water impacted by contaminated seepage from the tailings cells that has migrated beyond the boundary of the NRC Licensed Site. There are also no ICs establishing land use restrictions in place in the area impacted by contaminated water seeping from the tailing cells.

Systems Operations/Operation & Maintenance

OU1 – Ground Water Remedial System Operation & Maintenance

Ground Water O&M is required by EPA's 1988 ROD, which addresses Site ground water, and by EPA's 1989 UAO to UNC, which requires UNC to implement the ground water remedy in the OU1 ROD. The required O&M activities include:

- Operation, maintenance, and monitoring of the ground water extraction wells and associated piping.
- Maintenance of interim covers and the final radon barrier on the tailings disposal cells.
- Operation and maintenance of the evaporation ponds, misters, and water cannons.
- Maintenance and sampling of ground water monitoring wells.
- Maintenance of fences and gates.

Pumping in the SWA was discontinued in 2001, due to the effectiveness of natural attenuation. Pumping in Zone 1 was discontinued, due to low productivity of the wells (combined pumping rate from the three wells is 0.64 gpm). UNC/GE continues ground water extraction in Zone 3 using wells along the seepage-impacted front (*see* Figure 10 for well locations). GE/UNC continues to monitor ground water in all hydrostratigraphic units.

The Zone 3 extraction wells are operational; however, they require frequent maintenance and pumping rates continue to decrease to less than 0.3 gpm/well in 2017. Combined flows from the Zone 3 wells have decreased from 1.9 gpm in 2014 to 1.18 gpm in 2017, and the annual volumes extracted have decreased from 1,097,483 gallons in 2013 to 619,000 gallons in 2017 (*see* Annual Monitoring Reports, Table 8). UNC/GE continues to actively promote the extraction of water by repairing the six extraction pumps as needed.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last five-year review (EPA 2013), as well as the recommendations from the last five-year review and the current status of those recommendations.

Table 4 - Protectiveness Determinations and Statements from the 2013 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Short-term Protective	The remedy at OU1 (the final source remedy) currently protects human health and the environment in the short term. Actions taken have minimized potential human exposures to contaminants found in the ground water and reduced the potential for the repository tailings to act as a source of ground water contamination. For the remedy to be protective in the long term, the following actions need to be taken: 1. Evaluate and revise the estimated background contaminant levels at the Site and reevaluate Site cleanup standards (*i.e.*, remediation goals) through the NCP decision-making process. 2. Complete the ongoing SWSFS Part III to develop and analyze remedial alternatives. 3. Continue the experimental efforts to create a subsurface hydraulic barrier in Zone 3 to slow down and contain the migration of the seepage-impacted water in the northern subsurface area. 4. Determine whether the SWA extraction wells have provided improvement in ground water quality with respect to uranium contamination when compared to Natural Attenuation. 5. Evaluate the use of various mechanism(s) of Natural Attenuation in the SWA for uranium as well as for other COCs in all hydrostratigraphic zones as part of the ongoing remediation effort to attain cleanup standards. 6. Renew efforts to establish ICs that will help protect human health by restricting the use of contaminated ground water on affected Navajo Nation, Tribal Trust, and Indian Allotment lands. 7. Evaluate whether a Technical Impracticability (TI) waiver is appropriate for the ARARs related to sulfate and TDS. This evaluation would be done as part of the ongoing SWSFS, Part III. 8. Evaluate the anthropogenic origin and the transient nature of the artificially created ground water hydrostratigraphic units impact on future EPA ground water decision making.
2	Will be Protective	The surface soil operable unit (OU2) remedy described in the 2013 OU2 ROD, which provides for the disposal of NECR mine waste at the Site TDA, is expected to be protective of human health and the environment upon completion. At present [*i.e.*, in 2013], remedial design activities are underway which will adequately address all exposure pathways that could result in unacceptable risks associated with OU2.
Sitewide	Short-term Protective	The remedial action that has been taken to address ground water contamination at the Site and the remedial action that has been taken to address contamination on the surface of the Site are presently protective of human health and the environment and should remain protective in the short term.

Table 5 - Status of Recommendations from the 2013 FYR (Note: In many circumstances at Superfund sites that address contaminated ground water, "background" is essentially defined as the amount of a contaminant that is present in the native ground water that is not due to local anthropogenic sources, such as a release. That is not what "background" means in this FYR because at the Site, there is no native ground water (except at the northern boundary of Section 36—not pertinent here). The Site hydrostratigraphic unit that was in place before the Site mill operated was water pumped out of the mines located northwest of the mill. This mine discharge water was untreated until 1975, and probably contained high concentrations of contaminants. After 1975, discharge water was allowed to contain uranium concentrations of up to 2 milligrams per Liter (mg/L) under the provisions of the two mines' NPDES permits. In EPA's 1988 OU1 ROD, the concentration of contaminants in this mine discharge water is referred to as "background." This FYR also refers to this contaminated water as "background." This makes sense because there was no appreciable subsurface water at the Site (other than the Section 36 water) until this mine discharge water came to the Site.

The "Background Threshold Value" (BTV), a term used in the following table, is a value that characterizes the background dataset, i.e., non-seepage-impacted water. Contaminant concentrations ("values") found in water samples taken from the subsurface that are below the BTV would be considered representative of "background" subsurface water (i.e., the mine discharge water that came to be located in the subsurface hydrostratigraphic unit at the Site); values above the BTV might be above background. The 95th percentile has been selected for this evaluation to serve as the BTV. However, it should be recognized that by definition, 5% of all true "background" subsurface water samples would be interpreted as above background using this BTV as a benchmark statistic. The BTVs presented here are UPL95 values (95th percentile upper prediction limits), which represent not-to-exceed values that are appropriate for compliance monitoring on a point-bypoint (i.e., well-by-well) basis (GE, 2012).

Note also that subsurface water described in this FYR as Tailings Seepage Water is water that became contaminated because it entrained contaminants as it passed through the mill tailings piles created by the United Nuclear Corporation mill on the Site.

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description (additional discussion below table)	Completion Date (if applicable)
1	1. The 1988 ROD did not provide a clear evaluation of the post-mining/pre-tailings background water quality in establishing the Site cleanup standards.	Evaluate and revise the estimated background contaminant levels at the Site and reevaluate Site cleanup standards (i.e., remediation goals) through the NCP decision-making process.	Ongoing	NRC revised ground water protection standards based on updated Background Threshold Values (BTVs) for the Site. NRC approved the BTVs in 2015. EPA has not acted on the proposed BTVs in a decision document.	N/A
1	2. The ground water remedy cannot attain the cleanup levels within a reasonable time frame because the source of anthropogenic recharge to the ground water system is no longer available and has resulted in a significant loss of aquifer saturated thicknesses.	Complete the ongoing SWSFS Part III to develop and analyze remedial alternatives.	Ongoing	EPA Region 6 will stop work on the SWSFS Part III determination until after EPA Region 9 completes a water quality investigation of the NECR and Quivira mines (see Data Review section below).	Stop Work

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description (additional discussion below table)	Completion Date (if applicable)
1	3. The Zone 3 extraction well system cannot hydraulically control the migration of tailings seepage-impacted water northward toward and eventually on to the Navajo Nation lands.	Continue the experimental efforts to create a subsurface hydraulic barrier in Zone 3 to slow down and contain the migration of the seepage-impacted water in the northern subsurface area.	Ongoing	The Zone 3 extraction system has been declining in performance due to the decreasing amount of water that is being extracted; consequently, active remedial operations in Zone 3 are reaching the limits of their effectiveness.	N/A
1	4. The question still remains as to whether or not the operation of the extraction system in the SWA is effective for improving ground water quality with respect to uranium and whether natural attenuation can be relied upon as part of the remedy to mitigate tailings seepage impacts on ground water.	Determine whether the SWA extraction wells have provided improvement in ground water quality with respect to uranium contamination when compared to natural attenuation.	Under Discussion	The SWA extraction system has remained idle since 2001 due to only sulfate and TDS migrating out of the tailing cells. TDS and sulfate are secondary drinking water standards, which are not remediation goals at the Site. Significantly, the natural geochemistry of the ground water appears to be effective for improving ground water quality with respect to uranium concentrations.	N/A
1	5. Uranium concentrations in the SWA ground water do not exceed the uranium cleanup level of 5.0 milligrams per Liter (mg/l) called for in the 1988 ROD. However, they do exceed the 2003 promulgated EPA Safe Drinking Water Act (SDWA) MCL for uranium of 0.030 mg/l.	Evaluate the use of various mechanism(s) of natural attenuation in the SWA for uranium as well as for other COCs in all hydrostratigraphic zones as part of the ongoing remediation effort to attain cleanup standards.	Under Discussion	UNC/GE submitted an expanded list of proposed BTVs in 2015, including COCs addressed in the 1988 ROD. The updated BTVs for each EPA-regulated COC were critically compared to ARARs and the ROD standards to propose appropriate cleanup levels for COCs. EPA has not acted on the proposed BTVs in a decision document.	N/A
1	6. In light of the technical difficulties of achieving Site ground water cleanup levels using engineering controls, ICs may have to play a larger role in protecting human health at the Site.	Renew efforts to establish ICs that will help protect human health by restricting the use of contaminated ground water on affected Navajo Nation, Tribal Trust, and Indian Allotment lands.	Under Discussion	Efforts to discuss ICs with the Navajo Nation have not been renewed	01/31/2019

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description (additional discussion below table)	Completion Date (if applicable)
1	7. Sulfate and TDS concentrations are not dependent on continued operation of extraction systems in the hydro-stratigraphic units at the Site, but rather these constituent concentrations are controlled by natural geochemical reactions, primarily the chemical equilibrium with gypsum and/or anhydrite.	Evaluate whether a TI waiver is appropriate for the ARARs related to sulfate and TDS. This evaluation would be done as part of the ongoing SWSFS, Part III.	Under Discussion	Statistical evaluation of the background sulfate and TDS concentrations has been completed. EPA has not acted on the proposed BTVs for sulfate and TDS.	N/A
1	8. Background water at the Site is not a natural water source but instead an anthropogenic artificial aquifer created by mine water effluent that was pumped from the Westwater Canyon Member of the Morrison Formation, which contains the uranium ore body.	Evaluate the anthropogenic origin and the transient nature of the artificially created ground water aquifers impact on future EPA ground water decision making.	Under Discussion	UNC/GE used statistical analysis of water chemistry from wells located outside of the seepage-impacted area to calculate BTVs from the mine discharge water that infiltrated the subsurface prior to the mill tailings seepage impact. UNC/GE submitted an expanded list of BTVs in 2015, including COCs addressed in the 1988 ROD. The updated BTVs for each EPA-regulated COC were critically compared to ARARs and the ROD standards to select appropriate cleanup levels. EPA has not acted on the proposed BTVs in a decision document	N/A

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

EPA published a public notice regarding the FYR in the *Gallup Independent* newspaper, on 11/1/2017. The notice stated that there was a five-year review and invited the public to submit any comments to the U.S. EPA. The notice also said that the results of the FYR will be described in the FYR report, which will be made available at the following Site information repositories:

> University of New Mexico – Gallup Zollinger Library
> 705 Gurley Avenue, Gallup, NM 87301
>
> Navajo Nation Environmental Protection Agency Superfund Office
> Highway 264/43 Crest Road St. Michaels, AZ 86511
> (928) 871-6859 / (800) 314-1846

During the FYR process, interviews were conducted with stakeholders, including UNC/GE, federal and tribal agencies, residents and Chapter House officials to document any perceived problems or successes with the remedy that has been implemented to date. Interview records are included in Appendix C. The results of these interviews are summarized below.

Interview questionnaires were sent out to each regulatory stakeholder and to UNC/GE in October 2017. Stakeholders included the NRC, U.S. Department of Energy (DOE) Office of Legacy Management, and the Navajo Nation EPA. Only DOE and UNC/GE sent a response. In its response to the questionnaires, DOE responded that its role in the Site is informal at this point but its purpose in the review process is "*twofold, first to ensure the intended end-state does not conflict with DOE future obligations under UMTRCA [Uranium Mill Tailings Radiation Control Act]. Second is DOE-LM [DOE Legacy Management] has many years of experience with cells such as the UMTRCA cell [i.e., the TDA cell at the Site] and can provide useful history, expertise and experience.*" In addition, DOE feels well informed, expects that the ground water remedy will be completed and require no monitoring under UMTRCA at the completion of the remedy, before NRC terminates the license and transfers the property to DOE.

UNC/GE emphasized in their response to the questionnaire that the remedy has performed as expected with the Zone 1 and SWA remedies being shut down since 1999 and 2001 respectively. UNC/GE stated that the Zone 3 remedy is reaching the limit of effectiveness as Zone 3 is dewatered. Additionally, UNG/GE states:

> Migration of the Zone 3 plume has been slowed, but it will only cease to migrate when certain natural hydraulic forces are balanced by the chemical reactions that are attenuating and restricting the movement of the seepage-impacted water. At this point, continued downgradient migration can no longer be altered by using hydraulic modifications (i.e. pumping) due to the dip of the geologic strata within which the groundwater moves.
>
> Pumping from Zone 3 wells continues, albeit at a consistently declining yield. Groundwater recovery from all Zone 3 pumping wells combined was about 2.3 gallons per minute (or about the same as a garden hose turned on low) at the time of the last Five-year Review. It is now about 1.4 gpm. The proportion of seepage-impacted water recovered to background water recovered is steadily shifting towards the latter. The groundwater recovery is rapidly meeting the limits of any beneficial effect if it has not already reached that point.

In addition, in-person interviews were conducted at the Coyote Canyon and Pinedale Chapter Houses on the Navajo Nation. On the Navajo Nation, Chapter House representatives presented the views of their respective Houses. Individual Navajos were also interviewed. The primary concerns expressed by individuals and by the Chapter Houses was the lack of site update information and regular communication from the regulatory agencies.

They also expressed an interest in having more educational presentations, particularly at schools, to inform young people about the Site.

Also, individuals and the Chapter Houses expressed concerns about windblown contamination that may have been deposited off-site or onto trees that could then be used as firewood. To address these concerns regarding windblown contamination, on June 19, 2017, the EPA ASPECT airplane conducted radiological surveys over the Site and the NECR and Quivira mines. Preliminary results did not indicate the presence of any off-site windblown contamination.

EPA participates in monthly teleconferences with the local community and responds to any questions and concerns raised by the community. The Site Community Involvement Plan was recently updated on May 18, 2018, and copies of the Community Involvement Plan were provided to the Red Water Pond Road Community Association and to Coyote Canyon, Pinedale, Church Rock, Standing Rock and Nahodishgish Chapterhouses.

Data Review

Sampling events occur quarterly in all three hydrostratigraphic units. The data are reported semi-annually and an annual report is prepared.

EPA has assessed remedy performance through a data review process (see Appendix D for Documents Reviewed). Data reviewed includes ground water performance monitoring data collected over the five-year review period covered in this report. Data review also included an evaluation of the historical Site ground water concentrations of COCs identified in the ROD, where updated BTVs were calculated through statistical analysis using Upper Prediction Limits at 95 percent confidence (UPL95) (*see supra* Table 5 introductory note regarding "background" and Background Threshold Value)) . Tailings-seepage-impacted water affects three hydrostratigraphic units - SWA, Zone 3, and Zone 1 (see Figure 3). Specific observations related to these hydrostratigraphic units are discussed below.

GE/UNC submitted a working draft of the SWSFS Part III to EPA for comment on January 6, 2017 (Chester Engineers, 2017a). A principal source of uranium for ground water in the SWA and Zone 3 was mine discharge water that was permitted to contain uranium concentrations up to 2 milligrams per Liter (mg/L). This mine water was discharged to Pipeline Arroyo from both the NECR and Quivira mines, which are located northwest of the Site (see Figure 2), for approximately17 years. Consequently, the hydrostratigraphic units are considered to be artificially created ground water of anthropogenic origin with degraded water quality from the the time they were discharged. That is, the hydrostratigraphic units are not naturally occurring, but were created when miners pumped uranium contaminated water from the mines into Pipeline Arroyo where it percolated into the subsurface.

Chester Engineers presented the following data from the working Draft SWSFS-Part III of the estimated background water volumes (mine discharge water) compared to the seepage-impacted volumes:

Hydrostratigraphic Unit	Background[4] Water Volume (gallons)	Seepage-Impacted Water (Oct 2015) (gallons)	Seepage-Impacted Water/Background Ratio (%)
SWA	17,831,613,510	140,451,966	0.788
Zone 3	701,624,000	11,274,873	1.6
Zone 1	2,161,720,000	9,360,781	0.433

EPA Region 9 will investigate the extent of the historic mine water discharge, i.e., the Background Water Volume (in the above table) in the vicinity of the NECR and Quivira mines (EPA, 2016). EPA Region 9 will begin their water quality investigation after UNC/GE installs sentinel monitoring wells on the Navajo Nation. Installation of

[4] *See supra* Table 5 introductory note regarding "background" and Background Threshold Value

the sentinel monitoring wells is planned for Summer 2018. Due to the significant volume of water volume from mine water discharge (21 billion gallons) that may be impacting the seepage-impacted water (161 million gallons) EPA Region 6 believes that stopping work on the SWSFS Part III is warranted until EPA Region 9 determines the extent of mine water discharge impact to the local water system in the vicinity of the Site. The remedial alternatives presented in the working draft SWSFS Part III may be inappropriate, due to the significant impact to the seepage-impacted water from the mine water discharge in the vicinity of NECR and Quivira Mines.

Site-wide ground water elevations have gradually declined since the OU1 remedy was constructed in 1989. A trend toward decreasing water levels continued in each hydrostratigraphic unit on the Site, even after the ground water extraction system operations ceased in the SWA and Zone 1 hydrostratigraphic units. The site-wide ground water elevation decline is primarily due to cessation of mine water discharges into Pipeline Arroyo in 1986. The mine water discharges in to the arroyo, prior to 1986, had infiltrated the subsurface and recharged the SWA, Zone 3, and Zone 1 hydrostratigraphic units during the mine dewatering operations.

Southwest Alluvium

The SWA potentiometric surface map for the October 2017 monitoring event (Figure 4) shows that, in the vicinity of the Site, ground water flows to the southwest, along the Pipeline Arroyo. Ground water also flows eastward beneath the northwestern part of the South Cell, reflecting the presence of a relatively high area (bulge) in the bedrock surface that encompasses the "Nickpoint" along Pipeline Arroyo (Figure 4). Contours of saturated thickness in the SWA (Figure 5) during the UNC/GE October 2017 monitoring event indicated that the northern portion of the ground water system, upgradient of the Nickpoint at well 0509 D (Figure 5), may have become separated (i.e., ponded due to loss of hydraulic continuity) from the ground water to the south. A time-series plot from January 1989 through January 2017 (Figure 6) shows the gradual decline in the SWA water level elevations. EPA ended extraction well pumping in January 2001 to conduct a natural attenuation study. Pumping was not reinitiated because attenuation via natural geochemical processes continues to be effective in controlling the COCs. Overall, water levels in the SWA have declined approximately 2 to 3 feet during the five-year review period covered in this report. The declining water levels and declining saturation thickness in the SWA support the conclusion that there is no continuing recharge and the hydrostratigraphic unit is drying out. Overall in the SWA, water levels (based on potentiometric surface maps water level graphs) have declined approximately 25 feet since 1989 and by approximately 2.6 feet during this current five-year period.

UNC/GE and others (NMED and NRC) have conducted several background ground water quality studies, primarily focused on relationships between major ion concentrations (i.e. TDS, sulfate, and bicarbonate) and uranium concentrations and the post-mining/pre-tailings ground water quality. Historically, only two ground water constituents (sulfate and TDS) exceed the 1988 ROD standards in the SWA seepage-impacted water seepage-impacted water outside the UNC property boundary. Sulfate and TDS also exceed the 1988 ROD standards in the background water samples (Wells 627, EPA 28, and SBL-1). However, when compared to the calculated Proposed BTVs (Table 6), there are no exceedances of TDS in any SWA wells, and sulfate exceedances occurred only in the downgradient background Well SBL-1 (Figure 7 and Table 6).

Mapping of bicarbonate isoconcentration contours is an important method of delineating SWA ground water that has been impacted by contaminated seepage from the disposals cells on the Site (Figure 8). The area of seepage-impacted water extends approximately 4000 feet along and southwest of the western margins of the Evaporation Ponds on the South Cell of the Tailing Disposal Area (Figure 8) and extends approximately 1800 feet beyond the UNC property boundary into Township 16 North, Range 16 West, Sections 3 and Section 10. The concentration of dissolved uranium in seepage-impacted water is often a function of the bicarbonate concentration. Uranium concentrations in the SWA seepage-impacted water occur within the same concentration range as the background (post-mining/pre-tailings) ground water. As shown in Figures 9a and 9b, uranium concentrations have generally attenuated in the alluvium as most of the seepage-impacted wells have shown overall stable trends since January 2001, when the extraction pumps were turned off, to the latest samples collected in October 2017. However, since 2009, samples collected from Well 509D, located northwest of the central cell, have consistently detected uranium

at concentrations exceeding the calculated BTV of 0.205 mg/L. The increasing uranium concentration found in GW-3 may be the result of sampling with less than 2 feet of water in the well, leading to an increased concentration of uranium. GW-3 has not been sampled since 2015, due to its location at the edge of Pipeline Arroyo, which has eroded and is no longer safe to sample. Uranium concentrations found in upgradient wells 0802 and 0808 and downgradient wells EPA 25 and EPA 28 are below proposed background standard of 0.205 mg/l. The spatial and temporal variability in SWA ground water uranium concentrations may be related to the heterogeneity of the uranium distribution in the sediments, local geochemistry (e.g., bicarbonate), and hydrologic factors (e.g., saturated thickness) that are not accounted for in the BTV statistical analysis.

Zone 3

The Zone 3 potentiometric surface contour map for the October 2017 monitoring event (Figure 10) indicates that ground water flows toward the north and northeast, approximately parallel with the eastern limit of Zone 3 saturation. A time-series plot from January 1981 through January 2017 (Figure 11) shows the effects of former pumping, current pumping, the former injection program, and natural drainage on Zone 3. From 2002 through 2016, most Zone 3 wells have shown overall decreasing ground water elevations (usually with small fluctuations) at the depth where Zone 3 saturation and contaminant migration is diminishing as the Zone 3 ground water continues to migrate away from the tailing cells as time goes on. Overall, Zone 3 water levels (based on saturated thickness [Annual Monitoring Reports, Table 7] and potentiometric surface maps) have declined by approximately 36 feet since 1989 and 3.0 feet during this current five-year period.

Zone 3 ground water sampling field measurements and contouring of pH values indicate the approximate area impacted by tailings seepage in Zone 3 during the October 2017 sampling event (Figure 12). The extent of seepage-impacted water was determined from pH and bicarbonate concentrations using: (1) seepage-impacted wells, (2) background and former background wells, and (3) northern monitoring and extraction wells. Ground water monitoring of the northern most Zone 3 wells indicates that this area is a complex zone of background water and seepage-impacted water mixing, with some isolated areas that have historically contained seepage-impacted water (i.e. Wells NBL-1 and PB-4 with less than pH 3). Based on all the latest sample information, the seepage-impacted water in Zone 3 extends approximately 3600 feet northeast of the TDA and is constrained within the UNC property boundary.

In general, COC concentrations in Zone 3 ground water are greatest in the highly acidic area of the plume (below pH 4) within the seepage-impacted areas to the southwest (i.e., in Wells 517, 518, 613, and 717) found closest to the TDA. During the 2017 ground water monitoring event, specific metals that exceed both the 1988 ROD standards and calculated BTVs in samples from Zone 3 wells include: aluminum, beryllium, cobalt, manganese, and nickel (Table 7).

Uranium, vanadium, and thorium-230 concentrations exceed the 1988 ROD standards and calculated BTVs in Zone 3 ground water samples taken from Well 613, located immediately northeast/ downgradient of the TDA north cell (Figure 13). Uranium concentrations also exceed the calculated BTV (0.395 mg/L) in Zone 3 ground water samples from Well 717, located along the western margin of the plume. However, the uranium concentrations found in Zone 3 ground water samples taken from Well 613 decreased significantly (from 1.1 to 0.73 mg/L) since 2013; whereas, uranium concentrations in Well 717 increased significantly (from 0.03 to 0.62 mg/L) since 2013. Sulfate concentrations in Zone 3 ground water samples taken from Well 717 also increased significantly (from 4,450 to 7,300 mg/L) since 2013, indicating the effect of seepage-impacted water at this location.

In Figure 14, UNC/GE has described two possible interpretations of uranium isoconcentration in Zone 3 ground water. As reported in Hatch Chester (2018), "The two 2017 alternative maps in Figure 14 are provided due to the uncertainty associated with the substantial water chemistry variability along the contact between seepage-impacted and background water, as well as the limited uranium data in the center of the seepage-impacted area. The Well 717 uranium concentration is likely to be a local effect of the seepage-impacted/background interaction,

as represented by the contours shown in Alternative 1. Alternative 2 provides for an alternative interpretation relating the Well 717 uranium to the acidic core of the seepage-impacted water, based on the low pH observed at the well."

UNC continues to evaluate the chemistry and water levels in the northern Zone 3 wells. UNC has modified the pumping rates to optimize the extraction system operations in Zone 3. However, UNC's efforts to counteract the overall northward hydraulic head and ground water flow is gradually approaching practical limits as the well yields decrease.

On October 14, 2013, the Navajo Nation requested that UNC install sentinel monitoring wells on Navajo Nation trust lands to track and monitor the ground water contamination in the Zone 3 hydrostratigraphic zone. UNC has submitted applications to the Navajo Nation, requesting permits for these sentinel monitoring wells (see Figure 17). Installation of the sentinel monitoring wells is pending the approval of the permits, but is expected to be completed in 2018. The proposed sentinel well locations were selected to validate the ground water flow model and to determine if the working hypothesis mentioned in the preceding paragraph is accurate.

Zone 1

The Zone 1 potentiometric surface contour map for the October 2017 monitoring event (Figure 15) indicates that ground water flows toward the north and northeast, similar to Zone 3 ground water flow. From 1999 through 2017, all Zone 1 wells have shown gradual decreasing ground water elevations (with small fluctuations), as ground water drains down-dip into partially saturated parts of this bedrock stratigraphic unit.

The temporary saturation of Zone 1 was created by the infiltration of former mine dewatering discharges. Zone 1 concentrations of COCs are considered background concentrations This anthropogenic ground water was later impacted by acidic seepage-impacted water from Borrow Pit No. 2 in the Central Cell. Field-measured pH values (below pH 4) and chloride concentrations (above 50 mg/L) indicate the approximate area impacted by tailings seepage in Zone 1. These samples were collected during the October 2017 sampling event (Figure 16). The results show that the seepage-impacted water in Zone 1 extends to the east approximately 400 feet beyond the UNC property boundary into Township 16 North, Range 16 West, Section 1.

Source remediation which consisted of neutralization and subsequent dewatering of the borrow pit was followed by capping of the central cell. Neutralization of the seepage-impacted water continues by both natural geochemical processes and with mixing seepage-impacted water with the background water. This has resulted in reduced concentrations of most COCs below the cleanup standards (both 1988 ROD and calculated BTVs. Tailings water that seeps out of the disposal cells contains elevated concentrations of metals and major ions, including sulfate and chloride, that exceed both the 1988 ROD standards and calculated BTVs in Zone 1 wells (Table 8).

Specific metals (cobalt and nickel) exceed both the 1988 ROD standards and calculated BTVs in samples taken from Zone 1 wells (515A, 604, EPA-5, and EPA-7) during the 2013 through 2017 ground water monitoring events. Manganese, chloride, chloroform, sulfate, and TDS also exceed the calculated BTVs in samples from Zone 1 Well 515A which is located at the UNC property boundary with Section 1. Radionuclides (specifically, combined radium-226/228) exceeded the 1988 ROD standard (5.0 pico Curies per Liter (pCi/L) in several Zone 1 wells throughout the current five-year review period, with concentrations ranging from 5 to 10.6 pCi/L (Table 8). However, there were no exceedances of the calculated BTV (12.1pCi/L) during the 2013 through 2017 ground water monitoring events.

The amount of water seeping from the Site disposal cells into Zone 1 ground water has diminished since extraction pumping ceased in 1999. This indicates that the natural system has been effective in attenuating the seepage-impacted water. The natural processes that are likely causing this attenuation are as follows:

- Acidic seepage is being neutralized (buffered) and adsorption is occurring, resulting in attenuation of metals and radionuclides.
- Natural geochemical conditions (i.e., gypsum equilibrium and bicarbonate availability) also are expected to control sulfate and manganese concentrations in Zone 1.

Site Inspection

The inspection of the Site associated with this Fifth FYR was conducted on 10/31/2017. In attendance were Ms. Janet Brooks, Remedial Project Manager, EPA-Region 6, with support from Mr. Steve Jetter and Mr. Angelo Ortelli, of the NMED-GWQB, Superfund Oversight Section, and Mr. Rick Spitz, Project Manager and Contractor on the Church Rock Project. The purpose of the inspection was to assess the protectiveness of the remedy.

Monitoring and extraction wells appeared to be in good condition and remain operational, except for SWA monitoring wells GW-2 and GW-3, which have not been sampled since October 2015 because of their proximity to areas of slope failure associated with Pipeline Arroyo (Photographs 3 and 4, Appendix E). Other areas of slope failure associated with Pipeline Arroyo were observed at the "Nick Point" (Photographs 5 and 6, Appendix E). Apart from Pipeline Arroyo there was no evidence of erosion or slope failure in other areas of the Site. Native vegetation has established itself on the radon barrier and protective rock cover placed within the tailings disposal cells. A fence and locked gates surround the TDA. Barriers and warning signs surrounded the evaporation ponds within the tailings impoundment area. Overall the Site appears to be well maintained and managed.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Question A Summary:

The OU1 remedy addresses ground water contamination in Zone 1, Zone 3 and the SWA using ground water extraction wells and treatment via evaporation. The OU1 ground water remedy was implemented and operated as specified in the 1988 ROD. However, as discussed in Section 4 of this report, ground water extraction was shut down in the SWA in 2001 for a natural attenuation test and was never restarted because natural attenuation was as effective as pumping, for controlling the migration of COCs. Zone 1 was shut down in 1999 due to the inability to maintain an adequate pumping rate. The ground water extraction and treatment system is currently only operating in a limited extent in Zone 3; therefore, the overall Site ground water extraction system is no longer operating. Ground water extraction continues at Zone 3 using wells along the seepage-impacted front, but it will likely be discontinued in the future as site conditions continue to change.

The OU1 remedy performed as intended in the Zone 3 hydrostratigraphic unit until the ground water extraction well systems started to reach the limit of their effectiveness. The reduced effectiveness is due to a loss in saturation from insufficient recharge and a buildup of clays in the hydrostratigraphic matrix. Cleanup levels have not been attained in Zone 3 because contaminant concentrations are dependent not only on pumping but also on the influence of mine discharge water (i.e., current background conditions impacting the seepage-impacted water).

The Zone 3 ground water extraction wells are operational, but they require frequent maintenance. Most of the Zone 3 extraction wells have yields that are below 0.5 gpm, due to precipitation of amorphous aluminosilicates and encrustation of the well screens with iron oxyhydroxides, carbonates, and/or gypsum; alteration of feldspars to clays in the sandstone matrix; and overall reduced saturated thickness of the hydrostratigraphic unit. UNC continues to evaluate the chemistry and water levels in the northern Zone 3 wells and have modified the pumping rates to optimize the extraction system operations. The effort to counteract the overall northward hydraulic head and ground water flow is gradually approaching practical limits as the well yields decrease. In short, Zone 3 ground water extraction and treatment most likely will be discontinued due to the impracticability of pumping water from wells that are running dry.

Declining pumping system performance was anticipated in the 1988 ROD (Appendix A), which states that "operational results may also demonstrate significant declines in pumping rates with time due to insufficient natural recharge of aquifers" and "In the event that saturated thicknesses cease to support pumping, remedial activity would be discontinued or adjusted to appropriate levels." In addition, the 2013 FYR also acknowledged the technical difficulties of achieving site ground water cleanup levels using engineering controls. The 2013 FYR said that institutional controls may need to play a greater role in protecting human health. Although the extraction systems are not operating, except to a limited extent in Zone 3, natural geochemical processes are continuing to attenuate the seepage-impacted plumes within each of the contaminated hydrostratigraphic units.

The 1988 ROD did not formally establish any ICs; however, as discussed in Section 2, certain enforcement documents, governmental controls, and informational controls are in place. In addition, informational controls such as signs are posted near the TDA (with "No Trespassing" signs) and surround the Site.

However, there are currently no ICs restricting the use of seepage-impacted water that has advanced beyond the NRC Licensed Site boundary in Sections 2, 3, and 10, and on Navajo Trust land to the north of Section 36.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Question B Summary:

Exposure Assumptions

There have been no changes to land use and no drinking water wells have been installed near the Site. Therefore, there is no current exposure pathway and, hence, the remedy remains protective in the short term. However, the long-term protectiveness of the remedy is contingent upon achieving protective cleanup levels within the aquifers.

Toxicity Data and Cleanup Levels

New federal MCLs identified in Table 1 are based on updated toxicological information and, therefore, are considered by the EPA to be protective. To ensure the long-term protectiveness of the remedy, it is recommended that these new MCLs be evaluated for potential as revised ARARs and TBCs for this Site. It should be noted that some of the changes made to the federal MCLs are, or may be, below Site background concentrations and would, therefore, not be appropriate requirements or TBC material. In such cases, the background concentration should be evaluated in lieu of the new or revised standard or criterion.

New, Revised, Promulgated or Enacted Standards since the 1988 ROD

Many of the issues from the Fourth FYR (2013) address the need to reconsider the ARARs in the 1988 ROD, as many numerical standards from which the ARARs were established have changed since the issuance of the 1988 ROD. For this FYR we compared the contaminant-specific ground water ARARs to current ARARs. Current ARARs reviewed for this comparison included the following: NMWQCC ground water standards, Maximum Contaminant Level Goals (MCLGs) under the SDWA, MCLs, Treatment Technology Action Levels (TTLs), Federal Secondary Drinking Water Standards, NRC Ground Water Protection Standards (GWPS), and 10 CFR Part 40 Appendix A (Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content) at Table 5C (Maximum Values for Ground-Water Protection). This comparison found that there are multiple analyte specific performance standards in the 1988 ROD that allow concentration levels of a contaminant that are greater than a current ARAR standard (see Table 1). Performance standards in the 1988 ROD for the following contaminants allow concentrations that exceed current ARARs: aluminum, antimony, arsenic, beryllium, cadmium, iron, lead, manganese, nickel, thallium, vanadium, uranium, sulfate, nitrate, and TDS. In addition to the 1988 ROD allowing higher concentrations of current ARARs, EPA's comparison found that there are performance standards in the 1988 ROD that call for concentrations of contaminants that are lower (i.e., more conservative) than the current ARAR. These more restrictive performance standards in the 1988 ROD include performance standards for barium, chromium, copper, and silver. EPA has summarized the results of its comparison of current ARARs to the standards in the 1988 ROD in Table 1. If current ARAR concentration standards are lower (i.e., more restrictive) than the 1988 ROD standards, then the current ARAR standards are in light blue. If current ARAR standards are higher (i.e., less restrictive), then the current ARAR standards are in light gray. Table 1 also includes one contaminant and one contaminant group that were not included in the 1988 ROD ARARs where a ground water standard exists and may be considered a potential COC. These are lead-210 and Total Trihalomethanes (TTHMs).

Remedial Action Objectives and Remediation Goals

The RAOs (EPA 1988) were described as follows:

- contain down-gradient contaminant migration within each target area;

- restore ground water down-gradient of the Tailings Disposal Area, to the maximum extent practicable, to meet the cleanup criteria; and
- restore ground water at the Tailings Disposal Area to a level that allows attainment of cleanup criteria at its boundary.

The RAOS are still considered to be valid objectives. However, as discussed above, it has not been possible to completely achieve the RAOs.

However, as stated in Appendix A of the 1988 ROD, it was anticipated that cleanup goals (which are referred to as remediation goals under the 1990 NCP) might not be reached within a reasonable time period due to the hydrogeologic characteristics of the hydrostratigraphic units and due to the fact that ground water extraction well systems have started to reach the limit of their effectiveness.

UNC submitted a license amendment request to the NRC in April 2012, that proposed revisions to the GWPS in the license based on updated BTVs for the following COCs: arsenic, cadmium, gross alpha, lead, lead-210, nickel, radium-226 and -228, selenium, thorium-230, and uranium.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

Question C Summary

There have been no changes to land use and no drinking water wells have been installed near the Site. Therefore, there is no current exposure pathway and, hence, the remedy remains protective in the short term. However, the long-term protectiveness of the remedy is contingent upon achieving protective cleanup levels within the individual hydrostratigraphic units (i.e. SWA, Zone 3, and Zone 1).

No other information has come to light that could affect the protectiveness of the remedy. There are no additional risks or previously unidentified risks that could affect performance or protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 1	**Issue Category: Other**			
	Issue: MCLs for certain contaminants of concern on the Site have changed, and these changed MCLs are applicable or relevant and appropriate requirements (ARARs) for the Site. EPA's policy regarding newly promulgated or modified environmental requirements that are promulgated or modified after a ROD is signed is that EPA will not reopen the remedy selection decision made in the ROD unless the new or modified requirement calls into question the protectiveness of the selected remedy. EPA believes that it is necessary to "freeze ARARs" when the ROD is signed. To do otherwise would disrupt CERCLA cleanups, whether the remedy is in design, construction, or in remedial action. Each of these stages represents significant time and financial investments in a particular remedy.			
	Recommendation: Determine if the changes in MCLs warrant a change in Remediation Goals for the remedy to remain protective.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	EPA	EPA/State	6/30/2020
OU(s): 1	**Issue Category: Remedy Performance**			
	Issue: The effectiveness of the Zone 3 O&M activities in controlling contaminant migration from the Site needs to be assessed and adjusted accordingly since mine discharge water may be drawing into the Zone 3 pumping wells.			
	Recommendation: Evaluate the current extraction pumping in Zone 3, to determine whether it is effective at controlling contaminant migration from the Site. In particular, the upgradient well series (i.e., RW-series) should be evaluated to determine whether it is drawing in background water (i.e., water that was contaminated mine discharge, but that was not contaminated by tailings from the UNC mill) from the west.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA/State	1/31/2019

OU(s): 1	Issue Category: Remedy Performance			
	Issue: Current pumping will reach a point where an extraction well will not be able to withdraw water from the Zone 3 hydrostratigraphic unit. At this point in time, the Zone 3 contaminated water will still migrate northward toward the Navajo Reservation.			
	Recommendation: Continue efforts to minimize northward advancement of the Zone 3 ground water that has been impacted by contaminants that seeped from Site tailings. These efforts should forestall contamination of aquifers underlying Navajo land where drinking water wells may be installed in the future. As part of these efforts, where practicable, extraction of contaminated ground water from Zone 3 should be continued in the northernmost extraction wells. These northern wells are located at the leading edge of the ground water that has been impacted by contaminants that seeped from Site tailings. Evaluate expanded use of Natural attenuation.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA/State	1/31/2019
OU(s): 1	**Issue Category: Institutional Controls**			
	Issue: Although no Navajo are currently using ground water that is contaminated with contaminants of concern (COCs) from the Site, there is a potential for water supply wells to be installed in areas that may become impacted with hazardous substances.			
	Recommendation: Renew efforts with stakeholders (e.g., the Navajo Nation and local residents) to establish Institutional Controls (ICs) that will restrict the use of contaminated ground water on Navajo, Tribal Trust, and Indian Allotment lands (and unrestricted fee lands, if any) in all three hydrostratigraphic units.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA/State	6/30/2019

VII. PROTECTIVENESS STATEMENT

Operable Unit:	*Protectiveness Determination:*
OU1	Short-term Protective

Protectiveness Statement:
The remedy at OU1 (the final source remedy) currently protects human health and the environment in the short term, because the remedial actions have minimized potential human exposures to contaminants in ground water and have reduced the potential for the repository tailings to act as a source of ground water contamination. However, in order for the remedy to be protective in the long term, the action items identified in this report should be implemented.

Operable Unit:	*Protectiveness Determination:*
OU2	Will be Protective

Protectiveness Statement:
The OU2 remedy is expected to be protective of human health and the environment upon completion.

Protectiveness Determination:
Short-term Protective

Protectiveness Statement:
Remedial actions at both OUs are currently protective of human health and the environment; therefore, the Site-wide remedy is and remains protective in the short term.

For the ground water exposure pathway, there is currently no known human exposure. However, follow-up actions are needed to achieve long-term protectiveness because the remedial progress of the ground water containment and restoration systems are reaching the limits of their effectiveness. Greater reliance on natural attenuation should be evaluated, and expanded used of institutional controls may be necessary for the ground water remedy to be protective in the long term.

VIII. NEXT REVIEW

The next five-year review report for the Site is required five years from the completion date of this review.

TABLES

Table 1 – 1988 ROD ARARs for OU1 and New, Revised, Promulgated or Enacted Standards since the 1988 ROD						
Contaminant	***1988 ROD Concentration (mg/L) unless noted***	***ARAR Source Identified in ROD***	***2013 NMWQCC GW Standard***	***2018 MCL, TTLs or Secondary DW Standard[a]***	***NRC GWPS (mg/L) unless noted***	***NRC GW Protection List[b]***
Aluminum	5	NMWQA [f]	5	0.05 to 0.2		
Antimony	0.014	HEALTH-BASED		0.006		
Arsenic	0.05	MCL	0.1	0.01	0.05	0.05
Barium	1	MCL, NMWQA [f]	1	2		1
Beryllium	0.017	HEALTH-BASED		0.004	0.05	
Cadmium	0.01	MCL, NMWQA [f]	0.01	0.005	0.01	0.01
Chromium	0.05	MCL, NMWQA [f]	0.05	0.1		0.05
Cobalt	0.05	NMWQA [f]	0.05			
Copper	1	NMWQA [f]	1	1.3		
Iron	5.5	BACK-GROUND	1	0.3		
Lead	0.05	MCL, NMWQA [f]	0.05	0.015		0.05
Manganese	2.6	BACK-GROUND	0.2	0.05		
Mercury	0.002	MCL, NMWQA [f]	0.002	0.002	0.05	0.002
Molybdenum	1	NMWQA [f]	1			
Nickel	0.2	NMWQA [f]	0.2		0.05	
Selenium	0.01	MCL	0.05	0.05	0.01	0.01
Silver	0.05	MCL, NMWQA [f]	0.05	0.1		0.05
Thallium	0.014	HEALTH-BASED		0.002		
Vanadium	0.7	HEALTH-BASED			0.1	
Zinc	10	NMWQA [f]	10	5		
Chloride	250	NMWQA [f]	250	250		
Sulfate	2,160	BACK-GROUND	600 [g]	250		
Nitrate	30	BACK-GROUND	10 [g]	10		
TDS	3,170	BACK-GROUND	1000 [g]	500		
Radium-226 And 228	5 [c]	MCL	30 [c]	5 [c]		5 [c]
Uranium - 238	5	NMWQA [f]	0.03	0.03		
Uranium - 238	Or 1,645 [c]					
Thorium-230 [d]	15 [c]	MCL			5 [c]	
Gross Alpha	15 [c]	MCL		15 [c]	15 [c]	15 [c]
Lead – 210	NA	NA			1 [c]	
TTHMs [e]	NA	NA	0.1	0.08	0.08	

Notes: Current standards less than the 1988 ROD ARAR are highlighted in blue and current standards greater than a 1988

[a] Federal Maximum Contaminant Level, Treatment Technology Action Level (TTLs), or Secondary Drinking Water Standard

[b] 10 CFR Appendix A to Part 40 - 5C-Maximum Values for Ground Water Protection

[c] pCi/L

[d] based on 15 pCi/L Gross Alpha

[e] Total trihalomethanes - include chloroform; TTHMs MCL = 0.08 mg/L; in addition, chloroform has an MCLG = 0.07 mg/L

[f] ROD Identifies NMWQA as Source for State of NM ARARs - NM numerical standards are from the NM Water Quality

[g] NMED Recommended Background Values according to a letter to EPA January 1998 differs from current NMWQCC

Table 2 - 1988 ROD Cleanup Levels and Contaminants Exceeding ARARs for each Hydrostratigraphic Unit

Contaminant	Value	Units	Hydrostratigraphic Units		
			SWA	Zone 3	Zone 1
Aluminum	5	mg/L		X	X
Antimony	0.014	mg/L			
Arsenic	0.05	mg/L		X	X
Barium	1	mg/L			
Beryllium	0.017	mg/L			
Cadmium	0.01	mg/L	X	X	X
Chromium	0.05	mg/L			
Cobalt	0.05	mg/L	X	X	X
Copper	1	mg/L			
Iron	5.5	mg/L			
Lead	0.05	mg/L			
Manganese	2.6	mg/L	X	X	X
Mercury	0.002	mg/L			
Molybdenum	1	mg/L	X	X	X
Nickel	0.2	mg/L	X	X	X
Selenium	0.01	mg/L	X	X	X
Silver	0.05	mg/L			
Thallium	0.014	mg/L			
Vanadium	0.7	mg/L			
Zinc	10	mg/L			
Chloride	250	mg/L			
Sulfate	2160	mg/L			
Nitrate	30	mg/L	X	X	X
Total Dissolved Solids (TDS)	3170	mg/L	X	X	X
Radium 226 & Radium-228	5	pCi/L		X	
Uranium-238	5 or 1645	mg/L pCi/L			
Thorium-230	15	pCi/L			
Gross Alpha	15	pCi/L	X	X	X

Notes:

1 SWA = Southwest Alluvium.

2 mg/L = milligram per liter, pCi/L = picocurie per liter.

3 EPA cleanup levels represent NMWQCC standards for Aluminum, Cobalt, Copper, Molybdenum, Nickel, Zinc, Chloride, and Uranium.

4 EPA cleanup levels represent MCLs for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver, Radium-226, Radium-228, Thorium-230, and Gross Alpha; numerically identical NMWQCC standards existed for Barium, Cadmium, Chromium, Lead, Mercury, and Silver.

5 EPA cleanup levels represent background levels for Iron, Manganese Sulfate, Nitrate, and TDS.

6 EPA cleanup levels represent health-based criteria for Antimony, Beryllium, Thallium, and Vanadium.

7 Although some NMWQCC standards and MCLs are numerically identical, the state standards represent dissolved concentrations, while the federal MCLs represent total concentrations.

Table 3 - 1988 ROD Cleanup Level Compared to Proposed Cleanup Levels

Contaminant	1988 ROD Cleanup Level	Units	Proposed Cleanup Levels		
			SWA	Zone 3	Zone 1
Aluminum	5.0	mg/L	5	5	5
Antimony*	0.014	mg/L	--	--	--
Arsenic	0.05	mg/L	0.01	0.757	0.01
Barium*	1.0	mg/L	--	--	--
Beryllium	0.017	mg/L	0.004	0.004	0.004
Cadmium	0.01	mg/L	0.025	0.09	0.01
Chromium*	0.05	mg/L	--	--	--
Cobalt	0.05	mg/L	0.05	0.391	0.05
Copper*	1.0	mg/L	--	--	--
Iron*	5.5	mg/L	--	--	--
Lead	0.05	mg/L	0.07	0.08	0.05
Manganese	2.6	mg/L	2.1	9.1	5.4
Mercury*	0.002	mg/L	--	--	--
Molybdenum	1.0	mg/L	1	66.1	1
Nickel	0.2	mg/L	0.2	0.569	0.2
Selenium	0.01	mg/L	0.07	0.05	0.05
Silver*	0.05	mg/L	--	--	--
Thallium*	0.014	mg/L	--	--	--
Vanadium	0.7	mg/L	0.1	0.1	0.1
Zinc*	10.0	mg/L	--	--	--
Chloride	250.0	mg/L	250	250	250
Sulfate	2160.0	mg/L	5815	5693	5539
Nitrate	30.0	mg/L	536.6	190	190
Total Dissolved Solids (TDS)	3170.0	mg/L	10376	8592	8020
Radium-226 and Radium-228	5	pCi/L	8.2	35.2	12.1
Uranium-238**	5.0	pCi/L	N/A	0.395	0.238
Thorium-230	15	pCi/L	4.5	17	1.6
Gross Alpha	15	pCi/L	15	39.7	15
Chloroform***	--	mg/L	0.08	0.08	0.08
Pb-210**	--	pCi/L	5.9	5.7	4.7

Notes:

* Contaminant removed from consideration during 1989 Remedial Design

**Calculated BTV=0.2050 mg/L. Historic background up to 0.367 mg/L from mine water discharge. UNC/GE recommends adoption of 0.03 mg/L.

*** Contaminant regulated by NRC.

Table 4 - Protectiveness Determinations and Statements from the 2013 Five-Year Review Report		
OU #	**Protectiveness Determination**	**Protectiveness Statement**
1	Short-term Protective	The remedy at OU1 (the final source remedy) currently protects human health and the environment in the short term. Actions taken have minimized potential human exposures to contaminants found in the ground water and reduced the potential for the repository tailings to act as a source of ground water contamination. For the remedy to be protective in the long term, the following actions need to be taken: 1. Evaluate and revise the estimated background contaminant levels at the Site and reevaluate Site cleanup standards (*i.e.,* remediation goals) through the NCP decision-making process. 2. Complete the ongoing SWSFS Part III to develop and analyze remedial alternatives. 3. Continue the experimental efforts to create a subsurface hydraulic barrier in Zone 3 to slow down and contain the migration of the seepage-impacted water in the northern subsurface area. 4. Determine whether the SWA extraction wells have provided improvement in ground water quality with respect to uranium contamination when compared to Natural Attenuation. 5. Evaluate the use of various mechanism(s) of Natural Attenuation in the SWA for uranium as well as for other COCs in all hydrostratigraphic zones as part of the ongoing remediation effort to attain cleanup standards. 6. Renew efforts to establish ICs that will help protect human health by restricting the use of contaminated ground water on affected Navajo Nation, Tribal Trust, and Indian Allotment lands. 7. Evaluate whether a Technical Impracticability (TI) waiver is appropriate for the ARARs related to sulfate and TDS. This evaluation would be done as part of the ongoing SWSFS, Part III. 8. Evaluate the anthropogenic origin and the transient nature of the artificially created ground water hydrostratigraphic units impact on future EPA ground water decision making.
2	Will be Protective	The surface soil operable unit (OU2) remedy described in the 2013 OU2 ROD, which provides for the disposal of NECR mine waste at the Site TDA, is expected to be protective of human health and the environment upon completion. At present [*i.e.,* in 2013], remedial design activities are underway which will adequately address all exposure pathways that could result in unacceptable risks associated with OU2.
Sitewide	Short-term Protective	The remedial action that has been taken to address ground water contamination at the Site and the remedial action that has been taken to address contamination on the surface of the Site are presently protective of human health and the environment and should remain protective in the short term.

Table 5 - Status of Recommendations from the 2013 Five-Year Review Report					
OU #	**Issue**	**Recommendations**	**Current Status**	**Current Implementation Status Description (additional discussion below table included in text)**	**Completion Date (if applicable)**
1	1. The 1988 ROD did not provide a clear evaluation of the post-mining/pre-tailings background water quality in establishing the Site cleanup standards.	Evaluate and revise the estimated background contaminant levels at the Site and reevaluate Site cleanup standards (i.e., remediation goals) through the NCP decision-making process.	Ongoing	NRC revised ground water protection standards based on updated Background Threshold Values (BTVs) for the Site. NRC approved the BTVs in 2015. EPA has not acted on the proposed BTVs in a decision document.	N/A
1	2. The ground water remedy cannot attain the cleanup levels within a reasonable time frame because the source of anthropogenic recharge to the ground water system is no longer available and has resulted in a significant loss of aquifer saturated thicknesses.	Complete the ongoing SWSFS Part III to develop and analyze remedial alternatives.	Ongoing	EPA Region 6 will stop work on the SWSFS Part III determination until after EPA Region 9 completes a water quality investigation of the NECR and Quivira mines (see **Error! Reference source not found.** section below).	Stop Work
1	3. The Zone 3 extraction well system cannot hydraulically control the migration of tailings seepage-impacted water northward toward and eventually on to the Navajo Nation lands.	Continue the experimental efforts to create a subsurface hydraulic barrier in Zone 3 to slow down and contain the migration of the seepage-impacted water in the northern subsurface area.	Ongoing	The Zone 3 extraction system has been declining in performance due to the decreasing amount of water that is being extracted; consequently, active remedial operations in Zone 3 are reaching the limits of their effectiveness.	N/A

Table 5 - Status of Recommendations from the 2013 Five-Year Review Report (continued)					
OU #	**Issue**	**Recommendations**	**Current Status**	**Current Implementation Status Description (additional discussion below table included in text)**	**Completion Date (if applicable)**
1	4. The question still remains as to whether or not the operation of the extraction system in the SWA is effective for improving ground water quality with respect to uranium and whether natural attenuation can be relied upon as part of the remedy to mitigate tailings seepage impacts on ground water.	Determine whether the SWA extraction wells have provided improvement in ground water quality with respect to uranium contamination when compared to natural attenuation.	Under Discussion	The SWA extraction system has remained idle since 2001 due to only sulfate and TDS migrating out of the tailing cells. TDS and sulfate are secondary drinking water standards, which are not remediation goals at the Site. Significantly, the natural geochemistry of the ground water appears to be effective for improving ground water quality with respect to uranium concentrations.	N/A
1	5. Uranium concentrations in the SWA ground water do not exceed the uranium cleanup level of 5.0 milligrams per Liter (mg/l) called for in the 1988 ROD. However, they do exceed the 2003 promulgated EPA Safe Drinking Water Act (SDWA) MCL for uranium of 0.030 mg/l.	Evaluate the use of various mechanism(s) of natural attenuation in the SWA for uranium as well as for other COCs in all hydrostratigraphic zones as part of the ongoing remediation effort to attain cleanup standards.	Under Discussion	UNC/GE submitted an expanded list of proposed BTVs in 2015, including COCs addressed in the 1988 ROD. The updated BTVs for each EPA-regulated COC were critically compared to ARARs and the ROD standards to propose appropriate cleanup levels for COCs. EPA has not formally approved of the proposed BTVs. EPA has not acted on the proposed BTVs in a decision document.	N/A

Table 5 - Status of Recommendations from the 2013 Five-Year Review Report (continued)					
OU #	**Issue**	**Recommendations**	**Current Status**	**Current Implementation Status Description (additional discussion below table included in text)**	**Completion Date (if applicable)**
1	6. In light of the technical difficulties of achieving Site ground water cleanup levels using engineering controls, ICs may have to play a larger role in protecting human health at the Site.	Renew efforts to establish ICs that will help protect human health by restricting the use of contaminated ground water on affected Navajo Nation, Tribal Trust, and Indian Allotment lands.	Under Discussion	Efforts to discuss ICs with the Navajo Nation have not been renewed	01/31/2019
1	7. Sulfate and TDS concentrations are not dependent on continued operation of extraction systems in the hydro-stratigraphic units at the Site, but rather these constituent concentrations are controlled by natural geochemical reactions, primarily the chemical equilibrium with gypsum and/or anhydrite.	Evaluate whether a TI waiver is appropriate for the ARARs related to sulfate and TDS. This evaluation would be done as part of the ongoing SWSFS, Part III.	Under Discussion	Statistical evaluation of the background sulfate and TDS concentrations has been completed. EPA has not acted on the proposed BTVs for sulfate and TDS.	N/A

Table 5 - Status of Recommendations from the 2013 Five-Year Review Report (continued)					
OU #	**Issue**	**Recommendations**	**Current Status**	**Current Implementation Status Description (additional discussion below table included in text)**	**Completion Date (if applicable)**
1	8. Background water at the Site is not a natural water source but instead an anthropogenic artificial aquifer created by mine water effluent that was pumped from the Westwater Canyon Member of the Morrison Formation, which contains the uranium ore body.	Evaluate the anthropogenic origin and the transient nature of the artificially created ground water aquifers impact on future EPA ground water decision making.	Under Discussion	UNC/GE used statistical analysis of water chemistry from wells located outside of the seepage-impacted area to calculate BTVs from the mine discharge water that infiltrated the subsurface prior to the mill tailings seepage impact. UNC/GE submitted an expanded list of BTVs in 2015, including COCs addressed in the 1988 ROD. The updated BTVs for each EPA-regulated COC were critically compared to ARARs and the ROD standards to select appropriate cleanup levels. EPA has not acted on the proposed BTVs in a decision document	N/A

Table 6- Detected Constituents in Southwest Alluvium, October 2017

Information Source: 2017 AMR (Hatch-Chester, 2018)

Chemical Name	NRC License Standard	1988 ROD Cleanup Level	Proposed BTV Cleanup Level	Unit	0509 D	0624	0627	0632	0801	0802	0803	0808	EPA23	EPA25	EPA28	EPA28 FD	GW1	SBL-01
ALUMINUM	--	5	5	mg/l		0.2												0.4
AMMONIA (AS N)	--	--	--	mg/l	0.2			0.1	4.4 D		0.13	1.21	0.46					
BICARBONATE (HCO3)	--	--	--	mg/l	2500	1670	600	1820	1600	2140	1590	1930	1360	1440	432	440	1800	452
CALCIUM	--	--	--	mg/l	877	689	523	547	570	638	614	645	649	795	491	482	676	477
CHLORIDE	--	250	250	mg/l	339 D	212 D	31 D	243 D	200 D	173 D	142 D	172 D	117 D	145 D	98 D	98 D	240 D	73 D
CHLOROFORM	80	--	80	µg/l				0.66		2.1		0.58					0.91	
COBALT	--	0.05	0.05	mg/l	0.01								0.01					0.03
GROSS ALPHA	15	15	15	pci/l			0.7	1.3			0.8		1	0.6	1	0.7	0.8	1.1
LEAD	0.07	0.05	0.07	mg/l							0.002	0.001						
LEAD-210	5.9	--	5.9	pci/l				1.6			1.5							
MAGNESIUM	--	--	--	mg/l	417	434	226	789	782	740	661	641	391	242	469	463	577	1220
MANGANESE	--	2.6	2.1	mg/l	4.36	0.14	0.15	2.4	6.27	1.31	3.23	2.1	6.81	0.44	0.46	0.49	0.1	4.02
NICKEL	0.078	0.2	0.2	mg/l														0.12
NITRATE (NO3)	--	30	536.6	mg/l	8.70 D	71.5 D	79.0 D	43.0 D	58.5 D	73.5 D	29.5 D	18.7 D		61.0 D	7.05 D	7.20 D	77.5 D	35.3 D
PH (FIELD)	--	--	--	su	6.41	6.57	6.86	6.49	6.61	6.52	6.55	6.52	6.68	6.72	6.88	6.86	6.67	6.61
PH (LAB)	--	--	--	su	6.60 H	6.63 H	7.02 H	6.60 H	6.72 H	6.62 H	6.65 H	6.62 H	6.70 H	6.85 H	6.93 H	6.88 H	6.73 H	6.80 H
POTASSIUM	--	--	--	mg/l	13	6	5	10	12	6	11	9	10	7	10	10	9	13
RADIUM-226	--	--	--	pci/l	0.3	0.2	0.2	0.5	0.2	0.2		0.3	0.3		0.3	0.5		0.4
RADIUM-228	--	--	--	pci/l	1.5			1.6		2.8						1.5		2.6
RADIUM 226 & 228	8.2	5	8.2	pci/l	1.8	0.2	0.2	2.1	0.2	3		0.3	0.3		0.3	2		3
SODIUM	--	--	--	mg/l	413 D	306 D	364	378 D	368 D	332 D	249 D	337 D	151	219 D	252	249	416 D	280 D
SULFATE (SO4)	--	2160	5815	mg/l	2100 D	2100 D	2170 D	3220 D	3250 D	2880 D	2840 D	2820 D	2210 D	1790 D	2900 D	2890 D	2550 D	5520 D
THORIUM-230	4.5	15	4.5	pci/l														
TOTAL DISSOLVED SOLIDS (LAB)	--	3170	10376	mg/l	5690 DH	5170 D	4080 D	6510 D	6520 D	6450 DH	5870 DH	6020 DH	4490 DH	4440 D	4830 D	4950 D	5840 D	8870 D
TOTAL TRIHALOMETHANES	80	--	80	µg/l				0.66		2.1		0.58					0.91	
URANIUM	0.3	5	0.205	mg/l	0.264	0.042	0.021	0.0759	0.0407	0.149	0.0696	0.0841	0.0351	0.13	0.0211	0.0218	0.0995	0.0102

Notes: Table modified by EPA.

— means that a cleanup level was not established for the analyte

Blank shaded values indicate that the analyte was not detected

Gray shaded values exceed the 1988 ROD Cleanup Levels

Blue shaded values exceed the Proposed BTV Cleanup level

Green shaded values exceed both the 1988 ROD Cleanup Levels and the Proposed BTV Cleanup Levels

D indicates that the sample was diluted for analysis

H indicates that the analysis was performed beyond the analytical method holding time

FD indicates a field duplicate sample

Table 7- ***Detected Constituents in Zone 3, October 2017***
Information Source: 2017 AMR (Hatch-Chester, 2018)

Chemical Name	NRC License Standard	1988 ROD Cleanup Level	Proposed BTV Cleanup Level	Unit	0420	0517	0613	0708	0711	0717	0717 FD	0719	EPA13	EPA14	MW-7	NBL-02	NW-1	NW-2	NW-3	NW-4	NW-5	RW-11	RW-A
ALUMINUM	--	5	5	mg/l		18.4	512 D	42.9	11	285	282	0.3		8.7		0.1							
AMMONIA (AS N)	--	--	--	mg/l	0.89	8.5 D	151 D	0.87	2.2 D	39 D	40 D	0.51	0.07	22 D					0.29			3.4 D	0.96
ARSENIC	0.757	0.05	0.757	mg/l				0.001	0.001				0.011						0.212 D			0.001	
BERYLLIUM	0.05	0.017	0.004	mg/l		0.012	0.131	0.069	0.036	0.156	0.163			0.011								0.001	0.001
BICARBONATE (HCO3)	--	--	--	mg/l	363							17	66	5 BH	263	344	428	143	448	42		137	57
CADMIUM	0.09	0.01	0.09	mg/l		0.006	0.044			0.019	0.019												
CALCIUM	--	--	--	mg/l	645	437	416 D	426	452	445	447	457	432	479	592	616			544			550	527
CHLORIDE	--	250	250	mg/l	45	32 DH	104 DH	26 DH	27 D	57 DH	56 DH	34 D	42 D	51 DH	37 D	45	17	32 D	39 D	23 D	34 D	36 D	32 D
CHLOROFORM	80	--	80	µg/l		4	61				0.52												
COBALT	--	0.05	0.391	mg/l	0.04	0.85	1.81	0.48	0.78	1.16	1.14	0.27	0.13	0.4	0.15	0.03						0.43	0.51
GROSS ALPHA	39.7	15	39.7	pci/l	3.1	11.5	36.1	16.2	9.5	24.4	23.8	4.9	6.8	6.3	10.3	5.6			27.6			12	14.9
LEAD	0.08	0.05	0.08	mg/l	0.001	0.011	0.006	0.008	0.009	0.036	0.028			0.005		0.001						0.002	
LEAD-210	5.7	--	5.7	pci/l												1.7			2.4			2.7	
MAGNESIUM	--	--	--	mg/l	173	550	678	573	486	496	496	698	950	333	311	176			304			488	625
MANGANESE	--	2.6	9.1	mg/l	3.45	12.8	45.7	13.5	9.55	20.2	20.1	6.35	7.24	7.47	4.85	1.89			1.38			6.72	7.63
MOLYBDENUM	--	1.0	66.1	mg/l	0.3				0.3				0.3		0.4	0.1			0.8			0.2	
NICKEL	0.569	0.2	0.569	mg/l	0.09	0.88	1.86	0.56	0.99	1.26	1.27	0.3	0.35	0.38	0.14							0.35	0.44
NITRATE (NO3)	--	30	190	mg/l	0.03	0.01	1.90 D	0.01	0.01	17.6 D	18.6 D	0.02	0.07	0.14	0.64	0.05			0.02			0.01	0.03
PH (FIELD)	--	--	--	su	6.40	3.37	2.90	3.78	3.89	3.09	3.07	5.27	5.81	5.34	6.80	6.44	7.05	6.14	7.23	6.71	5.48	6.49	5.68
PH (LAB)	--	--	--	su	7.04 H	2.87 H	3.01 H	3.31 H	3.27 H	3.20 H	3.20 H	5.68 H	6.09 H	4.97 H	7.20 H	6.76 H	7.15 H	6.18 H	6.91 H	6.48 H	3.83 H	6.48 H	5.94 H
POTASSIUM	--	--	--	mg/l	7	13	2	13	11	2	2	12	14	10	9	7			8			12	11
RADIUM-226	--	--	--	pci/l	3.9	5.8	10.6	8.6	7.7	12	17.1	3.8	5	5.8	8.3	4.9			20			9.7	12.4
RADIUM-228	--	--	--	pci/l	4.5	7.5		2.9	7.2	7	5.9	11.7	8.4	12	15	11.1			15.1			20.6	19.9
RADIUM 226 & 228	35.2	5	35.2	pci/l	8.4	13.3	10.6	11.5	14.9	19	23	15.5	13.4	17.8	23.3	16			35.1			30.3	32.3
SODIUM	--	--	--	mg/l	137 D	140 D	211 D	115 D	113 D	163 D	161 D	145 D	172 D	152 D	145 D	151 D			171 D			143 D	157 D
SULFATE (SO4)	--	2160	5693	mg/l	2360 D	4130 DH	7730 DH	4450 DH	3880 D	5230 DH	5240 DH	4390 D	5310 D	2990 DH	2810 D	2270 D			2700 D			3610 D	4200 D
THORIUM-230	17	15	17	pci/l		15.2	528		0.2			0.4											
TOTAL DISSOLVED SOLIDS (LAB)	--	3170	8592	mg/l	3690 D	5670 D	10600 D	6410 D	5160 D	7300 D	7270 D	6100 D	7240 D	4340 D	4240 D	3510 D	3710 D	4850 D	4080 D	4370 D	5320 D	5120 D	5950 D
TOTAL TRIHALOMETHANES	80	--	80	µg/l		4	61				0.52												
URANIUM	0.395	5	0.395	mg/l	0.208	0.394	0.732	0.148	0.254	0.619	0.615	0.0166	0.009	0.0507	0.0615	0.235			0.196			0.0734	0.0123
VANADIUM	0.1	0.7	0.1	mg/l			1.1																

Notes: Table modified by EPA.

— means that a cleanup level was not established for the analyte

Blank shaded values indicate that the analyte was not detected

Gray shaded values exceed the 1988 ROD Cleanup Levels

Blue shaded values exceed the Proposed BTV Cleanup level

Green shaded values exceed both the 1988 ROD Cleanup Levels and the Proposed BTV Cleanup Levels

B- Possible blank contamination

D - Reporting limit increased due to sample matrix

H - Analysis performed past recommended holding time

FD indicates a field duplicate sample

*Table 8- **Detected Constituents in Zone 1, October 2017***
Information Source: 2017 AMR (Hatch-Chester, 2018)

Chemical Name	NRC License Standard	1988 ROD Cleanup Level	Proposed BTV Cleanup Level	Unit	0142	0515 A	0604	0614	EPA02	EPA02FD	EPA04	EPA05	EPA07
ALUMINUM	--	5	5	mg/l		0.2 D	1	0.1					0.7
AMMONIA (AS N)	--	--	--	mg/l		21 D		73 D	0.27	0.43		8.8 D	
BICARBONATE (HCO3)	--	--	--	mg/l	346	862	31	976	290	303	167	48	642
CALCIUM	--	--	--	mg/l	66	455 D	445	555	406	411	484	457	496
CHLORIDE	--	250	250	mg/l	17	364 D	96 D	292 D	24	24	34 D	36 D	233 D
CHLOROFORM	80	--	80	µg/l		305	13	42				0.54	0.95
COBALT	--	0.05	0.05	mg/l		0.02	0.11					0.03	0.07
GROSS ALPHA	15	15	15	pci/l	0.8	2.9	1.9	1.1	1.8	2.2	1.5	2.1	1.8
LEAD	0.05	0.05	0.05	mg/l				0.005					
LEAD-210	4.7	--	4.7	pci/l		1.3				1.3			
MAGNESIUM	--	--	--	mg/l	34	1320	803	680	194	195	379	465	871
MANGANESE	--	2.6	5.4	mg/l	0.04	8.04	4.04	0.93	1.83	1.85	3.42	0.17	1.8
NICKEL	0.07	0.2	0.2	mg/l		0.11	0.22						0.1
NITRATE (NO3)	--	30	190	mg/l	0.49	35.9 D	55.5 D	160 D	0.1	0.02	0.59	8.05 D	116 D
PH (FIELD)	--	--	--	su	7.89	5.98	5.38	6.38	6.95	6.93	6.78	6.29	6.09
PH (LAB)	--	--	--	su	7.40 H	6.14 H	5.43 H	6.57 H	6.93 H	6.72 H	6.78 H	6.01 H	6.34 H
POTASSIUM	--	--	--	mg/l	4	18	12	14	7	7	9	7	8
RADIUM-226	--	--	--	pci/l	0.7	2	1.3	0.7	1.5	1.6	0.9	1.2	0.5
RADIUM-228	--	--	--	pci/l	2.9	6.5	5.8	4.4	5.6	5.1	4.4	4.8	3.3
RADIUM 226 & 228	12.1	5	12.1	pci/l	3.6	8.5	7.1	5.1	7.1	6.7	5.3	6	3.8
SELENIUM	0.01	0.01	0.05	mg/l		0.003		0.002					
SODIUM	--	--	--	mg/l	315	603 D	308 D	468 D	207	208	181	105	380 D
SULFATE (SO4)	--	2160	5539	mg/l	667 D	5800 D	4380 D	3360 D	1890 D	1880 D	2860 D	3010 D	4010 D
THORIUM-230	1.6	15	1.6	pci/l									0.2
TOTAL DISSOLVED SOLIDS (LAB)	--	3170	8020	mg/l	1310 D	10000 D	6850 D	6930 D	3200 D	3170 D	4470 D	4620 D	7300 D
TOTAL TRIHALOMETHANES	80	--	80	µg/l		305	13	42				0.54	0.95
URANIUM	0.238	5	0.238	mg/l		0.0093	0.0004	0.0464	0.0013	0.0012		0.0019	0.0019

Notes: Table modified by EPA.

— means that a cleanup level was not established for the analyte

Blank shaded values indicate that the analyte was not detected

Gray shaded values exceed the 1988 ROD Cleanup Levels, yellow shaded values exceed NRC License Standard

Blue shaded values exceed the Proposed BTV Cleanup level. Green shaded values exceed both the 1988 ROD Cleanup Levels and the Proposed BTV Cleanup Levels

D - Reporting limit increased due to sample matrix FD indicates a field duplicate sample H - Analysis performed past recommended holding time

Table 9 – SWA Proposed Background Threshold Value Cleanup Levels based on UPL95 Summary Comparisons (Chester Engineers, 2015b)

TABLE 4

Summary Comparisons of Upper Prediction Limits (k= SWA POC samples X (4 qtrs X 8 yrs) + 80 yrs) = 578) for Potential Concentrations in Southwest Alluvium Background Groundwater to Site Cleanup Standards and Potential ARARs

United Nuclear Corporation, Church Rock Site; Church Rock, New Mexico

Parameter	Units	Current ROD Standard[1]	Basis for ROD Standard	Max RL[2]	Background Dataset Percent < RL	95% Kaplan Meier UPL for Next 578 Observations (UPL95 (k=578))	Alternate UPL95[4]	UPL95 > ROD Standard?	Potential ARAR Value[1]	Potential ARAR[1]	Potential Background Threshold Value (BTV)	Potential Cleanup Level	Increase/Decrease With Respect To Current ROD Standard	Potential Cleanup Level Justification	Additional Comments Related to Data from 2007-2014 (except as noted)
Lab TDS	mg/L	3,170	Background	10	0%	-	10,376	YES	4,800	NMWQCC - Bkgd	10,376	10,376	Increase	BTV > Current ROD Standard and ARAR	No exceedances of BTV since 1Q 2007, one historical exceedance in background well. BTV has never been exceeded in currently sampled wells in SWA (background and impacted).
SO4	mg/L	2,160	Background	8	0%	-	8,818	YES	2,125	NMWQCC - Bkgd	8,818	8,818	Increase	BTV > Current ROD Standard and ARAR	Since 1Q 2007, BTV exceedances have occurred only at SBL-01.
Cl	mg/L	250	NMWQCC - O	4	0%	-	344.5	NO	250	NMWQCC - O	344.5	250	Same	ARAR and ROD Standard > BTV	Only two ARAR exceedances outside Section 3 since 1Q 2007 (GW-1 in Oct 2007 (255 mg/l) and Jan 2008 (270 mg/l)).
NO3 as N	mg/L	30	Background	3	1%	538.6	-	YES	190[7]	NMWQCC - Bkgd	538.6	538.6	Increase	BTV > Current ROD Standard and ARAR	No exceedances of BTV at any location and one ARAR exceedance (GW-3) since 2007. Recommend eliminating as COC.
Al	mg/L	5	NMWQCC - I	0.1	84%	0.226	-	NO	5	NMWQCC - I	0.226	5	Same	ARAR and Current ROD Standard > BTV	No exceedances of ARAR since 2007. Recommend eliminating as COC.
Co	mg/L	0.05	NMWQCC - I	0.01	83%	0.0347	-	NO	0.05	NMWQCC - I	0.035	0.05	Same	ARAR and Current ROD Standard > BTV	Since 2007, BTV and ARAR exceedances have occurred only at SBL-01. Recommend eliminating as COC.
Mn	mg/L	2.6	Background	0.05	11%	2.103	-	NO	0.2	NMWQCC - O	2.1	2.1	Decrease	BTV > ARAR but BTV < Current ROD Standard	BTV will generally or often be exceeded in EPA-23, 631, 633, 630, SBL-01 and 632. Since 2007, only SBL-01 and EPA 25 have exceedances outside Section 2.
Mo	mg/L	1	NMWQCC - I	0.1	89%	0.0425[3]	-	N/A	1	NMWQCC - I	0.1	1	Same	ARAR and Current ROD Standard > BTV	Molybdenum not detected at any location since 2007. Recommend eliminating as COC.
Rad_226	pCi/L	5 (combined Ra)	EPA MCL	0.2	34%	4.34	See Rad_tot	N/A	5 (Combined Ra)	EPA MCL	See Rad_tot	See Rad_tot	N/A	N/A	Regulated as total of Rad-226 and Rad-228 (i.e., combined radium).
Rad_228	pCi/L	5 (combined Ra)	EPA MCL	1	68%	6.05	See Rad_tot	N/A	5 (Combined Ra)	EPA MCL	See Rad_tot	See Rad_tot	N/A	N/A	Regulated as total of Rad-226 and Rad-228 (i.e., combined radium).
As	mg/L	0.05	EPA MCL (former)	0.001	92%	0.0039	-	NO	0.01	EPA MCL (current)	0.004	0.01	Decrease	ARAR > BTV but ARAR < Current ROD Standard	Periodic detections during 2007-2014 outside Section 2. Detections occur in groups. Multiple results at ARAR in July 2007. One exceedance of ARAR in GW-3 (0.013 mg/L) in October 2011, followed by ND. Recommend eliminating as COC.
Be	mg/L	0.017	Health-based	0.1	100%	N/A	-	N/A	0.004	EPA MCL	N/A	0.004	Decrease	ARAR (Be not detected in background)	No detections during 2007-2014 at any location (RL reduced from 0.010 mg/l to 0.001 mg/l in July 2012). Recommend eliminating as COC.
Cd	mg/L	0.01	EPA MCL (former)	0.01	97%	0.0251	-	YES	0.005	EPA MCL (current)	0.025	0.025	Increase	BTV > Current ROD Standard and ARAR	No detections at any monitoring location during 2007-2014 (including Section 2) at RL of 0.001 mg/L. Recommend eliminating as COC.
Pb	mg/L	0.05	EPA MCL (former)	0.05	98.5%	0.0536[5]	-	N/A	0.015	MCLG and TT	0.07[5]	0.07	Increase	BTV > Current ROD Standard and ARAR	Since 1Q 2007, no exceedances of Pb BTV or ARAR at any location detected in impacted water (RL reduced from 0.050 mg/l to 0.001 mg/l in July 2012). Recommend eliminating as COC.
Ni	mg/L	0.2	NMWQCC - I	0.05	87%	0.0781	-	NO	0.2	NMWQCC - I	0.078	0.2	Same	ARAR and Current ROD Standard > BTV	No detections in impacted water during 2007-2014 (including Section 2) at RL of 0.052 mg/L (below proposed BTV). Ni regularly detected at background well SBL-01 above BTV, up to 0.180 mg/l (Jan 2011). Recommend eliminating as COC.
Se	mg/L	0.01	EPA MCL (former)	0.001	47%	0.0659	-	YES	0.05	EPA MCL (current)	0.07	0.07	Increase	BTV > ARAR and Current ROD Standard	No detections above 0.034 mg/L (i.e., below proposed BTV, ARAR and current ROD standard) in impacted water during 2007-2014 (including Section 2). Recommend eliminating as COC.
V	mg/L	0.7	Health-based	0.1	100%	N/A	-	N/A	0.1	NRC License	N/A	0.1	Decrease	ARAR < Current ROD Standard	One detection in impacted water since 2007 (GW-2, 0.013 mg/L, July 2009). Recommend eliminating as COC.
U[6]	mg/L	5	NMWQCC (former)	0.0003	0.2%	0.2050	-	NO	0.03	EPA MCL (current)	N/A	N/A	N/A	N/A	Range of U concentrations in historical background up to 0.387 mg/L. During 2007-2014, the maximum detected concentration in impacted water was 0.378 mg/l at GW-3; GW-3 is the only well outside Section 2 with results that exceed the BTV (0.205 mg/L).
Chloroform[8]	mg/L	N/A	N/A	0.001	100%	N/A	-	N/A	0.08	EPA MCL (TTHMs)	N/A	0.08	N/A	ARAR (Chloroform not detected in background)	No detections in impacted water exceeding 0.080 mg/L. Maximum detection 0.019 mg/L, well 602 (April 2011).
Rad_tot	pCi/L	5	EPA MCL (Combined Ra)	0.2	21%	8.188	-	YES	5	EPA MCL	8.2	8.2	Increase	BTV > ARAR and Current ROD Standard	No BTV exceedances from 2007 to 2014. Recommend eliminating as COC.
Th-230	pCi/L	15	EPA MCL (gross alpha)	0.2	92%	4.519	-	NO	5	NRC License (current)	4.5	4.5	Decrease	Potential NRC License GWPS equals BTV	No exceedances of BTV or ARAR from 2007 to 2014. Max concentration 2 pCi/l in background well SBL-01. Recommend eliminating as COC.
Pb-210	pCi/L	N/A	N/A	1	78%	5.843	-	N/A	1	NRC License (current)	5.9	5.9	N/A	BTV > ARAR	No exceedances of BTV from 2007 to 2014. Max result at well 632, 4.7 pCi/L, April 2010. Recommend eliminating as COC.
Gross_Alpha	pCi/L	15	EPA MCL	1	70%	9.763	-	NO	15	EPA MCL	9.8	15	Same	ARAR and Current ROD Standard > BTV	No exceedances of BTV or ARAR from 1Q 2007 through 2014. Maximum concentration 2.8 pCi/l in impacted water outside Section 2 (GW-1). Recommend eliminating as COC.

Notes:
1. See Table 3 for Current ROD Standards and Potential ARARs.
2. RL is an abbreviation of reporting limit.
3. Only three Mo detections, UPL95 considered statistically unreliable, maximum detected 0.1 mg/L proposed BTV.
4. Alternate UPL95s calculated for parameters with "full datasets" (i.e., datasets without nondetects):
   - Lab TDS: 95% Chebyshev UPL (single sample) = 10,376 mg/L
   - SO4: 95% Chebyshev UPL (single sample) = 8,818 mg/L
   - Cl: 95% Chebyshev UPL (single sample) = 344.5 mg/L
5. Only two Pb detections, UPL95 considered statistically unreliable, maximum detected 0.07 mg/L proposed BTV.
6. The primary source of uranium loading to the Southwest Alluvium was the infiltration of permitted mine water discharges, which had uranium concentrations up to 2 mg/L, rather than tailings seepage. Although the uranium concentration in post-mining/pre-tailings water has attenuated to a typical concentration range of 0.01 to 0.3 mg/L (General Electric Company (from Roy B. Blickwedel), March 2006, Regulatory Significance of the Occurrence and Distribution of Dissolved Uranium in Groundwaters of the Southwest Alluvium, Church Rock Site, New Mexico), it is not possible to establish a single number that will account for the variability associated with the permitted uranium discharges.
7. The ARAR selected for nitrate is considered an NMED WQCC based on a background value of 190 mg/l related to historical grazing activities, as recommended by the NRC (1996) and supported by NMED (1998).
8. The NRC modified the site License Standard for chloroform to a total trihalomethanes (TTHMs, of which chloroform is one) standard of 0.08 mg/l as of August 2006; chloroform is typically the only TTHM compound present in groundwater samples and the background statistics are based on historical chloroform results.

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Table 10 – Zone 3 Proposed Background Threshold Value Cleanup Levels based on UPL95 Summary Comparisons (Chester Engineers, 2015b)

TABLE 6
Summary Comparisons of Upper Prediction Limits (in Zone 3 POC samples 1 (14 qtrs X 5 yrs) = 70) for Parameter Concentrations in Zone 3 Background Groundwater to Site Cleanup Standards and Potential ARARs
United Nuclear Corporation, Church Rock Site; Church Rock, New Mexico

Parameter	Units	Current ROD Standard	Basis for ROD Standard	Max RL[1]	Background Dataset Percent < RL	95% Kaplan Meier UPL for Next 216 Observations (UPL95 (N=216))	Alternate UPL95[2]	UPL95 > ROD Standard?	Potential ARAR Value[3]	Potential ARAR[3]	Potential Background Threshold Value (BTV)	Potential Cleanup Level	Increase/Decrease With Respect To Current ROD Standard	Potential Cleanup Level Justification	Additional Comments Related to Data from 2007-2014 (except as noted)
Lab TDS	mg/L	3,170	Background	10	0%	-	8,832	YES	4,600	NMWQCC - Stgd	8,832	8,832	Increase	BTV > Current ROD Standard and ARAR	BTV exceeded at 613 (Section 2), no exceedances at other locations from 2007 to 2014.
SO4	mg/L	2,160	Background	6	0%	-	5,693	YES	2,125	NMWQCC - Stgd	5,693	5,693	Increase	BTV > Current ROD Standard and ARAR	From 2007 to 2014, BTV exceeded at 613 and once at PB-4. BTV probably won't be regularly exceeded outside Section 2.
Cl	mg/L	250	NMWQCC - D	1	0%	-	69.84	NO	250	NMWQCC - D	69.9	250	Same	ARAR and Current ROD Standard > BTV	No ARAR exceedances from 2007-2014, maximum concentration 212 mg/l at DB13. Recommend eliminating as COC.
NO3 as N	mg/L	10	Background	2	17%	87.78	-	YES	190[4]	NMWQCC - Stgd	87.8	190	Increase	ARAR > BTV and Current ROD Standard	Outside ARAR and BTV not exceeded from 2007-2014, maximum concentration 53.1 mg/l at DT17. Recommend eliminating as COC.
Al	mg/L	5	NMWQCC - I	0.2	68%	1.055	-	NO	5	NMWQCC - I	1.1	5	Same	ARAR and Current ROD Standard > BTV	ARAR exceedances at well 613 (Section 2) and many wells in Section 36 (e.g., 617, 709, 717, 719, EPA-14, NBL-01, PB-3, PB-5, PB-6).
Co	mg/L	0.05	NMWQCC - I	0.01	9%	0.391	-	YES	0.05	NMWQCC - I	0.391	0.391	Increase	BTV > Current ROD Standard and ARAR	BTV exceedances at well DB13 (Section 2) and at multiple wells in Section 36 (e.g., 617, 709, 717, 719, EPA-14, NBL-01, PB-3, PB-6).
Mn	mg/L	2.6	Background	0.01	1%	9.149	-	YES	0.2	NMWQCC - D	9.1	9.1	Increase	BTV > Current ROD Standard and ARAR	BTV exceedances at well DB13 (Section 2) and at wells in Section 36 (e.g., 617, 709, 717, EPA-14, PB-6).
Mo	mg/L	1	NMWQCC - I	0.1	14%	68.1	-	YES	1	NMWQCC - I	68.1	68.1	Increase	BTV > Current ROD Standard and ARAR	No BTV exceedances from 2007 to 2014. Recommend eliminating as COC.
Ra6_226	pCi/L	5 (Combined)	EPA MCL	0.2	12%	6.132	See Ra6_top	N/A	5 (Combined Ra)	EPA MCL	See Ra6_top	See Ra6_top	N/A	N/A	Reported as total of Ra6-226 and Ra6-228 (i.e., combined radium).
Ra6_228	pCi/L	5 (Combined)	EPA MCL	1	29%	17.68	See Ra6_top	N/A	5 (Combined Ra)	EPA MCL	See Ra6_top	See Ra6_top	N/A	N/A	Reported as total of Ra6-226 and Ra6-228 (i.e., combined radium).
As	mg/L	0.05	EPA MCL (former)	0.001	27%	0.787	-	YES	0.01	EPA MCL (current)	0.787	0.787	Increase	BTV > Current ROD Standard and ARAR	Very few exceedances since 2007 (NBL-1 and EPA 13). Recommend eliminating as COC.
Be	mg/L	0.017	Health-based	0.05	100%	N/A	-	N/A	0.004	EPA MCL	N/A	0.004	Decrease	ARAR (Be not detected in background)	ARAR exceeded at multiple Z3 monitoring locations during 2007 to 2014, historical reporting limit of 0.010 mg/l, reduced to 0.001 mg/l in July 2012.
Cd	mg/L	0.01	EPA MCL (former)	0.01	95%	0.0318[5]	-	N/A	0.005	EPA MCL (current)	0.03[5]	0.03	Increase	BTV > Current ROD Standard and ARAR	No exceedances of BTV from 2007 to 2014. Recommend eliminating as COC.
Pb	mg/L	0.05	EPA MCL (former)	0.05	95%	0.0631[6]	-	N/A	0.015	MCLG and TT	0.06[6]	0.06	Increase	BTV > Current ROD Standard and ARAR	Few exceedances since 2007 (wells NBL-01 and PB-4).
Ni	mg/L	0.2	NMWQCC - I	0.05	39%	0.569	-	YES	0.2	NMWQCC - I	0.569	0.569	Increase	BTV > Current ROD Standard and ARAR	BTV exceedances at multiple Z3 monitoring locations.
Se	mg/L	0.01	EPA MCL (former)	0.001	77%	0.03744	-	NO	0.05	EPA MCL (current)	0.037	0.05	Increase	ARAR > Current ROD Standard and BTV	No exceedances of ARAR from 2007 to 2014. NRC standard is 0.010 mg/l, rather than 0.050 mg/l. Recommend eliminating as COC.
V	mg/L	0.7	Health-based	0.1	100%	N/A	-	N/A	0.1	NRC License	N/A	0.1	Decrease	ARAR (V not detected in Background)	Exceed cleanup level at 613 (within Section 2) and suspect few exceedances in April 2008 at (617, 709, EPA-13, EPA-14). Recommend eliminating as COC.
U	mg/L	5	NMWQCC (former)	0.0003	1%	0.335	-	NO	0.03	EPA MCL (current)	0.335	0.335	Decrease	BTV > ARAR but BTV < Current ROD Standard	Exceeded frequently at well 613 and 420, and infrequently at 604 B, NBL-01 and PB-04. Consider eliminating as COC.
Chloroform[7]	mg/L	N/A	N/A	0.001	99.5%	N/A	-	N/A	0.08	EPA MCL (TTHM)	N/A	0.08	N/A	ARAR (Chloroform detected only once in background sample at 0.0011 mg/l)	Exceedances only at 613 (within Section 2). Consider elimination as COC.
Ra6_top	pCi/L	5	EPA MCL (Combined Ra)	0.2	10%	35.18	-	YES	5	EPA MCL	35.2	35.2	Increase	BTV > Current ROD Standard and ARAR	From 2007 to 2014, exceeded at 604 B (3 times); 717 (many times); EPA-14 (several times until 2009); NBL-01 (1 time); RW-11 (twice); and RW-A (twice).
Th-230	pCi/L	15	EPA MCL (gross alpha)	0.2	93%	16.99	-	YES	5	NRC License (current)	17	17	Increase	BTV > Current ROD Standard and ARAR	Since 2007, many exceedances at 613 (Section 2); four exceedances at PB-04, one exceedance each at 617 and NBL-01.
Pb-210	pCi/L	N/A	N/A	1	83%	6.674	-	N/A	1	NRC License (current)	6.7	6.7	N/A	BTV > ARAR	Few exceedances including 613 (Section 2), NBL-01, PB-04, and 719.
Gross_Alpha	pCi/L	15	EPA MCL	1	16%	39.73	-	YES	15	EPA MCL	39.7	39.7	Increase	BTV > Current ROD Standard and ARAR	Exceedances in 613; 604-B (Jan 2012); 617 (July 2012); NBL-1 (exceeded in Oct 2010 and January 2011).

Notes:
1. See Table 3 for Current ROD Standards and Potential ARARs.
2. RL is an abbreviation of reporting limit.
3. Alternate UPL95s calculated for parameters with "full datasets" (i.e., datasets without nondetects).
   Lab TDS: 95% Chebyshev UPL (Gaps samples) = 8,832 mg/L
   SO4: 95% Chebyshev UPL (single samples) = 5,693 mg/L
   Cl: 95% WH UPL (gamma distribution) for next 216 observations = 69.84 mg/L
4. Only 3 distinct Cd detections, UPL95 considered statistically unreliable. Maximum detected 0.09 mg/L proposed BTV.
5. Only 4 distinct Pb detections and UPL95 is less than UCL95 (see Table 5). UPL95 considered statistically unreliable. Maximum detected 0.03 mg/L proposed BTV.
6. The ARAR selected for nitrate is considered as NMED WQCC based on a background value of 190 mg/l related to historical grazing activities, as recommended by the NRC (1996) and supported by NMED (1999).
7. The NRC modified the site License Criteria for chloroform to a total trihalomethanes (TTHMs, of which chloroform is one) standard of 0.08 mg/l as of August 2008; chloroform is typically the only TTHM compound present in groundwater samples and the background statistics are based on historical chloroform results.

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Table 11 – Zone 1 Proposed Background Threshold Value Cleanup Levels based on UPL95 Summary Comparisons (Chester Engineers, 2015b)

TABLE 5
Summary Comparisons of Upper Prediction Limits (n= Zone 1 POC samples X (4 qtrs X 5 yrs) + 85 yrs) = 370) for Parameter Concentrations in Zone 1 Background Groundwater to Site Cleanup Standards and Potential ARARs
United Nuclear Corporation, Church Rock Site; Church Rock, New Mexico

Parameter	Units	Current ROD Standard[1]	Basis for ROD Standard	Max RL[2]	Background Dataset Percent < RL	Kaplan Meier UPL for Next 370 Observations (UPL95 [n=370])	Alternate UPL95[4]	UPL95 > ROD Standard?	Potential ARAR Value[3]	Potential ARAR[3]	Potential Background Threshold Value (BTV)	Potential Cleanup Level	Increase/Decrease With Respect To Current ROD Standard	Potential Cleanup Level Justification	Additional Comments Related to Data from 2007-2014 (except as noted)
Lab TDS	mg/L	3,170	Background	10	0%	-	6,020	YES	4,600	NMWQCC - Edge	6,020	6,020	Increase	BTV > Current ROD Standard and ARAR	From 2007 to 2014, BTV exceeded at 519-A (Section 2); 617 (Section 2), EPA-7.
SO4	mg/L	2,160	Background	0	0%	-	6,839	YES	3,125	NMWQCC - Edge	6,839	6,839	Increase	BTV > Current ROD Standard and ARAR	From 2007 to 2014, BTV exceeded at 519-A (Section 2); 617 (Section 2).
Cl	mg/L	250	NMWQCC - D	1	0%	-	109.3	NO	250	NMWQCC - D	109.3	250	Same	ARAR and Current ROD Standard > BTV	Since 1Q 2007, ARAR exceeded at 614 and 519-A, EPA-6 and EPA-7 below 250 mg/l except for EPA-7 exceedance in July 2013).
NO3 as N	mg/L	10	Background	0.1	72%	16.01	-	NO	190[10]	NMWQCC - Edge	16	190	Increase	ARAR > BTV and Current ROD Standard	Only two ARAR exceedances between 2007 and 2014 (EPA-7, April and July 2008).
Al	mg/L	5	NMWQCC - I	0.1	87%	0.285	-	NO	5	NMWQCC - I	0.285	5	Same	ARAR and Current ROD Standard > BTV	Since 1Q 2007, ARAR not exceeded outside Section 2. Recommend eliminating as COC.
Co	mg/L	0.05	NMWQCC - I	0.01	90%	0.0237	-	NO	0.05	NMWQCC - I	0.024	0.05	Same	ARAR and Current ROD Standard > BTV	Since 1Q 2007, exceeded at 604; 519; 519-A; EPA- 8.
Ba	mg/L	2.5	Background	0.01	0.4%	0.393	-	YES	0.2	NMWQCC - D	0.4	0.4	Increase	BTV > Current ROD Standard and ARAR	Exceeded at 604; 519-A; last time BTV exceeded outside Section 2 was EPA-7, October 2003.
Be	mg/L	1	NMWQCC - I	0.1	99%	0.0994[5]	-	NO	1	NMWQCC - I	0.100	1	Same	ARAR and Current ROD Standard > BTV	Not detected in Zone 1 samples since 2003. Recommend eliminating as COC.
Rad_226	pCi/L	5 (combined)	EPA MCL	0.2	2%	3.439	See Rad_tot	N/A	5 (Combined Ra)	EPA MCL	See Rad_tot	See Rad_tot	N/A	N/A	Regulated as total of Rad-226 and Rad-228 (i.e., combined radium).
Rad_228	pCi/L	5 (combined)	EPA MCL	1	20%	5.677	See Rad_tot	N/A	5 (Combined Ra)	EPA MCL	See Rad_tot	See Rad_tot	N/A	N/A	Regulated as total of Rad-226 and Rad-228 (i.e., combined radium).
As	mg/L	0.05	EPA MCL (former)	0.001	84%	0.00259[6]	-	NO	0.01	EPA MCL (current)	0.004[6]	0.01	Decrease	ARAR > BTV but ARAR < Current ROD Standard	Since 1Q 2007, one slight exceedance of ARAR outside Section 2 (EPA-5, 0.012 mg/l, 4/2/2011) and highest impacted water As concentration 0.005 mg/L within Section 2. Recommend eliminating as COC.
Be	mg/L	0.017	Health-based	0.05	100%	N/A	-	N/A	0.004	EPA MCL	-	0.004	Decrease	ARAR (Be not detected in background)	Since 1Q 2007, Be detections 0.003 mg/l or less (all RL reduced from 0.005 mg/l to 0.001 mg/l in July 2012). Recommend eliminating as COC.
Cd	mg/L	0.01	EPA MCL (former)	0.01	99%	0.00642[7]	-	N/A	0.005	EPA MCL (current)	0.01[6]	0.01	Same	BTV equals Current ROD Standard > ARAR	Since 1Q 2007, no Cd detected (RL=0.005 mg/l). Recommend eliminating as COC.
Pb	mg/L	0.05	EPA MCL (former)	0.05	99.6%	N/A	-	N/A	0.015	LCL/G and TT	0.05[7]	0.05	Same	BTV equals Current ROD Standard > ARAR	Since 1Q 2007, no Pb exceedances (RL reduced from 0.053 mg/l to 0.001 mg/l in July 2012). Recommend eliminating as COC.
Ni	mg/L	0.2	NMWQCC - I	0.05	99%	0.0834[8]	-	N/A	0.2	NMWQCC - I	0.07[8]	0.2	Same	Current ROD Standard and ARAR > BTV	Ni not detected above ARAR outside Section 2. Four Ni detections above BTV outside Section 2 since 2007. Ni detected with Section 2 (e.g. wells 634 and 519-A) concentration trends generally decreasing.
Se	mg/L	0.01	EPA MCL (former)	0.001	96%	0.00338[9]	-	N/A	0.05	EPA MCL (current)	0.004[9]	0.05	Increase	ARAR > BTV and Current ROD Standard	Since 1Q 2007, maximum detection within Section 2 is 0.028 mg/L, max detect outside Section 2 is 0.002 mg/L. Recommend eliminating as COC.
V	mg/L	0.7	Health-based	0.1	100%	N/A	-	N/A	0.1	NRC License	N/A	0.1	Decrease	ARAR (V not detected in Background)	Since 1Q 2007, only one V detection (in impacted water), 0.2 mg/l in EPA-7, April 2008. Recommend eliminating as COC.
U	mg/L	0	NMWQCC (former)	0.0004	17%	0.238	-	NO	0.03	EPA MCL (current)	0.238	0.238	Decrease	BTV > ARAR but BTV < Current ROD Standard	Since 1Q 2007, all U concentrations in impacted water are below BTV. All concentrations outside Section 2 are also below ARAR (0.030 mg/l). Recommend eliminating as COC.
Chloroform[11]	mg/L	N/A	N/A	0.001	99.6%	N/A	-	N/A	0.08	EPA MCL (TTHM)	N/A	0.08	N/A	ARAR (Chloroform detected only once in background sample at 0.00091 mg/L)	Exceeded at 614 and 519-A (within Section 2). Since 1Q 2007, no chloroform exceedances outside Section 2.
Rad_tot	pCi/L	5	EPA MCL (Combined Ra)	0.2	1%	12.08	-	YES	5	EPA MCL	12.1	12.1	Increase	BTV > Current ROD Standard and ARAR	One exceedance from 2007 to 2014 within Section 2 (519, 22 pCi/l, only one sample from this location). Consider eliminating as COC.
Th-230	pCi/L	15	EPA MCL (gross alpha)	0.2	92%	1.819	-	NO	5	NRC License (current)	1.6	1.6	Decrease	Potential NRC License GWPS equals BTV	No exceedances 2007-2014; maximum concentration outside Section 2 is 0.7 pCi/L and within Section 2 is 1.4 pCi/L (both are below BTV and ARAR). Recommend eliminating as COC.
Pb-210	pCi/L	N/A	N/A	1	81%	4.659	-	N/A	1	NRC License	4.7	4.7	N/A	BTV = ARAR	Since 2007, BTV exceeded only once at non-impacted well 0142. Recommend eliminating as COC.
Gross_Alpha	pCi/L	15	EPA MCL	1	35%	8.954	-	NO	15	EPA MCL	8	15	Same	ARAR and Current ROD Standard > BTV	Since 1Q 2007, no exceedances of ARAR. Recommend eliminating as COC.

Notes:
1. See Table 3 for Current ROD Standards and Potential ARARs.
2. RL is an abbreviation of reporting limit.
3. Only five detections, UPL95 considered statistically unreliable, maximum detected 0.1 mg/l, proposed BTV.
4. Alternate UPL95's calculated for parameters with "full datasets" (i.e., datasets without nondetects):
   Lab TDS: 95% Chebyshev UPL (single sample) = 6,020 mg/L
   SO4: 95% Chebyshev UPL (single sample) = 6,839 mg/L
   Cl: 95% Chebyshev UPL (single sample) = 109.3 mg/L
5. Only 4 distinct As detections, UPL95 considered statistically unreliable. Maximum detection 0.004 mg/L proposed BTV.
6. Only 3 distinct Cd detections, UPL95 considered statistically unreliable. Maximum detection 0.01 mg/L proposed BTV
7. Only 1 Pb detection, UPL95 considered statistically unreliable. Maximum detection 0.05 mg/L proposed BTV
8. Only 2 distinct Ni detections, UPL95 considered statistically unreliable. Maximum detection 0.07 mg/L proposed BTV
9. Only 4 distinct Se detections, UPL95 considered statistically unreliable. Maximum detection 0.004 mg/L proposed BTV
10. The ARAR selected for nitrate is considered an NMED WQCC based on a background value of 190 mg/l related to historic grazing activities, as recommended by the NRC (1996) and supported by NMED (1998).
11. The NRC modified the site License Standard for chloroform to a total trihalomethanes (TTHMs, of which chloroform is one) standard of 0.08 mg/l as of August 2006; chloroform is typically the only TTHM compound present in groundwater samples and the background statistics are based on historical chloroform results.

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FIGURES

Information Source: 2017 AMR (Hatch-Chester, 2018)

Figure 1: Site Location Map

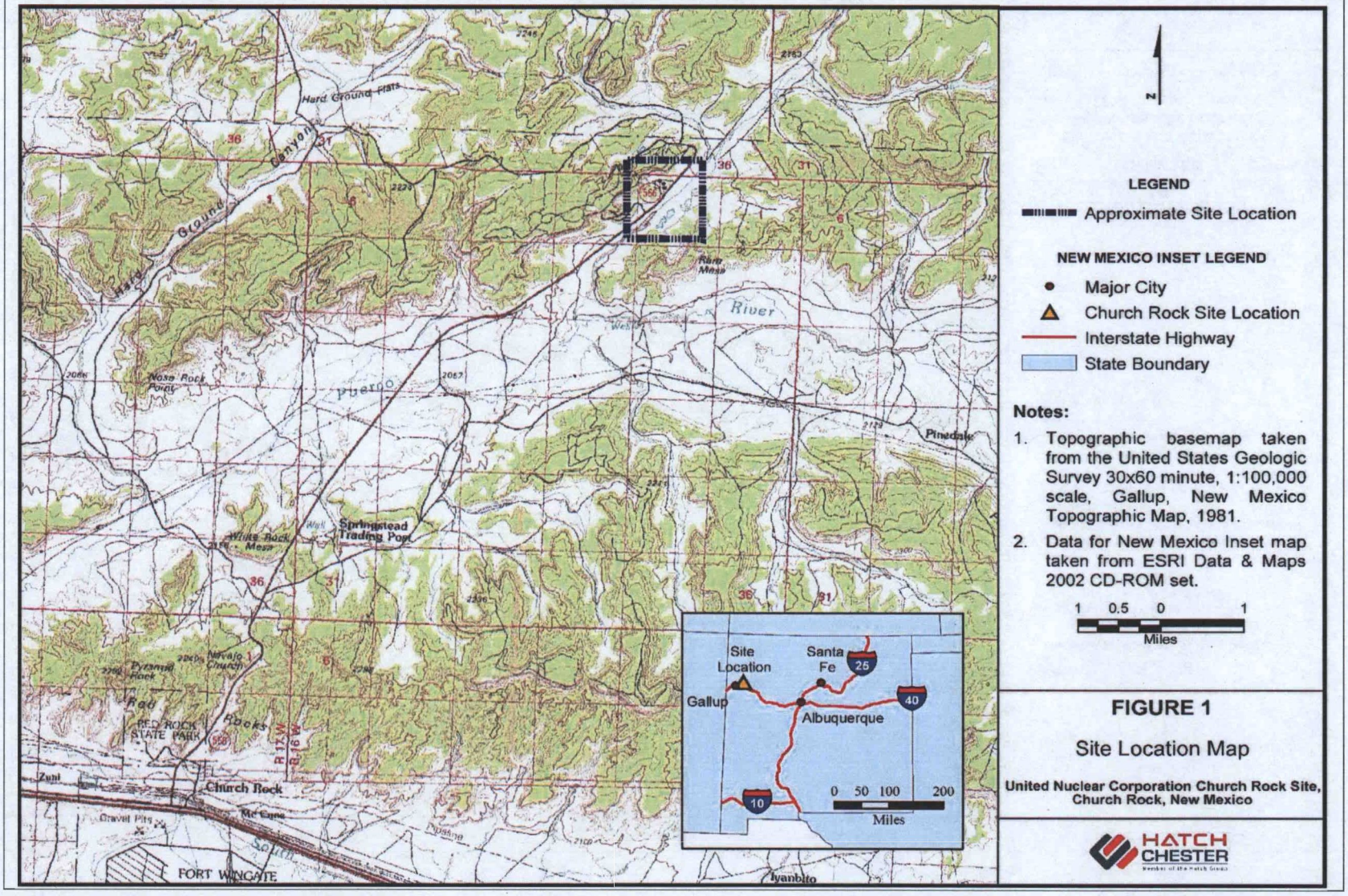


FIGURE 1

Site Location Map

United Nuclear Corporation Church Rock Site, Church Rock, New Mexico

HATCH CHESTER

Figure 2: Site Layout

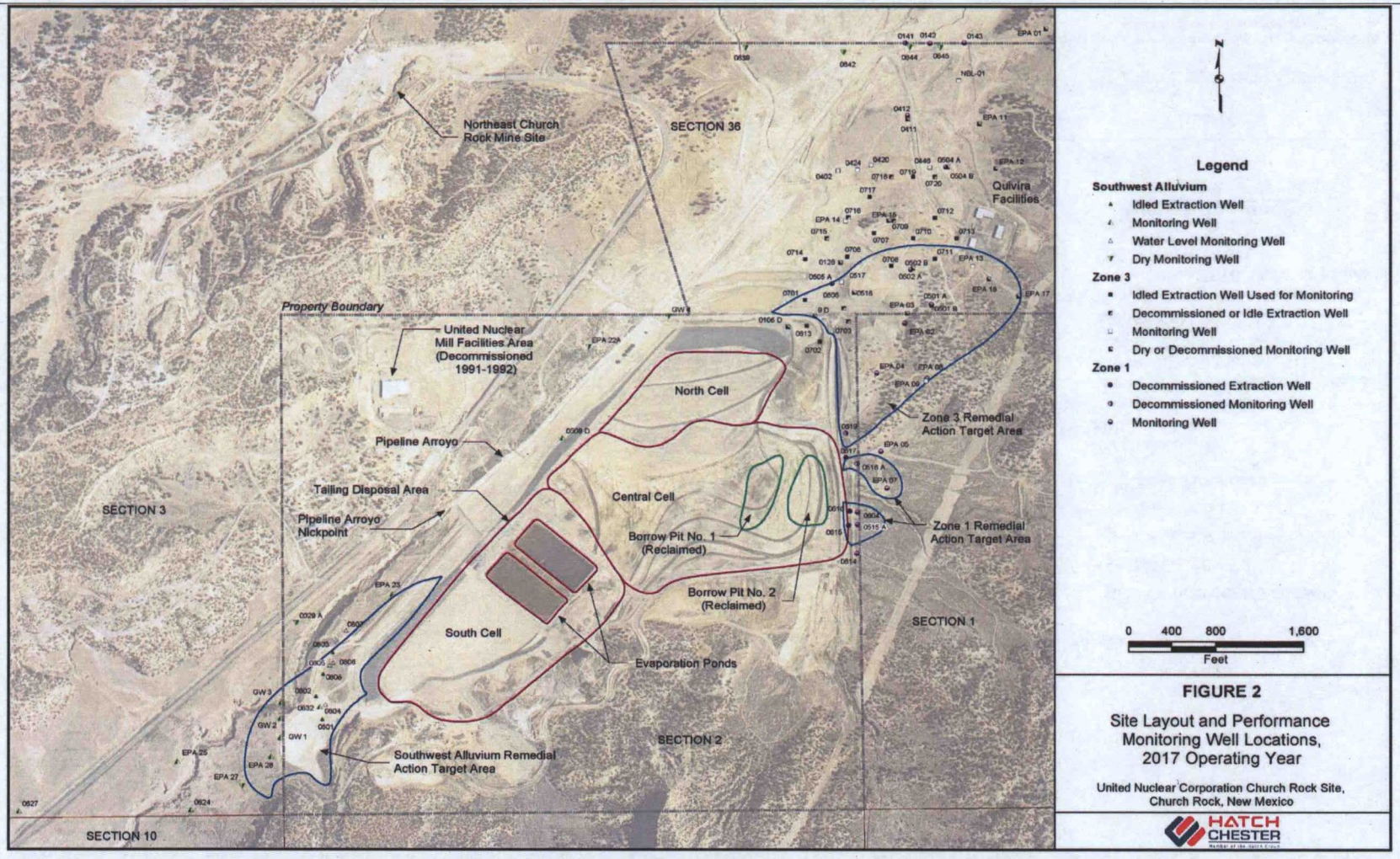


Figure 3: Extent of Seepage-Impacted Ground Water, October 2017

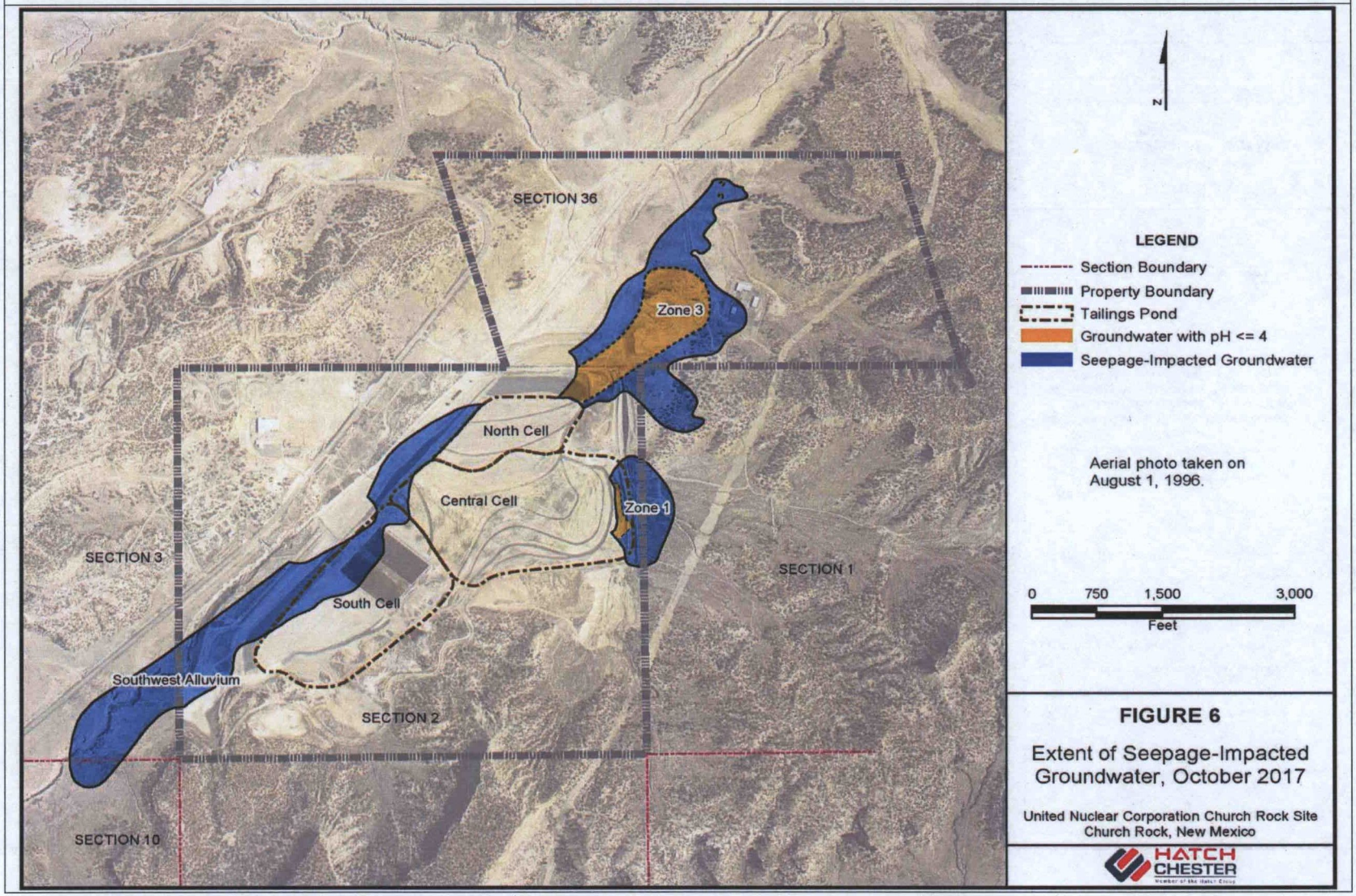


Figure 4: Southwest Alluvium Potentiometric Map, October 2017

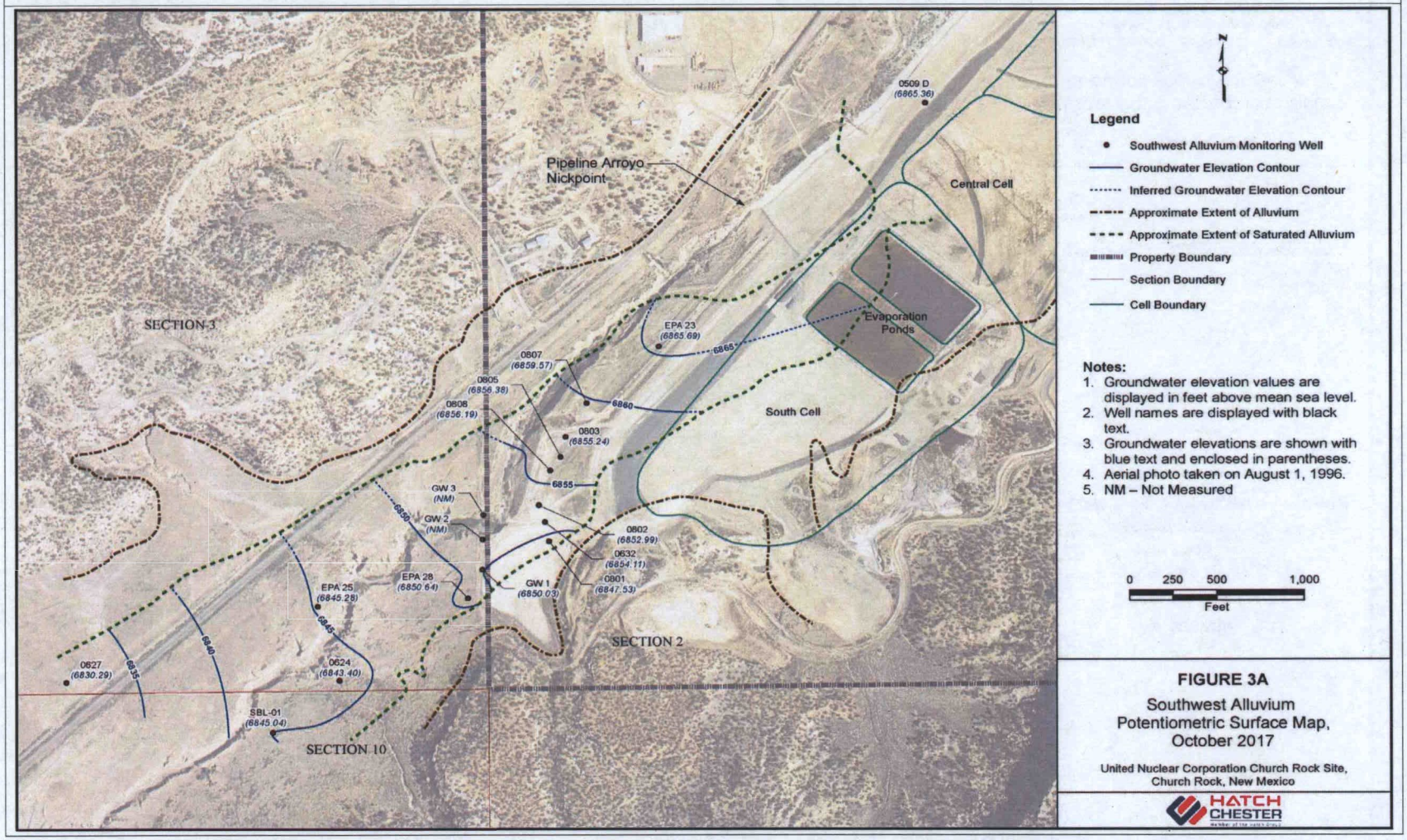
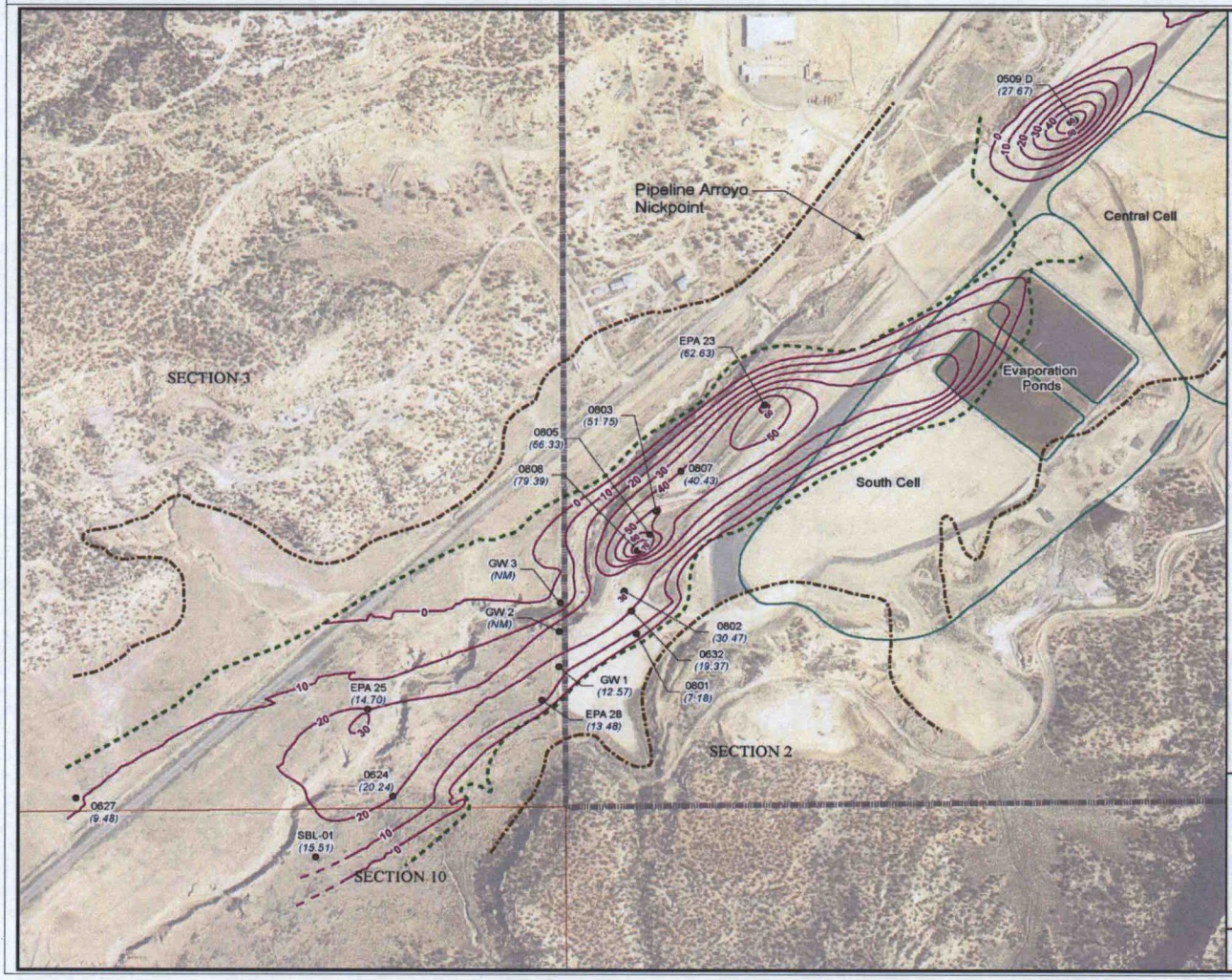


Figure 5: Southwest Alluvium Saturated Thickness Map, October 2017



Legend

- Southwest Alluvium Monitoring Well
- Approximate Extent of Alluvium
- Approximate Extent of Saturated Alluvium
- Property Boundary
- Section Boundary
- Cell Boundary
- Saturated Thickness Contours (feet)
- Inferred Saturated Thickness Contours (feet)

Notes:

1. Well names are displayed with black text.
2. Saturated thicknesses (feet) are shown with blue text and enclosed in parentheses.
3. Aerial photo taken on August 1, 1996.
4. The posted value of saturated thickness at well 0509 D derives from reference to the screen bottom. The alluvium extends as much as 38 feet below this depth in the vicinity of this well.
5. Saturated thickness at SBL-01 estimated due to incomplete well construction information.
6. NM – Not Measured

0 250 500 1,000
Feet

FIGURE 3B

Southwest Alluvium
Saturated Thickness Map,
October 2017

United Nuclear Corporation Church Rock Site,
Church Rock, New Mexico

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Figure 6: Southwest Alluvium Water Levels, 1989-2017

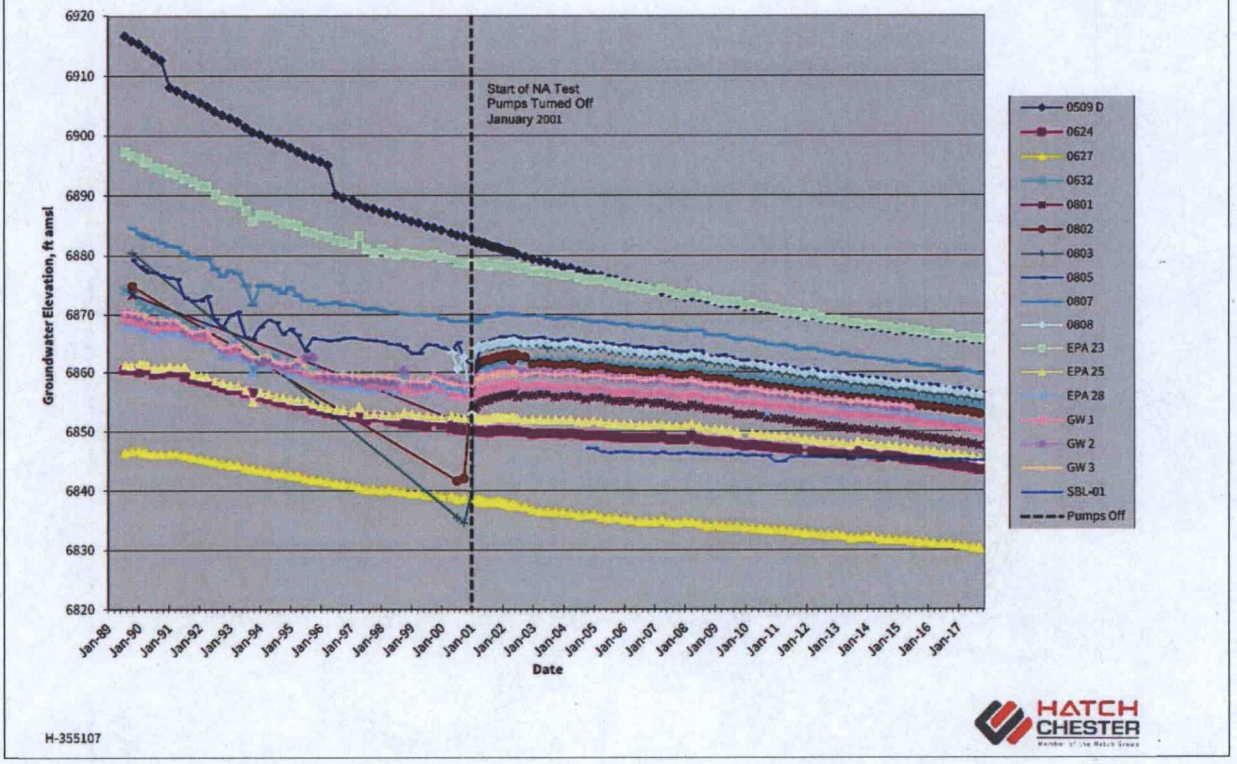


Figure 7: Southwest Alluvium Sulfate Concentrations, 1989-2017

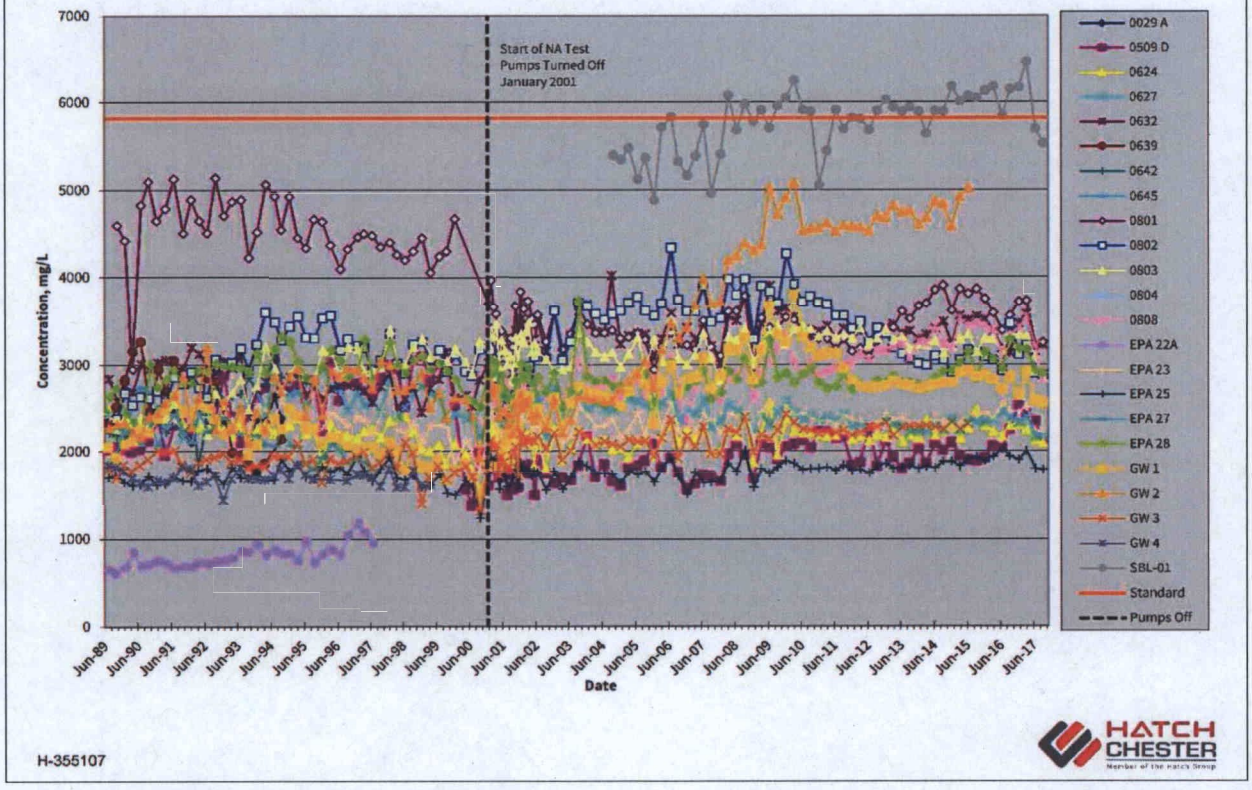


Figure 8: Southwest Alluvium Bicarbonate Isoconcentration Map, October 2017

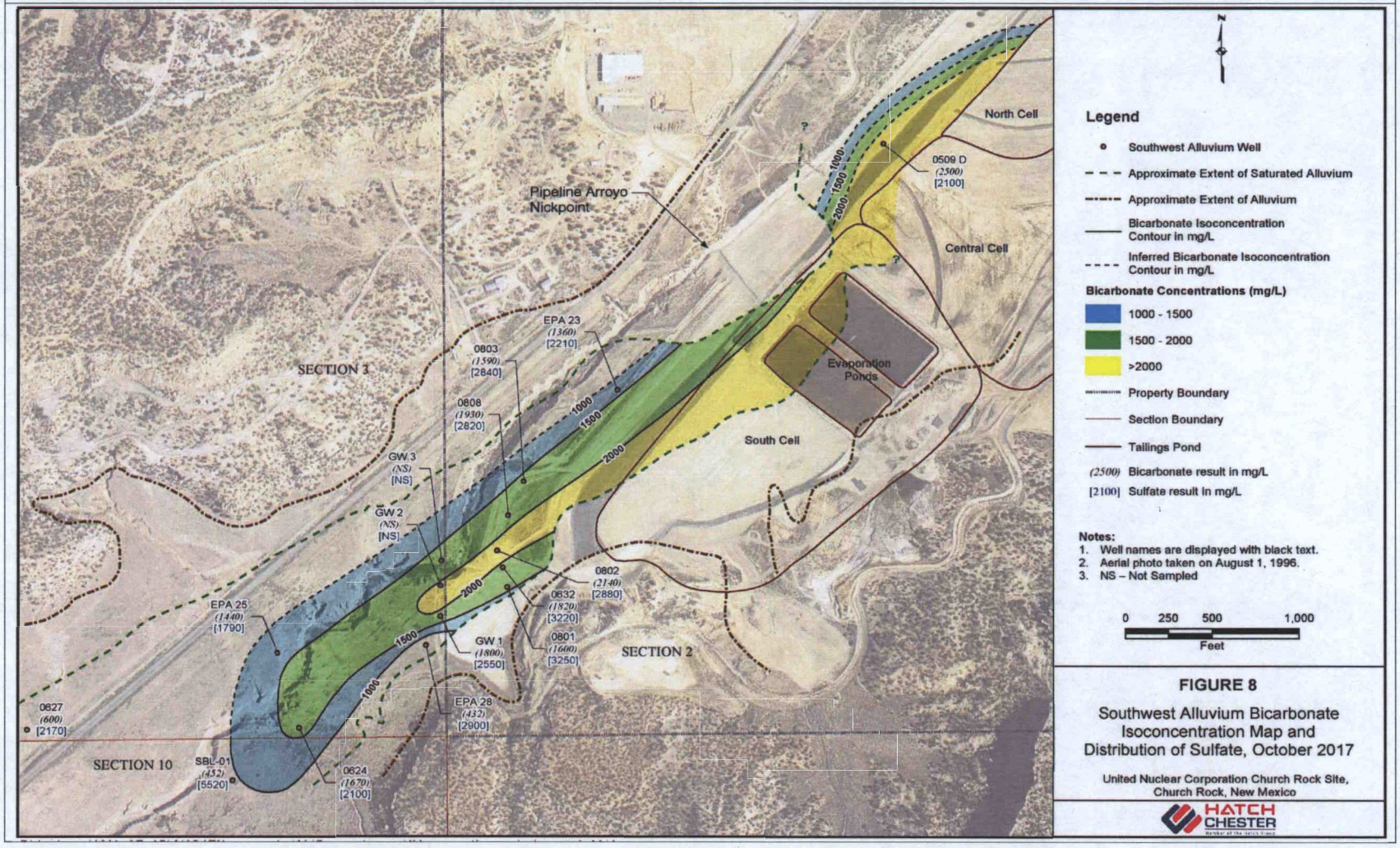


Figure 9a: Uranium Concentrations in Southwest Alluvium Wells (509 D and GW 3)

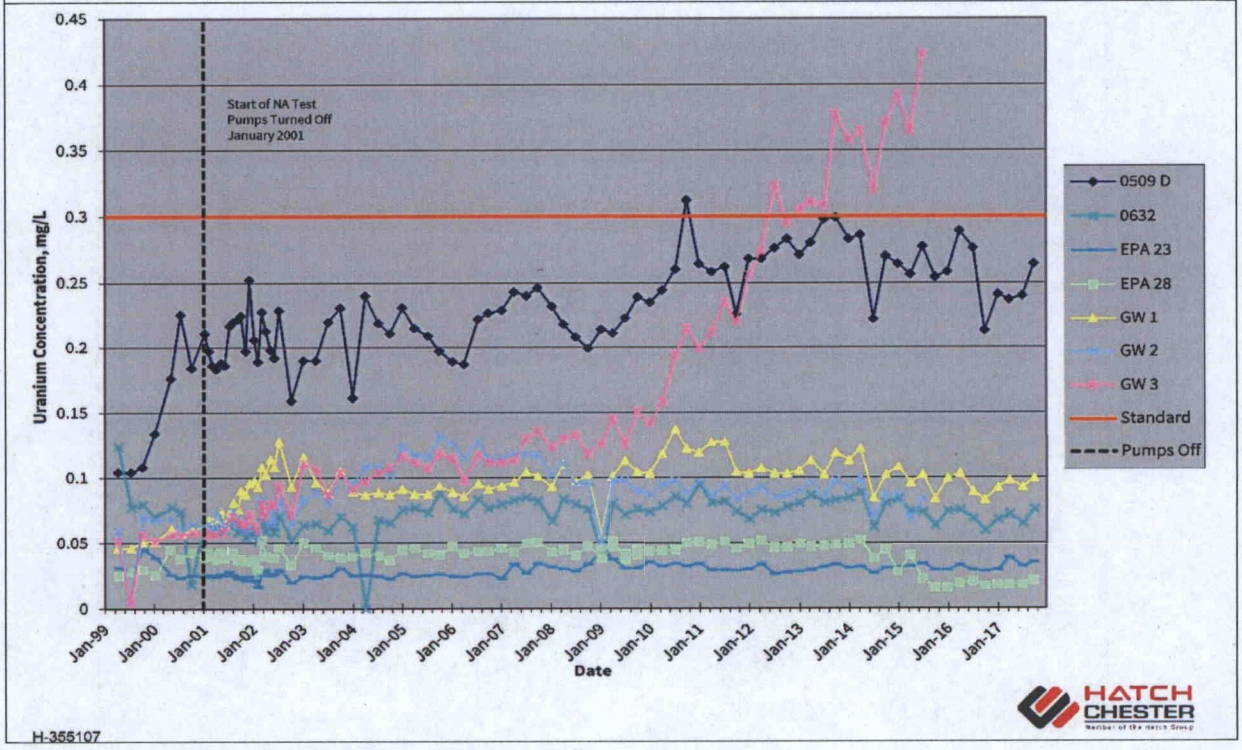


Figure 9b: Uranium Concentrations in Southwest Alluvium Wells

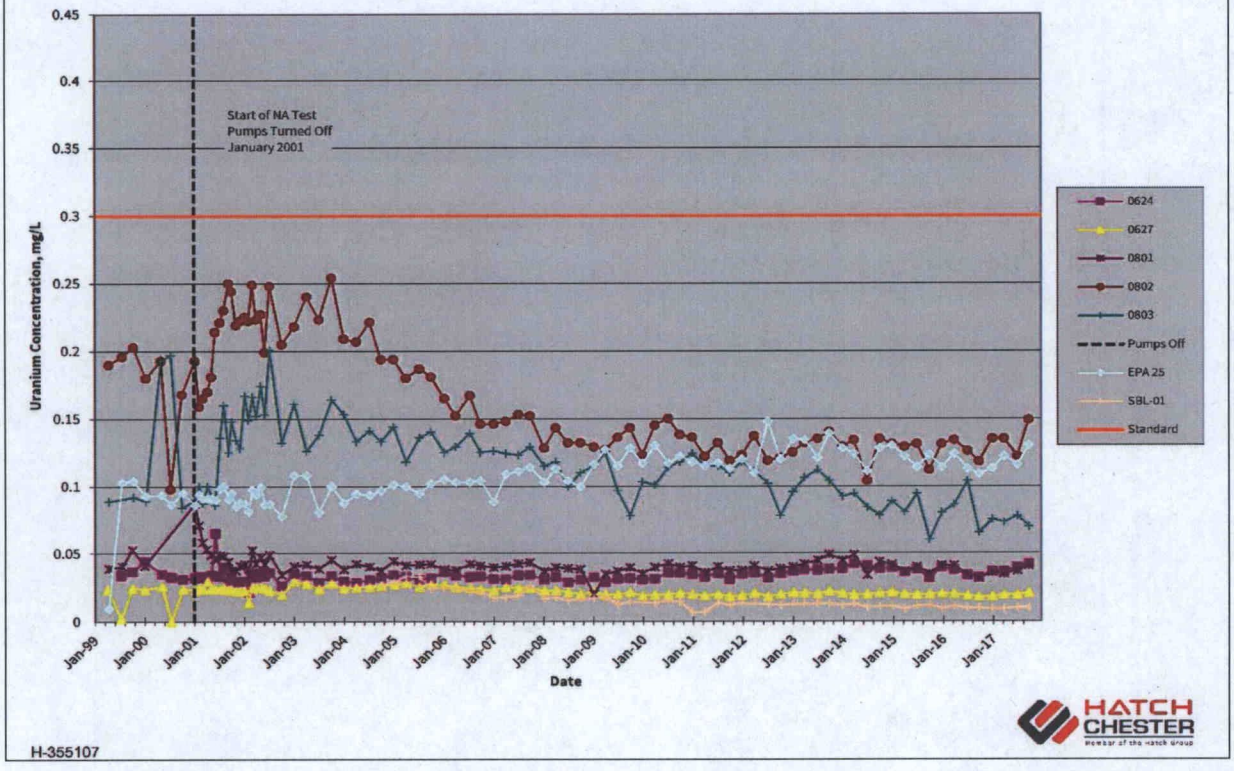


Figure 10: Zone 3 Potentiometric Surface Map, October 2017

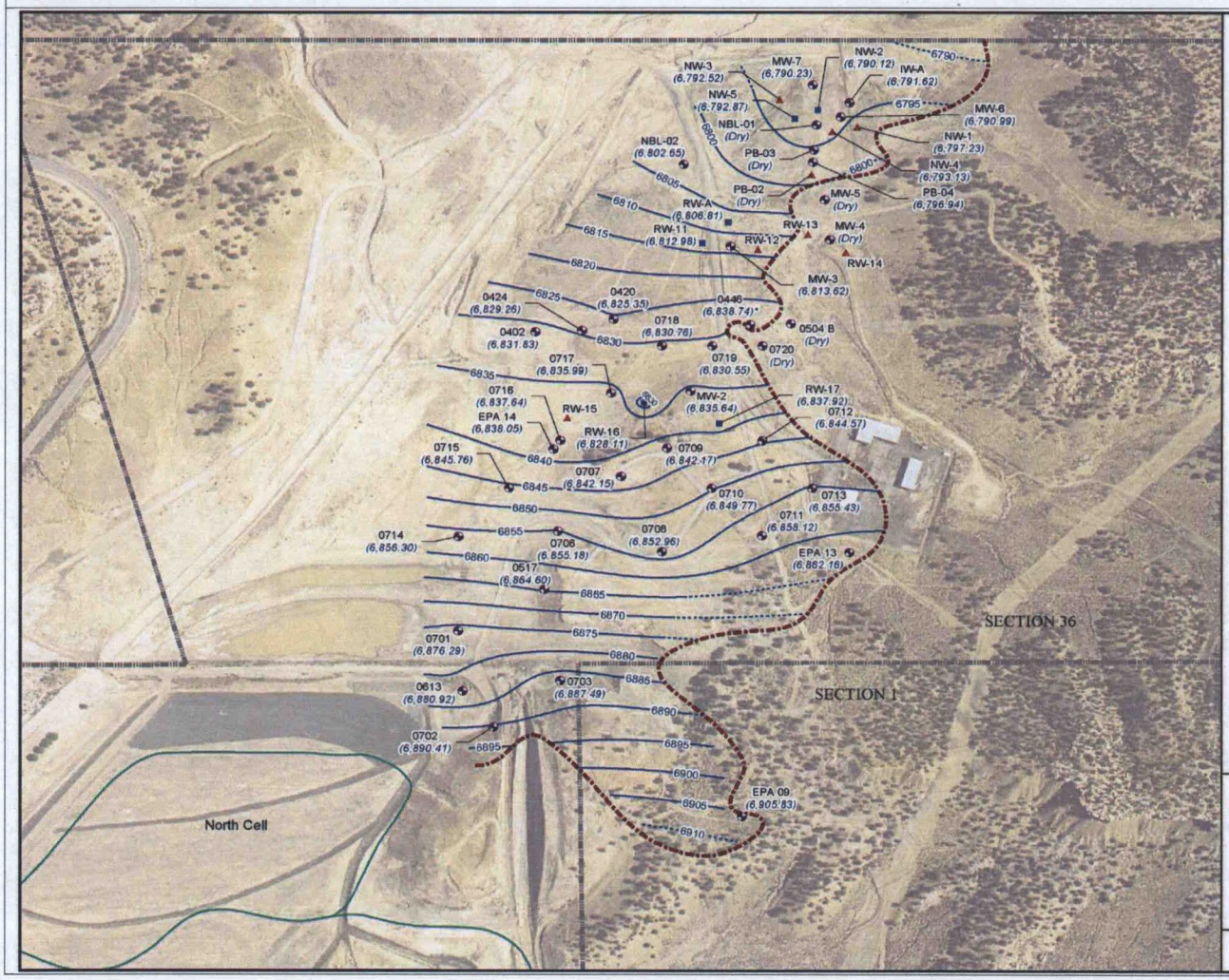
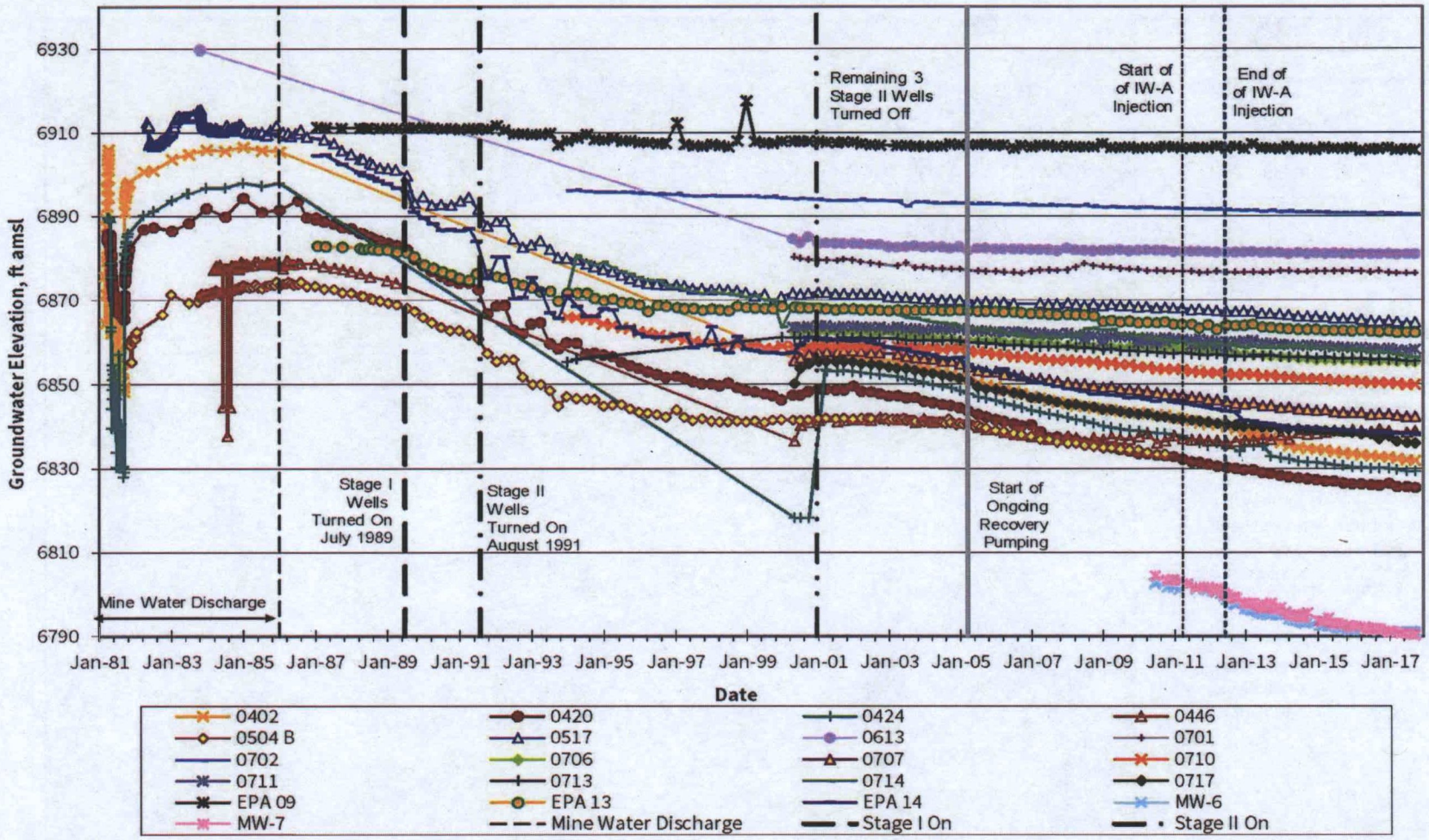


Figure 11: Effects of Past and Current Pumping to Dewater Zone 3



*EPA 14 measuring point elevation adjustment applied as of Jan-13

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Figure 12: Zone 3 Approximate Extent of Seepage-Impacted Ground Water, October 2017

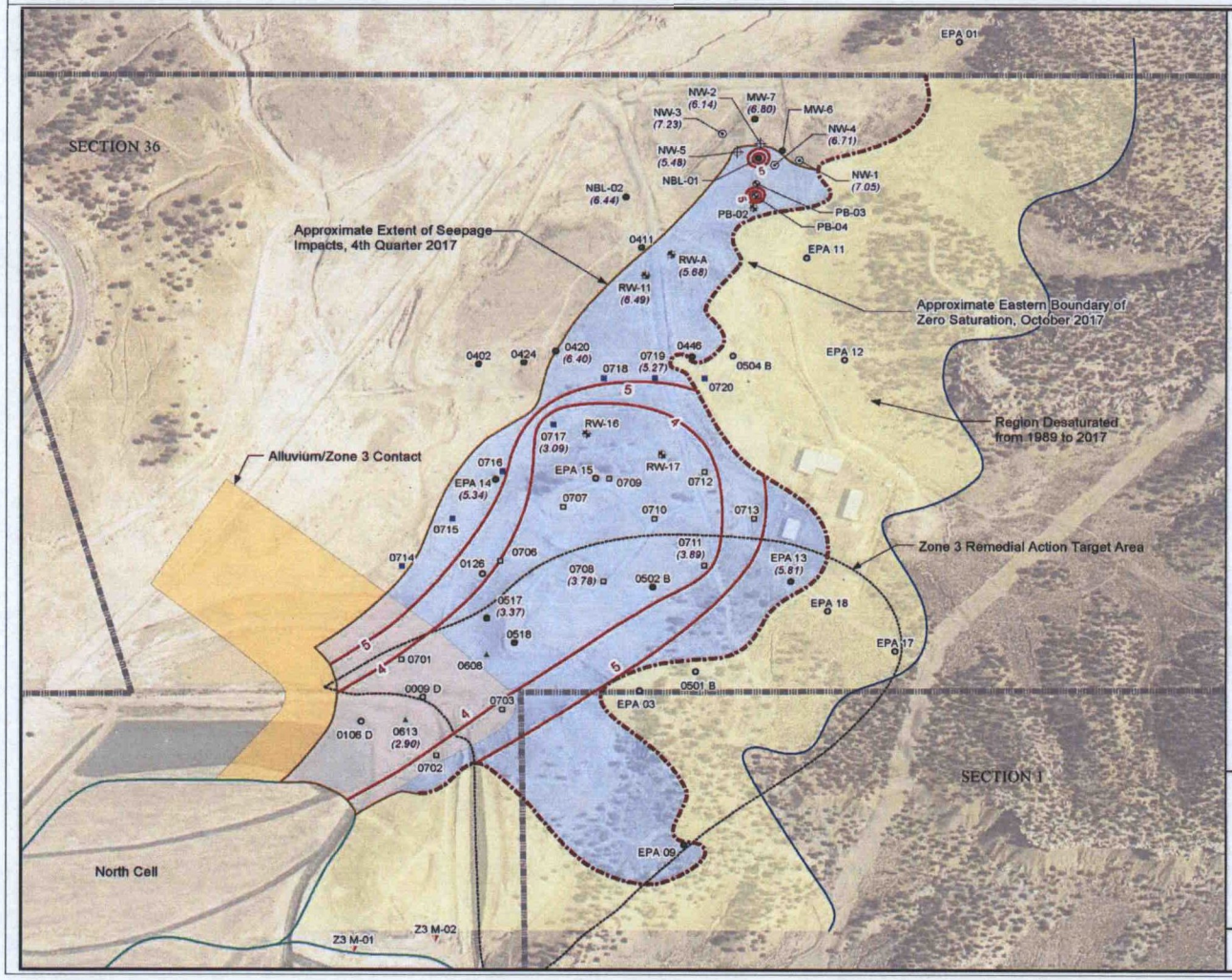

FIGURE 35

Zone 3 Approximate Extent of Seepage Impacts, October 2017

United Nuclear Corporation Church Rock Site, Church Rock, New Mexico

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Figure 13: Zone 3 Uranium, Vanadium, and Radionuclides Concentrations, 1989-2017

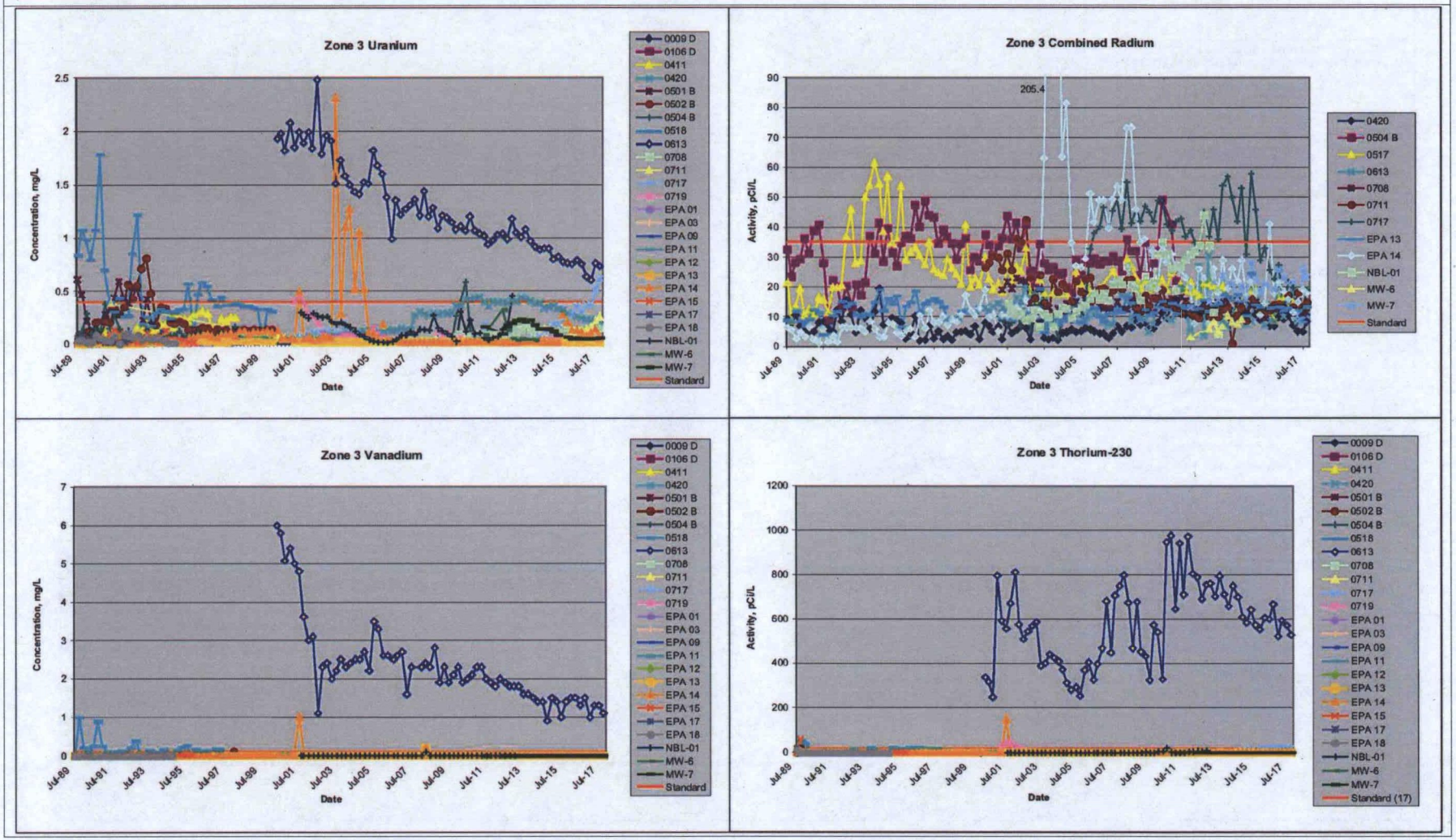


Figure 14: Zone 3 Uranium Isoconcentration Maps, October 2017

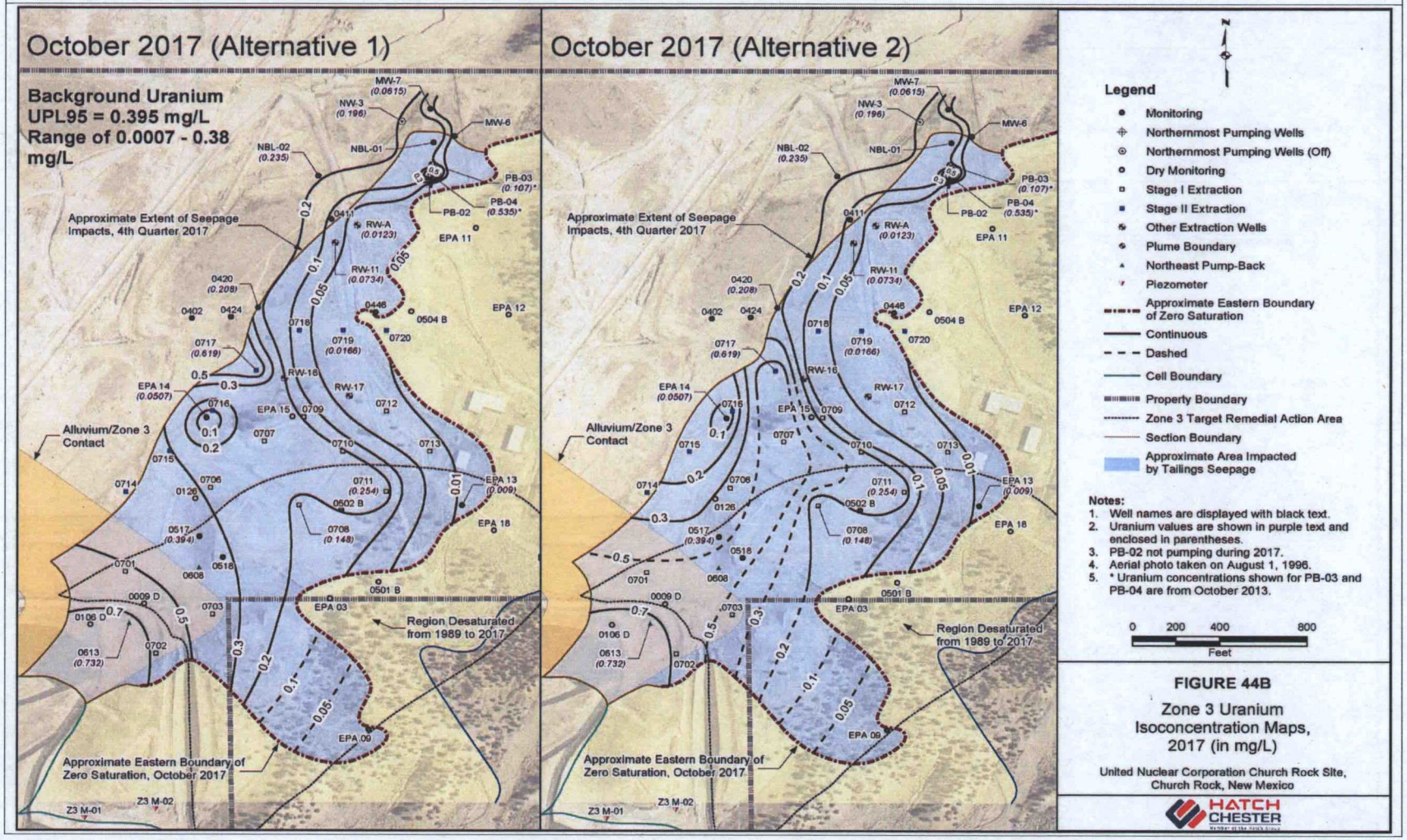


Figure 15: Zone 1 Potentiometric Surface Map, October 2017

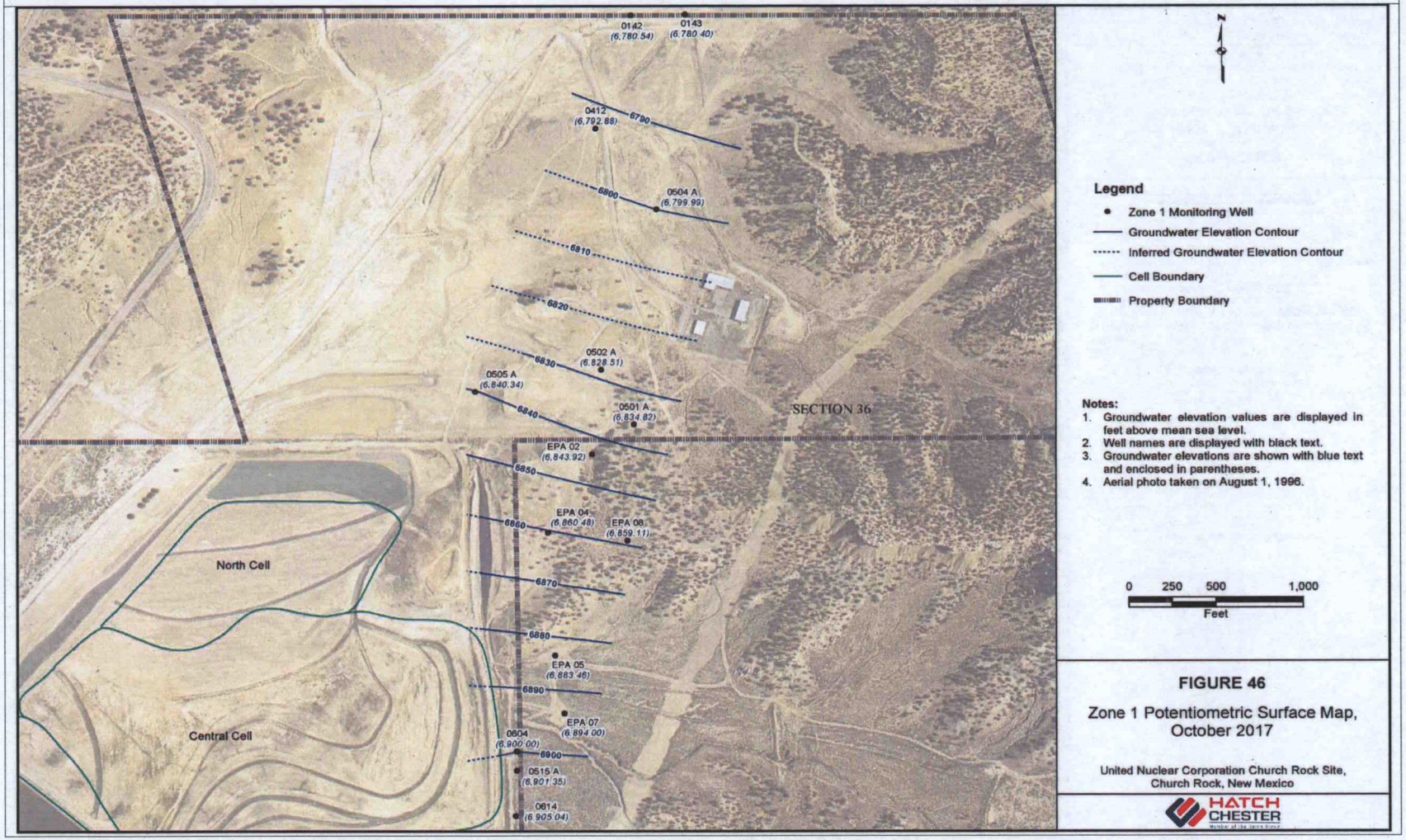


Figure 16: Zone 1 Extent of Seepage Impacts, October 2017

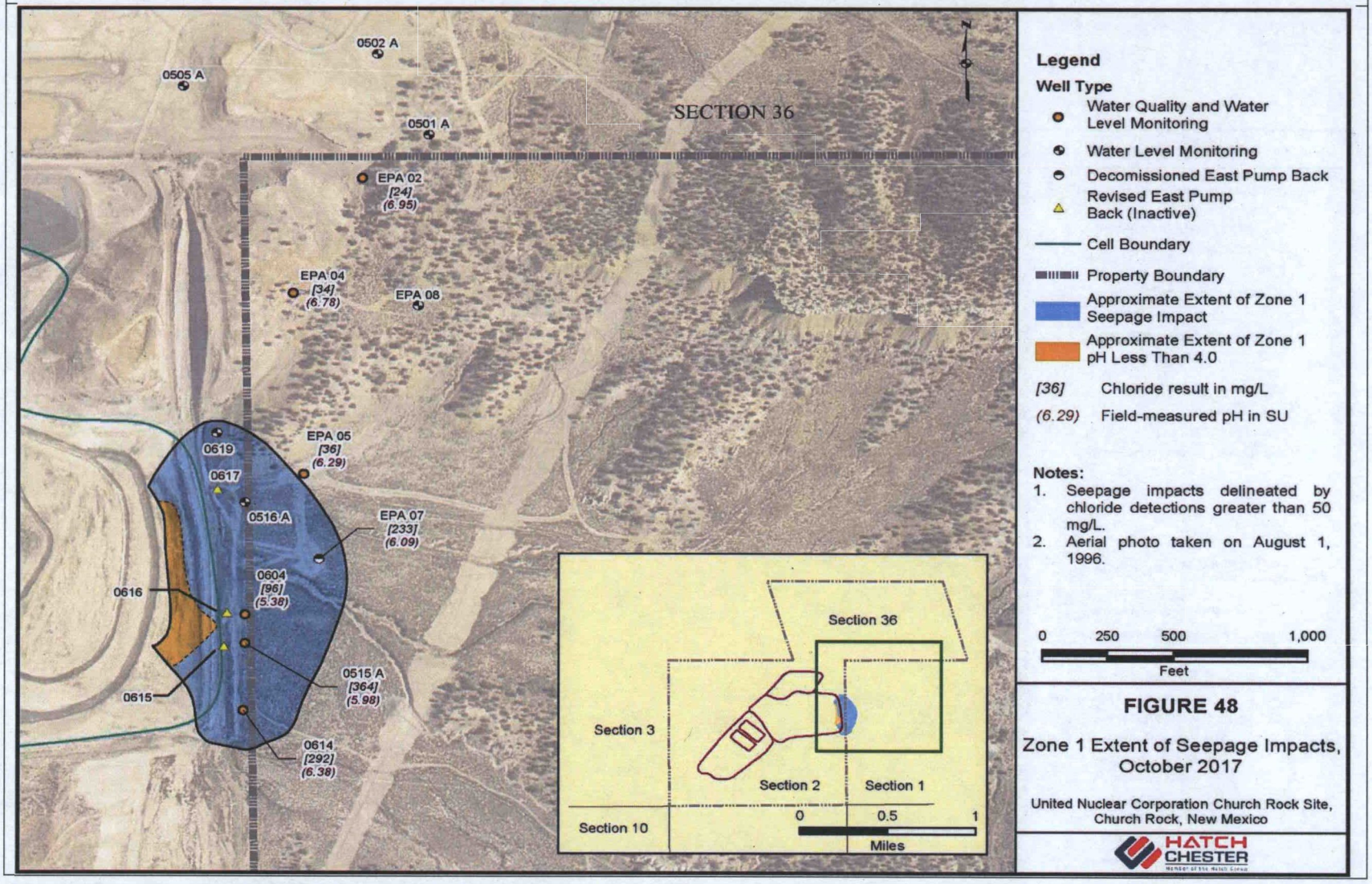
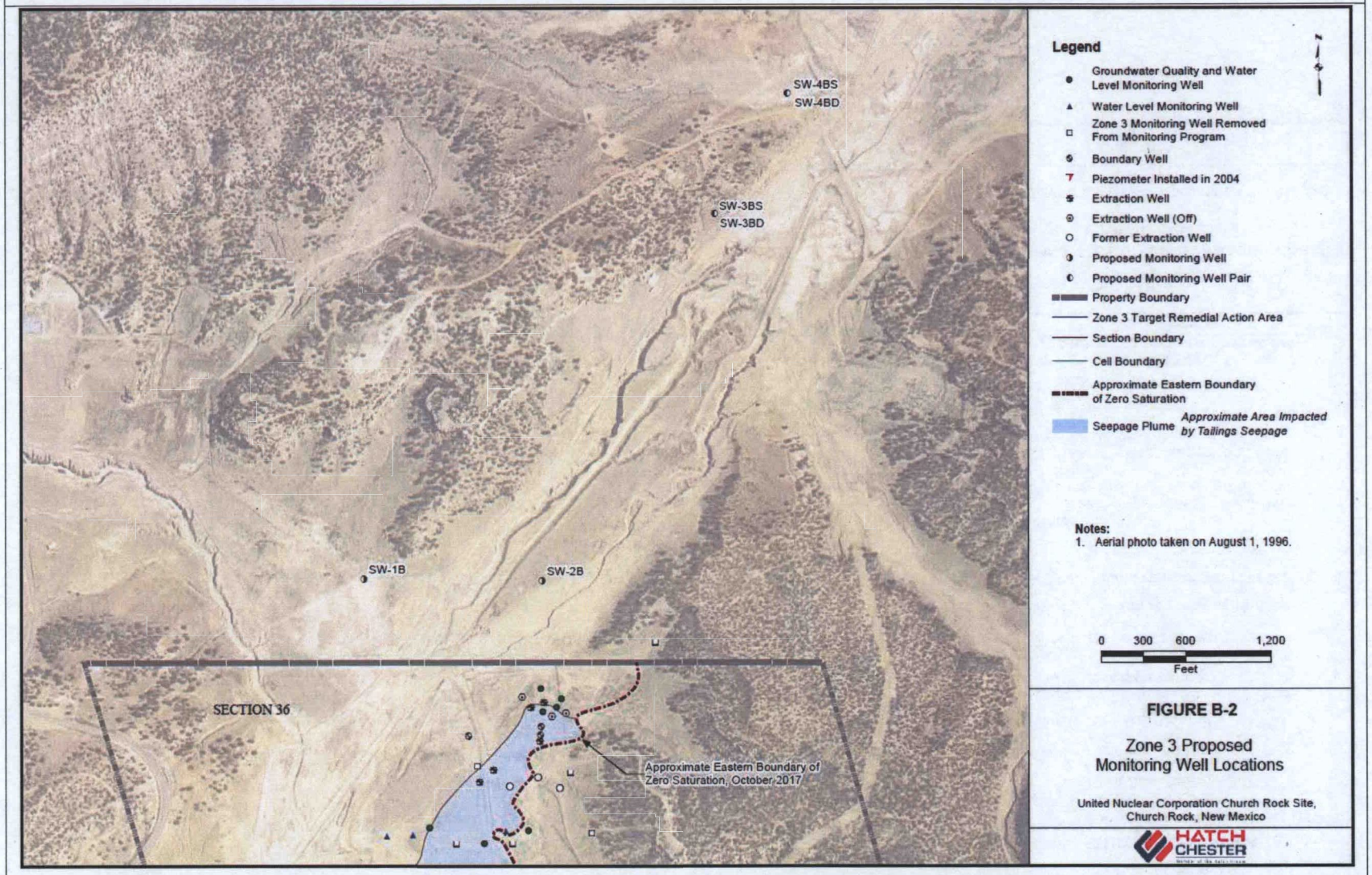


Figure 17: Zone 3 Proposed Sentinel Monitoring Well Locations, October 2017



APPENDICES

APPENDIX A

SITE INSPECTION CHECKLIST

Site Inspection Checklist

I. SITE INFORMATION	
Site name: United Nuclear Corporation	**Date of inspection:** October 31, 2017
Location and Region: McKinley County, New Mexico, EPA R6	**EPA ID:** NMD030443303
Agency, office, or company leading the five-year review: New Mexico Environment Department (NMED)	**Weather/temperature:** Partly cloudy, breezy, low 60's

Remedy Includes: (Check all that apply)

Landfill cover/containment — **XX** Monitored natural attenuation
XX Access controls — **XX** Groundwater containment
XX Institutional controls — Vertical barrier walls
XX Groundwater pump and treatment
XX Surface water collection and treatment
Other_____

_____

Attachments: X Inspection team roster attached — Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Ricky Spitz (AMEC Foster Wheeler) Project manager 10/31/2017
   Name — Title — Date
   Interviewed: **XX** at site — at office — by phone — Phone no.
   Problems, suggestions _____

   _____

2. **O&M staff** _____ _____
   Name — Title — Date
   Interviewed — at site — at office — by phone — Phone no. _____
   Problems, suggestions; _____

   _____

3. **RD/RA consultant** _____ _____ _____
   Name — Title — Date
   Interviewed — at site — at office — by phone — Phone no. _____
   Problems, suggestions; _____

   _____

4. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency NM Environment Department
Contact Steve Jetter Project Manager _____ 505-827-0072
Name Title Date Phone no.
Problems; suggestions; __
Not interviewed since person is an author of the 2018 UNC Five Year Review Report

Agency Navajo Nation Superfund Program
Contact Binod Chaudhary Sr Environmental Engineer _____ 928-871-7820
Name Title Date Phone no.
Problems; suggestions; Report attached See Interview Record from Navajo Nation

Agency _____
Contact _____ _____ _____
Name Title Date
Phone no.
Problems; suggestions; _____

Agency _____
Contact _____ _____ _____
Name Title Date
Phone no.
Problems; suggestions; _____

5. **Other interviews** (optional)

Interviews with community members were held at the Coyote Canyon and Pinedale Chapter Houses of the Navajo Nation (See Interview Records)

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	O&M manual	**XX** Readily available	Up to date	N/A
	As-built drawings	**XX** Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	**XX** N/A
	Remarks: UNC has all available documentation in the office and it is kept up to date. All Annual Review Reports From 1999-2016 on site and show maps of wells in each zone and facility features.			
2.	**Site-Specific Health and Safety Plan**	**XX** Readily available	**X** Up to date	N/A
	Contingency plan/emergency response plan	**XX** Readily available	**X** Up to date	N/A
	Remarks: On-site in Health and Safety Binder / NECR IRA 2009			
3.	**O&M and OSHA Training Records**	**XX** Readily available	**XX** Up to date	N/A
	Remarks: Records available online			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	**XX** N/A
	Effluent discharge	Readily available	Up to date	**XX** N/A
	Waste disposal, POTW	Readily available	Up to date	**XX** N/A
	Other permits **XX**	**XX** Readily available	**XX** Up to date	N/A
	Remarks: NRC Source Material License SUA 1475			
5.	**Gas Generation Records**	Readily available	Up to date	**XX** N/A
	Remarks:			
6.	**Settlement Monument Records**	Readily available	Up to date	**XX** N/A
	Remarks:			
7.	**Groundwater Monitoring Records**	**XX** Readily available	Up to date	N/A
	Remarks: Annual reports kept on site and delivered to regulatory agencies in timely manner.			
8.	**Leachate Extraction Records**	**XX** Readily available	Up to date	N/A
	Remarks: The remedy is not really classified for leachate extraction. However, the groundwater extraction remedy removes seepage impacted groundwater from the tailing disposal. Currently only the Zone 3 system is operating. Information is reported in each annual report.			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	**XX** N/A
	Remarks			

10. **Daily Access/Security Logs** **XX** Readily available **XX** Up to date N/A
Remarks: UNC Site contractor AMEC Foster Wheeler maintains daily on site presence during the work week. Staff patrol site regularly and check access gate locks and fences. Monitor site access and visitors must sign in at office in log book.

IV. O&M COSTS

1. **O&M Organization**
State in-house Contractor for State
PRP in-house **XX** Contractor for PRP
Federal Facility in-house Contractor for Federal Facility
Other_____

2. **O&M Cost Records**
Readily available Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____

Total annual cost by year for review period

From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons:
None identified

V. ACCESS AND INSTITUTIONAL CONTROLS Applicable N/A

A. Fencing

1. **Fencing damaged** Location shown on site map XX Gates secured N/A
Remarks: Fences are in place and properly maintained and inspected weekly. Special attention is given after rain events. Gates are closed and secured with chains and locks.

B. Other Access Restrictions

1. **Signs and other security measures** Location shown on site map N/A
   Remarks: Radiation danger and No Trespassing signs are visibly posted on fences and at gate entrances. Monthly inspections performed.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
   Site conditions imply ICs not properly implemented Yes No N/A
   Site conditions imply ICs not being fully enforced Yes No N/A

   Type of monitoring (*e.g.*, self-reporting, drive by)

   Frequency

   Responsible party/agency

   Contact _____ _____ _____
   Name Title Date
   Phone no.

   Reporting is up-to-date Yes No N/A
   Reports are verified by the lead agency Yes No N/A
   Specific requirements in deed or decision documents have been met Yes No N/A
   Violations have been reported Yes No N/A
   Other problems or suggestions: Report attached

2. **Adequacy** ICs are adequate ICs are inadequate N/A
   Remarks

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
   Remarks

2. **Land use changes on site** N/A
   Remarks: No land use changes during this reporting period

3. **Land use changes off site** N/A
   Remarks: None

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map **XX** Roads adequate N/A
   Remarks_____

B. Other Site Conditions

Remarks:_____

VII. LANDFILL COVERS Applicable **XX** N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
Areal extent_____ Height_____
Remarks_____

8. **Wet Areas/Water Damage** Wet areas/water damage not evident
Wet areas Location shown on site map Areal extent_____
Ponding Location shown on site map Areal extent_____
Seeps Location shown on site map Areal extent_____
Soft subgrade Location shown on site map Areal extent_____
Remarks_____

9. **Slope Instability** Slides Location shown on site map No evidence of slope instability
Areal extent_____
Remarks_____

B. Benches Applicable **X** N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** Location shown on site map N/A or okay
Remarks_____

2. **Bench Breached** Location shown on site map N/A or okay
Remarks_____

3. **Bench Overtopped** Location shown on site map N/A or okay
Remarks_____

C. Letdown Channels Applicable **X** N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Location shown on site map No evidence of settlement
Areal extent_____ Depth_____
Remarks_____

2. **Material Degradation** Location shown on site map No evidence of degradation
Material type_____ Areal extent_____
Remarks_____

3. **Erosion** Location shown on site map No evidence of erosion
Areal extent_____ Depth_____
Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable **X** N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition

Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable **X** N/A

1. **Gas Treatment Facilities**
Flaring Thermal destruction Collection for reuse
Good condition Needs Maintenance
Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
Good condition Needs Maintenance
Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
Good condition Needs Maintenance N/A
Remarks_____

F. Cover Drainage Layer Applicable **X** N/A

1. **Outlet Pipes Inspected** Functioning N/A
Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
Remarks_____

G. Detention/Sedimentation Ponds Applicable **X** N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
Siltation not evident
Remarks_____

2. **Erosion** Areal extent_____ Depth_____
Erosion not evident

Remarks_____

3. **Outlet Works** Functioning N/A
Remarks_____

4. **Dam** Functioning N/A
Remarks_____

H. Retaining Walls Applicable **X** N/A

1. **Deformations** Location shown on site map Deformation not evident
Horizontal displacement_____ Vertical displacement_____
Rotational displacement_____
Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable **X** N/A

1. **Siltation** Location shown on site map Siltation not evident
Areal extent_____ Depth_____
Remarks_____

2. **Vegetative Growth** Location shown on site map N/A Vegetation does not impede flow
Areal extent_____ Type_____
Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
Areal extent_____ Depth_____
Remarks_____

4. **Discharge Structure** Functioning N/A
Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable **X** N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____ Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES **XX** Applicable N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines **XX** Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance N/A
   Remarks: Only Zone 3 extraction wells are operational. Zone 3 consists of 6 extraction wells currently pumping at <0.5 gpm and well yields continue to decrease from approx. 2.3 gpm in 2013 to approx. 1.4gpm in 2017. Pumps and wells require frequent maintenance. SWA extraction remedy was switched to natural attenuation and Zone 1 remedy decommissioned (1999) with regulatory agency approval.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   XX Good condition Needs Maintenance
   Remarks: Equipment is maintained in good working condition.

3. **Spare Parts and Equipment**
   XX Readily available Good condition Requires upgrade Needs to be provided
   Remarks: Spare pumps, piping, valves stored at on-site office.

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable **XX** N/A

1. **Collection Structures, Pumps, and Electrical**

Good condition Needs Maintenance
Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks_____

3. **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks_____

C. Treatment System **XX** Applicable N/A

1. **Treatment Train** (Check components that apply)
Metals removal Oil/water separation Bioremediation
Air stripping Carbon adsorbers
Filters_____
Additive (*e.g.*, chelation agent, flocculent)_____
Others: Extracted water treated through evaporation in two on-site ponds
XX Good condition Needs Maintenance
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
XX Equipment properly identified
Quantity of groundwater treated annually: 988,000 gals (2014) and 619,000 gals (2017)
Quantity of surface water treated annually_____
Remarks: Annual pumping volumes are decreasing due to decreased saturated thickness of the aquifers.

2. **Electrical Enclosures and Panels** (properly rated and functional)
N/A **XX** Good condition Needs Maintenance
Remarks_____

3. **Tanks, Vaults, Storage Vessels**
XX N/A Good condition Proper secondary containment Needs Maintenance
Remarks_____

4. **Discharge Structure and Appurtenances**
N/A **XX** Good condition Needs Maintenance
Remarks Water is treated in two large evaporation ponds. The ponds are way oversized for current pumping rates/volumes. To maintain the liners from deterioration from exposure to sun

and weather, supplemental water from the on-site domestic well is used to fill the ponds

5. **Treatment Building(s)**
XX N/A Good condition (esp. roof and doorways) Needs repair
Chemicals and equipment properly stored
Remarks

6. **Monitoring Wells** (pump and treatment remedy)
XX Properly secured/locked XX Functioning XX Routinely sampled XX Good condition
All required wells located Needs Maintenance N/A
Remarks SWA wells GW-2 and GW-3 are to close to the Pipeline Arroyo embankments to be sampled safely. These wells have not been sampled since 2015. Additional Zone 3 sentinel wells have been proposed for placement on Navajo Nation land, but have not been installed, since the permitting process has not been completed yet.

D. Monitoring Data

1. Monitoring Data
XX Is routinely submitted on time **XX** Is of acceptable quality

2. Monitoring data suggests:
XX Groundwater plume is effectively contained **XX** Contaminant concentrations are declining

D. Monitored Natural Attenuation XX Applicable __ NA

1. **Monitoring Wells** (natural attenuation remedy)
XX Properly secured/locked XX Functioning XX Routinely sampled
XX Good condition All required wells located Needs Maintenance N/A
Remarks: Natural attenuation of metals and radionuclide is occurring in all three aquifer zones based on declining trends historically. However, for Zone 3, the NA rate is not high enough to overcome natural ground water flow gradient controlled by the stratigraphic dip and plume continues to migrate to the north.

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as

designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

See Interview Record with Roy Blickwedel (GE) and Annual Monitoring Reports for details on effectiveness of the remedy.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M measures for the Zone 3 extraction system is adequate but they do not affect the current or long term protectiveness of the remedy. The monitoring well network/program for all 3 zones is adequate for establishing concentration trends and plume migration. Additional sentinel wells have been proposed for Zone 3 on Navajo Nation land north to support the groundwater model and plume migration but those well have not been installed to date.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

None. The remedy has performed as well as expected in the ROD.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

See Interview Record with Roy Blickwedel (GE)

APPENDIX B

SITE CHRONOLOGY

Chronology of Events for UNC and NECR Sites	
Event	**Date**
UNC and Kerr McGee receive National Pollution Discharge Elimination Permits (NPDES) to release mine water to unnamed arroyo leading to Pipeline Canyon Arroyo.	January 1975
EPA 906/9/9-75-002 report released documenting NECR Mine discharge water elevated in radium & uranium above NPDES limits.	September 1975
UNC milling operations begin under license from the State of New Mexico Radiation Protection Bureau.	June 1977
Retention dam on UNC south tailings disposal cell breached & released an estimated 93 million gallons of acidic mill tailings water and sediment to Pipeline Canyon / Rio Puerco River. EPA Region 6 and NMEID respond to contaminant release.	July 1979
NMEID orders UNC to perform cleanup of Rio Puerco contaminated areas to 3 pCi/g of Ra-226, Th-230, & Pb-210 where possible.	August 13, 1979
NMEID orders UNC to implement discharge plan to control contaminated tailings seepage	November 9, 1979
UNC sampled off site monitor well TWQ-124 & results indicated that Th-230 level exceeded NM Radiation Protection Regulations beyond the restricted area of the licensed facility. Other non-radiological constituents were degrading off site ground water quality.	October 28, 1980
EPA begins discussions with UNC over the need for a ground water investigation of tailings seepage from mill site that follows the CERCLA Process (Comprehensive, Environmental Response, Compensation and Liability Act or Superfund Act of 1980).	February 19, 1982
EPA informs UNC that the mill site has been placed on Interim Priority List for hazard ranking analysis, a measure that is used in the process to consider a site for the National Priority List (NPL) or Superfund. UNC milling operations begin under license from State of New Mexico Radiation Protection Bureau.	April 2, 1982
UNC announces mill closing due to depressed uranium market.	May 1982
EPA provides UNC with final Administrative Order on Consent (AOC) developed in coordination with NMEID. UNC did not sign the AOC.	November 8, 1982
EPA performs Field Investigation Team (FIT) inspection sampling of tailings solution, surface water, and ground water at UNC Site.	November 8 & 15, 1982
UNC mill site placed on the National Priorities List (NPL) of Superfund Sites due to off-site migration of radionuclides and chemical constituents in ground water.	1983
EPA conducts Remedial Investigation (RI) field activities to determine the nature& extent of ground water contamination in the three water-bearing formations at the Site.	March 1984 - August 1987
In 1984, UNC blocked EPA access to the Church Rock facility, and EPA brought an action to compel site access. UNC counterclaimed seeking declaratory and injunctive relief. U.S. District Court granted an EPA motion to dismiss the UNC counterclaims, &UNC provided access to the Site to EPA. *United States v. United Nuclear Corporation*, 610 F Supp. 527, 528 (D.N.M., 1985).	April 18, 1985
NMEID returns Uranium Mill Tailings Radiation Control Act (UMTRCA) federal regulatory program to the U.S. Nuclear Regulatory Commission (NRC).	June 1986

Chronology of Events for UNC and NECR Sites	
Event	**Date**
EPA and NRC sign Memorandum of Understanding (MOU) coordinating EPA's CERCLA ground water remedial action with NRC's reclamation & closure activities under the Source Materials License and UMTRCA for Title II sites.	August 26, 1988
EPA releases RI and Feasibility Study (FS) report along with proposed plan of action field sheet.	August 1988
EPA issues a Record of Decision (ROD) describing the remedy to address UNC contaminated water beyond the boundaries of the tailings disposal cells by extraction-evaporation of ground water.	September 30, 1988
UNC submits Remedial Design Report.	April 1989
Remedial action implemented in Zone 1 – Borrow Pit No. 2 dewatered.	April 1989
EPA issues Unilateral Administrative Order (UAO) Docket No. CERCLA 6-11-89 to UNC requiring UNC to implement the Site CERCLA ground water operable unit remedy determined by the ROD.	June 29, 1989
Remedial action implemented in Zone 3 – 12 new extraction wells begin pumping.	August 1989
Remedial action implemented in Southwest Alluvium – 3 new extraction wells begin pumping.	October 1989
Ground Water Corrective Action Annual Review 1989 documents remedial action construction completion.	December 1989
United States had brought action against UNC in 1991 for response cost recovery under CERCLA; and in late 1992, the U.S. District Court issued an opinion and order granting a U.S. motion for partial summary judgment on the issue of costs and denying a UNC cross motion for summary judgment. *United States v. United Nuclear Corporation*, 814 F Supp. 1552 (D.N.M., 1992).	December 28, 1992
NRC issues a background water quality study that recommends higher concentrations of background constituents than presented in the ROD.	1996
First Five-Year Review completed.	September 24, 1998
NRC, EPA, and NMED approve the decommissioning of ten Zone 3 wells, three Zone 1 wells, and one Southwest Alluvium well because they meet the decommissioning criteria of producing less than 1 gallon per minute (gpm).	July 30, 1999
NRC approves eliminating the Section 1 portion of Zone 3 as a point of exposure.	September 16, 1999
UNC submits request to terminate all Zone 3 pumping and for Technical Impracticability waiver to EPA, NRC and NMED.	May 2000
All but three Zone 3 wells decommissioned in accordance with criterion.	June 2000
EPA approves UNC's request to shut down remaining three Zone 3 wells to slow seepage migration rate.	November 2000

Chronology of Events for UNC and NECR Sites	
Event	**Date**
License Amendment No. 31 allows UNC to temporarily suspend the corrective action pumping in Zone 3.	December 29, 2000
License Amendment No. 32 approves the conversion of the Zone 3 Phase II extraction wells to monitoring wells.	March 8, 2001
UNC submits Draft Tribal Resolution and Environmental Right-of-Way to the Navajo Nation to form basis for ICs.	March 2001
EPA gives UNC approval to temporarily shut down Southwest Alluvium extraction wells and an 18-month Natural Attenuation Test is conducted.	February 2001 – July 2002
UNC submits Final Report and Technical Impracticability Evaluation – Southwest Alluvium Natural Attenuation Test to EPA, NRC and NMED.	November 2002
UNC submits proposal to conduct hydraulic fracturing pilot test.	May 21, 2003
UNC conducts the hydraulic fracturing pilot test in Zone 3.	June 2003
Second Five-Year Review completed.	September 18, 2003
UNC submits Final Report – Hydraulic Fracturing Pilot Test Results and Preliminary Full-Scale Design, United Nuclear Church Rock Facility.	December 2003
EPA comments on the Final Report – Hydraulic Fracturing Pilot Test Results and Preliminary Full-Scale Design and directs UNC to perform supplemental feasibility study (SFS) for Zone 3.	March 10, 2004 and March 19, 2004
EPA approves Final Report - Hydraulic Fracturing Pilot Test Results and Preliminary Full-Scale Design.	May 21, 2004
UNC conducts the Phase 1 full-scale hydraulic fracturing test in Zone 3.	September 2004
UNC installs well SBL-01 in Section 10, Southwest Alluvium.	October 2004
UNC submits the draft SFS for Zone 3 for review.	October 27, 2004
EPA disapproves draft SFS for Zone 3 and directs UNC to perform a Site-wide SFS (SWSFS) consistent with the NCP.	June 24, 2005
Meeting between EPA, UNC, NRC, NMED, and NNEPA to discuss the SWSFS. UNC generally expresses its opposition to the feasibility study process.	August 17, 2006
Meeting between EPA, NNEPA, BIA and NMED in Window Rock, AZ, to discuss feasibility of ICs restricting the use of contaminated ground water.	January 18, 2006
Meeting between EPA and NNEPA in Dallas, TX, to continue discussions on ICs.	March 16, 2006
EPA approves in-situ alkalinity stabilization pilot study for Zone 3.	May 12, 2006
EPA directs UNC to perform the SWSFS in writing, stating that the feasibility study is appropriate and necessary.	June 23, 2006
Meeting between EPA, NNEPA, BIA, and NMED in Albuquerque, NM to continue discussions on ICs.	August 21, 2006

Chronology of Events for UNC and NECR Sites	
Event	**Date**
UNC submits the draft List of Preliminary Assembled Remedial Alternatives for the SWSFS.	September 2006
UNC begins the in-situ alkalinity stabilization pilot study in Zone 3. The study is completed in February 2007.	October 2006
UNC submits the draft SWSFS, Part 1, Church Rock Remediation Standards Update.	February 2007
UNC submits In-Situ Alkalinity Stabilization Pilot Study Report.	June 2007
EPA disapproves SWSFS, Part 1, Church Rock Remediation Standards Update and requires revision to address written comments.	January 25, 2008
Meeting between EPA, NMED, NRC, NNEPA and UNC to discuss status of remedial activities. UNC notifies regulatory agencies that pumping of hydraulic fracture wells in Zone 3 was unsuccessful in stopping migration of seepage-impacted ground water. UNC proposes to submit a plan for additional extraction wells for Zone 3.	March 12, 2008
UNC submits summary of hydrogeologic analysis evaluation of ground water flow and recommended plan for additional extraction wells for interception and recovery of seepage-impacted ground water in Zone 3.	April 2008
UNC submits white paper on statistics to address some of EPA comments on the SWSFS, Part 1.	May 2008
EPA notifies NRC of approval of UNC's recommendation for additional extraction wells.	June 2008
UNC installs five new extraction wells (the NW-series) in northern Zone 3.	September 2008
Third Five Year Review completed.	September 17, 2008
UNC submits calculation of background statistics with comparison values.	October 2008
UNC submits calculation of estimated UCL95 statistics and exposure point concentrations in impacted groundwater. UNC submits to NRC an alternate concentration limits application for Zone 1.	December 2008
Pumping of the NW-series of extraction wells in northern Zone 3 begins. Later in the year the pumping scheme was reorganized to include three of the five wells.	February 2009 and November 2009
EPA accepts revised SWSFS Part I, Remediation Standards Update and gives approval for UNC to proceed with SWSFS Part II: Development and Screening of Remedial Alternatives.	February 11, 2009
EPA Region 6 conducts community meeting at Pinedale Chapter House to give an update on the UNC 2008 Five Year Review.	May 5, 2009
UNC-GE letter to NRC on Technical Impediments to Site Closure at the Church Rock Mill Site (lack of consensus, unattainable cleanup standards, & complex issues related to statistics and geochemistry).	May 20, 2009
EPA Region 9 releases Northeast Church Rock (NECR) Engineering Evaluation/Cost Analysis (EE/CA) report for non-critical time removal of NECR mine waste. The preferred alternative for disposition of NECR Mine waste is disposal at an NRC-licensed facility, namely the UNC Mill Site tailings disposal ponds.	June 11, 2009
UNC submits revised Site-Wide Supplemental Feasibility Study Part II.	July 2009

Chronology of Events for UNC and NECR Sites	
Event	**Date**
UNC submits hydrogeologic analysis of recent Zone 3 injection testing (new background well NBL-2) in northern Zone 3 and proposal to enhance remediation using one or more injection wells amended with sodium bicarbonate	December 2009
UNC proposes the location for a pilot injection well in Zone 3.	April 2010
UNC submits report entitled, The Remedial Design: Conceptual Approach to Enhanced Remediation in Zone 3-New Injection Wells combined with Existing Extraction Wells.	May 17, 2010
UNC submits a hydrogeologic analysis of injection testing of Zone 3 well IW-A during July 2010.	August 2010
UNC-GE submits NRC License SUA-1475 Amendment request for revised dates to complete ground water corrective actions (12-31-2013) and to install final radon barrier and erosion protection cover on tailings pond (12-31-2014).	September 1, 2010
EPA provides UNC-GE with combined agency comment-approval letter (EPA, NRC, NMED, NNEPA) on SWSFS Part II dated July 2009, and general considerations-requirements to proceed with Part III	September 2, 2010
UNC submits revised version of the Updated Baseline Human Health Risk Assessment.	March 4, 2011
UNC starts injection at well IW-A of site Mill well water amended with alkalinity (sodium bicarbonate.	April 14, 2011
UNC submits revised versions of SWSFS Part I and Part II.	April 26, 2011
EPA issues a comment letter on the draft updated human health risk assessment	July 2011
UNC submits a technical memorandum summarizing two previously submitted reports on Zone 3 tailings seepage sourcing and groundwater recharge, with an information update.	August 2011
EPA Region 9 provides regional assessment report on ground water quality in/around UNC-NECR Mill facilities	September 2011
EPA issues comment letter on the Site-Wide Supplemental Feasibility Study Part II (July 2009) (in fact, this comment letter addressed Parts I, II, and III).	October 2011
UNC submits provisional responses to EPA comment letter (July 2011) on the draft baseline human health risk assessment (March 2011).	October 2011
UNC provides report on the Hydrogeologic Assessment of Injection at Zone 3 Well IW-A through September 2011 to EPA and NRC.	November 1, 2011
UNC submits a document requesting discussion and clarification about the EPA comment letter (October 14, 2011) addressing revised Site-Wide Supplemental Feasibility Study Parts I and II (April 2011).	November 2011
By email, UNC provides all agency stakeholders with revisions to the draft updated human health risk assessment (March 2011).	February 2012

Chronology of Events for UNC and NECR Sites	
Event	**Date**
EPA risk assessment specialist provides UNC with comments (by email) on the revised draft updated human health risk assessment (February 2012). Follow-up phone discussion between EPA risk specialist and UNC on April 27, 2012	March 2012
GE submits to NRC a license amendment request for revised groundwater protection standards based on updated background concentrations (statistically calculated background threshold values). The three site hydrostratigraphic units are addressed individually.	April 2012
UNC submits to NRC, "License Amendment Request Revised Ground Water Protection Standards Based on Updated Background Concentrations Source Material License SUA-1475 Ground Water Corrective Action Program United Nuclear Corporation Church Rock Tailings Site."	April 21, 2012
UNC presents the numeric groundwater hydraulic modeling (with focus on Zone 3) to all agency stakeholders at the annual technical meeting in Albuquerque.	May 14, 2012
UNC submits to EPA: "Overview of Draft Attached Tables, Summary Comparisons of Upper Prediction Limits for Parameter Concentrations in Background Groundwater to Site Cleanup Standards and Potential ARARs for All Three Hydrostratigraphic Units at the Church Rock Mill Tailings Site."	June 2012
UNC provides final version of the Updated Baseline Human Health Risk Assessment for the Church Rock Site in order to: 1) update risk estimates for the Site using current risk assessment methods-information; 2) support reassessment of remediation levels; 3) compare remedial alternatives; & 4) identify Point of Compliance (POC) & Point of Exposure (POE) concentrations in accordance with NRC requirements.	August 2012
EPA Region 6 provides UNC with acceptance letter for Updated Baseline Human Health Risk Assessment (August 13, 2012 version).	September 11, 2012
UNC notifies the agencies that injection of sodium bicarbonate-amended water, in Zone 3 well IW-A, was terminated on June 29, 2012.	October 2012
UNC provides ground water flow model report of the Church Rock Site & local area for three genetic classes of ground water to support decision-making for future Zone 3 ACL	October 2012
EPA issues Record of Decision (ROD) for the Site Surface Soil Operable Unit Alternative 2 preference for disposal of NECR mine waste at UNC Mill Site tailings evaporation ponds under NRC license SUA-1475.	March 2013
EPA Office of Research and Development (ORD) issues technical memorandum on the background ground water conditions in the SWA and Zones 1 and 3 of UNC Site and the proposed cleanup and compliance monitoring levels for COPCs using the statistically-based 95 percent upper prediction limits (UPL95s) (also known as "Overview of Draft Attached Tables, Summary Comparisons of Upper Prediction Limits for Parameter Concentrations in Background Groundwater to Site Cleanup Standards and Potential ARARs for All Three Hydrostratigraphic Units at the Church Rock Mill Tailings Site.").	March 2013
DOE issues comments to NRC regarding the April 2012 UNC License Amendment Request for Revised Groundwater Protection Standards Based on Updated Background Concentrations.	April 2013

Chronology of Events for UNC and NECR Sites	
Event	**Date**
NRC issues response to DOE comments on the April 2012 UNC License Amendment Request for Revised Groundwater Protection Standards Based on Updated Background Concentrations.	June 2013
NRC issues Request for Additional Information (RAI) pertaining to License Amendment Request (April 2012) for Revised Groundwater Protection Standards.	June 2013
Fourth Five Year Review completed.	September 2013
NNEPA formally requests that UNC locate, permit, drill, construct and operate sentinel wells on north of the UNC Church Rock Mill Site Section 36 boundary.	October 2013
UNC submits to NRC a response to the RAI pertaining to License Amendment Request (April 2012) for Revised Groundwater Protection Standards.	January 2014
UNC submits to NRC a revised groundwater flow model report.	June 2014
NRC issued a draft Environmental Assessment (EA) pertaining to the License Amendment Request (April 2012) for Revised Groundwater Protection Standards for review by other governmental agencies.	August 2014
UNC submits proposed sentinel well locations north of the UNC Church Rock Mill Site Section 36 boundary.	September 2014
EPA and NMED issue comments to NRC regarding August 2014 EA pertaining to the License Amendment Request (April 2012) for Revised Groundwater Protection.	October 2014
UNC submits proposed potential cleanup levels to EPA: "Updated Overview of Draft Attached Tables, Summary Comparisons of Upper Prediction Limits for Parameter Concentrations in Background Groundwater to Site Cleanup Standards and Potential ARARs for All Three Hydrostratigraphic Units at the Church Rock Mill Tailings Site (March 29, 2015)."	March 2015
NRC issues License Amendment No. 52 on April 9, 2015 which approves the April 2012 license amendment request related to revised groundwater protection standards (based on updated statistically calculated background threshold values). The three site hydrostratigraphic units are addressed individually.	April 2015
EPA indicates that UNC may proceed with the SWSFS using the March 2015 proposed potential cleanup levels.	September 2015
GE submits to NRC a license amendment request (October 22, 2015) to update the license for progress and changes that have taken place with respect to corrective action program and the on-going re-design and environmental review of the tailings disposal impoundment to incorporate mine spoil. Some editorial and typographical corrections are also proposed (including corrections to License standards). This license amendment request was intended to withdraw and replace a previous request dated January 22, 2015.	October 2015
UNC submits to EPA a letter describing how the proposed monitoring well network on the Navajo Reservation will be used to collect the hydrogeochemical information needed to establish areas where future administrative controls would be applied, in support of a future remedy.	April 2016

Chronology of Events for UNC and NECR Sites	
Event	**Date**
EPA and the Navajo Nation approve the proposed monitoring well locations on the Navajo Reservation and agree that UNC that should proceed with the plan to permit and install monitoring wells north of the Section 36 boundary on the Navajo Reservation (email from Janet Brooks to Roy Blickwedel, July 27, 2016).	July 2016
EPA requests quarterly reporting of northern Zone 3 monitoring well sampling, starting with October 2016 monitoring event.	August 2016
GE/UNC requests (December 8, 2016, corrected February 13, 2017) to amend previous license amendment request that was submitted on October 22, 2015. The amendment is to remove well GW 2 as a POC well for the Southwest Alluvium. All other aspects of the October 22, 2015 request remain the same.	February 2017
UNC submits to the Navajo Nation Department of Water Resources (Technical, Construction and Operations Branch [TCOB]), a preliminary well drilling permit application	April 2017

APPENDIX C

INTERVIEW RECORDS

INTERVIEW RECORD

Site Name: UNC-Church Rock Superfund Site		EPA ID #: NMD030443303
Subject: Fifth Five-Year Review	**Time:** 2:00	**Date:** 11/1/2017
Type: Visit **Location of Visit:** Coyote Canyon Chapter House		

Contact Made By:

Name: Ms. Janet Brooks	**Title:** Remedial Project Manager	**Organization:** EPA Region 6
Name: Mr. Angelo Ortelli Mr. Steve Jetter	**Title:** Project Manager Project Manager	**Organization:** NMED

Individual Contacted:

Name: Mr. /Ms. Sharon Warren Also, Mr. Leroy and Ms. Thelma Beyal, residents near Mill (Hardground Flats)	**Title:** Chapter Secretary	**Organization:** Coyote Canyon Chapter

Telephone No: **Fax No:** **E-Mail Address:**	**Street Address:**

Summary Of Conversation

Question 1: What is your overall impression of the project? (general sentiment)

No opinion – Ms. Warren is not well informed about the project. She would really appreciate getting more information and a site tour for the Chapter Council, interested community members, and herself.

Question 2: What effects have the site operations had on the surrounding community?

There has been an issue with work associated with mine site activities and detouring of traffic during bridge construction. People locking access gates and preventing access to communities (Hardground Flats) further up road. This is an issue for emergency response.

Question 3: Are you aware of any community concerns regarding the site or its operation and

administration? If so, please give details.

Community is worried about wind born dust contamination and has a study of this been performed. Janet explained that this was done at least locally in 1995. Based on the time since it was done, there was concern that additional study should be performed.

Community concerned that in-depth health study has not been performed. How many people have been impacted – health wise from the uranium mining and mill activities?

Leroy Beyal had concern with what effects on livestock and deer eating contaminated food and how these effects human consumption of the meat.

Question 4: Are you aware of any complaints, incidents or activities at the Site such as vandalism, trespassing, or emergency response from local authorities? If so, please provide details.

No, none during this five-year period. Heard of issues with down fences and cattle trespasses from Red Pond Road community but these occurred over five years ago.

Question 5: Do you feel well informed about the Site's activities and progress?

No – Coyote Canyon Chapter has not been kept informed on the UNC Mill Site remediation. We were informed that Coyote Canyon is in the Fort Defiance Agency and not the Crownpoint/Eastern Agency which includes the Pinedale and Church Rock Chapters which are closer to the Site.

Question 6: Do you have any comments, questions, or recommendations regarding the Site's management or operation?

Ms. Warren recommended that there be more community involvement and updates with the Coyote Canyon Chapter. This could take the form of fact sheet, meetings or simply email updates. At least semi-annual meetings/updates should be considered. It is best to advertise on local Gallup radio channel (???) in both English and Navajo.

Leroy Beyal recommended that presentation be visual in nature, show numbers, trends, satellite imagery, etc.

INTERVIEW RECORD

Site Name: UNC-Church Rock Superfund Site		**EPA ID #: NMD030443303**
Subject: Fifth Five-Year Review	**Time:** 9:40	**Date:** 11/2/2017
Type: Visit **Location of Visit:** Pinedale Chapter House		
Contact Made By:		
Name: Ms. Janet Brooks	**Title:** Remedial Project Manager	**Organization:** EPA Region 6
Name: Mr. Angelo Ortelli **Steve Jetter**	**Title:** Project Managers	**Organization:** NMED
Individual Contacted:		
Name: **Ms. Joann Miller (Citizen 1)** **Ms. Gladys Brody (Citizen 2)**	**Title:**	**Organization: Member of Community Land Use Planning Committee**
Telephone No: **Fax No:** **E-Mail Address:**	**Street Address:**	

Summary of Conversation

Question 1: What is your overall impression of the project? (general sentiment)

Both women are not familiar with what is going on at the site. They were glad to hear that the mine site will be cleaned up and returned to productive use.

Question 2: What effects have the site operations had on the surrounding community?

People are still concerned with effects of mine discharge water had on animals that drank the water and for people that consumed these animals

Question 3: Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

There was concern expressed about livelihood of area residents. This included concern about downwinders (effects on people living downwind from the mine and tailing disposal area) and concern with windblown contamination. Concern was also expressed regarding people gathering wood from the area that is used as firewood to heat homes. How they might be affected.

There was also concern for when large flood events occur in the arroyo that passes by the site and the potential to release contamination or damage the repository.

Question 4: Are you aware of any complaints, incidents or activities at the Site such as vandalism, trespassing, or emergency response from local authorities? If so, please provide details.

Neither women were aware of any incidents occurring at the site.

Question 5: Do you feel well informed about the Site's activities and progress?

No - Both women said they were not well informed about the site activities or progress.

Question 6: Do you have any comments, questions, or recommendations regarding the Site's management or operation?

Both women thought the should be more outreach and education about the site. Thought it would be beneficial to educate the youth by providing educational material or outreach to area boarding schools.

They asked about how long is the long-term monitoring going to take place.

INTERVIEW RECORD

Site Name: United Nuclear Corporation (UNC) Church Rock Superfund Site	**EPA ID No.: NMD030443303**	
Subject: Fifth Five Year Review	**Time:**	**Date:**
Type: email solicitation **Location of Visit:**		

Contact Made By:

Name: Janet Brooks	**Title: Remedial Project Manager**	**Organization: EPA Region 6**
Name: Steve Jetter	**Title: Project Manager**	**Organization: NMED**

Individual Contacted:

Name: Art Kleinrath	**Title:**	**Organization: Department of Energy, Office of Legacy Management**
Telephone No: 970-248-6034 **Fax No:** **E-Mail Address: art.kleinrath@LM.doe.gov**	**Street Address: 2597 Legacy Way** **City, State, Zip: Grand Junction, CO 81503**	

Summary Of Conversation

Question 1 - What is the U.S. Department of Energy's (DOE's) role on this project?

The Department of Energy (DOE) has no formal role in the CERCLA process. It does perform all the work under UMTRCA. That process including the O&M if any facility whether it be an active water remediation or a facility for the disposal of mine waste is solely between USEPA and its responsible party.

Question 2 - What is your overall impression of the groundwater remediation effort at the site?

Southwest alluvium has only SO4, manganese, chloride, nickel at all exceeding and none are very much over the limits. The ground water that was polluted was not natural ground water. Primarily, the ground water that was polluted was the manmade ground water that was pumped from the mines and which then drained into the Southwest Alluvium and into the Zone 1 and into the Zone 3.
According to the US EPA website: "Four water wells are within a 4-mile radius, the nearest being 1.7 miles northeast of the Site; however, nearby residents generally have used bottled water." (from site profile). It would appear risk is mitigated.

Question 3 - From your perspective, what effects have site operations had on the surrounding community?

The NRC regulated clean-up caused awareness and maintained the apprehension of potential contamination. The EPA activities have maintained that awareness. The EPA activities have provided much more understanding and education to the public on the issue.

Question 4 - Are you aware of any community concerns regarding the site or its operation and administration? If so, please provide details.

In regards to the Ground water only a general "is it safe?" concern. I also get a lot of feeling of "can we just get it done".

Question 5 - Have there been routine communications or activities (e.g., site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please describe purpose and results.

Review and comment on documents: The DOE purpose in the review process is twofold, first to ensure the intended end-state does not conflict with DOE future obligations under UMTRCA. Second is DOE-LM has many years of experience with cells such as the UMTRCA cell and can provide useful history, expertise and experience.

Question 6 - Is the ground-water remedy progressing in accordance with DOE's expectations or requirements for the site? Please explain.

DOE expects the groundwater remedy to be completed and require no more monitoring at the time of NRC termination of license and transfer to DOE.

Question 7 - Is the DOE aware of opportunities to optimize the operation, maintenance, or sampling efforts

at the site?

DOE expects the groundwater remedy to be completed and require no monitoring under UMTRCA at the time of NRC termination of license and transfer to DOE.

Question 8 - From DOE's perspective, have any of the changes in site operations had an effect on the protectiveness or effectiveness of the ground-water remedy? Please explain.

We do not know of any such changes. The Groundwater remedy is nearing its end of effectiveness.

Question 9 - Are you aware of any changes in DOE standards since the time the remedial approach was delineated which may call into question the protectiveness or effectiveness of the remedial approach?

The numerical standards for media (soil/water/flux) established by the NRC are and will be set by license amendment. All such standards are risk based and protective. DOE will set, subject to NRC concurrence, operational parameters

Question 10 - Do you feel well informed about the site's activities and progress?

Yes we are kept informed.

Question 11 - Do you have and comments, suggestions, or recommendations regarding the site's management or operation?

We do not have any additional input, because we are included in the development of the site plans so our comments are made during that time.

INTERVIEW RECORD

Site Name: United Nuclear Corporation (UNC) Church Rock Superfund Site		EPA ID No.: NMD030443303	
Subject: Fifth Five Year Review		Time:	Date:
Type: email solicitation Location of Visit:			
Contact Made By:			
Name: Janet Brooks	Title: Remedial Project Manager	Organization: EPA Region 6	
Name: Steve Jetter	Title: Project Manager	Organization: NMED	
Individual Contacted:			
Name: Roy Blickwedel	Title: Remedial Project Manager	Organization: GE	
Telephone No: 610-892-7935 Fax No: E-Mail Address: Roy.blickwedel@ge.com		Street Address: 475 Creamery Way City, State, Zip:Exton, PA 19341	

Summary Of Conversation

Question 1 - What is your overall impression of the project? (General sentiment)

Remediation has generally been effective and it has been protective of human health and the environment.

Question 2 - What is the current status of the groundwater remediation at the Site?

The active groundwater pumping systems in two of the three water-saturated strata that were impacted by tailings seepage migration have been discontinued. Zone 1 was discontinued in July 1999 with the approval of the Nuclear Regulatory Commission (NRC) because the decommissioning criteria were achieved. Groundwater quality in the offsite portion of Zone 1 complies with the NRC groundwater protection standards. In some locations within the UNC-owned property, nickel, and total trihalomethanes may exceed the NRC groundwater protection standards, although there is ample hydrologic and geochemical evidence that shows the extent of seepage-impacted water is naturally diminishing in Zone 1.

In the Southwest Alluvial system, active pumping was discontinued in 2001 with EPA and NRC approval to conduct an 18-month natural attenuation test. The report, completed in December 2002, recommended the replacement of the current remedy with a natural attenuation remedy for metals and radionuclides, and a Technical Impracticability Waiver for sulfate and TDS. The Southwest Alluvium complies with all of the NRC groundwater protection standards, and the EPA standards for all hazardous constituents.

Zone 3 pumping was discontinued in December 2000 with the approval of NRC. EPA recognized during the 1st Five-Year Review of 1996 that Zone 3 pumping was not effective, and was perhaps detrimental to the containment of seepage-impacted water in Zone 3. Approval to cease pumping was granted in December 2000, conditioned on the installation of a sentinel monitoring well and the evaluation of other remedy enhancement alternatives. Alternative remedy enhancements were pilot tested between 2003 and 2012. None have been successful in enhancing the effectiveness of the remedy for very long. However, the hydraulic fracturing test resulted in the placement of some new extraction wells that avoid the problems associated with the former pumping system. Pumping from the new Zone 3 wells continues.

Sentinel wells for Zone 3 have been proposed for placement on the Navajo Reservation, and are currently in the permitting process. The wells will also be used to confirm the groundwater flow model.

Question 3 - Did the groundwater remedy function as expected in the Southwest Alluvium and Zone 3? How well did the groundwater remedy perform?

The groundwater pumping remedy has achieved significant desaturation of the impacted groundwater in each area. As anticipated in the June 1988 Record of Decision (ROD) and the Initial Five-year Review, and as substantiated in the various technical reports for the site, groundwater pumping has reached the limits of its effectiveness. In all three groundwater target areas further groundwater pumping will have no additional, appreciable, beneficial effect on achieving cleanup goals beyond the natural processes that are occurring. The remedy has functioned as well as was expected when EPA chose it in the ROD.

As a practical matter, EPA expected that it would be necessary to reevaluate the performance goals that were established in the ROD. EPA expected that significant desaturation of the impacted media could occur and that it would be necessary to change the performance goals that were established in the ROD. Despite the anticipated technological limitations, groundwater quality in the offsite portion of Zone 1 is in compliance with the NRC groundwater protection standards, and the Southwest Alluvium is in full compliance with the NRC groundwater protection standards.

Question 4 - Did the groundwater remedy function as expected in Zone 3? How well did the

groundwater remedy perform?

The remedy functioned as well as was expected when EPA chose it in the June 1988 Record of Decision (ROD). While the groundwater pumping remedy has not attained all of the remediation goals that were established in the Record of Decision (ROD), this was anticipated in the ROD. EPA expected that significant desaturation of the impacted media could occur and that it would be necessary to change the performance goals that were established in the ROD.

UNC has expended tremendous effort and resources to enhance the effectiveness of EPA's selected remedy for Zone 3 as recommended in the 2nd Five-Year Review. While UNC's efforts have improved upon the original remedial design, they too are reaching the limit of their effectiveness. Migration of the Zone 3 plume has been slowed, but it will only cease to migrate when certain natural hydraulic forces are balanced by the chemical reactions that are attenuating and restricting the movement of the seepage-impacted water. At this point, continued downgradient migration can no longer be altered by using hydraulic modifications (i.e. pumping) due to the dip of the geologic strata within which the groundwater moves. UNC has not identified other proven, innovative, or emerging technologies that will achieve cleanup goals in Zone 3 because of declining saturated thicknesses, the alteration of arkosic sandstone to clay, encrustation, and the resultant poor formation yields.

Pumping from Zone 3 wells continues, albeit it at a consistently declining yield. Groundwater recovery from all Zone 3 pumping wells combined was about 2.3 gallons per minute (or about the same as a garden hose turned on low) at the time of the last Five-year Review. It is now about 1.4 gpm. The proportion of seepage-impacted water recovered to background water recovered is steadily shifting towards the latter. The groundwater recovery is rapidly meeting the limits of any beneficial effect if it has not already reached that point.

Question 5 - What does the monitoring data show? During operation and post operation of the remedial systems, were there trends that showed contaminant levels decreasing over time?

Descriptions of contaminant trends depend on the compound considered and whether one is discussing Zone 1, Zone 3, or the Southwest Alluvium, and so the annual review reports should be consulted for detailed answers to this question. In general, the trends for hazardous constituents had diminished both with distance from the tailings disposal area and through time and reached asymptotic conditions before groundwater recovery ceased in Zone 1 and the Southwest Alluvium. The concentrations since pumping was terminated remain stable, and are the result of the natural capacity of the formation to immobilize the hazardous constituents rather than the former pumping that took place.

In Zone 3, concentrations of regulated constituents have been stable for several years. Concentrations of regulated constituents may vary in response to variations in the pumping configuration which is routinely modified to promote the recovery of seepage-impacted groundwater and minimize the recovery of background groundwater. As reported above, the proportion of non-impacted groundwater recovery to seepage-impacted groundwater recovery is unavoidably increasing as the saturated thickness declines. The limited groundwater recovery that UNC is currently able to accomplish is sufficient to capture seepage-impacted water at the

leading edge of impacts, but is not and will not ever be capable of achieving either the current NRC groundwater protection standards or the EPA's ROD standards absent the complete dewatering of Zone 3 which is technologically impracticable.

Some of the EPA-mandated constituents-of-concern, such as sulfate and manganese, are controlled solely by equilibration with naturally occurring minerals in the formation that the water moves through. As a consequence, the monitoring data for these constituents are remarkably stable through time. It was NRC's conclusion in 1996 that these constituents are inappropriate for determining the effectiveness of the groundwater corrective action program.

Question 6 - From your perspective, have any of the groundwater remedial systems reached their limit of effectiveness? If so, please explain.

First, let me explain the General Electric Company's (GE's) role on this project. In September 1997 UNC was acquired by a company that was in turn acquired by GE, and as a result UNC became a wholly-owned, indirect subsidiary of GE. GE Corporate Environmental Programs was retained through a separate administrative services agreement to assist UNC both technically and administratively with environmental issues at Church Rock.

As to GE's perspective, it is certain that the current remedy has reached the limits of effectiveness for Zone 1 and the Southwest Alluvium. Moreover, the remedial systems have achieved what was anticipated in the ROD. Water quality due to tailings seepage has generally remained stable or improved since the cessation of pumping operations in both these units. **UNC believes that the termination of groundwater corrective actions in Zone 1 and the Southwest Alluvium is long overdue.**

In Zone 3, the new pumping configuration which was adopted since the last five-year review has slowed the rate at which seepage-impacted water can migrate. This has been beneficial because it allowed natural restorative processes to be more effective. Over the past few years, UNC has adjusted the configuration by adding wells and removing them as needed to maximize hydraulic control over the seepage-impacted water. UNC also injected alkalinity into the seepage front to help neutralize the seepage-impacted water, however, it was necessary to cease the alkalinity injection because of its tendency to promote the retention of uranium in solution. Current groundwater recovery from all Zone 3 pumping wells combined is about 1.4 gallons per minute, and this rate is in steady decline. **It will be necessary to change the remedial goals and/or to invoke other administrative controls, supported by sentinel well monitoring, for the CERCLA process to attain closure and for the site to be transferred to the DOE for long-term stewardship.**

Question 7 - Are there any trends that show contaminant levels increasing or that indicate continued

expansion of the groundwater plume in the three aquifer zones? Please explain.

There are no water quality trends, which are attributable to the seepage of tailings-impacted water, to indicate that contaminant levels are increasing in any of the remedial target areas (none of which may be considered aquifers). Variations in contaminant concentrations are always explained by natural processes that are unrelated to tailings-seepage. Since the last Five-Year Review, the areas of impact have been stable to declining in extent.

In the last Five-Year Review, we recommended that this question be revised to be more meaningful; however, that suggestion seems to have been dismissed. The question that should be asked now and in the future is not whether contaminant levels increased or decreased, but rather, whether the changes are attributable to tailings seepage; and second, whether those changes are within the range of concentrations that are naturally encountered in the background water. These two questions are far more meaningful as a basis for decision-making, and the answers to them indicate that the remedy is protective and should be terminated.

Question 8 - From GE's perspective, have any of the changes in site operations had an effect on the protectiveness or effectiveness of the ground-water remedy? Please explain.

The cessation of pumping has not affected protectiveness. The remediation remains protective of human health and the environment. The remedy functioned as well as was expected when EPA chose it in the June 1988 Record of Decision (ROD). EPA expected that significant desaturation of the impacted media would limit or end the ability to achieve improvement in groundwater quality through continued pumping, and that it would be necessary to change the performance goals that were established in the ROD.

GE believes that it is the attenuative capacity of the natural system, more than the pumping remedy, which has produced most of the remedial progress that has been observed in the Southwest Alluvium and in Zone 1. The stable water chemistry that has occurred post-shutdown attests to this conclusion.

As for Zone 3, UNC remains willing to recover seepage-impacted groundwater until it is no longer practicable to do so, and to assist EPA to establish off-site administrative controls. The pending installation of sentinel wells in Zone 3 is partly to support the administrative controls. The definition of "practicable" should be based upon an ability to sustainably pump seepage-impacted water in sufficient quantities to mitigate seepage-migration. It appears that the recovery system is very close to, or at, this limit. The endpoint cannot be based upon the current ROD standards; those levels quite simply can never be achieved.

Question 9 - From your perspective, what effects have site operations had on the surrounding community?

Relations with the surrounding community have been productive and positive.

Question 10 - Are you aware of any community concerns regarding the site or its operation and administration? If so, please provide details.

UNC is not aware of any community concerns regarding site operations.

Question 11 - Have there been any complaints, violations, or other incidents related to the site that require a response by your office? If so, please describe the events and results of the responses.

None.

Question 12 - Do you have and comments, suggestions, or recommendations regarding the project?

EPA recognized as early as the 1986 ROD and as late as the First 5-year Review in 1998, that technical limitations would be reached with respect to meeting the goals that were established for the site. In the First 5-year review in 1998, EPA validated the technical limitations that it anticipated in the ROD using the 10 years of operational data in existence at that time. EPA recommended that UNC begin to use other available tools to fully close the site, such as Alternate Concentration Limits and Technical Impracticability Waivers. UNC embarked upon a program to develop the EPA's recommendations and for the next several years conducted appropriate investigations and reported on its progress. Several NRC license amendments were adopted to advance these recommendations.

The fundamental technical limitations that EPA anticipated from the ROD and the First 5-Year Review have not changed. UNC understands that EPA believes that performing a second FS is the best approach to make sure that the stakeholders are fully involved. However, the supplemental FS will not change what EPA anticipated 25 years ago in the ROD. As stated in Appendix A of the ROD: "However, operational results may demonstrate that it is technically impractical to achieve all cleanup levels in a reasonable time period, and a waiver to meeting certain contaminant-specific applicable or relevant and appropriate requirements (ARARs) may require re-evaluation as a result. Operational results may also demonstrate significant declines in pumping rates with time due to insufficient natural recharge of aquifers. The probability of significant reductions in the saturated thickness of aquifers at the site must be considered during performance evaluations since much of the water underlying the tailings disposal area is the result of mine water and tailings discharge, both of which no longer occur. In the event that saturated thicknesses cease to support pumping, remedial activity would be discontinued or adjusted to appropriate levels." This is precisely what has taken place over the nearly quarter century of performance monitoring; more importantly, the remedy has always been and continues to be considered effective. The new FS will not change the fact that the original

cleanup goals cannot be met, and that waivers and other administrative tools will have to be adopted before the Church Rock Mill can be transferred to the Department of Energy's Long-term Stewardship Program.

UNC understands that USEPA may evaluate institutional controls as a potential supplement to the ROD, in addition to or in combination with the adoption of natural attenuation mechanisms, Technical Impracticability Waivers or modified cleanup standards for the Church Rock site. As EPA is aware, UNC worked with the Navajo Nation from 2001 to 2003 to develop an institutional control plan to prevent potential exposure to seepage-impacted water. Neither the proposed Tribal Resolution nor the environmental right-of-way that was developed has been formally responded to since they were first proposed more than 10 years ago. Given that it is unrealistic to consider the background groundwater as a viable source of water for human and/or animal consumption at present or in the future, UNC continues to believe administrative controls should be considered as part of the final remedy. For its part, UNC has demonstrated its willingness over the past 20 years to work cooperatively with all parties to forge an outcome that benefits local residents. This has included an offer made more than 15 years ago to provide for an alternative water source to nearby residents should they not have access to viable supplies either for stock watering or domestic consumption because of the naturally poor water quality in the region.

Thank you for allowing us to share our perspective during this fifth 5year review.

APPENDIX D

DOCUMENTS REVIEWED

Documents Reviewed

Chester Engineers, 2009. *Revised Submittal: Site-Wide Supplemental Feasibility Study Part II, United Nuclear Corporation, Church Rock Tailings Site, Church Rock, New Mexico*. July 2009.

Chester Engineers, 2011b, Revised Site-Wide Supplemental Feasibility Study Parts I and II, Church Rock Site, Church Rock, New Mexico. April 26, 2011.

Chester Engineers, 2012. *Updated Baseline Human Health Risk Assessment – Final, Church Rock Site, Church Rock, New Mexico*. August 2012.

Chester Engineers, 2014. *Annual Review Report – 2013, Groundwater Corrective Action, Church Rock Site, Church Rock, New Mexico*. January 2014.

Chester Engineers, 2014. *Groundwater Flow Model of the Church Rock Site and Local Area, Church Rock, New Mexico – Revised*. June 2014.

Chester Engineers, 2015. *Annual Review Report – 2014, Groundwater Corrective Action, Church Rock Site, Church Rock, New Mexico*. January 2015.

Chester Engineers, 2015. Email from Robert Warren (Chester Engineers) to Janet Brooks (EPA-RPM), Subject: Updated UPL95 summary tables. *Attached Tables and Summary Comparisons of Upper Prediction Limits for Parameter Concentrations in Background Groundwater to Site Cleanup Standards and Potential ARARs for All Three Hydrostratigraphic Units at the UNC Church Rock Mill Tailings Site.* March 29, 2015.

Chester Engineers, 2016. *Annual Review Report – 2015, Groundwater Corrective Action, Church Rock Site, Church Rock, New Mexico*. February 2016.

Chester Engineers, 2017a. *Working Draft Revised Site-Wide Supplemental Feasibility Study Part III, United Nuclear Corporation, Church Rock Tailings Site, Church Rock, New Mexico*. January 2017.

Chester Engineers, 2017b. *Annual Review Report – 2016, Groundwater Corrective Action, Church Rock Site, Church Rock, New Mexico*. February 2017.

General Electric Company (by Roy S. Blickwedel), 2006. *Regulatory Significance of the Occurrence and Distribution of Dissolved Uranium in Groundwaters of the Southwest Alluvium, Church Rock Site, New Mexico*. ADAMS Accession Number ML061000082. March 2006.

General Electric Company, 2012, Letter to NRC, Subject: *License Amendment Request for Revised Groundwater Protection Standards based on Updated Background Concentrations, Source Materials License SUA-1475, Groundwater Corrective Action Program, United Nuclear Corporation Church Rock Mill and Tailings Site*. April 17, 2012.

Hatch-Chester, 2018. *Annual Review Report – 2017, Groundwater Corrective Action, Church Rock Site,*

Church Rock, New Mexico. January 2018.

New Mexico Environment Department, 2014. Letter from Jerry Schoeppner, Chief (Ground Water Quality Bureau) to Thomas McLaughlin, Project Manager (U.S. Nuclear Regulatory Commission). *Response to 8/15/2014 Nuclear Regulatory Commission (NRC) Draft Environmental Assessment (EA) for the Proposed Amendment Request for United Nuclear Corporation (UNC), Church Rock Mill Site, Source Materials License SUA-1475.* October 28, 2014.

U.S. Environmental Protection Agency (EPA), 1988. *Record of Decision, United Nuclear Corporation, Ground Water Operable Unit, McKinley County, New Mexico.* EPA R06-R88-44, Region 6. September 1988.

U.S. EPA, 2001. *Comprehensive Five-Year Review Guidance*, Office of Solid Waste and Emergency Response, EPA 540-R-01-007, OSWER No. 9355.7-03B-P. June 2001.

U.S. EPA, 2013. *Fourth Five-Year Review Report for the United Nuclear Corporation Ground Water Operable Unit, Church Rock, McKinley County, New Mexico*, September 2013.

U.S. EPA, 2013. Memorandum (13-R06-001): *Comments on background groundwater conditions in the Southwest Alluvium and Zones 1 and 3 of the Upper Gallup Sandstone at the United Nuclear Corporation Church Rock Mill and Tailings Site, Church Rock, New Mexico.* National Risk Management Research Laboratory, Ground Water and Ecosystems Restoration Division, Office of Research and Development (ORD). From Ralph Ludwig and Robert Ford to Janet Brooks. March 25, 2013.

U.S. EPA, 2013. *Record of Decision, United Nuclear Corporation, McKinley County, New Mexico. EPA ID: NMD030443303, Operable Unit: OU02, Surface Soil Operable Unit.* EPA Region 6, Document No. 681353. March 29, 2013.

U.S. EPA, 2016a. *Transmittal of the Five-Year Recommended Template*, Office of Superfund Remediation and Technology Innovation. OSWER, OLEM-9200.0-89. January 20, 2016. Updated October 11, 2016.

U.S. EPA, 2016b. Letter from Alexis Strauss, Acting Regional Administrator, EPA Region 9 to The Honorable Russell Begeye, President, Navajo Nation *Abandoned Uranium Mines on the Navajo Nation*. July 18, 2016.

U.S. Nuclear Regulatory Commission, 2015. Letter from Andrew Persinko, Deputy Director (NRC, Division of Decommissioning, Uranium Recovery, and Waste Programs) to Roy Blickwedel (General Electric Company). *License Amendment Request for Revised Groundwater Protection Standards Based on Updated Background Concentrations, Source Materials License SUA-1475, Groundwater Corrective Action Program, United Nuclear Corporation Church Rock Mill and Tailings Site*. License Number SUA-1475, Amendment No. 52. April 9, 2015.

Weimer, W.C., R.R. Kinnison, J.H. Reeves, 1981. *Survey of Radionuclide Distributions Resulting from the Church Rock, New Mexico, Uranium Mill Tailings Pond Dam Failure.* Prepared by the Pacific Northwest Laboratory for Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington D.C. NUREG/CR-2449, PNL-4122. December 1981.

APPENDIX E

SITE PHOTOGRAPHS

Photograph 1: The gated and secured site access road to the tailings disposal cells and ground water remedial action target areas.

Photograph 2: Southeast view across the lined evaporation ponds on the south cell. Ponds contain mostly supplemental water from the facility supply well, and less than 5 percent from ground water extraction.

Photograph 3: North view across Pipeline Arroyo, shows the close proximity of Wells GW-2 (south side) and GW-3 (north side) to the severely eroded and sloughed embankments.

Photograph 4: North view across Pipeline Arroyo, shows the close proximity of Well GW-3 (north side) to the severely eroded and sloughed embankment, prohibiting sampling due to safety concerns.

Photograph 5: Southwest view of Pipeline Arroyo, downstream of the "Nick Point", that shows the severely eroded and sloughed embankments.

Photograph 6: Southeast view of a bend in Pipeline Arroyo at the "Nick Point", that shows the continual undercutting and erosion of the embankment.

Photograph 7: North view across the northwest ground water remedial action area, that shows the Zone 3 ground water extraction wells.