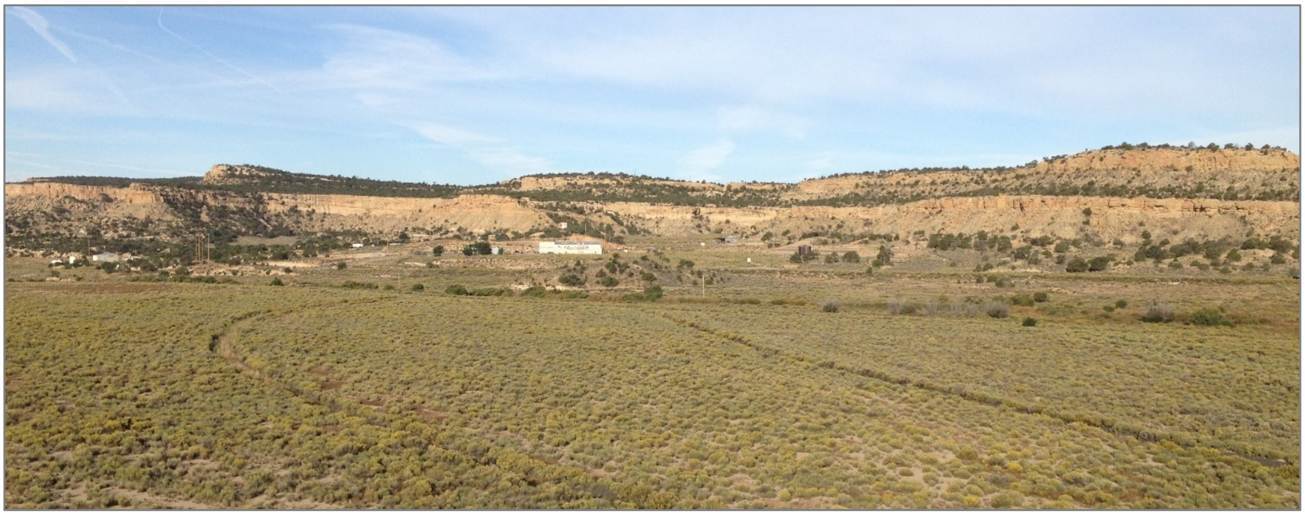
Supplemental Environmental Report for the United Nuclear Corporation Site Source Material License Amendment Request

McKinley County, New Mexico, USA



Prepared for:

United Nuclear Corporation
P.O. Box 3077
Gallup, NM 87305

General Electric Company
475 Creamery Way
Exton, PA 19341

Prepared by:

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

6000 Uptown Blvd. NE, Suite 220
Albuquerque, NM 87110

With Support From:

DCRM
Dinétahdóó Cultural Resources Management LLC

Trinity Consultants

Stantec

Cedar Creek Associates, Inc.

September 24, 2018

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
95% Design Report	Stantec, 2018a
2013 Record of Decision	USEPA, 2013
AADT	average annual daily traffic
ACM	asbestos containing material
AEA	Atomic Energy Act of 1954
AERMET	American Meteorological Society/Environmental Protection Agency Regulatory Model Meteorological Processor
AIRFA	American Indian Religious Freedom Act
ALARA	as low as reasonably achievable
amsl	above mean seal level
AQCR	Air Quality Control Region
ARARs	Applicable or Relevant and Appropriate Requirements
Area of Analysis	the area relevant and appropriate for analysis; may be different depending upon the resource
ARPA	Archeological Resources Protection Act
AOC	Administrative Settlement Agreement and Order on Consent
ASOS	Municipal Airport Automated Surface Observation System
AUM	Abandoned Uranium Mine
BCC	Birds of Conservation Concern
BGEPA	Bald and Golden Eagle Protection Act
bgs	below ground surface
BIA	Bureau of Indian Affairs
BISON-M	Biota Information System of New Mexico
BLM	Bureau of Land Management, United States
BMP	Best Management Practices
Brushy Basin	Brushy Basin Member
Cadna-A	Computer Aided Noise Abatement
CDC	Centers for Disease Control, United States
CDP	Census Designated Place
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
cfs	cubic feet per second
Clive facility	Energy Solutions Clive Operations
CMH	Convective Mixing Height
COC	constituent of concern
cpm	counts per minute
CY	cubic yards

ACRONYMS AND ABBREVIATIONS (CONTINUED)

D50	median diameter
dB	decibels
dBA	A-weighted decibels
DCRM	Dinétahdóó Cultural Resources Management
Design AOC	USEPA, 2015
DEM	Digital Elevation Model
DOE	Department of Energy, United States
DRO	diesel-range petroleum hydrocarbon
DSHA	Deterministic seismic hazard analysis
DWMRC	Utah Division of Waste Management and Radiation Control
Dwyer	Dwyer Engineering
EDGR	Environmental Data Gap Reports
EECA	engineering evaluation/cost analysis
EFRI	Energy Fuels Resource Inc.
EMNRD	New Mexico Energy, Minerals, and Natural Resources Department
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EPM	Environmental Protection Measures
ER	Environmental Report
ERRG	Engineering/Remediation Resources Group, Inc
ESA	Endangered Species Act of 1973
ESOC	Ecological Systems of Concern
ET	evapotranspiration/evapotranspirative
FEMA	Federal Emergency Management Agency
FMCS	Federal Motor Carrier Safety Administration
ft	foot or feet
ft/s	feet per second
FSL	Field Screening Level
FSS	Final Status Survey
g	grams
GAP	Gap Analysis Program, United States Geological Survey
GBENPR	Golden and Bald Eagle Nest Protection Regulations
GE	General Electric Company
GIS	Geographic Information System Mapping
gpd	gallons per day
gpm	gallons per minute

ACRONYMS AND ABBREVIATIONS (CONTINUED)

HASP	Health and Safety Plan
HHRA	human health risk assessment
HI	noncancer hazard index
HRI	Hydro Resources Incorporated
HUC	Hydraulic Unit Code
IMPROVE	Interagency Monitoring of Protected Visual Environments
IR	Impairment Category, used by NMOSE
ISO	International Organization for Standardization
KABQ	Albuquerque Sunport ASOS station
km	kilometers
LAR	Licensing Amendment Request
Ldn	day-night average sound level
Leq	equivalent continuous sound level
LRU	Land Resource Unit
License	Source Materials License SUA-1475
LLNL	Lawrence Livermore National Laboratory
m	meters
m/s	meters per second
m^2s	meters squared per second
MBTA	Migratory Bird Treaty Act of 1918
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mrem	millirem (see rem)
Mill Site	UNC Mill and Tailings Facility
Mine Site	Northeast Church Rock Mine Site
MLRA	Major Land Resource Area
MMD	New Mexico Mining and Minerals Division
MMH	Mechanical Mixing Height
mmhos/cm	millimhos per centimeter
MOU	Memorandum of Understanding
mph	miles per hour
MSOC	Mine Site Outlet Channel
MSHA	The Mine Safety and Health Administration
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAIP	The National Agriculture Imagery Program
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDC	North Diversion Channel

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NECR	Northeast Church Rock
NED	National Elevation Dataset
NEMSA	Non-Economic Material Storage Area
NEPA	National Environmental Policy Act
NHNM	Natural Heritage New Mexico
NHNM	Natural Heritage New Mexico
NHPA	National Historic Preservation Act
NM	New Mexico
NM 566	New Mexico Highway 566
NMAC	New Mexico Administrative Code
NMBMMR	New Mexico Bureau of Mines and Mineral Resources
NMCHAT	New Mexico Crucial Habitat Assessment Tool
NMCRIS	New Mexico Cultural Resources Information System
NMDA	New Mexico Department of Agriculture
NMDGF	New Mexico Department of Game and Fish
NMDOT	New Mexico Department of Transportation
NMED	New Mexico Environmental Department Air Quality Bureau
NMEID	New Mexico Environmental Improvement Department
NPDES	National Pollutant Discharge Elimination System
NMSHPO	New Mexico Historic Preservation Office
NMOSE	New Mexico Office of the State Engineer
NMSLO	New Mexico State Land Office
NMSS	Nuclear Material Safety and Safeguards
NNEPA	Navajo National Environmental Protection Agency
NNESL	Navajo Nation Endangered Species List
NNHA	Navajo Nation Housing Authority
NNHP	Navajo Nation Natural Heritage Program
NNHPD	Navajo Nation Historic Preservation Department
NPL	National Priorities List
NPS	National Parks Service
NRC	Nuclear Regulatory Commission
NRC Regulatory Guidance	NRC, 1997
NRCS	US Department of Agriculture Natural Resources Conservation Service
NRHP	National Register of Historic Places
NUREG	Nuclear Regulatory Commission Regulations, United States
NWMA	New Mexico Noxious Weed Management Act of 1998
NWI	National Wetlands Inventory
NWS	National Weather Service
OSHA	Occupational Safety and Health Administration
pCi/g	picocuries per gram

ACRONYMS AND ABBREVIATIONS (CONTINUED)

pCi/m²s	picocuries per meters squared per second
PGA	peak ground acceleration
Project Area	collectively refers to the Mine Site and Mill Site
Proposed Action	would allow UNC to excavate approximately 1,000,000 CY of mine spoils from the Mine Site and place the waste into a repository to be constructed within the footprint of the Mill Site TDA (Repository).
PNL	Pacific Northwest Laboratory
PPE	personal protective equipment
PRG	Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites
PSD	prevention of significant deterioration
PSHA	probabilistic seismic hazard analysis
PTE	Potential to Emit
PTW	Principle Threat Waste
RAL	Removal Action Level
RCPP	Release Contingency and Prevention Plan
RCRA	Resource Conservation and Recovery Act of 1976
rem	roentgen equivalent in man, unit of radiation dosage
Repository	a repository to be constructed within the footprint of the Mill Site
REIRS	Radiation Exposure Information and Reporting System
RFFA	Reasonably Foreseeable Future Action
ROD	Record of Decision
RMIR	Radioactive Material Incident Report
RWPRC	Red Water Pond Road Community
SARA	Superfund Amendments and Reauthorization Act of 1986
SER	Supplement to the Applicant's Environmental Report
SERI	Species of Economic and Recreational Importance
SGCN	Species of Greatest Conservation Need
SLAMS	State or Local Air Monitoring Station
SPCCP	Spill Prevention, Control, and Countermeasure Plan
SO-1	Step Out Area 1
Support Area	
SWMP	Stormwater Management Plan
SWAP	State Wildlife Action Plan
TCP	Traditional Cultural Property
TDA	Tailings Disposal Area
TDS	Total Dissolved Solids
TEDE	Total Effective Dose Equivalent
TENORUM	Technically Enhanced Naturally Occurring Radioactive Materials

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TI	Technical Impracticability
TLD	thermoluminescent dosimeters
TMDL	Total Maximum Daily Load
TPH	total petroleum hydrocarbon
TSS	Total Suspended Solids
TWA	Time Weighted Average
UMTRCA	The Uranium Mill Tailings Radiation Control Act of 1978
UNC	United Nuclear Corporation, subsidiary of GE
USC	United States Code
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USEPA	Environmental Protection Agency, United States
USFWS	United States Fish and Wildlife Service
USACE	Army Corps of Engineers, United States
USGS	United States Geological Survey
UWB	Gallup Underground Water Basin
VOC	Volatile Organic Compounds
VRM Class	Visual Resource Management Classification system used by the Bureau of Land Management
WCA	The New Mexico Wildlife Conservation Act
White Mesa	White Mesa Uranium Mill
WOTUS	Waters of the United States
WYBC	Western Yellow Billed Cuckoo

CHAPTER 1. INTRODUCTION

This Supplement to the Applicant's Environmental Report (SER) is submitted on behalf of United Nuclear Corporation (UNC), a wholly owned, indirect subsidiary of the General Electric Company (GE), to supplement the application to amend Source Materials License SUA-1475 (the License) for the former Church Rock Mill and Tailings Site, McKinley County, New Mexico, USA (License Amendment Request [LAR]). The original Environmental Report (ER) for the Northeast Church Rock Mine Site (Mine Site) and UNC Mill and Tailings Facility Site (Mill Site) was submitted by UNC in 1975 (ML13070A155). An additional ER (ML13070A158) was submitted by D'Appolonia (1981) in support of a license renewal application. Because this application is to amend an existing source materials license, the SER incorporates by reference, updates, or supplements the information previously submitted to reflect any significant environmental change. In instances where there is no change from the previously submitted information, then information is summarized to provide the basis for the no-change determination.

This SER has been prepared in accordance with the guidance contained in NUREG-1748, Environmental Review Guidance for Licensing Actions Associated with Nuclear Material Safety and Safeguards (NMSS) Programs (NRC, 2003). In compliance with the requirements of Title 10 Code of Federal Regulations (CFR) §§ 51.45 and 51.60 (a), this SER describes the Proposed Action, a statement of its purposes, a description of the environment affected, and a discussion of impacts of the Proposed Action and reasonable alternatives on the environment.

The Project Area considered in this SER is composed of two parts: (1) the NECR Mine Site and (2) the UNC Mill Site (Figure 1.0-1). The Mine Site and Mill Site are located within the Church Rock-Crownpoint subdistrict of the Grants uranium district, which produced more uranium from 1951-1980 than any other district in the United States (McLemore et al., 2013). A summary of the operational history and previous enforcement activities, beginning in 1977 with Mill Site licensing, is provided by USEPA (2013a). For the purposes of this SER, the Mine Site and the Mill Site are treated as one site.

The 125-acre Mine Site is a former uranium mine located approximately 17 miles northeast of Gallup, McKinley County, New Mexico, within Sections 34 and 35 of Township 17 North (T17N), Range 16 West (R16W), and Section 3 of T16N, R16W (Figure 1.0-1). The Mine Site was operated from 1967 to 1982 under a mineral lease as a conventional, underground mine that recovered uranium ore from the Westwater Canyon Member of the Jurassic Morrison Formation. The Mine Site comprised two shafts, two waste piles, several mine vent holes, and a production well approximately 1,800 feet (ft) deep that was used to dewater mine workings during operations (USEPA, 2013a). Approximately 40 acres of the 125-acre Mine Site are patented mining claim lands owned by UNC within Section 34 of T17N, R16W. The remaining surface estate is held in trust by the United States Government for the Navajo Nation, and the associated mineral rights are owned by Newmont USA, Ltd.

A former uranium-ore processing mill and its adjacent, byproduct material (tailings) disposal area (TDA) compose the Mill Site, which is a United States Nuclear Regulatory Commission (NRC)-licensed facility located within UNC-owned Section 2 of T16N, R16W (USEPA, 1988a). The UNC uranium mill processed uranium ore from 1977 to 1982 using a combination of crushing, grinding, and acid-leach solvent extraction methods. Section 36 of T17N, R16W, located northeast of the Mill Site, is also owned by UNC and is bounded to the north by the Navajo Reservation. The Mill Site was placed on the National Priorities List (NPL) in 1983 (48 Federal Register 40658, Sept. 8, 1983), and is the subject of a Memorandum of Understanding (MOU) between USEPA and NRC (USEPA, 1988b). The 902-acre Mill Site comprises the former mill and ore-processing facilities, which was released by NRC for unrestricted use in 1993, and the TDA, which is an area of restricted use.

1.1 Proposed Action

The Proposed Action would allow UNC to excavate approximately 1,000,000 cubic yards (CY) of mine spoils (consisting of overburden, waste rock and sub-economic material, or protore; referred to collectively as Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining, or TENORM) from the Mine Site and place the waste into a repository to be constructed within the footprint of the Mill Site TDA (Repository).

The Proposed Action includes the excavation, transportation, and disposal of the Mine Site waste in the Repository to be constructed at the TDA at the Mill Site (Figure 1.1-1). The USEPA-defined Action Levels for cleanup, as established by the USEPA (2011a), are 2.24 picocuries per gram (pCi/g) radium-226 and 230 milligrams per kilogram (mg/kg) for natural uranium (Removal Action Level [RAL]). In addition, mine spoils that contain 200 pCi/g or more of radium-226 and/or 500 mg/kg or more of total uranium are defined as principal threat waste (PTW) by the USEPA. The PTW will be segregated from the lower activity mine spoils and will be transported to an offsite, licensed and controlled reprocessing facility and will not be disposed of at the Mill Site (USEPA, 2013a; Stantec, 2018a).

The Proposed Action will consist of the following work elements:

- Excavation of mine spoils that exceed the USEPA-defined Action Levels at the Mine Site
- Transportation of the PTW for offsite reprocessing at the White Mesa Mill, located in Blanding, Utah (White Mesa)
- Transportation of the mine waste (excluding PTW) to the Repository
- Construction of the Repository at the Mill Site for permanent disposal with provision for a base layer between the Repository and underlying tailings
- Construction of an evapotranspirative (ET) cover over the final mine waste surface in the Repository
- Cleanup verification of the Mine Site removal areas

- Restoration and revegetation of the Mine Site and Mill Site following construction
- Establishment of Institutional Controls, if necessary, to meet goals and standards
- Preparation for long-term site management and license transfer

In compliance with the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery (Design AOC, USEPA, 2015), the engineering and design of the Proposed Action has been completed to the 95% design level. The 95% Design (Stantec, 2018a) was completed following a Design Work Plan (MWH, 2016a) that was approved by the USEPA in 2016 (USEPA, 2016).

The desired outcome of the Proposed Action is to protect human health and the environment and to comply with the USEPA 2013 Record of Decision (USEPA, 2013a) and any pertinent regulations and requirements. The Mine Site was identified by both the Navajo Nation and the USEPA as the highest priority abandoned uranium mine for cleanup (USEPA, 2014a).

1.2 Purpose and Need of Proposed Action

The purpose of the Proposed Action is to comply with the Action Memorandum: Request for a Non-time Critical Removal Action at the Northeast Church Rock Mine Site, McKinley County, NM, Pinedale Chapter of the Navajo Nation (USEPA, 2011) and Record of Decision, United Nuclear Corporation Site, McKinley County, New Mexico, USEPA ID NMD030443303; Operable Unit: OU 02, Surface Soil Operable Unit (USEPA, 2013a).

As described in the Design AOC (USEPA, 2015), the USEPA has found concentrations of uranium and radium-226 in the mine spoils that exceed background concentrations of uranium and radium-226 in nearby soils. Though the USEPA and UNC have consolidated mine waste contaminated with uranium and radium-226 at the Mine Site to reduce the risk of human exposure through inhalation or ingestion, the USEPA has determined that mine spoils present at the Mine Site should be addressed with the response action selected in USEPA (2011a) and permanently disposed of at the Mill Site, as selected in USEPA (2013a). This remedy was selected by the USEPA as necessary and protective of human health and the environment in response to actual or threatened releases of hazardous substances into the environment (USEPA, 2013a). The Proposed Action must also meet the requirements of the License.

Specifically, the need for the Proposed Action is to meet the remedial action objectives. As described by the USEPA (2013a), these objectives are to:

- Prevent exposure to current and future human and ecological receptors from internal/external radiation, ingestion, dermal contact, and inhalation (i.e., inhalation of associated gas or dust) of soil, mine waste, and tailings contained within the TDA containing concentrations of radionuclides and their daughter products that exceed remediation goals.

- Prevent migration [onsite and offsite into soil, sediment, ground water, air (as gas or dust), and surface water] of soil, mine waste, and tailings located within the TDA containing concentrations of radionuclides and their daughter products such that exposure to current and future human and ecological receptors from internal/external radiation, ingestion, dermal contact, and inhalation (i.e., inhalation of associated gas or dust) of soil, mine waste, and tailings does not exceed interim remediation goals.
- Prevent the migration of concentrations of contaminants located in the soil, mine waste, and tailings contained within the TDA to groundwater where the migration of those contaminants would result in groundwater concentrations that exceed remediation goals established in the USEPA 1988 ROD for the Ground Water Operable Unit (including any amendment), and, through this action, prevent human and ecological receptors from being exposed to groundwater with concentrations of contaminants that exceed remediation goals established in the 1988 ROD, including any amendment.

1.3 Pertinent Statutes and Regulations

The Proposed Action has been designed in accordance with the Superfund Remedial Design and Remedial Action Guidance (USEPA, 1986). Although the USEPA has determined that the Proposed Action will satisfy the statutory requirements of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) section 121 (b), 42 United States Code (USC) § 9621 (b) (USEPA, 2013a; USEPA, 2018a), Source Material License SUA-1475 does not permit the disposal of non-byproduct material (e.g., mine waste), as defined by Section 11e.(2) of the Atomic Energy Act of 1954, as amended (AEA). As a result, an amendment of the License will be required under Title 10 of the CFR Part 40 prior to construction of any selected alternative that involves the disposal of non-byproduct material.

As described by USEPA (2013a), there are two federal agencies with overlapping jurisdiction over the Project Area considered in this SER: the USEPA and the NRC. In 1988, USEPA and NRC signed a MOU to define the roles and authorities [53 Federal Register 37887, September 28, 1988]. Within the USEPA, Regions 6 and 9 are working jointly to oversee the remedy design under the Design AOC. USEPA Region 6 regulates groundwater contamination outside of the TDA at the Mill Site in accordance CERCLA and the National Contingency Plan; and USEPA Region 9 is the lead Regional office for addressing CERCLA concerns at the Mine Site. The NRC is the lead regulatory agency for the TDA reclamation and for surface area closure activities at the Mill Site as per the MOU between NRC and USEPA (USEPA, 1988b).

The USEPA has environmental requirements that will need to be met as part of the Proposed Action to remove and dispose of Mine Site mine waste at the Mill Site. Section 121(d) of CERCLA, 42 USC Section 9621(d), requires that onsite remedial actions attain or waive promulgated federal environmental Applicable or Relevant and Appropriate Requirements (ARARs), or more stringent promulgated state environmental ARARs, upon the completion of the remedial action. ARARs are identified on a site-by-site basis for all onsite response actions where CERCLA authority is the basis for cleanup.

Under the License, UNC is required to prepare and record an environmental evaluation of any activity likely to cause an environmental impact not previously assessed by the NRC. Though NRC is not party to the Design AOC, UNC must submit a License Amendment Request (LAR) to the NRC to amend its License to allow for the disposal of non-byproduct material within the TDA (USEPA, 2013a). The LAR is accompanied by this SER, which has been prepared according to the guidance presented in NUREG-1748 and in fulfilment of the requirements presented in 10 CFR §51.45.

Please refer to Appendix N of the LAR, which describes the plan for complying with applicable regulatory requirements and permits.

CHAPTER 2. ALTERNATIVES

2.1 Detailed Description of Alternatives

2.1.1 No-Action Alternative

The No-Action Alternative would require the NRC to reject UNC's LAR and to leave in place at the Mine Site all mine waste that currently exceeds RALs for cleanup defined by the USEPA, leaving the USEPA to identify an alternative remedy than the one selected in the 2013 ROD (USEPA, 2013a). If the LAR to dispose of mine waste at the Mill Site were not approved, then the remedy as proposed in this SER could not be implemented. No excavation of waste would occur at the Mine Site and the Repository and environmental conditions in the Project Area would continue to be managed under the current conditions for the License.

The removal of mine waste to RALs (2.24 pCi/g radium-226 and 230 mg/kg for natural uranium) and its placement at the TDA, as defined in USEPA (2011 and 2013a), would not be achieved. Instead, UNC would continue to fulfill the requirements of current License conditions and work toward attaining groundwater protection standards defined in the License. UNC would continue the compliance monitoring program, continue to comply with groundwater protection standards at point-of-compliance wells, and implement the required corrective action programs for groundwater as defined by the NRC. Once authorized by the NRC, the actions described in the approved tailings reclamation plan (Canonie, 1991), as amended, would be implemented to control radon emissions as expeditiously as practicable, considering technological feasibility, in accordance with the License.

2.1.2 Alternative A - Proposed Action

The Proposed Action would execute the License amendment and would enable UNC to excavate approximately 1,000,000 CY of mine spoils from the Mine Site and dispose of it at the Mill Site. In addition, the Proposed Action would enable UNC to excavate and segregate PTW, which would be re-processed at White Mesa, a licensed and controlled milling facility in San Juan County, Utah, that is owned and operated by Energy Fuels Resources, Inc (EFRI). The Proposed Action fulfills the requirements of the *Selected Remedy for Operable Unit 2, the Surface Soil Operable Unit, of the UNC Superfund Site* (USEPA, 2013a). The USEPA selected this remedy in accordance with CERCLA, as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The following sections describe each component of the Proposed Action, as described in Stantec (2018b).

2.1.2.1 Mine Site

The Mine Site removal is divided into several phases:

1. Excavation of mine waste to depths where measurements show wastes are below the RAL (2.24 pCi/g for radium-226 and 230 mg/kg for uranium) or to contact with bedrock, but will not exceed 10 ft in depth in areas where clean fill would be placed to final grade
2. Transportation of the excavated mine waste via haul road to the Repository or transportation of PTW offsite for re-processing
3. Completion of confirmation gamma radiation surveys to demonstrate that remaining materials within the Mine Site have measured activity concentrations below the RALs
4. Construction and maintenance of temporary stormwater controls during removal activity
5. Final grading of excavated areas
6. Restoration

The 1,000,000-CY volume estimate of mine waste to be removed from the Mine Site is based on results of gamma radiation surveys, soil sampling, and laboratory analysis completed by UNC (MWH, 2007; MWH, 2008; MWH, 2014). As part of the preliminary final design of the Proposed Action, Stantec (2018b) estimated an excavation volume of 725,240 CY using a neat-line excavation surface compared to the existing ground topography. This estimate includes PTW material and total petroleum hydrocarbon (TPH)-impacted soils but does not include an additional 10,800 CY of buried debris. The 1,000,000 CY estimate for the Proposed Action is a conservative, overall estimate of waste, debris, and a volume contingency to ensure that Repository is designed with an appropriate factor of safety.

The excavation of mine wastes would be performed using standard excavating equipment and haul trucks. Removal would begin by first excavating to the initial specified depths identified in Drawing 3-02 of Stantec (2018). Confirmation gamma scanning would then be used to assess whether the material exceeds the RAL. Based on the scanning results, the excavation would either be determined to be complete or would proceed incrementally until material levels are shown to be below RALs or until bedrock is encountered.

While excavating in areas that may contain PTW, should surface scanning indicate radium-226 concentrations in the soils of within 80% of the RAL (the PTW RAL), the soils would be segregated by the contractor and hauled to the PTW staging area at the former Trailer Park area within the Mine Site (Figure 2.0-1). A grab composite sample would be collected from the excavated material for confirmatory radium-226 and total uranium analyses by a laboratory in accordance with the frequency and procedures provided in LAR Appendix C. Upon confirmation that the material exceeds the RAL, the material would be given final designation as PTW and remain in the staging area until it is loaded into highway trucks for transport to White Mesa for re-processing. Should the laboratory results indicate that the material is below the PTW RAL, then the material would be relocated to the removal area for transport and placement within the Repository.

Final restoration grading plans provide positive drainage into existing drainages, maintain excavated and fill slopes at a horizontal to vertical ratio of 3H:1V or shallower, unless excavated slopes expose bedrock, and minimize excavated slope lengths, as appropriate. The design for the regrading of the Proposed Action (Stantec, 2018a) is shown in Drawings 3-11 of the LAR. Details regarding volume estimates for removal are presented in LAR Appendix C.

2.1.2.2 Haul and Access Roads

Haul roads would be constructed to transport the mine waste from the Mine Site to the Repository (Figure 2.0-2). Articulated dump trucks with 30-CY capacity would be used to transport both mine waste and borrow material. The maximum speeds of haul trucks would be limited to 20 miles per hour (mph). A combination of one-lane and two-lane road widths would be used, where one-lane haul traffic is sized at twice the haul vehicle width and two-lane haul traffic is sized at 3.5 times the haul vehicle width (Figure 2.0-2). The one-lane segment would be used to reduce the construction footprint of the haul road in the steeper terrain. The mine waste haul road would have a gravel surface, and turnouts would be constructed to allow trucks to pass each other, if required. Haul and access roads would be constructed from native materials as a cut-and-fill, with excavated material from the uphill side placed as fill on the downhill side. Material needed to fill gully crossings or other low areas would be generated by road cuts near the needed fill.

A manually controlled traffic safety and contamination control system would be used to manage at-grade transportation at the intersection of the mine waste haul road and New Mexico Highway 566 (NM 566). Coordination with the New Mexico Department of Transportation (NMDOT) for approval and operation of this haul road crossing system would be required. Following the completion of the Proposed Action, impacted areas of NM 566 would be inspected for structural damage. Any damage to the pavement or underlying road prism resulting from haul operations would be corrected to the satisfaction of the NMDOT.

In addition to haul roads for transporting mine waste from the Mine Site to the Mill Site, haul roads would be constructed to access each of the four areas designated for borrow materials. Each borrow haul road would have two-lane running widths, be constructed at existing grade, and extend from the edge of the TDA to each borrow area (Figure 2.0-2). Once on the TDA, the haul trucks would operate directly on the existing cover surface within designated routes that would restrict construction traffic to specified routes.

All newly constructed roads located within the Exclusion Area would be subject to final cleanup and verification in accordance with the Cleanup Verification Plan (LAR Appendix T). An air monitoring plan, including requirements for dust control during construction, is provided in LAR Appendix Q. The cleanup would be conducted to a level designated by the USEPA for unlimited surface use of the Mine Site after cleanup.

2.1.2.3 Mill Site Repository

Mine Site waste would be hauled to and placed in the Repository constructed on the TDA (Figure 2.0-3). The Repository would be constructed by removing the existing erosion protection layer, which consists of a nominal 6-inch-thick layer of soil and rock above a radon barrier in the TDA. The material removed would be segregated and reused for Repository cover construction. The existing clay radon barrier would serve as the foundation for the Repository and would be modified in place by compacting the material to meet design requirements for a low-permeability radon barrier. This radon barrier would be located on top of the existing tailings within the TDA to control radon flux from the tailings. Excavated mine spoils would then be placed and compacted directly on the prepared radon barrier. The materials would be spread in lifts to facilitate compaction from north to south, and the perimeter slopes of the compacted mine-waste surface would extend outward as the surface is raised by the placement of more waste.

Once all waste is placed within the Repository, an ET cover system would be constructed. The cover system has been designed and would be constructed to minimize the release of radon to the atmosphere, not exceeding an average release rate of 20 picoCuries per square meter per second (pCi/m^2s). The uppermost layer of the 4-ft thick cover system would consist of an erosion protection layer composed of a soil-rock admixture. The rock in this layer would provide erosional stability, and the soil admixture would serve as the growth media for vegetation that would provide transpiration. Beneath the protective layer would be a layer of additional soil. The thicknesses of these two layers and the sizes of the rock used for erosion protection vary based on the slope length and steepness of the Repository (Figure 2.0-4). Dwyer (2018) documents how the cover design satisfies the regulatory criteria and performance objectives and its ability to provide adequate protection for a design life of 1,000 years. The layout for the different erosion protection layers and the cover design details for the three different Dwyer Engineering (Dwyer) cover sections are shown on Drawing 7-09 in the Section 7 Drawings. Materials to be used for the cover will consist of (1) soil from the onsite borrow areas and (2) erosion protection rock both reused from the existing TDA cover and imported from an offsite rock quarry or quarries.

The design capacity of the Repository, as approved by the USEPA, would accommodate 1,030,000 CY of mine waste, providing approximately 30% contingency storage.

2.1.2.4 Onsite Borrow Areas

The volume of soil required to implement the Proposed Action is presented in Table 2.1-1. Four onsite borrow areas (Figure 2.0-3) were identified as material sources that would meet the volume and material property requirements (MWH, 2012; MWH, 2014; Dwyer, 2017; LAR Appendix H). The chemical and physical characteristics of the soils present in each borrow area were analyzed to identify suitable source materials that would meet the design specifications for the cover system. Dwyer (2017) concluded that the physical properties of soils from each borrow area were sufficient for the cover system and would not require phasing, sequencing, or blending of soils to meet the project cover specifications.

INTERA (2017), in the Environmental Data Report for the Northeast Church Rock Site Removal Action and the United Nuclear Corporation Site Remedial Action, completed additional field surveys and laboratory testing and concluded that the soils present in the North, South, and East borrow areas are suitable for use as reclamation growth media and that no special handling of the soils from these three areas would be required. Analytical results from the West Borrow area showed localized pockets of elevated concentrations of salts and calcium carbonate, making the soils suitable for subsurface rooting media in the cover system, but precluded from use as the surface material. Based on these assessments, an estimate of available soil material at each onsite borrow location is presented in Table 2.1-2.

Table 2.1-1. Soil Material Requirements for the Proposed Action (Stantec, 2018a)

Material Type	Required Quantity (CY)
Soil to fill existing cover swales	11,000
Soil for cover layers	351,000
Clean soil fill for grading around Repository	12,000
TOTAL	374,000

Table 2.1-2. Estimate of Available Soil Material at Each Onsite Borrow Area (Stantec, 2018a)

Borrow Area	Estimated Available Quantity (CY)
North Borrow	71,000
South Borrow	160,000
East Borrow	55,000
West Borrow	89,000
TOTAL	375,000

2.1.2.5 Offsite Borrow Areas

The paucity of suitable rock sources within the Project Area would require that most of the rock necessary for erosion protection in the soil cover system, as well as to stabilize stormwater channels, be obtained from an offsite quarry.

The estimated volumes of required material, along with locations for proposed use in constructing the Proposed Action, are presented in Table 2.1- 3.

Table 2.1-3. Rock Material Requirements for the Proposed Action (Stantec, 2018a)

Material Specification	Required Quantity (CY)	Location(s) Used
Type I Filter	9,900	East Repository Drainage Channel, Dilco Hill Channels A and B Jetty/Pipeline Arroyo
Type II Filter	22,200	East Repository Drainage Channel, Dilco Hill Channels A and B Jetty/Pipeline Arroyo
D_{50} = 1.5 in.	17,000	Repository Cover System
D_{50} = 2.0 in.	11,000	Repository Cover System
D_{50} = 3.0 in.	20,500	Repository Cover System
D_{50} = 3.0 in.	17,200	East Repository Drainage Channel, Jetty/Pipeline Arroyo, Erosion Protection for West Apron, 5H:1V Cover Slope Erosion Protection
D_{50} = 6.0 in.	700	Dilco Hill Channels A and B, Mine Site Outlet Channel
D_{50} = 9.0 in.	1,700	East Repository Drainage Channel, Dilco Hill Channels A and B, Mine Site Outlet Channel
D_{50} = 18.0 in.	700	Mine Site Outlet Channel
D_{50} = 27.0 in.	78,000	Jetty/Pipeline Arroyo

An established, commercial, permitted offsite quarry would be selected by the Construction Supervising Contractor to meet the durability requirements (NRC, 2002). Three offsite quarries have been identified for potential use to supplement the available onsite rock. Two quarries are located near Gallup, New Mexico (approximately 20 miles southwest of the Project Area), and another quarry is located near Prewitt, New Mexico (approximately 50 miles east of the Project Area) (Figure 2.0-5). Rock samples obtained from each quarry have been analyzed and determined to be suitable for meeting NRC durability requirements (LAR Appendix H/1, LAR Appendix I.9).

2.1.2.6 PTW Management and Reprocessing

PTW would be transported to the White Mesa, located in San Juan County, Utah. for re-processing. This conventional uranium mill is owned and operated by EFRI. The Utah Department of Environmental Quality Division of Waste Management and Radiation Control (DWMRC) radioactive materials license number UT 1900479, as amended, permits EFRI to process over 8 million pounds of uranium per year. The Mill is located approximately 210 miles to the northwest of the Project Area via public roads and highways. The proposed transportation route from the Mill Site to White Mesa is shown in Figure 2.0-6.

Five locations within four of the Mine Site removal areas were identified by Stantec (2018) as containing waste with radium-226 values greater than 200 pCi/g or greater than 500 mg/kg of total uranium. PTW within 80% of the PTW RAL (160 pCi/g for radium-226 and 400 mg/kg uranium) would be removed and transported offsite so that no material above the PTW RAL would be placed in the Repository. Identification and segregation of the PTW would be performed using a combination of in-situ and ex-situ gamma radiation level measurements.

During excavation of PTW, material would be removed in 1-ft increments, both vertically and horizontally, and would be scanned by a full-time material radiological scanning technician. When results of the surface scanning indicate concentrations in soils are within 80% of the RAL, the soils would be segregated by the Contractor and hauled to a PTW staging area at the former Trailer Park near the end of NM 556 (Figure 2.0-1). A composited grab sample would be collected from the excavated material for confirmatory laboratory analysis that the material exceeds the RAL. If the analytical results confirm the material as PTW, then the material would be designated as PTW and remain in the staging area until it would be loaded into trucks for transport to White Mesa for re-processing. If the analytical results demonstrate that the material is below the PTW RAL, then the material would be relocated to a previously defined removal area for transport and placement in the Repository.

2.1.2.7 Jetty Area

A portion of Pipeline Arroyo that is vulnerable to erosion in the future would be stabilized by constructing a riprap chute to prevent the southeastward migration of the drainage channel toward the Repository due to erosion (Figure 2.0-7). Channel reconstruction to control lateral scour within the Jetty Area would involve grading a natural break in the slope of the Pipeline Arroyo drainage channel, known as a “knickpoint,” and reconstructing a buried rock jetty, constructed in the 1990s and once used to control grade and lateral migration. The existing jetty, which is not sufficiently robust for preventing channel incision and bank erosion toward the east, is composed of basalt riprap with a median rock size (D50) of 6 inches diameter. The chute would extend from just downstream of the knickpoint on the right bank (looking downstream) to the embankment of the TDA. The chute would slope 5.3% longitudinally and be comprised of riprap with a median diameter of up to 27 inches. As a result, about half of the material would be rock 27 inches in diameter with a mixture of smaller and larger rock mixed in to provide sufficient protection from channel incision and bank erosion.

2.1.3 Alternative B - Conveyance

Under Alternative B, the areas of disturbance associated with the Mine Site removal areas, construction support zones, soil borrow areas, access roads, Jetty Area, topsoil stockpile, and Repository would be the same as the Proposed Action. In place of hauling the mine waste by truck and crossing NM 566 at grade, the objective of this alternative would be to reduce the potential impacts to transportation on NM 566 by conveying the mine waste from the Mine Site removal area with an above-grade, covered conveyor system from the Mine Site to the Mill Site (Figure 2.1-1). East of the one-lane haul road, the conveyor system would be placed within the same access road as the Proposed Action and cross NM 566 at the same crossing location as under the Proposed Action (Figure 2.1-2). West of the one-lane haul road, the conveyor would be oriented northwest-southeast and be located outside of the haul roads proposed under the Proposed Action. Assuming that the width of the disturbed area for the conveyor and one-lane access road along its side were 30 ft, this alternative would disturb 2 acres less than the proposed disturbance from proposed haul and access roads under the Proposed Action. The system would include a bridge structure to protect passing traffic from any spills or debris falls. During construction, the system would be assembled on land along the propose haul route from the Mine Site to NM 566 to permit maintenance and will be raised by crane where it would cross NM 566. Construction would require temporary lane closures and interruptions to transportation.

2.1.4 Alternative C – Material Sourcing for Cover

In place of sourcing cover material from the four proposed borrow areas (Figure 2.0-3), cover material would be sourced from the Jetty Area (Figure 2.0-7). Excavation for the proposed stormwater control structure at the Jetty Area would require 497,000 CY of soil excavation and approximately 49,000 CY of sandstone excavation on the west side of Pipeline Arroyo. From the estimated 497,000 CY of soil to be removed, approximately 50,000 is excluded from use as a borrow source for construction. The use of the remaining 447,000 CY of soil from the Jetty Area excavation would replace the need to borrow soil from the West Borrow (89,000 CY), the East Borrow (55,000 CY), the South Borrow (160,000 CY) and the North Borrow Area (71,000 CY) (Figure 2.0-3). The four original borrow sources provide an estimated cumulative total available volume of 375,000 CY. The area of disturbance of the Jetty Area under Alternative C would not differ from the Proposed Action (Figure 2.0-7). However, sourcing cover material from the 23-acre area disturbed for construction of the Jetty Area in place of the proposed Borrow Areas would reduce the overall area of land disturbance associated with the cleanup and stabilization by 48 acres, inclusive of the disturbance associated with proposed haul roads. The stratigraphy on the southeastern side of Pipeline Arroyo within the Jetty Area (Figure 2.0-7) consists of fill deposits from 0 to about 10 to 15 ft below ground surface (bgs), grading to dry, indurated buried soils approximately from 15 to 25 ft bgs, then medium to dense soils grading to loose or very loose (or soft) material at depths greater than 50 ft bgs, encountering bedrock at 60 to 106 ft bgs (Stantec, 2018a). The results from drilling and sampling in 2018 would be analyzed prior to construction to better characterize suitability for cover.

2.1.5 Alternative D – Disposal of Principal Threat Waste

Under Alternative D, PTW would be disposed of at the same frequency and by the same trucks as the Proposed Action at the Energy Solutions Clive Operations (Clive facility). The Clive facility is located approximately 572 driving miles from the Mine Site in Clive, Utah (Figure 2.1-3), approximately 75 miles west of Salt Lake City, Utah. The Clive facility has been in operation for nearly 30 years and is a licensed, controlled facility that accepts waste from all regions of the United States. Under Alternative D, Clive would be used for PTW disposal in place of PTW re-processing at White Mesa.

The disposal of the PTW would meet the USEPA requirement for the selected remedy but would require a transportation route that would be 361 driving miles longer (one direction) than the proposed route to White Mesa. All 361 miles would be on federal highways. In addition, Alternative D would require transportation of PTW through 2 additional towns in Colorado, and 10 to 12 additional towns in Utah, plus Salt Lake City and its suburbs. The route would also pass through the Native American lands of the Ute Mountain Reservation in Colorado. As shown in Figure 2.1-3, the route would use the following roads:

- NM 566, 12 miles
- I-40 Frontage Road, 4 miles
- I-40 W, 5 miles
- US 491 N, 194 miles
- US 191 N, 85 miles
- I 70 W 24 miles
- US 6 W, 127 miles
- I-15 N, 50 miles
- I-80W, 71 miles

The disposal of the PTW would consume volume in this low-level radioactive waste disposal facility. The material would be disposed of in engineered embankments, or cells, that are constructed approximately 12 ft bgs and built up to 38 ft above grade.

2.2 Alternatives Considered but Eliminated

As part of the remedy selection process for cleanup, the USEPA evaluated several alternatives, which are described in detail in USEPA (2013a). These alternatives were considered but eliminated based on USEPA assessment. The following section identifies each alternative considered but eliminated from detailed analysis in this SER.

The USEPA used nine selection criteria to select the Proposed Action (USEPA, 2013), resulting in the elimination of several alternatives considered during the EECA (Table 2.2-1).

Table 2.2-1. USEPA Selection Criteria Used to Select the Proposed Action.

Criterion	Description	Type
1	Overall protection of human health and the environment	Threshold
2	Compliance with ARARs	Threshold
3	Long-term effectiveness and performance	Primary balancing
4	Reduction of toxicity, mobility or volume	Primary balancing
5	Short-term effectiveness	Primary balancing
6	Implementability	Primary balancing
7	Cost	Primary balancing
8	State acceptance	Modifying criteria
9	Community acceptance	Modifying criteria

Those alternatives eliminated by the USEPA have also been eliminated from detailed analysis in this SER. A summary of each alternative eliminated from detailed analysis, as presented in USEPA (2009) is presented in the following sections.

2.2.1 Excavation and Disposal of All Mine Site Wastes at an Offsite Treatment, Storage and Disposal Facility

This alternative assumes that all the mine waste with concentrations above the Action Level of 2.24 pCi/g radium would be excavated and disposed of offsite at a licensed and permitted storage and disposal facility. The implementation of this alternative would include site preparation, excavation, waste transportation and disposal, and post-excavation site-restoration activities. An underground utility survey would be completed to identify the location of subsurface utilities in all areas having excavation and stockpiling activities. Existing structures, culverts, catch basins, vaults and vent shafts would be decontaminated where practicable and disassembled for future use or demolished for removal. Temporary onsite facilities for decontamination of personnel and equipment would be constructed along with temporary facilities for project management. Approximately 157 acres would be disturbed during excavation and the same excavation sequence for the Proposed Action would be used to complete the excavation activities. USEPA estimated that the cost for this alternative would be $293.6 million based on disposal costs for the US Ecological facility in Grandview Idaho, which are significantly lower than costs at the Clive facility.

Securing adequate trucking resources for the estimated 9 work seasons would be challenging. In addition, the time needed for each round trip would be 2 to 3 days, making it a longer trip than other alternatives. As a result, this alternative was eliminated from detailed analysis because it would be logistically difficult, has a greater likelihood of transportation incidents on the public roadways, and would pose a relatively greater risk to human health and the environment based on estimated trucking emissions.

2.2.2 Consolidation and Covering of Mine Waste on the Mine Site

This alternative assumes that the mine waste would be consolidated and contained under a cover at the Mine Site instead of excavation and removal. Under this alternative, an underground utility survey would be used to verify the location of subsurface utilities in areas identified for (1) the in-situ cap, (2) excavation and transfer to a consolidation area or (3) heavy equipment traversing paths. A land survey would delineate areas of mine waste to remain in place for cover and delineate the excavation areas. Existing culverts, catch basins, and vaults would be disassembled for future use, demolished for removal, or included within the covered area. Temporary onsite facilities for project management would be mobilized to Project Area for the duration of the Proposed Action.

Initial removal work would involve clearing and grubbing and removal of organic debris. Stormwater controls and perimeter air monitoring would be implemented during the action. Areas considered for excavation and transport for consolidation include Sandfill 3, NECR-2, Sediment Pad, Boneyard, Vents Holes 3 and 8, Trailer Park, Mine Site Channel Outlet, Sandfill 1, and NECR-1. Excavation would not exceed 10 ft bgs. The preferred areas to consolidate the excavated waste material were Ponds 1 and 2 (Figure 2.0-1). A 2-ft-thick soil cover was designed to serve as a radon shield, to be durable, to minimize infiltration, and to maximize runoff, and would be placed over the consolidated waste. The cover area would occupy approximately 12 acres, and the material would be sourced from the borrow areas identified in the Proposed Action.

This alternative would require the least amount of material handling, the least amount of backfill, the least ground disturbance, and is the least costly. It was identified by USEPA as being unsupported by the Navajo Nation and to the local community and was eliminated from detailed analysis.

2.2.3 Construction of an Above-Ground Capped and Lined Repository on the Mine Site

This alternative assumes above-ground containment of the mine wastes at the Mine Site in a lined and capped repository. Like the consolidation and covering alternative, the PTW would be placed at the bottom of the repository so that the mine waste with higher concentrations would be encapsulated by wastes of lower concentrations. The principal difference between consolidation and covering mine waste on the Mine Site and construction of an above-ground capped and lined repository at the Mine Site is the use of a liner underneath the waste in this alternative. Like other alternatives where mine waste remained onsite at the Mine Site, USEPA eliminated this alternative from detailed analysis because it was identified as being unsupported by the Navajo Nation and to the local community.

2.2.4 Consolidation of the Mine Wastes with a Cap and Liner at the Mill Site

This alternative assumes that mine waste at the Mine Site would be consolidated and subsequently contained under a cover, but also includes the requirement to install a liner beneath all mine waste. Under this alternative, mine waste and PTW would need to be excavated, a liner would then need to be installed, and then the waste would then need to be placed back on the Mill Site in a manner that would serve to encapsulate the PTW. However, given that mine waste would not be removed from the Mine Site, USEPA eliminated this alternative from detailed analysis because it was identified as being unsupported by the Navajo Nation and to the local community.

2.2.5 Other Licensed Facilities for PTW Disposal

The following facilities were considered as options for PTW disposal during the design process, but were not considered feasible alternatives due to the greater distance from the Mine Site than those facilities considered in Section 2.1 of this SER.

- Waste Control Specialists Facility, Andrews, Texas – 481 miles from the Mine Site
- Clean Harbors Facility, Deer Trail, Colorado – 627 miles from the Mine Site
- US Ecology Facility, Grand View, ID – 710 miles from the Mine Site
- US Ecology Facility, Richland, WA – 1135 miles from the Mine Site

2.3 Cumulative Effects

There are past, present, and reasonably foreseeable future actions that are not connected with the Proposed Action or alternatives and could result in cumulative impacts when combined with the Proposed Action or alternatives. The following discussion summarizes the known past, present, and reasonably foreseeable future actions within the Project Area that could cumulatively impact resources that would be affected by the Proposed Action or alternatives considered in this SER. These actions include other remediation projects, mine site cleanups, and Interim Removal Actions within the Project Area.

2.3.1 Interim Removal Actions at Mine Site

Interim Removal Actions adjacent to the Mine Site are past actions in the final phases of reclamation that could cumulatively impact resources when combined with the proposed project. USEPA (2007) issued a Request for Time-Critical Removal Action memorandum for cleanup of soils exceeding radium-226 concentrations of 2.24 pCi/g from Step Out Area 1 (SO-1) and from the unnamed arroyo number 1 (Figure 2.1-4).

The Interim Removal Actions were conducted in 2009 and 2010 (MWH, 2010a) and a Final Status Survey of the arroyo, which consisted of gamma surveying and soil sampling and analysis, was completed by MWH (2010b and 2011). Following this action, the USEPA (2011b) issued a Request for Time-Critical Removal Action memorandum for the Drainage East of Red Water Pond Road, referred to as Step Out Area 2 (SO-2). In response, UNC conducted a removal action of the East Drainage in 2012 (MWH, 2013b). Approximately 30,000 CY of soil were removed from the East Drainage area and from a small area within SO-1. Soils with radium-226 were stockpiled on the NECR-1 pad and soils with TPH and radium-226 comingled were stockpiled in the TPH stockpile. These past actions, when combined with the Proposed Action or any of the alternatives, could have a cumulative effect on resources. Potential cumulative effects for each designated resource are analyzed in Chapter 4.

2.3.2 Structure Remediation

Structure remediation in the Church Rock, Pinedale, Nahodishgish, and Coyote Canyon Chapters of the Eastern Abandoned Uranium Mine (AUM) region is a present action that could have a cumulative effect on resources when combined with the Proposed Action. In cooperation with the NRC and the USEPA, the Navajo Nation and other agencies are amid an effort to address the legacy of uranium mining within the Navajo Nation (USEPA, 2014b). Though that effort covers a broad region, one of its objectives is to assess and cleanup structures that were contaminated by the presence of mined or naturally occurring radioactive materials. Historically, uranium mining or milling waste was occasionally used as sand for aggregate in foundations or in stucco, and contaminated stones were incorporated into the walls and floors of structures.

Current goals described in their current Five-Year Plan include the Navajo Nation Environmental Protection Agency (NNEPA) scanning up to 100 homes per year and identifying for USEPA those to be considered for follow-up actions (USEPA, 2014b). Based on the findings, the USEPA plans to conduct remediation at up to 10 homes per year across the Navajo Nation. Of the 878 structures that were scanned during this period, 34 structures were addressed either through financial compensation, rebuilding the structure, or removing soil (soil removed from 18 properties). Within the Eastern AUM region, which includes the Project Area, a total of seven structures have been remediated during the period of 2008 to 2012 (USEPA, 2014b). If more structures are addressed in the future within the Project Area, and if activities include rebuilding or soil removal, then it is possible that activity associated with those actions could have a cumulative effect on resources when combined with the Proposed Action or any one of the alternatives.

2.3.3 Quivira Mine Site

A reasonably foreseeable future action would be mine cleanup activities at the Quivira Mine Site. The USEPA received a distribution of the Anadarko Litigation Proceeds for the cleanup of the Northeast Church Rock Quivira Mine Site, located immediately north of the Red Water Pond Road Community and the Mine Site (Figure 1.0-1). The USEPA awarded Arrow Indian Contractors a

$3.85 million contract to clean up portions of the Quivira Mine, including interim removal actions at the vent holes and bridge restoration required to access the site. By the end of 2018, the USEPA has set an objective to complete an engineering evaluation/cost analysis (EECA) to evaluate cleanup options for the Quivira Mine Site. If the USEPA process following the EECA results in an action to address the legacy of mine waste, then the activities associated with that action could have a cumulative effect on resources when combined with the Proposed Action or any one of the alternatives.

2.4 Comparison of Predicted Environmental Impacts

Table 2.4-1 provides a summary of the impacts of the Proposed Action and alternatives. Detailed descriptions of impacts are presented for each alternative, as applicable, for each environmental resource in Section 4.0 of this SER. This summary does not assume that identified mitigation measures would be implemented. Implementation of any mitigation measures identified in Chapter 5 would potentially reduce impacts beyond those described in Table 2.4-1.

Table 2.4-1. Comparison of Predicted Environmental Impacts

Resource or Impact Category	No Action	Alternative A Proposed Action	Alternative B Conveyance	Alternative C Material Sourcing for Cover	Alternative D PTW Disposal
Land Use	Land-use restrictions at both Mine Site and Mill Site would remain in place; no mine waste would be transported or conveyed from the Mine Site to the Mill Site, so regional land outside the Project Area that currently has unrestricted use would remain unrestricted.	Short-term disturbance of 340 acres of land; short-term, adverse impacts from restrictions on 57 acres currently unrestricted due to construction of haul and access roads; long-term, beneficial impacts associated with the release of the Mine Site for unrestricted use upon the successful completion of cleanup.	Short-term disturbance of 338 acres of land; Same short-term, adverse impacts to land use as under the Proposed Action.	Short-term disturbance of 292 acres of land; Elimination of Borrow Areas and associated disturbance of 48 acres are within area of restricted; Same short-term, adverse impacts to land use as under the Proposed Action.	Same as Proposed Action.
Transportation	No waste would be excavated from the Mine Site, no construction would occur at the Mill Site TDA, and no PTW would be disposed of offsite; no impacts to local or regional transportation would occur.	Moderate (60%), short-term adverse increase in traffic volume from construction traffic; traffic delays on NM 566 from construction traffic; short-term, minor, adverse impact from increased potential for accidents by hauling PTW; the estimated number of accidents expected transporting PTW material under the Proposed Action is <1;	Fewer interruptions to traffic on NM 566 than under the Proposed Action; Same impacts from construction transportation, and accidents as Proposed Action.	Same as the Proposed Action.	An additional expected accident transporting PTW compared to Proposed Action; Same impacts from construction transportation and traffic interruptions as under the Proposed Action.
Geology	No ground-disturbing activities would take place and no changes to geology would occur.	None.	Same as Proposed Action.	Same as Proposed Action.	Same as Proposed Action.
Soils	231 acres of disturbed soils from historic operations would remain unchanged.	Minor, short-term, local, adverse impacts from disturbing 340 acres; Minor, long-term, local, beneficial impacts from removing waste exceeding USEPA-defined levels.	Similar to Proposed Action, but 2 fewer acres disturbed.	Similar to Proposed Action, but 48 fewer acres disturbed.	Same as Proposed Action.
Surface Water	Both bank and headward channel erosion would continue to occur in Pipeline Arroyo in the absence of any intervention to stabilize the arroyo. NRC concerns for continued undercutting, tailings exposure, and downstream (offsite) migration would remain.	Minor, long-term, beneficial impact from the removal of spoils above USEPA RAL; stabilization work at Jetty Area would address NRC concerns for continued undercutting, tailings exposure, and downstream (offsite) migration.	Similar to Proposed Action, but 2 fewer acres disturbed.	Similar to Proposed Action, but 48 fewer acres disturbed.	Same as Proposed Action.

Resource or Impact Category	No Action	Alternative A Proposed Action	Alternative B Conveyance	Alternative C Material Sourcing for Cover	Alternative D PTW Disposal
Groundwater	None.	Minor to negligible, beneficial, long-term impact on groundwater resources by constructing a newer ET cover system better able at reducing tailings liquid fluxes at the base of the unsaturated alluvium; Negligible impact from groundwater diversions to meet water demands of construction.	Same as Proposed Action.	Same as Proposed Action, but slightly less water diverted.	Same as Proposed Action.
Vegetation	231 acres of ruderal vegetation communities from the Mine Site and Repository would remain in its current condition. Unreclaimed or inadequately reclaimed existing disturbances would remain as such.	Short-term, minor, adverse impact from disturbance of 340 acres and associated vegetative communities, most (66%) occurring on previously disturbed lands.	Similar to Proposed Action, but 2 fewer acres disturbed.	Similar to Proposed Action, but 48 fewer acres disturbed.	Same as Proposed Action.
Wildlife	No change to existing conditions for wildlife.	Short-term, local, negligible to minor, adverse impacts to wildlife would occur primarily through gradual loss of poor-quality habitat and disturbance of 340 acres by construction activities and human presence.	Similar to Proposed Action, but 2 fewer acres of poor-quality disturbed.	Similar to Proposed Action, but 48 fewer acres of poor-quality habitat disturbed.	Same as Proposed Action.
Meteorology, Climatology and Air Quality	None.	Short-term, adverse impacts from the exceedance of the NAAQS and NMAAQS PM2.5 and TSP for the 24-hr averaging period without identified mitigation strategy.	Increase in emissions compared to Proposed Action from transfer points of the conveyance system.	Similar to Proposed Action.	Similar to Proposed Action.
Noise	None.	Short-term, local, moderate, adverse impact from operational scenario causing sound levels greater than 55 dBA at all receptors except for one.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.
Cultural	None.	Long-term, beneficial impact by restoring affected areas to pre-mining conditions; Indirect, short-term, adverse impacts on 9 archaeological sites by altering the surrounding landscape; No impact to NRHP eligibility of each site.	Same as Proposed Action.	Same as Proposed Action.	Same as Proposed Action.

Resource or Impact Category	No Action	Alternative A Proposed Action	Alternative B Conveyance	Alternative C Material Sourcing for Cover	Alternative D PTW Disposal
Visual/Scenic	None.	Negligible degree of contrast to the landscape over a long-term period, and a moderate degree of contrast during the temporary, short-term construction period; Some irreversible impacts, such as a change in topography due to excavation at Mine Site or placement of waste at the Mill Site.	Strong degree of contrast to the landscape over short-term construction period from the use of a conveyance system over NM 566. Same long-term impacts as Proposed Action.	Similar to Proposed Action, though short-term impacts at the Borrow Areas would be eliminated by sourcing material from Jetty Area.	Similar to Proposed Action.
Socioeconomic	None.	Short-term, minor, beneficial, regional impact from estimated 40 construction jobs and associated gains in income.	Similar to Proposed Action, but fewer jobs created due to elimination of positions for some haul truck drivers.	Same as Proposed Action.	Same as Proposed Action, except for relatively longer employment period for those hauling PTW.
Environmental Justice	No change to existing condition. All mine waste would be left in place exposing an Environmental Justice population to levels of radium-226 and uranium metal above USEPA action limits.	Long-term, beneficial impact on an Environmental Justice population by removing waste above USEPA action limits for cleanup; Short-term, local, adverse impacts on transportation, air quality, and noise; Short-term, beneficial, regional the employment opportunities.	Similar to Proposed Action, except for fewer traffic interruptions by use of conveyor system.	Same as Proposed Action.	Same as Proposed Action.
Public and Occupational Health	No change to existing condition.	Long-term, beneficial impacts by eliminating a USEPA identified risk to both human health and ecological receptors; Short-term, minor, adverse impacts due to increased airborne releases of nonradioactive and radioactive material, direct exposure to radioactive material, occupational-related accidents, traffic-related accidents, and impacts associated with facility design failures, extreme weather or seismic events.	Same as Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action, with increased potential for a traffic accident.

CHAPTER 3. DESCRIPTION OF AFFECTED ENVIRONMENT

The purpose of this section is to provide information about present environmental conditions. These baseline conditions will be used in Chapter 4, Environmental Impacts, to assess the impacts of the No Action Alternative, Proposed Action, and Alternatives B through D on the existing environment. The affected environment is analyzed according to specific resources, with an Area of Analysis defined for each resource as appropriate.

3.1 Land Use

Approximately 85% of the land within McKinley County, which defines the regional setting for the Area of Analysis for Land Use, is rangeland that is primarily used for livestock grazing (NRC, 1997a). Most urban or built-up land uses are within the municipal boundary of Gallup, New Mexico, which is the largest urban center and the only incorporated municipality in the County (NNMCG, 2012). Land use in the smaller, established rural communities outside of Gallup and in the tribal communities is low-intensity, widely dispersed residential use. In these areas, any land not used for rangeland is nearly entirely residential (NNMCG, 2012). Recreational activities in McKinley County occur primarily in the Mount Taylor Ranger District of the Cibola National Forest, which encompasses Mt. Taylor and the Zuni Mountains (NRC, 2009). Although a portion of the New Mexico Mining Belt extends into McKinley County, only approximately 2% of the land surface in the county is used for uranium or coal mining (Figure 3.1-1) (NRC, 1997a).

Land ownership remains relatively unchanged from the distribution of land ownership presented in D'Appolonia (1981), where approximately 80% of the land in McKinley County is still owned by the federal government or is held in trust for Native American tribes or pueblos. Approximately 60% of McKinley County is Indian Trust land. Private lands make up roughly 20% of the county, followed by the Bureau of Land Management (BLM) (7%), the Forest Service (5%) and State lands (5%) (Figure 3.1-2).

Land cover in McKinley County is primarily a mix of pinyon-juniper woodland (~38%), semi-desert shrub steppe (~21%), and semi-desert grassland (~17%) (Figure 3.1-3) (USGS, 2011). A complete list of land cover classifications for McKinley County can be seen in Table 3.1-1.

Land-use planning with McKinley County has been largely unplanned. However, the most recent McKinley County Community Plan update states that the land use goals for the community are "to promote wise and sustainable use of lands within the County, providing for an effective balance between preservation, open space, growth and development" (NNMCG, 2012). The mission statement acknowledges the County has no jurisdiction over Indian Trust lands but seeks cooperation in advancing general policies. The Navajo Nation Housing Authority (NNHA) has also published a planning manual for developing communities, along with the Vision Statement "Housing our Nation by growing sustainable communities." The manual gives general guidelines for community development but does not discuss any specific plans for the land within McKinley County (Swaback, 2012).

Table 3.1-1. Land Cover Classifications for McKinley County

Land Use	Area (acres)	Percent
Agricultural & Developed Vegetation	575	0.02%
Desert & Semi-Desert	1,540,121	44.11%
Developed & Other Human Use	30,501	0.87%
Forest & Woodland	1,603,459	45.93%
Introduced & Semi Natural Vegetation	703	0.02%
Nonvascular & Sparse Vascular Rock Vegetation	361	0.01%
Open Rock Vegetation	159,274	4.56%
Open Water	4,052	0.12%
Recently Disturbed or Modified	10,105	0.29%
Shrub & Herb Vegetation	142,230	4.07%
Total	3,491,381	100.00%

The Project Area, consisting of the Mine and Mill Sites, is in the west-central portion of the County. Land use within two miles of the Project Area, which defines the local Area of Analysis, consists primarily of grazing land with around 34 homesteads (UNC, 2017). Potential growth in residential land use within the Area of Analysis is currently limited due to minimal existing infrastructure. Because land use outside of Gallup is largely unplanned (NNMCG, 2012), the future land use is assumed to remain unchanged. Additionally, no unusual animals, facilities, agricultural practices, game harvests, or food processing operations have been reported for the Area of Analysis (UNC, 2017).

Surface land ownership within the 2-mile radius is roughly 55% Navajo Nation Reservation, 20% Navajo Nation off-reservation trust land, 14% private, and 12% federal lands managed by the United States Department of Interior Bureau of Land Management (Figure 3.1-4). In addition, four Navajo Chapters oversee land within 2 miles of the Project Area - Coyote Canyon, Standing Rock, Church Rock, and Pinedale (Figure 3.1-5).

Pinyon-juniper woodland is the predominant land cover (49%) within the Area of Analysis, followed by semi-desert shrub steppe (20%) and mixed bedrock canyon and tableland (14%) (Figure 3.1-6) (USGS, 2011). A complete list of land cover classifications within two miles of the Project Area can be found in Table 3.1-2.

Transportation corridors in the Area of Analysis are varied, ranging from I-40, the multi-lane interstate highway, to dirt roads which serve the rural communities, to NM 566, a two-lane paved road extending north from I-40, is the major access route to the Project Area from I-40 (UNC, 1975; NRC, 1997a). Regional transportation is reviewed in greater detail in Section 3.2.

Table 3.1-2. Land Cover Classifications within 2 Miles of the Project Area

Land Use	Area (sq m)	Area (acres)	Percent
Desert & Semi-Desert	21,229,200	5,246	32.67%
Developed & Other Human Use	27,000	7	0.04%
Forest & Woodland	33,396,300	8,252	51.40%
Open Rock Vegetation	9,852,300	2,435	15.16%
Open Water	31,500	8	0.05%
Shrub & Herb Vegetation	438,300	108	0.67%
Total	64,974,600	16,056	100.00%

Most of the surface estate of the Mine Site is located on land owned and held in trust by the United States for the Navajo Nation. Newmont Realty Corp. presently owns the minerals estate in those areas. UNC owns both the surface and mineral estate on a small portion of the Mine Site, including most or all of the former storage area and the Non-Economic Materials Storage Area (NEMSA). The UNC-owned property at and adjacent to the Mine Site comprises approximately 61.2 acres located in the Southeast corner of Section 34. In addition, UNC is the fee owner of the Mill Site.

3.2 Transportation

D'Appolonia (1981) evaluated the impact of process chemical shipments to the mill and yellowcake shipments from the mill in terms of the probability of an accident and subsequent release to the environment. However, transportation corridors were not identified, and traffic data was not presented by D'Appolonia (1981).

The Proposed Action includes two independent transportation actions, each with an associated local and regional Area of Analysis:

1. Construction and use of a haul road crossing on NM 566 for transport of mine waste from the Mine Site to the Mill Site Repository. The Area of Analysis for this transportation action is local.
2. Offsite transport of PTW to a licensed and controlled milling facility in San Juan County, Utah using the existing network of interstate highways, US highways, and state highways. The Area of Analysis for this transportation action is regional.

3.2.1 Local Affected Roads and Highways

Transportation routes near the Project Area, which comprises the Mine and Mill Sites, include interstate highways, non-interstate U.S. highways, state highways, county roads, Navajo-Bureau of Indian Affairs (BIA) roads, and named and unnamed local roads. Transportation related to the Proposed Action would be conducted on interstate highways, non-interstate U.S. highways, and state highways. These activities would be conducted in compliance with state and federal traffic laws and regulations and Gallup, New Mexico would occur within existing road and highway rights-of-way. Easements or other land use restrictions would not be expected to affect the use of these public roads.

3.2.2 Site Access Transportation Route

The primary access to the Project Area for construction and haul traffic related to the Proposed Action will be via NM 566. Figure 2.0-3 depicts the road network near the Mine and Mill Sites.

The Project Area would be reached by the following route:

- I-40 East/West Exit 33
- Northwest on I-40 Frontage Road, approximately 4 miles
- North on US 566, approximately 10 miles to the Project Area

Section 3.2.5 provides details on surfacing, number of lanes, speed limits, and average annual daily traffic (AADT) for the major transportation routes for the Proposed Action. Material shipments to and from the Mine Site are described in detail in Section 4.2 of this SER.

3.2.3 Mine Waste Haul Road Crossing at NM 566 Transportation Route

Mine waste excavated at the Mine Site west of NM 566 would be transported to the Mill Site Repository for disposal, which is located east of NM 566. The mine waste haul road crosses NM 566 north of the existing UNC offices, as shown on Figure 2.0-3. A traffic and contamination control system are necessary for the intersection of the mine waste haul road and NM 566. The impact of mine waste transportation is described in detail in Section 4.2 of this SER.

The local Area of Analysis was monitored for AADT. Based on a traffic count conducted between March 28 and April 28, 2017 on NM 566 immediately east and west with the intersection with Pipeline Canyon Road, approximately 130 vehicles per day travel through the area affected by the Proposed Action between 7:00 a.m. and 7:00 p.m. (INTERA, 2017). A typical maximum of 14 vehicles per hour occurring during typical morning and evening commuting times (INTERA, 2017). Approximately 12 of these 130 vehicles should be considered typical daily traffic from mine activity, and the remaining 118 vehicles can be assumed to be non-mine traffic (INTERA, 2017).

3.2.4 PTW Transportation and Disposal Route

USEPA mandated in the Non-Time Critical Action Memo (USEPA, 2011a) that PTW either be reprocessed to reclaim metals and radionuclides or, if reprocessing is not technically feasible, be transported offsite to a licensed and controlled disposal facility meeting the performance standard as defined by the USEPA under the Offsite Rule 40 CFR § 300.440 (USEPA, 2011a). USEPA states in the 2013 ROD Section 1.4 (USEPA, 2013a), that PTW from the Mine Site will not be disposed at the Mill Site. The impact of PTW shipments from the Project Area are described in detail in Section 4.2 of this SER.

The Proposed Action includes transportation of PTW to White Mesa in Blanding, San Juan County, Utah, approximately 211 miles from the Mine Site for reprocessing. The anticipated transportation route from the Mine Site to the White Mesa Mill is depicted on Figure 3.2-1 and uses the following roads:

- NM 566, 12 miles
- I-40 Frontage Road, 4 miles
- I-40 W, 5 miles
- US 491 N, 114 miles
- US 160 W, 13 miles
- CO 41 N, 41 miles
- US 191 N, 22 miles

Alternative D considers the Clive facility in Clive, Utah, a disposal site that meets the USEPA requirements of the 2011 Action Memo (USEPA, 2011a). This facility is located approximately 572 miles from the Mine Site, as depicted on Figure 3.2-2, using the following roads:

- NM 566, 12 miles
- I-40 Frontage Road, 4 miles
- I-40 W, 5 miles
- US 491 N, 194 miles
- US 191 N, 85 miles
- I-70 W 24 miles
- US 6 W, 127 miles
- I-15 N, 50 miles
- I-80W, 71 miles

3.2.5 Transportation Route Traffic Information

Table 3.2-1 provides details on surfacing, number of lanes, speed limits, and AADT for the major transportation routes for the Proposed Action. Table 3.2-2 provides accident and fatality rates for New Mexico, Colorado, and Utah roads.

Table 3.2-1. Transportation Route Traffic Information

Transportation Route Information					
Route	Surfacing	Lanes	Speed Limit (mph)	AADT (veh/day)*	State Dept. and Data Dates
CO 41 N	Asphalt/Concrete	2	65	800	CDOT, 2015
NM 18 S	Asphalt/Concrete	2	55	8,000	NMDOT, 2016
NM 206 S	Asphalt/Concrete	2	55	1,900	NMDOT, 2016
NM 566 S	Asphalt/Concrete	2	55	5,000	NMDOT, 2016
NM 566 S @ Haul Road Crossing	Asphalt/Concrete	2	55	118	Site Data (INTERA, 2017)
US 6 W	Asphalt/Concrete	2/4	65	12,400	UTDOT, 2016
US 160	Asphalt/Concrete	2	65	2,800	CDOT, 2015
US 191 N UT (Energy Solutions Route	Asphalt/Concrete	2	65	2,700	UTDOT, 2016
US 191 N UT (White Mesa Route)	Asphalt/Concrete	2	65	9,100	UTDOT, 2016
US 491 N CO/UT	Asphalt/Concrete	2	65	5,400	CDOT, 2015
US 285	Asphalt/Concrete	4 (Divided)	65	1,400	NMDOT, 2016
US 380	Asphalt/Concrete	2	65	2,300	NMDOT, 2016
I-15	Asphalt/Concrete	4 (Divided)	75	187,600	UTDOT, 2016
I-40 W	Asphalt/Concrete	4 (Divided)	75	20,000	NMD0T, 2016
I-40 E	Asphalt/Concrete	4 (Divided)	75	204,000	NMDOT, 2016
I-70	Asphalt/Concrete	4 (Divided)	75	9,500	UTDOT, 2016
I-80	Asphalt/Concrete	4 (Divided)	75	31,300	UTDOT, 2016

AADT = Average Annual Daily Traffic

*This data was estimated from state DOT websites and used only for depicting the difference in the magnitude of traffic on the various transportation routes. All estimated data rounded to the nearest 1,000.

Table 3.2-2. Traffic Accident Rates

State	Crash Rate	Fatality Rate	Data Information
CO	173 per 100M VMT	0.98 per 100M MVT	2012 Accident and Rates Book
New Mexico	162 per 100M VMT	1.5 per 100M VMT	2016 Traffic Crash Annual Report
Utah	203 per 100 MVT	0.91 per 100 MVT	2016 Crash Summary

3.3 Geology and Soils

3.3.1 Geology

Regional and local geologic characteristics of the Mine and Mill Sites are discussed in detail in each previous ER (UNC, 1975; D'Appolonia, 1981). For example, D'Appolonia (1981) summarizes several geologic and seismologic studies completed in support of licensing the Mill Site (e.g., SH&B, 1974, 1976a, 1976b, 1978; SAI, 1980; SAI and Bearpaw, 1980; and UNC, 1975), along with supplemental studies to assess the feasibility and environmental consequences of mill operations (SAI, 1980; CSI, 1980).

The Area of Analysis for geological resources is the San Juan Structural Basin at a regional scale **(**Figure 3.3-1) and the area of the Proposed Action at a local scale (Figure 1.1-1). Although the geology of the Area of Analysis has not changed since these reports were published, additional geotechnical investigations have been completed to help further understand the local geological conditions at the Mine and Mill sites. A review of the regional and local geology and the site-specific geotechnical investigations are presented in the following sections or are incorporated by reference.

3.3.1.1 Geology Overview

The Mine and Mill sites are located within the Colorado Plateau physiographic province, which is characterized by escarpments, canyons, badlands, and plateaus, with scattered volcanoes and volcanic fields (Stone et al., 1983). The Colorado Plateau in New Mexico includes the San Juan structural basin, which is host to oil, gas, and uranium resources. The San Juan structural basin covers approximately 21,600 square miles, primarily in northwestern New Mexico, with smaller portions in adjacent parts of southwestern Colorado and northeastern Arizona (Kernodle, 1996). It is about 140 miles wide and 200 miles long (Kernodle, 1996).

The basin is bounded by structural uplifts on all sides (Kelley, 1963), whereas the central part of the basin consists of relatively flat-lying sedimentary rocks (Figure 3.3-1). Topographic relief spans more than 7,000 ft between the high-elevation mountains and uplifts and the low-elevation sags and basin center. The structural center of the basin is located beneath the northeastern part of the basin. Up to 14,400 ft of sedimentary rocks, ranging in age from Devonian to Tertiary, fill the basin (Craigg, 2001). These rocks dip into the basin relatively steeply on the northern, western, and eastern margins of the basin, and less steeply along the southern margin, a regional cross section adapted from Stone et al. (1983) and Kernodle (1996). The older rocks crop out along the basin perimeter and are overlain by successively younger rocks toward the center of the basin

Given the wealth of both fluid and solid minerals hosted in the San Juan structural basin, its stratigraphy has received considerable attention. Organized by age from oldest to youngest, the major geologic units as presented in Stone et al. (1983) in the San Juan Basin are as follows:

- Undivided Paleozoic-era rocks and the Permian-age San Andres Limestone and Glorieta Sandstone.
- The Upper Triassic Chinle Formation and the Upper Jurassic Entrada Sandstone, the Bluff-Cow Springs Sandstone, the Summerville Formation, and the Todilto Limestone.
- The Upper Jurassic Morrison Formation, the members of which currently recognized by the United States Geological Survey (USGS) are, from older to younger: The Recapture Member (Recapture), the Westwater Canyon Member, and the Brushy Basin Member (Brushy Basin).
- The Cretaceous Dakota Sandstone, the late Cretaceous Mancos Shale (Mancos), and the Upper Cretaceous Mesaverde Group, which contains the Gallup Sandstone, the Crevasse Canyon Formation, the Point Lookout Sandstone, the Menefee Formation, and the Cliff House Sandstone.
- The Upper Cretaceous Lewis Shale, the Pictured Cliffs Sandstone, the Kirtland Formation, and the Fruitland Shale.
- The Tertiary Ojo Alamo Sandstone and the Animas, Nacimiento, and San Jose Formations, as undivided Tertiary rocks.

Many of these geologic units (such as the Gallup Sandstone, the Point Lookout Sandstone, and the San Jose Formation) are only found in parts of the San Juan Basin (Stone et al., 1983). Other units, including the Mancos Shale and the Morrison Formation, extend across all or nearly all of the San Juan Basin (Stone et al., 1983).

Locally, Quaternary alluvium and Upper Cretaceous rocks are exposed at the surface within the Area of Analysis (Green and Jackson, 1975). The Mill Site, including portions of the TDA, are constructed on top of alluvium, which consists of interfingering, poorly sorted, lenticular deposits of clay, silt, sand, and gravel (D'Appolonia, 1981). The alluvium thickness ranges from approximately 0 ft in the northeastern and eastern portions of the TDA to 150 ft in the west-central portion of the TDA (SAI, 1981). Detailed cross-sections show the vertical and lateral distribution of alluvial deposits within the Area of Analysis (Figures 2-4, 2-5, and 2-6 in Canonie, 1987). Underlying the alluvium is the Dilco Coal Member of Crevasse Canyon Formation. The Dilco Coal Member is approximately 150-ft thick and consists of interbedded sandstone, siltstone, shale, and coal beds. Beneath the Dilco Coal member is the Upper Gallup Sandstone, a unit upon which a portion the TDA was constructed. Locally, the Upper Gallup Sandstone has been subdivided into three zones for ease of identification at the Mill Site (Canonie, 1987). Underlying the Upper Gallup Sandstone is the Upper D-Cross Tongue Member of the Mancos Shale. A summary of thickness and lithology of each of these lithostratigraphic units is presented in Table 3.2-3.

Table 3.2-3. Summary of Stratigraphic Units and Lithology Present at the Mill Site TDA.

Adapted from Bearpaw (1980), D'Appolonia (1981), and Canonie (1987).

Era	Period	Lithostratigraphic Unit		Approximate Thickness (ft)	Lithology
Cenozoic	Quaternary	Alluvium		0-150	Unconsolidated deposits of silt, sand, and gravel in stream valleys, on flood plains, and on upslope areas adjacent to bedrock outcrops. Includes alluvial fan deposits.
Mesozoic	Cretaceous	Crevasse Canyon Formation	Dilco Coal Member	150	Uppermost portion consists of light-gray to yellowish-brown, fine- to medium-grained sandstone and siltstone; light- to dark-gray shale and coal. Middle portion of unit is massive, often cross-bedded, fine-grained sandstone. Lowermost portion of unit consists of dark-gray, highly carbonaceous shale (near coals); light gray to grayish-brown shale where in contact with siltstone and thin-bedded, often ripple marked, sandstone. Crops out in central area and in northeast corner of TDA but is located topographically above tailings cells.
		Gallup Sandstone	Zone 3, upper sandstone	70 to 90	Fine- to coarse-grained, quartzose sandstone with a continuous, 2- to 7-ft thick coal and shale seam in the lower part.
			Zone 2, shale and coal	15 to 20	Shale and coal with fine-grained sandstone and thin, lenticular coal interbeds at the bottom of the unit.
			Zone 1, lower sandstone	80 to 90	Fine- to medium-grained massive sandstone with thin beds of carbonaceous shale and coal. Clay and coal content increases with depth.
		Mancos Shale	Upper D-Cross Tongue Member	130	Massive, dark-gray, calcareous, silty shale with interbedded, discontinuous, thin-bedded, fine-grained sandstones and siltstones

Local structural features, including the Pipeline Canyon and Fort Wingate Lineaments and the Pinedale Monocline are each described by Canonie (1987).

3.3.1.2 Geotechnical Studies

In the 2013 technical memorandum, *Church Rock Mill Site Repository – Summary of Relevant Geotechnical Data*, MWH (2013a) reviewed the geotechnical investigations performed at the Mill Site relevant to the pre-design work. Those studies included investigation centered on the TDA, the embankment, the alluvium, Zone 3 Sandstone, and proposed borrow areas for the Proposed Action. Additional review of geotechnical data is also presented by Dwyer in Appendix A3 of MWH (2014). The results of these studies were incorporated into the Section 3.5 of the LAR and are incorporated herein by reference.

3.3.1.3 Seismic Hazards

Seismic hazards were analyzed in D'Appolonia (1981). D'Appolonia (1981) Figure B4-9, shows the locations of earthquake epicenters and their magnitudes. In 1997, the NRC re-evaluated the seismic stability of the reclamation plan at the Mill Site. Two critical slopes on the TDA were evaluated for the peak ground acceleration (PGA) anticipated at the location based on the maximum anticipated earthquake (6.25 magnitude) (NRC, 1997a). A recommended PGA of 0.22g was used in the analysis (NRC, 1997a). Both stations that were analyzed resulted in a factor of safety of 1.0 or greater, satisfying the stability requirements of NRC (1997a).

As part of the 95% Design, Stantec (2018) conducted a site-specific probabilistic seismic hazard analysis (PSHA) and a deterministic seismic hazard analysis (DSHA) to determine the appropriate seismic design for the TDA. The PSHA evaluated a 124-mile (200-km) radius surrounding the Mill Site based on seismotectonic modeling and geologic characterization of the Mill Site. The DSHA was performed to compare the PSHA with the previous work by D'Appolonia (1981) and NRC (1997b). The NRC require a reclaimed facility to be designed for a lifetime of 1,000 years to the extent possible, and 200 years at a minimum. The PGA used in this analysis used a 10,000-year return period, making it a conservative but appropriate design criteria. Stantec also conducted extensive research into the historical seismicity of the area around the Mill Site and compiled data on seismic activity in the Colorado Plateau, the region in which the Project Area is located, from 1887 through 2016 (Figure 3-1, LAR Appendix G.7) for all seismic events with a moment magnitude (M_W) greater than 2.5, for a total of 413 events. Stantec (2017) also compiled Quaternary displacement faults within 93 miles (150 km) of the Project Area to include in the model. The shear wave velocity estimated for the top 100 ft (30 meters [m], V_{S30}) was 902 ft/s for the alluvium, 1,857 ft/s m/s for sandstone, and 1,380 ft/s as the average of the two for the area (Stantec, 2017).

The results of the PSHA estimated a PGA ranging from 0.26 g to 0.30 grams (g) for the long-term and are incorporated into the design of the TDA. This PGA compares well to the DSHA value of 0.31 g; however, it is notably higher than the PGA calculated by the Lawrence Livermore National Laboratory (LLNL) in the 1997 evaluation. Stantec (2017) speculated that the LLNL value could have been for soft rock and not the alluvium which was used for this evaluation. USGS 2014 maps indicate a PGA of 0.08 g for a return period of 2,475 years, which is slightly less than the 0.13 g value produced by Stantec (2017), making the value adopted by Stantec more conservative for the design of the Proposed Action.

3.3.1.4 Volcanic Hazards

Though there are currently no active volcanos, multiple volcanic districts exist within New Mexico and the southern Colorado Plateau (USGS, 2017). The most prominent volcanic area near the Area of Analysis is Mt. Taylor, a stratovolcano located approximately 60 miles southeast of the Mill Site, immediately northeast of Grants, New Mexico. Mt. Taylor and its volcanic field, with multiple protruding volcanic necks, covers part of the San Juan Basin and Rio Grande Valley (Hunt, 1937). Eruptions of Mt. Taylor likely began in the Miocene and ceased sometime in the Pliocene (Hunt, 1937). The Zuni-Bandera Volcanic Field is located in Cibola County, approximately 65 miles to the south-southeast of the Mine Site and straddles the Colorado Plateau border with the Basin and Range province. It is primarily composed of basalt which formed cinder cones, lava flows, and lava tubes. The most recent eruption was approximately 3,000 years ago (USGS, 2017). The Valles Caldera, a caldera-type volcano, is in Sandoval Country in the Jemez Mountains to the northeast of the Mine Site (USGS, 2017). It stretches about 12 miles by 14 miles, is primarily made of rhyolite, and most recently erupted approximately 40,000 years ago (USGS, 2017). The final volcanic feature in the vicinity of the Mine Site is the Carrizozo Lava flow in Lincoln County, approximately 200 miles to the southeast (USGS, 2017). It erupted around 5,000 years ago over the course of 20 to 30 years and created a basalt landscape that is about 1 square mile (USGS, 2017). None of these volcanoes are actively monitored by the USGS and are not assigned an alert-level due to their inactivity (USGS, 2017).

3.3.2 Soils

This section identifies and describes the existing environment for soil resources that may potentially be impacted by the Proposed Action or the alternatives. The Area of Analysis for direct and indirect impacts to soil resources would occur within areas of proposed surface disturbance for each alternative.

3.3.2.1 Data Sources and Methodology

Data sources used for the soils analysis of the Proposed Action include the following:

- Custom Soil Resources Report Fort Defiance Area, and McKinley County Area, New Mexico (NRCS, 2018)
- Environmental Data Report for the Northeast Church Rock Site Removal Action and United Nuclear Corporation Site Remedial Action (INTERA, 2017)
- Revegetation Recommendations (Cedar Creek, 2010)

- Reclamation Reports for NECR Removal Actions and Mine Site Revegetation (Cedar Creek, 2011 through 2016)
- Environmental Report on the Church Rock, New Mexico, Uranium Mill and Mine (D'Appolonia, 1981)
- Soil Conservation Service, United States Department of Agriculture Handbook 18. (NRCS, 1993)
- Soil Survey of McKinley County Area, New Mexico (NRCS, 2001)

Existing soil conditions were evaluated through a combination of literature research and field reports specific to the Project Area and region.

3.3.2.2 Existing Conditions

3.3.2.2.1 Area of Analysis

Existing conditions within the Area of Analysis have been described using NRCS soil mapping (NRCS, 2018), which is based on third-order soil surveys. Third-order surveys are conducted by plotting soil boundaries by observation and interpretation of remotely sensed data and then verifying by traversing representative areas (NRCS, 1993).

The Area of Analysis is located in the southeastern portion of Major Land Resource Area (MLRA) 35 – Colorado Plateau, Land Resource Unit (LRU) 35.1 – Colorado Plateau Mixed Grass Plains (NRCS, 2006). The region is generally characterized by rough, broken terrain; including small, steep mountainous areas, plateaus, cuestas, and mesas, intermingled with steep canyon walls, escarpments, and valleys. The region represents an area of transition between the Plateau, Rocky Mountain, and Basin and Range Provinces. The region has very little surface water, where annual precipitation in the region ranges from 8 to 18 inches, depending on elevation (NRCS, 2001).

The Area of Analysis is predominantly located at elevations between approximately 6,990 ft above mean sea level (amsl) and 7,270 ft amsl in the mesa lands of northwestern New Mexico. It lies directly north of Ram Mesa, a dominant feature in the Puerco River Valley northeast of Church Rock, New Mexico. Alluvial valleys, floodplains, and drainage ways along valley floors and valley sides are common throughout the area. The alluvial valleys gradually transition to subtle alluvial fans and fan remnants, abruptly terminating at the colluvium shed from escarpments of upland mesas, cuestas, and plateaus. The deeper alluvial soils support mostly mixed shrub and grassland communities, with shallower upland soils supporting mixed pinon juniper woodlands, with grass and shrub understories.

Seven (7) soil map units are present within the Area of Analysis (Figure 3.3-2 and Table 3.2-4). The soils in the Project Area are generally classified as well drained and range from shallow on the mesas and cuestas to deep in the gently sloping and flatter alluvial areas. Surface soil textures are predominantly sandy loams. Slopes range mostly from zero to 35%, with few areas approaching 35 to 70 %. Depth to restrictive features, such as bedrock or hardpan, which is a dense and less permeable unit within the soil, ranges from 5 inches to over 80 inches. Due to the semi-arid climate characteristics of the region, the uppermost soil layers (called soil horizons) are generally thin and contain little organic material. No prime or unique farmland was identified within the Area of Analysis using the NRCS Web Soil Survey farmland classification tool.

Table 3.2-4. Third-Order Soil Map Units within the Project Boundary

Soil Map Units			
Map Unit Number	Map Unit Name	Acres	Percent of Total Acreage
114	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	2.8	0.8
120	Toldohn-Vessilla-Rock outcrop complex, 8 to 35 percent slopes	4.4	1.3
126	Uranium mined lands	1.9	0.5
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	6.7	2.0
241	Mentmore loam, 1 to 8 percent slopes	1.0	0.3
244	Buckle fine sandy loam, 1 to 8 percent slopes	24.0	7.0
265	Uranium mined lands	242.3	71.2
291	Rock outcrop-Eagleye-Atchee complex, 35 to 70 percent slopes	0.2	0.1
350	Toldohn-Vessilla-Rock outcrop complex, 8 to 35 percent slopes	55.7	16.4
365	Vessilla-Rock outcrop complex, 2 to 15 percent slopes	1.4	0.4
Total		340.2	100

3.3.2.2.2 Suitability of Reclamation Material

The uppermost soil unit, or topsoil, would be used to cover disturbed areas for the re-establishment of vegetation during the reclamation process for the Proposed Action and each alternative that disturbs the soil resources. The NRCS evaluates the upper 40 inches of soil for use as topsoil, and soils are rated as good, fair, or poor as potential sources of topsoil (NRCS, 2018). Ratings are based on soil properties that affect plant growth; ease of excavating, loading, and spreading material; and reclamation of the borrow area. Specific soil characteristics affecting topsoil source ratings include soil reaction, available water capacity and fertility, rock fragments, slope, depth to water table, texture, depth to bedrock or cemented pan, and thickness of suitable material.

According to NRCS data, the topsoil source ratings for the soils within the Area of Analysis are approximately 6% good, 2% fair, and 13% poor (Figure 3.3-3). Approximately 4% of the soils have no topsoil rating because they are composed of bedrock, while the remaining area is mapped as uranium-mined lands (without any soils information due to past disturbance).

According to NRCS data, reclamation material ratings for the soils within the Area of Analysis is 1% fair and 19% poor. Approximately 4% of the soils have no reclamation material rating due to bedrock while the remaining area is mapped as uranium-mined lands (without any soils information due to past disturbance). The remaining soils do not have reclamation materials ratings because they are minor components. Figure 3.3-3 shows the reclamation material rating for each map unit. Soils rated as good or fair means that vegetation can be established and maintained, and the soil can be stabilized through modification of one or more properties or the implementation of mitigation measures. Soils with poor ratings mean that revegetation and stabilization would be difficult and costly. Map unit composition, physical characteristics, and limitations for use of soils are detailed in Table 3.2-4.

Despite the poor ratings of local soils for use in reclamation as topsoil, successful reclamation of similar soils has been achieved in previous efforts. Annual reports detailing the reclamation success following the previous removal actions and temporary pile construction can be found in Cedar Creek reclamation reports (Cedar Creek, 2015). Knowledge gained from previous reclamation efforts has been incorporated into and utilized to develop the Revegetation Plan (Stantec, 2018a).

Table 3.2-4 also provides general information about the soils in the Area of Analysis (Landform, Parent Material, Depth to Restrictive Layer or Bedrock). There are also physical and chemical descriptions. Natural Drainage Class describes the soil as excessively drained, well drained, moderately drained, and poorly drained. Most soils found in the Area of Analysis are well drained. Surface Runoff Class describes the soil runoff susceptibility as very high, high, medium, low, and very low. Most soils found in the Project Area are medium to very high runoff potential. The calcium carbonate column presents the maximum percent calcium carbonate found in the soil profile. Soils in the Project Area ranged from 2 to 15%. The salinity column presents the maximum salinity found in the soil profile, measured in millimhos per centimeter (mmhos/cm). Soils in the Project Area ranged from 0 to 8 mmhos/cm. The sodium adsorption ratio column presents the maximum sodium adsorption ratio found in the soil profile. Soils in the Project Area ranged from 2 to 25 sodium adsorption ratio. The available water storage column presents the predicted available water (inches) in the soil profile. Soils in the Project Area ranged from 1.1 to 10.7 inches of available water.

3.3.2.2.3 Erosion Potential

Wind erodibility groups were used to determine susceptibility of bare soils to wind erosion. Wind erodibility groups are based on compositional properties of the surface layer that affect susceptibility to wind erosion such as texture, rock content, presence of carbonates, and organic matter content (NRCS, 1993). Group ratings range from 1 to 8, with 1 being the most susceptible and eight being the least susceptible to wind erosion. In the Area of Analysis, most soil units range between wind erodibility groups 2 and 6, with the majority of the soils rated as a 3 or 4.

NRCS-derived K factors were used to determine susceptibility of bare soils to sheet and rill (water) erosion. The K factor is an index ranging from 0.02 to 0.64, ranking soil erodibility from low to high, respectively. Soil properties affecting water erosion include texture, organic matter content, structure, and saturated hydraulic conductivity. Soils in the Area of Analysis exhibit moderate K factors, ranging from 0.17 to 0.37, with most of the soils identified as highly erodible.

3.4 Water Resources

The Project Area is located within the Little Colorado Watershed and Gallup Groundwater Basin (Figure 3.4-1). Sufficient regional and site-specific data on the physical and hydrological characteristics of groundwater and surface water are available to provide the baseline data necessary to evaluate impacts on water bodies, aquifers, aquatic ecosystems, and social and economic structures of the Area of Analysis. On a regional scale, the San Juan Structural Basin has been a major focus area of hydrogeological research for over 40 years due to its wealth of energy resources. Historical groundwater sampling events are summarized in Engineering/Remediation Resources Group, Inc. (ERRG) (2011) as part of their mining impact study on groundwater in the Project Area, which has been the subject of various ongoing and past investigations since 1977. These studies include the National Uranium Resource Evaluation Program (USGS, 2004), and the USEPA, the USGS, and UNC and its contractors. In addition, the groundwater and surface water resources local to the Project Area have been the subject of nearly continuous investigation for the past four decades. These documents provide much of the background information necessary to prepare this SER compliant with NUREG-1748 and to attain the ARARs determined by the USEPA (2011, 2013a).

3.4.1 Previous Work

Much effort has been put into further describing and understanding the hydrostratigraphy of the Mine and Mill Sites and extensively investigating the surface water and groundwater conditions since the writing of the 1981 ER. For example, Stone et al. (1983), Raymondi and Conrad (1983), Gallaher and Cary (1986), Van Metre et al. (1997), Kernodle (1996), ERGG (2011), Chester Engineers (2014, 2017), NMOSE (2017), and additional work by the USGS, NRC, and Region 6 USEPA have all contributed to a deeper understanding of the groundwater and surface water resources in the area and how they have been affected by mining, and particularly mine dewatering discharge. These resources are used in this section to supplement information previously presented in D’Appolonia (1981) based on these new investigations and their findings.

3.4.2 Surface Water Resources

3.4.2.1 Regional Surface Water Resources

3.4.2.1.1 Features

The Area of Analysis for regional surface water resources in this SER is the Hard Ground Canyon-Puerco River Watershed (Figure 3.4-2). A watershed drains an area of land whereby smaller streams feed into larger rivers or basins. Watersheds come in various sizes and can be broken down by their Hydraulic Unit Code (HUC) into smaller and more specific regions. The Hard Ground Canyon-Puerco River Watershed, a HUC 10 watershed, encompasses the upper reaches of the Puerco River as it runs from south of Crownpoint, New Mexico, east and southeast towards Gallup, New Mexico. Pipeline Arroyo, which runs through the Mine Site, drains into the Puerco River, which eventually flows into the Little Colorado River. The Hard Ground Canyon-Puerco River Watershed is part of the Little Colorado River Basin. This Basin is approximately 26,500 square miles and encompasses the area from northwestern New Mexico, including parts of McKinley, Cibola and Catron counties, on into northeastern Arizona, which composes most of the basin (USGS, 2007-2014). The basin drains from northeast to southwest, from the Puerco River headwaters in New Mexico to the Little Colorado River in Arizona (USGS, 2007-2014).

Two monitoring stations were referenced in D'Appolonia (1981) which were run by the USGS: 09395350 Puerco River near Church Rock, and 09395500 Puerco River at Gallup. These monitoring stations have since been discontinued and are no longer in operation. Water elevation data was recorded at 09395350 from 1977 through 1992, and at 09395500 from 1940 through 1982. No other stations are available in the area of the Mine Site.

There are no perennial streams in the New Mexico region of the Upper Puerco Watershed (NRC, 2009). Gallaher and Cary (1986) state that there are a few small springs along the Puerco River in the Church Rock district but that perennial streams are otherwise limited. The New Mexico Office of the State Engineer recently determined that there were no perennial reaches in the Upper Puerco Watershed in the New Mexico Region (NMOSE, 2017).

3.4.2.1.2 Uses

Uses of surface water in the Grants Mineral Belt (Figure 3.4-1), an area defined by its mining productivity, particularly the abundant uranium, are limited (Gallaher and Cary, 1986). Gallaher and Cary (1986) knew of no documented domestic use of surface waters in the Grants Mineral Belt at the time of publication, but that any streams with water were used for livestock watering. During mine dewatering years, the mine discharge created perennial springs from previously ephemeral arroyos which became important livestock watering supplies (Gallaher and Cary, 1986). Bluewater Lake (Figure 3.4-1), the closest large body of surface water, is not suitable for municipal water supply but is currently used for irrigation (NMOSE, 2017). The Puerco River receives effluent from the wastewater treatment plant in Gallup (Van Metre et al., 1997).

3.4.2.1.3 Water Quality

Figure 3.4-2 shows a reach of the Puerco River that has been designated as impaired by the New Mexico Environment Department (NMED) (NMOSE, 2017). This reach is approximately 22 miles long and has been affected by ammonia from an unknown source (NMOSE, 2017). It is considered an Impairment (IR) Category 5A waterway which is categorized by impairment from one or more of the stream's designated uses, with a Total Maximum Daily Load (TMDL) scheduled to be calculated for the impairing constituent (NMOSE, 2017). There are 19 other impaired water bodies in McKinley County which are affected by nutrients/eutrophication, temperature, and biological indicators, including three others in the IR 5 Category (NMOSE, 2017). The few perennial streams in the Grants Mineral Belt have naturally low concentrations of trace elements and radionuclides (Gallaher and Cary, 1986). Miller and Wells (1986) describe controls on sediment and contaminants storage sites along the Puerco River and find no significant difference between concentrations of analyzed elements within its floodplain or channel compared to various tributaries. Delemos et al. (2008) also conclude that uranium levels in the majority of over 100 sediment and suspended sediment samples were not elevated above background concentrations.

3.4.2.1.4 Waters of the United States in Region and Area of Analysis

Waters of the United States (WOTUS), as defined by the 1986/1988 regulatory definition that is currently applicable and consistent with Supreme Court decisions and guidance documents, are present within the region (NRC, 2009). Regionally, WOTUS tend to be limited to ephemeral streams or arroyos with few perennial streams (NRC, 2009). Using the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory surface waters and wetlands mapper, ephemeral streams (arroyos) and areas of sporadic ponding were identified, including ponding areas in the Tailings Facility. The USEPA and Army Corps of Engineers define wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (USEPA, 2018b). As no wetland-dependent vegetation was observed during the field survey (INTERA, 2017), by the definition set forth by the USEPA, there are no wetlands areas in the Project Area.

WOTUS are limited to ephemeral drainages within the Project Area. Wetlands (33 CFR §328.3(b)) are not present in the Project Area. An inventory of wetlands within the region of the Project Area was conducted using the USFWS National Wetlands Inventory (NWI) (USFWS, 2017), which is an online inventory of digital data that identify wetlands. The inventory identified only arroyos and areas of sporadic ponding, including ponding areas in the TDA. However, a pedestrian survey of the Project Area, including the specific areas delineated as areas of ponding water in the NWI, confirmed that no wetland vegetation is present near the arroyos, evaporation ponds, or tailings storage facility except for an occasional tamarisk in the vicinity (INTERA, 2017). Though invasive tamarisk is present, there were no wetland-obligate species or wetlands identified during the field survey of the Project Area (INTERA, 2017).

3.4.2.2 Site-Specific Surface Water Resources

Work has been completed focusing on Pipeline Arroyo and Puerco River downstream of the Project Area by Raymondi and Conrad (1983), Van Metre et al. (1997), Gallaher and Cary (1986), Canonie (1987), and ERRG (2011). New work has been produced on Pipeline Arroyo and Puerco River areas downstream of the Mine Site since the publication of D'Appolonia (1981). These area-specific works include Raymondi and Conrad (1983), Gallaher and Cary (1986), and Van Metre et al. (1997), which discuss details of water quality, stream flow, infiltration and evaporation, effects of mine dewatering, and water gradients; relevant summaries of each are incorporated below.

3.4.2.2.1 Uses

As the Project Area is located in an area of low precipitation and high evaporation, surface water uses are very limited (NNMCG, 2012). Pipeline Arroyo was used for mine dewatering and discharge practices between 1967 and 1986 (ERRG, 2011). Peak discharge in the Church Rock Mining District was in 1980, slowing down thereafter due to industry decline (Gallaher and Cary, 1986). Gallaher and Cary (1986) cite a maximum volume of discharge into the Puerco River from the Church Rock Mining District (UNC and Quivira mines) of approximately 5,000 gallons per minute (gpm), reaching areas as far as 50 miles downstream. Discharge from NECR and Quivira mines from 1970 to 1986 is shown in Figure 3.4-3. Prior to mine dewatering at the Mine Site, Pipeline Arroyo was an ephemeral stream; during mining, the arroyo had a steady flow because of the mine water discharge, which was pumped into an unnamed arroyo that fed into Pipeline Arroyo (ERRG, 2011). Surface water use in the Church Rock-Crownpoint Subdistrict of the Grants Mineral Belt was limited prior to mine dewatering due to the unreliable nature of the water bodies (Gallaher and Cary, 1986). After mine dewatering created a more consistent flow regime, surface waters became an important source of livestock water for the local community (Gallaher and Cary, 1986). Van Metre et al. (1997) estimate that approximately 615 tons of uranium and 260 Curies of gross alpha activity were released into Pipeline Arroyo from mine dewatering over the course of the lifetime of the mines. The NECR mine ended operations in 1983, as did Quivira in 1986 (Figure 3.4-3).

In addition to the water that was discharged into Pipeline Arroyo as a product of mine dewatering, the arroyo was also subjected to a massive release of mill-tailings waters in the July 1979 South Disposal Cell dam failure. The extent of contamination is addressed in Section C6.1.4 D'Appolonia (1981). It has been estimated that approximately 94 million gallons of water and 18,000 tons of suspended solids were released during the dam failure, which flowed down Pipeline Arroyo and ultimately into the Puerco River (ERRG, 2011). Cleanup efforts following the dam failure are described in Sections C6 and C7 of D'Appolonia (1981). The conclusion in

D'Appolonia (1981) was that 32 family groups downstream along the Puerco River between the Church Rock Mill and Gallup were affected by the breach. None of the households used surface water for drinking but did use it for livestock watering.

The State of New Mexico requires that an entity making an appropriation of surface water requires a valid permit through NMOSE. The permit allows the grantee the ability to place water to beneficial use in accordance with the approved conditions. As defined in 19.26.2.7 New Mexico Administrative Code (NMAC) (2005), beneficial use is *"the direct use or storage of water by man for a beneficial purpose including, but not limited to, agricultural, municipal, commercial, industrial, domestic, livestock, fish and wildlife, and recreational uses."* Livestock watering, which occurred in the Project Area, is considered a beneficial use by the State; however, it is uncertain to what degree water rights were sought for the surface waters use of flows within Pipeline Arroyo during the period of mine water discharge.

3.4.2.2.2 Features

The most prominent site-specific drainage feature is Pipeline Arroyo, which drains approximately 18 square miles and is composed of upland mesas and buttes that flow steeply over rock outcrops into alluvial valley bottoms that form ephemeral channels (Stantec, 2018a). Pipeline Arroyo bisects the Mill Site from north to south and serves as the primary drainage route for the Project Area (Figure 3.4-4). Pipeline Arroyo is a tributary to the Puerco River, which continues west-southwest toward Gallup from the Mine Site (Figure 3.4-2). As these two streams are infrequently flowing in the absence of mine dewatering activity, there is little information on flood frequency.

Stantec (2018a)performed calculations on flood hydrology for Pipeline Arroyo as part of the LAR. It was estimated that a 10-year flood would have a peak flow of 1,217 cubic feet per second (cfs), and 100-year flood would have a peak flow of 4,932 cfs. A Probable Maximum Flood was estimated to have a peak flow of 27,502 cfs, the highest capacity probable for Pipeline Arroyo. Scour and sediment transport should be expected during these infrequent events as the arroyo continues to evolve (Stantec, 2018a). Based on historical images since the 1950s, scour may continue to deepen and widen the arroyo with minimal lateral migration; however, remedial design for Pipeline Arroyo will stabilize the stream in the vicinity of the Repository (Stantec, 2018a).

3.4.2.2.3 Water Quality

In 1973, UNC applied for a National Pollutant Discharge Elimination System (NPDES) permit which became effective in January 1975, as did the permit applied for by the Quivira mine. Gallaher and Cary (1986) present background runoff water quality data from the Church Rock Mining District based on 13 samples from the area and compare that to raw and treated mine water from the same district. Gallaher and Cary (1986) concluded that as a consequence of uranium mining, the water quality of much of the surface water is inconsistent with regional water uses. The findings of their water comparisons are summarized below:

Total Suspended Solids (TSS)

TSS of final mine effluent was generally measured as less than 10 miiligrams per liter (mg/L). The average TSS values for runoff were in excess of 30,000 mg/L. As mine water moved through the water course, discharge from the Quivira Church Rock I mine outfall increased from a concentration of 52 mg/L to 3,500 mg/L in Gallup after traveling 19 miles, entraining clays and silts along the way.

Total Dissolved Solids (TDS)

TDS values in samples taken from Pipeline Arroyo in late 1985 were 300-600 mg/L. TDS in natural runoff in the area were of similar values. Gallaher and Cary concluded that mine water discharge did not influence TDS in receiving streams in the Church Rock-Crownpoint Subdistrict.

Trace Elements

Molybdenum, selenium, and uranium are the three of the nine consistently analyzed trace elements that were routinely higher in treated mine water than in natural runoff. All three constituents are associated with uranium ore and were consistent with the known mine dewatering activity. Arsenic, vanadium, and barium were detected at times in significant concentrations from mine dewatering discharge and are associated with the treatment process used to remove radium-226. The Church Rock-Crownpoint District treated mine water had a median concentration of total uranium equal to 1.1 mg/L which was significantly higher than the natural uranium concentrations of 0.02-0.06 mg/L detected in runoff from the North Fork of the Puerco River unaffected by mining activities. These concentrations of trace elements were generally within the NPDES permit limitations but some elements (lead, vanadium, gross alpha, and radium-226) exceeded the livestock watering criteria set forth by the National Academy of Sciences and National Academy of Engineering on behalf of the USEPA. This is the primary example of how surface water quality is incompatible with its local uses.

Radionuclides

Median concentrations of total radionuclides from treated mine water were less than those in natural runoff, with the exception of radium-226. The main difference in radionuclides in treated mine water versus natural runoff is in the percentage of dissolved versus suspended solids. Mine water had higher amounts of radionuclides associated with the dissolved phase than did natural runoff. Natural runoff often exceeded 15 pCi/L of total radium-226 but usually exhibited less than 2 pCi/L of dissolved radium-226. Most mine water discharges measured total radium-226 equal to or less than 6 pCi/L. Effluent at locations tested during “upset” conditions resulted in total radium-226 concentrations as high as 200 pCi/L, which is more similar to concentrations found in untreated mine water. In general, perennial streams in the Grants Uranium District have naturally low concentrations of dissolved trace elements and radionuclides, which distinguishes them from the treated mine water.

3.4.2.2.4 Sediment Transportation and Erosion

Pipeline Arroyo is usually dry, but it can temporarily convey torrential flows following heavy rains. Flood measurements are not available. Stantec (2018a) prepared a numerical rainfall-runoff model to estimate the flood hydrology in Pipeline Arroyo as part of the Northeast Church Rock 95% Design Report (Stantec, 2018a) which can be seen in Figure 3.4-4. The estimates of peak flows in Pipeline Arroyo at the Mill Site are 27,502 cfs for the Probable Maximum Flood (PMF), 4,932 cfs for the 100-year flood, and 1,217 for the 10-year flood. Pipeline Arroyo has no levees or flood control measures in the vicinity of the Mill Site (Stantec, 2018a).

Erosion characteristics in Pipeline Arroyo in the vicinity of the Mill Site are controlled by local bedrock conditions, channel grade, types of soils and rock in channel. The most prominent bedrock control, the knickpoint, is a bedrock outcrop located in Pipeline Arroyo channel adjacent to the Mill Site evaporation ponds. Above the knickpoint, the channel is relatively flat and wide with little evidence of erosion. Below the knickpoint, the channel slopes are steeper, and the channel has experienced significant scour, evidenced by deeply incised and vertical sidewalls.

Sediment transport in Pipeline Arroyo is highly dependent on flow and channel conditions. Most times of the year, the arroyo is dry and does not transport sediment. During the infrequent periods when the arroyo is temporarily flowing, the arroyo will transport sediment, but estimates of sediment transport rates and bed gradation are not available. The design basis flood for the Remedial Activities at the Mill Site is the Probable Maximum Flood, with an estimated discharge of 27,502 cfs in Pipeline Arroyo.

3.4.3 Groundwater Resources

3.4.3.1 Regional Groundwater Resources

Regional groundwater was comprehensively assessed by Stone et al. in their 1983 report on the hydrogeology of the San Juan Structural Basin in New Mexico. This definitive publication brought in previous research completed by the New Mexico Bureau of Mines and Mineral Resources (NMBMMR) and the USGS, with additional research completed during four masters' thesis projects from the New Mexico Institute of Mining and Technology. This work discusses the aquifer units in great detail, including water quality properties, specific conductance of each unit, and the drivers thereof, in addition to the effect that uranium mine dewatering had on groundwater quality and water levels.

Regional and local aquifers in the Area of Analysis, the Hard Ground Canyon-Puerco River Watershed, have not changed from what was described by D'Appolonia (1981), although some refinement and additional detail has been published. NMOSE (2017) described the primary water-bearing formations from youngest to oldest as follows:

- Quaternary Alluvium: Although not an important regional aquifer, the Quaternary Alluvium, which was created by mine dewatering, is used for stock wells near the Project Area, and can be found deposited in arroyos, washes, and stream channels.
- Cretaceous Mesaverde Group: Yields from wells in the Crevasse Canyon Formation of the Mesaverde Group range from 0.5 to 1.5 gallons per minute (gpm) and may be a source of water for domestic or stock use. This formation yields an insufficient capacity for municipal supply and has a specific conductance less than 2,000 µmhos.
- Mancos Shale: A massive shale with thin, water-bearing sandstone units. The sandstone units may provide water for stock wells.
- Dakota Sandstone: The Dakota Sandstone has well yields around 50 gpm of fair quality water in the Project Area. It is approximately 50 ft thick and is composed of coal, shale, siltstone, and sandstone. In the Gallup Basin, the Dakota has yields closer to 10 gpm and a specific conductance of 2,000-10,000 µmhos.
- Westwater Canyon: The Westwater Canyon is a member of the Jurassic Morrison Formation composed of sandstones with well yields around 50 gpm of variable quality in the Project Area. The uranium ore body is found in the Westwater Canyon member and impacts water quality in the Grants Uranium District. The Morrison Formation in the Gallup Basin exhibits specific conductance of 400-2,200 µmhos and can produce up to 500 gpm as a whole (not specifically the Westwater Canyon member).
- Zuni Sandstone: The Zuni Sandstone can be up to 500 ft thick with little-known hydrologic properties, though there are at least 5 known stock wells which are completed in this rock unit.

Observed changes since 1981 in regional groundwater resources are the product of changes in the use and withdrawals within the aquifers. Municipal water for the City of Gallup, near the Project Area, has reported extensive drawdown from continued pumping in the confined aquifers (NMOSE, 2017). This drawdown has caused lowering of the water table, which has resulted in the need to drop pump intake depths and a decline in effective transmissivity (NMOSE, 2017). These two factors create a situation which yields less water at a higher cost (NMOSE, 2017). Water levels in the two well fields for the City of Gallup are predicted to continue to decline at a rate of 20 ft per year or greater based on historical pumping activities (NMOSE, 2017).

The City of Gallup is the best source of extensive information near the Project Area on a regional scale. NMOSE has deemed current groundwater consumption to be unsustainable (NMOSE, 2017). Uses of water in the Gallup Underground Water Basin (UWB) include municipal supply for the City of Gallup, rural community supply, domestic use, minerals processing, and to a lesser extent, road construction (NMOSE, 2017). In the Gallup UWB, trends from the Northwest New Mexico Regional Water Plan (NMOSE, 2017) show a basin-wide rate of decline equal to approximately 1.74 ft per year on average since the 1980s. The basin's water level is predicted to decline another 87 ft over the next 50 years and impact approximately 31% of all wells drilled in the Gallup UWB (NMOSE, 2017). The expectation by the NMOSE is that by 2060 there will be only 4,742 acre-ft per year (ac-ft/yr) of available water in the Gallup mined sub-basins, down from 6,864 ac-ft/yr in 2010 (NMOSE, 2017). In the event of a 20-year drought, modeled from 2020 to 2040, the projected available water is lowered to 3,918 ac-ft/year by 2060, approximately 57% of what was available in 2010 (NMOSE, 2017).

Regional water quality research by Van Metre et al. (1997) measured that the overall radioactivity, gross alpha (dissolved), decreased significantly in the Puerco River since the end of mine dewatering in 1986. However, based on their sampling data, it appears that Pipeline Arroyo and the Puerco River Basin in the vicinity of the Project Area were affected by mining activities, evidenced in the activities ratios (the ratio of uranium to thorium as uranium decays) of dissolved uranium from stream flow, hand-driven wells, and near-stream alluvial wells with activity ratios ranging from 1.0 to greater than 1.5; mine effluent in the Church Rock area had an average activity ratio near 1.0 (Van Metre et al., 1997). Gross alpha, uranium, and radium were frequently measured in the Puerco River during the 1970s and 1980s, but there is only one known sample of the dissolved isotopes of uranium taken during the dewatering period at the mouth of Pipeline Arroyo (Van Metre et al., 1997). The results of this sample were an activity ratio of 1.07 and a dissolved uranium concentration of 1,330 µg/L (Van Metre et al., 1997). Van Metre and Gray (1992) estimated the average concentration of dissolved uranium in groundwater in the alluvial aquifer to be approximately 330 micrograms per liter (µg/L) due to infiltration of mine effluent.

3.4.3.2 Site-Specific Groundwater Resources

3.4.3.2.1 Hydrostratigraphy

Site-specific hydrostratigraphy from D'Appolonia (1981) is based on the boring logs produced during the drilling the NECR mine shaft (Figure B4-5 in D'Appolonia, 1981). The hydrostratigraphy has not changed since 1981 though additional information has been determined through continued investigation of the Project Area. The hydrostratigraphic units of interest onsite are the Quaternary Alluvium, and Zone 3 and Zone 1 of the Upper Gallup Sandstone (see Table 3.3-1), which were described in Section B4.2.2 of D'Appolonia (1981) and Section 3.3 of this report . The Alluvium, a mix of silt, clay, sand, and gravel, Zone 3, a coarse sandstone, and Zone 1, a fine sandstone, have been the subject of much investigation (Canonie, 1987). A discussion of the monitoring and remediation that has occurred in these zones is presented in 3.4.3.2.3.

The Alluvium is the topmost water-bearing layer across the majority of the Project Area. The Alluvium can reach a thickness of up to 150 ft and exhibits an average permeability of 10^{-2} centimeters per second (cm/sec) (very well-drained) and an average transmissivity of approximately 7,000 gallons per day per foot (gpd/ft) (Canonie, 1987). Specific conductance of the Alluvial groundwater ranges from 300 to 4,500 µmhos and well yields up to 10 gpm (NMOSE, 2017).

The uppermost unit of the Gallup Sandstone is Zone 3; a coarse sandstone with two coal and shale seams, with thicknesses between 70 and 90 ft. Zone 3 has an average permeability of 10^{-3} cm/sec and an average transmissivity of 1,000 gpd/ft (Canonie, 1987). Zone 2, which separates Zone 3 and Zone 1, is a coal and shale mix, approximately 15 to 20 ft thick, with no vertical hydraulic communication, effectively acting as an aquiclude, a solid, impermeable unit, between Zone 3 and Zone 1 (Canonie, 1987). Zone 1, a fine to medium-grained sandstone with thin layers of coal and shale, can be 80 to 90 ft thick (Canonie, 1987). It has an average permeability of 10^{-4} cm/sec and an average transmissivity of 150 gpd/ft (Canonie, 1987). The Gallup Sandstone groundwater as a whole has a range of measured specific conductance from 457 to 3,100 µmohs and varying well yields up to several hundred gpm (NMOSE, 2017). The Mancos Shale underlies Zone 1 of the Gallup Sandstone and has an unquantified but low permeability which allows it to act as an aquiclude and deter further vertical migration (Canonie, 1987).

Groundwater use in the Project Area is limited to drinking, sanitation, equipment cleaning, decontamination, and dust control (Spitz, 2018). Figure 3.4-5 shows all of the wells known to the NMOSE within a 4-mile radius of the Project Area. Of the 146 wells, 143 of these are owned by UNC for mining, industrial, and domestic purposes. Of the remaining three, one is a municipal well owned by the City of Gallup; one is a mining well owned by Kerr-McGee Corporation; and the third is a domestic well owned by Timothy Terrell (NMOSE, 2018).

Potentiometric surface maps from the Chester Engineers 2016 annual report (Chester Engineers, 2017) show groundwater conditions consistent with previous years. Figure 3.4-6 illustrates the southwest gradient in the alluvium with a high point near Wells 509 D and USEPA 23. This bulge originates from the “knickpoint” in Pipeline Arroyo, a rim-like bedrock high point, downstream of which the waterway is incised (Chester Engineers, 2017). A general downward trend in water levels in the Alluvium wells over time as the water drains from the unit has been observed Chester Engineers (2017). The active pumping of the Alluvium unit ceased in January 2001; however, water levels have continued to drop via natural drainage.

The potentiometric surface map for Zone 3 is shown on Figure 3.4-7. Flow in this unit is to the north-northeast (Chester, 2017). Water levels in this zone have also decreased over time, primarily in response to the various pumping regimes that have taken place, as illustrated in Chester (2017). This figure also includes data from the period when mine dewatering occurred and shows the impact that action had on some of the Zone 3 wells. Figure 3.4-8 shows the potentiometric surface in Zone 1, which has a gradient to the north-northeast. Chester (2017) observed historical water levels in Zone 1 and how they continue to decrease since shortly after pumping was stopped in July 1999.

Continued investigation into the nature of the Project Area has led to the conclusion that it is unlikely that a shallow groundwater system existed in Pipeline Arroyo area prior to mine dewatering (ERRG, 2011). It is believed that the water found in all three zones (Alluvium, Zone 1, and Zone 3) likely originated with the water infiltrating down through the channel after being discharged into Pipeline Arroyo from the mines (USEPA, 2013b). This concept is supported by the observed peak in water levels in these units between 1977 and 1986, which coincides with the dewatering of the Westwater Canyon member (USEPA, 2013b). During mine dewatering, an estimated 37 billion gallons of water were pumped into Pipeline Arroyo and Puerco River over the course of 16 years (ERRG, 2011). An additional 94 million gallons of water was released into Pipeline Arroyo during the 1979 dam breach (ERRG, 2011). Saturated thickness in the three shallow units has declined over time since 1986 when pumping ceased and no additional water was put into the system to grow the “artificial” aquifers (USEPA, 2013b). USEPA believes that the shallow groundwater units are headed toward pre-mine dewatering hydrologic conditions and that the aquifers are drying up (USEPA, 2013; Canonie, 1987). Due to the lack of tritium found in the Upper Chinle Formation, which is below the Morrison Formation that was dewatered, it appears water from the Puerco River that was discharged from the mine has not reached the bedrock formations via the alluvial aquifer (Van Metre et al., 1997).

3.4.3.2.2 Monitoring and Remediation

Monitoring and remediation of the Project Area has been ongoing since D’Appolonia (1981). The precursor to NMED, the New Mexico Environmental Improvement Department (NMEID), request for installation of a well system to monitor tailings seepage is mentioned in the 1981 report; however, much has occurred since then. The primary driver of monitoring and remediation that has occurred in the three zones of interest is the 1988 ROD (USEPA, 1988a). This document lays out the six-pronged remediation approach which consists of the following actions to be implemented: (1) Monitoring program to determine contamination of groundwater outside of the TDA; (2) Operation of existing seepage extraction system already in place in Zones 1 and 3; (3) Containment and removal of contaminated groundwater in Zone 3; (4) Containment and removal of contaminated groundwater in the Alluvium; (5) Evaporation of extracted groundwater in evaporation ponds onsite; and (6) Performance monitoring and evaluation program to review water levels and contaminant concentrations in each unit over time (USEPA, 2013b). The groundwater monitoring and extraction systems were already part of the remedy implemented under NMEID prior to the publication of the 1988 ROD. NMEID remediation began in 1980 and Uranium Mill Tailings Radiation Control Act (UMTRCA) remedial activities began in 1982 (USEPA, 2013b). A groundwater plume of seepage-impacted water exists in Zone 3, Zone 1, and the Alluvium which can be seen on Figure 3.4-9. Specifics on the remediation and monitoring that has taken place in each zone is sourced from the 2013 USEPA publication of the Fourth Five-Year Review (USEPA, 2013b) after implementation of the 1988 ROD.

Alluvium

The original remedial action was designed to create a hydraulic barrier to mitigate further migration of contamination in the alluvial groundwater with concurrent source remediation. Additional wells were installed to meet these goals, some of which have gone dry since pumping began due to dewatering. In 2001, the extraction system was temporarily shut down in a move to determine if natural attenuation was a viable remediation option for this unit. The wells have remained off since that time while a Technical Impracticability (TI) waiver was sought for sulfate and TDS standards. An estimated 131.1 million gallons of water had been removed from the Alluvium at the time of the 2001 shut down. The estimated volume of remaining tailings seepage impact fluid in the alluvium was 170,022,900 gallons over an area of 67 acres (Chester Engineers, 2011).

Zone 3

The purpose of the Zone 3 remedy was to mitigate further contaminant migration to the north by creating a hydraulic barrier and dewatering the unit. The initial system design estimated that to achieve these results, 200 million gallons of water would need to be removed from the unit. During the dewatering, extraction wells were put online in stages to document the sinking water levels in the unit. Wells were decommissioned if they produced less than 1 gpm after cleaning and stimulation. Additional wells were installed in 2002 for plume boundary monitoring. The plume is made up of water that has been impacted by seepage from the North, Central, and South Cells of the Tailings Pond (Hatch Chester, 2018). The plume stretches southwest-northeast from Section 10 through Sections 3, 2, and 1 into Section 36 (Hatch Chester, 2018). One of the main purposes of the wells installed in each unit is to monitor the extent of the groundwater plume (Hatch Chester, 2018).

Zone 1

The remedial action set out in the 1988 ROD intended to dewater the Zone 1 unit with pumping from extraction wells. Pumping occurred from 1984 through 1999. Extraction wells were decommissioned in 1999 due to significant decline in pumping rates. An estimated 2.9 million gallons of groundwater were extracted from Zone 1 during the active remediation. An estimated 8.6 million gallons of tailings seepage-impacted fluid still remains in Zone 1 over an area of 11 acres (Chester Engineers, 2011).

Monitoring continues in all three of these units on a quarterly basis. A report is produced annually which summarizes the groundwater corrective action program for the previous year (Hatch Chester, 2018).

3.4.3.2.3 Water Quality

The annual groundwater report from Hatch Chester for the year 2017 describes current understanding of water quality conditions and shows continued trends in groundwater quality onsite based on quarterly monitoring (Hatch Chester, 2018). The Alluvium is continuing to be observed for natural attenuation with the pump system idle due to the performance of natural attenuation being at least as effective as active pumping (Hatch Chester, 2018). No hazardous constituents exceeded revised USEPA cleanup standards or NRC License standards in seepage-impacted water during 2017 (Hatch Chester, 2018). With one exception, all point of compliance (POC) wells have met the current license standards since January 2011 (Hatch Chester, 2018).

Constituent concentrations can be seen in the Hatch Chester (2018) report on Table 2. Historical groundwater quality results can be seen in Appendix A of Hatch Chester (2018). During the October 2017 (most recent) sampling event, there were eight total exceedances between the fourteen wells sampled. The eight exceedances were for chloride, manganese, and nickel. Chloride exceeded the USEPA Cleanup Level of 250 mg/L, manganese exceeded the USEPA Cleanup Level of 2.1 mg/L, and Nickel exceeded the NRC License Standard of 0.078 mg/L, but not the USEPA Cleanup Level of 0.2 mg/L. Figure 6 in the Hatch Chester (2018) report shows the extent of the seepage-impacted groundwater which extends southwest down the western margin of the impoundment cells, continuing 1,400 ft to the southeast corner of Section 3. The total length of the impacted area is estimated to be 6,600 ft (Hatch Chester, 2018). Historically, only sulfate and TDS have exceeded historical USEPA standards in the seepage-impacted Alluvium, as well as the background wells (Hatch Chester, 2018). However, compared to the revised USEPA standards, two background wells exceeded the sulfate standard with no exceedances of the TDS standard in 2017 (Hatch Chester, 2018). A few locally increasing trends in common dissolved ions have been observed but are unrelated to the tailings seepage and occur due to a chemical reaction between recharge water and natural Alluvium materials (Hatch Chester, 2018). The seepage-impacted water was predicted to have reached Well SBL 1 by this time based on seepage velocities and effective porosities calculated for the Alluvium; however, the plume is not at Well SBL 1 as of yet (Hatch Chester, 2018). The downgradient limit of the plume is in approximately the same location as it has been since 2014 based on sampling data and contouring (Hatch Chester, 2018).

In Zone 3, 11 wells are monitored in the performance monitoring program (Hatch Chester, 2018). Zone 3 background water is considered to be the discharge in Pipeline Arroyo during mining activities (Hatch Chester, 2018). The background water was impacted by tailing seepage from the North Cell (Hatch Chester, 2018). Table 14 of the Hatch Chester (2018) report provides the analytical data for the groundwater sampling data, with historical data in Appendix B. Beryllium, nickel, thorium-230, vanadium, uranium, radium, and gross alpha exceeded NRC license standards at least once in one or more wells (POC and monitoring) during the 2017 quarterly monitoring (Hatch Chester, 2018). The northern edge of the seepage-impacted water was in the same location as was observed in 2016 and is expected to continue to be held by pumping from wells NW 2 and NW 5 (Hatch Chester, 2018).

In Zone 1, eight wells are monitored in the performance monitoring program (Hatch Chester, 2018). Infiltration of mine water discharge is the background water for this unit; seepage-impacted water later influenced this unit (Hatch Chester, 2018). Neutralization techniques and monitored natural attenuation have decreased the elevated concentrations of metals, radionuclides, and major ions (Hatch Chester, 2018). Hatch Chester reports that other, non-analytical aspects of water quality have continued to improve with natural attenuation over active pumping such as acid neutralization by attenuation of pH, metals, and other seepage constituents, indicating diminished impacts of seepage temporally and spatially (Hatch Chester, 2018).

3.4.3.2.4 Water Rights

UNC is currently diverting groundwater for industrial uses from the "Mill Site Well" under NMOSE Permit No. G-12-S. The well is located within Section 2, Township 16N, Range 16W (Figure 3.4-5). The well is approximately 1,500-ft deep, 8-inches in diameter, and produces water from three intervals screened across the Westwater Canyon Member (see Figure B.2-1 of the LAR). UNC plans to use water diverted from this well for decontamination, sanitary services, and dust control purposes (Stantec, 2018a).

3.5 Ecological Resources

The Area of Analysis for ecological resources is defined by the proposed limits of disturbance for the Proposed Action, with an additional 200-ft buffer for vegetation and an additional buffer for wildlife approximately 3,280 ft (1 km) in diameter (Figure 3.5-1).

The purpose of this section is to describe the ecological characteristics of the Area of Analysis for the vegetative communities, noxious weeds, wildlife, habitats, and special status species. Although ecological resources are presented in D'Appolonia (1981), both anthropogenic uses and variable climatic conditions over time have influenced the current vegetation and wildlife resources. Therefore, new surveys throughout the Area of Analysis have been implemented to describe the current existing conditions.

3.5.1.1 Existing Conditions

Existing conditions within the Area of Analysis have been identified by recent field surveys (Cedar Creek, 2011, 2014; INTERA, 2017). In addition, a supplemental survey was completed in 2018 to capture areas of disturbance associated with the Proposed Action that were previously un-surveyed (Cedar Creek, 2018 [forthcoming]). Five dominant vegetative communities that characterize the landscape exist within the Area of Analysis for vegetation: Reclaimed (or ruderal), Bottomland, Grassland, Shrubland, and Pinyon-Juniper (Cedar Creek, 2010, 2014). The distribution and composition of these plant communities vary throughout the Area of Analysis. The topography of the Area of Analysis varies from low-elevation mesas transitioning to rock outcroppings, shallow canyons, and alluvial and arroyo valleys. Mesa tops are dominated by the Pinyon-Juniper community, where soils are generally shallow over bedrock or exhibit elevated coarse fragment content. The mesa slopes are principally host to the Pinyon-Juniper community, especially on steeper rocky escarpments. Alluvial valleys exhibit the Grassland and Shrubland communities, and arroyo valleys are primarily Bottomland communities dominated by herbaceous vegetation with occasional shrubs.

These areas were sampled for baseline evaluation to quantify the floral resources and provide a logical target for eventual revegetation onsite. Floristic surveys of the baseline resulted in the identification of a total of 74 taxa, including 17 grass or grass-like species; 33 forbs; 4 noxious weeds; and 20 trees, shrubs, sub-shrubs, or succulents (INTERA, 2017).

None of the ecological communities found within the Area of Analysis can be characterized as important ecological systems that are especially vulnerable to change or that contain important species habitats. There are no aquatic environments within the Area of Analysis. The mapped vegetation communities are presented on Figure 3.5-1 and listed in Table 3.5-1. Site-specific field efforts have verified that no rare, threatened, or endangered plant species occur in the Area of Analysis.

Table 3.5-1 Extent of Vegetation Communities in the Project Area (excluding the 200-ft Buffer)

Vegetation Community	Acres	Percent of Total
Reclaimed	224	66
Bottomland	47	14
Grassland	13	4
Shrubland	6	2
Pinyon-Juniper	50	15
Totals	340	100

3.5.1.1.1 Reclaimed

Reclaimed areas, most of which are located centrally within the Project Area, are previously disturbed areas which exhibit natural or planned reclamation. Reclaimed areas cover approximately 224 acres (66%) of the Project Area. A total of 22 species have been observed. Shrubs and sub-shrubs provide most of the vegetative cover, followed by perennial grasses. Dominant taxa are rubber rabbitbrush (*Chrysothamnus nauseosus*), western wheatgrass (*Agropyron smithii*), alkali sacaton (*Sporobolus airoides*), and crested wheatgrass (*Agropyron cristatum*). Burningbush (*Kochia scoparia*) is the most common forb. Reclaimed areas exhibit average above-ground vegetative production and woody plant density.

Reclaimed areas are currently in an early seral stage but are expected to progress to a mature grassland with shrubland patches as perennial species gradually become dominant. Rubber rabbitbrush is an early seral species and may become less dominant as other shrub and sub-shrub species mature. At this stage of succession, Reclaimed areas generally provide limited value to wildlife habitat but stabilize the area for further successional development.

3.5.1.1.2 Bottomland

Bottomland areas cover approximately 47 acres or 14% of the Project Area. They are lowland valleys and arroyos with a higher amount of available water in the soil profile and fined-textured soils, resulting in increased vegetative cover and a more prominent and diverse herbaceous contribution.

A total of 25 species have been observed, as well as the greatest forb diversity of the vegetative communities within the Area of Analysis. Perennial grasses provided the majority of vegetative cover, followed by shrubs and sub-shrubs. Dominant taxa are western wheatgrass, rubber rabbitbrush, burningbush, squirreltail (*Sitanion hystrix*), and fourwing saltbush (*Atriplex canescens*). Several noxious weed species have been detected in the Bottomland community, including field bindweed (*Convolvulus arvensis*), nodding plumeless thistle (*Carduus nutans*), bull thistle (*Cirsium vulgare*), and Scotch cottonthistle (*Onopordium acanthium*). Higher soil moisture results in above-average above-ground biomass production and average woody plant density.

Bottomland areas are typically important communities which support prey base for predators; however, current and past grazing pressure and anthropogenic disturbances in this community cause these to be characterized as early to mid-seral with diminished ecological value as habitat.

3.5.1.1.3 Grassland

Grasslands are located in thick-soiled alluvial valleys dominated by grazing-tolerant short grasses and occasional forbs and cover approximately 13 acres or 4% of the Project Area. A total of 20 species have been observed, with perennial grasses providing the most cover, followed by shrubs and sub-shrubs. The dominant taxon was blue grama (*Bouteloua gracilis*). Grassland communities typically produce low levels of above-ground biomass and average woody plant density.

Grassland communities in this area are generally considered mid-late seral and support fossorial mammal communities as well as avian foraging and hunting grounds for avian and mammalian predators, but limited cover for nesting animals. A history of livestock grazing has limited the Grassland community ecological capacity as habitat in its current condition.

3.5.1.1.4 Shrubland

Shrublands cover approximately 6 acres, or 2% of the Project Area, and are located in thick-soiled alluvial valleys. They demarcate where the landscape exhibits xeric conditions, rockier soils, or where land management/succession has allowed shrubs to invade grasslands. Vegetation consists of a dominant shrub layer and a sub-dominant, grazing tolerant herbaceous layer. Shrubs and sub-shrubs provide the majority of vegetative cover, followed by perennial grasses. Dominant taxa were big sagebrush (*Artemisia tridentata*), blue grama, and threadleaf snakeweed (*Gutierrezia microcephala*). A total of 15 species have been observed. Shrubland communities produce average above-ground biomass and elevated woody plant density.

Shrublands are late-seral communities that provide good cover for wildlife and as such support a viable prey base for predators.

3.5.1.1.5 Pinyon-Juniper

Pinyon-Juniper areas cover approximately 50 acres (15%) of the Project Area and are located on thin-soiled slopes, mesas, escarpments, and benches. Vegetation ranges from a savanna of scattered trees with herbaceous understory to dense woody dominated areas with an occasionally dense shrubby understory and/or poor herbaceous understory. A total of 28 species have been observed, with shrubs, sub-shrubs, and trees providing the majority of vegetative cover. Dominant taxa are two-needle pinyon (*Pinus edulis*), Stansbury cliffrose (*Purshia stansburiana*), and Utah juniper (*Juniperus osteosperma*). The Pinyon-Juniper community produces below average above ground herbaceous biomass and average woody plant density.

Pinyon-juniper communities are typically late seral and can vary greatly in physical expression. As such, they provide good wildlife habitat in terms of nesting sites, cover, and food sources. Thin soils and typically steep slopes makes Pinyon-Juniper areas more susceptible to anthropogenic and natural disturbances, such as excessive livestock grazing and wildfires.

3.5.1.1.6 Special Status Species

A list of threatened, endangered, and rare plant species that are known to occur, or have the potential to occur, within McKinley County and the ecotypes within the Area of Analysis was compiled by combining the lists developed from the USFWS, Navajo Natural Heritage Program (NNHP), and (Natural Heritage New Mexico) NHNM (Table 3.5-2). The letters received from agencies confirming no special status species within the Project Area is provided in Appendix A of this SER. Systematic pedestrian surveys for the special status species and appropriate habitats were conducted within the Area of Analysis. No appropriate habitat to support the identified special status species or the plant species themselves were found within the Area of Analysis.

Table 3.5-2 Potential Special Status Plant Species in the Area of Analysis (Project Area and 200-ft Buffer)

Scientific Name	Common Name	Special Status			
		USFWS[1]	EMNRD[2]	NN[3]	NHNM[4]
Astragalus naturitensis	Naturita Milk-vetch	SoC[5]	SoC	G3	S2
Erigeron rhizomatus	Zuni Fleabane	Threatened	Endangered	G2	S1
Erigeron sivinskii	Sivinski's Fleabane	SoC	SoC	G4	S2

[1]US Fish and Wildlife Service, Endangered Species Act

[2]New Mexico Energy, Minerals, and Natural Resources Department, Endangered Plant Species List

[3]Navajo Nation, Endangered Species List

[4]Natural Heritage New Mexico

[5]Species of Concern

3.5.1.1.7 Noxious Weeds

A noxious weed list compiled from the New Mexico Department of Agriculture (NMDA, 2016) and the Navajo Nation Integrated Weed Management Plan (BIA, 2016) were used to complete field surveys.

Nine species listed by the NMDA and/or BIA were observed onsite (Table 3.5-3). Russian thistle and burningbush were found commonly in the reclaimed community. Bull thistle was found in the reclaimed and bottomland community in discrete and sizable patches. Tamarisk is the dominant species within Pipeline Arroyo. Other species found in the Project Area were generally isolated in patches with a few individuals.

Table 3.5-3 Noxious Weeds Present in the Area of Analysis (Project Area and 200-ft Buffer)

Scientific Name	Common Name	Classification	
		NMDA[1]	BIA[2]
Acroptilon repens	Russian Knapweed	B	B
Cardaria draba / Cardaria sp.	Whitetop / Hoary Cress	A	A
Carduus nutans	Nodding Plumeless Thistle	C	A
Cirsium vulgare	Bull Thistle	B	A
Convolvulus arvensis	Field Bindweed	NL[3]	C
Kochia scoparia	Burningbush	NL	C
Onopordium acanthium	Scotch Cottonthistle	A	A
Salsola kali	Russian Thistle	NL	C
Tamarix spp.	Saltcedar / Tamarix	C	A

[1]NMDA (2016)
[2]BIA (2016)
[3]Not Listed

3.5.2 Wildlife

Existing wildlife habitat, use, and occurrences within the Area of Analysis were evaluated through a combination of literature research and field sampling efforts. Baseline surveys for wildlife were conducted by visual observation by sight and sound. In the baseline reports produced by Cedar Creek (2010, 2014), traplines, fixed-radius avifauna observation stations, and fixed-length sign observation transects were established throughout the Project Area. The site-specific "variable-length" observational transects were extended radially from the central disturbance area for a length of between 100 and 200 meters to provide a better indication of (1) wildlife use of the overall vicinity and habitats, (2) any remaining mine-related impacts, and (3) any continuing hazards to wildlife. Observational transects were only implemented during the early morning or late evening hours to maximize opportunity for observing indigenous wildlife. Furthermore, Area of Analysis habitats were evaluated in regard to their capability to provide life requisites for anticipated indigenous wildlife, including sensitive or special status species.

Wildlife surveys were completed in the spring and fall by traveling to areas of suitable habitat and scanning with binoculars to locate evidence of wildlife activity (INTERA, 2017). Incidental observations were recorded while onsite as well as any sign of wildlife including tracks or scat.

3.5.2.1 Existing Conditions

Existing conditions within the Area of Analysis have been described by baseline reports conducted by Cedar Creek and INTERA (Cedar Creek, 2010, 2014; INTERA, 2017; D'Appolonia, 1981). The Area of Analysis supports multiple plant communities, but is dominated by pinyon-juniper woodland, bottomland, sagebrush, and reclaimed grassland. The distribution and composition of these plant communities varies throughout the study area and is influenced by soils, hydrology, and disturbance history. The mapped vegetation communities within the Area of Analysis are presented on Figure 3.5-1. Habitat distribution and range for species were analyzed using USGS Gap Analysis Program (GAP), Biota Information System of New Mexico (BISON-M), and NatureServe during the preliminary review.

3.5.2.1.1 Habitat Assessment

The New Mexico Crucial Habitat Assessment Tool (NMCHAT), a collaborative project between the New Mexico Department of Game and Fish (NMDGF), NHNM, and the Western Association of Fish and Wildlife Agencies, was searched to incorporate wildlife values, sensitive animal and plant species, and important ecosystem features into this habitat assessment. The tool provides a rank from 1 (most crucial) to 6 (least crucial) for the following habitat assessment parameters:

- Species of Concern: These include federally listed species and their designated Critical Habitat; state-listed species and Species of Greatest Conservation Need (SGCN) and their habitats, and observations for additional species tracked by NHNM that are considered vulnerable to imperiled.
- Terrestrial Species of Economic and Recreational Importance (SERI): Rankings are based on models developed by the NMDGF for 'General' and 'Priority' occupied habitat for bighorn sheep, elk, mule deer, pronghorn, cougar, and black bear.
- Aquatic SERI: These species are defined by the NMDGF-designated sportfish waters.
- Wildlife Corridors: These important habitats provide linkages between core habitats for sustaining populations across landscapes. Rankings are based on a corridor model developed for NMDGF (Menke, 2008).
- Wetland and Riparian Areas: These are areas of high value for wildlife habitat and ecosystem services. Rankings are based on a combination of Playa Lakes Joint Venture assessments, NMED Outstanding Natural Resource Waters, NMED, and NHNM – New Mexico Rapid Assessment Methodology, and NHNM Biodiversity Significance scores riparian/wetland sites.
- Large Natural Areas: Large Natural Areas are represented by large intact blocks of landscape that are minimally fragmented by roads, powerlines, railroads, pipelines, and other human impacts. Areas are delineated using the Landscape Condition Model (Comer and Hak, 2012) that computes an impact score based on the distance to various anthropogenic influences.

- Natural Vegetation Communities: Natural Vegetation Communities are at-risk Ecological Systems of Concern (ESOC). Ecological Systems follow the definitions of Comer et al. (2003) and the conservation status ranked at a national scale by the ESOC Ranking Working Group (N-ranks 1 through 5 where N1 = Critically Imperiled, N2 = Imperiled, N3 = Vulnerable, N4 = Apparently Secure, N5 = Secure).
- USFWS Critical Habitat Area: Species specific critical habitat areas mapped by the USFWS.

In general, the scores for the Area of Analysis were relatively low, or not applicable, due to the high number of residential properties and anthropogenic disturbance in the area. No critical or important habitats, features, or corridors for general wildlife were found within the Area of Analysis. Scores are listed in Table 3.5-4 (with 1 being most crucial and 6 being least crucial):

Table 3.5-4 New Mexico Crucial Habitat Assessment Tool (NMCHAT) Rankings within the Area of Analysis (Project Area and 3,280 ft [1-km] Buffer)

Category	Ranking[1]
Species of Concern	4
Terrestrial SERI[2]	4
Aquatic SERI	6
Wildlife Corridors	6
Wetland and Riparian Areas	6
Large Natural Areas	None Found
Natural Vegetation	6
USFWS Critical Habitat Areas	None Found

[1] A ranking of 1 being most crucial and 6 least crucial
[2] Species of Economic and Recreational Importance

3.5.2.1.2 General Wildlife

The general wildlife species occurring in the Area of Analysis are typical of the northwestern quarter of New Mexico and are presented on Table 3.5-5. In addition to the game and avifauna species discussed below, common mammalian species observed include black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audoboni*), coyote (*Canis latrans*), and a variety of small rodents (Cedar Creek, 2010, 2014, 2017; INTERA, 2017; D'Appolonia, 1981). The Gunnison's prairie dog is listed as a SGCN in New Mexico, and a comprehensive conservation plan for the species was drafted May 12, 2008. The little pocket mouse is also listed as sensitive in the NNHP. Both species have been observed within the Area of Analysis.

Table 3.5-5 General Wildlife Species Observed within the Area of Analysis (Project Area and 3,280 ft [1-km] Buffer)

Common Name	Scientific Name	Special Status
Badger	*Taxidea taxus*	
Black tailed jackrabbit	*Lepus californicus*	
Bobcat	*Lynx rufus*	
Botta's Pocket Gopher	*Thomomys bottae*	
Cliff Chipmunk	*Tamias dorsalis*	
Coyote	*Canis latranis*	
Deer Mouse	*Peromyscus maniculatus*	
Desert Cottontail	*Sylvilagus audoboni*	
Garter Snake	*Thamnophis elegans vagrans*	
Gunnison's Prairie Dog	*Cynomys gunnisoni*	SGCN[1]
Horned Lizard	*Phrynosoma sp*	
Little Pocket Mouse	*Perognathus longimembris*	NNHP Sensitive[2]
Mexican Woodrat	*Neotoma mexicana*	
Mule Deer	*Odocoileus hemionus*	
Pinyon Mouse	*Peromyscus truei*	
Plains Pocket Mouse	*Perognathus flavescens*	
Plateau Spotted Whiptail	*Cnemidophorus septemvittatus*	
Porcupine	*Erethizon dorsatum*	
Prairie Lizard	*Sceloporus undulata consobrinus*	
Prairie Rattlesnake	*Crotalus viridis*	
Rock Squirrel	*Otospermophilus variegatus*	
Western Fence Lizard	*Sceloporus occidentalis*	
Western Harvest Mouse	*Reithrodontomys megaloitis*	

[1]Species of Greatest Conservation Need
[2]Navajo Natural Heritage Program

3.5.2.1.3 Migratory Birds

A total of 56 bird species were observed within the Area of Analysis (Cedar Creek, 2010 and 2014; INTERA, 2017; D'Appolonia, 1981), with the species observed listed in Table 3.5-6. All species except the scaled quail are protected under the Migratory Birds Treaty Act (MBTA). There are six species of avifauna found within the Area of Analysis that are listed as SGCN found in the SWAP (NMDGF, 2016), four species occurrences designated as Black Capped Chickadee (USFWS, 2008), and four species listed as sensitive in the NNHP. No threatened and endangered migratory bird species were observed in the Area of Analysis.

Overall, there is limited capacity for migratory bird habitat within the Area of Analysis due to a history of anthropogenic disturbance and lack of a perennial water source. However, the large, north-facing canyons on the eastern edge of the wildlife survey provide a buffer area, and Ram Mesa provide a somewhat healthy Pinyon-Juniper community with an abundance of cavities for protection/nesting and suitable herbaceous habitat for resident and migratory bird species. Baseline surveys show that these habitats exhibited the largest diversity of species for migratory birds.

Table 3.5-6 Migratory Bird Species Observed in the Area of Analysis (Project Area and 3,280 ft [1-km] Buffer)

Common Name	Scientific Name	Special Status
American Kestrel	*Falco sparvarius*	
American Pipet	*Anthus rubescens*	
American Robin	*Turdus migratorius*	
Black Capped Chickadee	*Poecile atricapillus*	
Black-throated Grey Warbler	*Setophaga nigrescens*	BCC[1], SGCN[2]
Blue Winged Teal	*Anas discors*	
Blue-grey Gnatcatcher	*Polioptila caerulea*	
Brewer's Blackbird	*Euphagus cyanocephalus*	
Brewer's Sparrow	*Spizella breweri*	BCC
Bushtit	*Psaltriparus minimus*	
Canyon Wren	*Catherpes mexicanus*	
Cassin's Flycatcher	*Muscicapa cassin*	
Chipping Sparrow	*Spizella passerina*	
Cinnamon Teal	*Anas cyanoptera*	NNHP Sensitive[3]
Cliff Swallow	*Petrochelidon pyrrhonota*	
Common Raven	*Corvus Corax*	
Cooper's Hawk	*Accipiter cooperii*	
Crow	*Corvus brachyrhynchos*	
Dark-eyed Junco	*Junco hyemalis*	
Downy Woodpecker	*Picoides pubescens*	
Great Horned Owl	*Bubo virginianus*	
Greater Road Runner	*Geococcyx californianus*	NNHP Sensitive
Green Tailed Towhee	*Pipilo chlorurus*	
Hairy Woodpecker	*Leuconotopicus villosus*	
Hermit Thrush	*Catharus guttatus*	
Horned Lark	*Eremophila alpestris*	
House Finch	*Haemorhous mexicanus*	
House Sparrow	*Passer domesticus*	
House Wren	*Troglodytes aedon*	
Juniper Titmouse	*Baeolophus ridgwayi*	BCC, SGCN
Lark Sparrow	*Chondestes grammacus*	
Mountain Bluebird	*Sialia currucoides*	SGCN
Mourning Dove	*Zenaida macroura*	
Norther Flicker	*Colaptes auratus*	
Northern Harrier	*Circus cyaneus*	NNHP Sensitive
Orange-crowned Warbler	*Vermivora celata*	
Pinyon Jay	*Gymnorhinus cyanocephalus*	BCC, SGCN
Plumbeous Vireo	*Vireo plumbeus*	
Red Naped Sapsucker	*Sphyrapicus nuchalis*	
Redtailed Hawk	*Buteo jamaicensis*	
Rock Wren	*Salpinctes obsoletus*	
Sage Sparrow	*Artemisiospiza nevadensis*	SGCN
Sage Thrasher	*Oreoscoptes montanus*	
Say's Phoebe	*Sayornis saya*	
Scaled Quail[4]	*Callipepla squamata**	NNHP Sensitive
Spotted Towhee	*Pipilo maculatus*	
Turkey Vulture	*Cathartes aura*	
Violet Green Swallow	*Tachycineta thalassina*	
Western Bluebird	*Sialia mexicana*	SGCN

Western Kingbird	*Tyrannus verticalis*	
Western Meadowlark	*Sturnella neglecta*	
Western Scrub Jay	*Aphelocoma californica*	
Western Tanager	*Piranga ludoviciana*	
White Throated Swift	*Aeronautes saxatalis*	
Wilson's Warbler	*Cardellina pusilla*	
Yellow-rumped Warbler	*Setophaga coronata*	

[1]Birds of Conservation Concern
[2]Species of Greatest Conservation Need
[3]Navajo Natural Heritage Program
[4]Not protected under MBTA

3.5.2.1.4 Raptors

A total of seven raptor species were observed within the Area of Analysis during baseline surveys (Cedar Creek, 2010, 2014; INTERA, 2017), with the species observed listed in Table 3.5-7. Only the northern harrier is listed as NNHP sensitive. All species encountered are protected under the MBTA.

Several rock outcrops are interspersed throughout the Area of Analysis. Their ecological value lies in the nesting habitat it provides for birds. This habitat exhibits the highest probability of supporting sensitive or special status species relevant to the Project Area, such as golden eagle, peregrine falcon, or Mexican spotted owl. Without vegetation, this ecotype cannot support year-round obligate species. The most significant feature within the wildlife survey buffer is Ram Mesa, a large mesa on southeast edge of the wildlife survey buffer. The south-facing cliffs show heavy nesting and roosting evidence by several species of raptor.

Table 3.5-7 Raptor Species Observed in the Area of Analysis (Project Area and 3,280 ft [1-km] Buffer)

Common Name	Scientific Name	Special Status
American Kestrel	*Falco sparvarius*	
Common Raven	*Corvus Corax*	
Cooper's Hawk	*Accipiter cooperii*	
Great Horned Owl	*Bubo virginianus*	
Norther Harrier	*Circus cyaneus*	NNHP Sensitive[1]
Red-tailed Hawk	*Buteo jamaicensis*	
Turkey Vulture	*Cathartes aura*	

[1]Navajo Natural Heritage Program

3.5.2.1.5 Golden Eagle

Golden eagles generally inhabit open and semi-open country such as prairies, sagebrush, sparse woodland, and barren areas, especially in hilly or mountainous regions, in areas with sufficient mammalian prey base and near suitable nesting sites. Nests are most often on rock ledges of cliffs but sometimes in large trees, or on steep hillsides. Nesting cliffs may face any direction and may be close to or distant from water. A pair may have multiple alternate nests and may use the same or alternate nests in consecutive years.

Golden Eagles have the potential to occur within the Area of Analysis. Potential nesting sites are present as well as nearby foraging grounds. Contact with NNHP yielded one Golden Eagle occurrence within 3 miles of the Area of Analysis; however, there have been no reported sightings or nests located within the Area of Analysis.

3.5.2.1.6 Game Species

Mule deer (*Ococoileus hemionus*) and scaled quail (*Callipepla squamata*) were observed within the Area of Analysis during baseline surveys (Cedar Creek, 2010 and 2014; INTERA, 2017).

There are no important habitat, features, or corridors for game species found within the Area of Analysis. NMCHAT Terrestrial SERI ranks the Project Area as 4 (with a rank of 1 being the most crucial and 6 least crucial). This slightly elevated score is likely due to the observed mule deer and scaled quail. However, as it was concluded in the baseline surveys (INTERA, 2017), populations were less than expected for these habitats based on direct observation of mule deer hoof prints and pellet groups.

3.5.2.1.7 Other Special Status Species

Mexican Spotted Owl (*Strix occidentalis*)
The Mexican spotted owl was listed as threatened by the USFWS on 03/16/1993 with the most recent critical habitat designated on 08/31/2004. It is also listed under the Navajo Endangered Species list (May 2008). This owl is a non-migratory raptor that most commonly occurs in mature, mixed conifer and pine-oak forests. They prefer nesting in Gambles oak and Ponderosa Pine with high vegetative cover and a multi-layered understory. The species can also occur in steep, parallel-walled canyons. The rocky architecture provides similarities in critical habitat structure that is normally associated with forest vegetation.

Critical habitat includes unit CP–2 (Zuni Mountains, Cibola, and McKinley Counties). This federally defined unit is located approximately 30 mi (48 km) southeast of Gallup, in west-central New Mexico. It contains primarily US Forest Service lands (Mount Taylor Ranger District, Cibola National Forests). This unit contains mixed-conifer and canyons habitat that contain attributes of Mexican Spotted Owl habitat. There is not suitable habitat for the Mexican Spotted Owl within the Area of Analysis and there have not been any reported sightings.

Western Yellow-Billed Cuckoo (*Coccyzus americanus*)
The Western Yellow-Billed Cuckoo (WYBC) was listed as a threatened species by the USFWS on 10/3/2014 and its critical habitat designated on 12/02/2014. The most proximate critical habitat

unit is located on the Rio Grande approximately 80 miles to the west. There is not any suitable habitat for the WYBC within the Area of Analysis and there have not been any reported sightings.

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)
The Southwestern willow flycatcher was listed as endangered by the USFWS on 2/27/1995 with critical habitat designated on 01/03/2013. There is not suitable habitat for the Southwestern willow flycatcher within the Area of Analysis and there have not been any reported sightings.

Zuni Bluehead Sucker (*Catostomus discobolus yarrowii*)
The Zuni bluehead sucker was listed as endangered by the USFWS on 07/24/2014 with critical habitat designated on 06/07/2016. Critical habitat has been designated in the Zuni Mountains southeast of Gallup, roughly 30 miles south of the Project Area. There are no aquatic systems present in the Area of Analysis that have the potential to support or effect the current sucker population.

3.6 Air Quality

To assess the climatology of the Mine and Mill Sites, data were analyzed from the nearby Gallup Municipal Airport Automated Surface Observation System (ASOS), which is operated by the National Weather Service (NWS) and is located approximately 18 miles to the southwest (Figure 3.6-1). The elevation of the Gallup ASOS station is 6,460 ft, and the Mill and Mine sites are at an altitude of approximately 7,000 ft. A meteorological tower was deployed at the Mill Site, operated from May 1977 through April 1978, and the data generated from the tower were presented in D'Appolonia (1981). The data from this period show winds which flow from the north and northeast in the summer and from the southwest in the summer, with wind speeds averaging around 2 m/s. The wind patterns are a result of wind funneling through the valley which is orientated southwest to northeast. Based on conclusions drawn in D'Appolonia (1981), it is expected that the Gallup ASOS site will provide a reasonable representation of the meteorological conditions observed at the Mill site.

To provide an updated review of the ambient meteorological conditions data for this SER, a more recent period of meteorological data was analyzed than that shown in D'Appolonia (1981). Data collected from January 1, 2002, through December 31, 2017, were used in the subsequent analysis discussed below. These data are more representative of the current meteorological conditions experienced near the Mine and Mill sites than the data originally discussed in D'Appolonia (1981).

The Mill Site is located in a region with a semi-arid to arid continental climate with approximately 71% sunshine (defined as clear-sky observations). The prevailing wind at the Gallup ASOS is from the southwest (225°) with an average wind speed of 3.1 m/s over the period of 2002 to 2017. More than half of the precipitation in the region falls during the summer monsoon which typically occurs in July, August, and September, with mostly dry conditions persisting in the region during the rest of the year. Maximum temperatures within this region can be as high as 100 °F with winter temperatures as low as -21 °F.

The Mill Site is located in a valley that extends southwest towards Gallup, New Mexico and into the broken high-plateau country of Arizona. The area surrounding the Mill Site is considered rough with rocky buttes and ridges and is crossed by many arroyos (D'Appolonia, 1981). The topography of the region indicates that valley flow will likely determine the wind direction, which is a similar circumstance to that observed at the Gallup ASOS.

As the data used for this analysis are maintained by the NWS, instruments are routinely calibrated, and the data follows strict quality controls. The USEPA Meteorological Monitoring Guidance for Regulatory Modeling Applications requires a data completeness of 90% for all meteorological parameters per quarter if it is to be considered representative for air-dispersion modeling purposes. The data from January 1, 2002 through December 31, 2017 were analyzed for data completeness and the results can be seen in Table 3.6-1. The table shows that all years within the period exceeded the data completeness requirement with one exception, 2006. In 2006, quarter 3 (summer) had 252 hours of data missing, which corresponds to a data completeness of 88.6%. However, due to the extensive data set (15 years) being used in this analysis, the lack of data during 2006 quarter 3 is expected to have negligible impacts on the overall assessment of the meteorological conditions.

Table 3.6-1 Gallup ASOS Data Completeness

	Missing Hours				Percent Complete				
Year	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Annual
2002	90	174	171	115	95.8%	92.1%	92.3%	94.7%	93.7%
2003	80	103	209	143	96.3%	95.3%	90.5%	93.5%	93.9%
2004	121	110.0	171	124	94.5%	95.0%	92.3%	94.3%	94.0%
2005	83	113	176	127	96.2%	94.9%	92.0%	94.2%	94.3%
2006	112	186	252	130	94.8%	91.6%	88.6%	94.0%	92.2%
2007	43	164	171	87	98.0%	92.6%	92.3%	96.0%	94.7%
2008	25	112	143	110	98.9%	94.9%	93.5%	95.0%	95.6%
2009	34	101	149	92	98.4%	95.4%	93.3%	95.8%	95.7%
2010	28	88	134	101	98.7%	96.0%	93.9%	95.4%	96.0%
2011	33	76	158	94	98.5%	96.6%	92.8%	95.7%	95.9%
2012	54	102	172	89	97.5%	95.4%	92.2%	95.9%	95.3%
2013	44	90	171	74	98.0%	95.9%	92.3%	96.6%	95.7%
2014	63	206	160	107	97.1%	90.7%	92.8%	95.1%	93.9%
2015	50	124	187	102	97.7%	94.4%	91.5%	95.3%	94.7%
2016	85	100	194	102	96.1%	95.5%	91.2%	95.3%	94.5%
2017	59	120	180	115	97.3%	94.6%	91.8%	94.7%	94.6%

3.6.1 Onsite Meteorological Tower Comparison

A meteorological tower was deployed at the Mill Site and operated from May 1977 through April 1978. This tower had a limited number of meteorological parameters which were monitored as listed below and in D'Appolonia (1981):

- Wind Speed
- Wind Direction
- Temperature
- Humidity
- Precipitation

The number and type of atmospheric parameters monitored at the Mill Site meteorological tower were truncated from those typically measured on meteorological towers installed for air dispersion modeling purposes. However, the wind speed and direction data collected from 1977 to 1978 can be compared to data collected during the same period from the Gallup ASOS site to identify similarities/differences in the flow pattern and demonstrate whether the Gallup ASOS data is representative of the Mine Site and Mill Site.

Figure 3.6-2 depicts a wind rose for the Gallup ASOS over the period when the North East Church Rock meteorological tower was active (May 1977 to April 1978). The wind rose shows a prevailing wind from the southwest (225°) and west-southwest (247.5°), occurring 27% of the time, with a low frequency of wind events from other directions. Additionally, there are a significant number (35.1%) of calm wind events where wind speeds are less than (<)1.3 m/s occurring.

The Mill Site meteorological data were taken from Table B2.4 of D'Appolonia (1981) and processed to assign calm wind event to wind speeds less than 1.3 m/s, similar to the Gallup ASOS data. The results of this analysis are illustrated in Figure 3.6-3 and show a similar wind pattern to that of the Gallup ASOS, with prevailing winds are from the southwest (225°) and south-southwest (202.5°) occurring 27% of the time and a significant number of calm wind event (45 %). There are some small differences in the overall wind pattern measured at the Mill Site, with a northerly (0°) component occurring approximately 6% of the time. Based on this analysis it is expected that the Gallup ASOS site will provide an appropriate representation of the meteorological conditions observed at the Mill Site.

3.6.2 Ambient Temperature

Monthly and annual summaries of the average and extreme temperatures and dew point temperatures are shown in Table 3.6-2 for the period from 2002 through 2017. The Mine Site and Mill Sites are located in an arid to semi-arid continental climate with typically 260 days or more of sunshine per year on average.

Table 3.6-2 Monthly and Annual Temperature and Dewpoint Summary

	Means					Extremes				Mean number of days per year			
										Max.		Min.	
Month	High Temp. (°F)	Low Temp. (°F)	Mean Temp. (°F)	Dew Point Temp. (°F)	Relative Humidity (%)	Record High (°F)	Year	Record Low (°F)	Year	90°F & Above	32°F & Below	32°F & Below	0°F & Below
January	44.9	17.0	31.0	16.9	55.5	62	2003	-18	2011	0	2	28	1
February	49.2	20.2	34.7	17.7	49.4	70	2016, 2017	-21	2011	0	1	26	1
March	58.0	24.4	41.2	17.0	37.2	80	2013	-6	2002, 2006	0	0	26	0
April	65.1	30.2	47.6	17.1	29.3	82	2012	10	2013	0	0	17	0
May	72.2	37.5	54.8	21.7	27.3	94	2002	15	2008	0	0	6	0
June	84.5	46.0	65.3	23.0	19.9	100	2016	29	2008	9	0	0	0
July	88.3	55.7	72.0	40.7	32.1	99	2003	38	2004	12	0	0	0
August	84.3	55.5	69.9	47.2	44.2	94	2002, 2009	40	2016	4	0	0	0
September	80.4	48.9	64.7	40.5	41.1	91	2017	24	2013	0	0	1	0
October	71.4	37.5	54.4	29.8	38.7	86	2015	12	2009	0	0	14	0
November	60.6	26.4	43.5	21.6	41.4	74	2005	-9	2006	0	0	25	0
December	48.2	18.4	33.3	16.9	50.4	65	2003	-8	2002, 2013	0	3	29	1
Annual	66.5	34.3	50.4	25.6	38.9	100		-21		25	7	173	3

Based on a comparison of the recent meteorological data from January 1, 2002, through December 31, 2017, to the D'Appolonia (1981) ER, on average the region has seen a slight increase in the average temperatures since the 1938 to 1960 climatological analysis was completed.

Table 3.6-2 reports the monthly and annual average temperatures at the Gallup ASOS. The highest average ambient temperature (T_a) and dew point temperature (T_d) occurred in July (T_a = 88.3 °F and T_d = 40.7 °F); the lowest average temperature and dew point were observed in January (T_a =17.0 °F and T_d = 17.0 °F). The average afternoon dew point depression in the region is typically between 15 °F to 40 °F leading to relative humidity ranging from 19% to 50%. Extremely dry conditions occurred with relative humidity < 10% regularly occurring at the Gallup ASOS station. These conditions are representative of those experienced at the Mine Site.

The seasonal diurnal cycle of ambient temperature at the Mine Site can be seen in Figure 3.6-4, the diurnal cycle is driven by daytime heating and night-time cooling. The figure shows that the seasonal diurnal cycle has the greatest temperature difference in the spring, with an average low ambient temperature of 37.5 °F and an average high temperature of 69.8 °F. The winter season has the lowest temperature difference through the cycle, with temperatures ranging by 25.9 °F; from a low temperature of 21.0 °F and an average high temperature of 46.9 °F. The maximum temperature recorded at the Gallup ASOS was 100 °F in July 1995 and 2003, and the lowest temperature was -21 °F recorded in February 2011.

3.6.3 Precipitation

As previously discussed, the Project Area is located in a semi-arid to arid region with less than 10 inches of rainfall annually. The climatological analysis reported in D'Appolonia (1981) showed an annual average precipitation of 10.7 inches/yr. The more recent data from 2002 through 2017 indicate a reduction in annual average precipitation to 7.4 inches/yr. Table 3.6-3 reports the average monthly and annual rainfalls at the Gallup ASOS station. Notably, 3.73 inches of rain typically falls during the annual monsoonal months in late summer (July through September). This represents 50% of the annual rainfall at the Mine Site.

An analysis of the rainfall rates over the 2002 to 2017 period found that 90% of all the hourly rainfall rates observed at the Gallup ASOS station were below 0.25 inches per hour. There were only 21 hours of precipitation which had a rate greater than 0.25 inches per hour during this entire period. Figure 3.6-5 shows the normalized frequency of the precipitation rates.

Table 3.6-3 Average Monthly Precipitation Rates

Precipitation Rates				
Month	Average Rainfall (in.)	Max Rainfall (in.)	Min Rainfall (in.)	Average Hours/Year w/ Precipitation
January	0.49	1.45	0.01	27.7
February	0.39	1.52	0.00	23.2
March	0.25	0.74	0.00	15.4
April	0.34	0.89	0.05	15.1
May	0.36	1.07	0.00	14.4
June	0.16	0.76	0.00	5.5
July	1.41	2.70	0.05	27.6
August	1.29	2.52	0.07	27.6
September	1.03	2.14	0.25	25.9
October	0.68	1.97	0.05	19.3
November	0.41	1.10	0.03	17.4
December	0.59	9.96	3.92	28.4
Annual	7.39	26.83	4.43	247.5

3.6.4 Wind Speed and Direction

The local airflow patterns at the Mine Site are similar to those presented by D'Appolonia (1981) for the Northeast Church Rock onsite meteorological station, with prevailing southwesterly through westerly winds. The prevailing wind direction at the Project Area is heavily influenced by the surrounding topography with valley flow along the southwest to northeast axis.

A more recent meteorological data set (2002 through 2017) was analyzed to provide a more representative assessment of the ambient conditions at the Mine Site. The wind speed and direction data were collected at the Gallup ASOS and the annual frequency distribution of wind speed and direction in the form of a wind rose for the data period can be seen in Figure 3.6-6. The wind rose shows that the prevailing wind is from the southwest blowing towards the northeast, a secondary maxima in wind direction was observed blowing from the northeast to the southwest. This characteristic is an indication of a valley flow where air travels up the valley during daytime heating and flows back down the valley during nighttime cooling. The average wind speed (measured at 10 m per standard ASOS setup) over the period is 3.1 m/s with a maximum hourly wind speed reaching 20.1 m/s. Table 3.6-4 shows the frequency distributions of wind speed and direction.

The seasonal variation in wind speed and direction can be observed by looking at the hourly average frequency distributions for individual months, shown in Figures 3.6-7 to 3.6-18. These wind roses all depict a frequency distribution which describes a wind pattern heavily influenced by the local topography. However, the monsoon months (July, August and September) have the largest variation in wind direction with a higher percentage of wind events occurring at directions not influenced by the valley flow. This result is not unexpected as the local impacts of thunderstorms and downdraft outflow can rapidly change the local wind direction and speed.

Table 3.6-4 Frequency of Wind Speed and Direction

		Wind Speed (m/s)						% of Wind Events
		<= 1.54	<= 3.09	<= 5.14	<= 8.23	<= 10.80	>10.8	
Wind Direction (°) Blowing From	0	0.22	0.38	1.03	0.39	0.03	0.01	2.05
	22.5	0.41	0.65	1.09	0.5	0.05	0.01	2.71
	45	1.36	1.95	1.22	0.33	0.03	0.01	4.9
	67.5	2.13	2.3	1.14	0.35	0.04	0.01	5.98
	90	1.47	1.36	0.87	0.26	0.06	0.02	4.05
	112.5	0.25	0.26	0.23	0.09	0.02	0	0.85
	135	0.19	0.21	0.34	0.18	0.03	0.01	0.95
	157.5	0.38	0.48	0.71	0.43	0.06	0.01	2.07
	180	0.84	1.23	1.96	0.73	0.14	0.03	4.93
	202.5	0.46	0.99	2.95	1.61	0.41	0.23	6.64
	225	0.47	1.18	3.7	4.16	1.68	0.89	12.08
	247.5	0.49	1	2.69	3.22	1.35	0.65	9.39
	270	0.78	1.23	2.24	2.02	0.64	0.24	7.14
	292.5	0.29	0.41	0.88	0.77	0.18	0.04	2.56
	315	0.14	0.26	0.65	0.51	0.1	0.02	1.68
	337.5	0.11	0.26	0.5	0.24	0.04	0.01	1.16
% of Wind Events		9.98	14.15	22.18	15.79	4.85	2.17	69.12
% of Calm Events								30.88

3.6.5 Stability of the Atmosphere

The mixing height of the boundary layer is defined as the height above the surface through which relatively vigorous vertical mixing occurs. There are two different mechanisms by which mixing occurs:

- Convective mixing is caused by the changes in buoyancy of air due to temperature or relative humidity variations. Convective mixing generally occurs during the daytime as solar energy heats the surface and atmosphere causing convection.
- Mechanical mixing is the mixing associated with the turbulent flow of the atmosphere. Mechanical mixing dominates during night-time as there is no solar energy to promote convective mixing.

To estimate the mixing height at the Mine Site and Mill Site, hourly surface meteorological data from Gallup ASOS were combined with twice daily radiosonde data collected from the Albuquerque Sunport ASOS (KABQ) station. The Albuquerque Sunport ASOS station provides the closest upper air sounding data and is approximately 127 miles (205 km) away from the Gallup ASOS station. Upper air data is not as spatially variable as surface data and therefore has less coverage by the NWS. The data were processed using USEPA AERMET as part of the BREEZE AERMET 7 interface and hourly values of both the convective mixing height and the mechanical mixing height were derived.

Table 3.6-5 shows both the monthly average Convective Mixing Height (CMH) and Mechanical Mixing Height (MMH) over the 2002 through 2017 period. The CMH has a larger magnitude and variation throughout the year as it is heavily dependent on the daytime heating, with the hotter summer months having the most mixing due to convection. The CMH ranges from approximately 700 m in the winter months and peaks in the summer at 2,500 m. The MMH shows less variation in height on a seasonal scale which is expected as this is predominantly controlled by wind speed and turbulence from the surface. However, the MMH does show a bi-modal pattern in height, with the first maxima, approximately 900 m, occurring in spring (April and May) which is typically the New Mexico “windy season” and a smaller mode, 600m, in October and November. The D’Appolonia (1981) ER reports a mixing height of ranging from 369 m to 2,688 m depending on the diurnal cycle, these values are similar to those derived from the Gallup ASOS data.

INTERA

Table 3.6-5 Average Monthly Convective and Mechanical Mixing Heights (m)

Average Monthly Convective and Mechanical Mixing Heights (m)	Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2002	CMH	768	1068	1429	1945	2226	2536	2176	1997	1812	1317	905.4	680.3
		MMH	408	447	618	750	671	656	526	506	517	441	504	349
	2003	CMH	863	1195	1488	2029	2161	2479	2492	2143	1875	1420	950	726
		MMH	309	538	547	787	704	671	511	478	465	490	567	426
	2004	CMH	767	1080	1526	1771	2369	2517	2309	1939	1929	1400	923	632
		MMH	413	440	469	679	741	612	543	554	551	604	497	354
	2005	CMH	783	981	1311	1802	2083	2480	2455	2162	1984	1353	1059	816
		MMH	451	412	602	774	619	682	527	448	553	449	455	395
	2006	CMH	933	1169	1479	1990	2365	2562	2202	1790	1685	1353	1009	674
		MMH	460	508	645	693	640	638	531	458	554	479	448	347
	2007	CMH	755	1144	1520	1805	2077	2451	2273	2129	2014	1449	915	778
		MMH	482	568	542	736	654	685	572	485	555	539	370	460
	2008	CMH	868	1046	1670	2050	2170	2367	2099	2060	1943	1388	990	752
		MMH	457	486	728	848	786	694	514	464	413	509	470	538
	2009	CMH	737	1171	1562	1991	2047	2392	2312	2285	1890	1385	902	715
		MMH	310	528	722	792	574	620	605	548	535	580	398	463
	2010	CMH	708	1180	1357	1937	2131	2457	2143	2011	1995	1488	1006	690
		MMH	367	406	592	844	864	655	479	522	404	464	571	469
	2011	CMH	856	1092	1593	1949	1980	2572	2354	2155	1939	1398	1007	554
		MMH	312	549	660	914	832	811	539	513	415	429	521	392
	2012	CMH	784	1121	1534	1963	2144	2628	2146	2082	1988	1447	1044	773
		MMH	453	522	624	669	748	624	509	490	432	523	382	465
	2013	CMH	787	1105	1638	2001	2267	2583	2055	2027	1823	1390	864	701
		MMH	428	487	588	831	695	653	566	452	512	577	457	420
	2014	CMH	884	1340	1531	2042	2187	2576	2202	1984	1710	1338	990	824
		MMH	434	506	670	780	713	787	537	467	434	441	613	366
	2015	CMH	690	1111	1541	2055	2025	2329	2002	2183	1871	1413	944	688
		MMH	270	437	449	668	580	530	465	457	420	461	514	460
	2016	CMH	840	1145	1575	1847	2214	2429	2384	1919	1860	1505	1050	729
		MMH	396	400	680	652	665	537	599	453	509	479	473	460
	2017	CMH	793	1113	1551	1921	2083	2417	2179	2082	2080	1415	1054	752
		MMH	519	512	570	708	647	596	490	469	557	527	467	328

Additionally, the Monin-Obukhov Length was also derived from the AERMET analysis. This parameter is an indicator of the stability of the atmosphere. The Monin-Obukhov Length is a parameterization which describes the buoyancy and mechanical flow of the atmospheric boundary layer. The boundary layer dynamics are significantly impacted by the surface conditions, such as topography and surface roughness through the mechanical flow (winds) and the convective mixing (buoyancy). The relationship between the Monin-Obukhov Length and atmospheric stability can be seen in Table 3.6-6. The monthly average values of the Monin-Obukhov Length can be seen in Table 3.6-7, which shows variation in the averages over a range from 38 to 327 m, indicating very stable to near-stable conditions. Daily variations in the atmosphere, particularly during the monsoon season would lead to more unstable conditions occurring.

Table 3.6-6 Monin-Obukhov and Atmospheric Stability Classifications

Atmospheric Stability		
Class	Monin-Obukhov Length (m)	Atmospheric Stability Classification
cL = -3	-100 ≤ L ≤ -50	Very Unstable
cL = -2	-200 ≤ L ≤ -100	Unstable
cL = -1	-500 ≤ L ≤ -200	Near Unstable
cL = 0	L > 500	Neutral
cL = 1	200 ≤ L ≤ 500	Near Stable
cL = 2	50 ≤ L ≤ 200	Stable
cL = 3	10 ≤ L ≤ 50	Very Stable

Table 3.6-7 Average Monthly Monin-Obukhov Lengths

Average Monthly Monin-Obukov Length (m)																
Month	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	170	69	208	165	131	163	192	124	114	141	176	143	89	71	94	195
Feb	139	102	88	128	74	98	138	266	137	112	111	214	86	67	71	157
Mar	267	184	110	166	244	137	150	230	159	195	182	215	192	96	204	139
Apr	327	110	188	117	129	132	138	127	164	193	99	177	131	94	94	137
May	302	169	154	99	119	161	179	84	187	199	165	178	120	128	113	142
Jun	240	64	52	105	104	156	80	116	88	156	38	64	66	175	79	48
Jul	193	164	126	72	130	128	185	99	120	78	165	165	218	110	155	107
Aug	199	120	120	89	141	87	106	119	71	170	134	174	96	94	76	87
Sep	197	108	121	122	155	103	52	106	42	114	108	98	74	65	103	81
Oct	138	193	135	85	94	85	107	125	98	80	106	171	102	87	81	66
Nov	175	133	141	70	129	59	97	62	131	129	67	142	140	119	121	83
Dec	111	104	95	113	61	177	220	165	161	103	117	131	87	171	118	42

3.6.6 Severe Weather

The type of severe weather is unlikely to have changed since the original D'Appolonia (1981) ER, however the intensity and frequency of severe weather events may have changed.

There are four main types of severe weather events that occur in McKinley County, as described below:

- Severe storms (defined as a storm with winds in excess of 58 mph) occur on a frequency of once every 3 years in McKinley County, based on reports from 1955 through 2017. In the state of New Mexico from 1979 to 2009 an average of 26 thunderstorm wind events were reported, this is considerably lower than the 70 thunderstorm wind events observed from 2007 through 2017.
- Tornados are considered rare in the Project Area. From 1950 to 2017 only one tornado has been observed in McKinley County. On average there are approximately 10 tornadoes per year in New Mexico with relatively "weak" intensities ranging from EF0 through to EF2.
- Flash flooding is the most common severe weather event in New Mexico. McKinley County has, on average, 2 flash flood events per year. Approximately two-thirds of these events statewide occur in July and August during the summer monsoons. The impacts of flash flood events can be increased when precipitation falls on burn scars from forest fires or on low-permeable soils such as clay. The local topography also plays an important role with many naturally forming seasonal arroyos transporting precipitation downstream.
- Severe drought is common to New Mexico. Most areas of New Mexico are susceptible to severe drought and subsequently, a high risk for wildfires. As there is no quantitative definition of drought, the term refers to an extended period of time with below-normal precipitation. The intensity of drought within the state can range from abnormally dry through exceptional drought with extended periods (multiple years) where 100% of the state is considered to be in drought conditions.

3.6.7 Topography

The principal topographic feature in the Project Area that influences wind patterns is the northeast-southwest trending valley shown in Figure 3.6-19. The Project Area is surrounded by mesas to the northwest and southeast, which have elevations up to approximately 7,500 ft. South of the Mill Site is a valley which runs approximately east/west with a parallel ridge line on the south side of the valley. The maximum elevation of this ridgeline is around 8,000 ft. The area is surrounded by arroyos which act as shallow valleys with seasonal running water during monsoon season or from melting snow. The topography of the region indicates that valley flow will likely determine the wind direction.

3.6.8 Baseline Air Quality

The Project Area is located within Air Quality Control Region (AQCR) 14 as defined by the USEPA and New Mexico Environmental Department Air Quality Bureau. The AQCR is defined based on the climate, meteorology, topography, vegetation, land use patterns, population characteristics and growth projections. Within this region, Prevention of Significant Deterioration (PSD) Increment minor source baseline dates have been set for NO_2, SO_2 and PM_{10}. The area is in attainment for all criteria pollutants (CO, NO_2, SO_2, $PM_{2.5}$, PM_{10}, Lead, and Ozone).

The assessment of background concentrations of pollutants is difficult for this area as McKinley County has no coverage by ambient monitors in the USEPA Regional Air Quality Network including the State or Local Air Monitoring Station (SLAMS), Interagency Monitoring of Protected Visual Environments (IMPROVE), and the NCore Multipollutant Monitoring Networks. Looking outside of the county, nearby monitors include a $PM_{2.5}$ monitor located in Apache County, Arizona (approximately 50 miles [81 km] away) and collocated ozone and NO_2 monitors located in San Juan County at the Chaco Culture National Historic Park (approximately 43 miles [69 km] away). The nearest ambient monitors for the remaining criteria pollutants (CO, SO_2 and PM_{10}) are located in Albuquerque, New Mexico (approximately 114 miles [184 km] away) or Farmington and Bloomfield, New Mexico (approximately 78 miles [125 km] away). Currently, there are no dedicated active lead monitors in New Mexico. The closest lead monitor is 199 miles (320 km) away in Claypool, Arizona. However, there is an IMPROVE site located approximately 99 miles (160 km east of the Mill Site near Española, New Mexico, which measures speciated particulates including lead. Due to the short-lived nature of lead aerosol in the atmosphere, it is unlikely that this monitor would be representative of the area near the Mill Site. As such, conservative background concentrations can be as estimated by the NMED for use in air dispersion modeling are reported in Table 3.6-8 below. Note that the NMED does not consider there to be an ambient background concentration of lead particulates in the atmosphere.

The table shows that background concentrations of most criteria pollutants are less than 15% of the National Ambient Air Quality Standards (NAAQS) with the exception of $PM_{2.5}$ and NO_2. The relatively high background concentration of $PM_{2.5}$ is expected due to the dry and windy conditions occurring in western New Mexico and sparse vegetation coverage. The relatively high background concentration of NO_2 observed at the monitor is due to the oxidation of NO in high ozone and VOC areas from combustion sources forming NO_2.

Table 3.6-8 Background Pollutant Concentrations and Percentage of Standards

Pollutant and Monitor		Location		Averaging Period							
				1-hr		8-hr		24-hr		Annual	
Pollutant	Monitor ID	Latitude	Longitude	Concentration (µg/m³)	% of Standard	Concentration (µg/m³)	% of Standard	Concentration (µg/m³)	% of Standard	Concentration (µg/m³)	% of Standard
CO	350010023	35.1343 N	106.585 W	1787.9	12%	1183.0	12%				
NO_2	350451005	36.7967 N	108.473 W	85.2	45%					10.8	12%
Ozone	350451005	36.7967 N	108.473 W	152.4	-						
$PM_{2.5}$	359919923	35.1343 N	106.585 W					22.5	64%	6.6	55%
PM_{10}	350043001	35.2972 N	106.544 W					21.0	14%	9.5	-
SO_2	350450009	36.7422 N	107.977 W	14.0	7%						

7.

3.6.9 Inventory of Nearby Emission Sources

To estimate the emissions of pollutants near the Project Area, surrounding source data was requested from the NMED. Emission rates of CO, H_2S, NO_x, $PM_{2.5}$, PM_{10}, TSP and SO_2 were analyzed out to a 31-mile (50-km) distance from the Mill Site to identify the maximum Potential to Emit (PTE) emission rate (tons/year) for the region. There is no inventory data for surrounding sources with lead emissions which would impact the Mine Site. Table 3.6-9 shows the number of sources in the region along with the total emission rate per pollutant.

Table 3.6-9 Total Emissions from Nearby Emission Sources

Nearby Sources		
Pollutant	Number of Sources	Emission Rate (tons/year)
CO	47	625
H_2S	3	24
NO_x	46	6536
$PM_{2.5}$	76	1080
PM_{10}	76	1313
TSP	76	1760
SO_2	38	4497

The location of these nearby emission sources can be seen in Figure 3.6-20. This aerial image shows that the majority of the sources are at least 10 miles (17 km) away from the Mine Site and Mill Site and are typically located along I-40, which runs east to west through Gallup.

3.7 Noise

3.7.1 Area of Analysis

A 2-mile radius from the center of the proposed limits of disturbance for the Proposed Action was used to define the Area of Analysis for noise (Figure 3.7-1).

3.7.2 Noise Standards

Environmental noise is measured in decibels (dB) using the A-weighted scale (dBA) to represent the intensity of pressure placed on the ear by sound waves, with the scale simulating human hearing by placing greater emphasis on higher frequencies which are perceived differently than low frequencies by the human ear (HRI, 2013). Noise can be a potential occupation hazard due to prolonged exposure or particularly loud sounds. Table 3.7-1 shows various common noises, the associated decibel level, and how it might feel to a listener, measured in dBA. Approximately 70 dBA over a 24-hour period is considered the level at which a person will not experience hearing loss from environmental noise over a lifetime according to the USEPA based on Noise Control Act of 1972 (HRI, 2013). The 8-hour exposure (typical working day) at which hearing loss may be experienced is 80 dB (Table 3.7-1), twice as loud as the USEPA Noise Control Act level as each increase of 10 dB doubles the perceived loudness of a sound. USEPA lists a $L_{eq(24)}$ of 55 dBA as the level at which outdoor noise is acceptable and will not interfere with daily living (USEPA, 1974). USEPA uses the term $L_{eq(24)}$ to represent the sound energy averaged over a 24-hour time period (USEPA, 1974). The day-night average, L_{dn}, is the $L_{eq(24)}$ minus an additional 10 dBA applied to the nighttime hours (10 p.m. to 7 a.m.) because people are generally less tolerant of noise at night while trying to sleep (USEPA, 1974). USEPA estimated the rural wilderness L_{dn} to be between 20 dBA and 30 dBA (USEPA, 1974).

Table 3.7-1 Common Noises and Associated Decibel Levels

Noise		
Decibels	Equivalent Sounds	Effect
150	Jet take-off from 25 meters	Eardrum rupture
140	Aircraft carrier deck	
130	Military jet take-off	
120	Thunderclap, chain saw, oxygen torch	Very painful
110	Steel mill, car horn at 1m, live rock music (108-114)	Human pain threshold
100	Outboard motor, lawn mower, jackhammer, garbage truck	Serious hearing damage possible from 8-hour exposure
90	Motorcycle	Hearing damage likely with 8-hour exposure
80	Garbage disposal, dishwasher, freight train, average factory	Possible hearing damage with 8-hour exposure
70	Passenger car at 65 mph, vacuum cleaner, freeway from 50'	Potentially bothersome to some people
60	Conversation in restaurant, air conditioner at 100'	Fairly quiet
50	Quiet suburb, conversation at home	
40	Library, bird calls (44), lowest urban ambient sound	
30	Quiet rural area	Very quiet
20	Whisper, rustling leaves	
10	Breathing	Barely audible

Notes:

1. Modified from Purdue University Chemistry Department citing Temple University Department of Civil/Environmental Engineering Source of the information is attributed to Outdoor Noise and the Metropolitan Environment, M.C. Branch et al., Department of City Planning, City of Los Angeles, 1970.

Consultation with state, regional, local, and affected Native American tribal agencies was completed to determine any applicable noise regulations or requirements that would apply to the noise generated by the proposed construction activities. Although the State of New Mexico does not have any applicable noise regulations, the State does permit local authorities to establish local laws and regulations that prevent adverse impacts to the acoustic environment. INTERA (2017) identified the need to consult with McKinley County, Navajo Nation Environmental Protection Agency (NNEPA), and the local chapters of the Navajo Nation (Church Rock Chapter, Coyote Canyon Chapter, and Pinedale Chapter) to determine applicable regulations.

On May 1, 2017, a letter concerning applicable noise regulations was sent to the identified local agencies. The letter described the proposed construction activities at the Mine Site and requested a determination of any noise regulations or requirements that would be applicable to the construction activities. The letters sent to each of the local agencies are attached to this SER as Appendix B. The letters were sent by certified mail through the United States Postal Service, and the delivery of each letter was confirmed except for the letter to the Coyote Canyon Chapter. An email, with the letter as an attachment, was sent on May 12, 2017, to the Coyote Canyon Chapter President and Community Services Coordinator. Where necessary, follow up calls were conducted from May 11 through June 7. Follow-up communication is also provided in Appendix B of this SER.

On May 10, 2017, McKinley County sent a letter confirming that McKinley County does not have any applicable noise regulations (Appendix B). On June 9, the NNEPA confirmed that they do not have a specific noise regulation that would apply to the impacts of the proposed construction activities, however the Navajo Nation Occupation Safety and Health Administration does follow the United States Department of Labor OSHA noise limits for all construction activities on Navajo lands (29 CFR 1910.95) (Appendix B). The Navajo Nation Church Rock Chapter confirmed on May 10 that the Chapter does not have any objections to the construction noise impacts (Appendix B). The Navajo Nation Coyote Canyon Chapter did not respond to the letter, email, or phone calls concerning applicable noise regulations (Appendix B). On June 7, the Navajo Nation Pinedale Chapter confirmed that it does not have any noise regulations that would apply to the proposed construction activities (Appendix B).

3.7.3 Baseline Noise

As mentioned in Section 3.1, the majority of the land near within the Area of Analysis is used for livestock grazing (NRC, 1997). The baseline L_{dn} for an undeveloped arid environment is 22 dB [28 dBA] but can range as high as 38 dB [44 dBA] on a windy day which is typical of the spring time in New Mexico (HRI, 2013). The primary source of noise near the project area is from traffic on Highway 566 and Red Water Pond Road (Figure 3.7-1). It is estimated that due to the low density of residents and primary land use of livestock grazing, the baseline noise levels are less than 50 dB [56 dBA] (HRI, 2013).

Baseline noise levels in more concentrated population areas, such as the City of Gallup, New Mexico and town of Church Rock, New Mexico, will be similar to urban noise levels of up to 78 dB [84 dBA] (HRI, 2013). Noise monitoring data are not available for the Area of Analysis, but it is unlikely that Red Water Pond Road Community currently has baseline noise levels at urban noise levels due to its rural nature and low population density. Figure 3.7-1 shows the dispersed nature of the residences in the Red Water Pond Road Community. The residences are considered sensitive receptors for the purposes of noise analysis.

3.8 Cultural Resources

3.8.1 Applicable Federal Laws

All cultural resources identified and recorded are evaluated for significance under certain federal statutes for the preservation and management of these resources. This process is intended to ensure that cultural resources are not inadvertently destroyed by the Prosed Action and alternatives, and to ensure that local communities are involved in the decision-making process.

3.8.1.1 The National Historic Preservation Act (NHPA)

Under the Section 106 process of the National Historic Preservation Act (NHPA; 36 CFR 60.4), cultural resources may be eligible for nomination to the National Register of Historic Places if they are more than 50 years old and "possess integrity of location, design, setting, material, workmanship, feeling, and association." One or more of the following criteria (a-d) must be applicable:

a. associated with events that have made a significant contribution to the broad patterns of our history; or

b. associated with the lives of a person significant in our past; or

c. embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d. has yielded, or may be likely to yield, information important in prehistory or history.

As defined in 36 CFR 60.4, cemeteries, birthplaces, or graves of historical figures; properties owned by religious institutions or used for religious purposes; structures that have been moved from their original locations; reconstructed historical buildings; properties primarily commemorative in nature; and properties that have achieved significance within the past 50 years are not ordinarily considered eligible for the National Register. However, such properties may qualify if they are integral parts of districts that do meet the eligibility criteria.

3.8.1.2 Archaeological Resources Protection Act (ARPA)

The Archaeological Resources Protection Act of 1979 (ARPA; 43 CFR Part 7) has two fundamental purposes:

- to protect irreplaceable archaeological resources on public lands and Indian lands from unauthorized excavation, removal, damage, alteration, or defacement; and

- to increase communication and exchange of information among governmental authorities, the professional archaeological community, and private individuals having collections of archaeological resources and data that were obtained prior to enactment of the Act.

For a resource to be considered an archaeological resource and thus merit protection, it must be both more than 100 years old and of archaeological interest.

3.8.1.3 American Indian Religious Freedom Act (AIRFA)

The American Indian Religious Freedom Act (AIRFA, 42 U.S.C. § 1996) provides that American Indians have the right to believe, express, and exercise their traditional religions and have access to sites, use and possession of sacred objects, and freedom of worship through ceremonies and rites. Any site or place (prehistoric or historic) that has religious, ceremonial, or sacred aspects or components needs to be dealt with in light of this law. Anasazi sites related to Navajo cultural traditions qualify for protection, as do all Navajo ceremonial sites, unmarked traditional places, and residential structures whose owners/users want them protected for religious and cultural reasons.

3.8.1.4 Native American Graves Protection and Repatriation Act (NAGPRA)

The Native American Graves Protection and Repatriation Act (NAGPRA, 25 U.S.C. §3001) provides protection of Native American graves; establishes procedures and legal standards for the repatriation of human remains, funeral objects, sacred objects, and objects of cultural patrimony, including those from archaeological contexts; and provides the United States district courts jurisdiction over any action brought by any person alleging a violation of the Act. The Act also recognizes certain tribal, Native Hawaiian, and individual rights in regard to burial sites located on federal and Indian lands, and it sets forth procedures for the intentional excavation and inadvertent discoveries of these items.

3.8.2 Cultural Overview

The Area of Analysis, which is defined by a 50-ft buffer surrounding the limits of disturbance defined for the Proposed Action (Figure 1.1-1), is located in the Church Rock, Coyote Canyon, and Pinedale Chapters of the Navajo Nation (Figure 3.1-5). The name “Church Rock” refers to a sandstone formation at the south edge of the Church Rock Chapter that resembles a church. The sandstone formation is known as Tsé ’Íi’áhí (Standing Rock). The Navajo name for the chapter is Kinłitsoh sinilí, often translated as “Group of Yellow Houses” (Rodgers, 2004; see also Wilson, 1995 for a variation on the translation). The name likely refers to a cluster of houses once known as Indian Village constructed during the World War II era near the intersection of old US Route 66 and NM 566. A modern housing development has replaced the old housing tract.

Two Council Delegates represent the chapter on the Navajo Nation Council in Window Rock, Arizona. The chapter is located in the Eastern Agency of the Navajo Nation. Agencies are administrative units of the Navajo Nation and the BIA. The day-to-day operations are handled by a Community Services Coordinator ("Chapter Manager"). The chapter membership decides on chapter policies and decisions affecting the community at monthly chapter meetings. The central Navajo Nation government in Window Rock provides oversight of the chapter's operations.

Mineral resources in the area include coal and uranium. Baars (1995) reports that discovery of uranium in the Church Rock area in 1962 by the Pinon-Sabre Corporation and 1966 by Kerr-McGee led to competitive bid leases by the Navajo Nation. UNC's Church Rock Mine began operations shortly thereafter. The production of uranium on these leases was part of a larger San Juan Basin trend. Many Navajos worked in these mines.

Many of the community members still raise livestock. The Navajo Nation has more than 4,169 livestock permittees in the Eastern Agency alone. To own and graze livestock on the Navajo Nation, a person must have a permit issued by the BIA. In 2003, sheep, goats, cattle, horses, llamas, and alpacas numbered about 108,639 across the reservation. The predominant species is sheep, followed by cattle and goats. Livestock still play an important role in the lives of Navajo people.

A review of the confidential Sacred Places Database at the NNHPD in Window Rock in 2018 revealed no sacred places within or immediately adjacent to the Area of Analysis.

However, in reviewing the database, it is clear that the Area of Analysis and the surrounding region is important in Navajo ceremony and culture. Specific ceremonies that have history and locations where offerings are given in conjunction with traditional Navajo prayers in the area include Hózhóójí (Blessingway) and Tł'éejí (Nightway). Undoubtedly, the area figures in many more unrecorded ceremonial traditions. The database also refers to the general area as a route for the Western Water clans' return to Navajo lands, and it suggests the area as a possible route for certain ceremonial progenitors between Jemez Pueblo (to the northeast) and Walpi on the Hopi mesas (to the west). The database also hints of an early Navajo habitation in the area.

Many of the important places mentioned in the Sacred Places Database and referred to in ceremonial repertoires are natural features (hills, springs, mesas, mountains, flora and fauna) and prehistoric sites. Many archaeological sites are important in Navajo history, traditions, clan origins, and the development and practice of ceremony and rituals.

Van Valkenburgh (1974) does not identify any TCPs within or in the immediate vicinity of the Project Area. The nearest identified resource is Churchrock, Tsé 'Íi'áhí, several miles to the south. The sandstone pinnacle known as Churchrock has ceremonial significance in a Holyway ceremony (see also Linford 2000:193).

3.8.3 Survey Techniques

Ethnographic and archaeological field work conducted in support of UNC's cleanup efforts began in 2005 and continued through 2018. The techniques used to conduct ethnographic and archaeological field surveys were similar for each survey and are described in each individual report. Additional descriptions of the findings of each report are summarized in the next section.

Prior to the start of ethnographic field work, the sacred sites files and maps at NNHPD were reviewed. The files did not show any TCPs near the project area, and it was determined that a separate TCP report was not warranted. The project archaeologists began by visiting each Navajo Nation Chapter to notify them of the pending work. Community members and agencies were notified of the field work prior to mobilizing to the survey area. During ethnographic interviews, interviewees were asked if they knew of any TCPs or unmarked graves near the survey area, and former miners still in their chapters. During the on-the-ground portion of the ethnographic survey, ethnographers were able to gather data regarding potential historic Navajo sites or graves, in-use sites, or TCPs in or near the project area. The protocol for interviews adhered to the procedures outlined in NNHPD’s guidelines.

Archaeological field work consisted of a team of archaeologists conducting a 100% coverage archaeological survey of the project areas, identifying and recording any encountered archaeological sites, and marking the cultural resources with high-visibility flagging tape. Project archaeologists adhered to State of New Mexico and Navajo Nation standards for field work during all phases of the investigations. The ethnographic inventory consisted of a team of ethnographers meeting with local residents, groups, and chapter officials to inquire about any marked and unmarked Navajo burials and areas of traditional cultural significance.

All project reports were submitted to the responsible state or tribal entity for compliance review. The reports outlined the purpose of the project, the area inventoried, methods, findings, and recommendations for resource protection. Once the reports were found to be acceptable, a cultural resources compliance form was issued to the sponsor detailing the level of management recommended for cultural resources documented during the investigations.

3.8.4 Summary of Historical and Cultural Resources Investigations

Historic and cultural resources surveys and reports have been completed for both the Mine Site (Boggess and Begay, 2005), the Mill Site (Appendix E in UNC, 1975), a 68.87-acre study on lands north of the Mine Site slated for remediation (Martin and Begay, 2009), 27.5 acres of land that have been reclaimed (Begay and Wero, 2011), 73.94 acres of land in and surrounding the Mill Site for proposed borrow material (Begay, 2013), a 120-acre study in both the Mill Site and Mine Site to collect data to fill the gaps in environmental data identified in the USEPA-approved Environmental Data Gap Report (INTERA, 2015), and a 32.22-acre study in both the Mill Site and Mine Site to address changes in the limits of disturbance associated with the Proposed Action. Each report describes the physical extent of the survey, the survey techniques used, qualifications of the surveyors, the findings of the survey, and recommendations for management of all cultural resources encountered during the individual studies.

The following list summarizes each report and its findings with summary information presented in Figure 3.8-1 and Tables 3.8-1 and 3.8-2:

- In 1974, an archaeological survey of Section 2, T16N R16W, was completed on behalf of UNC. Three (3) archaeological sites were identified during the survey. One (1) site was recommended for protection by avoidance since the site was not located in an area of proposed disturbance. Excavation of the two (2) other sites was recommended (Appendix E in UNC, 1975).
- In 2005, an archaeological survey of the 125-acre Mine Site and an ethnographic study of the area were completed on behalf of UNC. No new sites were recorded, and no previously recorded sites were identified during the pre-field investigation (Boggess and Begay, 2005).
- In 2009, an archaeological survey of 68.87 acres located north of the Mine Site, which were proposed for reclamation, was completed. One (1) TCP, two (2) in-use sites, and one (1) site evaluated as not eligible for nomination to the National Register of Historic Places were identified during the survey (Martin and Begay, 2009).
- In 2011, a cultural resources inventory of 27.5 acres was completed for the proposed reclamation of two (2) parcels of land located north and east of the Mine Site. Ethnographic interviews were also conducted as part of the study. Areas of archaeological significance were identified during the survey, and conditions of compliance were defined by the Navajo Nation Historic Preservation Department, which included protecting and avoiding one (1) site during ground-disturbing activities (Begay and Wero, 2011).
- In 2013 an archaeological survey of 73.94 acres, which were proposed as areas for five (5) soil borrow pits for the Proposed Action, was completed. Four (4) archaeological sites were identified during the survey, and archaeological clearance was recommended for each site. During the survey, the project archaeologists interviewed nearby residents concerning any sacred places, burials, or TCPs that might be affected by the proposed undertaking. No TCPs were identified in the area of effect (Begay, 2013).
- In 2017, an archaeological survey of 120 acres to collect data to fill the gaps in environmental data identified in the USEPA-approved INTERA (2015), was completed. Five archaeological sites were identified and assessed: two previously identified archaeological sites located on private lands and three newly identified archaeological sites on Navajo Nation Tribal Trust lands. During the survey, the project archaeologists interviewed nearby residents concerning any sacred places, burials, or TCPs that might be affected by the proposed undertaking. No TCPs were identified in the area of effect (Martin et al., 2017).
- In 2018, an archaeological survey of 32.22 acres was completed in both UNC and NECR areas to address changes in the limits of disturbance identified by Stantec (Begay, 2018,

forthcoming). Two new archaeological sites were identified and assessed with (1) site located on private lands and one site on Navajo Nation Tribal Trust lands. It was recommended that the proposed undertaking proceed as both of the archaeological sites are located in the cultural buffer zone surrounding the area of potential effect and will not be impacted by the Proposed Action or alternatives (Begay, 2018, forthcoming).

In addition to the surveys completed for the Proposed Action, a cultural resources inventory of 56.38 acres was completed by Wero (2015) for the nearby former Quivira uranium mine (Figure 1.0-1). This survey was in support of the proposed reclamation of four (4) former uranium mine vent holes, one (1) staging area where an earthen dam is located and six (6) access roads in the Quivira abandoned uranium mine areas adjacent to the NECR project area. Four (4) archaeological sites were identified during the archaeological survey, and ethnographic interviews were conducted to determine if any local TCPs or marked and unmarked burials were present in the Project Area. Archaeological clearance with specific site treatment recommendations were provided to the NNHPD. Cultural resources compliance was obtained for the client utilizing the recommendations provided by Dinétahdóó Cultural Resources Management (DCRM). This survey report offers the most recent analysis of sacred places within a 1-mile radius of the project area (Wero, 2015).

Table 3.8-1 Archaeological Resources Documented During Previous and Recent Investigations in the Project Area

Documented Archaeological Resources				
Designation	Classification	Land Status	Recommendation	Report
LA 11617	Prehistoric Anasazi Habitation	Private (UNC)	Avoidance	UNC, 1975
LA 11618	Prehistoric Anasazi Habitation	Private (UNC)	Excavation	UNC, 1975
Unknown	Historic Navajo Activity Area	Navajo Tribal Trust	No Recommendations	Martin and Begay, 2009
NM-Q-21-100	Prehistoric Anasazi Habitation	Navajo Tribal Trust	Avoidance	Begay and Wero, 2011
NM-Q-20-50	Historic Navajo Habitation	Navajo Tribal Trust	Avoidance	Begay and Wero, 2011
LA 177466	Prehistoric Anasazi Artifact Scatter	Private (UNC)	Avoidance	Begay, 2013
LA 177467	Prehistoric Anasazi Habitation	Private (UNC)	Avoidance	Begay, 2013
LA 177468	Prehistoric Anasazi Habitation	Private (UNC)	Avoidance	Begay, 2013
LA 177469	Prehistoric Anasazi Habitation	Private (UNC)	Avoidance	Begay, 2013
NM-Q-20-69	Prehistoric Anasazi Artifact Scatter	Navajo Tribal Trust	Avoidance	Martin, Begay, and Wero, 2017.
NM-Q-20-70	Prehistoric Anasazi Habitation	Navajo Tribal Trust	Avoidance	Martin, Begay, and Wero, 2017.
NM-Q-20-70	Prehistoric Anasazi Artifact Scatter	Navajo Tribal Trust	Avoidance	Martin, Begay, and Wero, 2017.
LA 177466 (Previously Documented)	Prehistoric Anasazi Artifact Scatter	Private (UNC)	Avoidance	Martin, Begay, and Wero, 2017.
LA 11617 (Previously Documented)	Prehistoric Anasazi Habitation	Private (UNC)	Avoidance	Martin, Begay, and Wero, 2017.
NM-Q-20-72	Multicomponent Rock Art Panel	Navajo Tribal Trust	No Recommendations	Begay, 2018 (forthcoming)
LA 191969	Prehistoric Anasazi Artifact Scatter	Private (UNC)	Avoidance	Begay, 2018 (forthcoming)

Table 3.8-2 contains documented archaeological sites in the UNC and NECR areas and the eligibility recommendations provided in the report where the resources are detailed. Eligibility recommendations are based on the requirements in the federal legislation described above, NHPA, NRHP, AIRFA, and NAGPRA.

Table 3.8-2 Evaluation of Cultural Resources Documented All During Previous Investigations in the UNC and NECR Mine Areas

Documented Cultural Resources			
Designation	Classification	Evaluation	Report
LA 11617	Prehistoric Anasazi Habitation	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	UNC, 1975
LA 11618	Prehistoric Anasazi Habitation	ARPA: No, NRHP: No AIRFA: No, NAGPRA: No Resource has been excavated.	UNC, 1975
Unknown	Historic Navajo Activity Area	ARPA: No, NRHP: No AIRFA: No, NAGPRA: No	Martin and Begay, 2009
NM-Q-21-100	Prehistoric Anasazi Habitation	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Begay and Wero, 2011
NM-Q-20-50	Historic Navajo Habitation	ARPA: Yes, NRHP: Yes AIRFA: Yes, NAGPRA: Yes	Begay and Wero, 2011
LA 177466	Prehistoric Anasazi Artifact Scatter	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Begay, 2013
LA 177467	Prehistoric Anasazi Habitation	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Begay, 2013
LA 177468	Prehistoric Anasazi Habitation	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Begay, 2013
LA 177469	Prehistoric Anasazi Habitation	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Begay, 2013
NM-Q-20-69	Prehistoric Anasazi Artifact Scatter	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Martin, Begay, and Wero, 2017.
NM-Q-20-70	Prehistoric Anasazi Habitation	AARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Martin, Begay, and Wero, 2017.
NM-Q-20-70	Prehistoric Anasazi Artifact Scatter	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Martin, Begay, and Wero, 2017.
LA 177466 (Previously Documented)	Prehistoric Anasazi Artifact Scatter	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Martin, Begay, and Wero, 2017.
LA 11617 (Previously Documented)	Prehistoric Anasazi Habitation	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Martin, Begay, and Wero, 2017.
NM-Q-20-72	Multicomponent Rock Art Panel	ARPA: No, NRHP: No AIRFA: No, NAGPRA: No	Begay, 2018 (forthcoming)
LA 191969	Prehistoric Anasazi Artifact Scatter	ARPA: Yes, NRHP: Yes AIRFA: No, NAGPRA: No	Begay, 2018 (forthcoming)

Each report was submitted to the appropriate agency depending on jurisdiction, including the New Mexico Environmental Improvement Agency, the NNHPD, and the New Mexico State Historic Preservation Division (NMHPD) of the Department of Cultural Affairs. However, if Native American burials or cultural items, eligible resources, or sacred sites are discovered within the surveyed areas to be disturbed, then all operations in the immediate vicinity of the discovery would cease, and the required notification, consultation, and reporting processes will be followed in compliance with the Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC Section 3001 *et seq* and its regulations under Title 43 CFR Part 10), the National Historic Preservation Act (NHPA)(16 USC 470 *et seq*; 36 CFR Part 800), the Archeological Resources

Protection Act of 1979 (ARPA)(16 USC Sections 47000-47011; 43 CFR Part 7), and the American Indian Religious Freedom Act (AIRFA) (42 USC Section 1996 *et seq*).

3.9 Visual/Scenic Resources

The area where the Proposed Action would be visible defines the viewshed boundary, which is used, in turn, as the Area of Analysis for visual and scenic resources. The viewshed boundary for the Proposed Action (Figure 3.9-1), which consists of dozens of separate polygons from where the Proposed Action would be visible, was developed using a GIS-based approach. The visualization modeling combines the limits of disturbance, digital elevation models of the project and surrounding area, and high-resolution imagery for McKinley County. Specifically, five datasets were analyzed:

1. 10-m (⅓ arc-second) Digital Elevation Model (DEM) from the USGS National Elevation Dataset (NED) of the surrounding area (USGS, 2017)
2. 1-m Pre-Construction DEM of the Proposed Action and surrounding area from MWH/Stantec (2017a)
3. 1-m Post-Construction DEM of the Proposed Action and surrounding area from MWH/Stantec (2017b)
4. Limit of Disturbance boundary file (MWH/Stantec, 2016)
5. USDA NAIP (National Agriculture Imagery Program) (2016) High-Resolution Imagery for McKinley County
6. First, twelve 10-m DEM tiles from the USGS NED were combined into one seamless mosaic that served as the pre-construction surface dataset that defined the pre-construction surface. To duplicate the resolution of the pre-construction dataset, the post-construction DEM developed from the design of the Proposed Action was re-sampled at the same scale and then extended beyond the limits of disturbance by stitching it to the undisturbed pre-construction surface. Locations where the Proposed Action would be visible were identified using the Visibility tool in the Spatial Analyst toolset. USDA NAIP (2016) imagery was then used to evaluate the results of the viewshed analysis and 3D modeling and to generate the texture for areas with elevation changed caused by the Proposed Action.

Following the Bureau of Land Management (BLM) Visual Contrast Rating guideline and suggestion to select key viewpoints where people are present and/or have public sensitivity (BLM, 1986b), key viewpoints were identified from within the zone of theoretical visibility as homes, residences, roads, or other visually significant resources. The locations of building structures were obtained from TerraSpectra Geomatics (2017), which published a point shapefile of building structures within 1 mile of Abandoned Uranium Mines on and within 1 mile of the Navajo Nation. Initial key viewpoints (Figure 3.9-2) were selected from this file after the following criteria had been applied:

- Structures must fall within the viewshed boundary
- Mine related structures or structures no longer in existence based on evaluation of 2016 NAIP and recent Google Earth imagery must be removed.

Once these above criteria had been applied, the GIS Grouping Analysis tool was used to group structures based on their location using a k-means statistical method. Finally, initial key viewpoints were selected by determining which structure locations possessed the highest viewing frequency of the Proposed Action in each group. This was achieved by recording the viewing frequency number from the VALUE field of the viewshed raster for each structure location using the Extract Multi Values to Point GIS tool. Additional key viewpoints were also identified while in the field. These additional viewpoints were selected because they provided good alternate viewing angles/locations of the Proposed Action, or, because after evaluating the area utilizing the Avenza Maps mobile application, they were highly likely to be in view of the Proposed Action.

Prior to collecting photographs from the key observations points, a letter was sent to the members of the Red Water Pond Road Community (RWPRC), located immediately north of the Mine Site, to inform members of the community of the purpose of collecting photographs (Castiglia, 2017). For key observation points located outside of the RWPRC, permission to collect photographs was granted verbally, in person, on an individual basis. In instances where owners were not present to grant permission or where viewpoint locations appeared heavily screened by vegetation, photographs were collected from public roads close to the key viewpoint.

In preparation for field photography, a map of the viewshed was developed using ArcGIS. The map displayed the extent of the Proposed Action along with the initial selection of 12 key viewpoints. The field map was loaded into Avenza PDF Maps, a mobile application, which was used to navigate to key viewpoints, orient the camera in the correct direction for Photograph collection, record coordinate information, and take notes documenting weather conditions and bearing information. At each key viewpoint, the camera, either a Nikon D80 or a Nikon D610, was mounted and leveled on a tripod, and Avenza PDF Maps was used to orient the camera in the direction of the Proposed Action. Coordinate information, bearing direction and current weather conditions were noted in Avenza PDF Maps, while ISO, focal length, shutter speed, date and time were recorded by the camera. All metadata were extracted from both the Avenza PDF Maps application and the cameras and compiled into one table, included in Appendix C of this SER, along with the filed photographs used to compile metadata and the photo visualizations created from the data..

There are no local or regional high-quality or significant views within the Area of Analysis. Regionally, and outside of the Area of Analysis, the primary areas with important views that attract visitors for their aesthetic qualities include the Chaco Culture Center National Historic Park, El Malpais National Monument, El Morro National Monument, Bisti Wilderness, and the Red Rock State Park, none of which are located near the Mine Site (NRC, 1997). Most of the region in the

Area of Analysis is classified by the BLM as VRM Class III and IV (NRC, 2009). Class III is a landscape where contrasts to basic elements caused by an activity can be evident but should remain subordinate to the existing landscape. A Class I landscape is one where activity attracts attention and is a dominant feature of the landscape in terms of scale. There are no Class I VRM areas in northwestern New Mexico, where the Mine Site is located (NRC, 2009). Class II locations in northern New Mexico are described in NRC, 2009, but do not exist near the Mine Site.

A map of the constructed features in the vicinity of the Mine Site can be seen on Figure 3.9-3. This map shows the distribution of local residences with minimal, dispersed development of the area outside of the NECR Mine and Mill Sites. Overall, the area surrounding the Mine Site is fairly sparsely populated with minimal infrastructure. Residents in the Red Water Pond Road Community, immediately north of the Mine Site, are closest to the limits of disturbance.

3.10 Socioeconomics

Much of the information included in this section is also contained in the Crownpoint Uranium Project Environmental Report, which was produced in March 2013 (HRI, 2013). As there has not been another nationwide census since that publication, much of the data about McKinley county has remained unchanged. The Area of Analysis for socioeconomics is McKinley County, New Mexico, and the census designated place is Church Rock, New Mexico. The City of Gallup, New Mexico, is the nearest major metropolitan area and is used for comparison.

3.10.1 Demographics

As of the last census in 2010, the population of McKinley County, New Mexico, was 71,492 (USCB, 2018). The annual population estimate from July 1, 2017 places the projected population at 72,564 residents, a growth rate of 1.5%, comparable to the State of New Mexico as a whole (USCB, 2018).

Table 3.10-1 shows the racial distribution of the populations of McKinley County, the State of New Mexico, the City of Gallup, and the town of Church Rock, which is considered a Census Designated Place and the closest location with data to the Project Area. Compared to the rest of the state, both McKinley County and Church Rock have a higher percentage of American Indians in the population.

Table 3.10-1 Race Distribution of Church Rock, Gallup, McKinley County, and New Mexico

Demographics								
Race	Church Rock[1]		Gallup		McKinley County		New Mexico	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
White	5	0.4%	7,631	35.2%	10,834	15.2%	1,407,876	68.4%
Black/African American	3	0.3%	257	1.2%	360	0.5%	42,550	2.1%
American Indian and Alaska Native	1,113	98.7%	9,498	43.8%	53,988	75.5%	193,222	9.4%
Asian	0	0.0%	434	2.0%	568	0.8%	28,208	1.4%
Pacific Islander	0	0.0%	11	0.1%	23	0.03%	1,810	0.1%
Other Race	0	0.0%	2,597	12.0%	3,522	4.9%	308,503	15.0%
Two or More Races	7	0.6%	1,250	5.8%	2,197	3.1%	77,010	3.7%
Total	1,128	100%	21,678	100%	71,492	100%	2,059,179	100%
Hispanic[3]	41	3.6%	6,864	31.7%	9,473	13.3%	953,403	46.3%

Notes:

1. Church Rock is considered a Census Designated Place and is the closest location with data to the Site.
2. Distributions are based on the 2010 Census Demographic Profile Data.
3. Hispanic origin can be associated with any race and is calculated as a separate component of total population.

3.10.2 Income

Table 3.10-2 shows the income breakdown of the populations of the same four areas analyzed for demographics above. The mean household incomes in McKinley County ($42,845) and Church Rock ($45,872) fall well below the statewide mean household income of $63,057. The mean income of Church Rock may be slightly higher than that of McKinley County as a whole due to the rural nature of the county and the effect of the local Fire Rock Navajo Casino which opened in 2008 (HRI, 2013). Hydro Resources, Inc. (HRI) examined the county income by race and noted that the American Indian population makes up a disproportionate number of low-income residents; however, that rate has been improving since 1989 (HRI, 2013). The percentage of residents below the poverty line in McKinley County is approximately twice as high as for New Mexico as a whole (HRI, 2013). Per capita personal income for residents of McKinley County in 2013 was $24,383, making it the lowest per capita income in the state, compared to $35,965 for the State of New Mexico and $44,765 for the United States (NMSU, 2016). Between 2007 and 2013, the per capita income percentage growth in McKinley County was 11.4% which was comparable to the nation’s rate of 12.4% despite McKinley County’s low income over all (NMSU, 2016).

Table 3.10-2 Income Distributions of Church Rock, Gallup, McKinley County, and New Mexico

Demographics								
Income Level	Church Rock[1]		Gallup		McKinley County		New Mexico	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Total Households	238	--	6,692	--	18,968	--	762,551	--
<$10,000	49	20.6%	1,284	19.2%	4,251	22.4%	73,898	9.7%
$10,000-$14,999	18	7.6%	549	8.2%	1,632	8.6%	49,598	6.5%
$15,000-$24,999	32	13.4%	713	10.7%	2,626	13.8%	95,366	12.5%
$25,000-$34,999	13	5.5%	710	10.6%	2,234	11.8%	83,931	11.0%
$35,000-$49,000	35	14.7%	488	7.3%	1,985	10.5%	106,317	13.9%
$50,000-$74,000	43	18.1%	1,243	18.6%	3,042	16.0%	130,192	17.1%
$75,000-$99,999	32	13.4%	545	8.1%	1,344	7.1%	86,104	11.3%
$100,000-$149,999	12	5.0%	852	12.7%	1,381	7.3%	83,894	11.0%
$150,000-$199,999	0	0.0%	180	2.7%	273	1.4%	29,082	3.8%
>$200,000	4	1.7%	128	1.9%	200	1.1%	23,902	3.1%
Median household income	$36,250		$38,646		$29,272		$45,674	
Mean household income	$45,872		$54,331		$42,845		$63,057	

Notes:

1. Church Rock is considered a Census Designated Place and is the closest location with data to the Site.
2. Data from the 2012-2016 American Community Survey 5-Year Estimates, 2016 version.

3.10.3 Employment and Education

Unemployment in Church Rock, Gallup, McKinley County, and New Mexico all fall between 4.5% and 7.9% which ranges slightly higher than the national average of 4.7% as of 2016 population estimates for all residents over the age of 16 (USCB, 2016). Employment in McKinley County decreased 7.4% between 2007 and 2013 during the start of the decline (2007) in uranium mining in the County (NMSU, 2016). McKinley County had a lower employment to population ratio (0.40) than either the state (0.52) or the nation (0.58), indicating that a low percentage of the population of McKinley County was employed when the data was collected in 2013 (NMSU, 2016). During the county's comprehensive planning process, county official noted limited job opportunities in the county due to low wages, high unemployment, and low job opportunity growth that did not keep pace with population growth (McKinley County, 2012).

The industry sector with the highest percentage of employed workers for both Church Rock and Gallup is the management/business/financial sector (Table 3.10-3) (USCB, 2016). The highest in McKinley County is education/legal/arts/media, whereas New Mexico employs more people in the administrative support sector than any other (USCB, 2016). Although the primary land use designation in McKinley County is agricultural/grazing, the farming/fishing/forestry sector has the smallest percentage of employees in the county (0.6%) (USCB, 2016). As of 2012, the Gallup-McKinley School District was the highest employer in the county, followed by the Gallup Indian Medical Center and the Rehoboth McKinley Christian Hospital (McKinley County, 2012). The mining industry has been a decreasingly important sector in McKinley County since 2007 (NMSU, 2016). The approximate number of people employed in the industry in 2012 was 121, which decreased to approximately 30 in 2015 (BBER, 2016).

Table 3.10-3 Occupation Distributions of Church Rock, Gallup, McKinley County and New Mexico

Occupation Category	Church Rock[1]		Gallup		McKinley County		New Mexico	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Civilian employed population 16 years and older	372	--	8,349	--	22,979	--	876,210	--
Management, business, financial	144	38.7%	3,303	39.6%	1,789	7.8%	110,874	12.7%
Computer, engineering, science	18	4.8%	268	3.2%	541	2.4%	47,722	5.4%
Education, legal, service, arts, media	78	21.0%	1,578	18.9%	3,140	13.7%	102,506	11.7%
Healthcare	12	3.2%	544	6.5%	1,210	5.3%	49,895	5.7%
Healthcare support	10	2.7%	205	2.5%	752	3.3%	23,228	2.7%
Protective services	13	3.5%	334	4.0%	787	3.4%	24,625	2.8%
Food preparation and serving	37	9.9%	532	6.4%	1,486	6.5%	56,421	6.4%
Cleaning and maintenance	7	1.9%	280	3.4%	1,287	5.6%	38,221	4.4%
Personal care	3	0.8%	417	5.0%	1,641	7.1%	39,084	4.5%
Sales	50	13.4%	565	6.8%	2,053	8.9%	88,958	10.2%
Administrative support	58	15.6%	1,308	15.7%	3,009	13.1%	115,680	13.2%
Farming, fishing, forestry	0	0.0%	49	0.6%	141	0.6%	8,363	1.0%
Construction	16	4.3%	385	4.6%	1,488	6.5%	56,708	6.5%
Installation, maintenance, repair	11	3.0%	128	1.5%	468	2.0%	32,976	3.8%
Production	10	2.7%	314	3.8%	1,710	7.4%	32,764	3.7%
Transportation	13	3.5%	343	4.1%	1,023	4.5%	31,042	3.5%
Material moving	0	0.0%	186	2.2%	454	2.0%	17,143	2.0%

Notes:

1. Church Rock is considered a Census Designated Place and is the closest location with data to the Site.
2. Data from the 2012-2016 American Community Survey 5-Year Estimates, 2016 version.
3. Estimates of count have some margin of error so percentages may not sum to 100%.

Compared to the State of New Mexico, McKinley County has a higher percentage of residents with less than a 9th grade education, or some high school but no diploma (Table 3.10-4), and a lower percentage of residents with advanced degrees (USCB, 2016). Native Americans and people of Hispanic origin have a lower percentage of residents with high school diplomas or a bachelor’s degree compared to those who identified as white across all four locations of interest (Church Rock CDP, Gallup, McKinley County, and New Mexico) (USCB, 2016). These data are comparable to what is seen on a national scale in terms of educational degrees grouped by race, although the percentages of college degree holders near the Project Area are generally lower than national percentages (USCB, 2016).

Current employment at the Project Site is six permanent full-time employees working under contract for UNC. Of the six, two live near Gallup, two near Thoreau, New Mexico, one near Vanderwagen, New Mexico, and one at Bluewater Lake, New Mexico. From the west, the route from Vanderwagen to Gallup is along Highway 602. From Gallup, these four employees continue on to Church Rock on Highway 118 (Old Route 66) and then to the Project Site on Highway 566. From the east, from Bluewater Lake to Thoreau, the route is on Highway 612. From Thoreau, the most often-traveled route is along Interstate 40, where the employees exit at Highway 118 and take the same route as those from Gallup (see Figure 3.10-1) (Spitz, 2018).

Table 3.10-4 Education Distributions of Church Rock, Gallup, McKinley County, and New Mexico

Education										
Degree Earned	Church Rock[1]		Gallup		McKinley County		New Mexico		United States	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Population 25 years and older	673	--	12732	--	43,490	--	1,373,920	--	213,649,147	--
Less than 9th grade	37	5.5%	972	7.6%	4,286	9.9%	92,818	6.8%	11,913,913	5.6%
9th to 12th grade, no diploma	107	15.9%	1,642	12.9%	7,105	16.3%	118,383	8.6%	15,904,467	7.4%
High school graduate (includes equivalency)	218	32.4%	3,365	26.4%	14,565	33.5%	362,627	26.4%	58,820,411	27.5%
Some college, no degree	177	26.3%	3,132	24.6%	9,808	22.6%	322,880	23.5%	44,772,845	21.0%
Associate's degree	63	9.4%	975	7.7%	2,942	6.8%	110,974	8.1%	17,469,724	8.2%
Bachelor's degree	57	8.5%	1,346	10.6%	2,854	6.6%	206,247	15.0%	40,189,920	18.8%
Graduate or professional degree	14	2.1%	1,300	10.2%	1,930	4.4%	159,991	11.6%	24,577,867	11.5%
White alone	5	--	6,183	--	8,326	--	1,046,556	--	162,504,000	--
High school graduate or higher	5	100.0%	5,077	82.1%	6,849	82.3%	906,254	86.6%	144,534,668	88.9%
Bachelor's degree or higher	3	60.0%	1,860	30.1%	2,418	29.0%	312,430	29.9%	51,383,399	31.6%
American Indian or Alaska Native alone	642	--	4,520	--	32,121	--	114,242	--	1,574,326	--
High school graduate or higher	504	78.5%	3,423	75.7%	22,998	71.6%	90,654	79.4%	1,248,671	79.3%
Bachelor's degree or higher	68	10.6%	427	9.4%	1,820	5.7%	12,260	10.7%	220,385	14.0%
Hispanic or Latino Origin	3	--	4,082	--	5,443	--	582,803	--	30,666,598	--
High school graduate or higher	0	0.0%	3,059	74.9%	3,802	69.9%	424,474	72.8%	20,158,627	65.7%
Bachelor's degree or higher	0	0.0%	516	12.6%	614	11.3%	86,010	14.8%	4,513,125	14.7%

Notes:

1. Church Rock is considered a Census Designated Place and is the closest location with data to the Site.
2. Data from the 2012-2016 American Community Survey 5-Year Estimates, 2016 version.
3. Degree by race is not an exclusive metric so percentages can be greater than 100% as one person can qualify for both categories.

3.10.4 Housing and Public Infrastructure

3.10.4.1 Housing

Table 3.10-5 shows statistics for the housing situation in the four areas used as comparison to the Project Area. The median value of an owner-occupied house in Church Rock and McKinley County is less than half of the median value for houses in Gallup and New Mexico over all (USCB, 2016). There is a higher vacancy rate for housing units in McKinley County (USCB, 2016), compared to the other locations shown in the table. McKinley County has a higher percentage of houses that lack plumbing, kitchen facilities, or phone service than the other study areas (USCB, 2016). Most of the existing houses are prefabricated structures built in the 1970s and 1980s which were brought in to accommodate the rapid influx of workers during that time period due to the demand for uranium and the volume of mines in the area (McKinley County, 2012). Many of those residences are deteriorating but a dearth of adequate housing has extended the life of those that are substandard dwellings (McKinley County, 2012).

Table 3.10-5 Housing Distributions of Church Rock, Gallup, McKinley County, and New Mexico

Housing								
Housing Metric	Church Rock[1]		Gallup		McKinley County		New Mexico	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Total housing units	289	--	8,296	--	25,768	--	912,445	--
Median value owner-occupied housing	$55,000	--	$132,000	--	$ 68,000	--	$ 161,600	--
Median contract rent	$684	--	$690	--	$634	--	$792	--
Occupied housing units	238	82.4%	6,692	80.7%	18,968	73.6%	762,551	83.6%
Vacant housing units	51	17.6%	1,604	19.3%	6,800	26.4%	149,894	16.4%
Owner occupied	162	68.1%	3,937	58.8%	13,601	71.7%	516,819	67.8%
Renter occupied	76	31.9%	2,755	41.2%	5,367	28.3%	245,732	32.2%
Persons per occupied housing unit	4.46	--	3.47	--	4.03	--	2.71	--
Lacking complete plumbing	13	5.5%	15	0.2%	1,975	10.4%	7,784	1.0%
Lacking complete kitchen facilities	13	5.5%	22	0.3%	1,391	7.3%	7,683	1.0%
No telephone service available	20	8.4%	414	6.2%	2,157	11.4%	25,608	3.4%

Notes:

1. Church Rock is considered a Census Designated Place and is the closest location with data to the Site.
2. Data from the 2012-2016 American Community Survey 5-Year Estimates, 2016 version.

3.10.4.2 Education Resources

The Project Area is part of the Gallup-McKinley School District which encompasses 36 schools throughout the county (GMCS, 2018). McKinley County has approximately 16,925 students enrolled in schools for kindergarten through 12th grade, 94% of which are served by public institutions (USCB, 2016). Miller Elementary, a kindergarten through 5th grade elementary school, is the sole public school in Church Rock (GMCS, 2018). For middle and high school, Church Rock students can attend Gallup Middle School and Gallup High School which are the most closely located secondary schools (GMCS, 2018). For higher education, McKinley County is served by the University of New Mexico at Gallup and Diné College, chartered by the Navajo Nation (UNM, 2018; HRI, 2013). As of 2016, approximately 3,590 residents were matriculating at an undergraduate institution, with another 490 students seeking graduate or professional degrees (USCB, 2016).

3.10.4.3 Public Services

McKinley County Fire and Emergency Medical Services (EMS) comprises 22 fire stations across 18 districts throughout the county, covering approximately 5,600 square miles of state, county, and tribal land (McKinley County, 2018). The department is primarily staffed by volunteers in addition to eight full-time and two part-time firefighters/Emergency Medical Technicians (EMTs) (McKinley County, 2018). The closest volunteer fire department to the Project Area is likely District 9 located in Crownpoint with up to 20 volunteers and basic firefighting equipment (HRI, 2013). The smaller Mariano Lake/Pinedale Volunteer Fire Department, composed of two to three volunteers, has the potential to provide additional firefighting protection (HRI, 2013).

Emergency health services are also provided by the fire districts in conjunction with EMS for McKinley County and Navajo Nation (HRI, 2013). There are no medical facilities in the Red Water Pond Road Community nor in Church Rock; however, residents can seek healthcare in Gallup at the Gallup Indian Medical Center. Although a shortage of healthcare providers contributes to a lack of accessibility, poverty is the single greatest contributor to poor health in the county, affecting one third of the county's population (McKinley County, 2012).

No public transit services exist in Church Rock or the majority of McKinley County; however Navajo Transit and other senior and disabled services operate in the county, as do public school bus services (McKinley County, 2012). The McKinley County Comprehensive Plan Update (2012) indicates that most of the transportation initiatives involve maintenance of existing roadways and improvement of county roads to make rural areas more accessible and less susceptible to flooding and erosion. Maintenance of county roads is extremely important in McKinley County because approximately 61% of the county's residents do not live in a city, town, or incorporated settlement where services are available (McKinley County, 2012). County residents spend an average time commuting to work between 25 and 49 minutes, making road safety and quality paramount to support transportation (McKinley County, 2012).

No mutual water systems were identified in the NMED Drinking Water Bureau monitoring database for the residents of Church Rock or Red Water Pond Road. The Church Rock community has a water and wastewater system located about five miles south of the Church Rock site (NRC, 1997). The Navajo Tribal Utility Authority operates a public water system for Mariano Lake, Pinedale, and Church Rock, New Mexico (NTUA, 2017). Drinking water for residents comes from four different groundwater sources (NTUA, 2017).

3.10.5 Taxes and Local Finance

Property tax is levied on real property for residents of McKinley County at a rate of $31.567 for every $1,000 of assessed value, which is one third the fair market value (HRI, 2013). Based on the median price of an occupant-owned residence in the McKinley County, the average annual property tax would be $716. The county collects taxes at the same rate as property tax for uranium production where the assessed value is 50% of the sale price (HRI, 2013). The gross receipts tax rate schedule for McKinley County is 6.75% (NMTRD, 2018). Additional taxation options for McKinley County include property tax on equipment and improvements outside of Navajo Nation and on any Navajo land that has been privately acquired (HRI, 2013). McKinley County also receives 0.25% gross tax proceeds as part of the goods and services tax collected by New Mexico (HRI, 2013). The tax is levied against businesses but is passed on to consumers in the equivalent of a sales tax (HRI, 2013).

New Mexico income tax is applied to total net income (state-derived and non-state income sources), and the percentage of state income is applied to gross tax (NMTRD, 2010). The State also applies a 0.75% natural resources tax and 3.5% severance tax on uranium at the price of sale (NMTRD, 2012).

Navajo Nation taxation can be applied to areas outside of the Navajo Reservation if the land is considered "Indian country" as defined in 18 U.S. C. Section 1151 (40 Code of Federal Regulations § 144.3) (HRI, 2013). Navajo Nation sales tax was raised from 5% to 6% as of July 2018 (ONTC, 2018). Business sales tax is 5% on all business gross receipts, and a 10% deduction is allowed for all gross receipts for compensation paid to Navajo employees (HRI, 2013). Navajo business activities tax is 3% on construction payments to contracts and subcontractors (HRI, 2013).

3.11 Public and Occupational Health

This section describes existing conditions of the Project Area with respect to public and occupational health. The Area of Analysis for this section is based on the proposed limits of disturbance at the Project Area (Figure 3.11-1) associated with the Proposed Action. The background conditions for the Project Area, a summary of existing and historical conditions of the Project Area and its surrounding area, and characterization activities that have been performed are identified and discussed. Identified information describing public and occupational health conditions associated with the Project Area is organized and discussed within the following major sections:

1. Major sources and levels of background radiation exposure, including natural and man-made sources;
2. Current sources and levels of exposure to radioactive materials;
3. Major sources and levels of chemical exposure;
4. Historical exposures to radioactive materials;
5. Occupational injury rates and occupational fatality rates; and
6. Summary of health effects studies.

3.11.1 Major Sources and Levels of Background Radiation Exposure, Including Natural and Man-made Sources

The major sources and levels of natural and man-made background exposure for the Area of Analysis are discussed in this section. Site-specific background concentrations for the Area of Analysis are also presented.

3.11.1.1 Major Sources of Background Radiation Exposure

Radiation dose is a measure of the amount of ionizing energy that is deposited in the human body. Ionizing radiation is a natural component of the environment and members of the public are routinely exposed to sources of radiation. Exposure of the public to radiation occurs as a result of natural background radiation and anthropogenic (man-made) radiation sources. Background radiation is defined by 10 CFR 20 as radiation from cosmic sources, naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material); and global fallout as it exists in the environment from the testing or use of nuclear explosive devices, or from past nuclear accidents such as Chernobyl, that contribute to background radiation and are not under the control of the licensee. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the NRC. Anthropogenic sources include radiation from medical procedures, consumer products, and industrial and occupational exposures.

Natural background radiation is the largest source of radiation exposure to humans (50%) (HPS, 2015). Primary among these radionuclides is radon and its decay products, which contribute to public exposure through inhalation. Radon concentrations depend on the uranium and thorium content of the soil, which varies widely across the United States. Cosmic radiation from space is another natural source of radiation, with some of this radiation passing through the earth's atmosphere to reach the earth's surface. Most cosmic radiation enters the atmosphere near the earth's poles, where shielding by the earth's magnetic field is the weakest, and at high altitudes, where the earth's atmosphere is the thinnest. Cosmogenic radionuclides consist primarily of tritium (hydrogen-3), carbon-14, and beryllium-7 (HPS 2015).

Anthropogenic medical sources of radiation exposure to humans contribute almost equally (e.g., 48 %) to that of natural background radiation sources (HPS 2015). For example, medical diagnostic procedures using radioactive material(s) and x-rays are the primary anthropogenic sources of radiation to the general public. The remaining 2 % of radiation exposure is attributed to consumer products, occupational exposure, and industrial exposure (HPS 2015).

3.11.1.2 Levels of Background Radiation Exposure

The National Council on Radiation Protection and Measurements (NCRP) estimates the average dose to the public from background radiation sources is 3.1 mSv/yr (310 mrem/yr) (NCRP 2009) but this rate varies by location and elevation. The average background radiation dose for New Mexico is 3.15 mSv/yr [315 mrem/yr] (NRC, 2009); only slightly higher than the estimated average dose to the public. In addition, the average member of the public receives approximately 3.1 mSv/yr [310 mrem/yr] from anthropogenic sources. Therefore, the total exposure for the average resident of the United States from both background and anthropogenic radiation sources is 6.2 mSv/yr [620 mrem/yr] (NCRP 2009). Assuming the same dose rate from anthropogenic sources, the total exposure for New Mexico residents from background and anthropogenic sources is equivalent to that of an average United States resident.

3.11.1.3 Radiological and Chemical Background Soil Concentrations at the Mine Site

Site-specific soil background concentrations were established for the Mine Site based on sampling conducted on August 17, 2006. The selected background sampling area was judged to have similar geology, topography and drainage, is located approximately one-half mile upwind of the Project Area and has no evidence of impacts from mining activities. The background area is shown in Figure 3.11-1.

A total of 27 surface soil samples were collected from an area located to the northwest of the Boneyard (area where refuse, discarded equipment from the Mine Site were stored). Background concentrations were measured for the following constituents: Ra-226, arsenic, molybdenum, selenium, uranium, and vanadium. The background concentrations for each constituent were determined based on the concentrations measured in the soil samples collected. Table 3.11-1 presents summary statistics for the measured background soil concentrations.

Table 3.11-1 Statistical Summary of Chemical and Radiological Background Concentrations—Mine Site

Analyte	Arsenic	Molybdenum	Selenium	Uranium	Vanadium	Ra-226
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	pCi/g
Minimum	2.0	2.5	0.1	0.8	18.0	0.6
Maximum	10.0	2.5	0.7	1.8	40.7	1.3
Mean	3.7	2.5	0.4	1.1	26.7	1.0
Standard Deviation	1.97	0.00	0.20	0.22	5.72	0.18
Skewness	2.27	NA	0.25	1.09	0.28	-0.59
Background (95%UCL)	4.6	2.5	0.4	1.2	28.7	1.1

Source: Table 4, Technical Memorandum: Results of Background and Radium-226 Correlation Sampling, Northeast Church Rock Mine Site, United Nuclear Corporation, October 2006

3.11.2 Current Sources and Levels of Exposure to Radioactive Materials

The following presents details regarding the sources of radioactive material at the Project Area, including the sources and estimated levels of exposure for a receptor at the Project Area. Figures 3.11-2 and 3.11-3 illustrate the physical layout of the Mine Site and Mill Site, respectively, and the location of receptors relative to these parts of the Project Area.

3.11.2.1 Mine Site

The Mine Site is considered the major source of soil contamination present within the Project Area. Operations at the Mine Site left uranium protore (low grade ore), waste rock, and overburden onsite after the operations ended. A risk-based soil field screening level (FSL) of 2.24 pCi/g was established for Ra-226 to define areas within the Mine Site that represent sources of radioactive material that require remedial action. This screening level corresponds to a risk of 2 × 10^{-4} risk for a residential scenario (USEPA 2011a).

3.11.2.1.1 Sources of Radiologically Contaminated Materials—Mine Site

The following former operational areas located within the Mine Site boundaries (as shown in Figure 3.11-2) were characterized and were found to have levels of Ra-226 above the Field Screening Level (FSL) of 2.24 pCi/g. The areas were characterized in 2007 and 2014 to determine the level of contamination present as well as the spatial extent to confirm or further refine the RAL boundaries.

NECR 1 and NECR 2. NECR 1 and 2 are pads that held ore and low-grade ore that were mined from the NECR Mine. The stockpiled ore was then transported from the NECR 1 and 2 pads to the Mill Site for processing. NECR 1 is in the northeastern end and NECR 2 is located in the southwestern end of the Mine Site as shown in Figure 3.11-2.

NECR-1 "Step-Out Area." The step-out area is adjacent to NECR-1 and includes the former trailer park area, former fuel storage area, sediment pond, ion exchange plant, and other areas containing mine wastes (Figure 3.11-2). The "Step-Out Area" is located to the north and east of the mine. The Trailer Park Area is located south of the eastern edge of NECR 1.

An Interim Removal Action was performed from August 2009 to May 2010. The work included demolition of existing mine buildings and associated concrete slabs located within the NECR 1 footprint. Additionally, approximately 109,800 CY of soil from the Step-Out Area, including approximately 33,000 cy from the Unnamed Arroyo and 4,000 cy of total petroleum hydrocarbon (TPH) impacted soil (TPH soil) were excavated (USEPA 2013). The excavated soils were placed on the NECR-1 pile, which was capped with 6 to 12 inches of clean imported fill. Areas that were excavated to a depth of more than about 1-foot (including the Unnamed Arroyo) were backfilled with imported material. In general, all soils with an activity concentration for radium-226 above 3.0 PCi/g were removed from the Unnamed Arroyo and the Step-Out Area until the average residual activity concentrations were less than 2.24 pCi/g in the excavated areas.

Sandfill Areas 1, 2 & 3. During closure of the Mill, the sandfill areas were used as temporary staging grounds for tailings material that had been processed through the Mill Site facility. The material was staged in the sandfill areas until placed in the mine stopes.

Ponds 1, 2 and 3. The ponds held stormwater and water pumped from the mine during dewatering. The water was subsequently treated in the ponds prior to discharge (under NPDES permit) to the Unnamed Arroyo (Arroyo #1).

Sediment Pad. The sediment pad was a holding area for sediments that were regularly removed from the ponds. The sediment was held at the Sediment Pad until transferred to the Mill Site.

Former Magazine Area. This area was used as a storage area for blasting materials for the mining operation. The area was surveyed as part of the step-out area of NECR 2.

Vent Holes 3 and 8. These vents were part of the underground mining operation.

Boneyard. Refuse and discarded equipment from the Mine Site were stored here.

Non-Economic Material Storage Area (NEMSA). This area was for storage of the mine overburden and low-grade ore (unmarketable materials).

3.11.2.1.2 Levels of Exposure to Radioactive Materials—Mine Site

The radiological surveys conducted in 2007 and 2014 to define the boundaries of the source areas described in Section 3.11 reported the radiation levels at the Mine Site in either units of counts per minute (cpm) or picoCurie per gram (pCi/g). INTERA (2017) documents the conversion of the activity-based levels to a corresponding dose rate.

For the purposes of the dose assessment, the Mine Site source areas were combined into three exposure areas, which are consistent with the Final Status Survey (FSS) boundaries presented in Appendix T of the LAR. The FSS grouped areas with elevated Ra-226 concentrations based on their proximity to each other and their vertical extent of contamination. The areas were combined as follows:

- FSS Area 1: Venthole 3 and 8 Area;
- FSS Area 2: NECR 1, NECR 2, Sandfill Areas 1, 2, and 3, Ponds 1, 2 and 3, Boneyard, NEMSA, and Sediment Pad;
- FSS Area 3: Trailer Park Area and Sediment Collection Area.

Figure 3.11-4 illustrates boundaries of the three exposure areas.

The dose assessment conservatively assumed a hypothetical future residential exposure scenario, consistent with the human health risk assessment (HHRA) presented in MWH (2007). The levels of exposure in mSv/yr and mrem/yr for each of the three exposure areas, as well as the entire site combined, are presented in Table 3.11-2.

Table 3.11-2 Levels of Radiological Exposure at Mine Site (INTERA, 2017)

Exposure Area	Area (m^2)	Dose (Site-related Sources plus Background)	
		(mSv/yr)	(mrem/yr)
1	37,032	1.34	134
2	384,830	4.47	444
3	53,551	0.82	82
Entire Site	475,413	3.81	381

3.11.2.2 Mill Site

An estimated 3.5 million tons of mill tailings were disposed in the tailings disposal area (TDA), which is divided by dikes into three cells: the South, Central, and North Cells (Figure 3.11-3). Surface reclamation is complete, except for the area of the south tailing cell covered by two evaporation ponds, which are part of the NRC-licensed groundwater corrective action program. The tailings cells have been capped with a radon barrier cover as part of the reclamation activities directed by the NRC.

3.11.2.2.1 Levels of Exposure to Radioactive Materials—Mill Site

From October 21, 2013 to February 18, 2014, radiological surveys were completed for the Mill Site (AVM, 2014). Pre- and post-drilling gamma radiation level surveys were conducted at 33 borehole locations at the Mill Site Tailings Disposal Area. The gamma radiation level rates at these 33 locations, measured in counts per minute, were converted to an exposure rate (micro Rad per hour, µR/hr) to determine the exposure level at the Mill Site. The average exposure rate across all of the locations is approximately 21 µR/hr. As mentioned previously, typically background radiation in the United States averages 315 mrem/yr, or 36 µrem/hr.

The average measured radon flux in 1996 was measured to be 5.7 pCi/m^2/s, compared to the limit of 20 pCi/m^2/s (NRC 1998). As a result, the tailings are not considered to be a current or future source for exposure to radiological (or chemical) contaminants for the Proposed Action.

3.11.2.3 Groundwater Underlying Project Area

Active corrective action systems for tailings seepage remediation at the Mill Site are in operation under NRC Source Materials License 1475. The contaminants of concern in groundwater from acidic mill tailings seepage are thorium, radium, aluminum, ammonia, and iron. There is no current human exposure to groundwater at the Project Area. Quarterly groundwater sampling is conducted by UNC personnel using appropriate Personal Protective Equipment (PPE). Future exposure to contaminants in groundwater is unlikely as described in Dwyer (2018). As a result, groundwater would not be a current or future source for exposure to radiological (or chemical) contaminants for the Proposed Action or the alternatives. Section 3.4 of this report provides additional information regarding groundwater and associated remedial activities.

3.11.3 Current Sources and Levels of Exposure to Chemicals

The following sections describe the current sources and levels of exposure to chemical contaminants in the Area of Analysis.

3.11.3.1 Mine Site Chemical Source Areas

Based on the past characterization activities, elevated levels of uranium are present throughout the Mine Site. The USEPA Region 9 PRG of 200 mg/kg was used as the uranium FSL (USEPA, 2011). It is noted that USEPA has subsequently harmonized Regions 3, 6 and 9 risk-based screening levels into a single table: "Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites." The RSL PRG for uranium has since changed, with the current value being 230 mg/kg for industrial soil exposure.

The same radiological source areas described in Section 3.11 were characterized and were found to also have levels of uranium above the field screening level (FSL) of 200 mg/kg (MWH 2007). Arsenic was detected at concentrations above background (the arsenic FSL of 1.6 mg/kg is less than the site-specific background concentration of 3.7 mg/kg). However, the data did not indicate a spatial pattern nor a correlation with the Ra-226 concentrations to confirm that the presence of arsenic was site-related (MWH 2007). Molybdenum, selenium, and vanadium concentrations were also measured but all results were well below their respective FSLs (MWH 2007). Table 3.11-3 summarizes the surface soil sampling results for uranium (metal).

Table 3.11-3. Surface Soil Sample Results for Uranium

Mine Site Source Area	Total Number of Samples	Number of Exceeding Samples	Concentration Range of Exceedances (mg/kg)
NECR 1	47	4	209 to 758
NECR 2	19	1	370
Trailer Area	5	0	--
Sandfill 1	18	0	--
Sandfill 2	13	0	--
Sandfill 3	15	1	396
Ponds 1 and 2	23	3	339 to 1080
Pond 3	15	3	1020 to 3970
Sediment Pad	14	3	363 to 1640
Vent Hole 3/8 area	5	1	358
Boneyard	5	0	--
NEMSA	5	0	--

3.11.3.2 Mine Site Levels of Exposure to Chemical Materials

A Human Health Risk Assessment (HHRA) was completed based on the laboratory analytical results of surface soils and subsurface soils to a depth of 10 ft below ground surface at the Mine Site (MWH, 2007). The HHRA was performed for each source area, assuming both onsite receptors (defined as current / future maintenance worker personnel, hypothetical future livestock grazer, and hypothetical future onsite residents) and offsite receptors (current / future residents and hypothetical future livestock grazer) exposed to soils and sediments at the Mine Site. The HHRA provides an estimate of the potential impacts to a receptor as a result of exposure to the chemical material present at the Mine Site.

Two exposure scenarios were evaluated in the HHRA for each receptor scenario: Scenario 1 evaluates exposure (and health risk) to receptors when only direct soil exposure pathways (i.e., incidental ingestion and inhalation of fugitive dust) are considered. Scenario 2 includes the evaluation of exposure and risk for five pathways (i.e., incidental soil ingestion, inhalation of fugitive dust, consumption of homegrown produce, consumption of homegrown meat/eggs, and external radiation) (USEPA, 2007). However, for a future site maintenance worker, Scenario 2 does not include consumption of home-grown plants or consumption of locally raised meat and eggs. Additionally, for the onsite livestock grazer, Scenario 2 does not include consumption of locally raised eggs or homegrown plants.

The results of the HHRA for potential exposure to uranium present at the Mine Site are summarized below:

- For scenario 1, noncancer hazards above the USEPA risk management threshold (Hazard Index [HI] of 1) were identified for surface and/or subsurface soil exposures for a hypothetical future onsite resident in each of the Mine Site chemical source areas. Uranium was identified as a chemical contaminant of concern (COC) for the hypothetical future onsite resident. For the remaining exposure scenarios, no surface or subsurface soil exposures in the Mine Site chemical source areas resulted in a noncancer hazard above the USEPA risk management threshold (HI of 1).
- For scenario 2, noncancer hazards above the USEPA risk management threshold (HI of 1) were identified for surface and/or subsurface soil exposures for a hypothetical future onsite resident in the Mine Site chemical source areas except for the Sandfill 1 and Sandfill 2 Areas and the Boneyard. For the remaining exposure scenarios, no surface or subsurface soil exposures in the Mine Site chemical source areas resulted in a noncancer hazard above the USEPA risk management threshold (HI of 1).

The results of the risk assessment, for offsite receptors are presented in the following:

- For Scenario 1, none of the Home Sites have an incremental risk or HQ above the USEPA risk management range of cancer risk equal to 1E-06 to 1E-04 or HQ > 1.
- For Scenario 2, none of the Home Sites on the western and eastern side of the Unnamed Arroyo have an incremental risk or HQ above the USEPA risk management range of cancer risk equal to 1E-06 to 1E-04 or HQ > 1.

3.11.4 Historical Sources and Levels of Exposure to Radioactive Materials

Historical sources of radioactive material include former mining activity near the Project Area and routine and unplanned releases associated with past uranium recovery activities.

3.11.4.1 Historical Mine Site Sources

There are no active nuclear facilities or active uranium recovery activities in the immediate Project Area that could result in potential additional radiation exposure to the local population. The NE Church Rock Quivira No. 1 and No. 1 East mine site are two former uranium mines that were operated by Kerr McGee Corporation from 1976 to 1985 and are located approximately 0.5 miles north of the Project Area (Figure 1.0-1). All the uranium ore from the Quivira Site mines, approximately five million pounds, was processed at the Ambrosia Lake Mill located in Grants, New Mexico (USEPA, 2013). This site was screened in October 2008 and an expanded site screening report was published in May 2010 (Weston 2010), which documented elevated gamma readings above background levels at the Project Area and the surrounding area. Contaminated material from the Quivira Mine has been observed in the road crown and shoulders and has migrated to at least one homesite east of Red Water Pond Road. USEPA Region 9 has overseen the following cleanup activities at the Quivira Mine:

- Removal of contaminated soil from one property on the east side of Red Water Pond Road,
- Repair of fences to keep people and animals off the Project Area,
- Stabilization of the mine site waste piles, and
- Application of chip seal paving to Red Water Pond Road from the turnoff at Rt. 566 up to the bridge.

A report of the mitigative work performed and characterization data collected at or near the mine site was published in September 2011. According to the report, the Project Area is to be monitored periodically for road sealing and related erosion work, erosion control measures, and fences and gates (RAML, 2011).

3.11.4.2 Historical Exposures to Radioactive Materials

The following provides a summary of historical exposures to radioactive materials in the Project Area.

3.11.4.2.1 Mill Site Tailings Pond Dam Failure

On July 16, 1979, the tailings pond dam at the Mill Site failed releasing approximately 94 million gallons of tailings liquid along with an estimated 1,100 tons of solids. A small emergency retention pond captured the approximately 1,100 tons of solid material from the release (NRC, 1981). However, most of the liquids flowed down Pipeline Arroyo into the Puerco River drainage system and the underlying alluvium. A multiagency cleanup effort and assessment was conducted and documented in the NRC report entitled "NUREG/CR-2449 Survey of Radionuclide Distributions Resulting from the Church Rock, New Mexico, Uranium Mill Tailings Pond Dam Failure" (NRC, 1981).

Pacific Northwest Laboratory (PNL), based on the request from the New Mexico Environmental Improvement Division and the NRC performed a site investigation and collected around 2400 samples from the Rio Puerco environment to characterize the tailings release extent and to determine the effectiveness of the cleanup operations. PNL provided a number of conclusions based on the investigation as summarized in NUREG/CR-2449 (NRC 1981). Some of the key conclusions from the investigation were:

- Concentrations of lead-210, Ra-226, and U-238 in samples throughout the length of the arroyo are not distinguishable from natural background concentrations.
- Concentrations of Thorium-230 range from background levels to levels elevated considerably greater than background.
- Sediment samples from two site-variability studies indicate that there is considerable Th-230 concentration variability within even limited areas of the arroyo.

The New Mexico Environmental Improvement Division (NMEID) prepared a health and environmental assessment report on the tailings dam failure, *The Church Rock Uranium Mill Tailings Spill: A Health and Environmental Assessment* (NMEID 1983), which reported the following conclusions:

- The United States Centers for Disease Control (CDC) in cooperation with the Church Rock community, found no documented human consumption of river water.
- Surface water contained levels of radioactivity and certain metals that approach or exceed standards and guidelines designed to protect the health of people, livestock and agricultural crops. Therefore, Puerco River water might be hazardous if used over several years as the primary source of drinking water, livestock water or irrigation water. The Puerco River was not recommended as a primary source of water for human consumption, livestock watering or irrigation.
- Based on limited testing conducted by the CDC, the additional radiation risk from consumption of local livestock was small. Further sampling was recommended to determine concentrations of radioactivity and metals in edible tissues and to re-evaluate long-term risk associated with the consumption of such tissues.
- No public, private or municipal wells producing water for domestic use or livestock watering were affected by the spill. However, public or private wells drawing water from the alluvium should be tested annually by appropriate authorities for salinity and gross alpha radioactivity.
- The hazard associated with the inhalation of contaminated river sediments suspended as respirable dust was negligible for local residents. Sampling of airborne dust along the Puerco River in Gallup soon after the spill showed only background levels of radioactivity.
- Native grasses, shrubs and corn samples collected along the Puerco River contained concentrations of radioactivity that fell within the range of background values.
- Neither an aerial nor a ground survey of the Puerco River area detected any external gamma radiation attributable to the spill.

3.11.4.2.2 Exposures Associated with Previous Uranium Recovery Operations

D'Appolonia, (1981) describes the use of the MILDOS-AREA computer code (developed by Argonne National Laboratory and Nuclear Regulatory Commission (NRC)) to calculate environmental radiation doses from atmospheric air particulate and radon gas transport from radionuclide sources emitted during uranium recovery operations. MILDOS provides estimated radiological airborne doses from milling operations to individuals and the regional population within a 50-mile radius (Stenge and Bander, 1981). The sources contributing to air particulate and radon gas releases at the Mill Site are: stack releases, dust and radon gas from tailings, dust and radon gas from ore piles, transportation of ore from the mine to the mill, and dust from ore-crushing operations. Two types of doses were calculated:

(1) The 40 CFR 190 regulatory dose. Defined as the dose received by an individual at a receptor location excluding the dose from tailings, Rn-222 and its daughter products: A MILDOS run was made using only the yellowcake dryer stack, yellowcake packaging stack, and pile sources. The greatest dose received by a child's lungs at the nearest residence location was 54 mrem/yr., which exceeded the regulatory limit of 25 mrem/yr. in Section 3-300 m of the Radiation Protection Regulations (NMEID, 1981).

(2) The total annual dose. Defined as the dose received by an individual at a receptor location from all radionuclide sources, including tailings, Rn-222 and its daughter products: The results of the dose assessments showed that the calculated total annual population doses were within the maximum allowable dose limits of 500 mrem/yr. as provided in Part 4 of the Radiation Protection Regulations (NMEID, 1980). The results also showed that the maximum doses were calculated to be received by the bronchial tubes via the inhalation pathway. Due to historical mining and milling operations, both the Mine Site and the Mill Site are contaminated with residual radiological contaminants. Mine waste within Mine Site and the solid and liquid wastes within the Tailings Disposal Area at the Mill Site resulted in elevated level radiological contamination at the Project Area.

3.11.5 Occupational Injury Rates and Occupational Fatality Rates

Historical occupational exposure rates are available in the NRC's Radiation Exposure Information and Reporting System (REIRS) for Radiation Workers and in Annual reports within NUREG-0713, *Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities* (NRC, various dates). Occupational injury and occupational fatality rates can be obtained from the Bureau of Labor Statistics for specific industries. The Mine Safety and Health Administration (MSHA) maintains statistics on occupational injury and fatality rates for all active mine sites. However, the Project Area is no longer operating as an active mining (or uranium recovery) site so MSHA statistics on injury and fatalities, if any, are not available to report. No other site-specific information related to the injury rates and occupational facilities rates were found within those information sources.

Occupational health and safety risks to workers from exposure to radiation are also regulated by the NRC, mainly through its Radiation Protection Standards contained in 10 CFR 20. In addition to annual radiation dose limits, these regulations incorporate the principal of maintaining doses “as low as reasonably achievable,” (ALARA) taking into consideration the purpose of the licensed activity and its benefits, technology for reducing doses and the associated health and safety benefits. To comply with these standards, measures are implemented for protecting workers, ensuring exposures and resulting does are less than the occupational limits as well as ALARA. The radiation safety office of the UNC performs an annual ALARA audit pursuant to the license conditions of the UNC’s License No, SUA-1475, and prepares a report entitled, “Environmental and Personal Monitoring Program for Inactive Sites”. According to these reports, it can be concluded that radiation exposure to employees, contractors and public is well below respective permissible limits and is normally low as can be expected.

Also of concern with respect to occupational health and safety are industrial hazards and exposure to non-radioactive pollutants, which can include normal industrial airborne pollutants associated with service equipment (e.g., vehicles) and fugitive dust emissions from access roads. Due to the current inactive facility status, no existing measurements associated with the non-radioactive pollutants relative to occupational health standards are currently available.

3.11.6 Summary of Health Effects Studies

Results of analytical samples and human health risk assessments summarized in previous sections indicated that concentrations of Ra-226 identified in soil and mine waste exceed background, pose an unacceptable excess lifetime cancer risk greater than 1×10^{-4}, and exceed USEPA Action Levels. Exposure to high levels of radium can result in an increased incidence of bone, liver, and breast cancer (ATSDR, 1999). The USEPA and the National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation, has stated that radium is a known human carcinogen (ATSDR,1999). Inhalation of radium contaminated particulates is of particular concern. Radium emits alpha radiation, which, when inhaled, becomes a source of ionizing radiation in the lung and throat, possibly leading to toxic effects.

For chemical contaminants, only levels of uranium were found be above the field screening level (FSL) of 200 mg/kg (MWH, 2007). Arsenic was detected at concentrations above background (the arsenic FSL of 1.6 mg/kg is less than the site-specific background concentration of 3.7 mg/kg); the data, however, did not confirm that the presence of arsenic was site-related. Molybdenum, selenium, and vanadium concentrations were also measured but all results were well below their respective FSLs (MWH, 2007).

Several investigations aimed at understanding the potential health effects of past exposure and continuing exposure from uranium mining in the larger Navajo community have been initiated. For example, the Diné Network for Environmental Health (DiNEH) project studies various environmental hazards including proximity to mining and milling sites and waste piles, as well as consumption of unregulated drinking water contaminated with uranium and other heavy metals (J

DeLemos et.al, 2007). According to the project, renal disease is pervasive throughout the Navajo Nation, with chronic kidney disease being three times more prevalent than in the general United States population. Diabetes and hypertension, risk factors for kidney disease, are also common among the Navajo people, but are not alone likely to account for the tripling of renal disease. It should be noted that this report does not specifically discuss studies of health effects to Navajo people living in proximity to the Mine or Mill Sites.

Between 2008 and 2012, USEPA and Navajo Nation Environmental Protection Agency (NNEPA) conducted screening level assessments of 521 abandoned uranium mines, with detailed assessments of the 45 sites most likely to pose a threat to human health or the environment (USEPA 2014a). The results of the screening indicated:

- Levels of gamma radiation for 71 mines are at less than two times background levels. Areas with levels that are at or below two times background levels should pose little or no current threat to residents.
- Levels of gamma radiation for 177 mines are above two times but below ten times background levels. Long-term exposure to soils at these mines should be avoided. Residents should not build homes, corrals or other structures, and should not gather building materials from these sites.
- Levels of gamma radiation for 226 mines are above higher than ten times background levels. Proximity of mines to homes is an important factor in determining risk to residents.
- No gamma radiation measurement could be collected from 47 mines.

The Mine Site is the highest priority cleanup on USEPA's abandoned uranium mines ranking list (USEPA, 2014a). A total of 24,012 gamma radiation measurements were collected. Measurements ranged from 8,587 to 115,129 counts per minute (cpm). Background levels were collected from 9 separate locations, and composited background level of 13,615 was established.

In May 2014, United States Government Accountability Office released a report, Uranium Contamination – Overall Scope, Time Frame, and Cost Information is Needed for Contamination Cleanup on the Navajo Reservation (GAO, 2014). The report included the following studies to show the health impacts associated with the exposure of uranium:

- Navajo community members who have lived near these sites have reported a variety of serious health effects, including cancers, according to CDC.
- USEPA reports that exposure to gamma radiation—such as from waste rock located near abandoned mines—can cause a variety of cancers, including lung cancer and leukemia, and that exposure to radon can cause lung cancer. Because of these potential dangers, USEPA recommends that people stay away from areas on the Navajo reservation with especially high levels of radiation—more than 10-times above the naturally-occurring, background radiation—to avoid potential health effects.

- ATSDR and USEPA have noted that abandoned mines pose a risk especially to children, when a residential scenario is a realistic land use on / around the Mine Site, since children tend to put dirt in their mouths, and the dirt at the mines could be contaminated.
- USEPA noted in the 2008 Health and Environmental Impacts of Uranium Contamination in the Navajo Nation 5-year plan (USEPA, 2008) that inhabitants of structures constructed with uranium mining waste are at risk of developing lung cancer because of the increased presence of radon in indoor air. In addition, given the consumption by Navajo residents of livestock that have grazed on plants located on or near abandoned mine sites, residents and researchers have identified the need to study the potential for exposure to radiation through consuming these animals.

3.12 Waste Management

This section describes the results of previous inventories completed to characterize the presence and estimated volume of radioactive, hazardous, mixed and solid wastes at the Mine and Mill Sites, which combined are used to define the Area of Analysis for this section. Because the Area of Analysis is limited to former mining and milling operations, there is currently no waste being generated, with the exception of a small amount of solid waste from routine administrative activities conducted at the UNC office and from a remedial groundwater system licensed by the NRC. As a result, the information presented herein is focused on characterizing the waste generated by former and historic operations, as identified by a number of waste inventories and investigations in support of the design of the Proposed Action.

3.12.1 Radioactive Waste

The principal source of radioactive waste within the Area of Analysis is mine waste from the Mine Site. The generation of mine waste ceased when mining activities were shut down at the Mine Site in 1982. To meet the requirements of the USEPA ROD (USEPA, 2013), mine waste with concentrations of radium-226 above 2.24 pCi/g and uranium above 230 mg/kg would be excavated and disposed of under the Proposed Action and Alternatives B, C, and D. Although this waste is considered radioactive, it is considered non-byproduct material, as defined by Section 11e.(2) of the AEA. The volume of mine waste to be excavated and removed from the Mine Site over an anticipated 3.5-year construction period is conservatively estimated to be approximately 1,000,000 CY of overburden, waste rock and sub-economic material, or protore, referred to collectively as TENORM. This volume is based on the results of gamma radiation surveys, soil sampling, and laboratory analysis completed by UNC (MWH, 2007; MWH, 2008; MWH; 2014). Although the original ER allowed for TENORM to be used as surface fill, UNC subsequently agreed to permanently dispose of mine waste to achieve a level protective of human health and the environment as required by the Design AOC (USEPA, 2015).

Under source materials license number SUA-1475, as amended, the NRC permits UNC to possess byproduct material at the TDA in the form of uranium waste tailings and other byproduct wastes generated by past uranium milling operations. Though this byproduct material does exist within the Area of Analysis, no radioactive waste would be generated from the TDA under any of the alternatives. Instead, the Proposed Action and Alternatives B, C, and D would each dispose of non-PTW waste on top of the Mill Site TDA, each using the same proposed design to meet NRC requirements for modifying the existing repository. In addition, approximately 19,000 CY of PTW would be disposed of at a licensed, offsite facility, as identified in each alternative.

3.12.2 Hazardous Waste

Inventories of petroleum-impacted soils within the Area of Analysis have been completed to assess the vertical and lateral extent of waste in the subsurface. The location and extent of TPH were investigated by MWH (2010b) and MWH (2010a). As summarized in MWH (2014a), diesel-range petroleum hydrocarbons (DROs) were identified during soil excavation activities at the NECR-1 pad and SO-1 areas. A bioventing pilot study was then conducted in 2011 (MWH, 2011), which demonstrated that the DROs could be treated effectively by bioremediation and bioventing, augmented by monitored natural attenuation, and excavation and stockpiling of impacted soils. Bioventing is currently ongoing. In addition, to manage this waste, approximately 4,000 CY of TPH-impacted soils were excavated in 2009 and another approximately 3,700 CY were excavated in 2012 (MWH, 2014a). The excavated TPH-impacted soils were placed in the TPH Stockpile area (Figure 3.11-2).

Investigations to determine the presence of any asbestos containing material (ACM) at the Mine Site were also completed for UNC as part of the pre-design studies (MWH, 2014). Five test pits to depths of were installed 10 to 25-ft in length and 3 to 4 ft below ground surface in the northeast corner of Pond 1 (Figure 3.11-2) to evaluate the presence of potential ACM in the area where vermiculite insulation material was suspected to be present based on anecdotal evidence (MWH, 2014a). Pieces of observed floor tile scattered at the surface and in the test pits were collected and submitted for laboratory analysis. Laboratory sample analyses indicated the white material contains 2 % chrysotile asbestos and the black mastic contains 3 % chrysotile asbestos, which qualifies as ACM (MWH, 2014a).

3.12.3 Mixed and Solid Wastes

Inventories of observable surface debris and solid waste were conducted to quantify the volume and type of debris present as part of the Pre-Design Studies for the Mill Site (MWH, 2014a) and Mine Site (MWH, 2014b). The debris included concrete, building remains, pipes, waste piles, and other scrap material. A written description and photographic record of the debris; an estimate of the size, depth, and/or quantity of the debris; and survey coordinates of debris locations were recorded for each object or area identified as containing debris. A geophysical survey was also conducted at the Mine Site to locate subsurface debris, and test trenches were dug in select locations to visually characterize the types of materials present (MWH, 2007). The limits of disturbance for the Proposed Action includes areas identified to contain mixed and solid wastes, even in the absence of radioactive waste that exceeds the RAL.

3.12.4 Current Disposal Sites and Radiation Sources

There are no direct radiation sources stored onsite at either the former Mine Site or Mill Site. The current disposal site within the Area of Analysis is limited to the Mill Site TDA, which is described in Chapter 1. In addition to the Mill Site TDA, licensed facilities that would accept PTW under the Proposed Action and Alternatives B, C and D are each identified in Chapter 2. The Mill Site TDA is and would continue to be licensed by the NRC and the offsite facilities are each regulated by the appropriate local or federal regulatory agency responsible for the accepted waste types.

CHAPTER 4. ENVIRONMENTAL IMPACTS

The following subsections 4.1 through 4.12 provide information and an analysis of the environmental impacts which may be expected within the Area of Analysis for each designated resource. For each resource, the Area of Analysis is defined, as well as the methodology and assumptions used in analysis. Section 4.13 presents information about Waste Management for the Proposed Action and alternatives. Chapter 5 describes the mitigation measures that would be implemented to minimize the potential adverse impacts identified for the Proposed Action or alternatives.

The Area of Analysis will vary depending upon the resource and the action evaluated. In general, the Area of Analysis is evaluated as local or regional. Environmental impacts are evaluated for the No Action Alternative, the Proposed Action, and the proposed alternatives B through D.

For each resource, the following terminology is used to describe the temporal context and significance of impact due to the implementation of each alternative.

Temporal Impacts

Short-term: Effects would last for the duration of the implementation of the alternative considered.
Long-term: Effects would last longer than the duration of the alternative considered.
Permanent: Effects would be permanent.

Significance Criteria

The following significance conclusions are indicated as appropriate.

Negligible: Effects would be so slight as to not be measurable.
Minor: The environmental effects would not be detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource.
Moderate: The environmental effects would be sufficient to alter noticeably, but not to destabilize important attributes of the resource.
Major: The environmental effects would be clearly noticeable and would be sufficient to destabilize important attributes of the resource.

4.1 Land Use Impacts

This section describes the impacts on land use that would be expected under each alternative. The land uses considered in this section are presented in Section 3.1 of this SER and are depicted on Figure 3.1-6. Issues concerning land use include impacts to existing uses of lands or changes in the uses of land due to a federal action or decision.

4.1.1 Land Use Impacts Analysis

Area of Analysis

The Area of Analysis for land use resources was analyzed for the No Action Alternative, the Proposed Action, and Alternatives B through D for local and regional environmental impacts, which are defined as follows:

Local: Land use in and within two miles of the Project Area
Regional: Land use within greater areas of McKinley County and/or along haul routes, depending upon the action taken.

Methodology

Impacts were evaluated by evaluating the changes in land use that would occur because of a given alternative, such as a change in institutional control, restrictions on uses to permit a given action or activity, or total acreage of land disturbed.

Assumptions

The analysis assumes under each action alternative that existing land-use restrictions in place by the USEPA would be released following the verification surveys to confirm cleanup activities had achieved the RAL.

4.1.2 Potential Land Use Impacts for Each Alternative

4.1.2.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not take place and no impacts to land use would occur. Local land use at the Mine Site would continue to be subject to restricted use due to the mine waste remaining onsite. Land use at the Mill Site would continue to be subject to restricted use due to the existing presence of mine tailings. No mine waste would be transported on haul roads from the Mine Site to the Mill Site, so regional land outside the Project Area that currently has unrestricted use would remain unrestricted.

4.1.2.2 Alternative A — Proposed Action

Under the Proposed Action, local impacts to land use would result primarily from surface-disturbing activities associated with the excavation of mine waste at the Mine Site, construction of haul and access roads from the Mine Site to the Mill Site, and improvements to the Mine Site Outlet Channel (MSOC) over Unnamed Arroyo No. 1 (Appendix F of the LAR).

Regional impacts may result from construction and mine waste hauling activities. During construction, grazing outside of areas which are currently under restricted use would also be restricted along haul/access roads, along Unnamed Arroyo No. 1, and other parts of the Limits of Disturbance, impacting a total of approximately 57 acres, as shown in Figure 4.1-1. Institutional controls that currently restrict land use at the Mine Site would be short-term and are expected to be released following the verification surveys to confirm cleanup has achieved the RAL. Land use would remain unchanged at the UNC Mill Site, as construction of the Repository atop the TDA would still place the facility under restricted use under UMTRCA. In addition, current well monitoring activities occurring on UNC property would not be affected by the construction activities.

These short-term, adverse impacts to land use would occur during the approximately 3.5-year construction period for the Proposed Action (Appendix K of the LAR). However, in contrast to this short-term adverse impact, long-term impacts would include beneficial impacts on land use associated with the release of the Mine Site and its associated haul/access roads for unrestricted use upon the successful completion of cleanup, as shown in Figure 4.1-2. The entire 124-acre Mine Site would be released for unrestricted use, and the 57 acres of temporarily restricted disturbed areas would return to unrestricted use.

4.1.2.3 Alternative B — Conveyance

Under Alternative B, land use impacts are expected to be local and approximately 2 acres less than those for the Proposed Action (Table 4.1-1). The Mine Site haul and access roads would not be constructed, and land use surrounding these areas would remain unchanged from the No Action Alternative. However, the conveyor and adjacent access road would result in restricted use. See Figure 4.1-3. Otherwise, there would be no difference in regional land use under this alternative as compared to the Proposed Action.

4.1.2.4 Alternative C — Material Sourcing for Cover

The sourcing of cover material from the Jetty Area would eliminate the need to use the Borrow Areas, and reduce the area disturbed by 48 acres (Table 4.4-1). However, the Jetty Area, the four Borrow Areas, and the Borrow Area Haul Roads east of NM 566 are all within the UNC Mill Site, which is currently designated as restricted use and would remain restricted after the Proposed Action or any of the alternatives. Therefore, the impacts to land use under Alternative C would be the same as under the Proposed Action.

4.1.2.5 Alternative D — Disposal of Principal Threat Waste

Because both the White Mesa and Clive facilities are licensed and controlled, there would be no difference in land use impacts under this alternative as compared to the Proposed Action (Table 4.1-1).

Table 4.1-1. Predicted Acres Disturbed

	Acres Disturbed				
Disturbance Feature	No Action	Alternative A Proposed Action	Alternative B Conveyance	Alternative C Material Sourcing for Cover	Alternative D PTW Disposal
Mine Site	136	136	136	136	136
North Channel/Arroyo	0	3	3	3	3
TDA Repository	96	96	96	96	96
Jetty Area	0	22	22	22	22
Repository Yards	0	13	13	13	13
Support Zone	0	13	13	13	13
Topsoil Stockpile	0	1	1	1	1
General Haul/Access Roads	0	8	6	8	8
North Borrow Area	0	10	10	0	10
South Borrow Area	0	14	14	0	14
East Borrow Area	0	9	9	0	9
West Borrow Area	0	9	9	0	9
North Borrow Haul Road	0	2	2	0	2
South Borrow Haul Road	0	3	3	0	3
East Borrow Haul Road	0	0	0	0	0
West Borrow Haul Road	0	2	2	0	2
TOTAL	231	340	338	292	340

4.1.3 Cumulative Impacts to Land Use

4.1.3.1 Interim Removal Actions at Mine Site

Cumulative impacts include the impacts of the Proposed Action and past clean-up activities conducted in 2009 and 2010 at SO-1, unnamed arroyo number 1, and SO-2. These past actions combined with the potential impacts of the Mine Site clean-up in the Proposed Action would result in an overall increase in land available for unrestricted use.

4.1.3.2 Structure Remediation

Assuming that the remediation of structures would not result in a change in land use, there would be no cumulative impact on land use when combined with the Proposed Action or alternatives.

4.1.3.3 Quivira Mine Site

Additionally, clean-up activities at the Quivira Mine Site combined with Alternatives B through D would also have a positive, cumulative impact on land use, due to additional land becoming available for use. However, details of future activities at the Quivira Mine Site are not known well enough to conclusively assess impacts with certainty.

4.2 Transportation Impacts

This section describes the potential transportation impacts associated with the Proposed Action and each alternative. The transportation routes considered in this section are presented in Section 3.2 of this SER. Other sections discuss associated, potential impacts that could result from changes in land use (Section 4.1), fugitive dust (Section 4.7), or noise (Section 4.8). Mitigation measures which may reduce adverse impacts are described in Chapter 5.

4.2.1 Transportation Impacts Analysis

Area of Analysis

The Area of Analysis for transportation was analyzed for the No Action Alternative, the Proposed Action, and Alternatives B through D for local and regional environmental impacts, which are defined as follows:

Local: Within the Project Area, resulting from construction and use of a haul road crossing on NM 566 for transport of mine waste from the Mine Site to the Mill Site Repository.

Regional: Outside of the Project Area, dependent upon action taken. All actions except for the No Action Alternative include offsite transport of PTW using the existing network of interstate highways, US highways, and state highways.

Methodology

The impacts to transportation were analyzed by evaluating the relative increase or decrease in traffic, based on the traffic counts presented in Section 3.2. In addition, the potential for traffic interruptions was evaluated if an alternative presented the potential for interrupting transportation on a public roadway. In addition, the potential for accidents and fatal accidents were evaluated using distance traveled, number of trips, and probabilities for accidents occurring.

Assumptions

This analysis assumes that the traffic count conducted between March 28 and April 28, 2017, on NM 566 immediately east and west with the intersection with Pipeline Canyon Road, form 7:00 a.m. and 7:00 p.m. (INTERA, 2017), is a conservative representation of typical travel conditions year-round.

4.2.2 Potential Transportation Impacts for Each Alternative

4.2.2.1 No Action Alternative

Under the No Action Alternative, no waste would be excavated from the Mine Site, no construction would occur at the Mill Site TDA, and no PTW would be disposed of offsite. As a result, no impacts to local or regional transportation would occur.

4.2.2.2 Alternative A – Proposed Action

4.2.2.2.1 Transportation Impacts from Construction

The potential transportation impacts associated with construction of the Proposed Action include increased traffic and potential for accidents during the short-term, 3.5-year period associated with construction. During the construction period, the anticipated workforce at the Project Area is expected to be 30 to 40 people, including contractors. Based on the anticipated employment and construction activities, the traffic increase on affected roads is estimated to be up to 35 vehicles per day. In addition, between 1 and 5 heavy truck shipments are anticipated each day. The truck shipments would include shipments of materials, equipment, and fuel. The potential traffic-related impacts during mine waste transportation route construction would be moderate and short-term. Based on the traffic count data presented in Section 3.2 of this ER, the traffic volumes on NM 566 in the immediate vicinity of the Project Area are estimated to increase by 60% during construction. Potential traffic impacts on other local roads will be less than 1%.

Mine waste excavated at the Mine Site west of NM 566 would be transported to the Mill Site for disposal at the Repository, which is located east of NM 566. The mine waste haul road would be hauled using an at-grade crossing at NM 566, north of the existing UNC offices (Figure 2.0-2). Traffic delays would be expected to occur on NM 566 at the haul road crossing when material was being hauled from the Mine Site to the Repository. The volume of traffic indicated above is expected to be accommodated with maximum traffic delays of 15 minutes during hauling operations. Alternative routes to avoid this crossing with an equivalent delay of less than 15 minutes are not present; thus, alternative routes are not assessed in this SER.

To mitigate traffic impacts, a temporary traffic light system would be employed for traffic safety at the crossing and would be monitored and operated by personnel stationed at a safe location off the travelled way. School buses would not be delayed. In addition, a contamination control system would be employed at the haul road crossing such that public traffic would be not impacted by fugitive mine waste material. In compliance with NMDOT requirements, a construction-related traffic control plan that describes the traffic light system would be submitted for all construction activity that impacts traffic on public roads.

4.2.2.2.2 Potential Impacts from PTW Hauling

The PTW material would be loaded at the PTW staging area into covered trucks or sealed intermodal shipping containers for transport to White Mesa Mill in Blanding, Utah. Shipments would be manifested and placarded per USDOT requirements. Upon completion of loading, trucks or intermodal containers would be inspected for external contamination prior to truck departure or container staging for transfer to highway vehicles. The transport company would have emergency response programs in place, including spill response equipment on board. Drivers would be trained in emergency response procedures. The receiving facility would also have emergency response plans in place for spill cleanup.

Accidents with Release of PTW Material

Approximately 1,750 40-ton shipments of PTW material are expected for the Proposed Action. These shipments are expected to occur in a single calendar year. Using the highest accident probability of 2.0 x 10^{-6} accidents per mile, as noted in Table 3.2-2, less than 1 accident (0.74) is expected during transport of material to White Mesa Mill, a distance of 211 mi. This probability was obtained by multiplying the probability of an accident per vehicle-mile (2.0 x 10^{-6}/mi) by the number of shipments (1,750) by the distance per shipment (211 mi).

Estimated Accidents

It is important to note that an accident may not result in the release of PTW material. D'Appolonia (1981) noted a probability estimate of 1 accident releasing yellowcake into the environment over the 20-year mine life. According to a report issued by the Federal Motor Carrier Safety Administration (FMCS, 2001), the likelihood that an en-route accident of radioactive materials would result in a release is about 50%. Thus, the estimated number of accidents that can be expected transporting PTW material under the Proposed Action is less than 1, and well below that previously calculated for transport of yellowcake in D'Appolonia (1981).

Fatal Accidents

Using the highest fatal accident probability of 0.015 x 10^{-6} fatal accidents per mile noted in Table 3.2-2, no fatal accidents are estimated (0.006) during transport to the White Mesa Mill.

4.2.2.3 Alternative B – Conveyance

Transportation Impacts from Construction

Under Alternative B, construction transportation impacts would not differ from those under the Proposed Action. Construction crews, material transport, and construction-related work adjacent to or within the NM 566 right-of-way is expected to be similar under all proposed alternatives.

Potential Mine Waste Transportation Impacts

Under Alternative B, no significant transportation impacts would occur from the conveyance of mine waste. The conveyor system would be shielded such that mine waste material could not spill onto NM 566. Traffic would cross beneath the conveyor and would not be delayed. Warning signage would be placed to note the presence of the conveyor.

Potential Impacts from PTW Hauling

Under Alternative B, PTW hauling transportation impacts would not differ from those under the Proposed Action.

4.2.2.4 Alternative C – Material Sourcing for Cover

Transportation Impacts from Construction

Under Alternative C, construction transportation impacts would not be expected to differ from those under the Proposed Action. Construction crews, material transport, and construction-related work adjacent to or within the NM 566 right-of-way would be similar under both alternatives.

Potential Mine Waste Transportation Impacts

Under Alternative C, mine waste transportation impacts would not differ from those under the Proposed Action. Borrow materials would not be hauled on public roads under any alternative.

Potential Impacts from PTW Hauling

Under Alternative C, PTW hauling transportation impacts would not be expected to differ from those under the Proposed Action.

4.2.2.5 Alternative D – Disposal of Principal Threat Waste

Transportation Impacts from Construction

Under Alternative D, construction transportation impacts would not differ from those under the Proposed Action. Construction crews, material transport, and construction-related work adjacent to or within the NM 566 right-of-way would be similar under each alternative.

Potential Mine Waste Transportation Impacts

Under Alternative D, mine waste transportation impacts would not differ from those under the Proposed Action.

Potential Impacts from PTW Hauling

The expected number of accidents would increase from less than 1 under the Proposed Action to 2 under Alternative D for transport of material to the Clive facility in Utah (572 miles). This probability was obtained by multiplying the probability of an accident per vehicle-mile (2.0×10^{-6}/mi) by the number of shipments (1,750) by the distance per shipment (572 mi).

Similar to the Proposed Action, an accident that may release PTW material is not expected.

Fatal Accidents

Under Alternative D, no fatal accidents are expected. However, the calculated number of accidents increases from 0.006 (Proposed Action) to 0.015 (Alternative D).

4.2.3 Cumulative Impacts to Transportation

4.2.3.1 Interim Removal Actions

Cumulative impacts include the impacts of the Proposed Action and past clean-up activities conducted in 2009 and 2010 at SO-1, unnamed arroyo number 1, and SO-2. Past actions associated with the Interim Removal Actions would have no cumulative effect on transportation when combined with the Proposed Actions or alternatives because the Interim Removal Actions occurred in the past and are now completed. With the Interim Removal Actions occurring years apart from the Proposed Action and alternatives, transportation impacts would not be cumulative.

4.2.3.2 Structure Remediation

If structures are remediated in the future within the vicinity of the Project Area during construction activities associated with the Proposed Action or alternatives, then minor, adverse cumulative impacts to transportation may possibly occur. For example, structure remediation activities that would require machinery or activities that could add to AADT. Structure remediation activities that would require material removal or rebuilding could involve construction machinery and vehicles that may travel into the Project Area. The cumulative increase in transportation could cause minor increases in stoppage times at the proposed crossing on NM 566 under the Proposed Action, Alternative C, and Alternative D. Though specific details of the activities and transportation activities would be required, the potential specific impacts could be assessed using the methods already identified in this section.

4.2.3.3 Quivira Mine Site

Future cleanup actions at the Quivira Mine Site could result in cumulative transportation impacts in and around the Project Area under the Proposed Action or any of the action alternatives, as it could increase the AADT of Red Water Pond Road or other local roads. These possible cleanup actions that could occur synchronously with the Proposed Action or the alternatives are not defined at this time, and specific cumulative effects would need to be reassessed using the methods identified in this section.

4.3 Geology and Soils Impacts

4.3.1 Geology

4.3.1.1 Geology Impacts Analysis

Area of Analysis

The Area of Analysis for geologic resources was analyzed for the No Action Alternative, the Proposed Action, and Alternatives B through D for local and regional environmental impacts, which are defined as follows:

Local: Within the Project Area, resulting from ground-disturbing activities for removal of mine waste and transport of mine waste from the Mine Site to the Mill Site Repository.

Regional: Outside of the Project Area, dependent upon action taken. All actions except for the No Action Alternative include offsite transport of PTW using the existing network of interstate highways, US highways, and state highways.

Methods of Analysis

Potential impacts to geology in the Area of Analysis are considered for the Proposed Action and alternatives. Impact indicators are based on potential impacts from ground-disturbing activities that would result in permanent or short-term change to bedrock geology and minerals.

Assumptions

This analysis assumes that any soils that contain radioactive or hazardous materials excavated from the Mine Site would be placed in the Repository at the Mill Site but that excavation would not disturb bedrock.

4.3.1.2 Potential Geology Impacts for Each Alternative

4.3.1.2.1 No Action Alternative

Under the No Action Alternative, no ground-disturbing activities would take place and no changes to geology would occur.

4.3.1.2.2 Alternative A – Proposed Action

Construction activities associated with the Proposed Action would principally occur on the ground surface within the Project Area. At the Mine Site, waste would be excavated where concentrations exceed USEPA Action Levels to a depth where RALs are below 2.24 pCi/g for radium-226 and 230 mg/kg for uranium, or to contact with bedrock. As a result, excavation would not impact bedrock.

At the Mill Site, borrow material excavated from the Borrow Areas would avoid removing bedrock. Obtaining rock suitable for meeting the material durability requirements of the Proposed Action from a commercial, offsite quarry would not impact geological resources given that the source would be a commercial, offsite source.

Overall, there would be no impacts to geologic resources under the Proposed Action.

4.3.1.2.3 Alternative B – Conveyance

No impacts to geology would occur under Alternative B as all the construction activities would take place on the surface of the Project Area and would not extend down into bedrock.

4.3.1.2.4 Alternative C – Material Sourcing for Cover

Under Alternative C, no impacts to geology would occur because the limited excavation proposed would take place near the Pipeline Arroyo Knickpoint in an area that has been previously disturbed. The proposed removal of additional soil would not impact the geology of the Project Area.

4.3.1.2.5 Alternative D – Disposal of Principal Threat Waste

Under Alternative D, no impacts to geology would occur, because all excavation activities would take place on the surface of the Project Area and would not extend down into bedrock.

4.3.1.3 Cumulative Impacts to Geology Resources

No cumulative impacts to geology are expected regardless of nearby Interim Removal Actions, structure remediations, or Quivira site activities, as neither the Proposed Action nor the proposed alternatives would result in any impacts to geologic resources.

4.3.2 Soils

The following section describes the potential impacts to soil resources associated with the Proposed Action and alternatives.

4.3.2.1 Soils Impacts Analysis

Area of Analysis

Local: Effects would occur inside the Project Area.
Regional: Effects would occur outside of the Project Area.

Methods of Analysis

Soil types within the Project Area were qualitatively assessed relative to anticipated effects of the proposed surface disturbance and associated reclamation activities. Adverse effects for the Proposed Action or alternatives may include soil removal, soil loss due to erosion by wind and water, profile mixing, compaction, contamination, and loss of productivity.

Soil indicators of significance include if the alternative would result in:

- substantial soil erosion,
- loss of prime farmland soils or impacts to alluvial valley floors, or
- the inability of the soil to support a functioning ecosystem.

Assumptions

- Areas of recently disturbed ground would be more susceptible to erosion. Erosion on the landscape may contribute to sedimentation or soil impacts.

- Site-specific erosion, sediment, and storm water management plans would be developed and implemented prior to start of construction following Appendices E, F, and I of the LAR.
- The Release Contingency and Prevention Plan (RCPP; Appendix R of the LAR) would be implemented in accordance with applicable regulations and proposed site plans. These would include a Spill Prevention, Control, and Countermeasure Plan (SPCCP), pollution removal, and other solid and hazardous material management programs and regulations.
- Erosion from disturbed areas would be minimal once vegetation or other surface stabilization is established, reducing the potential for sediment transport. Successful establishment of herbaceous vegetation generally takes a minimum of 3 to 5 years with active irrigation and monitoring.
- Designed reclamation and stabilization features are those that will successfully control surface water runon and runoff and limit erosion for storm events at least as large as the 1 in 200-year event, and in most cases the PMP. (Part I.3.2., Appendix I of LAR).

Impacts Common to All Alternatives

The principal impact to soils within the Project Area would be from earthmoving activities associated with removal of TENORM at the Mine Site and construction of the Repository at the Mill Site. Direct effects may include structural, physical, and chemical alterations that could result in the potential for decreased soil function, the potential for increases in wind or water erosion, and the potential contamination of soils from spills or leaks of hydrocarbons associated with excavation operations. Potential indirect effects to soils resources may include offsite dust impacts due to wind erosion or offsite sedimentation due to water erosion.

Earthmoving activities that would potentially impact soils include:

- Excavation of mine waste that exceeds the USEPA-defined Action Level at the Mine Site
- Disturbances necessary to arrange the transportation of the PTW for offsite reprocessing or disposal
- Construction of throughways for transportation or conveyance of the mine waste (excluding PTW) to the Mill Site for staging for offsite disposal or transport to the Mill Site Repository
- Construction of laydown yards and ancillary disturbances necessary for staging and assembly across the Project Area
- Construction of the Repository at the Mill Site, along with necessary ancillary disturbances
- Excavation, transport, and temporary storage of earthen materials for use in the construction of an ET cover over the final mine waste surface in the Repository
- Disturbances associated with cleanup verification of the Mine Site removal areas
- Disturbances associated with the restoration and revegetation of the Mine Site and Mill Site following construction

Construction activities may increase the potential for erosion from both wind and water due to the removal of vegetation and the physical disturbances from vehicle and heavy equipment traffic. Likewise, compaction of soils and removal of vegetation resulting from construction activities may increase the potential for surface runoff and sedimentation in local drainages and streams outside disturbed areas. The Revegetation Plan and the following sections describe BMPs and EPMs (such as topsoil management practices, topsoil stockpiling, erosion control methods, and the use of surface water diversions) to minimize potential soil impacts associated with the Proposed Action and alternatives.

EPMs have been proposed to minimize effects to soils through the use of BMPs. Fair and poor topsoil may require additional amendments, or other practices to increase their suitability for use as a reclamation growth media. Data from previously successful local reclamation efforts would be utilized to inform the selection of successful practices to reclaim areas with fair and poor topsoil (Stantec, 2018a).

Soil Quality

Ground-disturbing activities that affect soil function may occur from the removal, stockpiling, and placement of soil for growth media. In turn, these activities may result in direct, localized, short-term effects to soils, which include physical and chemical changes. These changes are caused by mixing, crushing, and compaction that occurs during salvage operations, transport, stockpiling, and final placement. Soil types with high amounts of coarse fragments will reduce the risk of compaction to underlying soils by providing structural support for heavy equipment. Physical effects of compaction on the soils include reduced permeability and porosity, damage to biological soil crusts, decreased available water-holding capacity, increased bulk density, and loss of soil aggregate structure. Surface soil aggregates are the most susceptible to damage and, if impacted, can create a surface crust when wetted, essentially sealing the soil surface and increasing the risk of soil erosion and impeding seedling growth during reclamation.

Construction activities will affect the productivity and fertility of newly disturbed soils by mixing and possible compaction of the soils during salvage and handling operations. Soil productivity is an interrelation between soil organic matter, infiltration, aggregation, pH, microbial biomass, bulk density, forms of nitrogen, topsoil depth, salinity, and nutrient supply (Havlin et al., 2005). Microorganisms (e.g., nematodes, bacteria, and fungi) are an important component of the soil matrix and are a critical component for nutrient cycling. A reduction in soil productivity or fertility indirectly affects vegetation growth and thus the success of reclamation efforts. In an effort to conserve the native soil structure and aggregation, microbial community, and the presence of organic matter, growth media will not be stockpiled any longer than is necessary to complete the project.

Wind and Water Erosion

The erosion potential of soil is determined by certain characteristics of the soil as well as the angle of the slope. Soil properties identified in Table 3.3-2 indicate that a majority of the soil units within the Project Area are susceptible to erosion, either by wind or water. Soil erosion would be expected to be localized and moderate in the short term (prior to reclamation) and localized and minor in the long term (post-restoration). Stockpiled soils would be susceptible to increased wind and water erosion during storm events or rapid snow melt. An increase in wind erosion will occur primarily during ground disturbance, salvage, and reclamation activities where soil is being moved with heavy equipment. These soils will continue to be susceptible to wind and water erosion until stabilizing vegetation becomes established.

Several EPMs specified in the Revegetation Plan presented in Appendix U of the LAR have outlined a number of measures to reduce direct, short-term, and long-term water erosion through BMPs. BMPs (such as berms, straw wattles or staked straw bales, mulches, or conditioners) will be used as necessary to reduce entrainment of sediment during precipitation events on stockpiled or reclaimed topsoils or borrowed growth media. Indirect effects from wind erosion during construction activities will be mitigated by regulating truck speed to 20 mph and by the wetting of roads during heavy truck traffic. Decreased speeds and watering to mitigate dust will also be employed during ground disturbance, high winds, or any conditions sufficiently dry to produce excessive dust.

Potential Contamination of Soils

Soil resources may be affected as a result of leaks or accidental releases of hydrocarbons or other fluids used in construction machinery. During construction activities, the construction contractors will employ a number of safeguards through monitoring and response. If spills or leaks occur, the construction contractor will employ controls and cleanup measures in accordance with USEPA guidelines. Therefore, contamination effects to soils, should they occur, are anticipated to be short-term, localized, and minor.

Reclamation under New Mexico Mining Act of 1993

Under Article 36 Section 69-36-1 through 69-36-20, the State of New Mexico has defined its rules for responsible utilization and reclamation of lands affected by exploration, mining, or the extraction of minerals that are vital to the welfare of New Mexico. Reclamation is defined as follows:

> *"The employment during and after a mining operation of measures designed to mitigate the disturbance of affected areas and permit areas and to the extent practicable, provide for the stabilization of a permit area following closure that will minimize future impact to the environment from the mining operation and protect air and water resources."*

Existing mining operations that produced marketable minerals for a total of at least two years between January 1, 1970, and the effective date of the NMMA are responsible for obligations pursuant to the closeout plan rules addressed under subparts 506.A and B of the NMMA. Subpart 506.A states:

> *"…closeout plans shall be based on site specific characteristics and the anticipated life of mining operation. Site specific characteristics include, but are not limited to, disturbances from previous mining operations, past and current mining methods utilized, geology, hydrology, and climatology of the area." Subpart 506.B states "A proposed closeout plan or a proposed closeout plan for a portion of the mine shall include a detailed description of how the permit area will be reclaimed to meet the requirements of Section 69-36-11B(3) of the [NMMA] and the performance and reclamation standards and requirements of Subpart 5."*

Reclamation is not complete until it meets requirements as defined in Section 69-36-11B(3):

> *"…the physical environment of the permit area…allows for the reestablishment of a self-sustaining ecosystem on the permit area following closure, appropriate for the life zone of the surrounding areas..."*

4.3.2.2 Potential Soils Impacts for Each Alternative

4.3.2.2.1 No Action Alternative

Under the No Action alternative, 231 acres of soils disturbed from historic mining operations would remain unchanged in their current condition. Any radiological exceedances above USEPA-defined limits in soil and earthen materials would remain exposed at the surface. Unreclaimed or inadequately reclaimed existing disturbances would remain as such. No additional short-term, localized, and minor soil impacts would occur because earthmoving and reclamation would not be implemented.

4.3.2.2.2 Alternative A - Proposed Action

The Proposed Action would have direct and indirect effects to the soil resources within the Project Area. Soil disturbance is proposed for up to 340 acres within the Project Area, which would be reclaimed following completion of construction. Existing, unreclaimed disturbances would be utilized when possible, and it is expected that the Proposed Action would result in the net increase of usable lands that have been previously disturbed or impacted by mining and other land-disturbing activities.

Topsoil would be removed from approximately 245 acres because of radiological exceedances or use as a borrow source for the Repository. In the short term, these lands are expected to exhibit elevated erosion risk and diminished capacity to support functioning ecological communities. However, effective implementation of the Revegetation Plan (Appendix U of the LAR), including appropriate BMPs and EPMs, will mitigate the expected limitations. Post-reclamation monitoring, as described in the Revegetation Plan (Appendix U of the LAR), will provide valuable information regarding the effectiveness of the reclamation treatments, BMPs, and EPMs. Approximately 244 acres are expected to return to the pre-mining land use of grazing and incidental wildlife use after complete revegetation.

The effects of earthmoving and construction range from degradation of soil structure, loss of microbiotic crust and function, increased compaction, and the disruption of soil development. Effects to soil resources after employing EPMs and BMPs will be short-term, localized, and minor. The radiological exceedances in soil and earthen material would be addressed. Therefore, the Proposed Action would result in long-term beneficial impacts. Overall, the impacts of the Proposed Action would be of minor significance with BMPs, EPMs, and mitigation incorporated, since no prime farmland soils or alluvial valley floors would be affected; and reclamation and revegetation would preclude substantial erosion and allow for the soils to support a functioning ecosystem.

4.3.2.2.3 Alternative B - Conveyance

Under Alternative B, the limits of disturbance associated with the NECR Mine Site Removal Areas, construction support zones, soil borrow areas, access roads, Jetty Area, topsoil stockpile, and Repository would be approximately the same as the Proposed Action, estimated at 338 acres. Effects on soil resources would be comparable to the Proposed Action. All procedures and BMPs for protecting soil resources would be the same as for the Proposed Action. Effects to soil resources would be short-term, localized, and minor. Overall, the impacts of the Alternative B would be of minor significance with BMPs, EPMs, and mitigation incorporated, since no prime farmland soils or alluvial valley floors would be affected, and reclamation and revegetation would preclude substantial erosion and allow for the soils to support a functioning ecosystem.

4.3.2.2.4 Alternative C – Material Sourcing for Cover

In place of sourcing cover material from the four proposed borrow areas (Figure 2.0-3), cover material would be sourced from the Jetty Area (Figure 2.0-7). Under Alternative C, the total disturbance acreage of the Project would be decreased to a total of 292 acres, minimizing the adverse impacts to soil resources compared to the Proposed Action. All procedures and BMPs for protecting soil resources would be the same as for the Proposed Action. Effects to soil resources would be short-term, localized, and minor. Overall, the impacts of the Alternative B would be of minor significance with BMPs, EPMs, and mitigation incorporated, since no prime farmland soils or alluvial valley floors would be affected, and reclamation and revegetation would preclude substantial erosion and allow for the soils to support a functioning ecosystem.

4.3.2.2.5 Alternative D – Disposal of Principal Threat Waste

There would be no net change in impacts to soils between Alternative D and the Proposed Action, so the impacts to soils and their significance would be the same.

4.3.2.3 Cumulative Impacts to Soils Resources

4.3.2.3.1 Interim Removal Actions

Disturbances to soil resources associated with Interim Removal Actions involve removal of vegetation and topsoil due to cleanup of soils exceeding radium-226 concentrations of 2.24 pCi/g. Cumulative adverse impacts to soils from the Proposed Action and Interim Removal Actions would be localized, short-term, and minor. The adverse cumulative impacts from the Interim Removal Actions are of minor significance, and ecosystems restored from the BMPs and EPMs associated with the reclamation plan are nearly complete.

4.3.2.3.2 Structure Remediation

Disturbances to soil resources associated with structure remediation projects involve construction of access roads and temporary staging areas, which results in soil compaction and removal of vegetation. Cumulative adverse impacts to soils from the Proposed Action and structure remediation projects would be localized, short-term, and minor. If the projects occurred simultaneously, there would be the potential for additional fugitive dust and offsite sediment transport. However, proper implementation of BMPs and EPMs would make the cumulative impact of small significance.

4.3.2.3.3 Quivira Mine Site

Cumulative adverse impacts to soils from the Proposed Action and any future actions at the Quivira Mine Site would be localized, short-term, and minor. If the projects occurred simultaneously, there would be the potential for additional fugitive dust and offsite sediment transport. However, proper implementation of BMPs and EPMs would make the cumulative impact of minor significance. Beneficial impacts to soils would be localized, long-term, and minor, as radiological exceedances in soil and earthen materials would be addressed.

4.4 Water Resources Impacts

This section presents the potential impacts from each alternative within the Area of Analysis for surface water (Section 4.4.1) and groundwater resources (Section 4.4.2).

4.4.1 Surface Water

4.4.1.1 Surface Water Impacts Analysis

Potential effects on surface water that may arise from changes from the alternatives analyzed in detail may be beneficial, adverse, major, minor, negligible, or significant, depending upon the action taken and resulting activities. For example, potential impacts could occur from activities disturbing the existing soil, such as road building, facility development, addition of storm water controls, and excavation. These activities have the potential to result in soil erosion that could elevate sediment loading in waterways. Soil-disturbing activities have the potential to degrade surface water quality by contributing additional suspended sediment to the ephemeral waterways from bare ground during runoff events. Other potential impacts are less likely to occur, such as minor spills from oil, lubricant, and fuels required for heavy equipment that could comingle with storm runoff.

Area of Analysis

The Area of Analysis for surface water impacts was analyzed for the No Action Alternative, the Proposed Action, and Alternatives B through D environmental impacts, which is defined by the boundary of the Hard Ground Canyon-Puerco River Watershed (Figure 3.4-2).

Methods of Analysis

Potential impacts to surface water resources were identified by comparing the locations of surface water bodies (arroyos, ponds, and others described in Section 3.4) to the surface disturbance proposed under the alternatives. A review of the proposed water supply and uses, runoff management, and process flow (supply, conveyance and storage, use, and disposal) was conducted and compared to current uses. This information and the known occurrence and characteristics of surface water resources described in Section 3.4 were compared to identify potential impacts.

Assumptions

The following assumptions were made in assessing potential surface water impacts:

- Areas of recently disturbed ground would be more susceptible to erosion. Erosion on the landscape may contribute to sedimentation in the surface water drainage system of arroyos that transports the sediment downstream to water bodies. Only a fraction of the total amount of soil erosion on the landscape actually reaches surface water channels such as those identified as Waters of the U.S.
- Site-specific erosion, sediment, and storm water management plans would be developed and implemented prior to start of construction following Appendices E, F, and I of the LAR.
- The Release Contingency and Prevention Plan (RCPP; Appendix R of the LAR) would be implemented in accordance with applicable regulations and proposed site plans. These would include a Spill Prevention, Control, and Countermeasure Plan (SPCCP), pollution removal, and other solid and hazardous material management programs and regulations.
- Erosion from disturbed areas would be minimal once vegetation or other surface stabilization is established, reducing the potential for sediment delivery to arroyos and other water bodies. Successful establishment of herbaceous vegetation generally takes a minimum of 3 to 5 years with active irrigation and monitoring.

- Designed reclamation and stabilization features are those that will successfully control surface water runon and runoff, and limit erosion for storm events at least as large as the 1 in 200-year event, and in most cases the PMP. (Part I.3.2., Appendix I of LAR).

Impacts to surface water resources would be considered significant if the Proposed Action or alternatives result in one or more of the following:

- Project infrastructure modifies the existing surface drainage features so that increased surface water flows create offsite damage to existing surface water drainages, adjacent land, or affect watershed conditions.
- Discharge from detention ponds and other project structures increase surface water flows offsite and cause downstream erosion.

No federally delineated floodplains (Flood Hazard Zone A as identified by FEMA) occur within or adjacent to the Project Area so impacts to floodplains will not be discussed further in this section.

4.4.1.2 Potential Surface Water Impacts for Each Alternative

4.4.1.2.1 No Action Alternative

Under the No Action Alternative, no changes to surface water impacts would occur and conditions would remain as normal. As a result, it is likely that both bank and headward channel erosion would continue to occur in Pipeline Arroyo in the absence of any intervention to stabilize the arroyo. As noted by the NRC (2003), damage to the jetty and continued headcutting toward the jetty could pose a risk of controlled erosion with the potential for tailings exposure and downstream migration. As a result, potential impacts to surface water resources from the No Action Alternative could be moderate, adverse, and long-term.

4.4.1.2.2 Alternative A – Proposed Action

Cleanup and erosion stability measures under the Proposed Action would potentially have a minor, long-term, beneficial impact on surface water resources. The removal and disposal of approximately 1,000,000 CY of material with a concentration of 2.24 pCi/g radium-226 and 230 mg/kg of uranium from the Mine Site would further reduce the potential for material above this USEPA-defined RAL to runoff from the Site. In addition, the proposed stabilization work at Unnamed Arroyo No. 1, Pipeline Arroyo in the Jetty Area, and at the NDC at the Mill Site would address NRC concerns of continued undercutting, tailings exposure, and downstream (offsite) migration. Other potentially adverse impacts from short-term, construction related activities would be mitigated using storm water controls and measures defined in the SPCCP, and the RCPP.

Hydrological system alterations would be limited to engineered improvements to the drainage system at sites within the Project Area. For example, improvements to the erosional stability of the engineered channel protecting Unnamed Arroyo No. 1 at the Mine Site Outfall Channel would have a beneficial impact on the arroyo's ability to manage water discharged from the Mine Site. The improvements, which were designed to have a capacity and erosional stability for the 100-year flood event, would address NRC concerns for bank and channel erosion and thereby help to manage sedimentary load during periods of channel flow. In addition, the riprap chute and associated channel stabilization of Pipeline Arroyo in the Jetty area would provide long-term grade control that would control risks associated with undercutting, tailings exposure, and downstream (offsite) migration. Similarly, improvements to the road and installation of check dams at the NDC would improve the channel's ability to manage runoff to the alluvial floodplain to the north of the TDA.

Areas disturbed during the construction period would be graded to reduce scouring and erosion potential using gentle sloping, terraces, earthen rides, and catch drains. These controls would also be used to minimize the potential for ponded water, reduce the risk of percolation from ponded water, and divert water away from open disposal locations, construction areas, and exposed mine waste. The drainage patterns in the disturbed areas would be integrated with the existing topography and drainage patterns to the extent possible. During construction activities, storm water controls may include channels, weirs, spillways, catch basins, check dams, and sediment basins. The controls would be implemented to mitigate offsite migration of mine waste. After the removal action, the excavated area and haul roads would be verified clean, reclaimed, and revegetated. Because the waterways are ephemeral, any adverse impact to surface water from suspended sediment would be minor.

4.4.1.2.3 Alternative B – Conveyance

The use of a conveyance system under Alternative B would have similar impacts to surface water as the Proposed Action. However, under Alternative B, surface disturbance would be approximately 2 acres less than the Proposed Action. Assuming that bare ground would have an increased potential for erosion and sediment loading, a potential for an adverse impact to water quality would be short-term and likely insignificant, especially given the use of storm water controls during construction combined with a naturally high concentration of suspended load and bed load that are typical in ephemeral drainages during periods of flow.

4.4.1.2.4 Alternative C – Material Sourcing for Cover

Impacts to surface water under Alternative C would be similar to the Proposed Action. However, under Alternative C, 49 fewer acres would be disturbed by eliminating borrow areas. Assuming that bare ground would have an increased potential for erosion and sediment loading, which would be an adverse impact on surface water resources, Alternative C would have less potential of an adverse impact than the Proposed Action. As with the Proposed Action, potential adverse impacts to surface water under Alternative C would likely be minor because erosion controls would be used during construction to control the risk of runoff and sedimentation during the short-term construction period.

4.4.1.2.5 Alternative D – Disposal of Principal Threat Waste

Under Alternative D, the final location for disposing of the PTW at the Clive facility compared to White Mesa would not change potential impacts to surface water resources. Acreage of potential ground disturbance would be similar, and therefore no difference in potential impacts from runoff during construction would be expected compared to the Proposed Action.

4.4.2 Groundwater

4.4.2.1 Groundwater Impacts Analysis

Area of Analysis

The Area of Analysis for groundwater impacts was analyzed for the No Action Alternative, the Proposed Action, and Alternatives B through D for local and regional environmental impacts. The Area of Analysis is defined by the boundary of the Hard Ground Canyon-Puerco River Watershed (Figure 3.4-2).

Methods of Analysis

Evaluation of potential impacts to shallow groundwater was performed qualitatively, using the knowledge of shallow groundwater systems and an understanding of the design features and monitoring system in place in the Project Area.

Assumptions

Impacts to groundwater were determined based on the potential for water quality degradation and the location and amount of any groundwater drawdown projected to occur from proposed withdrawals.

The following assumptions were used in the analysis of impacts to the groundwater resources:

- Structures, stockpiles, and the TDA would be designed to minimize adverse impacts to groundwater quality and would comply with federal and state requirements that protect potable water.
- All monitoring and environmental protection measures described in the LAR would be implemented.

Impacts to groundwater would be significant if the Proposed Action or alternatives result in damage to potable water sources from project components.

4.4.2.2 Potential Groundwater Impacts for Each Alternative

4.4.2.2.1 No Action Alternative

Under the No Action Alternative, no construction would take place within the Project Area, and no groundwater would be required for construction. No mine waste would be placed on top of existing mill tailings at the TDA. The cap system currently in place would continue to operate, and risks to groundwater quality from any potential downward migration would remain unchanged. As a result, the No Action Alternative would have no impact on groundwater resources.

4.4.2.2.2 Alternative A – Proposed Action

The Proposed Action would have a minor to negligible, beneficial, long-term impact on groundwater resources by constructing a new ET cover system that would be as protective to groundwater quality than the existing system. The placement of mine waste on top of the existing tailings and constructing a new cover system would create a negligible change in the influx of pore water from the TDA into the underlying groundwater (Dwyer, 2018). Dwyer (2018) used consolidation and unsaturated flow modeling to compare soil profiles under a No Action Alternative with the same profiles under the Proposed Action. The work showed that a small amount of tailings consolidation would take place due to the additional weight of the mine waste and ET cover, causing some stress to be added to the existing material. Despite this additional stress, the modeling results demonstrate that the ET cover under the Proposed Action is better able to reduce tailings liquid fluxes at the base of the unsaturated alluvium than the No Action Alternative (Dwyer, 2018). This is not to say that there is ongoing tailings seepage currently; rather whatever the current condition is under the No Action Alternative, the Proposed Action would improve on it (Dwyer, 2018). In addition to impacts from potential vertical migration, long-term modeling of lateral seepage was conducted to evaluate the potential for water accumulation on the existing radon barrier that could result in side seeps. The modeling results showed no potential for side seeps emerging from the impoundment under the Proposed Action (Dwyer, 2018).

In addition to groundwater quality, potential impacts from groundwater withdrawals were also considered. Under the Proposed Action, groundwater would be withdrawn from well number G-12-S, which is screened in the Westwater Canyon Member of the Morrison Formation. Stantec (2018) estimates a maximum rate of withdrawal of approximately 102 gpm. This withdrawal to meet water demands for construction would be short-term during the 3.5-year construction period and would have only a negligible, adverse impact on regional groundwater resources of the Westwater Canyon Member. Water rights owned by UNC would be sufficient to fulfill the water demands during construction and the appropriate approvals from the NMOSE would be obtained prior to diverting any additional groundwater.

4.4.2.2.3 Alternative B – Conveyance

Under Alternative B, there would be no changes in the design of the Repository or construction water demands compared to the Proposed Action. As a result, the potential impacts to groundwater quality would be the same as under the Proposed Action. The conveyance system would have similar water demands during construction compared to those for hauling; and, as a result, impacts to groundwater resources under Alternative B would be similar to the Proposed Action.

4.4.2.2.4 Alternative C – Material Sourcing for Cover

There is the potential for Alternative C to require slightly less groundwater withdrawals than those estimated for the Proposed Action. Fewer haul roads would require less water for dust control measures. Though this reduction would have an insignificant, minor beneficial impact on regional groundwater resources, there would be a minor reduction in the negligible, adverse impacts from withdrawals compared to the Proposed Action. No other groundwater impacts would differ from those under the Proposed Action.

4.4.2.2.5 Alternative D – Disposal of Principle Threat Waste

Disposing of PTW at the Clive facility under Alternative D would have impacts on groundwater resources similar to the re-processing of PTW at White Mesa under the Proposed Action. Groundwater impacts would not differ from those under the Proposed Action.

4.4.3 Cumulative Impacts to Water Resources

4.4.3.1 Interim Removal Actions

Disturbances associated with Interim Removal Actions involved removal of vegetation and topsoil due to cleanup of mine waste exceeding radium-226 concentrations of 2.24 pCi/g. Cumulative adverse impacts to water resources from the Proposed Action and Interim Removal Actions would be localized, short-term, and minor. The adverse cumulative impacts from the Interim Removal Actions are of minor significance, and ecosystems restored from the BMPs and EPMs associated with the reclamation plan of the Interim Removal Actions are nearly complete.

4.4.3.2 Structure Remediation

Disturbances associated with structure remediation projects involve construction of access roads and temporary staging areas. Cumulative adverse impacts to water resources from the Proposed Action or alternatives and structure remediation projects would be localized, short-term, and minor. If the projects occurred simultaneously, there would be the potential for additional fugitive dust which could contain constituents that could impact surface water. However, proper implementation of BMPs and EPMs would make the cumulative impact of small significance.

4.4.3.3 Quivira Mine Site

Cumulative adverse impacts from the Proposed Action and any future actions at the Quivira Mine Site would be localized, short-term, and minor. If the projects occurred simultaneously, there would be the potential for additional fugitive dust. However, proper implementation of BMPs and EPMs would make the cumulative impact of small significance. Beneficial impacts to water resources would be localized, long-term, and minor, as radiological exceedances in soil and earthen materials would be addressed and thus unable to impact water resources.

4.5 Ecological Resources Impacts

This section presents the regulatory framework applicable to ecological resources within the Project Area (Section 4.5.1). This section also presents the potential impacts from each alternative within the Area of Analysis for vegetation (Section 4.5.2) and wildlife resources (Section 4.5.3), as well as cumulative impacts (Section 4.5.5).

4.5.1 Regulatory Framework for Ecological Resources

4.5.1.1 Federal

Endangered Species Act of 1973

The Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531-1544) makes it unlawful for a person to "take" a listed fish or wildlife species. The ESA safeguards the continued existence of any species classified under 50 CFR 17.11 as "endangered" or "threatened", as well as habitat that is determined by the Secretary of the Interior to be critical to such species. For plants, there is no "take" prohibition, but Section 9 makes it unlawful to remove and reduce to possession any endangered plant species; maliciously damage or destroy any endangered plant species on federal lands; remove, cut, dig up, damage, or destroy any such species from any other area in knowing violation of any law or regulation of any State; or violate any regulations pertaining to threatened plants. The ESA is administered by the US Fish and Wildlife Service (USFWS), in consultation with other federal and state agencies.

ESA protected species are defined as:

- Federally Threatened or Endangered Species: Any species that the USFWS has listed as an endangered or threatened species under the ESA throughout all or a significant portion of its range;
- Proposed Threatened or Endangered Species: Any species that the USFWS has proposed for listing as a federally endangered or threatened species under the ESA; and
- Candidate Species: Plant or animal taxa that that are under consideration for possible listing as threatened or endangered under the ESA. Insufficient information on the vulnerability and threats to Candidate Species exists to warrant listing as threatened or endangered, but for which development of a proposed listing regulation is precluded by other higher priority listing activities. The USFWS encourages cooperative conservation efforts for these species because they are, by definition, species that may warrant future protection under the ESA. Candidate species receive no statutory protection under the ESA.
- Species of Concern: A taxon for which further biological research and field study are needed to resolve their conservation status, or are considered sensitive, rare, or declining on lists maintained by the Natural Heritage Programs and other institutions.

Critical habitat is defined as *"... the specific areas within the geographical area occupied by the species... on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection..."*

The ESA prohibits the "take" (i.e., killing, destroying, harming, or harassment) of listed threatened or endangered species without special exemptions. Protection under the ESA also extends to species and habitat proposed for listing (proposed).

Migratory Bird Treaty Act of 1918:

The Migratory Bird Treaty Act of 1918 (MBTA), 16 U.S.C. 703-712, defines a migratory bird as any bird species listed in 50 CFR 10.13. The MBTA makes it illegal for anyone to *"take, possess, import, export, transport, sell, purchase, barter, or offer for sale any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations*."

The MBTA provides protection for 1,007 species of native migratory birds. All native birds commonly found in the United States with the exception of native resident gallinaceous birds are protected under the provisions of the MBTA. The USFWS Birds of Conservation Concern (BCC) document lists a total of 27 species that are of the highest priority for the Southern Rockies/Colorado Plateau and that may occur in the Project Area (USFWS, 2008). The purpose of the BCC list is to identify those species in greatest need of conservation action, outside of those species already listed by the USFWS as threatened or endangered.

Bald and Golden Eagle Protection Act:

The Bald and Golden Eagle Protection Act (BGEPA), 16 U.S.C. 668, applies primarily to taking, hunting, and trading activities that involve any bald or Golden Eagle. The act prohibits the direct or indirect take of an eagle, eagle part or product, nest, or egg. The term "take" as used in the act includes "*pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb*."

Golden Eagles are protected by the MBTA and the BGEPA, both of which prohibit take. The Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other Recommendations (Pagel et al., 2010) provides guidance to conduct informed impact analyses and mitigation during the NEPA process.

Any person who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

Nuclear Regulatory Commission

NUREG-1748, or the Environmental Review Guidance for Licensing Actions Associated with Nuclear Material Safety and Safeguards (NMSS) Programs, provides guidance for the environmental review process.

4.5.1.2 State

New Mexico Wildlife Conservation Act

The New Mexico Wildlife Conservation Act (WCA), NMSA 17-2-40.1, gives authority to the NM Department of Game and Fish (NMDGF) to develop recovery plans for species listed by the state of New Mexico as threatened or endangered. Listed threatened and endangered species are reviewed biennially, with the most recent review occurring in 2016 (DGF, 2016b). NMDGF also produces the State Wildlife Action Plan (DGF, 2016a), a non-regulatory planning document that provides a high-level overview of the status of species and habitats in New Mexico and will allow the State to receive federal aid to help secure the status of Species of Greatest Conservation Need (SGCN).

Natural Heritage New Mexico

Administered by the University of New Mexico, Natural Heritage New Mexico (NHNM) ranks plant species by their conservation status in the state of New Mexico. Critically Imperiled (S1) species are extremely rare or especially vulnerable to extirpation; Imperiled (S2) species are rare or especially vulnerable; Vulnerable (S3) species are rare/uncommon or found in a restricted range; Apparently Secure (S4) species are uncommon but not rare and often widespread in New Mexico; and Secure (S5) species are common, widespread, and abundant in New Mexico.

Energy, Minerals, and Natural Resources Department Endangered Plant Species List (NMAC 19.21.2)

Taxa listed on the Energy, Minerals, and Natural Resources Department (EMNRD) Endangered Plant Species as Endangered are listed under the provisions of the federal ESA or *"is a rare plant across its range within the state of New Mexico of such limited distribution and population size that unregulated taking could adversely impact it and jeopardize its survival in the state."* A plant taxa listed as a Species of Concern should be protected from land use impacts when possible because it is a unique and limited component of the regional flora.

New Mexico Noxious Weed Management Act of 1998

The Noxious Weed Management Act of 1998 (NWMA) pertains to the control of noxious weeds in New Mexico. A noxious weed is defined *as "a plant species that is not indigenous to New Mexico and that has been targeted by the NWMA for management or control because of its negative impact on the economy or the environment."* The New Mexico Department of Agriculture (NMDA) administers the NWMA and released a 2016 memo outlining the noxious weed classification and listing the current noxious weeds of New Mexico.

According to the NWMA, Class A species are currently not present in New Mexico or have limited distribution; and preventing new infestations of these species and eradicating existing infestations is the highest priority. Class B Species are limited to portions of the state and their continued spread should be stopped. Class C species are wide-spread in the state, and management decisions for these species should be determined at the local level.

4.5.1.3 Tribal

Navajo Nation Integrated Weed Management Plan

The Bureau of Indian Affairs, Navajo Region developed the Integrated Weed Management Plan (BIA, 2016) in an effort to develop a balanced approach to weed management. A noxious weed species list is provided, as well as classification system that mirrors that of the NWMA.

Navajo Natural Heritage Program and Endangered Species List

The Navajo Endangered Species List (No. RCS-41-08) (NNESL) and the Navajo Nation Sensitive Species List (2008) are administered by the NNHP. They provide a list of species of concern and provide a classification system of level of endangerment on Navajo Nation lands. A NNESL classification of Group 1 (G1) indicates a species is extirpated from the Navajo Nation, Group 2 (G2) indicates a species whose prospects of survival or recruitment are in jeopardy, Group 3 (G3) indicates a species for which survival is likely to be in jeopardy in the foreseeable future, and Group 4 (G4) indicates insufficient information to support a classification as G2 or G3 but reasons for their consideration exist. Both G2 and G3 are considered 'Endangered' under the NNESL.

Golden and Bald Eagle Nest Protection Regulations

The Navajo Nation Department of Fish and Wildlife administers the Golden and Bald Eagle Nest Protection Regulations (GBENPR), RCS-42-08, whose purpose *"is to promote the conservation of breeding eagles on the NN by protecting their nests from human activities…"* The GBENPR provides protective measures Golden and Bald Eagle nests within the Navajo Nation.

4.5.2 Vegetation

4.5.2.1 Vegetation Impacts Analysis

Area of Analysis

Project Area including a 200-ft buffer for plants and 1,000-m buffer for wildlife.

Local: Impacts would occur only inside the Project Area.
Regional: Impacts would occur both inside and outside the Project Area to the adjacent vegetation communities.

Methods of Analysis

Vegetative resources within the Area of Analysis were qualitatively assessed relative to anticipated effects of the Proposed Action and associated reclamation activities. Adverse effects may include loss of vegetative cover and production, exposure of soils to erosion, alteration of species composition, vegetative structure, and visual aesthetics, and the introduction, spread, and expansion of non-native species.

Impacts to vegetation would be considered major or significant if any of the alternatives result in any of the following:

- loss of vegetative cover and production;

- alteration of species composition or structure;
- loss of special status species; or
- increase of noxious species cover.

Assumptions

No critical habitats are present within the Area of Analysis; similarly, the vegetative communities are reflective of those commonly encountered in the local area.

Given the limited use of the Area of Analysis by most plant and animal species of concern, impacts are expected to be limited, negligible to minor, and short-term in nature. All disturbed areas would be reclaimed either concurrently or at the completion of construction activities. Mitigation measures designed to manage noxious weeds and prevent or reduce impacts to wildlife are discussed in Chapter 5 of this SER. A detailed description of ecological resources associated with the Area of Analysis is contained in Section 3.5 of this SER.

4.5.2.2 Potential Vegetation Impacts for Each Alternative

4.5.2.2.1 No Action Alternative

In the No Action Alternative, 231 acres of ruderal vegetation communities from the Mine Site and Repository would remain in its current condition. Any radiological exceedances in soil and earthen materials will remain exposed at the surface. Unreclaimed or inadequately reclaimed existing disturbances would remain as such. No additional short-term, localized, and minor vegetation resource impacts would occur because earthmoving and reclamation would not be implemented.

4.5.2.2.2 Alternative A - Proposed Action

The Proposed Action consists of significant ground-disturbing activities associated with excavation, transport, and treatment of waste material at the Mine Site and Mill Site, and the subsequent reclamation and stabilization of all disturbed areas. Within the Project Area, a total of 340 acres are expected to be disturbed, 224 (66 %) of which are previously Reclaimed areas (Table 3.5-1). The Proposed Action would have direct and indirect effects to the vegetation resources within the Project Area, including the removal of topsoil or overburden that would result in a gradual loss of plant communities on 340 acres (Table 3.5-1). Impacts would primarily be localized, short-term, and moderate until reclamation replaced vegetation to the approved reclamation plan conditions (Stantec, 2018a). Several growing seasons would be needed for revegetated areas to be restored to the reclamation plan recommendations. Ongoing reclamation efforts would be monitored until revegetation goals are met.

The majority of disturbance of the Proposed Action would be in the previously Reclaimed community (224 acres, 66% of total Project Area), the Bottomland (47 acres, 14% of total Project Area), and Pinyon-Juniper (50 acres, 15% of total Project Area) communities, and to a minor extent in the Grassland (13 acres, 4% of total Project Area) and Shrubland (6 acres, 2% of total Project Area) communities (Table 3.5-1). Direct impacts to vegetative communities include the short-term loss of vegetation cover and productivity; long-term modification of vegetation; plant species composition alterations; exposure of soils to accelerated erosion; and changes to the areal extent of cover types. Modification of vegetative structure and species composition would manifest by the transition of native habitats to reclaimed habitats in the short term, which would eventually progress through ecological succession. Indirect impacts include the short-term increased potential for non-native species invasion, establishment, and expansion; and changes in visual aesthetics. Visual and scenic impacts are analyzed in Section 4.9.

Overall, the adverse impacts of the Proposed Action would be minor, assuming that the BMPs and EPMs would be implemented in compliance with all regulations and the fact that the majority of disturbance would be on previously disturbed lands (Reclaimed communities). Reclamation and revegetation would minimize accelerated erosion and allow for the soils to support a functioning ecosystem.

Special Status Species

Due to their absence from the Area of Analysis, there would be no impacts to plant special status species with the potential to occur in the Project Area (Table 3.5-2).

Noxious Weeds

Nine species of noxious weeds have been observed within the Area of Analysis (Table 3.5-3), and construction activities paired with significant soil disturbance could potentially allow for the spread of those noxious weeds. Without proper management noxious weeds often out-compete desirable plant species, including special status plant species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with surrounding undisturbed vegetation.

Prior to construction activities, noxious weed species (excluding Russian thistle and burningbush) found within the Project Area should be treated to limit the spread of noxious weeds. Russian thistle and burningbush are commonly found in the arid west and decrease as perennial plant communities establish and disturbance diminishes. Thorough treatment of noxious weeds prior to initiation of the Proposed Action paired with implementation of proposed weed management practices during construction and reclamation activities would limit the spread of noxious or invasive species, resulting in impacts to vegetation that would be negligible to minor, short-term, and localized in nature (INTERA, 2017). Weed management practices are discussed further in the Revegetation Plan (Stantec, 2018a).

4.5.2.2.3 Alternative B – Conveyance

Under Alternative B, the areas of disturbance associated with the NECR Mine Site Removal Areas, construction support zones, soil borrow areas, access roads, Jetty Area, topsoil stockpile, and UNC Mill Site Repository would be 338 acres, similar to the Proposed Action. Impacts to vegetation from implementing Alternative B would be similar to those described for the Proposed Action.

4.5.2.2.4 Alternative C – Material Sourcing for Cover

Under Alternative C the total acreage of surface disturbance would less than the Proposed Action, with a total of 292 acres of disturbance**. The noxious weeds (tamarisk and bull thistle) found in the Pipeline Arroyo would be removed and revegetated with a native species.** Overall, the impacts on vegetation from implementing Alternative C would be similar to those described for the Proposed Action.

4.5.2.2.5 Alternative D – Disposal of Principal Threat Waste

The acreage and locations of the proposed surface disturbance under Alternative D are the same as that described for the Proposed Action. Therefore, the impacts on vegetation from implementing Alternative D would be the same as those described for the Proposed Action.

4.5.3 Wildlife

4.5.3.1 Wildlife Impacts Analysis

Area of Analysis

Project Area including a 200-ft buffer for plants and 1,000-m buffer for wildlife.

Local: Impacts are confined to a small part of the population, habitat, or range.
Regional: Impacts would affect a widespread area of suitable habitat, or a large part of the population or range of a species.

Methods of Analysis

Wildlife resources within the Area of Analysis were qualitatively assessed relative to anticipated effects of the Proposed Action and associated reclamation activities. Adverse effects may include loss of habitat, disturbance from construction activities, and increased human presence.

Wildlife indicators would be significant if the proposed project would result in:

- Long-term, major, and large loss of populations;
- Loss of special status species or other important wildlife habitat.

Assumptions

No critical habitats are present within the Area of Analysis. Given the limited use of the Area of Analysis by most plant and animal species of concern, impacts are expected to be limited, negligible to minor, and short-term in nature. It is important to note that no important habitat or features for special status species were found in the Area of Analysis. Although no tribal, federal, or state threatened, endangered, candidate, or proposed wildlife species have been recorded in the Area of Analysis, any mitigation actions deemed necessary through the consultation process would be implemented if observed in the future.

4.5.3.2 Potential Wildlife Impacts for Each Alternative

4.5.3.2.1 No Action Alternative

Under the No Action Alternative, 231 acres of poor-quality habitat within the Area of Analysis would remain in its current condition. Any exceedances of the USEPA RAL in soil and earthen materials would remain exposed at the Mine Site and the TDA would not be disturbed. Unreclaimed or inadequately reclaimed existing disturbed areas would remain the same.

In evaluating ecological risks to wildlife in the 2013 Record of Decision, the ecological risks reported in UNC (1975) were conservatively adopted by the USEPA (2013). As part of its decision-making process for the ROD, the USEPA determined from the 1975 analysis that the mule deer was the single most “important species” and had the highest potential for exposure to ionizing radiation (USEPA, 2013). Identified risk pathways include ingestion and inhalation of radionuclides released in ventilation air from the mill, in groundwater discharged by the mine, and from ore dusts (UNC, 1975). However, UNC (1975) concluded that such sources would not pose a significant environmental stress on the mule deer. In addition, as noted by USEPA (2013), the inhalation and ingestion risks are much less than in 1975. Presently, no radionuclides are released in ventilation air from the mill or discharged by the mine.

As described in Section 3.5, mule deer were observed in the Area of Analysis during baseline surveys. However, as it was concluded in the baseline surveys (INTERA, 2017), populations were less than expected for these habitats based on direct observation of mule deer hoof prints and pellet groups. Under the No Action Alternative, not cleaning up mine spoils would continue to expose wildlife, including mule deer, to mine spoils above the USEPA RAL. As a result, there would be no change to the insignificant stress, which has been largely eliminated by changes in the inhalation and ingestion pathways for mule deer or other wildlife considered less “important” (UNC, 1975; USEPA, 2013).

4.5.3.2.2 Alternative A - Proposed Action

The Proposed Action would temporarily disturb 340 acres of poor-quality wildlife habitat within the Area of Analysis during contaminated material excavation, transportation, and other remediation activities.

General Impacts to Wildlife Under the Proposed Action

Overall, the adverse impacts of the Proposed Action on wildlife would not be significant, assuming that the BMPs and EPMs would be implemented in compliance with all approved wildlife protection measures and required regulations and the fact that the majority of disturbance would occur on previously disturbed lands (Reclaimed communities). Reclamation and revegetation would minimize accelerated erosion and allow for the soils to support a functioning ecosystem. Long-term, adverse impacts would be mitigated by complete reclamation of the disturbed Project Area and facilities. Native plant communities similar to the surrounding area established during reclamation would provide additional habitat for wildlife species that were displaced during project construction.

Most wildlife, including the larger and more mobile species, would disperse due to the increased noise and human presence as the construction activities intensify. Short-term, localized adverse impacts to wildlife would occur primarily through gradual loss of habitat and disturbance by construction activities and human presence. Given the relatively small disturbance footprint and the multi-year pace of remediation, these impacts would be negligible to minor. Habitat lost during the contaminated material removal would be reestablished after those areas have been adequately remediated. Once the construction activities have been completed, all wildlife habitat would be reestablished in accordance with the approved reclamation plan and provide general wildlife habitat enhancement, resulting in a long-term, positive habitat gain. Any disturbance to wildlife as a result of construction-related noise and activity would be short-term, and wildlife would be free to occupy all habitats, minimizing long-term impacts. Wildlife habitat would be altered by localized, negligible-to-minor, short-term impacts from implementation of the Proposed Action following completion of reclamation. A complete reclamation and revegetation plan (Appendix U of the LAR) would provide adequate long-term mitigation of sites disturbed during construction activities that would offset any short-term significant adverse impacts to wildlife habitat. Removal of contaminated mine waste in the Project Area would also remove the source of radiation exposure, thereby preventing any further major, regional, long-term impacts to health, fecundity, and reproductive ability of wildlife.

Wildlife may be directly impacted within the Area of Analysis through the disruption of the mine waste during the excavation process. Although no guidelines concerning acceptable limits of radiation exposure have been established for the protection of other taxa, it is generally agreed that the dosage limits for humans serve as conservative standards for wildlife. Exposure limits would be closely monitored and maintained within safe protection limits for humans; and, therefore, no significant adverse radiological impact is expected for animals within the Area of Analysis.

The risk of spills of contaminated material from trucks is low but should be considered when evaluating potential impacts to wildlife along a transportation corridor. Release of contaminated materials has the potential to occur and adversely affect wildlife until it is cleaned up. The environmental impacts of a contaminated material spill will depend on the substance, quantity, timing, and location of the spill, as well as the speed and efficacy of the response and cleanup.

With rapid response and cleanup actions, a spill of contaminated material is likely to result in localized, negligible to minor, short-term adverse impacts to wildlife.

Mitigation measures that would minimize impacts to wildlife are detailed in Chapter 5.

Impacts to Migratory Birds under the Proposed Action

Contaminated material excavation and other construction activities have the potential to produce localized, negligible to minor, short-term impacts to migratory birds through short-term habitat loss and fragmentation, nest destruction and abandonment, and vehicular strikes. Nesting surveys would be conducted prior to grubbing and mine waste removal to mitigate potential impacts to breeding pairs and active nests during the breeding season. The nest surveys should identify any active nest within the area proposed for vegetation removal so that proper avoidance and minimization efforts may be implemented to reduce the risk of damaging nests, killing birds, or otherwise disrupting habitat during nesting.

A total of 55 species of migratory birds were observed utilizing the Area of Analysis (Table 3.5-6). It is reasonable to conclude that species displaced by construction and remediation activities in the short-term can utilize foraging grounds, nesting locations and other life requirements that are available in the adjacent habitat. Once reclamation has concluded successfully, migratory birds displaced by construction activities would be able to return and utilize the new habitat.

The likelihood for the direct impacts resulting in injury or mortality for migratory birds is greatest during the construction phase due to increased levels of traffic and physical disturbance. It is anticipated that some birds may be killed by increased vehicular traffic; however, reduced speed limits should mitigate potential impacts, resulting in localized, minor, short-term impacts to migratory birds.

Impacts to Raptors under the Proposed Action

Contaminated mine waste excavation and other construction actives have the potential to produce localized, negligible to minor, short-term impacts to raptors. Impacts could include temporary habitat loss and fragmentation, nest destruction and abandonment, vehicular strikes, and electrocution from overhead power lines. Nesting surveys would be conducted prior to vegetation and mine waste removal to mitigate potential impacts to breeding pairs and active nests during the breeding season. Nest surveys should identify any active raptor nest within the area proposed for vegetation removal so that proper avoidance and minimization efforts may be implemented to reduce the risk of incidental take. Implementation of the USFWS- and NNHP-recommended seasonal and spatial protection buffers for raptor nests and eagle roost sites (if encountered) would be utilized during the nesting season.

Seven species of raptor (American kestrel, common raven, Cooper's hawk, great horned owl, northern harrier, red-tailed hawk, and turkey vulture) were observed utilizing the **Area of Analysis** (Table 3.5-7). These species are highly mobile, have broad home ranges, and some rotate through multiple nests. It is reasonable to conclude that species displaced by remediation activities can utilize foraging grounds, nesting locations, and other habitat requirements that are available in similar habitat elsewhere in their range. Once reclamation has been successfully concluded, raptors displaced by construction activities would be able to return and utilize the habitat.

The Proposed Acton would not adversely impact regional raptor populations, though individual birds or pairs may be affected. Direct impacts to raptors could include injury or mortality due to collisions with facility-related vehicular traffic.

The likelihood for the impacts resulting in injury or mortality for raptors would be greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Traffic would persist during remediation activities but should occur at a reduced, more predictable level, and many species of raptor can acclimate to this type of vehicular traffic. Speed limits would be enforced during all construction and maintenance operations to reduce impacts to wildlife throughout the year, but particularly during the breeding and nesting season.

Impacts to Game Species under the Proposed Action

No big game migration corridors or important features (calving grounds, winter concentration areas, and perennial water) are known to occur on the Area of Analysis. Mule deer and scaled quail are the only game species observed utilizing the Area of Analysis (INTERA, 2017). Any individual species displaced by the Proposed Action can utilize foraging grounds and other resources that are available in the nearby habitat.

Impacts to Special Status Species Under the Proposed Action

As shown on Tables 3.5-5 and 3.5-6, there were 10 species of avifauna and 2 species of mammals found within the Area of Analysis during baseline surveys that are listed as either a species of greatest conservation need (SGCN) as defined by the New Mexico SWAP (DGF, 2016), birds of conservation concern (BCC) (USFWS, 2008), or sensitive in the NNHP. Direct impacts of special status species are similar to those of general wildlife, including temporary habitat loss and fragmentation, nest/den destruction and abandonment, and vehicular strikes. It is important to note that no important habitat or features for special status species were found in the Area of Analysis.

Although no tribal, federal, or state threatened, endangered, candidate, or proposed wildlife species have been recorded in the Area of Analysis, any mitigation actions deemed necessary through the consultation process would be implemented if observed in the future.

4.5.3.2.3 Alternative B – Conveyance

Under Alternative B, the areas of disturbance associated with the Mine Site Removal Areas, construction support zones, soil borrow areas, access roads, Jetty Area, topsoil stockpile, and Mill Site Repository would be 332 acres, similar to the Proposed Action. Conveyance would eliminate some of the potential impacts from vehicle collisions and spills but would not provide much difference in wildlife impacts compared to the Proposed Action.

Overall, the impacts on wildlife from implementing Alternative B would be similar to those described for the Proposed Action.

4.5.3.2.4 Alternative C – Material Sourcing for Cover

Under Alternative C, the total acreage of surface disturbance would total 292 acres, so the adverse impacts to wildlife resources would be a little less than under the Proposed Action. **The noxious weeds (tamarisk and bull thistle) found in the Pipeline Arroyo would be removed and revegetated with a native species.** Overall, the impacts on wildlife from implementing Alternative C would be similar to those described for the Proposed Action.

4.5.3.2.5 Alternative D – Disposal of Principal Threat Waste

The acreage and locations of the proposed surface disturbance under Alternative D are the same as that described for the Proposed Action. Therefore, the impacts on wildlife from implementing Alternative D would be the same as those described for the Proposed Action.

4.5.4 Cumulative Impacts to Ecological Resources

There are past, present, and reasonably foreseeable future actions that could result in cumulative impacts to wildlife and plants when considered in combination with any of the action alternatives. The following discussion summarizes the known past, present, and reasonably foreseeable future actions within the Project Area that could cumulatively affect the same ecological resources that would be affected by the alternatives considered in this SER. These actions include other mine site cleanups, infrastructure and public purpose projects, and livestock grazing within the region.

4.5.4.1 Interim Removal Actions at Mine Site

Disturbance to ecological resources associated Interim Removal Actions involve removal of vegetation and topsoil due to cleanup of soils exceeding radium-226 concentrations of 2.24 pCi/g. Cumulative adverse impacts to vegetation and wildlife resources from the Proposed Action and Interim Removal Actions would be localized, short-term, and minor. The adverse cumulative impacts from the Interim Removal Actions are of small significance and ecosystems restored from the BMPs and EPMs associated with the reclamation plan are nearly complete.

4.5.4.2 Structure Remediation

Disturbance to ecological resources associated with structure remediation projects involves construction of access roads and temporary staging areas, which leads to removal of vegetation. Cumulative adverse impacts to vegetation and wildlife resources from the Proposed Action and structure remediation projects would be localized, short-term, and minor. Proper implementation of BMPs and EPMs would make the cumulative impact of minor significance.

4.5.4.3 Quivira Mine Site

A reasonably foreseeable future action would be mine cleanup activities at the Quivira Mine Site. If the projects occurred simultaneously, there would be the potential for additional short-term loss of habitat and increase to vehicular traffic. However, proper implementation of BMPs, EPMs, and adherence to wildlife protection measures would make the cumulative impact of minor significance. Beneficial impacts to ecological resources would be localized, long-term, and minor, as radiological exceedances in soil and earthen materials would be eliminated and the extent of vegetation cover and wildlife habitat would increase following successful reclamation at project completion.

4.5.4.4 Livestock Grazing

Livestock grazing has likely affected ecological resources within and adjacent to the Project Area. These activities may have resulted in a shift in vegetation communities that may have affected habitat quality. Cumulative adverse impacts to ecological resources from the Proposed Action and livestock grazing would be localized, short-term, and minor. Proper implementation of BMPs, EPMs, and adherence to wildlife protection measures would make the cumulative impact of minor significance.

4.6 Meteorology, Climatology, and Air Quality Impacts

This section provides an evaluation of the potential meteorology, climatology, and air quality impacts estimated for the Proposed Action and alternatives. Chapter 5 contains a detailed analysis of mitigation measures for meteorology, climatology, and air quality impacts.

4.6.1 Meteorology, Climatology, and Air Quality Impacts Analysis

The Clean Air Act describes National Ambient Air Quality Standards (NAAQS) for six common air pollutants known as criteria pollutants. New Mexico has additional standards known as the New Mexico Ambient Air Quality Standards (NMAAQS). Ambient concentrations of these pollutants above NAAQS/NMAAQS thresholds are expected to be harmful to human health and the environment. The criteria pollutants are:

- Carbon Monoxide (CO)
- Hydrogen Sulfide (H_2S)
- Nitrogen Dioxide (NO_2)
- Ozone (O_3)
- Particulate Matter, in three sizes (PM2.5, PM10 and Total Suspended Particulate [TSP])
- Sulphur Dioxide (SO_2)

Although Volatile Organic Compounds (VOCs) are not a criteria pollutant, they are regulated on a federal and state level. The applicable NAAQS and NMAAQS concentrations are shown in Table 4.6-1.

Table 4.6-1. National Ambient Air Quality Standards (NAAQS) and New Mexico Ambient Air Quality Standards (NMAAQS)

Pollutant Averaging Periods and Standards			
Pollutant	Averaging Period	NAAQS ($\mu g/m^3$)	NMAAQS ($\mu g/m^3$)
CO	8-hour	10,303.6	9,960.0
	1-hour	40,069.6	14,997.5
H_2S	1-hour	-	13.9
NO_2	Annual	99.66	94.02
	24-hour	-	188.03
	1-hour	188.03	-
O_3	8-hour	137.3	-
$PM_{2.5}$	Annual	12.0	-
	24-hour	35.0	-
PM_{10}	24-hour	150.0	-
TSP	Annual	-	60.0
	24-hour	1,760.18	150.0
SO_2	Annual	-	52.4
	24-hour	-	261.9
	3-hour	1,309.3	-
	1-hour	196.4	-

Area of Analysis

The Area of Analysis for meteorology, climatology, and air quality depends upon the source of effluent. The Area of Analysis for air dispersion modeling is depicted on Figure 4.6-1.

Methods of Analysis

Impacts were analyzed primarily through the use of air dispersion analysis to collect more data about pathways of effluent to potential receptors, and visibility impairment analysis to gauge impacts on air quality.

Analyses of sources of effluent (particulate matter and gaseous) were performed using data collected during field events reported in INTERA (2017), combined with meteorological data, modeled emission rates, and methods provided in guidance documents by USEPA and other regulatory authors, as appropriate for the source of effluent and activity.

Visibility impairment analysis was performed using available data, USEPA guidance, and VISCREEN modeling software.

Assumptions

- Winds in and around the Project Area are consistent with historical data.
- All mitigation methods, BMPs, and EPMs are followed as recommended.

4.6.2 Air Dispersion Modeling

Air dispersion modeling is the method by which facilities typically show compliance with the NAAQS and NMAAQS. An air dispersion model was generated for operations under both the proposed and alternative operating scenarios.

4.6.2.1 Description of Effluents

As the proposed operations at the Project Area would be predominantly excavating and transporting of material, emissions of Particulate Matter (PM) are expected to have the largest impact. In addition, there would be some gaseous emissions in the form of CO, NO_2 and SO_2 due to sources which utilize internal combustion. There are no direct sources of H_2S or ozone; however secondary formation of ozone can occur from precursor pollutants such as VOCs and NO_x but is expected to be minimal.

PM ($PM_{2.5}$, PM_{10} and TSP) emissions would occur from the following processes at the mine site:

- Material being worked/disturbed at the Mine Site removal area, Repository, Jetty Area and Borrow Areas;
- Dust disturbed on unpaved haul roads by vehicle traffic;
- Working of stockpiles;
- Screening of material; and
- Conveyor drop points.

Gaseous (CO, NO_2, SO_2 and VOC) emissions will occur from the following processes/equipment:

- Emergency generators;
- Conveyor system generators; and
- Fuel storage and operations.

Emission calculations for each of the sources at the facility were performed based on the methods discussed in the *Environmental Data Collection Work Plan for the Northeast Church Rock Site Removal Action and the United Nuclear Corporation Site Remedial Action, McKinley County, New Mexico* (INTERA, 2017). Included below is a description of the methodologies used to calculate emissions from these sources.

4.6.2.1.1 Unpaved Roads

Emissions of particulates occur due to the disturbance of dust on unpaved haul roads as vehicles travel along the road. These emissions are directly proportional to the volume of traffic and depend on various site parameters including average vehicle weight and the surface silt content. Section 13.2.2 of AP-42 (USEPA, 2006a), Unpaved Roads, was used to calculate emissions from the facility's unpaved haul roads.

4.6.2.1.2 Uncovered Stockpiles

Dust emissions from uncovered storage piles occur due to various factors such as loading and unloading of material onto the pile and disturbances by wind. The emissions from the stockpiles depend on the age of the pile, moisture content, and size distribution of particulates. The emissions associated with the loading and unloading operations were calculated using Aggregate Handling and Storage Piles values from EPA (2006b).

Wind-blown emissions from uncovered storage piles were developed based on guidance for Industrial Wind Erosion in EPA (2006c) and are proportional to the amount of erodible material, number of pile disturbances, and the ambient wind speed.

Wind-blown dust emissions from uncovered haul trucks were also estimated. The Western Regional Air Partnership (WRAP) Fugitive Dust Handbook (Countess Environmental, 2006) provides guidance for calculating these emissions.

4.6.2.1.3 Material Screening

Material screening will occur to separate soil and rock. This operation results in emissions of particulates. Values for Crushed Stone Processing and Pulverized Mineral Processing (USEPA, 2004) used to calculate the emissions from the screening operations. Emissions from screening operations are based on the amount of material screened.

4.6.2.1.4 Disturbed Areas

The project will consist of various cut, fill, and re-grading activities. These areas will have the potential for particulate emissions due to wind erosion. The calculation methodology for these areas is the same as the wind erosion for uncovered storage piles and is based on Section 13.2.5 of USEPA (2006c).

4.6.2.1.5 Fuel Storage

During remediation, fuel would be stored at the Fuel Farm Area within the Former Mill Site Yard (See LAR Drawing 2-02). Emissions of VOCs would occur from the tanks storing the fuel. It is expected that both gasoline and diesel will be stored. The calculation methodology will follow guidance for Organic Liquid Storage Tanks provide by USEPA (2006d).

4.6.2.1.6 Vehicle Fueling

Vehicles at the facility will be re-fueled from the fuel storage tanks. This will result in the potential for VOC emissions. Calculated emissions from this activity were based on the methodology presented in USEPA (2006e) for the Transportation and Marketing of Petroleum Liquids.

4.6.2.2 Release Point Characteristics

Each source of emissions has a different release point characteristic. However, the majority of the sources at the Mine Site are considered fugitive in nature for air quality purposes. As such, they have no discrete release point but instead are released over an area or within a volume of air. Examples of fugitive sources would be emissions from unpaved haul roads and wind-blown dust from a disturbed area.

Some sources would have distinct release point characteristics, such as generators which have a discrete exhaust stack. Table 4.6-2 shows the release point characteristics used for the proposed sources at the Mine Site. Assumptions on the source characteristics were made based on default parameters provided by NMED (2016 and 2017) in two versions of the Air Dispersion Modeling Guidance.

Table 4.6-2. Release Point Parameters

Area Sources

ID	Description	Source Type	Number of Sources	Release Height (m)	Init Lat Dim (m)	Init Vert Dim (m)	Data Source
HR1	Mine Waste Haul Road	Fugitive	119	4.0	6.1	3.2	NMED Air Dispersion Modeling Guidance (2017) Section 5.3.3 Haul Roads & 5.3.2 Fugitive Equipment Sources
HR2	Haul Road Spur	Fugitive	35	4.0	6.1	3.2	
HR3	Access Ramp	Fugitive	15	4.0	6.1	3.2	
HR4	Clean Access Road	Fugitive	42	4.0	6.1	3.2	
HR5	South Borrow Haul	Fugitive	59	4.0	6.1	3.2	
HR6	East Borrow Hail	Fugitive	12	4.0	6.1	3.2	
HR7	West Borrow Haul	Fugitive	58	4.0	6.1	3.2	
HR8	North Borrow Haul	Fugitive	39	4.0	6.1	3.2	
HR9	Repository Access Road	Fugitive	177	4.0	6.1	3.2	
HR10	Jetty Access Road	Fugitive	51	4.0	6.1	3.2	
CB1	Conveyor	Fugitive	1	4.0	0.47	0.93	
CB2	Conveyor	Fugitive	1	4.0	0.47	0.93	
CB3	Conveyor	Fugitive	1	4.0	0.47	0.93	
SP1	PTW Stockpile	Fugitive	1	6.0	55.7	4.7	Stockpile Area based on Proposed Action Footprint
SP2	Imported Rock	Fugitive	1	6.0	11.6	4.7	
SP3	Screened Rock	Fugitive	1	6.0	11.6	4.7	
SP4	Topsoil Stockpile	Fugitive	1	6.0	19.6	4.7	
SC1	Screener	Fugitive	1	4.0	1.2	2.3	

Area Sources

ID	Description	Source Type	Area (m^2)	Release Height (m)	Init Vert Dim (m)	Data Source
DA1	Mine Site	Fugitive	674,285	4.0	2.3	Borrow Pile Area based on Proposed Action Footprint; Release Height and Init Vert Dim Based on NMED Air Dispersion Modeling Guidance (2017) 5.3.2 Fugitive Equipment Sources
DA2	DA2 is split into 4 smaller areas below:					
DA2_1	South Borrow Pile	Fugitive	70,688	4.0	2.3	
DA2_2	North Borrow Area	Fugitive	625,174	4.0	2.3	
DA2_3	West Borrow Area	Fugitive	45,518	4.0	2.3	
DA2_4	East Borrow Area	Fugitive	45,033	4.0	2.3	
DA3	Repository	Fugitive	464,152	4.0	2.3	
DA4	Jetty Excavation	Fugitive	108,999	4.0	2.3	

Point Sources

ID	Description	Source Type	Stack Height (m)	Stack Temp (K)	Stack Velocity (m/s)	Stack Diameter (m)	Data Source
CU1	CSF 1	Point	1.8	650.0	18.1	0.3	NMED Air Dispersion Modeling Guidance (2016) Section 4.8.1 Neighboring Sources Data
CU2	CSF 2	Point	1.8	650.0	18.1	0.3	
CU3	CSF 3	Point	1.8	650.0	18.1	0.3	
CU4	Mine Area 1	Point	1.8	650.0	18.1	0.3	
CB-Gen1	Conveyor Belt Generator 1	Point	1.8	650.0	18.1	0.3	
CB-Gen2	Conveyor Belt Generator 2	Point	1.8	650.0	18.1	0.3	

4.6.2.3 Air Dispersion Modeling Analysis

To assess the impact of the operations on the ambient air shed, air dispersion modeling was conducted using the EPA American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The most recent version (v18081) of AERMOD was executed for the air dispersion modeling analysis. The following sections described setup information for the modeling analysis.

4.6.2.3.1 Receptor Grid and Elevation Data

For modeling purposes, the center point of the Area of Analysis was designated at 35.650021°N, 108.504678°W (UTM: Zone 12, 725,910 mE, 3,948,000 mN). A variable receptor grid was set up radially from the center point location out to 25 km with receptor spacing increasing with distance from the center point. The resolution of the variable receptor spacing is shown in Table 4.6-4. Additionally, a facility receptor perimeter was set up to include approximate fence lines, terrain boundaries and NM 566 which runs through the area of operations. The perimeter receptor grid has a spacing of 25m. An aerial image of the variable and boundary receptors is shown in Figure 4.6-1. For modeling purposes, ambient air is classified as any location the general public could have access to outside the contiguous plant property.

Elevation data for the receptors and sources were retrieved from the USGS National Elevation Dataset (NED) and has a 1/3 arc second resolution.

Table 4.6-4. Variable Receptor Grid

Emission Factor Control Efficiencies			
Shell	Starting Radial Distance (m)	Ending Radial Distance (m)	Spacing (m)
1	0	2,200	50
2	2,200	4,000	100
3	4,000	5,000	250
4	5,000	10,000	500
5	10,000	15,000	1,000
5	15,000	25,000	5,000

4.6.2.3.2 Meteorological Data

As discussed in Section 3.6, the local meteorology at the Mine Site can be represented by data collected at the Gallup Airport ASOS station. The NMED provided meteorological data for this site for air dispersion modeling in support of air quality permitting. The NMED meteorological data set were collected from January 1, 1987, through December 31, 1991. A wind rose for this meteorological data is shown in Figure 4.6-2.

4.6.2.3.3 Modeled Emission Rates

Emission rates were calculated for all sources that would be operational during the Proposed Action and action alternative. Several sources were not included in air dispersion modeling, such as emissions from emergency generators and infrastructure/construction activities, as they would be considered intermittent and not a source of steady-state emissions by the NMED. However, as the operations associated with the Proposed Action and alternatives would cause a significant amount of earth disturbance, emissions from wind-blown dust are conservatively included. The emission rates shown in Table 4.6-5 are considered the Potential to Emit (PTE) emission rates as they include any reductions due to control practices or reduction in operational hours. Table 4.6-5 shows the maximum short-term emission rate (lb/hr) and long-term emission rate (tons/year). The short-term emission rate is used in the air dispersion modeling with variable emission rates to account for the hours of operation per day.

Table 4.6-5. Proposed Potential to Emit Emission Rates

Controlled Emission Rates																			
	NO_x		CO		VOC		SO_2		PM_{30}		PM_{10}		$PM_{2.5}$		Total HAPs		Radionuclides	
Unit	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
HR1	-	-	-	-	-	-	-	-	1.768	1.301	0.151	0.111	0.015	0.011	-	-	0.000	0.000
HR2	-	-	-	-	-	-	-	-	0.016	0.012	0.001	0.001	0.000	0.000	-	-	-	-
HR3	-	-	-	-	-	-	-	-	0.006	0.004	0.001	0.000	0.000	0.000	-	-	-	-
HR4	-	-	-	-	-	-	-	-	0.019	0.014	0.002	0.001	0.000	0.000	-	-	-	-
HR5	-	-	-	-	-	-	-	-	1.605	1.181	0.163	0.120	0.016	0.012	-	-	-	-
HR6	-	-	-	-	-	-	-	-	0.360	0.265	0.037	0.027	0.004	0.003	-	-	-	-
HR7	-	-	-	-	-	-	-	-	0.860	0.633	0.073	0.054	0.007	0.005	-	-	-	-
HR8	-	-	-	-	-	-	-	-	1.588	1.168	0.161	0.118	0.016	0.012	-	-	-	-
HR9	-	-	-	-	-	-	-	-	1.424	1.048	0.145	0.106	0.014	0.011	-	-	-	-
HR10	-	-	-	-	-	-	-	-	0.229	0.170	0.026	0.021	0.005	0.005	-	-	-	-
CB1	-	-	-	-	-	-	-	-	0.336	0.306	0.110	0.100	0.031	0.028	-	-	-	-
CB2	-	-	-	-	-	-	-	-	0.336	0.306	0.110	0.100	0.031	0.028	-	-	-	-
CB3	-	-	-	-	-	-	-	-	0.336	0.306	0.110	0.100	0.031	0.028	-	-	-	-
SP1	-	-	-	-	-	-	-	-	4.708	2.547	2.233	1.230	0.338	0.186	-	-	0.159	0.087
SP2	-	-	-	-	-	-	-	-	139.170	10.182	65.835	4.866	9.969	0.736	-	-	-	-
SP3	-	-	-	-	-	-	-	-	23.548	2.782	11.149	1.366	1.688	0.206	-	-	0.792	0.097
SP4	-	-	-	-	-	-	-	-	19.658	4.422	9.309	2.142	1.409	0.323	-	-	0.661	0.152
SC1	-	-	-	-	-	-	-	-	0.400	0.004	0.135	0.001	0.103	0.000	-	-	-	-
DA1	-	-	-	-	-	-	-	-	7.231	13.596	3.494	6.754	0.527	1.014	-	-	0.159	0.088
DA2_1	-	-	-	-	-	-	-	-	4.970	3.691	2.363	1.802	0.358	0.271	-	-	0.159	0.087
DA2_2	-	-	-	-	-	-	-	-	0.215	0.941	0.107	0.471	0.016	0.071	-	-	-	-
DA2_3	-	-	-	-	-	-	-	-	0.167	0.732	0.084	0.366	0.013	0.055	-	-	-	-
DA2_4	-	-	-	-	-	-	-	-	0.166	0.726	0.083	0.363	0.012	0.054	-	-	-	-
DA3	-	-	-	-	-	-	-	-	1.717	7.518	0.858	3.759	0.129	0.564	-	-	-	-
DA4	-	-	-	-	-	-	-	-	0.402	1.759	0.201	0.879	0.030	0.132	-	-	-	-
DA5	-	-	-	-	-	-	-	-	0.015	0.065	0.007	0.033	0.001	0.005	-	-	-	-
DA6_1	-	-	-	-	-	-	-	-	0.243	1.066	0.122	0.533	0.018	0.080	-	-	-	-
DA6_2	-	-	-	-	-	-	-	-	0.227	0.994	0.113	0.497	0.017	0.075	-	-	-	-
TK1	-	-	-	-	0.005	0.024	-	-	-	-	-	-	-	-	0.000	0.002	-	-
TK2	-	-	-	-	0.005	0.024	-	-	-	-	-	-	-	-	0.000	0.002	-	-
TK3	-	-	-	-	0.005	0.024	-	-	-	-	-	-	-	-	0.000	0.002	-	-
CU1	15.500	3.875	3.340	0.835	0.296	0.074	1.235	0.309	1.100	0.275	1.100	0.275	1.100	0.275	3.227	0.807	-	-
CU2	15.500	3.875	3.340	0.835	0.296	0.074	1.235	0.309	1.100	0.275	1.100	0.275	1.100	0.275	3.227	0.807	-	-
CU3	15.500	3.875	3.340	0.835	0.296	0.074	1.235	0.309	1.100	0.275	1.100	0.275	1.100	0.275	3.227	0.807	-	-
CU4	15.500	3.875	3.340	0.835	0.296	0.074	1.235	0.309	1.100	0.275	1.100	0.275	1.100	0.275	3.227	0.807	-	-
CB-Gen1	0.250	0.227	0.307	0.280	0.013	0.012	0.000	0.000	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	-	-
CB-Gen2	0.440	0.401	0.493	0.449	0.023	0.021	0.001	0.001	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	-	-
Totals	62.690	16.128	14.161	4.069	1.235	0.400	4.941	1.236	216.124	58.841	101.587	27.026	19.205	5.019	12.911	3.235	1.929	0.512

4.6.2.3.4 Proposed Action Versus Alternative Source Groups

To represent the operations occurring in both the Proposed Action and alternatives, modeling source groups were assigned. The Proposed Action was split into five source analysis groups (A1 through A5) to isolate material being transported from the main Mine Site and the Borrow Areas. Approximately 1,000,000 CY of mine waste would be transported from the Mine Site to the Repository via haul trucks. Clean fill would be transported from each of the Borrow Areas by haul truck to act as coverage at the Repository. It is expected that material would only be transported from one area at a time to the Repository. The following alternative actions were also included in the analysis:

- Alternative Action B1 – Conveyors would be used to transport spoil material from the Mine Site to the Repository. Clean fill would be transported by haul truck from the Borrow Areas as per Proposed Action scenarios A2 through A5.
- Alternative Action C1 – Spoils material would be transported from the Mine Site by haul truck to the Repository while excavation is occurring at the Jetty Area.
- Alternative Action C2 – Clean fill would be sourced from the Jetty Area rather than the Borrow Areas and transported by haul truck to the Repository for cover.
- Alternative Action D1 – This is similar to Proposed Action A1, however PTW would be screened at the PTW stockpile and transported offsite. Spoil would still be hauled by truck from the Mine Site to the Repository. Clean fill would be transported from Borrow Areas as per Proposed Action scenarios A2 through A5.

A matrix of the active air emission sources for each of the proposed and alternative actions are presented in Table 4.6-6.

Table 4.6-6. Proposed Action and Alternative Modeling Source Groups

Proposed Action							Alternative B	Alternative C		Alternative D
ID	Description	A1	A2	A3	A4	A5	B1	C1	C2	D1
HR1	Mine Waste Haul Road	Yes						Yes		Yes
HR2	Haul Road Spur									
HR3	Access Ramp									
HR4	Clean Access Road									
HR5	South Borrow Haul		Yes			Yes				
HR6	East Borrow Hail			Yes						
HR7	West Borrow Haul				Yes					
HR8	North Borrow Haul					Yes				
HR9	Repository Access Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HR10	Jetty Road								Yes	
CB1	Conveyor from Mine Waste						Yes			
CB2	Conveyor from Mine Waste						Yes			
CB3	Conveyor from Mine Waste						Yes			
SP1	PTW Stockpile	Yes					Yes	Yes	Yes	Yes
SP2	Imported Rock	Construction not included for air dispersion modeling								
SP3	Screened Rock	Yes					Yes	Yes	Yes	Yes
SP4	Topsoil Stockpile		Yes	Yes	Yes	Yes		Yes	Yes	Yes
SC1	Screener	Yes					Yes	Yes	Yes	Yes
DA1	Mine Site	Yes					Yes	Yes		Yes
DA2	DA2 is split into 4 smaller areas below:									
DA2_1	South Borrow Pile		Yes							
DA2_2	North Borrow Area					Yes				
DA2_3	West Borrow Area				Yes					
DA2_4	East Borrow Area			Yes						
DA3	Repository	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DA4	Jetty Excavation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DA5	Road Construction	Construction not included for air dispersion modeling								
DA6	Facility Construction	Construction not included for air dispersion modeling								
CU1	CSF 1	Emergency Generators are not modeled if operated less than 500 hours/year.								
CU2	CSF 2	Emergency Generators are not modeled if operated less than 500 hours/year.								
CU3	CSF 3	Emergency Generators are not modeled if operated less than 500 hours/year.								
CU4	Mine Area 1	Emergency Generators are not modeled if operated less than 500 hours/year.								
CB-GEN1	Conveyor Generator 1						Yes			
CB-GEN2	Conveyor Generator 2						Yes			

4.6.2.3.5 Hours of Operation

In addition to the operations at the Project Area being divided into modeling source groups for the Proposed Action and alternatives and subcategorized into areas of activity within each of the actions, the daily operating schedules were also included in the air dispersion modeling analysis. It is expected that operations would occur from 07:00 and run to 16:00 Monday to Friday at various areas of the site. These hours of operation were associated with any anthropogenic activities in the air dispersion model (such as haul road operations and screening), wind-blown emissions were assumed 24 hours a day.

4.6.2.3.6 Particle Depletion

Particulates emitted to the atmosphere have the potential to be removed due to gravitational settling and washout from precipitation. To account for these depletion phenomena, dry deposition processes were included within the air dispersion model. Dry deposition parameters are proportional to the PM size fraction and the composition of the PM emitted. Typical depletion parameters were used for haul roads, rock handling for mining industries and combustion sources. Table 4.6-7 lists each of the depletion parameters per source type and PM size.

Table 4.6-7. PM Depletion Parameters

Emission Factor Control Efficiencies				
Emission Source	Particle Size Range (μm)	Mass Mean Particle Diameter (μm)	Mass Weighted Size Fraction	Particle Density (g/cm^3)
Vehicle Fugitive Dust Depletion Parameters	$PM_{2.5}$			
	0-2.5	1.57	1	2.5
	PM_{10}			
	0-2.5	1.57	0.25	2.5
	2.5-10	6.91	0.75	2.5
	TSP			
	0-2.5	1.57	0.05	2.5
	2.5-10	6.91	0.15	2.5
	10-15	12.63	0.05	2.5
	15-30	23.23	0.75	2.5
Rock Handling (Fugitive Dust Emission Factors for the Mining Industry) Depletion Parameters	$PM_{2.5}$			
	0-2.5	1.57	1	2.7
	PM_{10}			
	0-2.5	1.57	0.078	2.7
	2.5-5	3.88	0.27	2.7
	5-10	7.77	0.652	2.7
	TSP			
	0-2.5	1.57	0.03	2.7
	2.5-5	3.88	0.1	2.7
	5-10	7.77	0.24	2.7
	10-20	15.54	0.38	2.7
	20-30	25.33	0.25	2.7
Combustion Stack Depletion Parameters	$PM_{2.5}$			
	0-2.5	1.57	1	1.5
	PM_{10}			
	0-2.5	1.57	1	1.5
	TSP			
	0-2.5	1.57	1	1.5

4.6.2.3.7 Significant Impacts Analysis

The modeled ground-level concentrations were compared to the corresponding significant impact levels (SILs) described in the NMED (2016) to determine whether the modeled ground-level concentrations at any receptor locations were "significant" (i.e., greater than the SIL). The significance analysis revealed that modeled ground-level concentrations for all PM sizes and averaging periods (24-hr and annual TSP, PM_{10}, and $PM_{2.5}$) are greater than the applicable SILs and therefore require additional modeling. Results from the significance analysis are shown in Table 4.6-8 for the Proposed Action and alternatives. The emissions of gaseous pollutants (CO, NO_2 and SO_2) are less than all applicable significance levels and therefore do not require any further modeling.

Table 4.6-8. Air Dispersion Modeling Significance Results

Air Dispersion Modeling Significance Results														
Pollutant	Averaging Period	Significance Level (µg/m³)	Modeling Scenarios - Proposed and Alternative Actions									Maximum Modeled Concentration (µg/m³)	Percent of Significance	Maximum Scenario
			A1	A2	A3	A4	A5	B1	C1	C2	D1			
CO	8-hr	500	0	0	0	0	0	1.4	0	0	0	1.4	0%	B1
CO	1-hr	2000	0	0	0	0	0	8.3	0	0	0	8.3	0%	B1
NO_2	Annual	1	0	0	0	0	0	0.028	0	0	0	0.028	3%	B1
NO_2	24-hr	5	0	0	0	0	0	0.56	0	0	0	0.56	11%	B1
NO_2	1-hr	7.54	0	0	0	0	0	6.7	0	0	0	6.69	89%	B1
$PM_{2.5}$	Annual	0.3	0.94	2.58	2.56	2.57	2.56	0.94	2.60	2.58	2.60	2.60	Significant	C1 & D1
$PM_{2.5}$	24-hr	1.2	13.21	14.85	14.81	14.81	14.81	13.22	14.89	14.88	14.89	14.89	Significant	C1 & D1
PM_{10}	Annual	1	5.32	16.65	16.56	16.59	16.56	5.32	16.74	16.65	16.74	16.74	Significant	-
PM_{10}	24-hr	5	122.88	108.27	108.09	108.12	108.09	122.88	122.95	122.23	122.95	122.95	Significant	C1 & D1
TSP	Annual	1	9.25	34.37	34.31	34.33	34.31	9.23	34.55	34.46	34.55	34.55	Significant	C1 & D1
TSP	24-hr	5	287.18	264.53	264.31	264.31	264.32	287.16	287.36	287.28	287.36	287.36	Significant	C1 & D1
SO_2	Annual	1	0	0	0	0	0	0.00050	0	0	0	0.00050	0%	B1
SO_2	24-hr	5	0	0	0	0	0	0.00095	0	0	0	0.00095	0%	B1
SO_2	3-hr	25	0	0	0	0	0	0.0050	0	0	0	0.0050	0%	B1
SO_2	1-hr	7.8	0	0	0	0	0	0.011	0	0	0	0.011	0%	B1

4.6.2.3.8 Surrounding Source and Background Concentration Data

Existing ambient air quality must be considered when evaluating compliance with the NAAQS and NMAAQS in the air shed impacted by the proposed operations. The evaluation of existing ambient air quality consists of emissions from both neighboring sources and monitored background concentrations. Tables 4.6-8 and 4.6-9 show the background concentrations and number of neighboring sources with emissions within a 50-km (~31-mile) distance from the mine site.

As per NMED guidelines for air dispersion modeling, all applicable surrounding sources and/or background concentrations were added to an impact model for pollutants with receptors exceeding the Significant Impact Levels (SILs).

Table 4.6-9. Air Dispersion Modeling Impact Results

Air Dispersion Modeling Impact Results						
Pollutant	Averaging Period	Background Concentration (µg/m3)	Proposed Action (A1) Modeled Concentration (µg/m3)	Proposed Action (A1) Percent of NAAQS/NMAAQS	Maximum Modeled (C1/D1) Concentration (µg/m3)	Maximum Modeled (C1/D1) Percent of NAAQS/NMAAQS
PM2.5	Annual	6.6	0.9	63%	2.6	77%
PM2.5	24-hr	22.5	13.2	102%	14.9	107%
PM10	Annual	-	5.3	-	16.7	-
PM10	24-hr	21.0	122.9	96%	123.0	96%
TSP	Annual	9.5	9.2	31%	34.5	73%
TSP	24-hr	21.0	287.2	205%	287.4	206%

4.6.3 Visibility Analysis

A visibility impairment analysis was conducted to demonstrate that emissions from the proposed operations would not have an adverse impact on visibility in the vicinity. Elements of the visibility impairment analysis include determining the visual quality of the area and assessing the visual impact of the proposed operations. The Mine Site is approximately 26 km from Gallup, NM and approximately 119 km from the closest Class I area, Petrified Forest National Park in Arizona. This National Park was evaluated for Class I visibility impacts.

Using methodologies discussed in the USEPA’s Workbook for Plume Visual Impact Screening and Analysis (1988c), a visibility impairments analysis was completed using VISCREEN, a plume visibility impact model. VISCREEN allows for two levels of visibility screening. Level 1 screening involves a series of conservative calculations designed to identify those emissions sources that have little potential for adversely affecting visibility. If visibility impairments are indicated, a Level 2 analysis, which allows for modification of default parameters including meteorological data, is performed. Only a Level 1 analysis was performed for this study.

Results from a VISCREEN analysis are expressed in terms of perceptibility (ΔE) and contrast. The color contrast parameter, ΔE, is used as the primary basis for determining the perceptibility of plume visual impacts in screening analyses. ΔE provides a single measure of the difference between two arbitrary colors as perceived by humans. USEPA guidance for plume visual impact screening suggests a critical value for ΔE of 2.0 for untrained observers under reasonable worst-case conditions. A green contrast value is also recorded because the human eye is most sensitive to intensity changes in green. The critical value for this contrast is 0.05 (USEPA, 1988c). VISCREEN may re-estimate these critical values based on inputs during the analysis.

VISCREEN conducts four tests of screening calculations. The first two tests refer to visual impacts caused by plume parcels located inside the boundaries of the given area. Tests of impacts inside the boundary are used to determine visual impacts when integral vistas are not protected.[1] The last two tests are for plume parcels located outside the boundaries of the area. The tests of visual impacts outside the boundaries of a sensitive area is only required if analyses for protected integral vistas are required.

The input parameters for a Level 1 visibility analysis in VISCREEN are shown in Table 4.6-10. The results of the Level 1 VISCREEN analysis are summarized in Table 4.6-11, which presents the following information:

- Background: The background against which the plume is viewed;
- Theta: The sun elevation angle above the horizon;
- Azimuth: The angle between the line of sight and the line connecting the source and observer (an azimuth angle of zero implies that the observer is looking directly toward the source);
- Distance: The distance from the source to the point at which the observer's line of sight intersects the plume;
- Alpha: The angle between the light of sight and the plume centerline;
- Delta E Critical: The perceptibility screening threshold (2.0);[2]
- Delta E Plume: The maximum modeled plume perceptibility;
- Contrast Critical: The contrast screening threshold (0.05); and
- Contrast Plume: The maximum modeled plume contrast.

[1] Workbook for Plume Visual Impact Screening and Analysis, p. 27.

[2] In some cases, VISCREEN changes critical delta E and contrast depending on input parameters.

Table 4.6-10. VISCREEN Input Parameters

Input Parameter	Input Value	Notes
PM Emission Rate	27 tpy	VISCREEN is a single source model; consequently, all elevated and ground-based emissions are lumped together as if they originated from a single source. Emissions reflect the short-term maximum except for the SSM emissions which reflect an annualized approach due to their infrequent occurrence.
NOx Emission Rate	16.1 tpy	
Background Visual Range	110 km	From Figure 9 of the Workbook for Plume Visual Impact Screening and Analysis.
Source-Observer Distance: Petrified Forest National Park	119 km	The distance from the plant to the nearest boundary is used in VISCREEN as the source-observer distance.
Minimum Distance to Class I Area: (assumed d) Petrified Forest National Park	119 km	The closest boundary to the Petrified Forest National Park equals to source-observer distance, approximately 119 km.
Maximum Distance to Class I Area: Petrified Forest National Park	153 km	The maximum distance is 153 km based on a 11.25° transect from the source-observer distance.
Meteorological Conditions: Stability Wind Speed	F 1 m/s	Default worst-case meteorological data are used in Level 1 analysis.

The results of the Level 1 VISCREEN analysis indicate that there are no potential adverse visibly impacts inside or outside of the airshed at the Petrified Forest National Park due to the Proposed Action or alternatives.

Table 4.6-11. Level 1 VISCREEN Results - Petrified Forest National Park

Maximum Visual Impacts Inside the Class I Area								
Background	Theta (°)	Azimuth (°)	Distance (km)	Alpha (°)	delta E		Contrast	
					Critical	Plume	Critical	Plume
Sky	10	84	119	84	2	0.046	0.05	0.001
Sky	140	84	119	84	2	0.01	0.05	0
Terrain	10	84	119	84	2	0.037	0.05	0
Terrain	140	84	119	84	2	0.006	0.05	0
Maximum Visual Impacts Outside the Class I Area								
Background	Theta (°)	Azimuth (°)	Distance (km)	Alpha (°)	delta E		Contrast	
					Critical	Plume	Critical	Plume
Sky	10	5	37.1	164	2	0.104	0.05	0.001
Sky	140	5	37.1	164	2	0.022	0.05	0.001
Terrain	10	5	37.1	164	2	0.062	0.05	0.001
Terrain	140	5	37.1	164	2	0.02	0.05	0

4.6.4 Impacts Discussion

The following section discusses the impacts for the Proposed and Alternative actions. Mitigation that would reduce the impacts of the Proposed Action and alternatives is discussed in in Section 5.

4.6.4.1 No Action

Under the No Action Alternative, the Proposed Action would not take place and no impacts to meteorology, climatology, and air quality would occur. No mine waste would be excavated from the Mine Site or transported to the Mill Site, so changes to air quality from existing conditions would not occur.

4.6.4.2 Proposed Action

Under the Proposed Action, the emissions from $PM_{2.5}$ and TSP for the 24-hr averaging period would cause an exceedance of the NAAQS and NMAAQS. The exceedance is caused by the working of material (number of disturbances) and throughput of material at the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4). As such the project would not be eligible for an air quality permit from the New Mexico Environmental Department (NMED). However, as described in Section 5.0 (Mitigation Measures), a mitigation strategy is proposed to move the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4) to different locations. With this mitigation strategy, the modeled results show that operations associated with the Proposed Action would not exceed the applicable NAAQS and NMAAQS. See Section 5.0 for additional details.

4.6.4.3 Alternative B – Conveyance

Under Alternative Action B, $PM_{2.5}$ and TSP for the 24-hr averaging period also cause an exceedance of the NAAQS and NMAAQS. The conveyance system would reduce activity on the mine site to repository haul road but has additional emissions from transfer points of the conveyance system. However, the exceedance would be caused by the working of material (number of disturbances) and throughput of material at the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4). As such, Alternative B would not be eligible for an air quality permit from the New Mexico Environmental Department (NMED).

However, as described in Section 5.0 (Mitigation Measures), a mitigation strategy is proposed to move the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4) to different locations. With this mitigation strategy, the modeled results show that operations associated with Alternative B would not exceed the applicable NAAQS and NMAAQS. See Section 5.0 for additional details.

4.6.4.4 Alternative C – Material Sourcing for Cover

Under Alternative Action C, $PM_{2.5}$ and TSP for the 24-hr averaging period also cause an exceedance of the NAAQS and NMAAQS. The sourcing of cover material from the Jetty area has minimal impact on the overall air quality impacts compared to the Proposed Action. The exceedance in NAAQS/NMAAQS is caused by the working of material (number of disturbances) and throughput of material at the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4). As such, Alternative C would not be eligible for an air quality permit from the New Mexico Environmental Department (NMED).

However, as described in Section 5.0 (Mitigation Measures), a mitigation strategy is proposed to move the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4) to different locations. With this mitigation strategy, the modeled results show that operations associated with Alternative C would not exceed the applicable NAAQS and NMAAQS. See Section 5.0 for additional details.

4.6.4.5 Alternative D – PTW Disposal

Under Alternative Action D, $PM_{2.5}$ and TSP for the 24-hr averaging period also cause an exceedance of the NAAQS and NMAAQS. The removal of PTW to an offsite location has minimal impact on the air quality. The exceedance is caused by the working of material (number of disturbances) and throughput of material at the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4). As such, Alternative D would not be eligible for an air quality permit from the New Mexico Environmental Department (NMED).

However, as described in Section 5.0 (Mitigation Measures), a mitigation strategy is proposed to move the Imported Rock Stockpile (SP2), Screened Rock Stockpile (SP3) and the Topsoil Stockpile (SP4) to different locations. With this mitigation strategy, the modeled results show that operations associated with Alternative D would not exceed the applicable NAAQS and NMAAQS. See Section 5.0 for additional details.

4.6.5 Cumulative Impacts to Meteorology, Climatology, and Air Quality

An impacts analysis of the emissions from the Mine Site, background concentrations and applicable surrounding sources was completed for the pollutants ($PM_{2.5}$, PM_{10} and TSP) and averaging periods with impacts (annual and 24-hr) that exceeded the SILs.

Table 4.6-9 shows the results of this analysis for the Proposed Action (Scenario A1) and the modeling scenarios with the highest concentration SIL results (Alternative Actions C1 and D1). The table shows that for the annual averaging period, impacts of $PM_{2.5}$, PM_{10} and TSP; and the 24-hr averaging period for PM_{10} concentrations are less than the applicable NAAQS and NMAAQS. However, the 24-hour averaging period impacts for $PM_{2.5}$ and TSP are greater than the NAAQS/NMAAQS at 107% and 206% respectively for the maximum concentration results of the C1 and D1 scenarios and 102% and 205% for the Proposed Action (Scenario A1). The dominant active sources at the site are the stockpiles (SP3 and SP4). The results of the modeling are also shown graphically in Figures 4.6-3 through Figure 4.6-8 for the Proposed Action (Annual and 24-hr for $PM_{2.5}$, PM_{10} and TSP) and Figure 4.6-9 to Figure 4.6-14 for the worst-case model results found with Alternative Actions C1 and D1.

In addition to these quantitative simulations, past, present, and reasonably foreseeable future actions that could result in cumulative impacts to meteorology, climatology and air quality were considered in combination with any of the action alternatives. The following discussion summarizes the known past, present, and reasonably foreseeable future actions within the Project Area that could cumulatively affect the same air quality resources that would be affected by the alternatives considered in this SER. These actions include past interim removal actions at the mine site, reasonably foreseeable structure remediation projects, and another mine site cleanup.

4.6.5.1 Interim Removal Actions at Mine Site

Past actions associated with the Interim Removal Actions would have no cumulative effect on air quality when combined with the Proposed Actions or alternatives because the Interim Removal Actions occurred in the past and are now completed. With the Interim Removal Actions occurring years apart from the Proposed Action and alternatives, air quality impacts would not be cumulative.

4.6.5.2 Structure Remediation

If structures are remediated in the future within the vicinity of the Project Area during the period of construction for the Proposed Action or alternatives, then minor, adverse cumulative impacts to air quality may possibly occur. For example, structure remediation activities that would generate particulate matter from demolition or removal activities could add to particulate matter sources from the Proposed Action or alternatives. Though specific details of such activities would be required, the significance of any cumulative effect could be evaluated using the results identified for each alternative discussed in this section.

4.6.5.3 Quivira Mine Site

Future cleanup actions at the Quivira Mine Site could result in a cumulative, adverse impact on air quality under the Proposed Action or alternatives. If cleanup actions at the Quivira Mine Site were to occur synchronously and also require the removal of vegetation and topsoil to achieve removal action limits set for the cleanup, those activities would likely add to particulate matter emissions to the atmosphere estimated for the Proposed Action and each alternative. Though specific details of such activities would be required, the significance of any cumulative effect could be evaluated using the results identified for each alternative discussed in this Section.

4.7 Noise Impacts

This section describes the noise impacts that would be expected under each alternative. The existing conditions for noise are presented in Section 3.7 of this SER. Issues concerning noise are limited to noise nuisances caused by proposed activities, as there are no noise-limiting regulations that would apply to the Proposed Action or alternatives, as reported in more detail by INTERA (2017).

4.7.1 Noise Impacts Analysis

Area of Analysis

A 2-mile radius from the center of the proposed limits of disturbance for the Proposed Action was used to define the Area of Analysis for noise (Figure 3.7-1).

Methods of Analysis

A comprehensive noise impact assessment of each alternative was conducted using Cadna-A (Computer Aided Noise Abatement) computer modeling software. The model is based on ISO Standard 9613-2, "*Acoustics – Attenuation of Sound During Propagation Outdoors*." Following this standard, the model accounts for reduction in sound level due to increased distance and geometrical spreading, air absorption, ground attenuation, and acoustical shielding by intervening structures, topography, and brush. The model is considered conservative since it represents atmospheric conditions that promote propagation of sound from source to receiver.

Sources of noise are represented in the model by point, line, and area sources (Figure 4.7-1). Each source is identified in the 95% Design (Sheet 2-01 and 4-01 of Stantec, 2018a) and assigned a sound power level using the Federal Highway Administration Construction Noise Handbook (Table 1 – CA/T Equipment Noise Emissions and Acoustic Usage Factors Database). The Project Area and surrounding ground are unpaved and absorptive; therefore, a ground absorption coefficient of 1.0 was assigned. The noise impact assessment was based on the worst-case 1-hour period with all noise sources operating simultaneously. The acoustic model predicted impacts up to a 2-kilometer radius from UNC office buildings, which was chosen as a central point within the Project Area.

Because the work of hauling mine waste and clean fill would be done by the same fleet of trucks, not all noise sources would be active simultaneously. To reflect the likely sequence of work, the Proposed Action and the Alternatives contain operational scenarios that are used to model the noise impacts for each operating scenario under a given alternative. These operational scenarios are shown in Table 4.7-1, which illustrates that some scenarios are identical across several Alternatives. For example, the Proposed Action, Alternative B, and Alternative D each include the hauling of clean fill from the Borrow Areas to the Repository by truck, so those scenarios (A2 through A5) are shown in all three Alternatives.

Table 4.7-1. Proposed Action and Alternative Modeling Source Groups

		Alternative A - Proposed Action					Alternative B - Conveyors					Alternative C - Jetty Area		Alternative D - PTW				
Model ID	Description	Scenario A1	Scenario A2	Scenario A3	Scenario A4	Scenario A5	Scenario B1	Scenario A2	Scenario A3	Scenario A4	Scenario A5	Scenario C1	Scenario C2	Scenario D1	Scenario A2	Scenario A3	Scenario A4	Scenario A5
HR1	Mine Site Haul Road	Included										Included		Included				
HR2	Access Road																	
HR3	Access Ramp																	
HR4	Clean Access Road																	
HR5	South Borrow Haul Road		Included			Included		Included			Included				Included			Included
HR6	East Borrow Haul Road			Included					Included							Included		
HR7	West Borrow Haul Road				Included					Included							Included	
HR8	North Borrow Haul Road					Included					Included							Included
HR9	Repository Access Road	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
HR10	Jetty Road												Included					
CB1	Conveyor Belt						Included											
SP1	PTW Stockpile	Included					Included					Included	Included	Included				
SP2	Imported Rock	*Construction not included for noise modeling*																
SP3	Screened Rock	Included					Included					Included	Included	Included				
SP4	Topsoil Stockpile		Included	Included	Included	Included		Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
SC1	Screener	Included					Included					Included	Included	Included				
DA1	Mine Site Removal Areas	Included					Included					Included		Included				
DA2	*DA2 is split into 4 smaller areas below:*																	
DA2_1	South Borrow Area		Included					Included							Included			
DA2_2	North Borrow Area					Included					Included							Included
DA2_3	West Borrow Area				Included					Included							Included	
DA2_4	East Borrow Area			Included					Included							Included		
DA3	Repository	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
DA4	Jetty Area	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
DA5	Road Construction	Construction not included for noise modeling																
DA6	Support Zones	Construction not included for noise modeling																
CU1	CSF 1	Emergency Generators are not modeled if operated less than 500 hours/year.																
CU2	CSF 2	Emergency Generators are not modeled if operated less than 500 hours/year.																
CU3	CSF 3	Emergency Generators are not modeled if operated less than 500 hours/year.																
CU4	Mine Area 1	Emergency Generators are not modeled if operated less than 500 hours/year.																
CB-GEN1	Conveyor Belt Generator 1						Included											
CB-GEN2	Conveyor Belt Generator 2						Included											

Assumptions

As part of developing the model, the following modeling inputs and assumptions were used in the acoustic model to predict the impact for every source group and Alternative/scenario.

- One (1) Front-End Loader and one (1) Dump Truck per Stockpile area
  - All assumed to operate continuously
- Two (2) Excavators, one (1) Dozer and five (5) Dump Trucks per Disturbed area
  - All assumed to operate continuously
- Two (2) Excavators per Jetty area
  - All assumed to operate continuously

The Proposed Action could potentially utilize up to four (4) stand-by generators for emergency power. However, these generators were not included in the assessment since they are used under intermittent/emergency circumstances only, and not during normal operations.

Table 4.7-2 compiles the modeled noise sources, sound power levels, and assumptions used. Terrain data were derived from the 95% Design (Sheet 2-01 and 4-01) for the Project Area, Jetty Area, and other nearby areas.

Table 4.7-2. Sound Power Levels by Source.

Sound Power Levels					
Source Description	Source ID	Number of sources per hour	Type of Source	Speed (mph)	Sound Power Level (Leq) (dBA)[1,2,3]
Haul Route 1	HR1	60	Line	20	119
Haul Route 2	HR2	7	Line	20	119
Haul Route 3	HR3	7	Line	20	119
Haul Route 4	HR4	7	Line	20	119
Haul Route 5	HR5	60	Line	20	119
Haul Route 6	HR6	60	Line	20	119
Haul Route 7	HR7	60	Line	20	119
Haul Route 8	HR8	60	Line	20	119
Haul Route 9	HR9	60	Line	20	119
Haul Route 10	HR10	10	Line	20	119
Stock Pile[4]	SP	1	Area	N/A	120
Disturbed Area[5]	DA	1	Area	N/A	128
Jetty Areas[6]	JET	1	Area	N/A	123
Conveyer	CB	1	Line	N/A	119 dBA per 100 m
Conveyer Generator[1]	CB-GEN	1	Point	N/A	117

Notes

1. Sound power levels were obtained from the Federal Highway Administration - Roadway Construction Noise Model User Guide, Table1
2. Sound power levels were calculated from the Sound pressure levels taken for each source at 50 ft
3. Sound power levels for conveyers were obtained from Conveyer Noise Specification and Control, Brown, S.C., 2004
4. Each stockpile area will have 1 front end loader and 1 truck operating. Sound levels from both sources were added for this area source (Front End Loader: 114.6 dBA, Truck: 118.7 dBA)"

5. Each Disturbed Area will have 2 excavators, 1 dozer and 5 trucks operating. Sound levels from all sources were added for this area source (Excavator: 119.6 dBA, Dozer: 119.6 , Truck: 118.7 dBA)"
6. Each Jetty Area will have 2 excavators. Sound levels from all sources were added for this area source (Excavator: 119.6 dBA)"

4.7.2 Potential Noise Impacts for Each Alternative

Satellite imagery identified noise-sensitive receptors within the 2-kilometer radius of the noise assessment area. The location of these receptors is shown in Figure 4.7-1. It was difficult to discern whether some structures found in the satellite images were residential dwellings. To be conservative in this assessment, any uncertainties were assumed residential.

Modeled noise contour maps are given in Figures 4.7-2 through 4.7-10 for each respective operational scenario detailed in Table 4.7-1. The 55-dBA contour line was identified in each figure, above which outdoor noise is considered a potential nuisance according to the USEPA Standards (USEPA, 1974). Contours were also displayed for every 10 dBA increment above 55 dBA.

Noise impacts are presented as 1-hour energy equivalent sound levels (Leq). Since the facility will operate a total of 7 hours during the daytime only, day-night average sound level (Ldn) were not reported/used. Noise impacts at each receptor are tabulated in Table 4.7-3 through Table 4.7-6 for the Proposed Action and Alternatives B, C, and D respectively. Impacts were compared to the noise level of 55 dBA, above which outdoor noise is considered a potential nuisance by USEPA (1974).

Based on the results of the acoustic modeling, the following impacts would be expected for each alternative:

4.7.2.1 No Action Alternative

Under the No Action alternative, no impacts to noise would occur. The noise level in the Project Area would continue to be similar to levels in other quiet, rural areas with noise primarily from traffic on public roads.

4.7.2.2 Alternative A – Proposed Action

Under the Proposed Action, short-term, local, moderate, adverse impacts would occur. Sound levels would vary according to each scenario:

- Scenario A1: Sound levels at all receptors except POR10 would be above 55 dBA (Figure 4.7-2);
- Scenario A2: Sound levels at all receptors would be below 55 dBA (Figure 4.7-3);
- Scenario A3: Sound levels at all receptors would be below 55 dBA (Figure 4.7-4);
- Scenario A4: Sound levels at all receptors would be below 55 dBA (Figure 4.7-5); and
- Scenario A5: Sound levels at all receptors would be below 55 dBA (Figure 4.7-6).

Table 4.7-3. Proposed Action Resulting Noise Levels

Proposed Action			Scenario A1		Scenario A2		Scenario A3		Scenario A4		Scenario A5	
Receptor ID	Receptor Description	USEPA Noise Level (dBA)	Sound Pressure Level (dBA)	Above USEPA Level ?	Sound Pressure Level (dBA)	Above USEPA Level ?	Sound Pressure Level (dBA)	Above USEPA Level ?	Sound Pressure Level (dBA)	Above USEPA Level ?	Sound Pressure Level (dBA)	Above USEPA Level ?
POR1	Residential	55	57	Exceedance	54	No	53	No	53	No	54	No
POR2	Residential	55	58	Exceedance	53	No	53	No	53	No	54	No
POR3	Residential	55	59	Exceedance	53	No	53	No	53	No	53	No
POR4	Residential	55	60	Exceedance	53	No	53	No	53	No	54	No
POR5	Residential	55	58	Exceedance	52	No	51	No	51	No	52	No
POR6	Residential	55	57	Exceedance	51	No	50	No	50	No	51	No
POR7	Residential	55	58	Exceedance	51	No	51	No	51	No	51	No
POR8	Residential	55	57	Exceedance	50	No	50	No	50	No	50	No
POR9	Residential	55	56	Exceedance	43	No	43	No	43	No	43	No
POR10	Residential	55	55	No	43	No	43	No	43	No	43	No
Contour Map Reference:			Figure 4.7-2		Figure 4.7-3		Figure 4.7-4		Figure 4.7-5		Figure 4.7-6	

4.7.2.3 Alternative B – Conveyors

Under the Alternative B, sound levels would be similar to the Proposed Action under each of the five operational scenarios that would occur:

- Scenario B1: sound levels at all receptors except POR10 would be above 55 dBA (Figure 4.7-7).
- Scenario A2 through A5 would be the same as the Proposed Action.

Table 4.7-4. Alternative Action B - Conveyors, Resulting Noise Levels

Alternative B - Conveyers			Scenario B1	
Receptor ID	Receptor Description	USEPA Noise Level (dBA)	Sound Pressure Level (dBA)	Above USEPA Level ?
POR1	Residential	55	58	Exceedance
POR2	Residential	55	58	Exceedance
POR3	Residential	55	59	Exceedance
POR4	Residential	55	61	Exceedance
POR5	Residential	55	58	Exceedance
POR6	Residential	55	58	Exceedance
POR7	Residential	55	58	Exceedance
POR8	Residential	55	57	Exceedance
POR9	Residential	55	56	Exceedance
POR10	Residential	55	55	No
Contour Map Reference:			Figure 4.7-7	

4.7.2.4 Alternative C – Jetty Areas

Under the Alternative C, sound levels would be similar to the Proposed Action, but would vary according to each operational scenario:

- Scenario C1: Sound levels at all receptors except POR10 would be above 55 dBA (Figure 4.7-8); and
- Scenario C2: Sound levels at all receptors would be below 55 dBA (Figure 4.7-9).

Table 4.7-5. Alternative Action C - Jetty Area, Resulting Noise Levels

Alternative C - Jetty Areas			Scenario C1		Scenario C2	
Receptor ID	Receptor Description	USEPA Noise Level (dBA)	Sound Pressure Level (dBA)	Above USEPA Level ?	Sound Pressure Level (dBA)	Above USEPA Level ?
POR1	Residential	55	57	Exceedance	54	No
POR2	Residential	55	57	Exceedance	54	No
POR3	Residential	55	58	Exceedance	54	No
POR4	Residential	55	60	Exceedance	55	No
POR5	Residential	55	58	Exceedance	52	No
POR6	Residential	55	57	Exceedance	51	No
POR7	Residential	55	58	Exceedance	52	No
POR8	Residential	55	57	Exceedance	51	No
POR9	Residential	55	56	Exceedance	44	No
POR10	Residential	55	55	No	44	No
Contour Map Reference:			Figure 4.7-8		Figure 4.7-9	

4.7.2.5 Alternative D – Disposal of Principal Threat Waste

Under Alternative D, sound levels would be similar to the Proposed Action under each of the five operational scenarios that would occur:

- Scenario D1: sound levels at all receptors except POR10 would be above 55 dBA (Figure 4.7-10).
- Scenario A2 through A5 would be the same as the Proposed Action.

Table 4.7-6. Alternative Action D - PTW, Resulting Noise Levels.

Alternative D - PTW			Scenario D1	
Receptor ID	Receptor Description	USEPA Noise Level (dBA)	Sound Pressure Level (dBA)	Above USEPA Level ?
POR1	Residential	55	57	Exceedance
POR2	Residential	55	58	Exceedance
POR3	Residential	55	59	Exceedance
POR4	Residential	55	60	Exceedance
POR5	Residential	55	58	Exceedance
POR6	Residential	55	57	Exceedance
POR7	Residential	55	58	Exceedance
POR8	Residential	55	57	Exceedance
POR9	Residential	55	56	Exceedance
POR10	Residential	55	55	No
Contour Map Reference:			Figure 4.7-10	

4.7.3 Cumulative Noise Impacts

4.7.3.1 Interim Removal Actions at Mine Site

Past actions associated with the Interim Removal Actions in 2009, 2010, and 2012 would have no cumulative effect on noise when combined with the Proposed Actions or alternatives because the Interim Removal Actions occurred in the past and are now completed. With the Interim Removal Actions occurring years apart from the Proposed Action and alternatives, noise impacts would not be cumulative.

4.7.3.2 Structure Remediation

If structures are remediated in the future within the Area of Analysis for noise impacts during construction activities associated with the Proposed Action or alternatives, then cumulative impacts to noise could possibly occur. For example, structure remediation activities that would require soil removal or rebuilding could involve machinery or activities that would be considered sound sources. Though specific details of the activities and sound sources would be required, the potential specific impacts could be assessed using the acoustic model along with the noise source groups already identified in this section.

4.7.3.3 Quivira Mine Site

Future cleanup actions at the Quivira Mine Site could result in cumulative noise impacts in the Project Area under the Proposed Action or any of the three Alternatives. These possible cleanup actions that could occur synchronously with the Proposed Action or the alternatives are not defined at this time, and specific cumulative effects would need to be reassessed in the acoustic model along with the noise source groups already identified in this section.

4.8 Cultural Resources Impacts

This section addresses the potential impacts to both identified cultural resources within the Area of Analysis, which is defined by the limits of proposed land disturbance, and to cultural resources that have not been visibly observed during past inventories, and that may occur as a result of implementation of the Proposed Action or alternatives.

In general, cultural resources are locations of human activity, occupation, or usage that contain materials, structures, or landscapes that were used, built, or modified by people. Cultural resources include spatially defined areas of human activity, such as archaeological sites, currently used Native American traditional practices use areas, or historic buildings.

4.8.1 Cultural Resources Impacts Analysis

Area of Analysis

The Area of Analysis includes the Project Area and a 50-ft buffer surrounding the limits of disturbance defined for the Proposed Action (Figure 1.1-1).

Methods of Analysis

Analysis of impacts to cultural resources was performed by reviewing reports of cultural resource investigations that have been completed in the Area of Analysis (see section 3.8.2). The locations and character of the recorded sites were compared to the areas of the Proposed Action where surface disturbance is proposed to identify important sites that may be affected or should be mitigated.

Section 106 of the NHPA requires that federal agencies take into account the effect of an undertaking on historic properties. Historic property, as defined by the regulations that implement Section 106, means *"any prehistoric or historic district, site, building, structure, or object included, or eligible for inclusion, in the NRHP maintained by the NPS."* The term includes properties of traditional religious and cultural importance to any Native American tribe or Native Hawaiian organization that meet the National Register criteria.

Potential impacts to NRHP-eligible sites are assessed using the "criteria of adverse effect" (36 CFR 800.5[a][1]): *"An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association."*

There are five broad categories of effect:

1. Physical destruction or alteration of a property or relocation from its historic location;
2. Isolation or restriction of access;

3. Change in the character of the property's use or of physical features within the property's setting, or the introduction of visible, audible, or atmospheric elements that are out of character with the significant historic features of the property;

4. Neglect that leads to deterioration or vandalism; and

5. Transfer, sale, or lease from federal to non-federal control, without adequate and legally enforceable restrictions or conditions to ensure the preservation of the historic significance of the property.

Effects to NRHP-eligible sites can be direct or indirect. Direct effects are caused by an undertaking and occur at the same time and place (40 CFR 1508.8[a]). These types of effects to NRHP-eligible sites include physical damage resulting from surface-disturbing activities and can occur to both recorded sites and subsurface sites or other sites not yet identified. Indirect effects are caused by an undertaking and are later in time or farther removed in distance but are still reasonably foreseeable (40 CFR 1508.8[b]). These types of effects often are not quantifiable and can occur both within and outside of the Area of Analysis. Indirect effects to NRHP-eligible sites include, but are not limited to, changes in erosion patterns due to construction activities, inadvertent damage due to off-road maintenance traffic, and illegal artifact collection due to increased access to an area.

GIS was used to overlay the locations of recorded sites with the areas proposed to be disturbed during implementation of the Proposed Action or alternatives in order to determine which archaeological sites would be affected and what mitigation would be needed to comply with legal requirements. General knowledge of the locations of cultural resources (such as traditional use areas and other culturally important areas, as well as of the surrounding landscape) were used to qualitatively describe potential effects of the Proposed Action or alternatives on known sensitive areas or traditional cultural properties.

Assumptions for Analysis

- Class III field inventories were conducted for all proposed disturbance areas prior to construction.
- Cultural resource protection and mitigation on all lands affected by the project will be in accordance with NHPA (P.L. 89-665; 16 USC 470 *et seq*, as amended) requirements, tribal standards, and a Protocol Agreement with the New Mexico State Historic Preservation Office (NMSHPO) and the NNHPD.
- Resources or sites of tribal concern will be protected in accordance with tribal consultation requirements and federal regulations.
- Where avoidance is not possible, mitigation measures will be developed in accordance with NHPA requirements, Navajo HPD standards, and the Protocol Agreement.

- Beneficial effects may occur if there are NRHP-eligible sites that would be stabilized and protected from further damage as a result of project implementation.
- Short-term effects associated with construction activities would include ground disturbance required to remove and relocate waste and fill materials, the modification of access and haul roads, and the installation of new structures or facilities.
- Construction activities, including heavy machinery use, could create noise and vibration that would adversely affect archaeological resources.
- Stockpiling construction materials and equipment would cause short-term visual effects to the landscape surrounding cultural resources.
- The NRC will continue tribal consultation throughout the environmental review and construction phase of the Proposed Action, if approved. Renewed contacts with some or all of the tribes may result from unanticipated discoveries.
- If ineligible sites were damaged by project-related activities, this would not be considered a significant impact.
- Impacts to cultural resources would be considered significant if there were adverse effects to NRHP-eligible sites that cannot be mitigated.

4.8.2 Potential Cultural Impacts for Each Alternative

4.8.2.1 No Action Alternative

The No Action Alternative represents the current condition of cultural resources within Area of Analysis that would continue into the future. The No Action Alternative would involve no surface disturbance with any cultural resources that are exposed being allowed to continue to degrade naturally. The No Action Alternative would have no significant adverse effects on NRHP-eligible cultural resources in the area of potential effect.

4.8.2.2 Alternative A – Proposed Action

As referenced in section 3.8.2, 16 archaeological sites have been documented in the Area of Analysis that represent centuries of occupation and land use. All of the 16 archaeological sites have been documented according to the NMSHPO and NNHPD standards for archaeological fieldwork.

Implementation of the Proposed Action would likely alter the characteristics of 9 of the recorded archaeological sites (Table 4.8-1). NRHP characteristics that may be affected include location, design, setting, materials, workmanship, feeling, and association. The 9 archaeological sites that would be affected have been determined to be eligible under ARPA and NRHP, as they have met both the significance and 100-year age guidelines. While no TCPs or sacred sites eligible for the NRHP have been identified within the area of potential effect, such properties or sites, if identified in future efforts, could experience long-term visual effects and may also include archaeological sites that could be permanently affected.

Table 4.8-1. Archaeological Resources that would be Affected by the Proposed Action.

Documented Cultural Resources				
Designation	Classification	Land Status	NRHP Eligibility	Recommendations
LA 11617	Prehistoric Anasazi Habitation	Private (UNC)	Eligible	Avoidance
NM-Q-21-100	Prehistoric Anasazi Habitation	Navajo Tribal Trust	Eligible	Avoidance
LA 177466	Prehistoric Anasazi Artifact Scatter	Private (UNC)	Eligible	Avoidance
LA 177467	Prehistoric Anasazi Habitation	Private (UNC)	Eligible	Avoidance
LA 177468	Prehistoric Anasazi Habitation	Private (UNC)	Eligible	Avoidance
LA 177469	Prehistoric Anasazi Habitation	Private (UNC)	Eligible	Avoidance
NM-Q-20-69	Prehistoric Anasazi Artifact Scatter	Navajo Tribal Trust	Eligible	Avoidance
NM-Q-20-70	Prehistoric Anasazi Habitation	Navajo Tribal Trust	Eligible	Avoidance
NM-Q-20-71	Prehistoric Anasazi Artifact Scatter	Navajo Tribal Trust	Eligible	Avoidance

Indirect impacts to cultural resources may occur under the provisions of the Proposed Action. While mitigative measures would be carried out to minimize the adverse impacts to documented cultural resources, indirect impacts to cultural resources would be negligible to minor. Indirect impacts include vibrations from construction activities, short-term visual effects from stockpiling of construction materials in the vicinity (Section 4.9), structural erosion controls and altered surface hydrology during and after construction (Section 4.4), and increased noise caused by construction activities (Section 4.7). Of the scenarios listed above, the potential for the greatest amount of alteration caused by indirect impacts lie in land management restorative and stabilization strategies that would be practiced before, during, and after clean-up activities.

Conversely, the implementation of the Proposed Action would have a beneficial, long-term impact by restoring the affected areas to pre-mining conditions that are more in-line with contemporary Native American mores and traditions. The implementation and completion of the Proposed Action would contribute to Navajo and Native American cultural knowledge being retained and transmitted to future generations through continued and enhanced use of the affected area. While both direct and indirect impacts associated with the Proposed Action would affect the documented cultural resources in the Project Area, the benefit in having the area restored greatly enhances the projected outcome of having the cultural resources remain in their natural state with the increased possibility of them being able to deteriorate naturally in-line with Native American beliefs.

Most of the potential direct and indirect impacts to the identified cultural resources would occur during the construction phase. In addition to the cultural resources that have been identified through past cultural resources inventories, the possibility of unearthing unknown resources that are buried increases during earthmoving. Construction could have a direct adverse impact on archaeological sites that have been listed as eligible under the NRHP if the sites were not avoided as recommended in Table 4.8-1. However, these adverse impacts would be minimized using mitigation measures. None of the short-term construction activities are expected to have a significant adverse effect on NRHP-eligible archaeological resources within the Area of Analysis.

While no significant adverse effects to the 9 archaeological sites would be expected, short-term effects have the potential to occur during construction activities. Ground disturbance in the form of soil removal, access and haul road construction and maintenance, final clean-up activities, and restoration processes all have the potential to indirectly impact the 9 archaeological sites by altering the landscape surrounding the sites.

4.8.2.3 Alternative B – Conveyance

Under Alternative B, mine reclamation activities would remain the same as described in the Proposed Action with the exception of the addition of a conveyance system to deliver waste materials across NM 566 in place of vehicle transportation to the Repository. This would result in 2 fewer acres disturbed, compared to the Proposed Action, and therefore slightly less chance to discover or disturb unknown archaeological sites. All other disturbed areas would not change, so the direct and indirect impacts to archaeological sites would be the same as described for the Proposed Action in these areas. No archaeological sites have been documented in the area of the conveyance system; therefore, no impacts are expected to occur to known archaeological sites under Alternative B.

4.8.2.4 Alternative C – Material Sourcing for Cover

Under Alternative C, mine reclamation activities would remain the same as described for the Proposed Action with the exception of the location of the source for the soil cover material. Because all soil cover material would be obtained from the Jetty Area, there would be 48 acres less in total surface disturbance. All other disturbed areas, transportation routes, and disposal locations would be the same as under the Proposed Action.

The change in soil borrow materials to the Jetty Area would eliminate all potential impacts to four archaeological sites (LA 177466, LA 177467, LA 177468, and LA 177469) located in or near the north, east, south, and west Borrow Areas identified in the Proposed Action. Impacts to the remaining 5 cultural resources listed in Table 4.8-1 are expected to remain the same under Alternative C. Under Alternative C, only 5 archaeological sites have the potential to be indirectly affected due to alteration of the surrounding landscape during construction activities, so the impacts would be less than under the Proposed Action. As long as mitigation measures are followed, there would be no significant adverse effects on cultural resources under Alternative C.

4.8.2.5 Alternative D – Disposal of Principal Threat Waste

Under Alternative D, mine reclamation activities in the Project Area would be the same as described for the Proposed Action. All removal areas, transportation routes to the Repository, soil borrow areas, and disposal locations described for the Proposed Action would not change.

Impacts to the 9 cultural resources listed in Table 4.8-1 would be the same as that described for the Proposed Action, assuming the same mitigation measures are implemented.

4.8.3 Cumulative Impacts to Cultural Resources

Future and current projects near the Project Area have the potential to adversely affect cultural resources that have been identified in previous cultural resource inventories as well as resources that have yet to be identified.

Similar projects (such as those projects listed in Section 2.3) that are reasonably foreseeable would not affect a specific cultural resource type but may have the potential to affect cultural resources from a wide temporal range that contain remnants of different cultural groups that exist in the region. The possibility of unearthing new cultural materials in the Area of Analysis or for the other three reasonably foreseeable future projects is minor to moderate given that the majority of mine-related clean-up activities would occur in areas that have been previously disturbed.

It is not anticipated that future or current work in the Area of Analysis or in the immediate region would knowingly destroy cultural resources as long as the appropriate management and mitigation strategies already identified are followed. Current and future reclamation planned in the Area of Analysis and surrounding region also has the potential to assist with the preservation of the cultural resources by ensuring all appropriate mitigative strategies are followed, thereby allowing for favorable outcomes for archaeological sites and other areas of cultural significance in the region as a whole.

The cumulative effects of both direct and indirect impacts to cultural resources in conjunction with the Proposed Action or alternatives are not anticipated to adversely affect NRHP qualities for the archaeological sites that have been identified as being eligible for listing.

4.9 Visual/Scenic Resources Impacts

This section describes the impacts on visual quality that would result from the Proposed Action and each alternative.

4.9.1 Visual/Scenic Impacts Analysis

Area of Analysis

The area where the Proposed Action would be visible defines the viewshed boundary, which is used, in turn, as the Area of Analysis for visual and scenic resources. The viewshed boundary for the Proposed Action, which consists of dozens of separate polygons from where the Proposed Action would be visible, was developed using a GIS-based approach. The Area of Analysis viewshed boundary is described in detail in Section 3.9 and is depicted in Figure 3.9-1.

Methods of Analysis

Visual impacts of the Proposed Action were assessed using GIS and photographic methods, as summarized in Section 3.9 and described in detail by INTERA (2017). The significance of visual impact was characterized according to the degree of Visual Resource Inventory and Evaluation System developed by the BLM (1986) and presented in Table 4.9-1.

Table 4.9-1. Degree of contrast criteria from BLM (1986).

Degree of Contrast	Criteria
None	The element contrast is not visible or perceived
Weak	The element contrast can be seen but does not attract attention
Moderate	The element contrast begins to attract attention and begins to dominate the characteristic landscape
Strong	The element contrast demands attention, will not be overlooked, and is dominant in the landscape

In addition to the degree of contrast, the period of impact is also considered. Impacts that would occur only during the construction period are considered short-term in that they would be limited to the 3.5-year period that is estimated to construct the Proposed Action. In contrast, recovery time associated with revegetating disturbed ground can require several additional years to re-establish grasses, shrubs, and trees on the bare ground. The recovery period associated with vegetation are considered long-term impacts, as they would ultimately re-integrate back into the visual landscape following a period of several years. Some impacts would be considered permanent, such as a change in topography due to excavation or placement of waste at the Repository.

Assumptions

The landscape and key viewpoints have not changed significantly since the data collected and reported by INTERA (2017).

4.9.2 Potential Visual Impacts for Each Alternative

4.9.2.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not be developed, and the landscape would remain in its current condition. As a result, there would be no impact to the visual landscape from the No Action alternative.

4.9.2.2 Alternative A –Proposed Action

The visual impacts analysis shows that the Proposed Action would have a weak degree of contrast to the existing landscape over a long-term period, and a moderate degree of contrast during the short-term construction period. Impacts on the visual landscape would be due primarily to the excavation of mine waste at the Mine Site, excavation of source material from Borrow Areas, the addition of haul and access roads, and the construction of the Mill Site Repository on top of the existing TDA. The extent of the Proposed Action covers ~340 acres, with maximum excavation depths up to 52 ft and construction of the Repository not to exceed a height of 43 ft. Photo visualizations show the relatively small size/scale of the Proposed Action when compared to the surrounding landscape, emphasizing that the long-term visual impacts to are expected to be weak (Appendix C of this SER). Due to vegetative cover and the topography of the region, visual impacts are more likely to be seen from roads than residences (Appendix C of this SER). Areas disturbed during the Proposed Action would be revegetated according to the proposed revegetation plan (Appendix U of Stantec, 2018a), which would visually reintegrate any short-term, moderate visual impacts back into the surrounding visual landscape.

The results of the visual impact analysis, along with the revegetation plan, indicate the Proposed Action would continue to meet visual resource Class III management objectives, which allow for moderate modification of the natural landscape that does not dominate the view of the casual observer (BLM, 1986).

4.9.2.3 Alternative B –Conveyance

Under Alternative B, visual resources impacts would be temporarily strong during the period of construction and reclamation period. The construction of a conveyance system to transport mine waste from the NECR Mine Site to the UNC Mill Site Repository would present a strong contrast with the surrounding landscape; however, visual impacts would likely only be noticeable from NM 566 near to where the conveyance system crosses the road. Once the mine wastes were successfully transported to the Mill Site, the conveyance system would then be dismantled.

Visual impacts from mine waste transportation under Alternative B would be stronger than that of Proposed Action at a few locations along NM 566, but the visual disturbances would be short-term.

4.9.2.4 Alternative C –Material Sourcing for Cover

Under Alternative C, visual resource impacts would be similar to those described for the Proposed Action. If cover material for the repository were to be sourced from the area of disturbance associated with the Jetty Area in place of Borrow Areas, short-term visual impacts at the Borrow Areas would be eliminated.

Under Alternative C, visual impacts would be eliminated at the Borrow Areas.

4.9.2.5 Alternative D –Disposal of Principal Threat Waste

Under Alternative D, visual impacts at the Project Area would remain the same as those described for the Proposed Action. PTW would be hauled offsite, but instead of being disposed of at White Mesa, Utah, the PTW would be disposed of at the Clive facility in Utah. Both facilities are licensed, controlled, and accept RCRA hazardous and radioactive waste and the volume considered for PTW would likely be insignificant compared to other waste managed at each site.

4.9.3 Cumulative Visual Impacts

Long-term cumulative impacts to the viewscape are expected to be low. Grading and revegetation activities would minimize any visual disturbances, helping to blend excavated areas and constructed features into the surrounding landscape. Overall, visual impacts are expected to meet BLM's Class III visual resource management objectives: modifications to the landscape under any alternative may be seen but should not dominate the view of the casual observer. Any modifications of the landscape with past Interim Removal Actions, potential structure remediation, or Quivira Mine Site cleanup efforts would likely have minor, cumulative adverse impacts to the visual landscape.

4.10 Socioeconomic Impacts

4.10.1 Socioeconomics Impacts Analysis

Area of Analysis

The Area of Analysis for socioeconomic impacts was analyzed for the No Action Alternative, the Proposed Action, and Alternatives B through D for local and regional environmental impacts, which are defined as follows:

Local: Within the Project Area and nearby communities.
Regional: McKinley County and surrounding communities of commutable distance.

Methods of Analysis

The potential impacts of the Proposed Action and alternatives on social and economic resources within McKinley County were assessed by evaluating the effects of potential revenues from construction jobs on existing economic and social conditions, housing capacities, and any related offset to the public costs of providing services to the additional work force. The following criteria are used to determine whether socioeconomic impacts would be significant:

- Substantial long-term change in any sector of the local economy of McKinley County, such as major expansion or contraction of employment, economic output, or diversity, or the economic well-being of residents.
- A change in county or community populations that would strain the ability of affected communities to provide or maintain housing and services or otherwise adapt to growth-related social and economic changes.
- An aggregate change in public sector revenue and expenditure flows likely to result in an inability on the part of affected units of government to maintain public services and facilities at established service levels, or to allow for improved services or a major increase in tax burdens on existing taxpayers.
- Permanent displacement of residents or users of affected areas that would result from project-induced changes in or conflicts with existing uses or ways of life.
- Disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population, which appreciably exceed those to the general population around the project area.

Impacts are considered short-term if they would result from changes that would occur only during the 3.5-year construction period. In contrast, impacts would be long-term if the change occurs during and after the construction period.

Assumptions

Socioeconomic impacts were calculated assuming jobs would be filled by McKinley County residents to the extent practicable. UNC has committed to seek every opportunity to employ and will give first preference to qualified, local, Navajo labor, to the extent consistent with the law (UNC, 2011).

4.10.2 Potential Socioeconomic Impacts for Each Alternative

4.10.2.1 No Action Alternative

Under the No Action Alternative, no jobs would be created from the Proposed Action or alternatives, and no changes to existing socioeconomic conditions would occur. Similarly, there would be no effect on housing capacities or any change to needs for public services being provided to an additional work force.

4.10.2.2 Alternative A – Proposed Action

The estimated 40 construction jobs created by the Proposed Action would have a minor, beneficial impact on the unemployment rate of 7.9% in the Area of Analysis during the construction period, assuming those jobs were filled by McKinley County residents. These construction jobs would include roles for machine operators, flaggers, and general laborers. Because these roles would represent 0.15% of the unemployed workers in the County, the small adjustment by 40 positions (less than one tenth of one %) would have a minor, beneficial impact to the county economy. Stantec (2018) estimates that between 70% and 80% of the workers needed for this project could be hired locally. The remaining 20% to 30% of workers would require specialized training that is not necessarily locally available (HRI, 2013). As a result, assuming that 70% (or 28) of the estimated 40 jobs were filled by the Church Rock CDP, which had 62 members unemployed in 2016 (USCB, 2016), the Proposed Action would have a beneficial impact on unemployment during the period of construction.

The average projected salary of the estimated 40 positions required to be filled under the Proposed Action would be approximately $35,000 per annum. The median family income for Church Rock is $36,250 (USCB, 2016). As a result, the short-term income and employment gains would have a beneficial impact on the economy of the Area of Analysis.

Some of the positions needed for implementing the Proposed Action would require personnel with training and experience that would likely result in sourcing employees from Gallup or Grants, the two closest large communities that are within commuting distance. As most services (such as housing, schools, and medical facilities) are located in the Gallup area and non-locals will mostly likely be sourced from Gallup, there will be no additional demand for housing, schools, or medical facilities, although the traffic may increase negligibly. Transportation impacts are discussed in detail in Section 4.2.

In conclusion, the Proposed Action would have minor, short-term beneficial impacts to socioeconomics, but none would be significant.

4.10.2.3 Alternative B – Conveyance

Under Alternative B, the use of a conveyor belt would eliminate the need for haul truck drivers to transport waste material from the excavation site to the Repository. Many workers would need to be hired for the excavation work, placement of material, maintenance of equipment, and oversight of the work; however, fewer workers would be needed overall compared to the Proposed Action. Construction of a conveyor system would bring in additional construction and technical jobs for building and demolition of the system. As a result, impacts to socioeconomics under Alternative B would be similar to those under the Proposed Action, but slightly less given the reduced number of haul truck drivers that would be required during the construction period.

4.10.2.4 Alternative C – Material Sourcing for Cover

Under Alternative C, socioeconomic impacts would be the same as those of the Proposed Action.

4.10.2.5 Alternative D – Disposal of Principal Threat Waste

Under Alternative D, socioeconomic impacts would be primarily the same as for the Proposed Action with the exception of job duration for those employed to haul PTW offsite. Alternative D proposes depositing the material at the Clive facility in Utah, which is approximately 576 miles from the Project Area, versus White Mesa in Utah, as in the Proposed Action, which is 198 miles from the Project Area (Figures 2.0-6 and 2.1-2). Drivers employed to haul PTW would have a longer job duration under Alternative D due to the distance between facilities. All other socioeconomic impacts are expected to be the same as for the Proposed Action.

4.10.3 Cumulative Socioeconomic Impacts

4.10.3.1 Interim Removal Actions at Mine Site

Past actions associated with the Interim Removal Actions in 2009, 2010, and 2012 would have a minor, cumulative, beneficial, long-term impact in that more usable land would be available to residents of the Project Area. Cumulatively, there would be more lands cleaned up and more lands without restriction that could be used for activities like livestock grazing, which may have a minor, local, beneficial impact on socioeconomics.

4.10.3.2 Structure Remediation

If structures were remediated in the future within the Area of Analysis during construction activities associated with the Proposed Action or alternatives, then a beneficial impact may result from the creation of additional, short-term jobs. If construction jobs associated with structure remediation would draw from the same pool of available workers, the cumulative effect would be beneficial in that there would be collectively more employment opportunities because of both actions. However, if structure remediation actions would require a workforce significantly less than that required for the Proposed Action or alternatives, the significance of the cumulative beneficial impact would likely be negligible to minor.

4.10.3.3 Quivira Mine Site

If cleanup activities at the Quivira Mine Site would also create short-term employment opportunities for the available workers within the Area of Analysis, there would be a cumulative, beneficial impact on socioeconomics. However, if the cleanup action would require a workforce slightly less than that required for the Proposed Action or alternatives, the significance of the cumulative beneficial impact would likely be minor.

4.11 Environmental Justice Impacts

Executive Order 12898 describes Environmental Justice as "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Following the Executive Order's description of Environmental Justice, information from the U.S. Census Bureau and direct observation were used to evaluate the presence of minority or low-income populations, or Environmental Justice populations, in areas that would be affected by the Proposed Action.

4.11.1 Environmental Justice Impacts Analysis

Area of Analysis

The Area of Analysis was assumed to be McKinley County, New Mexico, as characterized in Section 3.10.

Methods of Analysis

Guidelines presented in Appendix C of NUREG 1748 (NRC, 2009) were followed to complete this analysis. Percentages of minority populations, income, and poverty levels in census tribal block groups within 5 miles of the Project Area were compared to state and county percentages. Results of the comparison provided findings related to the potential for disproportionately high adverse human health or environmental effects associated with the Proposed Action. These results are presented in Tables 4.11-1 through 4.11-3.

Assumptions

This section assumes that action levels of 2.24 pCi/g for radium-226 and 230 mg/kg for uranium selected by the USEPA (2011) would be protective of human health.

As stated in Appendix C of NUREG 1748 (NRC, 2009), minority is defined as *"individuals who are members of the following population groups: American Indian and Alaska Native; Asian; Native Hawaiian and Other Pacific Islander; African American (not of Hispanic or Latino origin); some other race; and Hispanic or Latino (of any race)."*

Low-income is defined as *"being below the poverty level as defined by the U.S. Census Bureau"* (NRC, 2009). If either the minority or low-income population of the block groups differs by more than 20 percentage points or exceeds 50 %, Environmental Justice should be considered in greater detail (NRC, 2009).

If disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population that appreciably exceeds the impacts to the general population within the Area of Analysis, then those impacts would be considered significant. As described in

Section 3.10, the American Indian population is the dominant race within the vicinity of the Project Area (Table 3.10-1) and is an Environmental Justice population that could be affected by the Proposed Action.

Tables 4.10-1 through 4.10-3 display specific race, income, and poverty information for the local tribal blocks compared to McKinley County and New Mexico.

Table 4.10-1. Demographic Ethnic Information for McKinley County (USCB, 2010)

Demographics												
Race	Tribal Block Group GeoID								McKinley County		New Mexico	
	2430T01400A		2430T00900B		2430T00900C		2430T01400B					
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
White	14	1.3%	7	0.4%	10	0.4%	5	0.3%	10834	15.2%	1407876	68.4%
Black/African American	2	0.2%	6	0.3%	0	0.0%	1	0.1%	360	0.5%	42550	2.1%
American Indian and Alaska Native	1045	96.8%	1888	98.8%	2487	98.3%	1774	98.9%	53988	75.5%	193222	9.4%
Asian	0	0.0%	0	0.0%	1	0.0%	0	0.0%	568	0.8%	28208	1.4%
Pacific Islander	0	0.0%	0	0.0%	0	0.0%	0	0.0%	23	0.0%	1810	0.1%
Other Race	4	0.4%	0	0.0%	0	0.0%	2	0.1%	3522	4.9%	308503	15.0%
Two or More Races	14	1.3%	10	0.5%	32	1.3%	11	0.6%	2197	3.1%	77010	3.7%
Total	1,079	100%	1,911	100%	2,530	100%	1,793	100%	71,492	100%	2,059,179	100%

Table 4.10-2. Demographic Income Information for McKinley County (USCB, 2018)

Demographics												
Income Level	Tribal Block Group GeoID								McKinley County		New Mexico	
	2430T01400A		2430T00900B		2430T00900C		2430T01400B					
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Total Households	273	--	469	--	630	--	471	--	18968	--	762551	--
<$10,000	78	28.6%	110	23.5%	206	32.7%	146	31.0%	4251	22.4%	73898	9.7%
$10,000-$14,999	29	10.6%	34	7.2%	88	14.0%	47	10.0%	1632	8.6%	49598	6.5%
$15,000-$24,999	29	10.6%	84	17.9%	94	14.9%	84	17.8%	2626	13.8%	95366	12.5%
$25,000-$34,999	42	15.4%	54	11.5%	78	12.4%	49	10.4%	2234	11.8%	83931	11.0%
$35,000-$49,000	44	16.1%	60	12.8%	72	11.4%	33	7.0%	1985	10.5%	106317	13.9%
$50,000-$74,000	32	11.7%	70	14.9%	46	7.3%	57	12.1%	3042	16.0%	130192	17.1%
$75,000-$99,999	7	2.6%	31	6.6%	36	5.7%	31	6.6%	1344	7.1%	86104	11.3%
$100,000-$149,999	9	3.3%	19	4.1%	8	1.3%	16	3.4%	1381	7.3%	83894	11.0%
$150,000-$199,999	3	1.1%	3	0.6%	0	0.0%	6	1.3%	273	1.4%	29082	3.8%
>$200,000	0	0.0%	4	0.9%	2	0.3%	2	0.4%	200	1.1%	23902	3.1%
Median household income	$25,313.00		$26,250.00		$16,591.00		$19,779.00		$29,272.00		$45,674.00	

Table 4.10-3. Demographic Poverty Information for McKinley County (USCB, 2018)

Poverty Level	Demographics											
	Tribal Block Group GeoID								McKinley County		New Mexico	
	2430T01400A		2430T00900B		2430T00900C		2430T01400B					
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Total Households	273	--	469	--	630	--	471	--	18968	--	762551	--
Income in the past 12 months below poverty level	118	43.2%	193	41.2%	349	55.4%	228	48.4%	7118	37.5%	145246	19.0%
Income in the past 12 months at or above poverty level:	155	56.8%	276	58.8%	281	44.6%	243	51.6%	11850	62.5%	617305	81.0%

4.11.2 Potential Environmental Justice Impacts for Each Alternative

4.11.2.1 No Action Alternative

Under the No Action Alternative, environmental conditions in the Project Area would continue to be managed under the current conditions for the License. All mine waste at the Mine Site that currently exceeds Action Levels for cleanup would be left in place exposing an Environmental Justice population to levels of radium-226 and uranium metal above the USEPA RAL. Consequently, Environmental Justice concerns would be adverse and long-term under the No Action Alternative.

4.11.2.2 Alternative A – Proposed Action

The removal and disposal of mine waste from the Mine Site would have a beneficial, long-term impact on an Environmental Justice population. Under the Proposed Action, PTW would be removed, segregated, and reprocessed at a licensed and controlled facility in San Juan County, Utah, thus eliminating potential threats to human health (Section 4.12) for the nearby Environmental Justice populations. After clean-up and removal of mine waste, grading and stabilization of the Mine Site would occur. Assuming a successful confirmation of mine waste removal, the institutional controls that currently restrict land use at the Mine Site would be lifted, and the area would be released for unrestricted use (Section 4.1).

In addition to the significant, long-term beneficial impacts on an Environmental Justice population, the Proposed Action would also have short-term, adverse and beneficial impacts during the construction period. The construction and maintenance of haul and access roads and the construction and excavation activities at the Mine Site and Mill Site would result in a disproportionately high, adverse impact on transportation (Section 4.2), air quality (Section 4.6), and noise (Section 4.7). However, the employment opportunities (Section 4.10) would create significant, beneficial, short-term impacts on an Environmental Justice population during the construction period. UNC has committed to seek every opportunity to employ and will give first preference to qualified, local, Navajo labor, to the extent consistent with the law (UNC, 2011).

4.11.2.3 Alternative B – Conveyance

Under Alternative B, short-term, adverse impacts to noise experienced by the Environmental Justice population would be similar to the Proposed Action (Section 4.7). However, impacts to transportation experienced by the Environmental Justice population would be relatively beneficial when compared to the Proposed Action. Traffic on NM 566 would experience less interruption due to the use of a conveyor system (Section 4.2). All other potential impacts to Environmental Justice populations would be the same as described for the Proposed Action.

4.11.2.4 Alternative C – Material Sourcing for Cover

Under Alternative C, impacts to Environmental Justice populations would be similar to those described for the Proposed Action. Although traffic patterns would change onsite, keeping the haul trucks more localized to the Jetty Area rather than ranging to the various borrow areas, the change would not be experienced by Environmental Justice populations.

4.11.2.5 Alternative D – Disposal of Principal Threat Waste

Under Alternative D, impacts to Environmental Justice populations would be the same as those described for the Proposed Action. PTW would be hauled offsite to a facility that is licensed to accept RCRA hazardous and radioactive waste.

4.11.3 Cumulative Environmental Justice Impacts

4.11.3.1 Interim Removal Actions at Mine Site

Past actions associated with the Interim Removal Actions in 2009, 2010, and 2012 would have a cumulative, beneficial, long-term impact on public health and land use when combined with the Proposed Action and each alternative. Cumulatively, there would be more lands cleaned up and more lands without restriction that could be used for activities like livestock grazing.

4.11.3.2 Structure Remediation

If structures are remediated in the future within the vicinity of the Project Area during construction activities associated with the Proposed Action or alternatives, then minor, adverse cumulative impacts to transportation could possibly occur. For example, structure remediation activities that would require material removal or rebuilding could involve construction machinery and vehicles that may travel into the Project Area. The cumulative increase in transportation could cause minor increases in stoppage times at the proposed crossing on NM 566 under the Proposed Action, Alternative C, and Alternative D. In addition, cumulative adverse impacts on noise may be experienced during the short-term construction periods, depending on the nature and location of the remediation.

4.11.3.3 Quivira Mine Site

Future cleanup actions at the Quivira Mine Site could result in cumulative, beneficial, long-term impacts to land use and public health in the Project Area when combined with the Proposed Action and each alternative. Any clean-up activities that would occur synchronously during the Proposed Action or alternatives might cause an Environmental Justice population to experience cumulative, adverse impacts to transportation, noise nuisance, and dust during a short-term construction period. However, the details of clean-up activities at the Quivira Mine Site would need to be better defined to evaluate any specific impacts.

4.12 Public and Occupational Health Impacts

This section provides an evaluation of the potential public and occupational health impacts from the Proposed Action and alternatives for non-radiological sources (Section 4.12.1) and radiological sources (Section 4.12.2). Mitigation measures are described in Section 5.0.

4.12.1 Non-Radiological Impacts

As presented in Section 3.11, the levels of uranium metal present at the Mine Site equate to a noncancer HI exceeding the USEPA risk management threshold for an unrestricted land use scenario. Hence, uranium was identified by the USEPA as a non-radiological COC. Releases of uranium in the environment may cause adverse long-term impacts for general members of the public and occupational health.

During the construction phase of the Proposed Action, potential impacts to public and occupational health include fugitive dust, combustion emissions, noise, and occupational hazard. Fugitive dust would be generated by heavy equipment used during the excavation process, transportation of contaminated soil and mine waste, construction of the Repository cells and disposal operations. Another source of fugitive emissions is dust from wind erosion of contaminated soils. Construction equipment used during the Proposed Action would likely be diesel powered and would result in normal diesel combustion and exhaust emissions. It should be noted that a fuel farm area would be established as part of the Proposed Action to store bulk fuel for mobile fuel trucks.

The following sections summarize the human health impacts associated with the non-radiological contaminants and materials associated with the Proposed Action and alternatives.

4.12.1.1.1 Location of Receptors Relative to the Project Area

During the Proposed Action, onsite construction workers would perform a variety of activities related to the removal action (e.g., site preparation, repository construction, excavation, transportation, and placement of the waste) at the Project Area. According to Appendix K, Figure K-1 of Stantec (2018), 773 working days would be needed for completing the Proposed Action.

Following the implementation of the Proposed Action, it is expected that the Project Area would be transferred to the DOE's Long-Term Surveillance and Maintenance Program under DOE's Office of Legacy Management. Under this DOE program, the UNC Site would be maintained and managed under the DOE to provide for continued containment and protectiveness. During that time, the onsite maintenance and surveillance workers (authorized users) would perform waste site surveillance activities such as walk downs and visual inspections as well as activities such as mowing the grass, clearing brush, and general site maintenance at the Project Area. Both construction workers and maintenance and surveillance workers are considered the most critical onsite receptors for the Project Area.

There are 34 home sites located within approximately two miles of the Project Area (UNC, 2018). Figure 4.12-1 illustrates the distances from the Project Area to the nearest site boundary and the nearest full-time resident. The nearest residential receptor is considered the most critical offsite receptor for the Project Area.

There are eight wells within approximately 2 miles of the Project Area; two wells have no known uses, three wells are inactive, and three wells are active (UNC, 2018). One of the active wells, the United Nuclear well or "Mill Site Well", is in Section 2 (Mill Site). Water from this well is discharged into the North and South evaporation ponds at the TDA to maintain a water depth of 0.5 ft in both ponds as an interim radon barrier and to minimize potential wind damage to the liner until final closure of the TDA (UNC, 2018). The well is extracting water from the Westwater Canyon Formation from a production interval between approximately 1,500 to 1,800 ft bgs (RSE, 2007). The other two active wells, the Friendship Well (14T-586) and Well 15K-303, are used for livestock watering. The Friendship Well cannot be impacted by seepage from the Mill Site TDA due to it topographic locations relative to hydraulic gradients (USEPA, 2013). Well 15K-303, located more than 2 miles to the northeast of the mill Site, is the only local well known to tap the Upper Gallup Formation and is used for livestock watering. However, the well is too distant from the TDA to be impacted by seepage from the TDA (USEPA, 2013). Results of sampling (King, 2007) indicate both that the water has not been impacted by tailings seepage and it is unsuitable for human consumption. No residents have private wells for domestic water supply, and instead many haul their own water from known sources outside the Area of Analysis for domestic supply and livestock watering. Therefore, none of the action alternatives would have an impact on drinking water resources, given the absence of drinking water supply wells within the Area of Analysis.

The nearest sensitive receptor, represented by the Church Rock Elementary School and Catherine A. Miller Elementary School, is located in Church Rock, NM, approximately 11 miles southwest of the Project Area. Given this distance and wind direction from the southwest (see Section 3.6.1), wind-blown and combustion emissions from the Project Area are not expected to result in any health impacts to these sensitive receptors.

4.12.1.1.2 Analysis of Liquid Nonradioactive Discharges to Water or Air

Each action alternative involves the excavation of mine waste from the Mine Site, and the hauling or conveyance, receiving, consolidating and disposal of the waste in the Repository to be constructed within the footprint of the Mill Site TDA. The design of the repository, at a minimum, would include a cap system and low-permeability layer (liner).

The cap system would mitigate direct contact with the mine waste, limit water infiltration, and perform as a radon barrier. The low-permeability layer (liner) would be placed between the NECR mine waste and the tailings currently disposed within the TDA and would prevent the migration of contaminants present in the disposed mine waste to groundwater. This layer would be constructed to eliminate the possibility that the layer will collect water and produce a "bathtub effect." The layer would be constructed of natural materials to eliminate the sudden failure risk associated with punctures and rips of a synthetic liner.

Stormwater controls would also be in place as a part of the Stormwater Management Plan (SWMP) (Appendix E of the LAR) to limit the release of contact stormwater, sediment, pollutants, and deleterious debris to downstream areas during and following the Proposed Action.

In addition, the nonradioactive contaminants in the mine waste are not volatile in nature. Therefore, under proposed operating conditions, there are no liquid nonradioactive discharges to water or air associated with the Proposed Action. Accordingly, further analysis of liquid nonradioactive discharges to water or air is not considered warranted for the Proposed Action.

4.12.1.1.3 Physical Layout of Nonradioactive Materials

The spatial distribution of mine spoils to be disposed of in the planned repository is described in Section 3.11. The spoils contain both radioactive and nonradioactive concentrations above the RALs defined by the USEPA.

Additionally, a fuel farm area would be established to store bulk fuel for mobile fuel trucks. It would be located within the Support Area in the Mill Site Area (Figure 4.12-2). The area would be adjacent to the Support Area perimeter fence to facilitate filling of fuel trucks located within the Exclusion Area. Sufficient space would be required for placement and secondary containment of 5,000 to 10,000 gallons of fuel storage, plus room for fuel transfer. Spill containment measures would be implemented according to an approved spill containment and cleanup plan. An additional fuel farm could potentially be placed in the Repository Yard for fueling of Repository cover construction equipment. The Repository Yard is also shown in Figure 4.12-2.

4.12.1.1.4 Location and Characteristics of Liquid and Gaseous Releases

Section 4.12.1 discussed that there would be no liquid or gaseous releases of nonradioactive contaminants expected under normal operating conditions during the Proposed Action. However, fugitive dust would be generated by heavy equipment used during the excavation process, transportation of contaminated material, construction of the Repository cells, and contaminated material disposal operations. Another source of fugitive emissions would be dust from wind erosion. Construction equipment would likely be diesel powered and would result in the normal release of diesel combustion emissions and exhaust. The locations for fugitive dust/combustion emissions include:

- Areas of Excavation/ Placement/ Grading
- Hauls Roads (Mine Waste and Borrow Materials)
- Screening Operations Areas
- Stockpiles
- Compaction Control Areas
- Fuel Farm Areas

4.12.1.1.5 Measured and/or Calculated Airborne Nonradiological Concentrations Supporting Exposure Evaluations

As discussed in 4.12.1.4, there would be no liquid (waterborne) or gaseous releases of nonradioactive contaminants expected under normal operating conditions during the Proposed Action or alternatives. However, fugitive dust and combustion emission would be generated during the excavation process, transportation of contaminated materials, construction of the repository cells and contaminated material disposal operations. Since the LAR is for a proposed action, environmental monitoring is not currently being conducted to measure airborne concentration, hence no exposure to the critical member of the public is calculated.

To minimize the dust emission, dust control measures would be implemented under each action alternative. During transportation and material handling activities, dust suppression measures would be conducted to reduce fugitive dust emissions and associated impacts to the nearby community.

To measure exposure due to airborne nonradiological contaminants, an air monitoring program would be conducted. As a part of the monitoring program, perimeter air monitoring stations would be positioned at an upwind location and at four downwind locations and operated to monitor and measure respirable dust (PM_{10} and $PM_{2.5}$) during construction activities to maintain a safe working environment and to protect the general public. Locations of perimeter monitoring stations are shown in Figure 4.12-3. Appendix Q of the LAR provides more detailed information related to the dust control and air monitoring program. Personal air space monitoring to ensure protection of onsite workers will be performed in accordance with the contractor's Health and Safety Plan (HASP). See Appendix L of the LAR for additional details.

4.12.1.1.6 Demonstration of Compliance Based on Calculated Public Exposure or Average Annual Concentrations of Nonradiological Concentrations

Under the Proposed Action and each action alternative, compliance would be demonstrated by comparing the measured perimeter monitoring data with against the USEPA's NAAQS, which were adopted by the State of New Mexico for respirable dust. Respirable dust standards used for comparison with Project Area perimeter dust monitoring data will be USEPA's NAAQS 24-hour Time Weighted Average (TWA) values of:

1. PM_{10}: 150 $\mu g/m^3$
2. $PM_{2.5}$: 35 $\mu g/m^3$

4.12.1.1.7 Workforce Populations, Locations and Exposure Time

An estimated 40 workers, consisting of machine operators, flaggers, and general laborers, would be employed onsite at the Project Area during the removal activity (Section 4.10 Socioeconomic Impacts). These workers would perform the activities related to the removal action. Following completion of the Proposed Action, the maintenance and surveillance workers (authorized users) would perform onsite surveillance activities.

According to the State of New Mexico soil guidance document, Risk Assessment Guidance for Site Investigations and Remediation, Volume 1, *Soil Screening Guidance for Human Health Risk Assessments* (NMED, 2017b), the exposure frequency for a construction worker is 250 days per year. Assuming a standard 8-hour work day, a construction worker will be onsite 2,000 hours/year during the removal activities. Based on the schedule presented in Figure K-1 of the LAR, the total number of working days required for the removal action is estimated to be 773 days.

Exposure parameters for maintenance/surveillance workers are not documented in NMED (2017b). Therefore, the exposure parameters for a commercial/industrial worker will be assumed for evaluating the exposures of maintenance/surveillance workers. Accordingly, maintenance/ surveillance workers will be onsite 225 days per year (NMED, 2017b). Assuming a standard eight-hour work day, the maintenance/surveillance worker will be onsite at the Project Area for 1,800 hours/year.

4.12.1.1.8 Calculated Nonradiological Exposures to the Workforce

A qualitative assessment and quantitative exposure monitoring would be performed to assess occupational exposure to the workforce. As a part of the qualitative assessment, an experienced industrial hygienist would characterize exposures to a workplace hazard based on the review of the chemical, physical, biological and toxicological characteristics of the material, quantity of use, frequency of use, conditions under which it would be used and past experience with similar operations. Appendix L, Health and Safety Plan (HASP) of the LAR presents detailed information related to qualitative assessment. The qualitative assessment includes, but is not limited to, an evaluation of the following:

- Description of operation, task, or process, including work practices and procedures, frequency and duration of operation.
- List of all potentially hazardous materials used, stored, handled, or produced. Include a description of how they are used, amount on hand, and estimated consumption rates. A list of hazardous materials used at the facility will be available as a component of the Hazard Communication Program.
- List of potential physical hazards, such as noise, heat, ionizing and non-ionizing radiation.
- List of potential biological or infectious agents.
- Description and efficiency of existing controls, including the type of personal protective equipment (PPE), administrative controls, and engineering controls and evaluations of their effectiveness.

Appendix L of the LAR identifies the following chemical hazards associated with the contaminated onsite soil: arsenic, total dust, respirable dust, diesel fuel, naphthalene, total petroleum hydrocarbons, and uranium (metal). Table L.8-1 of Appendix L of the LAR presents the occupational exposure limits (including OSHA Permissible Limit), some physical and chemical properties, routes of exposure and signs and symptoms of exposure for these chemical hazards. All UNC employees, contractors, and subcontractors involved with the Proposed Action and each action alternative would be required to understand the hazards and follow site-specific safety and health procedures included in the Project HASP to minimize potential risks of harm to personnel working on the Proposed Action.

During the construction phase, construction workers would be exposed to the following two types of emissions:

7. Fugitive dusts that would be generated by heavy equipment during the excavation process, transportation of contaminations, construction of the repository cells and disposal operations; and
8. Combustion emissions resulting from exhaust of diesel-powered heavy construction equipment.

Real-time air monitoring would be conducted for particulate levels as a part of the Dust Control and Air Monitoring Program to ensure the activities comply with the state and federal air quality regulations. Appendix Q of the LAR presents detailed information related to air monitoring of dust particulates at the Project Area and the application of dust suppression to minimize the dust emission. In addition, Appendices B.7 and Q identify a number of emission reduction strategies that would be implemented as a part of green and sustainable practices to minimize both dust and combustion emissions. The goal for these programs is to minimize the exposure of both chemical and radiological hazards to the workers and public.

4.12.2 Radiological Impacts

As presented in Section 3.11, results of analytical samples and human health risk assessments indicated that concentrations of Ra-226 in soil and mine waste exceed background, pose an unacceptable excess lifetime cancer risk greater than 1×10^{-4}, and exceed the USEPA RAL of 2.24 pCi/g for radium-226. Under the Proposed Action, the mine waste would be excavated and disposed in the Repository to be constructed within the footprint of the UNC Mill Site TDA.

During the construction phase of the Proposed Action, fugitive dust would be generated as a result of construction of the Repository cells, heavy equipment used during the waste excavation process, transportation of the mine waste, and disposal operations. After the construction phase, there would be potential for fugitive dust emission due to wind erosion of cover material. In addition, radon gas would be generated during and after the construction phase because of the decay of radionuclides in the contaminated soil. Therefore, exposure to fugitive dust and radon emissions may cause adverse impacts to public and occupational health as discussed in the remainder of this section.

4.12.2.1.1 Pathway Assessment

A pathway assessment is performed to evaluate potential impacts associated with the Proposed Action and evaluate each possible public and occupational exposure pathway based on sources, contaminant release mechanisms, probable environmental fates of contaminants, and the locations and activities of potential receptors (i.e., during and following completion of the Proposed Action). Pathways are reviewed to determine whether contaminant sources can migrate via one or more environmental transport processes to an exposure point, where current and future human receptors are present. If so, the pathway is considered a "complete" exposure pathway. Public and occupational exposures are evaluated for all complete exposure pathways.

4.12.2.1.2 Receptor Locations

Figure 4.12-1 illustrates the distances from the Project Area to the nearest site boundary and the nearest full-time resident. Section 4.12.1 discusses project area location information, including:

- Nearest site boundary
- Nearest full-time resident
- Potable water sources

Following verification of cleanup completion under the Proposed Action, the Mine Site would be released for future unrestricted use, as approved, by the Navajo Nation. In contrast, access to the UNC Mill Site would continue to be restricted to maintain contaminant containment and protectiveness.

Perennial surface water is not present at the Site. Pipeline Arroyo is the nearest surface water body to the Project Area and currently exhibits seasonal, ephemeral flow in direct response to precipitation. There are no fish species known to inhabit Pipeline Arroyo, or downstream in the

Puerco River near the City of Gallup (USACE, 1978). The fishing location closest to the Proposed Action is Bluewater Lake, a constructed reservoir built in 1927, with a capacity of 45,500 acre-ft, approximately 33 miles to the southeast.

The Project Area and the surrounding areas within a 2-mile radius are not designated for recreational use. The nearest designated recreational use area is Red Rock Park, located in the community of Church Rock, which is approximately 11 miles southwest of the Project Area. Red Rock Park is formerly a state park and is now a park owned and maintained by the City of Gallup; primary recreational activities include (but are not limited to) camping, rodeo riding, and hiking. Additionally, recreational activities in McKinley County occur primarily in the Mount Taylor Ranger District of the Cibola National Forest, which encompasses Mt. Taylor and the Zuni Mountains (Section 3.1 Land Use). The Mount Taylor Ranger District is approximately 55 miles southwest of the Project Area.

4.12.2.1.3 Potential Pathways for Releases

Several contaminant release mechanisms have the potential to impact public and occupational health both during and following completion of the Proposed Action.

1. **Releases to the Atmosphere**. Contaminant transport in the air phase would be via two distinct release mechanisms: windblown dispersion of contaminated particulates into the atmosphere and radon release. Radon release is the only release mechanism by which radiological contaminants can be released to the atmosphere from the Proposed Action.

   Radon emanation is a result of radioactive decay. Radon-222 is a descendent of uranium-238 and uranium-234, via the intermediate daughter products, thorium-230 and radium-226, and it will be generated wherever radium-226 is present. Radon gas migrates through the soil pore spaces to the ground surface and disperses into the atmosphere. Not all of the radon that is produced enters the atmosphere; some radon retained within the contaminated material, where it decays to polonium-218 without migrating. The installation of a cap structure and other fill materials within the repository will minimize the releases of radon into the atmosphere. Therefore, radon can be released into the atmosphere during and after the completion of the Proposed Action. Both onsite and offsite receptors will be exposed to radon via inhalation during and after the completion of the Proposed Action.

   During the construction phase, fugitive dust would be generated by the construction of the repository cells, heavy equipment used during the excavation process, transportation of contaminated material, and disposal operations. Other sources of fugitive emissions during and after the completion of the Proposed Action would be dust from wind erosion. Radon gas would be generated because of the decay of radionuclides in the contaminated soil. Dust suppression measures would be implemented to reduce fugitive dust emissions and associated impacts to the nearby residents.

Radiological particulate contaminants in air can be deposited on the ground surface under both dry and wet (rain or mist) conditions and can result in exposures to both livestock and human receptors. The travel distance by the particulates depends on several meteorological factors, such as wind speed, atmospheric stability, and horizontal and vertical dispersion coefficient. Fodder grown in the area of deposition may be used to feed livestock animals. Therefore, a human receptor can then be exposed via consumption of meat and milk, thereby increasing the potential for both individual or population doses. However, it should be noted that during the Proposed Action, dust suppression measures, other pollution control techniques and the installation of cap structure would prevent or minimize the fugitive dust emission. Therefore, the amount of the radiological contaminants to be deposited on the ground surface are expected to be minimal. A perimeter air monitoring program would be implemented to measure the impact associated with the airborne radiological contaminants.

2. **Leaching to Groundwater**. The potential for Mine Site waste to be placed on the TDA to impact groundwater has been evaluated in detail (Dwyer, 2018). At the request of USEPA, UNC developed computer models that simulated what would happen to the tailings in the TDA under various scenarios and determined that placing the NECR Mine Site waste on top of the tailings is not expected to result in the leaching of additional contaminants to the ground water or surrounding soil (see Section 4.4 of this document and Dwyer, 2018).

3. **Releases to Surface Water.** Storm water runoff to surface water bodies represents a potential fate and transport pathway. Surface water at or near the Project Area is ephemeral in nature; none is present year-round. Dissolution of radionuclides in storm water and subsequent infiltration/percolation is also a method for transporting surficial contaminants to subsurface soil. The proposed storm water design would divert the storm water runoff to prevent contact with contaminated material, and will be directed into the North Cell Drainage Channel, Runoff Control Ditch and Branch Swale H. Therefore, storm water runoff would not negatively impact the surface water bodies at or near the Project Area during and after completion of the Proposed Action. Hence, the exposure pathways associated with surface water and sediment would be mitigated by stormwater controls.

4.12.2.1.4 Radioactive Discharges to Water or Air

Based on the evaluated release mechanisms, there is little to no potential for radioactive discharges to surface water or groundwater during and following the completion of the Proposed Action. However, a potential exists for radon gas to be released into the atmosphere via radon emanation during both the construction phase and the maintenance and surveillance phase of the Proposed Action. The potential also exists for radiological contaminants to be released to the atmosphere via fugitive dust emissions during and after the completion of the Proposed Action. As previously discussed, a perimeter air monitoring program would be implemented to measure the concentrations of radon gas and airborne particulate at the boundary of the Project Area. The collected data would be used to assess any impacts to the health of the general public during and after completion of the Proposed Action. Appendix Q the LAR provides detailed information related to the air monitoring program.

4.12.2.1.5 Distribution Data for Projected Populations, Affected Food and Water Sources and Use

The area surrounding the Project Area is sparsely populated and includes Indian Trust Land (USEPA, 2013). According to the 2017 Land Use Report (UNC, 2018), there are a total of 34 residential homes within approximately 2-mile radius of the Mill Site.

An estimated 40 workers would be employed at the Project Area during the construction and removal activity (Section 4.12.1). Following completion of the construction and removal activities, maintenance and surveillance workers would perform surveillance and maintenance activities.

No site-specific information related to the annual meat, milk, and crop production rate are available for the Project Area. 2015 New Mexico Agricultural Statistics (NMDA, 2016) include annual production rates for meat, milk, and crops for McKinley County, where the Project Area is located. 2015 New Mexico Agricultural Statistics (NMDA, 2016) reports the following livestock data:

- Number of livestock as of January 1, 2016:
  - Number of Cattle and Calves = 27, 500
  - Number of Beef Cows = 18,400
  - Number of Sheep and Lamb = 26,500
- As of January 1, 2016, the total number of milk cows for the State of New Mexico was 315,000 and the annual milk production rate is 24,900 pounds per milk cow. Milk production information specific to McKinley County is not available.
- During 2016, the annual total number of commercial beef cattle slaughtered in the State of New Mexico was 3,500. The total live weight of these cattle was reported at 3,679,000 pounds, corresponding to an average slaughter weight of 1,051 pounds per animal.

As mentioned earlier, there are no fish species known to inhabit the Puerco River near the City of Gallup and the same is assumed true of the portion of Pipeline Arroyo, the drainage system that drains the Project Area. The fishing location closest to the Proposed Action is Bluewater Lake, approximately 33 miles to the southeast.

Neither NMDA (2016) or 2016 New Mexico Agricultural Statistics (NMDA 2017) provide information related to annual production of vegetables in McKinley County. According to a 1981 Environmental Report prepared for the Site (D'Appolonia, 1981), five garden plots are cultivated within a 5-mile (8-km) radius around the mill. The average garden site is estimated to be 13,123 ft^2 (4,000 m^2). The average vegetable production per square kilometer is 207 kg/m^2/year.

There are eight wells located within approximately two miles of the Project Area. Only three of these wells are reported as active (UNC, 2018). Of these three wells, two are used solely for livestock watering. Water from the other well is discharged into the North and South evaporation ponds to maintain a water depth of 0.5 ft in both ponds as an interim radon barrier and to minimize potential wind damage to the liner until final closure of the TDA. None of those wells are used as drinking water sources.

4.12.2.1.6 Crop Production and Consumption Information

Data from the 2012 Census indicates that the total number of farms in McKinley County is 2,297 (NMDA, 2016). The average size of the farms is 1,316 acres. The major crop produced in McKinley county is alfalfa hay. During 2015, 900 tons of alfalfa hay were produced on a total of 500 acres of land, resulting in an average yield of 1.8 tons of alfalfa hay/acre.

The Proposed Action would not impact the groundwater in the Area of Analysis. Impacts to groundwater are being addressed as a part of the groundwater operable unit. Accordingly, details regarding crops grown on irrigated land using water withdrawn within the Area of Analysis are not addressed further for the Proposed Action.

4.12.2.1.7 Dose Contributed by Annual Husbandry, Facilities, Agricultural Practices, Game Harvests, or Food Processing Operations

No animal husbandry facilities, agricultural practices, game harvests, or food processing operations have been reported for the region surrounding the Project Area (Section 3.1 Land Use). As mentioned in Section 3.1 Land Use, the primary land use surrounding the Project Area is grazing for sheep, cattle, and horses. Radiological particulate contaminants in air can be deposited on the ground surface and can create exposures to those grazing livestock. Application of dust suppression measures would minimize such exposure to the livestock.

4.12.3 Public and Occupational Exposure Analysis for Each Alternative

Area of Analysis

The Area of Analysis for public and occupational health was analyzed for the No Action Alternative, the Proposed Action, and the Alternatives B through D for local and regional impacts, which are defined as follows:

Local: Within the Project Area, resulting from construction activities, excavating and transporting of TENORM waste from the Mine Site to the Mill Site, and disposing of the TENORM waste in the planned repository located at the Mill Site.

Regional: Outside of the Project Area, dependent upon the action taken. All actions except for the No Action Alternative include offsite transport of PTW using the existing network of interstate highways, US highways, and state highways and offsite dispositioning of PTW (reprocessing or disposal).

Methodology

The impacts to public and occupational health were analyzed by evaluating the applicability of the identified potential impacts to the activities associated with each alternative.

The Project Area was analyzed for sources of emissions (particulate and gaseous) and location of receptors for a pathway assessment. A pathway assessment was performed to evaluate potential impacts associated with the Proposed Action and evaluates each possible public and occupational exposure pathway based on sources, contaminant release mechanisms, probable environmental fates of contaminants and the locations and activities of potential receptors (i.e., during and following completion of the Proposed Action). Pathways were reviewed to determine whether contaminant sources can migrate via one or more environmental transport processes to an exposure point, where current and future human receptors are present. If so, the pathway is considered as a "complete" exposure pathway. Public and occupational exposures are evaluated for all complete exposure pathways.

Data were collected to support this analysis as reported in INTERA (2017) and calculated using USEPA guidance. In addition, mitigation measures to decrease impacts were evaluated, as well as the likelihood of accidents during the Proposed Action or alternatives that would increase impacts to public or occupational health. Details regarding mitigation measures are presented in Section 5.0.

Assumptions

The following assumptions were made during the analysis of the impacts to public and occupational health:

- The onsite receptor is assumed to be either the construction worker or the maintenance and surveillance worker. The onsite receptor will receive training in accordance with the HASP.
- The offsite receptor is assumed to be the closest near-by resident. Institutional controls will be in-place during construction to prevent access to the Project Area by the offsite receptor.
- Design requirements for the excavation and removal of waste will result in a residual contamination level less than the RAL of 2.24 pCi/g for Ra-226 at the Mine Site.
- Design requirements for the repository liner is assumed to prevent leaching and migration of contaminants to the groundwater underlying the Mill Site. Design requirements for the repository cover will prevent radon emanation at the surface of the repository as well as infiltration of precipitation into the repository.

4.12.3.1 No Action Alternative

Under the No Action Alternative, there would be no construction activities, no waste would be excavated from the Mine Site, no waste would be transported to and disposed of at the Mill Site, and no PTW would be reprocessed or disposed of offsite. As a result, no impacts to public and occupation health would occur. (i.e., increased airborne releases of nonradioactive and radioactive material, direct exposure to radioactive material, occupational-related accidents, traffic-related accidents, facility design failures, or impacts associated with extreme weather or seismic events).

4.12.3.2 Alternative A – Proposed Action

The Proposed Action requires construction activities, excavating waste from the Mine Site, transporting and disposing of waste in a repository at the Mill Site, and PTW would be transported to and reprocessed at White Mesa Mill in Blanding, Utah. Excavation and disposal of contaminated waste/soil from the Mine Site would achieve the USEPA RAL aimed at protecting both human health and ecological receptors and would prevent migration of spoils with concentrations above the RAL into the soils, sediment, groundwater, air and surface water. The design of the repository, at a minimum, would include a cap system and low-permeability layer (liner). The cap system would mitigate direct contact with the mine waste, limit water infiltration, and perform as a radon barrier. The low-permeability layer (liner) would prevent the migration of contaminants present in the disposed NECR mine waste to ground water.

The potential impacts to public and occupational health as presented in Sections 4.12.1 through 4.12.3 are applicable to Proposed Action. These impacts include increased airborne releases of nonradioactive and radioactive material, direct exposure to radioactive material, occupational-related accidents, traffic-related accidents, and impacts associated with facility design failures, extreme weather or seismic events. However, under the Proposed Action, dust control measures would be implemented during transportation and material handling activities to reduce fugitive dust emissions and associated impacts to the workers and nearby community. The efficacy of these controls would be confirmed with the ongoing emission monitoring to be conducted during construction activities to maintain a safe working environment and to protect the general public. It is expected that the cumulative public and occupational health impacts associated with both radiological and nonradiological contamination entrained in the airborne particulates would be minor and short-term during the construction period.

4.12.3.2.1 Physical Layout of Radioactive Materials

The location and concentration of mine waste to be removed from the Mine Site is described in Section 3.11 and shown in Figure 3.11-2. The mine waste contains both radioactive and nonradioactive contaminants. The waste would be excavated, consolidated, covered, and capped in a repository to be constructed on top of the existing TDA at the UNC Mill Site (Figure 3.11-3).

4.12.3.2.2 Characteristics of Radioactive Effluents

As mentioned in subsection 4.12.2.1.2, the Proposed Action would result in the generation of two effluents: fugitive dust emissions and radon gas. Fugitive dust emissions would occur because of construction activities (road building, construction of the repository cells), excavation and transportation of the contaminated soils, and disposal operations, which result in the disturbance of soil. Fugitive dust emission would also result from wind erosion of surface soils. The radiological characteristics of the fugitive dust would be consistent with the radionuclides entrained in the contaminated soils. Radon gas would be generated because of the decay of radionuclides in the contaminated soil. Effluent discharge is considered non-point source, i.e. diffuse, for both types of (airborne) effluents.

4.12.3.2.3 Measured and/or Calculated Radiation Dose Rates and Airborne Radioactivity Concentrations

Air monitoring is not currently being conducted because the relicensing application is for a Proposed Action and the associated effluents are not being generated. Accordingly, measured radiation dose rates and airborne radioactivity concentrations are not yet reported. As part of the Proposed Action, monitoring would be performed to measure the airborne internal radiation exposure from particulates and radon gas and the external radiation exposure resulting from gamma radiation. Respirable dust would also be monitored during the construction phase to determine the effectiveness of dust control measures. Appendix Q (Dust Control and Air Monitoring Plan) of LAR documents the proposed air monitoring plan.

4.12.3.2.4 Methodology for Demonstrating Compliance with Acceptable Dose Limit for a Member of the Public

According to 10 CFR 20.1301, the regulatory dose limit for individual members of the public (critical receptor) is 100 mrem/yr. Compliance with the dose limit in §20.1301 can be demonstrated in one of the two following ways [§20.1302(b)(1) and (2)]:

1. Demonstrating by measurement or calculation that the Total Effective Dose Equivalent (TEDE) to the individual likely to receive the highest dose from Site operations (critical receptor) does not exceed the annual dose limit (i.e., 100 mrem/yr); or
2. Demonstrating that: (i) the annual average concentration of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area does not exceed the values specified in Table 2 of Appendix B to Part 20; and (ii) if an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 2 millirem per hour (mrem/hr).

According to Appendix Q of the LAR, compliance with the acceptable dose limit for internal radiation would be demonstrated by comparing the annual average concentrations of radioactive material released in gaseous and airborne particulate effluents against the airborne effluent concentration limits listed in Table 2, Column 1 of Appendix B to Part 20. The dose for external gamma radiation would be compared against the maximum dose rate of 0.002 rem/hour and/or 0.05 rem per/year.

4.12.3.2.5 Dose Calculation for Workforce

According to Appendix Q of the LAR, occupational air monitoring would be conducted for onsite workers as addressed in the Health and Safety Plan (Appendix L of the LAR). As a part of the occupational monitoring, exposure related to both internal and external radiation will be calculated. For internal radiation, monitoring would include:

- Airborne gross alpha activity from air particulate inhalation
- Airborne radon and radon progeny inhalation

To evaluate external radiation exposure, both thermoluminescent dosimeters (TLDs) and direct gamma radiation exposure rate field measurements would be used.

According to Appendix Q of the LAR, the compliance criteria for the general members of the public would also be utilized for the worker. These compliance criteria are presented in Section 4.12.2.

4.12.3.2.6 Summary of External Radiation Monitoring and Airborne Radiation Monitoring Program

As a part of the Proposed Action, an air monitoring program would be conducted to protect the members of the public and workers. During the air monitoring program, exposure related to both external gamma radiation and airborne radiation would be measured at upwind and downwind locations. Figure 4.12-3 presents the proposed air station locations that would be used to measure both external gamma radiation and airborne radiation (particulates and radon gas). As documented in Section 3.6.3, the predominant wind direction in the region is from the southwest to the northeast. The air monitoring stations would be located as described below:

- Two downwind air monitoring stations would be placed at the Mine Site to account for occasional shifts in the wind direction throughout the day (one near each residence downwind of the Mine Site, which are located generally northeast of the excavation areas)
- One downwind air monitoring station would be placed northeast of the Repository at the Mill Site tailings impoundment
- One downwind air monitoring station for dust monitoring would be placed northeast of the borrow area
- One upwind (background) air monitoring station would be placed south of the Mine and Mill Sites

Detailed information on the monitoring program is presented in Appendix Q of the LAR and summarized below:

External Monitoring Program: To evaluate potential external radiation exposure, environmental TLDs would be exposed continuously at the perimeter air monitoring stations and would be submitted for laboratory analysis on a quarterly basis. Until the TLD results are received from the laboratory, external exposure from gamma radiation would be estimated based on area exposure rate field measurements using a calibrated micro-R-meter. Quarterly TLD laboratory results and weekly field gamma results would be reviewed to assess compliance with the external radiation dose limits for individual members of the public as specified in 10 CFR 20.1301 and NMAC 20.3.4.413.

External exposure monitoring program would also be implemented under proposed air monitoring to protect the workers. Employees working within the tailings area would wear a TLD badge as a part of the external exposure monitoring program.

Airborne Radiation Monitoring Program: Monitoring would be conducted for airborne gross alpha activity from air particulates and airborne radon and radon progeny. Airborne gross alpha activity would be monitored by collecting grab air particulate samples. To evaluate potential internal radiation exposure, the RAS-2 air filters would be counted onsite for gross alpha activity from uranium, radium-226 and thorium-230 after radon progeny from the particulate sample has decayed, generally 72 hours, using an Alpha Radiation Counting Instrument such as Ludlum 2929/43-10-1. To evaluate potential internal airborne radon and radon progeny concentrations, track etch radon monitors would be continuously exposed at the perimeter air monitoring stations and submitted for laboratory analysis on a quarterly basis.

As mentioned earlier, acceptable effluent concentration limits for radionuclides including radon are presented in 10 CFR part 20, Appendix B, Table 2, Column 1. Among all alpha emitters, an airborne effluent concentration limit for thorium-230 based on Y lung classification is the most conservative. Therefore, the gross alpha concentration would be compared against effluent concentration limit for thorium-230 to demonstrate compliance with the acceptable dose limit. The radon-222 limit for the class “with daughters removed” would be selected as the acceptable concentration criteria because the track etch radon monitor is equipped with a filter that removes the daughters prior to the measurement of radon-222.

Internal exposure monitoring program would also be implemented under the proposed air monitoring to protect the workers. For internal radiation, monitoring would include:

- Airborne gross alpha activity from air particulate inhalation
- Airborne radon and radon progeny inhalation

In addition, the following activities would be typically performed as a part of the internal exposure monitoring.

- Self-monitoring of Alpha would be done by employees working within the tailings area daily prior to leaving the area with occasional spot checks
- Bioassays would be collected for employees working within the tailings area semi-annually

4.12.3.2.7 Foreseeable Accidents

The accidental release of radiological contaminants can occur due to a variety of events. The following summarizes events that could result in an accidental release of contaminants to the environment and the potential consequences.

Accidental Events

The accidental events that could lead to environmental releases are as follows:

1: Severe Weather: On average, a severe storm event (defined as a storm with winds in excess of 58 mph) occur on a frequency of once every three years in McKinley County, based on reports from 1955 through 2017. From 1950 to 2017, only one tornado was observed in McKinley County. The most common severe weather event in New Mexico is flash flooding. McKinley County has, on average, two flash flood events per year. Approximately two-thirds of these events occur in July and August during the summer monsoons.

In addition, like most areas in New Mexico, this area is susceptible to severe drought and subsequently, a high risk for wildfires. The maximum temperature recorded in Gallup, New Mexico, was 100 °F in July 1995 and 2003.

2. Seismic Hazard including Earthquake: Seismic hazards were analyzed in 1981 Environmental Report prepared for the Site (D'Appolonia, 1981). Figure B4-9 of the 1981 Environmental Report show the locations of earthquake epicenters and their magnitudes. In 1997, the NRC re-evaluated the seismic stability of the reclamation plan at the Church Rock site. Two critical slopes on the tailings impoundment were evaluated for the peak ground acceleration (PGA) anticipated at the location based on the maximum anticipated earthquake (6.25 magnitude) (NRC, 1997). A recommended PGA of 0.22g was used in the analysis (NRC, 1997). Both stations that were analyzed resulted in a factor of safety of 1.0 or greater, satisfying the stability requirements in the NRC Regulatory Guidance (NRC, 1997).

As part of the design plan, Stantec (2018) conducted a site-specific probabilistic seismic hazard analysis (PSHA) and a deterministic seismic hazard analysis (DSHA) to determine the appropriate seismic design for the UNC Mill Site TDA. The PSHA evaluated a 124-mile (200-km) radius surrounding the Mill Site based on seismotectonic modeling and geologic characterization of the Mill Site. The DSHA was performed in order to check the PSHA and for comparison to previous work, mentioned above. The NRC and USEPA guidance require a reclaimed facility to be designed for a lifetime of 1,000 years to the extent possible, and 200 years at a minimum. The PGA used in this analysis used a 10,000-year return period, making it a conservative, but appropriate design criteria. Stantec conducted extensive research into the historical seismicity of the area around the Mill Site (Figure 1, Appendix G.7) and compiled data on seismic activity in the Colorado Plateau, the region in which the site is located, from 1887 through 2016 (Figure 3-1, Appendix G.7) for all seismic events with a moment magnitude (M_W) greater than 2.5, for a total of 413 events. Stantec also compiled Quaternary displacement faults within 93 miles (150-km) of the site to include in the model. The shear wave velocity estimated for the top 100 ft (30 meters, V_{S30}) was 902 ft/s for the alluvium, 1,857 ft/s m/s for sandstone, and 1,380 ft/s as the average of the two for the area (Stantec, 2018a).

The results of the PSHA estimated a PGA ranging from 0.26 g to 0.30 g for the long-term and are incorporated into the design of the TDA. This PGA compares well to the DSHA value of 0.31 g;

however, it is notably higher than the PGA calculated by Lawrence Livermore National Laboratory (LLNL) in the 1997 evaluation. Stantec speculated that the LLNL value could have been for soft rock and not the alluvium, which was used for this evaluation. USGS 2014 maps indicate a PGA of 0.08 g for a return period of 2,475 years, which is slightly less than the 0.13 g value produced by this study, making this a more conservative design (Stantec, 2018a).

3. Transportation Related Accidents: PTW material with concentrations of 200 pCi/g or more of Ra-226 and/or 500 mg/kg or more of total uranium would be loaded, at the PTW staging area, into covered trucks or sealed intermodal shipping containers for transport to an offsite, licensed and controlled disposal facility or reprocessing facility and all contaminated universal mine waste and soil with Ra-226 concentrations above the RAL of 2.24 pCi/g and below 200 pCi/g would be loaded into the truck, transported to the Repository and disposed in the repository, located on the Mill Site TDA. In addition, those trucks would have either diesel or gasoline fuel.

There is a potential for both onsite and offsite accidents during the transportation of the wastes. Potential hazard associated with such accidents may include injuries, fires, fuel spills, traffic hazards and exposure to the radioactive materials. In 1981, Sandia National Laboratories developed the Radioactive Material Incident Report (RMIR) database to contain information on transportation-related accidents and incidents involving radioactive materials that have occurred in the United States. C. E. Cashwell and J. D. McClure prepared a report, titled *Transportation Accidents/incidents Involving Radioactive Materials (1971-1991)* to present information involving transportation accidents, handling, accidents and incidents that have occurred for the 21-year time frame of 1971 through 1991. The report summarizes the following:

- Accidents comprise 22% (329) of the events (1506) compiled for the United States.
- 288 out of 329 accidents happened on highways.
- 3,506 radioactive material packages were involved in transportation accidents. Of that total, only 223 (6%) were classified as having been damaged with no loss of contents or failure (i.e., package damaged with loss of radioactive contents). The packages that experienced releases were those containing limited quantities of radioactive material.
- Type B packages used for larger quantities of radioactive materials performed very well during accidents. There were only two minor accidents with damages; however, no release of radioactive material occurred.

4. Engineering System Failures of the Repositories: Based on the design criterion as stated in 40 CFR §§ 192.02(a),192.32(b)(1)(i), and 264.111(a), the longevity of the cap for repositories was designed for a minimum of 200 years with minimal maintenance and for effectiveness up to 1,000 years, to the extent reasonably achievable. It is designed to protect the mine waste, reduce the potential for leachate development, and prevent contaminated runoff by limiting infiltration of precipitation and by providing erosion protection and durability. However, over some period, accidental failure could reduce the effectiveness of the cap structures.

Consequences of the Accidental Events

The environmental consequences for the above accidental events are as summarized below:

1. Impact of Surface Water and Sediment: Areas which could be impacted via flash flooding during excavation and construction are the Pipeline Arroyo, the haul road crossings, and the borrow areas. As mentioned earlier, storm water controls would be in place as a part of the SWMP (Appendix E of the LAR) to limit the release of contact stormwater, sediment, pollutants, and deleterious debris to downstream areas during and following the removal action. Therefore, due to SWMP, and based on similar experiences from the July 1979 historical release event, the Proposed Action would not have a significant impact on surface water or sediment due to potential releases of contamination to the surface water.

2. Impact to Atmosphere: During severe storm, wildfires, tornado and other natural disaster events, and releases from chemical spills, emission from Project Area could be released into the atmosphere. Such releases could impact both human health and ecological receptors, located down-gradient from the Project Area. It is important to note that an erosion protection layer (soil and rock), cover soil and radon barrier, which are part of the Proposed Action, would be constructed to prevent the releases of such emissions into the atmosphere. UNC has been preparing an annual ALARA for NRC to present results of environmental surveillance (gamma radiation, air monitoring including particulates and radon) results for protection of occupational and public health. The results of the ALARA reports showed that the program has met the requirements under 10 CFR Part 20, Subpart G – Radiation Protection Program, Sec. 20-1101(c). This means that the emissions into the atmosphere did not result in unacceptable consequence for the general members of the public. However, as already documented, an air monitoring program would be in place to measure the future consequence of atmospheric releases from the Site during the Proposed Action.

4.12.3.3 Alternative B – Conveyance

Except for transportation risk associated with the Alternative B, the impacts to public and occupational health associated with Alternative B would be the same as those identified for the Proposed Action. By conveying the mine waste from the Mine Site removal area with an above-grade, covered conveyor system from the Mine Site to the Mill Site, the traffic-related delays during transportation of waste on NM 566 would be minimized. See Section 4.2 for detail regarding impacts to transportation.

4.12.3.4 Alternative C – Material Sourcing for Cover

Except for land disturbance risks associated with Alternative C, the impacts to public and occupational health associated with Alternative C would be the same as those identified for the Proposed Action. During this alternative, soils from the Jetty Area would be characterized at the laboratory during excavation activities to determine eligibility for use as cover material. Sourcing cover material from the 23-acre area disturbed for construction of the Jetty in place of the proposed

Borrow Areas would reduce the overall area of land disturbance associated with the cleanup and stabilization by 48 acres, inclusive of the disturbance associated with proposed haul roads. This could potentially reduce the impacts from airborne particulates discharged to the atmosphere.

4.12.3.5 Alternative D – Disposal of Principal Threat Waste

The impacts to public and occupational health associated with Alternative D would be the same as those identified for the Proposed Action. The increased distance traveled to the disposal facility may represent an increase in the potential for traffic accidents.

4.12.4 Cumulative Impacts to Public and Occupational Health

There is one past action and two reasonably foreseeable future actions that are not connected with the Proposed Action or alternatives that could result in cumulative impacts to public and occupational health when they are combined with the minor impacts expected from the Proposed Action and alternatives:

Interim Removal Actions at Mine Site

Cleanup completed as part of the past Interim Removal Actions combined with cleanup proposed under the Proposed Action and each alternative would have a cumulative, beneficial, long-term impact on public and occupational health according to USEPA-established action limits. Combined, these separate clean up actions would cumulatively cleanup more land and consolidate waste exceeding the USEPA defined RALs.

Structure Remediation

If future structures are addressed within the Project Area, and if activities include rebuilding or soil removal, then it is possible that activities associated with those actions could have a cumulative, beneficial, long-term impact on public and occupational health within the Area of Analysis when combined with the Proposed Action or alternatives.

Quivira Mine Site

By the end of 2018, the USEPA has set an objective to complete an EECA to evaluate cleanup options for the Quivira Mine site, located north of the Red Water Pond Road Community and Mine Site. If the USEPA process following the EECA results in a future action to address the legacy of mine waste, then activities associated with that action could have a cumulative, beneficial, long-term effect on public and occupational health when combined with the Proposed Action or alternatives.

4.13 Waste Management Impacts

In contrast to previous sections, which describe the impacts of the Proposed Action and each alternative on a given environmental resource, this section identifies the waste sources, management systems, anticipated disposal and reduction plans, and waste management cumulative impacts from the Proposed Action. Previous inventories have been completed to characterize the presence and estimated volume of radioactive, hazardous, mixed and solid wastes at the Mine and Mill Sites, which combined are used to define the Area of Analysis for this section. Because the Area of Analysis is limited to former mining and milling operations, there is currently no waste being generated, except for a small amount of solid, non-hazardous waste from routine administrative activities conducted at the UNC office and from a remedial groundwater system permitted by the NRC.

4.13.1 Waste Sources

Sources of radioactive, hazardous, and mixed and solid waste are presented in Section 3.12 of this SER.

4.13.2 Waste Management and Disposal

The plans for collecting, storing and disposing of wastes associated with the Proposed Action and each alternative are presented in Section 2.1 of this SER.

4.13.3 Waste Minimization

Waste minimization would be achieved by excavating mine waste carefully to avoid comingling waste above the RAL and the surrounding clean material to the extent possible. As described in Appendix C of the LAR, waste removal would begin by first excavating to the initial specified depths identified in Drawing 3-02 of the LAR. Confirmation gamma scanning would then be used to assess whether the material exceeds the RAL. Based on the scanning results, the excavation would either be determined to be complete or would proceed incrementally, even as little as 1 ft both horizontally and vertically, until material radiological levels are shown to be below RAL or until bedrock is encountered.

4.13.4 Cumulative Waste Management Impacts

4.13.4.1 Interim Removal Actions

Disposing of waste removed during the Interim Removal Actions and placed at the NECR-1 pad and TPH stockpile and mine waste excavated from the Mine Site during the Proposed Action and alternatives would have a beneficial impact on waste management. The consolidation and disposal of waste would have a long-term, beneficial impact on managing radiological, hazardous, and mixed and solid wastes. The combined volume of mine waste removed from the Mine Site and Interim Removal Action areas would have a long-term, beneficial impact on managing waste.

4.13.4.2 Structural Remediation

If structures are addressed in the future within the Area of Analysis, and if activities include rebuilding or soil removal, then it is possible that activity associated with those actions could have a minor, beneficial, cumulative effect on public health when combined with the Proposed Action or alternatives.

4.13.4.3 Quivira Site Cleanup

If the USEPA process results in a future action that would require mine waste removal, then activities associated with that action could have a cumulative, beneficial, long-term effect on waste management when combined with the Proposed Action or alternatives.

CHAPTER 5. MITIGATION MEASURES

The following sections describe the proposed mitigation measures that could minimize the potential adverse impacts from the Proposed Action and each action alternative described in Section 4.0. Mitigation measures are not identified for the No Action Alternative, as no changes to the environment from existing conditions would be anticipated to occur. Any residual impacts or unavoidable adverse impacts that may remain after mitigation measures have been applied, as well as any further impacts caused by the mitigation measures themselves, are noted in each section.

5.1 Land Use

Additional mitigation measures would not be required.

5.2 Transportation

Additional mitigation measures would not be required.

5.3 Geology and Soils

No mitigation measures would be required as there would be no impacts to geological resources.

Several EPMs specified in the Revegetation Plan presented in Appendix U of the LAR have outlined a few measures to reduce direct, short-term, and long-term soil erosion through BMPs. BMPs (such as berms, straw wattles or staked straw bales, mulches, or conditioners) would be used as necessary to reduce entrainment of sediment during precipitation events on stockpiled or reclaimed topsoil or borrowed growth media. Indirect effects from wind erosion during construction activities would be mitigated by regulating truck speed to 20 mph and by the wetting of roads during heavy truck traffic. Decreased speeds and watering to mitigate dust would also be employed during ground disturbance, high winds, or any conditions sufficiently dry to produce excessive dust.

During construction activities, the construction contractors would employ a number of safeguards through monitoring and response. If spills or leaks of hydrocarbons occur, the construction contractors would employ controls and cleanup measures in accordance with USEPA guidelines.

5.4 Water Resources

Areas disturbed during the implementation of an action alternative would be graded to reduce scouring and erosion potential using gentle sloping, terraces, earthen rides, and catch drains. These controls would also be used to minimize the potential for ponded water, reduce the risk of percolation from ponded water, and divert water away from open disposal locations, construction areas, and exposed mine waste. The drainage patterns in the disturbed areas would be integrated with the existing topography and drainage patterns to the extent possible. During construction activities, storm water controls may include channels, weirs, spillways, catch basins, check dams, and sediment basins. The controls would be implemented to mitigate offsite migration of mine waste. After the removal action, the excavated area and haul roads would be verified clean, reclaimed, and revegetated.

5.5 Ecological Resources

Overall, the impacts of each action alternative on wildlife would not be significant, assuming that the BMPs and EPMs would be implemented in compliance with all approved wildlife protection measures and required regulations and the fact that the majority of disturbance would occur on previously disturbed lands (Reclaimed communities). Reclamation and revegetation would minimize accelerated erosion and allow for the soils to support a functioning ecosystem. Long-term impacts would be mitigated by complete reclamation of the disturbed site and facilities. Native plant communities similar to the surrounding area established during reclamation would provide additional habitat for wildlife species that were displaced during project construction.

The following wildlife protection measures would be implemented during implementation of each action alternative to minimize damage to habitat and disruption of wildlife:

1) Reduced speed limit for haul and access roads to minimize the possibility of wildlife collision;
2) Nesting surveys to be conducted prior to the commencement of vegetation and mine waste removal, New Mexico Department of Game and Fish and Navajo Nation Department of Fish and Wildlife will be consulted if any nests are found;
3) Implementation of USFWS and NNHP recommended seasonal and spatial protection buffers for raptor nests and eagle roost sites; and
4) Implementation of a revegetation plan (Appendix U of LAR) that would provide general wildlife habitat enhancement.

Although no tribal, federal, or state threatened, endangered, candidate, or proposed wildlife species have been recorded in the Area of Analysis, any mitigation actions deemed necessary through the consultation process would be implemented if observed in the future.

5.6 Air Quality

5.6.1.1 General Emission Control Techniques

The following control techniques are available for reducing the emissions from anticipated sources under each action alternative:

5.6.1.1.1 Unpaved Roads

There are several options to control emissions from unpaved roads. These typically fall into one of the following categories: vehicle restrictions, such as limiting speed; weight or number of vehicles; surface improvements, such as adding gravel or slag to a dirt road; surface treatment; or including watering or treatment with chemical dust suppressants. The WRAP Fugitive Dust Handbook (Countess Environmental, 2006) and the NMED accepted values for aggregate handling, storage pile and haul road emissions (NMED, 2018) were used to establish control efficiencies for haul road calculations. Specific PM emission control efficiencies applied to the haul roads are shown in Table 4.6-2.

5.6.1.1.2 Uncovered Stockpiles

Several methods for controlling PM emissions from stockpiles are discussed in the Countess Environmental (2006). Specific PM emission control efficiencies applied to the stockpiles are shown in Table 5.6-1.

Table 5.6-1. Air Dispersion Modeling Results with Mitigation

Air Dispersion Modeling Results - With Stockpile Location Mitigation														
Pollutant	Averaging Period	Modeling Scenarios - Proposed and Alternative Actions									Maximum Modeled Concentration (μg/m^3)	Background Concentration (μg/m^3)	Percent of NAAQS/NMAAQS	Scenario
		A1	A2	A3	A4	A5	B1	C1	C2	D1				
$PM_{2.5}$	Annual	0.6	0.3	0.2	0.2	0.2	0.6	0.6	0.5	0.6	0.6	6.59	60%	C1 & D1
$PM_{2.5}$	24-hr	3.7	2.8	2.7	2.7	2.7	3.7	3.9	3.9	3.9	3.9	22.5	76%	C1 & D1
PM_{10}	Annual	3.6	1.7	1.3	1.3	1.3	3.6	3.7	3.1	3.7	3.7	-	-	-
PM_{10}	24-hr	40.7	30.5	29.9	29.9	29.9	40.6	40.7	40.5	40.7	40.7	21	41%	C1 & D1
TSP	Annual	6.0	2.0	2.1	1.8	1.8	6.0	6.2	6.1	6.2	6.2	9.53	26%	C1 & D1
TSP	24-hr	79.2	57.1	57.2	57.1	57.1	79.0	79.2	78.9	79.2	79.2	21	67%	C1 & D1

5.6.1.1.3 Material Screening

Based on Section 11.19.2 of AP-42 (USEPA, 2004), controls such as wet suppression can significantly decrease emissions from screening operations. Specific PM emission control efficiencies applied to the screening operations are shown in Table 4.6-2.

5.6.1.1.4 Disturbed Areas

The primary control method for disturbed areas discussed in Countess Environmental (2006) is stabilization with chemical dust suppressant. It may be appropriate to consider other equally effective control techniques measures, such as covering the disturbed area with straw. For this project, no controls are assumed for disturbed areas.

5.6.1.1.5 Fuel Storage

There are control technologies available for fixed roof tanks. These include submerged fill and systems where vapors are collected and then compressed, adsorbed, and/or combusted. Due to the expected small amounts of emissions from the fuel storage tanks, only submerged fill of tanks was assumed as a control of VOC emissions.

5.6.1.1.6 Vehicle Fueling

Vapor balancing can be used to capture vapors displaced from the tank being filled back into the fuel storage tank, resulting in a control efficiency of 88 to 92%. Due to the relatively low emissions expected from this activity, vapor balancing will not be used.

5.6.1.2 Proposed Action Stockpiles

Specific mitigation measures were evaluated for reducing potential emissions from stockpiles included in the Proposed Action. As described in Section 4.6, the results of air dispersion modeling of emissions from the Proposed Action show exceedances in the NAAQS and NMAAQS for the following pollutants and averaging periods:

- TSP: 24-hour
- PM_{10}: 24-hour
- $PM_{2.5}$: 24-hour

The main source causing these exceedances are the stockpiles (SP1, SP2, SP3 and SP4). The operations at these stockpiles have a 60% control based on watering. However, the size and throughput of these stockpiles produces significant emissions of PM. Combining this high PM emission rates with the proximity to Highway 566, which is classified as a publicly accessible receptor, causes PM exceedances along the Highway to occur.

Solutions to mitigate the high PM concentrations from an air dispersion modeling perspective include:

- Reducing the number of disturbances per hour at each of these stockpiles.
- Reducing the total throughput of material per hour at the stockpiles.

- Extra controls such as three-sided wind fences or enclosures, dust suppressants, covering stockpiles.
- Utilize an ambient monitoring network of real-time detectors to alert operations if the ambient concentrations of PM are approaching predefined limits of 80% of the NAAQS or NMAAQS.
- Moving the stockpiles away from sensitive receptors such as Highway 566.

To evaluate mitigation measures for exceedances in the NAAQS and NMAAQS associated with the Proposed Action, the stockpiles SP2, SP3, and SP4 were moved from the proposed locations to new locations within the Project Area. The Imported Rock and Screened Rock (SP2 and SP3) are moved to the east of the repository yard. The Topsoil Stockpile (SP4) is moved north closer to the Mine Site. As such, the predicted concentrations from air dispersion modeling are drastically reduced. Based on this mitigation strategy, the site-wide results combined with the background concentrations and applicable surrounding sources are shown in Table 5.6-1.

Table 5.6-1. Air Dispersion Modeling Results with Mitigation

Air Dispersion Modeling Results - With Stockpile Location Mitigation														
Pollutant	Averaging Period	Modeling Scenarios - Proposed and Alternative Actions									Maximum Modeled Concentration (µg/m³)	Background Concentration (µg/m³)	Percent of NAAQS/NMAAQS	Scenario
		A1	A2	A3	A4	A5	B1	C1	C2	D1				
$PM_{2.5}$	Annual	0.6	0.3	0.2	0.2	0.2	0.6	0.6	0.5	0.6	0.6	6.59	60%	C1 & D1
$PM_{2.5}$	24-hr	3.7	2.8	2.7	2.7	2.7	3.7	3.9	3.9	3.9	3.9	22.5	76%	C1 & D1
PM_{10}	Annual	3.6	1.7	1.3	1.3	1.3	3.6	3.7	3.1	3.7	3.7	-	-	-
PM_{10}	24-hr	40.7	30.5	29.9	29.9	29.9	40.6	40.7	40.5	40.7	40.7	21	41%	C1 & D1
TSP	Annual	6.0	2.0	2.1	1.8	1.8	6.0	6.2	6.1	6.2	6.2	9.53	26%	C1 & D1
TSP	24-hr	79.2	57.1	57.2	57.1	57.1	79.0	79.2	78.9	79.2	79.2	21	67%	C1 & D1

As the table shows under these mitigated conditions the PM concentrations for all averaging periods are below the applicable standards for all scenarios. Figure 5.6-1 through Figure 5.6-6 show the model results for the mitigated Proposed Action (Annual and 24-hr for $PM_{2.5}$, PM_{10} and TSP) and Figure 5.6-7 to Figure 5.6-12 for the worst-case model results for Alternative Actions C1 and D1.

In addition to mitigating adverse impacts on air quality, the movement of stockpiles SP2 and SP3 would have temporary, unavoidable, adverse impacts on other resources. For example, longer hauling distances from the stockpiles to the Mill Site would increase traffic interruptions compared to the locations identified in the Proposed Action. The movement of the stockpiles closer to the Mine Site would also place the sources closer to the community along Red Water Pond Road.

5.7 Noise

In the absence of any applicable noise standards that would apply to each of the alternatives (see Section 3.7.1), mitigation measures for noise are considered only to address any potential nuisance concerns. Alternative housing of affected residents would mitigate any noise nuisances from the action alternatives. The adjacent community of approximately 75 people along Red Water Pond Road to the north of the Mine Site is being offered voluntary alternative housing during the multi-year construction period. USEPA is working with individual households to find alternative housing arrangements that meet their needs.

5.8 Historical and Cultural Resources

The most prevalent form of mitigation recommended by both the NMSHPO and NNHPD is avoidance. Avoidance of eligible cultural resources follows these procedures:

9. Activities are restricted to the area of potential effect.
10. A temporary fence should be installed around the NHRP-eligible property to include a 50-ft buffer zone monitored by a qualified archaeologist onsite.
11. In the event of a discovery of any undocumented cultural resources during any phase of construction and operation, all operations must cease in the area of discovery and the appropriate entity, according to land status, must be notified to determine the next steps.

The severity of impacts to archaeological sites associated with the proposed project can be minimized by avoidance through fencing of archeological sites and the monitoring of any ground disturbance within 50 ft of the resource. The fencing and monitoring of the nine identified archaeological sites would deter any significant impact to the identified cultural resources. If any archaeological site cannot be avoided or fenced, consultations with the NNHPD or NMSHPO would occur to determine an appropriate mitigation strategy; i.e., limited testing or data recovery.

If avoidance of an identified cultural resource is not possible before, during, or after construction, or should any redesign components be created, consultations with both the NMSHPO and NNHPD would be completed to determine if further testing or full data recovery would be recommended to mitigate the adverse effects on each of the affected sites.

5.9 Visual/Scenic Resources

Reduction of visual impacts would be achieved by regrading and revegetating each disturbed area. Locally sourced soils and native plant species would be used to regrade and revegetate, helping to blend the disturbed areas into the landscape and return the Mine and Mill Sites to pre-construction conditions as best as possible. Recommendations for revegetation are provided in Appendix U of the LAR.

5.10 Socioeconomic

Socioeconomic impacts under each of the alternatives do not require mitigation as the impacts are minor in scale and beneficial in nature.

5.11 Environmental Justice

Voluntary alternative housing would assist in mitigating any adverse, temporary impacts on noise, dust, and transportation. The adjacent community of approximately 75 people along Red Water Pond Road to the north of the Mine Site is being offered voluntary alternative housing during the multi-year construction period. USEPA is working with individual households to find alternative housing arrangements that meet their needs.

5.12 Public and Occupational Health

5.12.1 Non-Radiological Sources

Two types of emissions related to non-radiological contaminants would be expected to occur during each action alternative:

(1) Fugitive dust emission during construction activities; and

(2) Emission due to combustion of diesel fuel by vehicle and construction equipment.

A number of dust suppression strategies would be implemented to minimize the exposure associated with the fugitive dust emission. Appendix Q of the LAR provides more detailed information regarding dust control. The specific dust suppression measures that would be employed for specific construction activities are listed below:

1. Excavation, placement, and grading
   - Application of water or other approved dust suppressants to reduce visible dust during execution of work
   - Maintenance and protection of native vegetation where possible, through minimization of site disturbance
2. Hauling
   - Application of water or other approved dust suppressants during hauling and loading;
   - Wetting and covering loads during hauling
3. Speed limits
   - Implementation a speed limit of 20 miles per hour on haul and access road.
   - Posting of signs related to speed limit and no-idle zone
4. Screening (separating soil and rock)

- Use of water trucks, water sprays and/or manned water hoses during screening operations

5. Stockpiles
   - Spraying of water directly to the active stockpiles during the construction of stockpile
   - Use of both moderate compaction and water will be required to effectively managed PTW stockpiles
   - Use a membrane cover for inactive PTW stockpiles.

As a part of green and sustainable practices, the following emission reduction strategies would be implemented:

- Ultra-low sulfur diesel fuel for vehicles and equipment
- Vehicle and equipment "no-idling" policy
- Vehicle speed limit
- Worker Transportation (carpool/rideshare)
- Emissions reduction measures for temporary generators
- Non-road diesel equipment fleet requirements
- Use of appropriately sized equipment for tasks to minimize unnecessary emissions and fuel use

5.12.2 Radiologic Sources

Several risk mitigation measures would be applied during the implementation each action alternative to minimize and/or prevent public and occupational exposure to radiological contaminants. Several appendices of the LAR present the risk mitigation measures and are summarized as follows.

Four facilities areas – Support, Decontamination, Controlled and Exclusion would be established within the Project Area as a part of each action alternative. Various types of site control and access programs would be implemented for each of these facilities areas for occupational and public health protection. Appendix B of the LAR provides detailed information related to those four facilities.

Each action alternative involves substantial construction-related activity over an extended time period and would require management and engineering actions to protect public and occupational health. Potential risks related to transportation and disposal of mine waste and potential fugitive dust emissions may be encountered. During transportation and material handling activities, dust suppression measures would be used to reduce fugitive dust emissions and associated impacts to nearby receptors. In addition, perimeter air monitoring stations would be positioned and operated to monitor emissions during construction activities to maintain a safe working environment and to protect human health and the environment. Appendix Q of the LAR provides detailed information on the Dust Control and Air Monitoring Program. Potential exposure and protection procedures for workers engaged in these activities are addressed in Appendix L of the LAR. Workers in the controlled areas would wear the appropriate safety equipment and implement safety practices such as air monitoring and access control for authorized personnel only. Site construction activities would also include stormwater management to mitigate the potential for offsite migration of mine waste during weather events. Appendices E and F of the LAR present detailed information regarding various stormwater controls at the Mine and Mill Site, respectively.

Each action alternative would also involve the transportation of mine waste. This activity may result in impacts to the local residents during the period of construction, including nuisance construction noise, inconvenience due to increased truck traffic on local roads, potential traffic detours or re-routing, and potential accidents or spills. Mitigation efforts include voluntary alternative housing for the community of approximately 75 people along Red Water Pond Road to the north of the Mine Site, the use of dust suppression measures, restriction of hours of operation as necessary, and air monitoring. Bulk carriers hauling mine waste would be securely covered and weighed to document compliance with total and axle load limits. A transportation plan would be used to identify the routes of travel, times of operation, and traffic rules. Appendix D of the LAR presents information related to haul road to be used during the transportation of waste. Appendix M of the LAR presents information related to traffic safety.

Emergency spill containment and cleanup contingencies would also be included in the transportation plan to address mine waste spills. The short travel distance could potentially reduce construction time, reduce transportation incidents on public roadways, and reduce the estimated trucking emissions based on total distance traveled. Appendix R of the LAR provides information related to release prevention and release contingency plans.

5.13 Waste Management

Additional mitigation measures would not be required.

CHAPTER 6. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

This section describes all environmental measurement and monitoring programs as they apply to implementation of the proposed action and each alternative.

6.1 Radiological Monitoring

As described in Section 4.12, the release and transportation of radiological contaminants to the atmosphere, whether by windblown dispersion of contaminated particulates into the atmosphere or radon release, is the principal radiological exposure pathway.

Perimeter air monitoring for internal and external radiation exposure to individual members of the public will be conducted using the methods described in Appendix Q of the LAR, and as summarized in Table Q.4-1 LAR. Please refer to this appendix and table for details concerning the proposed radiological monitoring. This monitoring plan would apply to the Proposed Action and each alternative.

6.2 Physiochemical Monitoring

Appendix L of the LAR identifies the following non-radiological hazards associated with the contaminated onsite soil: arsenic, total dust, respirable dust, diesel fuel, naphthalene total petroleum hydrocarbons, and uranium (metal). During the implementation of the Proposed Action and each alternative, construction workers would be exposed to the release of non-radiological contaminants to the atmosphere by:

- Fugitive dusts that would be generated by heavy equipment during the excavation process, transportation of contaminations, construction of the repository cells and disposal operations; and
- Combustion emissions resulting from exhaust of diesel-powered heavy construction equipment.

Appendix Q of the LAR presents detailed information for the real-time air monitoring that would be conducted for particulate levels as a part of the Dust Control and Air Monitoring Program to ensure the activities comply with the state and federal air quality regulations. Please refer to this appendix and table for details concerning the proposed non-radiological monitoring. This monitoring plan would apply to the Proposed Action and each alternative.

6.3 Ecological Monitoring

Appendix U of the LAR presents the plans for revegetation and monitoring at the Mine and Mill Sites. The monitoring program and success criteria follow the framework from the Mining and Minerals Division of the New Mexico Energy, Minerals and Natural Resources Department (MMD). Please refer to this appendix and table for details concerning the proposed non-radiological monitoring. This monitoring plan would apply to the Proposed Action and each alternative.

6.4 Stormwater Pollution Prevention Plan

Appendix E of the LAR describes the requirements for the Construction Stormwater Pollution Prevention Plan (CSWPPP) that would be prepared and followed by the Construction Contractor. Under the Proposed Action and each alternative, the CSWPPP would identify required observations and mitigation measures to address problems related to controlling stormwater and sediment from leaving the project work areas. Please refer to this appendix and table for details concerning the proposed non-radiological monitoring. This monitoring plan would apply to the Proposed Action and each alternative.

6.5 Cultural Resources Monitoring

Section 4.8 describes how the Proposed Action and each alternative would potentially impact cultural resources sites and describes how the implementation of the Proposed Action would likely alter the characteristics of nine of the recorded archaeological sites (Table 4.8-1). As part of proposed mitigation for the Proposed Action and each alternative, a temporary fence would be installed around each eligible property and include a 50-ft buffer zone that would be monitored by a qualified archaeologist. If any cultural resources were observed during monitoring, then all work would immediately cease, and the appropriate authorities would be notified. This monitoring plan would apply to the Proposed Action and each alternative.

CHAPTER 7. COST BENEFIT ANALYSIS

This section has been prepared by Stantec, the Project Engineer, and describes the additional construction costs and drawbacks associated with the alternatives being analyzed, in comparison with the for the proposed action. NUREG/BR- 0058 and NUREG-1530 (NRC, 1995a; 1995b) provide detailed guidance. The discussion of costs and examples of reasons for not selecting each alternative includes the additional costs of each alternative and a qualitative discussion of environmental impacts, as presented in Section 4.0.

The overall cost estimate for the Proposed Action is in progress and will submitted separately from the LAR. Therefore, the costs described here apply only to the additional cost for Alternatives B, C and D beyond the construction cost associated with these specific aspects of the Proposed Action. Although the costs for these alternatives are based on the complete design, this exercise was completed as a study. Therefore, the estimates for the alternatives are considered Class 4 estimates with an accuracy estimate of -20% to +30%.

Order of magnitude costs were estimated for the additional construction costs associated with the alternatives for conveyance (Alternative B), borrow sources (Alternative C), and the disposal rather than the re-processing of the PTW material (Alternative D). Table 7.0-1 summarizes the estimated additional costs associated with these three elements beyond the cost for the Proposed Action. Aside from cost, each presents additional environmental issues, for which they were primarily excluded from selection during the design process. The costs of these additional environmental impacts are not accounted for here. Each alternative is described in detail in Section 2.0.

Table 7.0-1 Summary of Estimated Costs for Alternatives

Alternative	Estimated Additional Construction Costs
B. Conveyance – transport of mine waste to the Repository by conveyor, rather than haul trucks	+$1M
C. Material sourcing – cover soil from the original four borrow areas vs. borrow only from the Jetty excavation	+$3M
D. Disposal of PTW at an offsite disposal facility – rather than reprocessing at the White Mesa Mill	+$5M

The additional cost of Alternative B is associated with installing a conveyor system from the Mine Site to the Repository. The assumptions include the use of haul trucks at each end of the conveyor to move material to and from the start and end points. The additional cost is based on the conveyance of 1M CY of material from the Mine Site. While this option provides the benefit of less haul traffic crossing the highway. Drawbacks to the use of a conveyor include:

- dust control for the elevated conveyor, high winds in the area could lead to dust control issues due to the material being moved further above the ground, resulting in additional cleanup required along the conveyor route
- size limits for moving debris on the conveyor, such that a truck fleet could still be required to move large debris
- specialized maintenance team to maintain/operate the conveyor beyond what a typical earthwork contractor may employ
- challenging foundation conditions, shallow rock could require specialty foundations for construction of the conveyor supports

Additional costs for Alternative C were by comparing the use of all four of the original borrow areas (North, South, East and West) for cover soil and then reclaiming the borrow areas upon completion (Proposed Action) with using only the Jetty excavation as the source for cover soil (Alternative C). This option assumes in both cases the jetty excavation would still be completed, however, the soils from the Jetty would be wasted in one of the other borrow areas for the option where the jetty soil is not used for borrow. Drawbacks to not using the jetty soil for construction include:

- wasted operations to excavate the jetty soil and then move the material to another part of the site without using it
- greater haul distances for the other four borrow areas to the cover, as compared with the jetty
- additional revegetation/reclamation efforts required for other four borrow sources if they are disturbed
- use of the north borrow disturbs a previously undisturbed area of the site

Alternative D costs were compared by estimating the hauling the PTW to the nearest RCRA/hazardous waste disposal facility versus hauling the PTW to the White Mesa Mill for reprocessing, as described for the Proposed Action. While several trucking options were evaluated for cost, the comparison for the estimated additional cost for this alternative is between the use of covered rear-dump trucks using the shortest travel routes (not limited to major interstates). Potential environmental impacts from selecting Alternative D include:

- increased highway haul distances
- disposal cost at a landfill versus credit for reprocessing of the materials at the mill

Details on the cost comparison calculations are attached as Appendix D of this SER.

CHAPTER 8. SUMMARY OF ENVIRONMENTAL CONSEQUENCES

The selection of any of the action alternatives could result in the irreversible commitment of specific resources used in project construction, especially for nonrenewable resources such as geological resources or cultural resources. It would also result in irretrievable commitment of resources, defined as lost production or use of renewable natural resources during the life of the action. The irreversible and irretrievable commitments of resources for this project are anticipated to be minimal. Those resources that would be affected by irreversible and irretrievable commitments of resources are summarized in the following sections:

8.1 Geology

Up to 168,900 CY of rock material (Table 2.1-3) would be required for constructing erosion protection in the soil cover system as well as stabilizing stormwater channels. Sourcing this material from a commercial quarry would result in irreversible and irretrievable commitments of those geologic resources.

8.2 Visual/Scenic

The placement of mine waste and construction of the Repository on top of the TDA would result in a maximum increase in land surface elevation of up to 43 ft above the existing surface. Excavation of mine waste at the Mine Site is expected to achieve a maximum excavation depth of 52 ft below the existing surface. Each change to topography would be a long-term impact, but not entirely irreversible commitment of visual/scenic resources.

8.3 Waste Management

The disposal of PTW would result in an irreversible and irretrievable commitment of space at a licensed and controlled disposal facility. The waste remaining aft the re-processing of PTW would result in an irreversible and irretrievable commitment of disposal space at a licensed and controlled facility.

CHAPTER 9. LIST OF REFERENCES

Agency for Toxic Substances and Disease Registry, 2011. Radium, Division of Toxicology and Environmental Medicine ToxFAQs™. July 1999.

Avian Power Line Interaction Committee (APLIC). 2005. Avian Protection Plan Guidelines. Website: http://www.aplic.org/mission.php

AVM Environmental Services, Inc. (AVM), 2014. Radiological Survey Report NECR Mine & Mill Site Pre-Design Studies. Consultant's Report prepared for MWH Global, Inc. and United Nuclear Corporation, April 30.

Baars, Donald L. 1995. Navajo Country: A Geology and Natural History of the Four Corners Region. University of New Mexico Press, Albuquerque.

Begay, J., and S.V. Wero. 2011. A Cultural Resource Inventory of 27.5 Acres of Land for Reclamation for MWH Global in Churchrock Mine in McKinley County, New Mexico.

Begay, Jeremy. 2013. A Cultural Resources Inventory of Five Proposed Borrow Pits for MWH Global in the NECR Mine Area, McKinley County, New Mexico.

_____. 2017. A Cultural Resource Inventory of the Proposed INTERA Churchrock AUM Clean-up in the Church Rock and Coyote Canyon Chapters, McKinley County, New Mexico.

_____. 2018, forthcoming. Archaeological survey of 32.22 acres completed in both UNC and NECR areas to address changes in the limits of disturbance identified by Stantec.

Biota Information System of New Mexico (BISON-M). 2018. Santa Fe, New Mexico, USA. http://www.bison-m.org (Accessed: April 19, 2018).

Boggess, Douglas H.M., and Richard M. Begay. 2005. A Cultural Resources Survey of 125 Acres for the Proposed Close out of the Northeast Churchrock Mine, McKinley County, New Mexico.

Brod, R.C., and Stone, W.J., 1981. Hydrogeology of Ambrosia Lake-San Mateo area, McKinley and Cibola Counties, New Mexico. New Mexico Bureau of Geology and Mineral Resources, Hydrogeologic Sheet 2, Socorro, New Mexico.

Brown, S.C., 2004. Conveyor Noise Specification and Control. Proceedings of ACOUSTICS 2004, November 3-5, Gold Coast, Australia. https://pdfs.semanticscholar.org/bb02/5e40ae462d9101bef3ccdddb0963a702219d.pdf

Bureau of Business and Economic Research (BBER), 2016. McKinley County. University of New Mexico. March 16.

Bureau of Indian Affairs (BIA). 2016. Navajo Nation Integrated Weed Management Plan.

Bureau of Land Management (BLM), United States Department of the Interior. 1986. BLM Manual 8400, Chapter 8431 Visual Resource Contrast Rating. Rel. 8-30. Updated Jan 17, 1986. Washington, D.C

Canonie Environmental (Canonie), 1987. Geohydrologic Report, Church Rock Site, Gallup, New Mexico. Prepared for UNC Mining and Milling, Gallup, New Mexico. May.

______.1991. Tailings Reclamation Plan, As Approved by NRC March 1, 1991, License No. SUA-1475. Prepared for United Nuclear Corporation. August.

Castiglia, P.J. 2017. Email Communication to Red Water Pond Road Community Members Regarding Field Work and Data Collection.

Cashwell, C. E. and J. D. McClure, *Transportation Accidents/incidents Involving Radioactive Materials (1971-1991)*

Cedar Creek Associates, Inc. 2010. Northeast Church Rock Mine, Vegetation & Wildlife Evaluations / Revegetation Recommendations, 2009 Evaluations and Planning. February.

———, 2010 - 2016. Reclamation Reports for NECR Removal Actions and Mine Site Revegetation.

———, 2014. Northeast Church Rock Mill Site, Baseline Vegetation and Wildlife Surveys. July.

———, 2015. 2014 Final Revegetation Evaluation for the 2009 Interim Removal Action at Northeast Church Rock Mine Site.

———, 2017. Revegetation Plan, Repository on Church Rock Mill Site Tailings Disposal Area, United Nuclear Corporation. October.

_____. 2018, report forthcoming. A supplemental survey was completed in 2018 to capture areas of disturbance associated with the Proposed Action that were previously un-surveyed.

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

———, 2017. Annual Review Report – 2016, Groundwater Corrective Action, Church Rock Site, Church Rock, New Mexico. February.

Chronic Diseases Division, Bureau of Epidemiology (CDD). 1980. Memo: Biological Assessment after Uranium Mill Tailings Spill, Church Rock, New Mexico. December 24.

City of Gallup, 2018. Streets and Storm Drainage. https://www.gallupnm.gov/354/Streets-and-Storm-Drainage. Accessed April 25, 2018.

Comer, P, D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, Virginia.

Comer, P, and Hak, J. 2012. Landscape Condition in the Coterminous United States. Spatial Model Summary. NatureServe, Boulder, Colorado, USA.

Countess Environmental, 2006. WRAP Fugitive Dust Handbook, Prepared for the Western Governor's Association, September 7th, Available online at https://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf

Craigg, S. D., 2001. Geologic Framework of the San Juan Structural Basin of New Mexico, Colorado, Arizona, and Utah with Emphasis on Triassic through Tertiary Rocks. United States Geological Survey Professional Paper 1420.

Craigg, S.D., Dam, W.L., Kernodle, J.M., Thorn, C.R., and Levings, G.W., 1990. Hydrogeology of the Point Lookout Sandstone in the San Juan Structural Basin, New Mexico, Colorado, Arizona and Utah. United States Geological Survey Hydrologic Investigations Atlas HA-720.

Craigg, S.D., Dam, W.L., Kernodle, J.M., and Levings, G.W., 1989. Hydrogeology of the Dakota Sandstone in the San Juan Structural Basin, New Mexico, Colorado, Arizona, and Utah. United States Geological Survey Hydrologic Investigations Atlas HA-720-I.

Crout, G. Stanley, 1984. Letter communication to Jay J. Mason on behalf of the City of Gallup Regarding Water Rights Sales. May 7.

Civil Systems, Inc. (CSI), 1980, "Final Design Report - Southeast Evaporation Ponds," prepared for United Nuclear Corporation Church Rock Facility, Gallup, New Mexico.

D'Appolonia. 1981. State of New Mexico Environmental Improvement Division Uranium Mill License Renewal Application – Environmental Report License No. NM-UNC-ML, UNC Mining and Milling Church Rock Operations, Division of United Nuclear Corporation, Church Rock Mill, Gallup, New Mexico. December.

Dam, W.L., Kernodle, J.M., Levings, G.W., and Craigg, S.D., 1989. Hydrogeology of the Morrison Formation in the San Juan Structural Basin, New Mexico, Colorado, Arizona, and Utah. United States Geological Survey Hydrologic Investigations Atlas HA-720.

Dam, W.L., 1990. Hydrogeology of the Morrison Formation in the San Juan structural basin, New Mexico, Colorado, Arizona, and Utah Edition. USGS Series Hydrologic Atlas Report Number 720-J, Originating office USGS Library Call Number M(200) Hy no.720-J.

Davis, Caroline M. 1980. Poor House Ruin, LA 21152. A Late Eleventh Century Anasazi Dwelling in McKinley County, New Mexico.

DeLemos, J., T. Rock, D Brugge, N Slagowski, T Manning, and J Lewis, 2007. *Lessons from the Navajo: Assistance with Environmental Data Collection Ensures Cultural Humility and Data Relevance*, Prog Community Health Partners. 2007 Winter;1(4):321-6. doi: 10.1353/cpr.2007.0039.

Delemos J.L, B.C. Bostick, A.N. Quicksall, J.D. Landis, C.C. George, N.L. Slagowski, T. Rock, D. Brugge, J. Lewis, and J. L. Durant, 2008. Rapid Dissolution of Soluble Uranyl Phases in Arid, Mine-Impacted Catchments near Church Rock, NM. Environmental Science Technology vol. 42, June 1.

Dwyer Engineering, LLC (Dwyer) 2017. 95% Draft Consolidation and Groundwater Evaluation Report, Northeast Church Rock Site Closure. October 31.

______. 2018. Cover System Design Report, Northeast Church Rock Site Closure. February 26.

Dwyer, Stephen F., 2011. Evaluation of Consolidation and Water Storage Capacity Related To Placement Of Mine Material on the Existing UNC Mill Site Tailings Impoundment. May 2011

Engineer/Remediation Resources Group, Inc. (ERRG). 2011. Draft Regional Groundwater Assessment of Impacts from Historic Releases of the MECR Mine and UNC Mill Facilities, Navajo Nation. September.

Federal Highway Administration (FHWA), 2006. Construction Noise Handbook. FHWA-HEP-06-015, DOT-VNTSC-FWHA-06-02, NTIS No. PB2006-109102. August.

Federal Motor Carrier Safety Administration (FMCSA), 2001. Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents. Prepared by Battelle, 505 King Ave, Columbus, OH. March

GAO, 2014. Uranium Contamination: Overall Scope, Time Frame, and Cost Information Is Needed for Contamination Cleanup on the Navajo Reservation

Gallaher, Bruce, 1983. *The Puerco River: Muddy Issues Raised by a Mine Water Dominated Ephemeral Stream.* Water Quality in New Mexico, Proceedings of Twenty-Eighth Annual New Mexico Water Conference. WRRI Report No. 169, June 1983.

Gallaher, B.M. and S.J. Cary, 1986. Impacts of Uranium Mining on Surface and Shallow Groundwaters, Grants Mineral Belt, New Mexico. New Mexico Environmental Improvement Division Library, September.

Gottlieb, Gail, 1980. New Mexico's Mine Dewatering Act: The Search for Rehoboth. Journal of Natural Resources vol. 653.

Gallup-McKinley County Schools (GMCS). GMCS Enrollment Data. Available at: https://www.gmcs.k12.nm.us/

Green, M.W. and T.J. Jackson, 1975, Geologic Map of the Church Rock Quadrangle, McKinley County, New Mexico, USGS Open File Report 75-258.

Harshbarger, J.W., C.A. Repenning, and R.L. Jackson. 1951. Jurassic Stratigraphy of the Navajo County. New Mexico Geological Society, Guidebook No. 2, pg 95-99, 103.

Hatch Chester, 2018. Annual Review Report – 2017 Groundwater Corrective Action Church Rock Site, Church Rock, New Mexico. January.

Havlin, J.L., Beaton, J.D., Tisdale, S.L., and Nelson, W.R., 1999. Soil Fertility and Fertilizers, An Introduction to Nutrient Management, Prentice Hall, New Jersey, 6th Edition.

Health Physics Society (HPS). 2015. Background Radiation Fact Sheet, Revised 2015, https://www.nrc.gov/docs/ML1710/ML17100A802.pdf, accessed May 2018.

Hunt, C.B. 1937. Igneous Geology and Structure of the Mount Taylor Volcanic Field, New Mexico. Geological Survey Professional Paper 189-B.

Hydro Resources, Incorporated (HRI), 2013. Crownpoint Uranium Project USNRC License SUA-1580 Renewal McKinley County, New Mexico, Environmental Report. March.

INTERA Incorporated (INTERA). 2015. Final Environmental Data Gap Report for the Northeast Church Rock Site Removal Action and the United Nuclear Corporation Site Remedial Action, Prepared for United Nuclear Corporation and General Electric Company, November 23.

———, 2017. Environmental Data Report for the Northeast Church Rock Site Removal Action and the United Nuclear Corporation Site Remedial Action, Consultant's Report prepared for United Nuclear Corporation/General Electric, January 26, 80 p.

ISO Standard 9613-2 Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2 : General Method of Calculation, First Edition, December 15,1996, ISO 9613-2.

ISR GEIS 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities: Chapters 1–4 (NUREG-1910, Volume 1), Office of Federal and State Materials and Environmental Management Programs, United States Nuclear Regulatory Commission.

Kelley, V. C., 1963. "Tectonic Setting," in Kelley, V. C. (comp.), *Geology and Technology of the Grants Uranium Region.* New Mexico Bureau of Mines and Mineral Resources, Memoir 15, pp. 19-20.

Kernodle, J.M., Levings, G.W, Craigg, S.D., and Dam, W.L., 1989. Hydrogeology of the Gallup Sandstone in the San Juan Structural Basin, New Mexico, Colorado, Arizona and Utah. USGS Series Hydrologic Atlas Report Number 720-H, Originating Office USGS Library Call Number M(200) Hy 720-H.

Kernodle, J. M., 1996. Hydrogeology and Steady-State Simulation of Ground-Water Flow in the San Juan Basin, New Mexico, Colorado, Arizona, and Utah. United States Geological Survey Water-Resources Investigations Report 95-4187.

King, L.J., 2007, Church Rock Uranium Monitoring Project, Presentation Materials for USEPA Community Involvement Conference. June.

Levings, G.W., Kernodle, J.M., and Thorn, C.R., 1996. *Summary of the San Juan Structural Basin Regional Aquifer-System Analysis, New Mexico, Colorado, Arizona, and Utah.* United States Geological Survey Water-Resources Investigations Report 95-4188.

Linford, Laurance D. 2000. Navajo Places: History Legend, Landscape. University of Utah Press, Salt Lake City.

Lorenz, J.C., and S.P. Cooper, 2003. Tectonic Setting and Characteristics of Natural Fractures in Mesaverde and Dakota Reservoirs of the San Juan Basin, New Mexico Geology, v. 25, no. 1, p. 3–14.

Lucas S.G. and Anderson, O.J., 1998. Jurassic Stratigraphy and Correlation in New Mexico: New Mexico Geology, v. 20, p. 97-104.

Martin, R., and R. Begay. 2009. A Cultural Resources Inventory of 68.87 Acres of Proposed Reclamation North of the Church Rock Mine, McKinley County, New Mexico.

McKinley County, 2012. Comprehensive Plan Update. September.

———, 2018. Fire and EMS Department. https://www.co.mckinley.nm.us/158/Fire-Rescue

McLemore, Virginia T., Brad Hill, Niranjan Khalsa and Susan Lucas Kamat, 2013. Uranium Resources in the Grants Uranium District, New Mexico: An Update; in Zeigler, Kate, J. Michael Timmons, Stacy Timmons and Steve Semken (eds.), Geology of Route 66 Region: Flagstaff to Grants, New Mexico Geological Society Guidebook, 64th Field Conference, pages 117 – 126.

Menke, K. 2008. Locating Potential Cougar (Puma Concolor) Corridors in New Mexico Using a Least-Cost Path Corridor Analysis. Bird's Eye View GIS, for New Mexico Department of Game and Fish.

Miller, J.R. and S.G. Wells, 1986. Types and Processes of Short-Term Sediment and Uranium-Tailings Storage in Arroyos: An Example from the Rio Puerco of the West, New Mexico.

MWH, Inc. (MWH), 2007. Removal Site Evaluation (RSE) Report. Northeast Church Rock Mine Site, Prepared for United Nuclear Corporation and General Electric. October.

———. 2008. Supplemental Removal Site Evaluation (RSE) Report. Northeast Church Rock Mine Site, Prepared for United Nuclear Corporation and General Electric. February.

———. 2010a. Interim Removal Action Completion Report, Northeast Church Rock Mine, Prepared for United Nuclear Corporation and General Electric. June.

———. 2010b. Post-IRA Status Survey, Interim Removal Action Status Report, Northeast Church Rock Mine Site, Prepared for United Nuclear Corporation and General Electric. June.

———. 2011. Interim Removal Action Completion Report Addendum. Prepared for United Nuclear Corporation and General Electric. March.

———. 2012. Potential Borrow Areas and Borrow Characterization Plan, Northeast Church Rock Mill Site, Technical Memorandum prepared for United Nuclear Corporation and General Electric. February 17.

______. 2013a. Church Rock Mill Site Repository – Summary of Relevant Geotechnical Data. Technical Memorandum.

———. 2013b. Construction Completion Report, Eastern Drainage Removal Action, Northeast Church Rock Mine Site. Prepared for United Nuclear Corporation and General Electric. March.

———. 2014. Pre-Design Studies Church Rock Mine Site Removal Action: Church Rock Mill Site. Prepared for United Nuclear Corporation and General Electric. October 31.

———. 2014b. Pre-Design Studies Church Rock Mine Site RA: Northeast Church Rock Mine Site. Prepared for United Nuclear Corporation and General Electric. October 31.

______. 2016aDesign Work Plan, Northeast Church Rock Mine Site Removal Action, March 17.

———. 2016b. Northeast Church Rock 30% Design Report. Prepared for United Nuclear Corporation and General Electric. July.

MWH/Stantec. 2017a. Northeast Church Rock 30% Design Report, Volume 1, Prepared for United Nuclear Corporation and General Electric Company, July 2016, 61 p.

_____. 2017b. Post-Construction DEM. Received on Mach 16, 2017

NatureServe. 2018. NatureServe Web Service. Arlington, Virginia, USA. Available http://services.natureserve.org (Accessed: April 19, 2018)

Navajo Nation Division of Natural Resources Department of Fish and Wildlife. 2008. Navajo Endangered Species List, Resources Committee Resolution No. RCS-41-08. NESL statuses revised 10 September, 2008 https://www.nndfw.org/nnhp/nnhp_nesl.pdf

Navajo Natural Heritage Program (NNHP). 2010. Legislation No. 0551-08, NNHP Raptor Electrocution Guidelines. https://www.nndfw.org/nnhp/docs_reps/repr.pdf

Navajo Tribal Utility Authority (NTUA), 2017. Water Quality Report 2016 NN3500211 Mariano Lake, Pinedale and Church Rock, New Mexico.

National Council on Radiation Protection and Measurements (NCRP), 2009. "Ionizing Radiation Exposure of the Population of the United States." Report No. 160, March 3, 2009, Bethesda, Maryland.

Natural Resources Conservation Service (NRCS). 1993. Soil Conservation Service (SCS). 1993. Soil Survey Manual. Soil Conservation Service, United States Department of Agriculture Handbook 18.

______. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. 2001. Soil Survey of McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties.

———, 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. Agricultural Handbook 296 digital maps and attributes. Available online.

———, 2018. Custom Soil Resource Report. Web soil survey. Soil Survey Area: Fort Defiance Area, Parts of Apache and Navajo Counties, Arizona and McKinley and San Juan Counties, New Mexico. Version 15, Sep 13, 2017. Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties. Version 12, Sep 13, 2017.

Neumann, Michael, 2018. Personal communication to P. Castiglia. July 19.

New Mexico Administrative Code (NMAC), 2018. Surface water laws.

New Mexico Crucial Habitat Data Set. New Mexico Crucial Habitat Assessment Tool (NMCHAT): Mapping Fish and Wildlife Habitat in New Mexico. 2013. New Mexico Game & Fish Department and Natural Heritage New Mexico. Published 12/10/2013. Accessed 3/30/2018. http://nmchat.org

New Mexico Department of Agriculture (NMDA). 2016. New Mexico Noxious Weed List Update. October 19, 2016.

_______.2017. New Mexico Agricultural Statistics Service (NASS). Accessible at: https://www.nass.usda.gov/Statistics_by_State/New_Mexico/

New Mexico Department of Game and Fish (NMDGF). 2016a. State Wildlife Action Plan for New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

———, 2016b. Threatened and Endangered Species of New Mexico, 2016 Biennial Review. New Mexico Department of Game and Fish, Wildlife Management and Fisheries Management Divisions, Santa Fe, New Mexico, USA.

New Mexico Energy, Minerals, and Natural Resources Department (NMEMNRD), State Forestry Division. 2006. Endangered Plant Species List. NMAC 19.21.2.

New Mexico Environment Department (NMED), 2016. New Mexico Air Quality Bureau Air Dispersion Modeling Guidelines, Revised September 1st, 80 p. https://www.env.nm.gov/wp-content/uploads/2017/01/NM_AirDispersionModelingGuidelines_1_September_2016.pdf

______. 2017. New Mexico Air Quality Bureau Air Dispersion Modeling Guidelines, Revised August 8th, 83 p. https://www.env.nm.gov/wp-content/uploads/2017/01/NM_AirDispersionModelingGuidelines_8_August_2017.pdf

______. 2018. Department Accepted Values for: Aggregate Handling, Storage Pile, and Haul Road Emissions, Available online at https://www.env.nm.gov/aqb/permit/documents/GuidanceforAggregatePilesandHaulRoadCalcs.pdf

New Mexico Environmental Institute (NMEI), 1974. An Environmental Baseline Study of the Mount Taylor Project Area of New Mexico. Prepared for the Gulf Mineral Resources Company.

New Mexico Environmental Improvement Division (NMEID), 1980, Radiation 2 Protection Regulations.

———, 1981, Amended Radiation Protection Regulations.

———, 1983, *The Church Rock Uranium Mill Tailings Spill: A Health and Environmental Assessment,* September 1983, New Mexico Environmental Improvement Division Health and Environment Department, Santa Fe, New Mexico

New Mexico Mining and Minerals Division (NMMMD). 2001. Rules and Regulations for Existing Mining Operations, Non-Coal Mining, Natural Resources and Wildlife. NMAC 19.10.5. May 15, 2001.

———, 1996. Closeout Plan Guidelines for Existing Mines. New Mexico Energy, Minerals, and Natural Resources Department, Mining and Minerals Division, Mining Act Reclamation Bureau.

New Mexico Office of the State Engineer (NMOSE), 2017. Northwest New Mexico Regional Water Plan. State of New Mexico Interstate Stream Commission. January.

———, 2018. OSE POD Locations. https://gis.ose.state.nm.us/gisapps/ose_pod_locations/ Accessed April 8.

New Mexico Rare Plant Technical Council (NMRPTC). 1999. New Mexico Rare Plants. Albuquerque, New Mexico: New Mexico Rare Plants Homepage. http://nmrareplants.unm.edu. (Latest update: 31 January 2018).

New Mexico State University (NMSU), 2016. The Economic Base of McKinley County, NM. Office of Policy Analysis at Arrowhead Center. July. http://arrowheadcenter.nmsu.edu/university-center/wp-content/uploads/sites/19/2016/08/McKinley-County-2016.pdf

New Mexico Taxation and Revenue Department (NMTRD), 2010. FYI-350: Corporate Income Tax and Corporate Franchise Tax. http://www.tax.newmexico.gove/Businesses/Corporate-Income_and_franchise_Tax/Pages?Filing-Requirements.aspx

_____, 2012. Hard Minerals Distribution, FY2010. http://www.tax.newmexico.gov/SiteCollectionDocuments/Tax-Library/Economic-and-Statistical-Information/Mineral%20Extraction%20Taxes/revenues_from_hard_minerals.pdf

_____, 2018. Current Year Gross Receipts Tax Rate Schedules, Effective January 1, 2018 through June 30, 2018. http://www.tax.newmexico.gov/gross-receipts-tax-historic-rates.aspx

Northwest New Mexico Council of Governments (NNMCG). 2012. McKinley County, New Mexico Comprehensive Plan Update. September.

Nuclear Regulatory Commission (NRC), United States. 1981, NUREG/CR-2449 Survey of Radionuclide Distributions Resulting from the Church Rock, New Mexico, Uranium Mill Tailings Pond Dam Failure"

———, 1997a. Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico. Docket No. 40-8968. February.

———, 1997b. Seismic Technical Evaluation Report of Church Rock Uranium Mill and Tailings Site. September 10.

———, 1998, Evaluation of Church Rock Radon Flux Tests, U.S. Nuclear Regulatory Commission, April 22, 1998.

———, 2002. Design of Erosion Protection for Long-Term Stabilization," NUREG-1623. September.

———, 2003. Environmental Review Guidance for Licensing Actions Associated with NMSS Programs (NUREG-1748). August 2003.

———, 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities, Final Report. NUREG-1910, Volume 1. May.

Office of Navajo Tax Commission, 2018. Home Page, Notices. http://www.tax.navajo-nsn.gov/ Accessed July 10.

Pagel J, D. Whittington, and G. Allen. 2010. Interim Golden Eagle Inventory and Monitoring Protocols; and Other Recommendations. United States Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 27 p.

Raymondi, R.R. and R.C. Conrad, 1983. Hydrogeology of Pipeline Canyon, Near Gallup, New Mexico. Groundwater, vol. 21, no. 2. March-April.

Rio Algom Mining, LLC (RAML), 2011, Final Removal Site Evaluation (RSE) Report for Northeast Church Rock-Quivira Site Evaluation for Church Rock (CR-1) and (CR-1E) Mine Sites.

Rodgers, Larry, Ed. 2004. Chapter Images: 2004 Profiles of 110 Navajo Nation Chapters. Navajo Nation Division of Community Development, in conjunction with LSR Innovations, Window Rock, AZ.

Science Applications Inc. (SAI), 1980, Groundwater Discharge Plan for United Nuclear Corporation, N.E. Church Rock Mill, Vol. 1, Albuquerque, New Mexico.

Sergent, Hauskins & Beckwith Engineers, Inc. (SH&B), 1974, Preliminary Geotechnical Investigation Report, Tailings Dam - Church Rock Uranium Mill, United Nuclear Corporation, Church Rock, New Mexico, SHB Job No.21 E74-1072.

______, 1976a, Report of Additional Geotechnical Studies, Church Rock Uranium Tailings Dam, Church Rock, New Mexico, SHB Job No. E75-1115.

______, 1976b, Geotechnical Investigation Report, United Nuclear Corporation, Tailings Pond and Dam, Church Rock Uranium Mill, Church Rock, New Mexico, SHB Job No. E76-1013.

______, 1978, Geotechnical and Design Development Investigation Report, Tailings Disposal Systems Analysis, United Nuclear Church Rock Mil 1, Church Rock, New Mexico, SHB Job No. E78-1041, Vol. 1.

SAI and Bearpaw Geosciences, 1980. Geology of the Church Rock Area, New Mexico. Report for UNC Mining and Milling.

Spitz, Richard, 2018. Email communication to Sara Taube Regarding UNC Water Rights.

Stantec Consulting Services, Inc. (Stantec). 2017. Cleanup Verification Plan, 60 Percent, Appendix T.

———. 2018a. Work Plan for Additional Soil Characterization at Proposed Jetty Improvements, Church Rock Mill Site, Northeast Church Rock Removal Action, February 16. 156 p.

———, 2018b. Northeast Church Rock 95% Design Report, Volume 1, April 9.

———, 2018c. Brief Description of Hydrological Setting for the Northeast Church Rock Mill Site. May 7.

Stone, W.J., Lyford, F.P., Frenzel, P.F., Mizell, N.H., and Padgett, E.T., 1983. Hydrogeology and Water Resources of the San Juan Basin, New Mexico. New Mexico Bureau of Mines and Mineral Resources Hydrologic Report 6.

Strenge, D. L. and T. J. Bander, 1981, MILDOS - A Computer Program for 11 Calculating Environmental Radiation Gases from Uranium Recovery Operations, NUREG/CR - 2011/PNL-3767.

TerraSpectra Geomatics. 2017. Structures within One Mile of Abandoned Uranium Mines on the Navajo Nation accessed from Arcgis Online: http://www.arcgis.com/home/item.html?id=b44ad7ca27ca4bce9dc33480c5a7f422

Swaback Partners, PLLC. 2012. The Sustainable Journey of Beauty, A Planning Manual for Developing New Housing and Community Initiatives on the Navajo Nation. October.

United Nuclear Corporation (UNC). 1975. Applicant's Environmental Report on the Church Rock, New Mexico Uranium Mine and Mill.

———. 2015. United Nuclear Corporation NECR Status Update, dated July 2015.

———. 2017. Annual Land Use Survey Report for 2016, License No. SUA-1475, Condition No. 31. March 31.

______.2018a, Annual Land Use Report for 2017, United Nuclear Corporation, License No. SUA-1475, Condition No.31, March 27, 2017.

______. 2018b, United Nuclear Corporation, Annual ALARA Audit, dated January 2018.

United States Army Core of Engineers (USACE) 1978, Draft Environmental Statement Puerco River and Tributaries, Gallup, New Mexico, U.S. Army Corp of Engineers, Los Angeles District.

United States Census Bureau (USCB), 2016. American Fact Finder. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml

United States Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS). 2001. Soil Survey of McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties.

———, 2018. Custom Soil Resource Report. Web soil survey. Soil Survey Area: Fort Defiance Area, Parts of Apache and Navajo Counties, Arizona and McKinley and San Juan Counties, New Mexico. Version 15, Sep 13, 2017. Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties. Version 12, Sep 13, 2017.

United States Department of Agriculture National Agriculture Imagery Program (USDA NAIP). 2016. Imagery for McKinley County, https://datagateway.nrcs.usda.gov/ accessed June 2016).

United States Department of the Army and City of Gallup, 2002. Project Cooperation Agreement for the construction of Little Puerco Wash Flood Control Structure, Gallup, McKinley County, New Mexico. June 25.

United States Environmental Protection Agency (USEPA): Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin on Safety, March 1974, 550/9-74-004.

United States Environmental Protection Agency (USEPA), Office of Emergency and Remedial Response, 1986. Superfund Remedial Design and Remedial Guidance. OSWER Directive 9355.0-4A. June

———.1988a. Record of Decision United Nuclear Corporation Ground Water Operable Unit McKinley County, New Mexico. September 30.

______. 1988b. Memorandum of Understanding Between Region VI of the U.S. Environmental Protection Agency and Region IV of the U.S. Nuclear Regulatory Commission for Remedial Action at the UNC-Churchrock Uranium Mill in McKinley County, New Mexico. August 26.

______. 1988c. Office of Air Quality Planning and Standards. Workbook for Plume Visual Impact Screening and Analysis. Research Triangle Park, NC. EPA-450/4/88/015. September 1988

______. 2004. AP-42, Compilation of Air Pollutant Emission Factors, Section 11.19.2. Crushed Stone Processing and Pulverized Material. Update to 5th Edition. https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

______. 2006a. AP-42, Compilation of Air Pollutant Emission Factors, Section 13.2.2. Unpaved Roads. Update to 5th Edition. https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf

______. 2006b. AP-42, Compilation of Air Pollutant Emission Factors, Section 13.2.4. Aggregate Handling and Storage Piles. Update to 5th Edition. https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0204.pdf

______. 2006c. AP-42, Compilation of Air Pollutant Emission Factors, Section 13.2.5. Industrial Wind Erosion. Update to 5th Edition. https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0205.pdf

______. 2006d. AP-42, Compilation of Air Pollutant Emission Factors, Section 7.1. Organic Liquid Storage Tanks. Update to 5th Edition. https://www3.epa.gov/ttnchie1/ap42/ch07/final/c07s01.pdf

______. 2006e. AP-42, Compilation of Air Pollutant Emission Factors, Section 5.2. Transportation and Marketing of Petroleum Liquids. Update to 5th Edition. https://www3.epa.gov/ttnchie1/ap42/ch05/final/c05s02.pdf

———. 2007. Request for a Time-Critical Removal Action at the Northeast Church Rock Residential Site, McKinley County, New Mexico, Navajo Nation Indian Reservation. April.

———, 2008, Health and Environmental Impacts of Uranium Contamination in the Navajo Nation Five-Year Plan, June, 2008, https://www.epa.gov/sites/production/files/2016-06/documents/nn-5-year-plan-june-12.pdf

———. 2009. Engineering Evaluation/Cost Analysis, Northeast Church Rock (NECR) Mine Site, Gallup, New Mexico, May 30th, 85 p.

______. 2011a. Action Memorandum: Request for a Non-Time Critical Removal Action at the Northeast Church Rock Mine Site, McKinley County, New Mexico, Pinedale Chapter of the Navajo Nation. EPA Regions VI and IX, September 29.

———. 2011b. Action Memorandum: Request for a Time-Critical Removal Action at the Northeast Church Rock Site Drainage East of Red Water Pond Road (Step Out Area #2), McKinley County, New Mexico, Cayote Canyon Chapter of the Navajo Nation and Indian Reservation. September 26, 24 p.

———, 2013a. Record of Decision United Nuclear Corporation Site McKinley County, New Mexico, Surface Soil Operable Unit OU02. USEPA Region 6, March 29.

———, 2013b. Fourth Five-Year Review Report for United Nuclear Corporation Superfund Site, Church Rock, McKinley County, New Mexico.

———. 2014, Objective 4: Cleanup of the Northeast Church Rock Mine Site and Additional High Priority Abandoned Uranium Mines, Federal Actions to Address Impacts of Uranium Contamination in the Navajo Nation, 40 p. https://www.epa.gov/sites/production/files/2016-06/documents/nn-five-year-plan-2014.pdf

———, 2014b, Federal Actions to Address Impacts of Uranium Contamination in the Navajo Nation, San Francisco, CA: US Environmental Protection Agency, 40 p.

______. 2015. Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery. April 27.

______. 2016. USEPA Approval with Modifications and Comments on November 23, 2016 Final Design Work Plan and Environmental Data Gap Report for the Northeast Church Rock Site Removal Action and the United Nuclear Corporation Site Remedial Action, Letter to R. Blickwedel of GE, February 16, 2016, 2 p.

———. 2018a, Acceptance of United Nuclear Corporation (UNC) Mill Site and Northeast Church Rock (NECR) Design with Comments, May 25th, Letter from S. Jacobs to R. Blickwedel, 7 p.

———, 2018b. Section 404 of the Clean Water Act: How Wetlands are Defined and Identified. https://www.epa.gov/cwa-404/section-404-clean-water-act-how-wetlands-are-defined-and-identified

United States Fish and Wildlife Service, 2008. Birds of Conservation Concern 2008. United States Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 p.

———, Endangered Species Act of 1973. 16 U.S.C. Sections 1531-1544.

United States Fish and Wildlife Services, 2017. National Wetlands Inventory, Surface Waters and Wetlands GIS Mapper. https://www.fws.gov/wetlands/data/Mapper.html

United States Geological Survey (USGS), 2004. *National Uranium Resource Evaluation (NURE) Hydrogeochemical and Stream Sediment Reconnaissance Data.* U.S. Geological Survey, Denver, CO.

———, 2007-2014, National Hydrography Dataset. http://nhd.usgs.gov. Accessed May 7, 2018.

———. 2011. United States Geological Survey, Gap Analysis Program (GAP). National Land Cover, Version 2. August.

———, 2016. USGS 09395500 Puerco River at Gallup, New Mexico. http://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=09395500

———, 2017. Volcano Hazards Program, U.S. Volcanoes and Current Activity Alerts. https://volcanoes.usgs.gove/index.html. Accessed October 23.

———, 2018. National Gap Analysis Project (GAP). Reston, Virginia, USA. http://www.gapanalysis.usgs.gov (Accessed: April 19, 2018)

University of New Mexico (UNM). 2018. Official Enrollment Reports. Available at http://oia.unm.edu/facts-and-figures/official-enrollment-reports.html

Van Metre, P.C. and J.R. Gray (Van Metre and Gray). 1992. Effects of uranium mining discharge on water quality in the Puerco River basin, Arizona and New Mexico.: Hydrological Sciences Journal, vol 37, no. 5, pp. 463-480.

Van Metre, P.C., L. Wirt, T.J. Lopes, and S.A. Ferguson .1997. Effects of Uranium-Mining Releases on Ground-Water Quality in the Puerco River Basin, Arizona and New Mexico. U.S. Geological Survey Water-Supply Paper 2476.

Van Valkenburg, Richard F. 1974. "Navajo Sacred Places'" *In Navajo Indians III*, Edited by Clyde C Kluckhohn. Garland Publishing, New York.

Volvo Construction Equipment North America, Inc. (Volvo), 2007. Volvo Articulated Hauler A35D, A40D. Reference no. 21 B 100 1925.

Weston 2009. Navajo Abandoned Uranium Mine Site Screen Report: NE Churchrock Quivira Mines (No. 2), Contract: W91238-06-F-0083, May 2009.

Weston 2010, Expanded Site Screening North East Church Rock—Quivira Mine, Navaho Nation, New Mexico, USEPA Contract No.: 91238-06-F-0083, April 2010.

CHAPTER 10. LIST OF PREPARERS

UNITED NUCLEAR CORPORATION CONTRIBUTORS

Roy Blickwedel, PG: Remedial Project Manager
BS, Geology; MS, Geology
Years of Experience: 40

INTERA INCORPORATED

Peter Castiglia, PG: SER Project Manager
BS, Geology; MS, Earth and Planetary Sciences
Years of Experience: 19

Kelsey Smuczynski: Land Use, GIS and Graphics, Environmental Justice, Visual and Scenic Resources
BS, Geography; BA, Geology
Years of Experience: 3

Sara Taube: Geology, Water Resources, Socioeconomics
BS, Earth and Environmental Science; MS, Environmental Sciences
Years of Experience: 8

Benjing Sun, PhD: Meteorology, Climatology, and Air Quality
BS, Theoretical Physics; MS, Environmental Sciences; PhD, Atmospheric/Environmental Chemistry
Years of Experience: 34

Erick Fox: GIS and Graphics, Noise, Land Use
BA, Urban Studies; MS, GIS and Remote Sensing
Years of Experience: 4

Mahmudur Rahman, PhD: Public and Occupational Health
BS, Mechanical Engineering; MS, Environmental Science; PhD, Environmental Science
Years of Experience: 18

Sara Lindberg: Public and Occupational Health
BA, Chemistry
Years of Experience: 32

Ed Hughes, PG: Waste Management
BS, Geology
Years of Experience: 23

Joanna Stakutis: Technical Editing
BA, English Writing and Rhetoric; MA, Secondary English
Years of Experience: 16

Lydia Wassan: Editing, technical editing, formatting
BA, English; MFA (in progress), Creative Writing
Years of Experience: 4

DAISY ENVIRONMENTAL LLC

Ellen Dietrich: Technical Reviewer
BA, Anthropology; graduate work in Soil Science
Years of Experience: 43

CEDAR CREEK, INC

Robert Murphy: CPSS: Soil Resources
BS, Environmental Soil Science
Years of Experience: 5

Jesse Dillon: Ecological Resources
BS, Rangeland Ecosystem Science
Years of experience: 12

TRINITY CONSULTANTS

Andrew Glen, PhD: Meteorology, Climatology and Air Quality
BS, Meteorology; MS, Atmospheric Science; PhD, Atmospheric Science
Years of Experience: 14

Rob Liles: Meteorology, Climatology, and Air Quality
BS, Meteorology; MS, Meteorology
Years of Experience: 30

Chris Scullion: Noise Impacts
BS, Engineering Science, Civil Engineering
Years of Experience: 14

Jafar Al-Khalaf: Noise Impacts
BS, Chemical Engineering
Years of Experience: 3

DINÉTAHDÓÓ CULTURAL RESOURCES MANAGEMENT

Jeremy Begay: Cultural Resources
BS, Anthropology
Years of Experience: 10

STANTEC

Jeff Coleman, PE: Transportation Impacts
BS, Chemical Engineering; MS, Civil Engineering
Years of Experience: 25