DOE-EM/GJ3101

Moab UMTRA Project
Annual Site Environmental Report for Calendar Year 2022

Revision 0

September 2023

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number 89303322DEM000073
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Moab UMTRA Project
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Revision 0

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Revision History

Revision	Date	Description
0	September 2023	Initial issue.

Contents

Figures

Tables

Acronyms and Abbreviations

AARST	American Association of Radon Scientists and Technologists
AEA	Atomic Energy Act
ALARA	As Low As Reasonably Achievable
ASER	Annual Site Environmental Report
ASL	Analytical Service Level
ASME	American Society of Mechanical Engineers
Bgs	below ground surface
Bkgd	background
BLM	Bureau of Land Management
CA	Contamination Area
CAA	Clean Air Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DNR	Department of Natural Resources
DOE	U.S. Department of Energy
DOECAP	Department of Energy Consolidated Audit Program
DOE O	DOE Order
DOT	Department of Transportation
EDE	Effective Dose Equivalent
EISA	Energy Independence and Security Act
EM	Environmental Management
EMS	Environmental Management System
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FFCA	Federal Facilities Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
ft	feet
IA	interim action
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
km	kilometers
lb	pounds
LL	Lessons Learned
MBTA	Migratory Bird Treaty Act
MEI	Maximally Exposed Individual
mg/L	milligrams per liter
MOA	memorandum of agreement
MOU	memorandum of understanding
mrem	millirem
mSv	millisievert
N	nitrogen
N/A	not applicable
NELAP	National Environmental Laboratory Accreditation Program
NEPA	National Environmental Policy Act

NESHAP	National Emissions Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NQA	Nuclear Quality Assurance
NRPP	National Radon Proficiency Program
NS	not sampled
ORP	Oxidation-Reduction Potential
pCi/L	picocuries per liter
QA	Quality Assurance
QAP	Quality Assurance Program
RAC	Remedial Action Contractor
RCRA	Resource Conservation and Recovery Act
REM	Roentgen Equivalent Man
RICR	Remote Independent Conformance Review
RRM	Residual Radioactive Material
RRR	Rim to Rim Restoration
SDWA	Safe Drinking Water Act
SME	Subject Matter Expert
SR	State Route
Sv	Sievert
SWPPP	Stormwater Pollution Prevention Plan
TAC	Technical Assistance Contractor
TED	Total Effective Dose
TLD	Thermoluminescent Dosimeter
TSCA	Toxic Substances Control Act
U	Uranium
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act
UPDES	Utah Pollutant Discharge Elimination System
US-191	U.S. Highway 191
USC	United States Code
USGS	United States Geological Survey
yr	year

Executive Summary

The Annual Site Environmental Report (ASER) serves as the principal document for communicating environmental protection performance information to the public. It is also the primary mechanism for documenting compliance with U.S. Department of Energy's (DOE's) requirements for radiation protection of the public and environment at its sites.

The scope of the UMTRA Project is to relocate uranium mill tailings and other contaminated materials from a former uranium-ore processing facility and from off-site properties known as vicinity properties in Moab, Utah, to an engineered disposal cell constructed near Crescent Junction, UT.

This ASER presents information pertaining to environmental activities conducted on the DOE Moab Uranium Mill Tailings Remedial Action (UMTRA) Project during calendar year 2022. This report includes Project activities conducted at the Moab site located near Moab, Utah, and the Crescent Junction, Utah, disposal site, located approximately 30 miles north of the Moab site.

The Project has six major environmental programs that pertain to this ASER including: Environmental Compliance, an Environmental Management System, Environmental Radiological Protection Program and Dose Assessment, Environmental Non-Radiological programs, Groundwater, and Quality Assurance (QA). Brief descriptions of these programs are provided below.

Environmental Compliance Program
The Project must operate in compliance with various federal environmental statutes, some of which are enforced at the state level through permits. During 2022, the Project remained in compliance with all regulations and permits, and there were no notices of violation. Section 2.0, Compliance Summary, addresses principle regulatory requirements and their implementation status on the Project.

Environmental Management System
Per DOE Order (O) 436.1, DOE sites must use an International Organization for Standardization (ISO) 14001 conforming Environmental Management System (EMS) as a platform to implement programs with objectives that contribute to sustainability goals. The Project's EMS is a structured process for reducing the environmental consequences of Project activities, and to maximize beneficial use of finite resources and minimize wastes. The Project's EMS integrates training and awareness of key environmental aspects, objectives and impacts into the core functions of the contractor's Integrated Safety Management System (ISMS) to ensure continuous improvement. Section 3.0 addresses the EMS for the Project.

Environmental Radiological Protection Program and Dose Assessment
The Project monitors radiological emissions and radiation dose rates to ensure DOE activities are protective of the public and the environment. The environmental monitoring network consists of on-site and off-site monitoring locations. The Project monitors concentrations of radon gas and selected airborne radioparticulates, as well as the radiation dose from direct gamma radiation. Samples for radon and radioparticulates in 2022 were analyzed quarterly from up to 28 locations between the Moab and Crescent Junction sites. The total radiation dose to the public did not exceed the DOE Order 458.1 dose limits from any radiological releases or direct gamma

radiation in 2022. Section 4.0 addresses the population dose and dose to the maximum exposed individual (MEI).

Environmental Non-radiological Program Information
Non-radiological environmental programs includes stormwater, fugitive dust, oil storage, and meteorological monitoring programs. The Moab site also has a Revegetation and Weed Control Program, which aims to stabilize and improve soil conditions, revegetate previously remediated areas with resilient, native vegetation, and control common and noxious weed species. Fire Protection Management and Planning is also covered. Section 5.0 addresses the Environmental Non-radiological Program Information.

Groundwater Program
The Groundwater Program at the Moab site is designed to limit ecological risk from contaminated groundwater discharging to the Colorado River. River protection is accomplished through a multifaceted approach. An interim action (IA) groundwater remediation system includes extraction of contaminant mass, primarily ammonia and uranium, near the uranium mill tailings pile and injection of fresh water closer to the river to protect critical habitat areas for endangered fish species. Groundwater and surface water monitoring measures IA system performance. During 2022, operation and monitoring of the IA system continued and no suitable habitat was formed.

The groundwater program continues to develop a final Groundwater Compliance Action Plan to determine a long-term strategy. Section 6.0 addresses the Groundwater Program.

Quality Assurance Program
The Project ensures the quality of its environmental data through implementation of contractor Quality Assurance (QA) Plans, which include validation of data collection and sample analysis. Section 7.0 addresses the Moab Site QA Program.

Key Activities in 2022
The Project shipped 976,741 tons of residual radioactive material (RRM) from the Moab site to the Crescent Junction disposal site during 2022. The cumulative total through 2022 was 13,170,009 tons or approximately 82% of the tailings pile, originally estimated at approximately 16 million tons total.

Document Availability
This document may be viewed in its entirety on the DOE Moab Project website at *www.energy.gov/em/moab/moab-umtra-homepage* and in the public reading room in the Grand County Public Library in Moab. Hard copies may be obtained by contacting the Acting Moab Federal Cleanup Director at (970) 257-2161 or at the address below.

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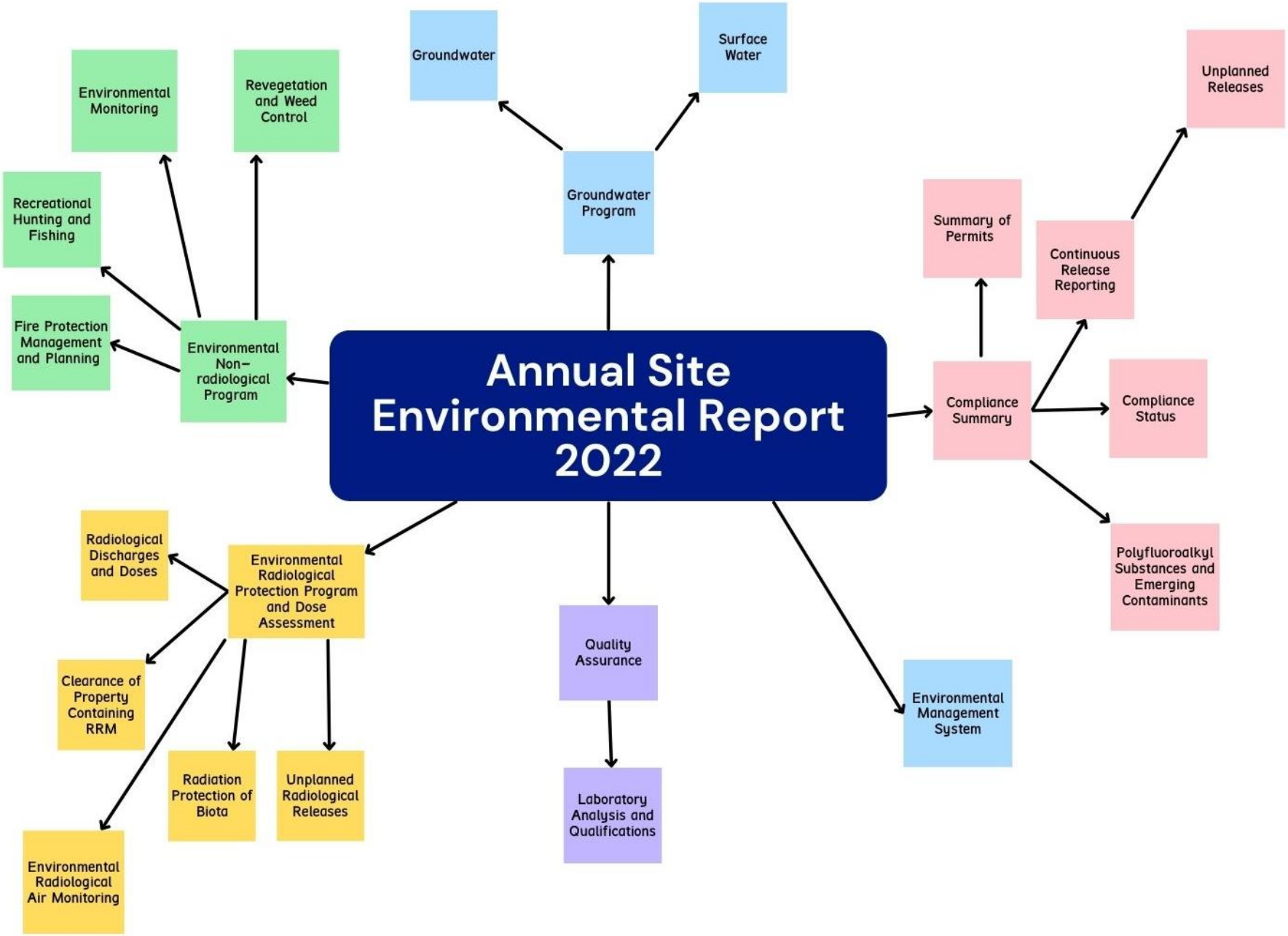
Comments or questions regarding this document may also be directed to the Project at (800) 637-4575. Members of the public who wish to comment on this document or who have questions are encouraged to contact DOE at the above phone number or by email at *publicaffairs@moabem.doe.gov.*


Annual Site Environmental Report 2022
Groundwater
Surface Water
Groundwater Program
Environmental Monitoring
Revegetation and Weed Control
Recreational Hunting and Fishing
Fire Protection Management and Planning
Environmental Non–radiological Program
Summary of Permits
Continuous Release Reporting
Unplanned Releases
Compliance Summary
Compliance Status
Polyfluoroalkyl Substances and Emerging Contaminants
Radiological Discharges and Doses
Environmental Radiological Protection Program and Dose Assessment
Clearance of Property Containing RRM
Radiation Protection of Biota
Unplanned Radiological Releases
Environmental Radiological Air Monitoring
Quality Assurance
Laboratory Analysis and Qualifications
Environmental Management System

1.0 Introduction

1.1 Site Locations

The Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site is located about three miles northwest of Moab in Grand County, Utah (Figure 1). The 480 -acre site is bordered on the north and west by sandstone cliffs. U.S. Highway 191 (US-191) parallels the northern site boundary, and State Route 279 transects the western portion of the property. Arches National Park has a common property boundary with the Moab site north of US-191. The Colorado River forms the eastern boundary. The Moab Wash, an ephemeral stream, runs northwest to southeast through the site and joins the Colorado River. The Scott M. Matheson Wetlands Preserve lies directly across the river from the site. Figure 2 shows Moab site features.

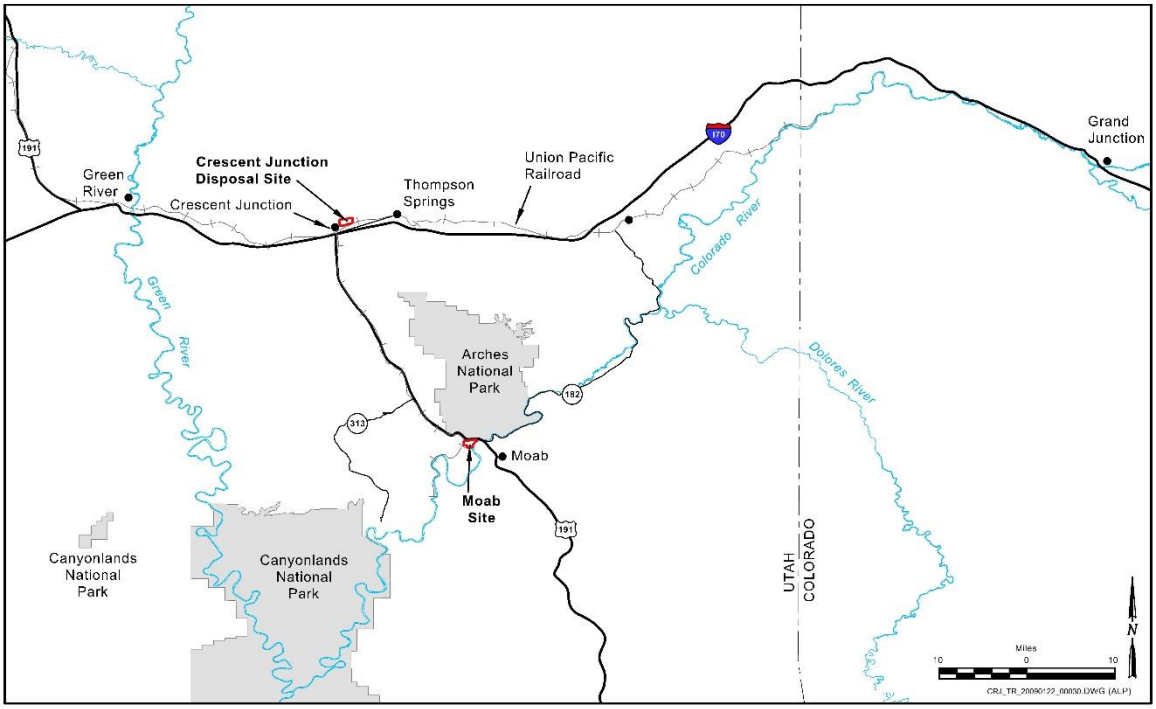


Figure 1. Location of Moab and Crescent Junction Sites

The Crescent Junction disposal site is also located in Grand County, northeast of the junction of Interstate 70 and US-191, approximately 30 miles north of the Moab site (Figure 1). It is the location for disposal of the Moab site RRM. Through a series of temporary withdrawals of public domain land and a permanent land transfer by the Department of the Interior, DOE currently owns 500 acres of land and has another 936 acres in a 20-year withdrawal (beginning in 2009) near Crescent Junction for the disposal cell and surrounding support areas. Figure 3 shows Crescent Junction site features.

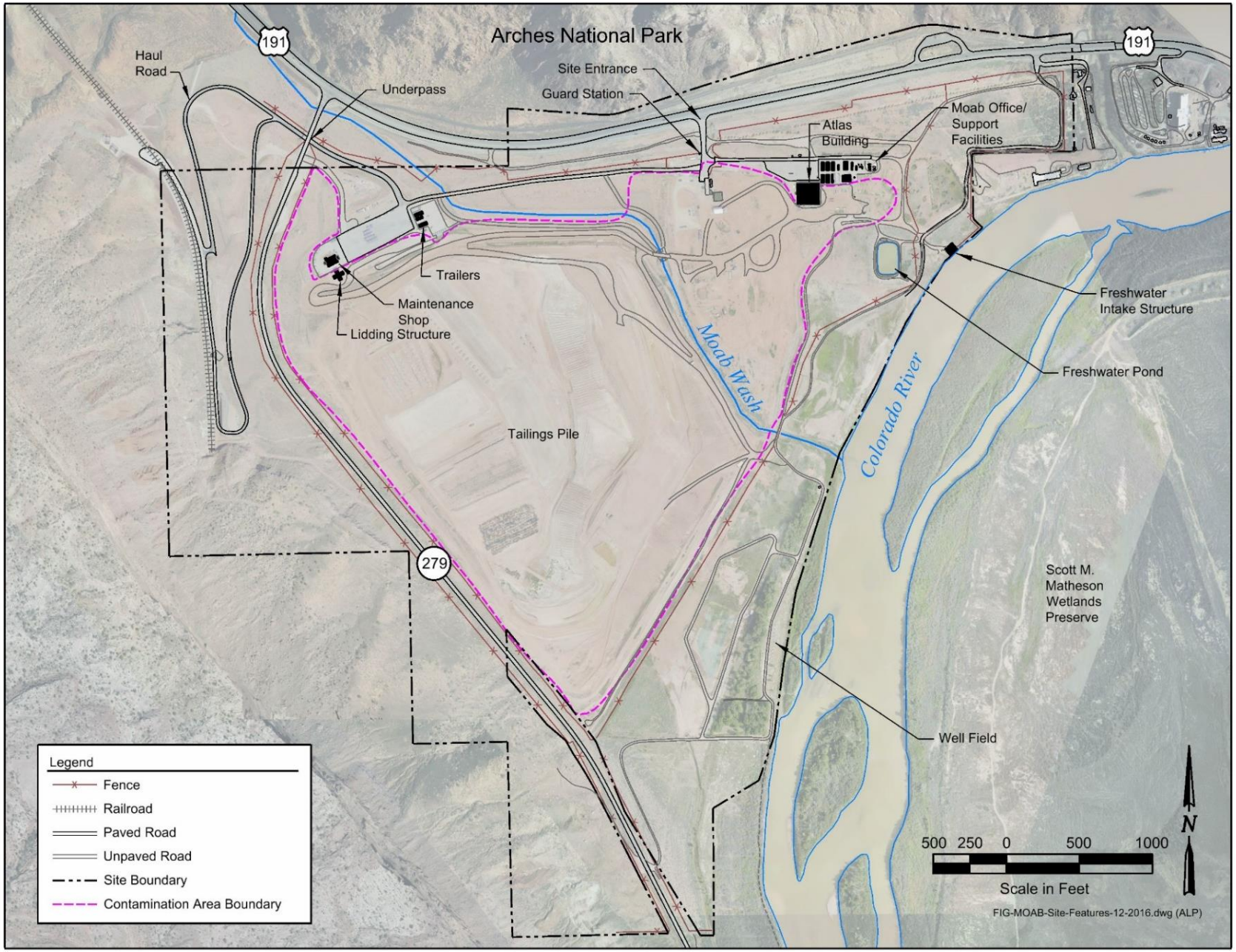


Figure 2. Moab Site Features

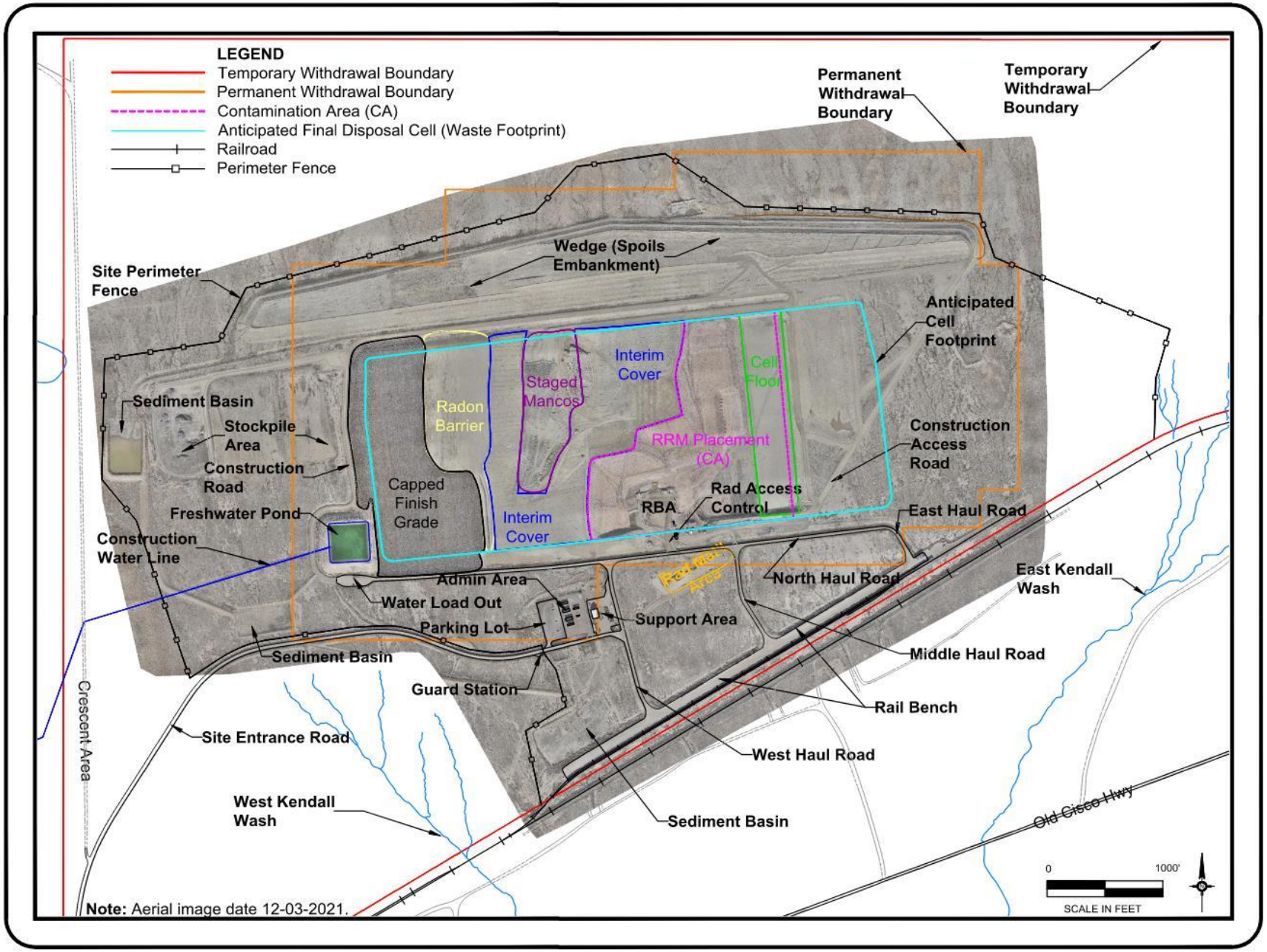


Figure 3. Crescent Junction Site Features

1.2 Site History

The Moab mill operated under various private owners from 1956 through 1984. The tailings created by the milling operations were pumped to an unlined impoundment in the western portion of the property. The tailings accumulated over time, forming a pile up to 90 feet thick. The eastern toe of the pile lies 750 feet from the Colorado River. When processing operations ceased, an estimated 16 million tons (12 million cubic yards) of residual radioactive material (RRM) were present in the pile, which occupied about 130 acres at the site. An interim cover was placed on the pile in 1995.

Congress enacted the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 (Public Law 106-398), and in October 2001, ownership and cleanup responsibility for the Moab site were transferred from the Atlas Minerals Corporation to the DOE. The Project is managed by the DOE Office of Environmental Management (EM) located in Grand Junction, Colorado (see Figure 1). The legislation stipulated that the Moab site undergo remediation as a Title I site under Title 42 United States Code Section 7901 (42 USC 7901), the Uranium Mill Tailings Radiation Control Act (UMTRCA).

In July 2005, DOE published the *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement* (FEIS) (DOE/EIS-0355). The FEIS presented the preferred remediation alternatives. In September 2005, DOE issued the *Record of Decision for the Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah* (6450-01-P), which detailed the selection of the preferred alternatives and basis for that decision. The first phase of the disposal cell was constructed in 2008; RRM shipments to the cell began in April 2009.

1.3 Project Mission

The Project's mission is to safely relocate uranium mill tailings and other process-related wastes, collectively known as residual radioactive material (RRM), from the former uranium ore-processing facility (mill site), and off-site contaminated properties known as vicinity properties in Moab, to an engineered disposal cell constructed near Crescent Junction. The RRM is primarily transported by rail. The mission also includes active remediation of contaminated groundwater at the Moab site.

1.4 Primary Operations and Project Activities

Primary operations and Project activities at the sites include:

- Excavating and conditioning RRM at the Moab site.
- Transporting RRM to the Crescent Junction disposal cell by rail.
- Excavating the Crescent Junction disposal cell.
- Placing and compacting RRM from the Moab site and vicinity properties in the cell.
- Placing interim and final cell cover layers.
- Operating an Interim Action (IA) groundwater remediation system at the Moab site, including groundwater extraction and freshwater injection.
- Monitoring contaminants of concern in air, soil, groundwater, and surface water.
- Revegetating and controlling weeds in previously remediated areas at the Moab site.

Key Activities in 2022
The Project shipped 976,741 tons of residual radioactive material (RRM) from the Moab site to the Crescent Junction disposal site during 2022. The cumulative total through 2022 was 13,170,009 tons or approximately 82% of the tailings pile, originally estimated at approximately 16 million tons total.

In October 2022, a contract change transferred scope of work from the Technical Assistance Contractor (TAC) to the Remedial Action Contractor (RAC), including environmental air monitoring, environmental compliance sustainability, meteorological monitoring, groundwater, and revegetation. This report was previously under TAC scope and was transferred to the RAC.

The fourth, and possibly final, cell excavation began in November of 2022 and is estimated to be completed in 2023 (see Figure 3 for "Anticipated cell footprint").

1.5 Environmental Setting

Meteorology
At the Moab site, the 2022 average annual temperature was approximately 59ºF. January was the coldest month, with the lowest temperature recorded being 12.3ºF. July was the warmest month, the highest temperature being 107.1ºF. The total rainfall in 2022 was approximately 7.0 inches. The Moab site heated rain gauge experienced data loss in May-June and September-October. Data from an onsite manual rain gauge was used to fill in the data gaps.

At the Crescent Junction site, the 2022 average annual temperature was approximately 59ºF. January was the coldest month, with the lowest temperature recorded for the month being 3.9ºF. July was the warmest month with the highest temperature being 101.6ºF. The total rainfall in 2022 was approximately 8.3 inches.

Geology and Hydrology
The primary hydrogeologic unit present at the Moab site consists of unconsolidated alluvium on the valley floor flanked by consolidated sandstones and shale on the canyon walls. The Moab site is susceptible to flooding from the Colorado River during runoff of spring snowmelt in the Rocky Mountains and from thunderstorms in the drainage basin of the Moab Wash.

The Colorado River generally reaches a maximum flow between late May and early June. Groundwater underlying the site moves from northwest to southeast, discharging to the Colorado River during base flows.

The Crescent Junction site is on a gently south-sloping surface of unconsolidated alluvium underlain by consolidated Mancos Shale. The site lies at the base of the Book Cliffs to the north. Surface drainage flows to ephemeral washes located to the south of the site that ultimately drain to the Green River. Groundwater underlying the Crescent Junction site occurs intermittently in sand lenses in the alluvium and in fractures in the Mancos Shale.

1.6 Area Demographics

Moab is the Grand County government seat and the principal city of southeastern Utah, with a population of 5,317 (2022 estimate, U.S. Census Bureau, *https://data.census.gov*). In addition to

Moab, the communities of Crescent Junction and Thompson Springs, also in Grand County, are affected by relocation of RRM to the Crescent Junction site.

The population of Grand County is 9,669 (2022 estimate, U.S. Census Bureau). Grand County's major economic base is tourism. Southeastern Utah has the nation's largest concentration of national and state parks, monuments, and recreation areas.

2.0 Compliance Summary

UMTRCA required the promulgation of cleanup standards now codified by the U.S. Environmental Protection Agency (EPA) at Title 40 Code of Federal Regulation Part 192 (40 CFR 192), "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," and assigned the U.S. Nuclear Regulatory Commission to oversee the cleanup and issue licenses for the completed disposal cells.

RRM at the Moab site contains contaminants in concentrations that could be hazardous to the environment and public health and that exceed EPA standards. Remediation of the Moab site and disposal at the Crescent Junction site are conducted in compliance with these standards.

RRM, specifically defined in 40 CFR 192.01, "Definitions," is "waste (which the Secretary determines to be radioactive) in the form of tailings resulting from the processing of ores for the extraction of uranium and other valuable constituents of the ores; and activities." RRM requiring cleanup at the Moab site includes uranium mill tailings, contaminated soil, debris from dismantling the mill buildings and associated structures, equipment, remnants of processing ponds, disposal trenches, and other wastes.

2.1 Compliance Status

The Project is committed to protecting the environment while conducting its mission. It operated without any notices of environmental violations during 2022. Table 1 summarizes federal and state environmental regulations and their implementation status on the Project.

2.2 Other Major Environmental Issues and Actions

Adapting to Climate Change

In September of 2022 the Moab UMTRA project released the *Moab UMTRA Project Climate Change Vulnerabilities and Resiliency Plan* (DOE-EM/GJ2193). This plan addresses how resilient the site is to climate change and environmental stresses.

The Project actively controls and monitors the water level in the Moab freshwater pond and the Crescent Junction construction water pond, reducing vulnerability during drought conditions. The *Moab UMTRA Project Flood and Drought Mitigation Plan* (DOE-EM/GJ1940) incorporates specific actions to protect the site from these natural hazards. During 2022 the site experienced continued drought conditions but in previous years the site has experienced flooding from the Colorado River. Climate change effects the timing of these flood waters and the *Project Flood and Drought Mitigation Plan* highlights specific actions that should be taken at varying water levels. Revegetation personnel continue to plant drought-tolerant native vegetation onsite.

Due to the comparatively short-term completion date for the Project, no additional climate change adaptation efforts are currently planned; however, the Project's environmental control plans are annually reviewed and revised as needed based upon changing weather conditions.

Natural Resources Conservation Programs and Projects
Although the Moab UMTRA Project did not directly participate in the White House Council on Environmental Quality (CEQ) *America the Beautiful* initiative conservation programs, many collaborative programs occurred at the Moab site promoting natural resources conservation:

- Collaborated with the Utah Division of Natural Resources to successfully control encroaching noxious weeds (i.e., tamarisk and Russian knapweed) along a shared boundary.
- Continued to participate in the Southeast Utah Riparian Partnership (SURP), a local ecological restoration group consisting of different federal, state, and local agencies, led by Rim to Rim Restoration. Under SURP, the Moab UMTRA Project applied for grants under the Watershed Restoration Initiative and was awarded herbicide and native seed for restoration.
- Continued strategic partnerships with U.S. Geological Survey (USGS), National Park Service (NPS), Utah Division of Forestry, Fire, and State Lands (DNR) and Rim to Rim Restoration to promote accomplishment of restoration goals and benefit the greater restoration community.
- Partnered with the U.S. Geological Survey (USGS) on 336 research plots in the wellfield to experiment with various treatments and seed mixes for revegetation purposes. USGS and UMTRA staff partnered to collect the second year of scientific data on the plots.
- Revegetation Manager partnered with the USGS on two presentations on revegetation challenges and successes at the Project: one to the national Society of Range Management and the other to a local ecological restoration collaboration called the Canyon Country Working Group.

2.3 Continuous Release Reporting

Not applicable to the Project.

2.4 Unplanned Releases

No unplanned radiological or non-radiological releases occurred in 2022.

2.5 Polyfluoroalkyl Substances (PFAS) and Emerging Contaminants

The contaminants of concern at the site do not include any emerging contaminants including PFAS, perfluoro octane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perchlorates, or 1,4-dioxane.

Table 1. Principle Regulatory Requirements and Status for the Moab Project

Federal or State Requirement	What it Covers	2022 Implementation Status
Environmental Restoration and Waste Management		
Resource Conservation and Recovery Act (RCRA), Federal Facilities Compliance Act (FFCA)	RCRA governs the generation, storage, handling, and disposal of hazardous wastes. RCRA gives Environmental Protection Agency (EPA) authority to control hazardous waste from "cradle to grave." In 1992, RCRA was amended by the FFCA, which required DOE to take a number of actions to manage mixed waste handled at its facilities.	All waste generated within the CA is considered RRM, the cleanup and management of which is regulated by UMTRCA, not RCRA; however, waste generated outside the CA is considered non-RRM and, therefore, can be regulated by RCRA. During 2022, no RCRA wastes were generated outside the CA. The Project maintains a Very Small Quantity Generator status.
National Environmental Policy Act (NEPA)	NEPA requires federal agencies to follow a prescribed process to anticipate impacts on the environment of proposed major federal actions and alternatives. DOE codified its implementation of NEPA in 10 CFR 1021, "National Environmental Policy Act Implementing Procedures."	NEPA reviews have been periodically conducted to ensure proposed Project activities are within the original bounds of the FEIS. During 2022, site operations were conducted in accordance with NEPA. One Supplement Analysis (for tailings volume and installation of metal art sculptures) and one Categorical Exclusion (groundwater hydroxyapatite injection) were completed in 2022.
Toxic Substance Control Act (TSCA)	TSCA was enacted to regulate the manufacturing and distribution of certain chemical substances and/or mixtures. TSCA specifically addresses the importation, use, and disposal of asbestos, polychlorinated biphenyls, radon, and lead-based paint.	All waste generated within the CA is considered RRM, the cleanup and management of which is regulated by UMTRCA, not TSCA; however, waste generated outside the CA is considered non-RRM and, therefore, can be regulated by TSCA. During 2022, no TSCA wastes were generated outside the CA.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	FIFRA governs the distribution, sale, and use of pesticides. This act categorizes pesticides as either restricted or general use.	During 2022, only three herbicides were used onsite (Milestone®, Telar® and Garlon3A®). Other herbicides are present onsite and are safely stored. All pesticides onsite are general use.

Table 1. Principle Regulatory Requirements and Status for the Moab Project (continued)

Federal or State Requirement	What it Covers	2022 Implementation Status
Radiation Protection		
DOE O 458.1 Admin Chg 4, "Radiation Protection of the Public and the Environment"	DOE O 458.1 is the key DOE order for public radiation protection. The order establishes requirements for DOE operations to protect members of the public and the environment from undue risk from radiation.	During 2022, the Project monitored radiological emissions. Project activities did not result in any dose to the public that exceeded the limits in DOE O 458.1.
DOE O 435.1, "Radioactive Waste Management"	This order was implemented to ensure all DOE radioactive waste is managed in a manner that protects workers, public health and safety, and the environment.	During 2022, the Project managed RRM in compliance with DOE O 435.1.
Atomic Energy Act of 1954 (AEA)	The AEA requires the management, processing, and utilization of radioactive materials in a manner that protects public health and the environment. UMTRCA amended the AEA and authorized the EPA to establish health and environmental standards for the disposal of uranium mill waste.	During 2022, nothing more related to AEA was implemented at the Project.
Air Quality and Protection		
Clean Air Act (CAA)	CAA establishes the requirements for facility air quality and air emissions.	The CAA is enforced at the state level through fugitive dust control plans prepared for both sites.
Utah Administrative Code (UAC) R307-205-8,"Emission Standards; Fugitive Emissions and Fugitive Dust; Tailings Piles and Ponds"	This state administrative code establishes minimum work practices and emission standards for sources of fugitive emissions and fugitive dust. Air entering the public domain must meet emission standards, for dust resulting from grading, excavating, depositing, natural erosion or other causes in association with such operation.	During 2022, EPA Method 9-certified individuals diligently monitored opacity and implemented controls outlined in the site fugitive dust control plans.

Table 1. Principle Regulatory Requirements and Status for the Moab Project (continued)

Federal or State Requirement	What it Covers	2022 Implementation Status
Air Quality and Protection		
40 CFR 61, National Emissions Standards for Hazardous Air Pollutants (NESHAP)	The CAA establishes emission standards for hazardous air pollutants associated with various industrial processes codified as NESHAP. NESHAP are stationary source standards for hazardous pollutants. Requirements are application to control radon emissions from the disposal of uranium mill tailings and apply to the final tailings disposal location after long-term stabilization of the disposal site has been completed as described in 40 CFR 61.221(a) and 40 CFR 61.223(e).	NESHAP regulations are not applicable to facilities subject to 40 CFR 192. NESHAP regulations for radon emissions do not apply during periods of active remediation.
Water Quality and Protection		
33 USC 1251, Clean Water Act (CWA) / National Pollutant Discharge Elimination System (NPDES)	Under the CWA, NPDES was designed to regulate and control pollutants from industrial wastewater and storm water discharges, both of which can have negative impacts on the quality of U.S. surface waters. The federal discharge requirements are implemented by the Utah Department of Environmental Quality (UDEQ), the Utah Pollutant Discharge Elimination System (UPDES), an equivalent state system.	As required by UPDES Storm Water General Permits (see Table 2), the Project prepared and continued to implement site storm water pollution prevention plans (SWPPP) and required inspections at each site (routine monthly and after a 0.5" or greater precipitation event). The Notice of Intents (NOI's) were renewed for 2022 with UDEQ for each site. During 2022, no discharges were noted under UPDES.
Storm Water Management and Energy Independence and Security Act (EISA)	Under Section 438 of EISA, federal agencies have requirements to reduce storm water runoff from federal development projects to protect water resources.	The Moab UMTRA Project is EISA exempt.
42 USC 300f, The Safe Drinking Water Act (SDWA)	SDWA establishes minimum drinking water standards and monitoring requirements.	The provisions of the SDWA are not directly relevant to the Project sites because neither groundwater nor surface water at or near the sites is used as a public drinking water supply. DOE did not engage in any activities that affected drinking water supply sources. Remediation wells are designated as a temporary withdrawal point. During 2022, a Temporary Change Application was received from the Utah Department of Natural Resources, Division of Water Rights (see Table 2).

Table 1. Principle Regulatory Requirements and Status for the Moab Project (continued)

Federal or State Requirement	What it Covers	2022 Implementation Status
Other Environmental Statutes		
U.S. Department of Transportations (DOT) Special Permit	Authorizes the transportation in commerce of non-DOT-specification bulk packages containing RRM from the Moab site and vicinity properties to the Crescent Junction disposal cell.	During 2022, the Project remained in compliance with the Special Permit.
Uranium Mill Tailings Radiation Control Act (UMTRCA), Floyd D. Spence Act	Title I of UMTRCA requires DOE to establish a remedial action program and authorizes DOE to stabilize, dispose of, and control RRM, including contaminated groundwater, in accordance with cleanup standards promulgated in 40 CFR 192. UMTRCA is the primary law governing site cleanup and disposal for the Project.	During 2022, the Project excavated and disposed of RRM and contaminated groundwater in compliance with 40 CFR 192.
DOE O 231.1B Admin Chg 1, "Environmental, Safety and Health Reporting"	DOE O 231.1B requires timely collection, reporting, analysis, and dissemination of data on environmental issues that could adversely affect the health, safety, and security of the public or workers, the environment, DOE operations, or DOE credibility.	This ASER summarizes Project environmental activities and protection performance during 2022.
National Historic Preservation Act (NHPA)	Memorandum of Agreements (MOAs) are in place among DOE, the Utah State Historic Preservation Office, the Utah DOT, and the Bureau of Land Management for protection of cultural and historic resources at the Project sites.	Cultural resources in Crescent Junction were surveyed. No impacts were noted during 2022.
40 CFR 112, Oil Pollution Prevention	The Project meets the criteria in 40 CFR 112 for oil storage quantities and its location near the Colorado River, the facility could reasonably be expected to discharge oil into or near the navigable waters of the United States.	The Project maintains a Spill Prevention, Control, and Countermeasures Plan (SPCC) and conducts quarterly visual inspections of oil storage containers.

Table 1. Principle Regulatory Requirements and Status for the Moab (continued)

Federal or State Requirement	What it Covers	2022 Implementation Status
Other Environmental Statutes (*continued*)		
Endangered Species Act (ESA)	The ESA prohibits activities that would jeopardize the continued existence of an endangered or threatened species or cause adverse modification to a critical habitat.	The Project reviewed work activities for potential impacts on threatened or endangered species. The Biological Opinion anticipates three age-0 Colorado pikeminnow, one age-0 humpback chub, one age-0 razorback sucker, and one age-0 bonytail could be taken annually through the completion of remediation. No known take occurred in 2022. Critical fish habitat is normally protected by interception of contaminated groundwater and injection of fresh water in wells near the Colorado River, however, no suitable habitat formed in 2022 due to below average river flow.
Executive Order (E.O.) 13751, "Safeguarding the Nation from the Impacts of Invasive Species"	E.O. 13751 calls on federal agencies to prevent the introduction, establishment, and spread of invasive species and to eradicate and control populations of invasive species that are established.	Invasive weeds are controlled with chemical, biological and mechanical methods. Section 5.2 summarizes the Project's invasive weed control efforts.
Migratory Bird Treaty Act (MBTA)	The MBTA implements various treaties and conventions among the U.S. and several other countries for the protection of migratory birds. Under the act, taking, killing, or possessing migratory birds, their body parts, nests, or eggs is unlawful.	During 2022, no endangered, threatened, or candidate species were noted on the Project sites.
DOE O 436.1, "Departmental Sustainability"	DOE O 436.1 requires all DOE sites to implement sound stewardship practices protective of the air, water, land, and other natural resources impacted by DOE operations. It also requires DOE sites to cost effectively meet or exceed compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements.	The Project developed an annual Site Sustainability Plan and continues to implement an Environmental Management System (EMS) manual that has been incorporated in contractor's Integrated Safety Management System (ISMS) to promote sound stewardship practices and to ensure compliance with this order. The *Moab UMTRA Project Climate Change Vulnerabilities and Resiliency Plan* (DOE-EM/GJ2193) was updated in Sept. 2022.

Table 1. Principle Regulatory Requirements and Status for the Moab (continued)

Federal or State Requirement	What it Covers	2022 Implementation Status
Other Environmental Statutes (*continued*)		
42 USC 11001, Emergency Planning and Community Right-to-Know Act (EPCRA)	EPCRA requires facilities with large quantities of hazardous or toxic chemicals, including petroleum products, to prepare emergency plans and report their inventories to EPA, the state, and local emergency planning groups.	The Project operated in accordance with emergency planning and annual reporting requirements and submitted Tier II Emergency and Hazardous Chemical Inventory Reports for 2022.
EO 11988, "Floodplain Management"	DOE's implementing regulations in 10 CFR 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements," identify the requirements of EO 11988 for actions that may affect floodplains. Portions of the Moab site fall within the 100-year floodplain of the Colorado River.	Activities conducted in the 100-year floodplain during 2022 were limited to seeding, mowing, irrigation, weed control, vegetative debris management and routine groundwater and surface water monitoring. None of these activities created adverse impacts or developments to the floodplain.
EO 11990, "Protection of Wetlands"	10 CFR 1022 implements the requirements of EO 11990 for actions that may affect wetlands.	Project activities performed in 2022 that could enhance jurisdictional wetlands included storm water controls, revegetation, and erosion control.

2.6 Summary of Permits

Table 2 shows the active environmental Project permits during 2022.

Table 2. Active Permits for the Moab Project

Permits	Issuing Agency	No. of Permits
US Fish & Wildlife Service; Green River Pump Station; Biological Opinion (FWS/R6; 6-UT-06-F-014)	US Fish & Wildlife Service	1
UPDES Construction General Permits: UTRC00000 1. Moab permit: UTR359185 2. Crescent Junction permit: UTR359187	State of Utah, Department of Environmental Quality, Division of Water Quality	2
Temporary Change Application (No. 01-40 t47856) to change points of diversion to support groundwater actions and a non-use application to extract water from the Colorado River	State of Utah, Department of Natural Resources, Division of Water Rights	2
Green River Pipeline Easements for accessing pump station, settling pond and pipeline.	Private Landowner (Vetere family)	2
Special Permit SP-14283 Fourth Revision for DOE to transport RRM and party status for the RAC	U.S. DOT	1
Utah Special Fuel Permit (12446321-004-SFU), required for qualified motor vehicles or bulk storage of fuel	Utah State Tax Commission	1

Table 2. Active Permits for the Moab Project (continued)

Permits	Issuing Agency	No. of Permits
Scientific Research and Collecting Permit ARCH-2021-SCI-0006 (Environmental Air Monitoring)	National Park Service	1
Asbestos Landfill Permit (MOA 021778)	State of Utah, Department of Environmental Quality, Division of Air Quality	1
Conditional Use Permit, Resolution #2006-2741	Grand County Council	1

2.7 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 FR 7629), directs federal agencies to identify and address, as appropriate, any activities that may affect minority and low-income populations. A minority has been defined as individual(s) who are members of the following population groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. A minority population has been identified where the minority population of the affected area exceeds 50 percent of the population. Low-income populations are groups with an annual income below the poverty threshold.

The *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement* (DOE/EIS-0355) addressed environment justice related to the Project. Table 3 presents the minority and low-income populations in Grand County, which is the location for both the Moab and Crescent Junction sites. Demographic information obtained from the U.S. Census Bureau was used to identify low income and minority populations within 50 miles of the Moab and the Crescent Junction sites. Table 3 uses census data from 2000 (at the time of writing of the Final Environment Impact Statement). The 2020 census data is approximate to these numbers.

Approximately 94 percent of Grand County was identified in the 2000 census as white, non-Hispanic. The Hispanic population in Grand County represents the largest minority population at 5.6%. A portion of the Uinta and Ouray Indian Reservation is located in northern Grand County and American Indian comprises the second largest minority at 4% of the population of Grand County.

Table 3 also presents the percentage of persons below the poverty line as defined by the U.S. Department of Commerce. 18 percent of Grand County was determined to be below the poverty line. The county poverty trends from 1989 through 1997 show that the percentage of the population falling below the poverty level increased by 34 percent in Grand County in this time period.

Table 3. Minority and Low-Income Populations in Grand County

Population Group	Grand County
2000 population	8,485
Percent Hispanic or Latino	5.6%
2000 population by race	8,373
White Non-Hispanic (percent)	7,861 (94%)
Black or African American (percent)	21 (0.3%)
American Indian (percent)	327 (4%)
Other (percent)	164 (2%)
Percent of people below 1997 poverty level	18%
Percent change 1989-1997	34

Source: 2000 Census

The poverty level established by the Census Bureau for 2000 for a family of four is $18,244. Assessment of the census data determined that within the 50-mile area, less than 1 percent of the population had a household income below the poverty level. One census block within 50 miles of the Crescent Junction site is reported to have greater than 50 percent minority population; this census block is approximately 20 miles north of the Crescent Junction site. One census block group north of the Crescent Junction site is reported to be below the poverty level. It is located about 25 miles north of the Crescent Junction site.

In the Final Environmental Impact Statement (FEIS), DOE applied the environmental justice guidance to determine whether there could be any disproportionately high and adverse human health or environmental impacts on minority or low-income populations. For the Crescent Junction disposal site, it was determined there is no evidence that it would expose populations at a level any higher than the general population. Although traffic in central Moab would be an adverse impact, it does not appear that minority or low-income populations would suffer disproportionately.

DOE has identified no high and adverse impacts, and no minority or low-income populations would be disproportionately affected by the implementation of the Moab or Crescent Junction sites.

3.0 Environmental Management System

The framework of the Project's Environmental Management System (EMS) is based on the "Plan-Do-Check-Act" cycle of the International Organization for Standardization (ISO) Standard 14001:2015, "Environmental Management Systems," to ensure continuous improvement. The Project's EMS is addressed in the first three core functions of Integrated Safety Management System (ISMS): define the scope of work, analyze the hazards, and develop and implement hazard controls. The ISMS includes environmental protection in the definition of safety. Once implemented, programs must be assessed, and any problems corrected to improve the effectiveness of the management system and to improve overall performance.

The EMS programs, processes, and procedures define how the DOE, as implemented by the Remedial Action Contractor (RAC), integrates environmental management controls into work

activities, and oversees execution of EMS within EM federal and contractor activities. The EMS dictates environmental and sustainability values for ensuring protection to the environment, worker, and public health, consistent with the requirements of ISO 14001:2015 and DOE Order 436.1, "Departmental Sustainability." The main objectives of the 2022 EMS helped in the following ways:

- Increased environmental performance: helped identify and reduce the environmental impacts, leading to better overall environmental performance.
- Regulatory compliance: ensured compliance with environmental regulations and avoid penalties or fines.
- Risk reduction: By identifying and mitigating environmental risks, helped the organization prevent or minimize environmental incidents or accidents.
- Resource efficiency: optimized our use of resources such as energy, water, and raw materials, leading to cost savings and reduced environmental impact.
- Improved stakeholder relations: continued demonstration of our commitment to environmental responsibility, which can enhance their reputation and relationships with stakeholders.
- Enhanced employee engagement: engage employees in environmental improvement initiatives, which can increase job satisfaction and foster a culture of environmental responsibility.
- Strategic advantage: differentiated organizations from competitors by demonstrating a commitment to sustainability and environmental responsibility, which can be a strategic advantage in the marketplace.

These objectives apply to everyone working on behalf of the DOE. All employees and subcontractors are expected to comply with environmental requirements dictated in the EMS and report environmental concerns to management. Managers promote environmental stewardship, site-wide sustainability practices, and take prompt action to address concerns.

As part of the work planning process, the Project utilizes an Environmental Aspects Checklist to consider environmental and human health impacts (adverse or beneficial) of new activities. The Project determines the likelihood of an environmental aspect that could occur and the consequences if it does, using a risk table associated with the environmental aspect's registry. The Project also determines if the environmental aspect is significant, and if aspects have or could have a significant impact on the environment, the Project, or the Project's mission. In 2022, no significant impacts occurred.

The EMS Core Team, consisting of representatives from the DOE and the RAC, met quarterly to identify and review objectives and measures to track performance, discuss EMS-related topics and brainstorm improvements.

A Sustainability Coordinator leads, develops, and implements a Site Sustainability Program in accordance with DOE O 436.1. This position maintains sustainability tracking metrics on a DOE "Sustainability Dashboard," managed by the DOE Sustainability Performance Division, and also prepares the annual Site Sustainability Plan.

3.1 Environmental Operating Experience and Performance Measurement

Sharing of lessons learned (LL) gained from site operational experience is consistent with the purpose and objectives of DOE O 210.2A, "DOE Corporate Operating Experience Program" and provide a component of continuous improvement to the EMS. LL are derived from work activities, assessments, and events, both positive and negative, which can be used to enhance or improve all aspects of operations, including environmental aspects. When lessons are learned at DOE sites, they are documented and shared so others can learn from them. The DOE LL database is reviewed weekly and applicable LL are distributed to managers for incorporation in work planning.

Key performance indicators for environmental objectives are established and environmental performance is monitored, evaluated, and measured through the sustainability dashboard and contractor assurance systems, environmental objective progress tracking, EMS Core Team meetings, and plans. These systems establish comprehensive and integrated oversight processes to ensure work performance meets applicable requirements for environment, safety, and sustainability. In addition, any opportunities to meet EM and/or Project objectives utilizing green and sustainable remediation practices are evaluated in part based upon a balance of environment, social, and economic factors for a holistic approach.

3.2 Accomplishments

Awards
The Project was the recipient of a 2022 Electronic Product Environmental Assessment Tool (EPEAT) Purchaser Award and associated Three-Star Award for the purchase of 57 EPEAT registered electronics.

For demonstrating exceptional achievements in Sustainable Acquisition, the Moab UMTRA Project achieved the Gold level for the fifth time which is also commended with the GreenBuy Superior Award.

4.0 Environmental Radiological Protection Program and Dose Assessment

4.1 Minimizing Potential Dose to the Public and the Environment

Dose Assessment
Each year an estimate is made of the potential radiation dose to the public that is attributable to Moab UMTRA Project operations during that calendar year. Estimates are calculated to confirm that no individual could have received a dose that exceeds the limits for protection of the public, as established by DOE O 458.1 "Radiation Protection of the Public and the Environment". This section provides estimates of the maximum potential dose to the public and to plants and animals (biota) from 2022 UMTRA Project activities.

2022 Highlights
As in previous years, the estimated maximum potential dose from the Moab UMTRA Project site's locations to an off-site individual was well below the DOE public dose limits specified in DOE O 458.1 (see Section 4.7.3 Radiological Air Monitoring and Results). Compared to the

public dose of radiation from natural and man-made sources (620 mrem annually total background), the Moab UMTRA Project is a very small fraction of additional radiation (<3.0 mrem).

There has been near-constant reduction in environmental annual dose from the Moab UMTRA Project as the RRM is being transported from Moab to Crescent Junction.

Total Dose from All Pathways. The 2022 total estimated dose from the Project to an off-site resident was <3.0 mrem. The DOE annual public dose limit is 100 mrem from all pathways.

Dose from the Air Pathway. Annual air emissions of radioactivity are regulated by EPA and limited to 10 mrem per year at the maximally exposed off-site receptor. The total annual dose from airborne emissions was approximately 3.0 mrem in 2022 which is well below the 10 mrem annual limit.

Dose from the Water Pathway. Dose from the surface water exposure pathway is not evaluated for the Moab UMTRA Project. The only potentially-impacted surface water is the Colorado River, which is not a source of domestic water for Moab or other nearby downstream towns or cities. Groundwater is not considered an exposure pathway because no off-site public water supplies are drawn from aquifers potentially affected by the Moab UMTRA Project.

Dose to Biota. Biota dose modeling indicates the plants and animals living on or near the Moab UMTRA Project are not being exposed to doses in excess of the DOE biota dose standard, according to the "Radiological Impacts—Wildlife and Plants" section in the FEIS Appendix A.

4.2 Radiation Sources at the Moab UMTRA Project

The contaminated material at the Moab UMTRA Project site contains low levels of radioactive materials, or residual radioactive material (RRM). This ore residue contains the radioactive decay products from the uranium chains (mainly the uranium-238 [U-238] chain) and heavy metals. In addition to the mill's low-level waste material, the tailings also contain debris from the mill site when it was dismantled.

On average, there was approximately 95% uranium extraction rate of the ore received at the Moab mill. The remaining leftover material is what makes up the mill tailings pile. The mill tailings or RRM is made up of the isotopes in Table 4 below, along with their average ratio by percentage. Samples from the tailings pile were analyzed by GEL Laboratories, an approved off-site laboratory. This study is not conducted every year. The last analysis was in 2018 but is still applicable in 2022. The ratios vary based on the quality of the ore being processed and its recovery percentage.

Table 4. Moab UMTRA Project Mill Tailing Isotopes and Composition Percentages

Moab UMTRA Mill Tailings Isotopes	Percentage of Mill Tailings Pile
Polonium-210 (Po 210)	22.00%
Radium-226 (Ra-226)	20.86%
Lead-210 (Pb-210[2])	19.70%
Thorium-227 (Th-227)	16.52%
Thorium-230 (Th-230)	12.10%
Uranium (U-Nat, U-234, U-235, U-238)	6.11%
Radium-223 (Ra-223)	1.26%
Actinium-227 (Ac-227)	0.89%
Protactinium-231 (Pa-231)	0.57%

Members of the public are routinely exposed to natural and man-made sources of ionizing radiation. In 2006, an individual living in the U.S. was estimated to receive an average annual effective dose equivalent (EDE) of about 620 mrem (6.2 mSv) (National Council on Radiation Protection and Measurements [NCRP] Report 160, 2009).

Of the typical radiation dose to a member of the public, about 310 mrem/year is from natural background sources such as cosmic radiation (from outer space) and terrestrial radiation and radon (from the subsurface; see Figure 4). The remainder is from man-made sources, such as consumer products and medical diagnostic procedures. The total annual dose to the public is 620 mrem/year.

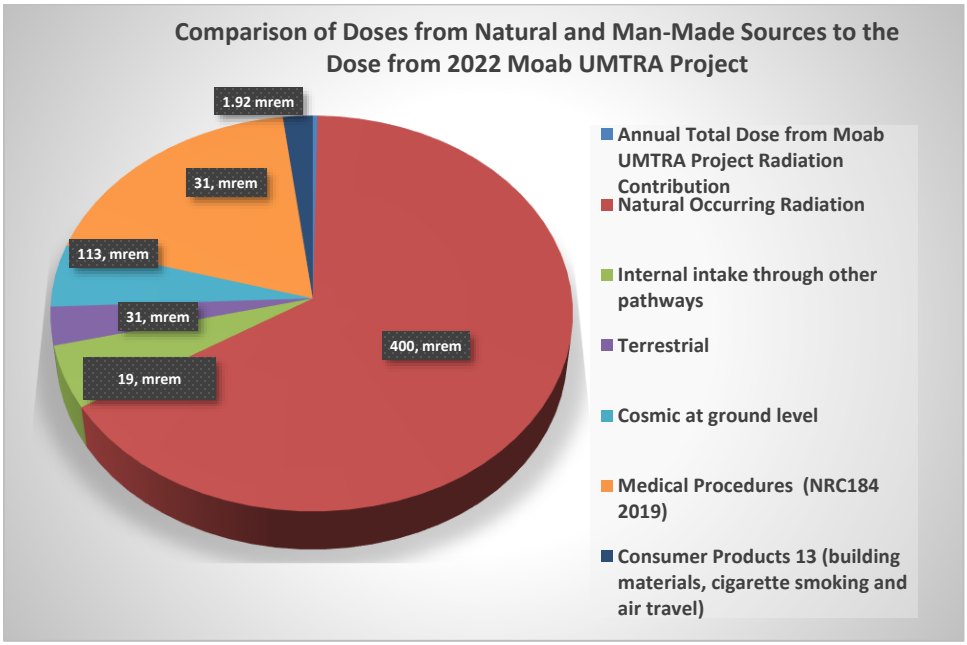


Figure 4. Comparison of Doses from Natural and Man-made Sources to the Dose from 2022 Moab UMTRA Project Effluents

Figure 4 shows the estimated (all pathway) maximum potential individual dose from the Moab UMTRA Project in 2022 compared with the average annual dose a U.S. resident receives from manmade and natural background sources. The estimated (all pathway) maximum individual dose from the Moab UMTRA Project in DOE Order 458.1 establishes requirements to protect the public and environment against undue risk from radiation. This order ensures DOE operations are conducted in a manner that limits any potential radiation exposures to ***A***s ***L***ow ***A***s ***R***easonably ***A***chievable (ALARA).

ALARA is an approach to radiation protection that advocates controlling or managing radiation exposures to as low as technical and practical considerations permit, and as far below the applicable limits of the Order as practicable. Deliberate efforts are taken at every level of the work to minimize the time of exposure, to maximize the distance from the potential source, and to utilize shielding whenever possible. ALARA radiological controls protect the worker and, as a result, also protect the public and the environment.

4.3 Exposure Pathways

An exposure pathway consists of a route for contamination to be transported by an environmental medium from a source to a receptor. Typical potential exposure pathways include inhalation of gases and particulates, ingestion of locally grown food products and game, and exposure to external penetrating radiation emitted from contaminated materials. At the Moab UMTRA Project, the exposure pathways exclude ingestion and include inhalation and exposure to external penetrating radiation.

This section presents results of the calculated radiation dose to the public from Project operations in 2022. Compliance with DOE O 458.1 may be demonstrated by calculating the dose to the maximally exposed individual (MEI), or the representative person or group from the public likely to receive the most radiation dose based on exposure pathways and parameters. See Section 4.7.3 (Radiological Air Monitoring and Results) for more details.

The Project established an MEI for each site. The maximum dose the public receives is calculated based on the MEI data and offsite monitoring locations. The DOE public dose limit is 100 millirems/year (mrem/yr) above background received through all the pathways, such as inhalation, ingestion, and direct radiation. A summary of the 2022 public radiation dose applicable to both the Moab and Crescent Junction sites compared to the DOE public dose limit is shown in Table 5.

Table 5. Moab Project 2022 Public Radiation Dose

Exposure Pathways	Annual Individual Dose			Estimated Collective Population Dose (9,669 people live within 80 km)
	Critical Receptor (MEI dose)	Comparison to DOE Standards 100 mrem/yr.	Comparison to Natural Background Radiation	
AIRBORNE RELEASE				
Total airborne Dose (measured at the ambient air ring)	1.92 mrem [1] (0.0195 mSv)	1.92%	Airborne Natural Background Radiation not measured	0.0019 person-rem (1.99E-5 person-Sv)
WATERBORNE RELEASES				
Total Waterborne Dose (effluents and natural)	N/A	N/A	N/A	N/A
Total From all Pathways	1.92 mrem (0.0195 mSv)	N/A	N/A	0.0019 person-rem (1.99E-5 person-Sv)

MEI = maximally exposed individual
Population within 80 km is based on the Grand County Utah Census Bureau July 2022 = 9,669
[1] = maximum MEI dose for the Moab UMTRA Project, which is the Moab, not Crescent Junction, site
mrem = millirem
mSv = millisievert

4.4 Clearance of Property Containing RRM

Remediation of Moab site contaminated soils (off-pile areas) not associated with the tailings pile and of vicinity properties is part of the Project scope to reduce potential health and environmental risks from historical uranium ore processing at the site. In 2022, DOE did not perform any off-pile or vicinity property remediation.

4.5 Radiation Protection of Biota

DOE O 458.1 requires protection of biota from adverse effects due to radiation and radioactive material released from DOE operations. Biota are aquatic animals and terrestrial plants and animals that may be found at the Moab and Crescent Junction sites. The chemical composition (salt and pH) of the tailings pile materials and local soil conditions limit vegetative growth. There are similar conditions at the Crescent Junction site.

The estimated radiological dose to biota from RRM at the Project sites is generally indistinguishable from the dose from naturally occurring radioactive material found in the surrounding environment. Therefore, the Project does not currently monitor the effects of radiological doses to biota and has no plan to monitor these doses.

4.6 Unplanned Radiological Releases

No unplanned radiological releases occurred in 2022.

4.7 Environmental Radiological Air Monitoring

Before tailings removal and disposal operations began, DOE initiated environmental air monitoring at and near the Moab and Crescent Junction sites. This was performed to collect baseline data and assess the potential for radiation dose to members of the public that could result from site operations. The original contamination source at the Moab site (tailings pile) is reduced by approximately 5,000 tons/train, which also reduces the exposure potential to the public.

The Project's current environmental monitoring network measures radon, direct gamma radiation, and airborne radioparticulates at on-site and off-site locations. The Moab site monitoring locations for 2022 are shown in Figures 5 and 6. The Crescent Junction site locations are shown in Figure 7, representing the environmental monitoring configuration for the first through the third quarters 2022. Figure 8 shows the Crescent Junction fourth quarter 2022 configuration, after changes to the environmental monitoring network occurred (as discussed in Section 4.7.1).

The environmental monitoring program was under the scope of the TAC for the first three quarters of 2022 (until September 30). Starting the fourth quarter of 2022 (October 1), the environmental monitoring program was transferred to RAC scope.

Environmental monitoring data are published in quarterly reports that are posted on the DOE Project website at *www.energy.gov/em/moab/moab-umtra-homepage* under Environmental Compliance and Plans. Reports are also available in the public reading room in the Grand County Library in Moab. Environmental monitoring data are also provided to the Grand County Moab Tailings Project Steering Committee liaison.

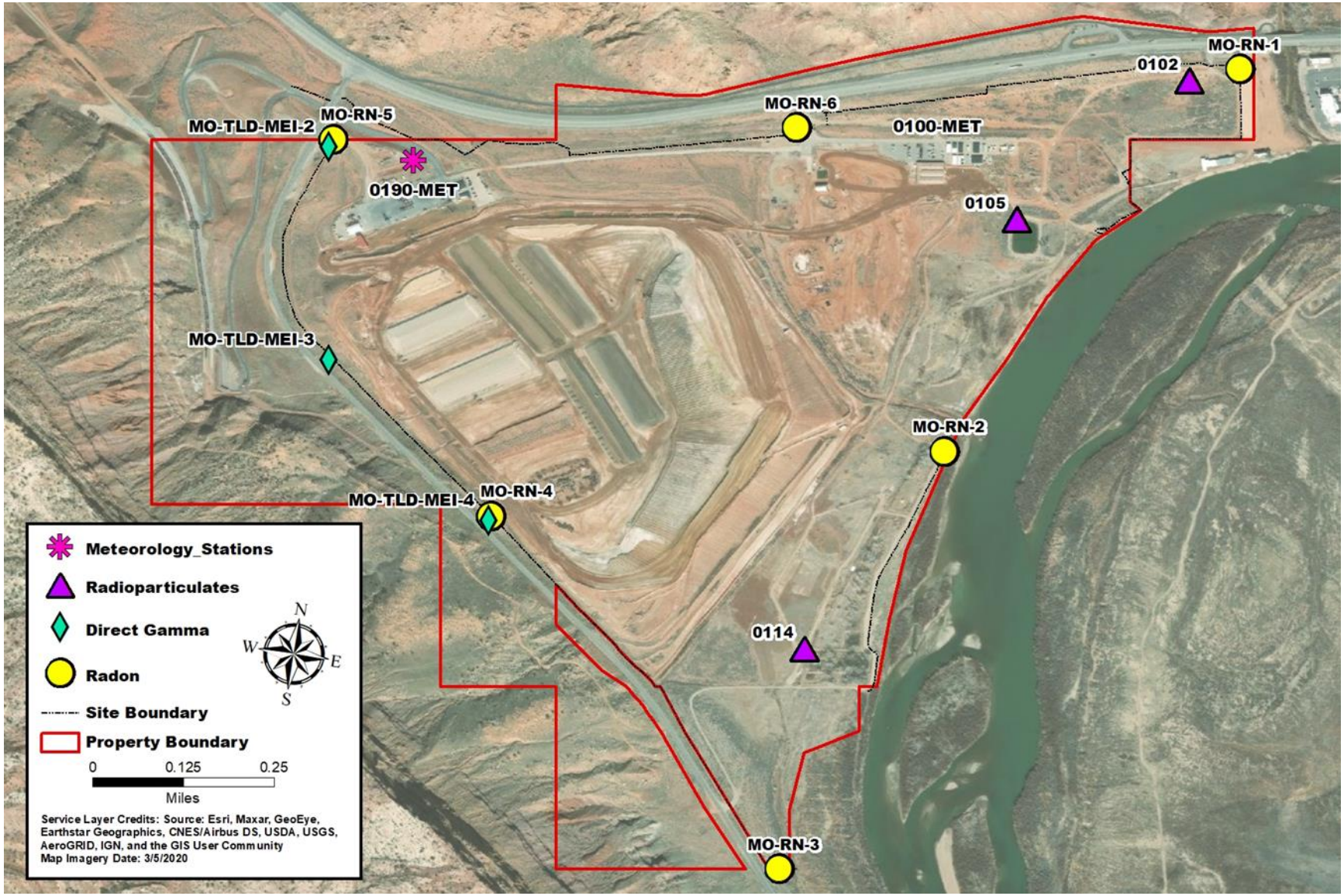


Figure 5. Moab On-site Environmental Monitoring Locations for 2022

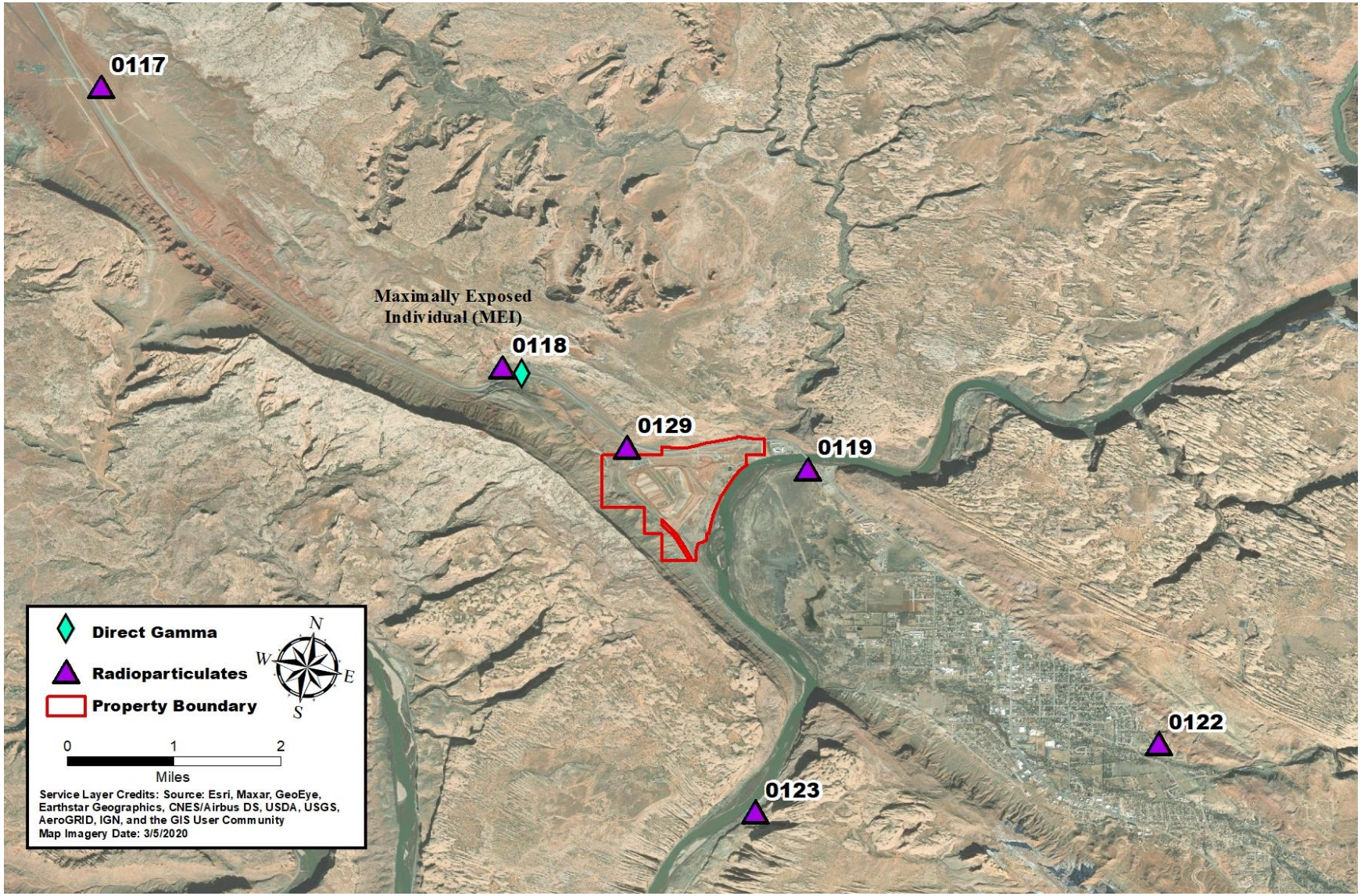


Figure 6. Moab Off-site and Maximally Exposed Individual (MEI) Environmental Monitoring Locations for 2022

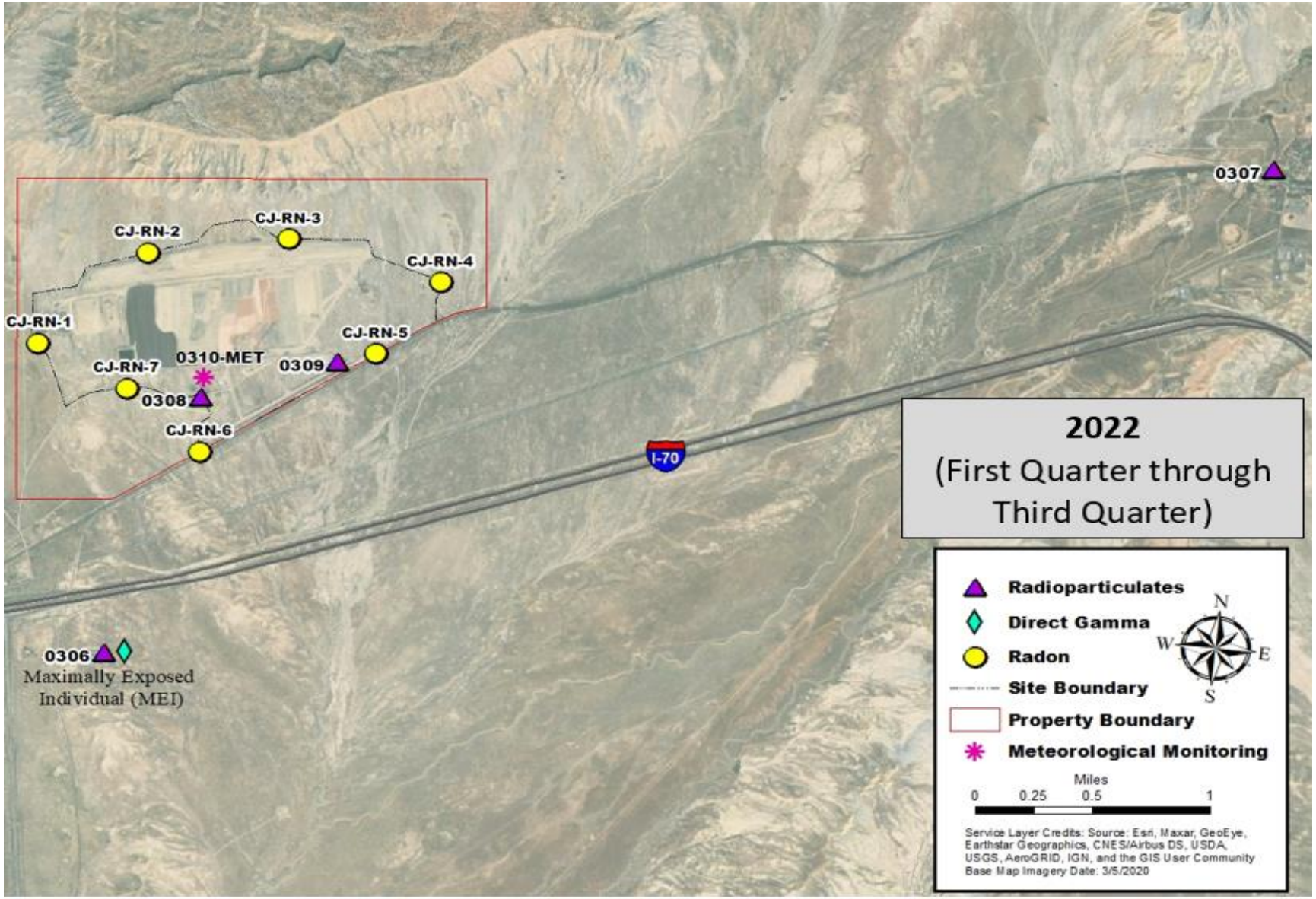


Figure 7. Crescent Junction Site Environmental Monitoring Locations for First through Third Quarters 2022 Only

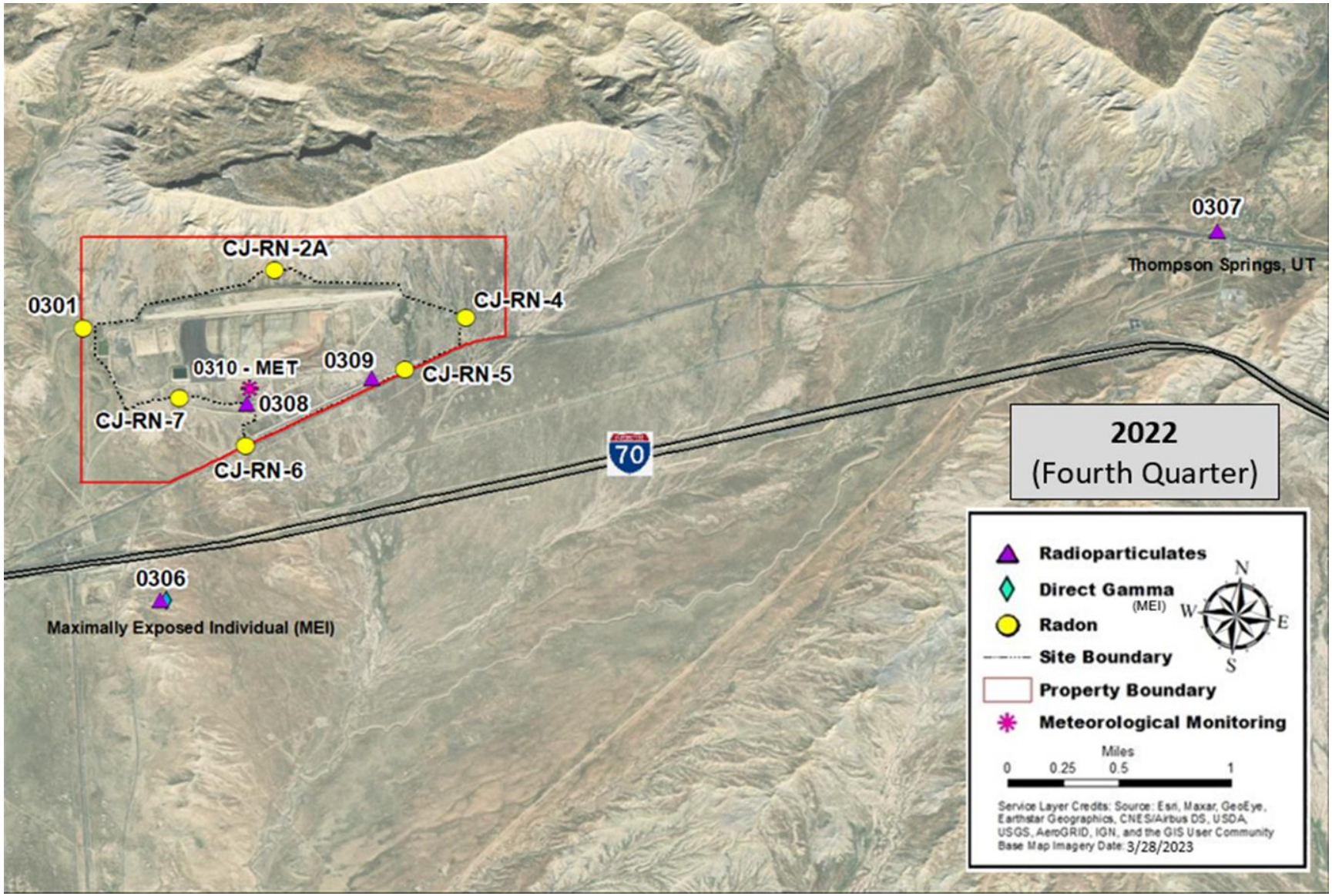


Figure 8. Crescent Junction Site Environmental Monitoring Locations for Fourth Quarter 2022 Only

4.7.1 Air Monitoring Network Changes

Beginning January 1, 2022, significant changes to monitoring station locations, names, and/or sampling methods occurred at both sites under the scope of the TAC:

- At the Moab site, in 2021 a total of 27 monitoring stations were present. In 2022, the stations were reduced to 16 total with reductions in radon and direct gamma sampling. The Maximally Exposed Individual (MEI) location was changed.
- At the Crescent Junction site, in 2021 a total of 10 monitoring stations were present. In 2022, the number of stations changed to 11 for the first 3 quarters and then 10 for the last quarter. Radon and direct gamma sampling were reduced in 2022.

The reason for the change is stated in the *Moab UMTRA Project Environmental Air Monitoring Data Quarterly Report for the Moab and Cresent Junction, Utah, Sites First Quarter (January-March 2022)* (DOE-EM/GJTAC3077) as "*to improve data quality and enhance compliance to DOE O 458.1. These changes include new air monitoring station layouts to the gamma and radon networks, updated radioparticulate dose calculations to include human breathing rate and updated dose conversion factors, updates to the Project's MEI with the addition of a representative person in Moab, updates to the background for gamma and radon at both project sites, and the addition of alarm levels.*"

Further changes to the Crescent Junction radon station network between the third and fourth quarters were also made by the TAC due to safety reasons (i.e., slips, trips, and falls while checking stations).

A summary of changes can be found in Table 6 and Figures 9-11 for the Moab site and Table 7 and Figure 12 for the Crescent Junction site.

4.7.2 Regulatory Requirements

Environmental monitoring results are used to demonstrate compliance with DOE O 458.1, Admin Chg 4, "Radiation Protection of the Public and the Environment," which states DOE radiological activities must be conducted in a manner that does not cause total effective dose (TED) to the public to exceed 100 millirems (mrem) in a year, or an equivalent dose to the lens of the eye exceeding 1,500 mrem in a year, or an equivalent dose to the skin or extremities of 5,000 mrem in a year. This excludes doses from background radiation, radon gas and its decay products in air, occupational doses, and medical exposures.

For the Project, the TED is the sum of the direct gamma radiation (minus background) and radioactive particulate material (radioparticulate) exposure. DOE O 458.1 also specifies releases of radioactive material to the atmosphere from DOE activities shall not exceed an annual average concentration of 3 picocuries per liter (pCi/L) of radon or its decay products, excluding background, at the site boundary.

Compliance with DOE O 458.1 is demonstrated by calculating the TED to the maximally exposed individual (MEI) or the representative person or group from the public likely to receive the highest radiation dose based on exposure pathways and parameters. The Project has established MEIs for each of the Moab and Crescent Junction Project sites.

Table 6. Summary of Environmental Monitoring Changes for Moab Site

MOAB SITE									
		Previous 2021 Sampling Methods				Current 2022 Sampling Methods			
Unique Location	2021 Station Name	Radon	Direct Gamma	Radio-particulate	2022 Station Name	Radon	Direct Gamma	Radio-particulate	Changes/Comments
1	0101	x	x						Removed starting 1st Quarter 2022
2	0102	x	x		MO-RN-1	x			
3	0102 RP	x	x	x	0102			x	
4	0103	x	x						Removed starting 1st Quarter 2022
5	0104	x	x						Removed starting 1st Quarter 2022
6	0105			x	0105			x	
7	0106	x	x		MO-RN-2	x			
8	0107	x	x						Removed starting 1st Quarter 2022
9	0108	x	x						Removed starting 1st Quarter 2022
10	0109	x	x		MO-RN-4 and MO-TLD-MEI-4	x	x		
11	0110	x	x		MO-TLD-MEI-3		x		
12	0111	x	x						Removed starting 1st Quarter 2022
13	0112	x	x		MO-RN-5 and MO-TLD-MEI-2	x	x		
14	0113	x	x		MO-RN-6	x			
15	0114	x	x	x	0114			x	
16	0117 [1]	x	x	x	0117			x	
17	0118	x	x	x	0118 (MEI)		x	x	
18	0119	x	x	x	0119			x	
19	0121 [1]	x	x						Removed starting 1st Quarter 2022
20	0122	x	x	x	0122			x	
21	0123	x	x	x	0123			x	
22	0124	x	x						Removed starting 1st Quarter 2022
23	0125	x	x						Removed starting 1st Quarter 2022
24	0127 [1]	x	x						Removed starting 1st Quarter 2022
25	0128	x	x						Removed starting 1st Quarter 2022
26	0129	x	x	x	0129			x	
27	MEI	x	x		See 0118 above				2021 MEI removed starting 1st Quarter 2022, moved to Arches National Park.
28					MO-RN-3	x			Added starting 1st Quarter 2022
TOTAL	**27**				**16**				

X = Yes/Presence
[1] = 0115, 0116, 0120, and 0126 removed prior to 2021
MEI = Maximally Exposed Individual

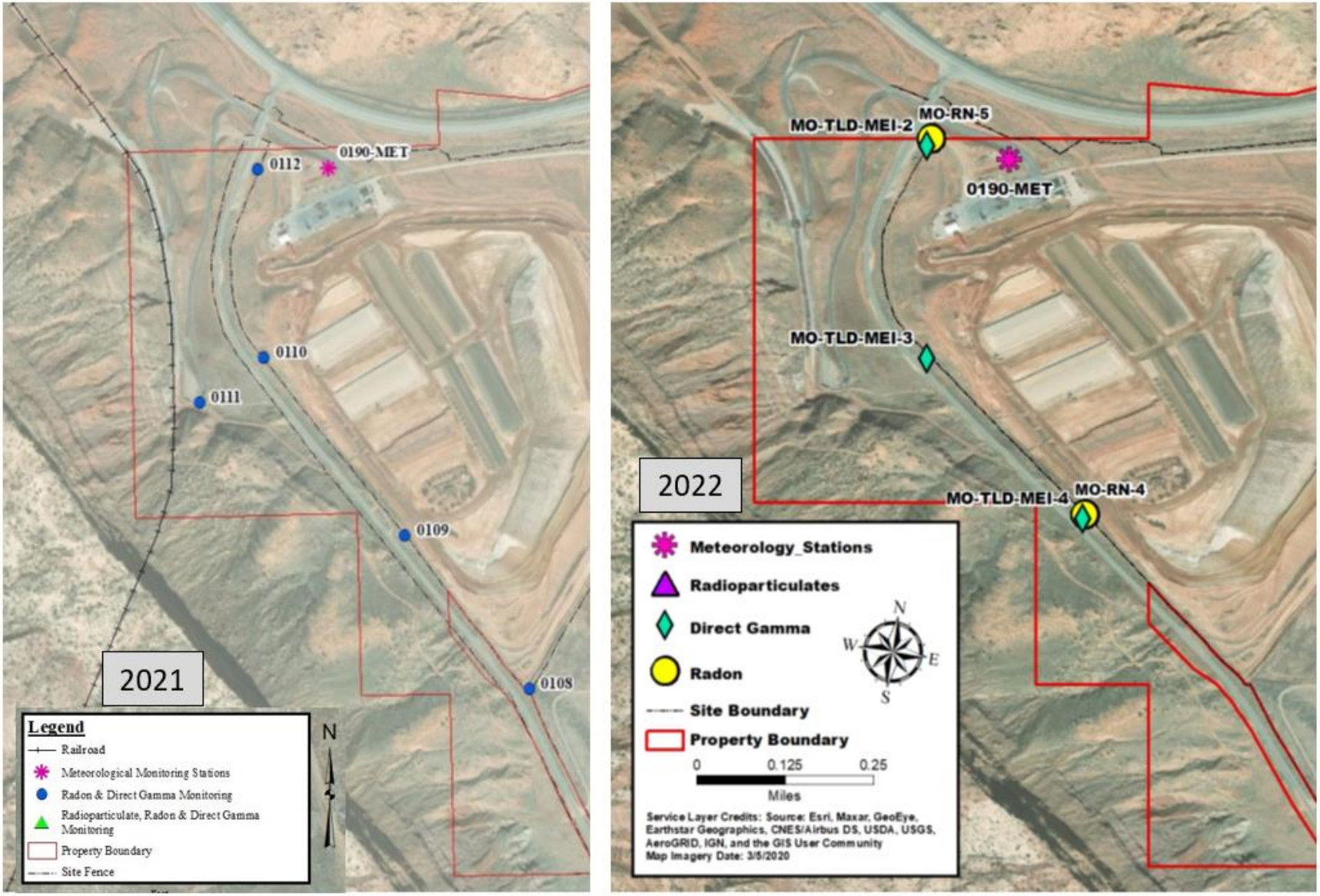


Figure 9. Comparison of 2021 and 2022 for the On-site Environmental Monitoring Network for the Western Side of Moab Site

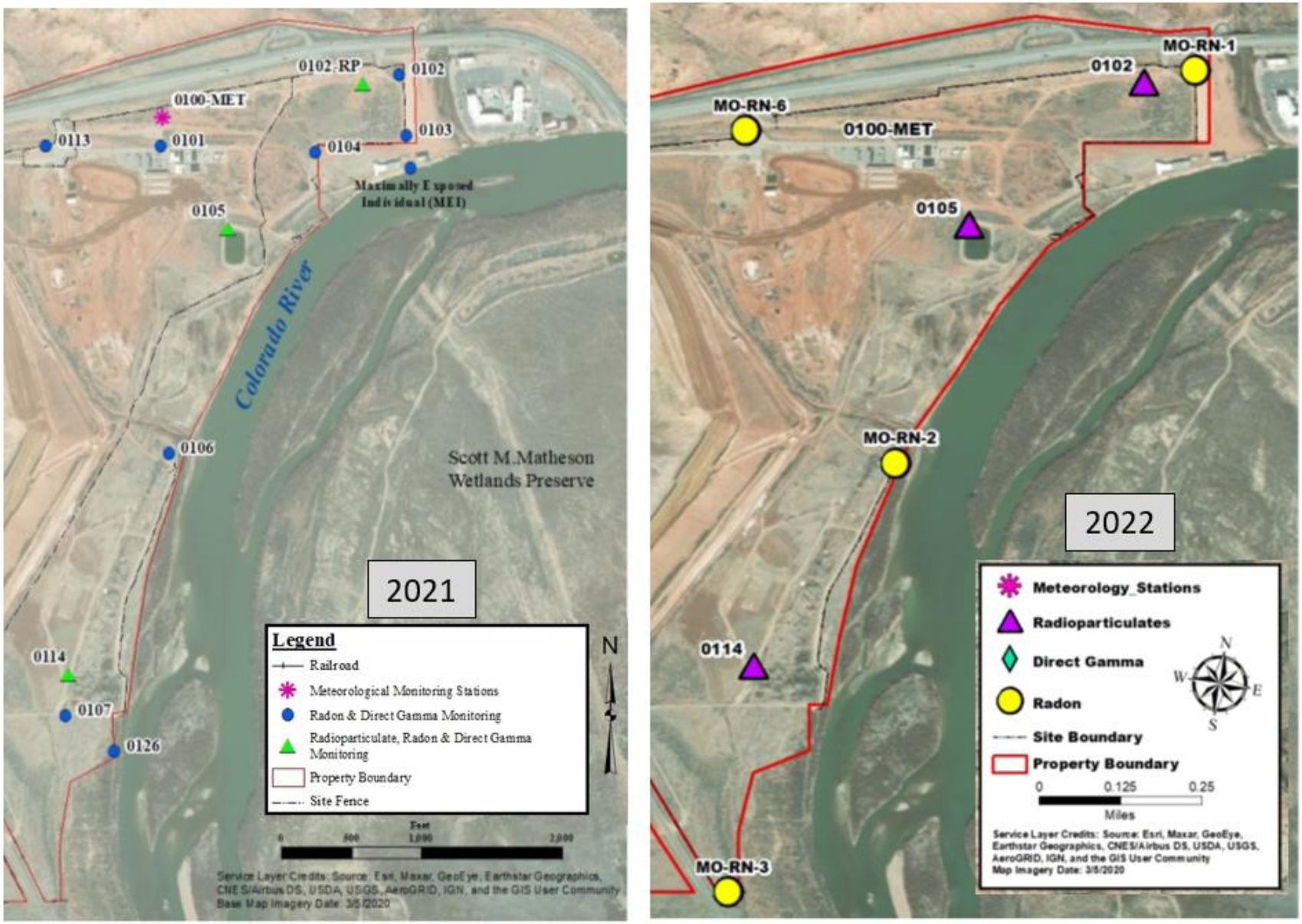


Figure 10. Comparison of 2021 and 2022 of the On-site Environmental Monitoring Network for the Eastern Side of Moab Site

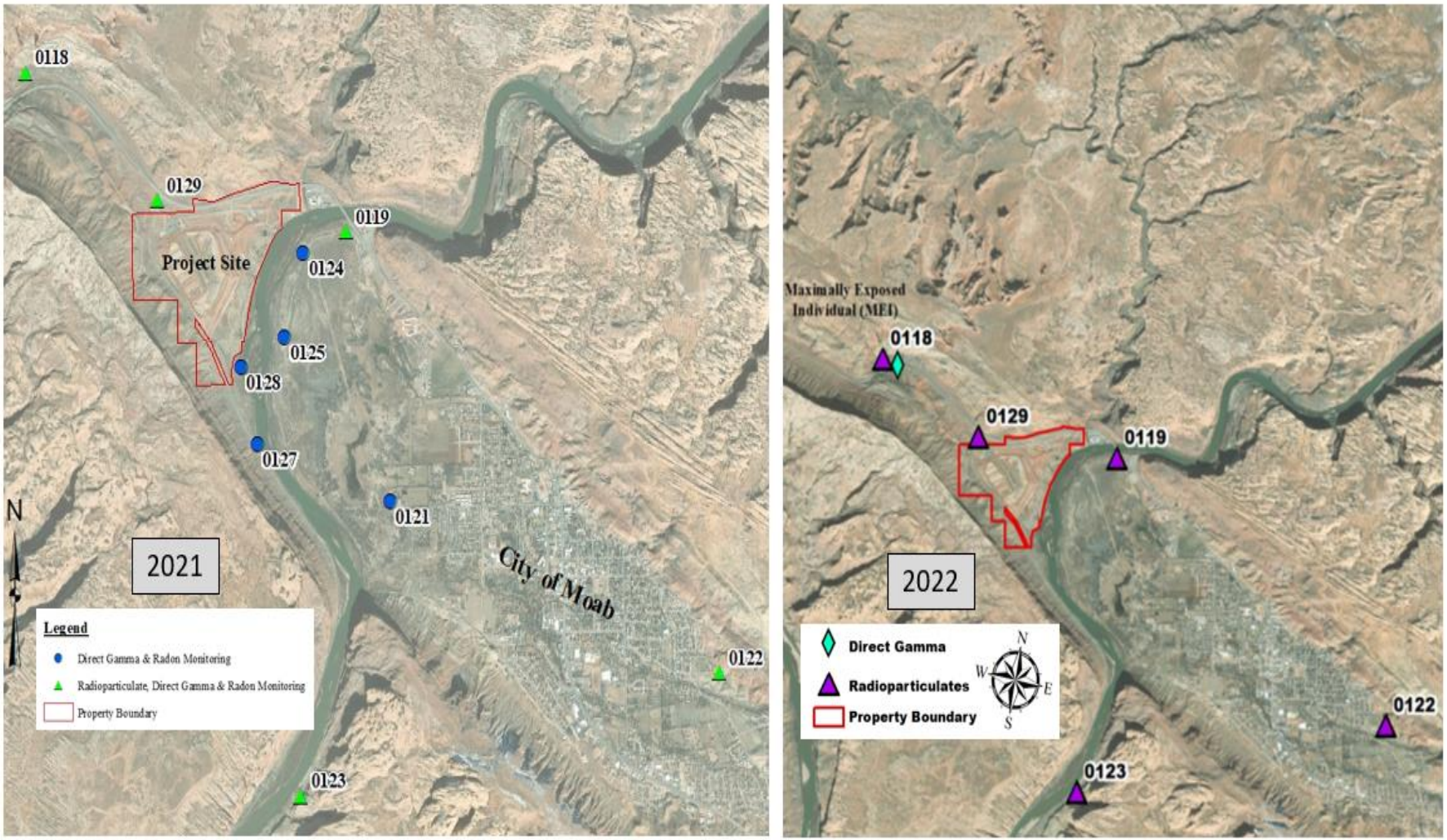


Figure 11. Comparison of 2021 and 2022 of the Off-site Environmental Monitoring Network for the Moab Site (close-up; maps are of different scales; station 0117 is in same location and is excluded from map)

Table 7. Summary of Environmental Monitoring Changes for Crescent Junction Site

CRESCENT JUNCTION SITE													
		Previous 2021 Sampling Methods				Current 2022 Sampling Methods			Presence During 2022 Quarters				
Unique Location	2021 Station Name	Radon	Direct Gamma	Radio-particu-late	2022 Station Name	Radon	Direct Gamma	Radio-particu-late	1Q	2Q	3Q	4Q	Changes/Comments
1	0301	x	x		0301	x						x	Removed starting 1st Quarter 2022; reinstalled 4th Quarter 2022
2	0302	x	x		CJ-RN-2	x			x	x	x		Station collected data for first 3 quarters of 2022, then removed starting 4th Quarter 2022
3	0303	x	x										Removed starting 3rd quarter 2021 (cell expansion)
4	0304	x	x										Removed starting 1st Quarter 2022
5	0305	x	x										Removed starting 1st Quarter 2022
6	0306	x	x	x	0306		x	x	x	x	x	x	MEI
7	0307	x	x	x	0307			x	x	x	x	x	
8	0308	x	x	x	0308			x	x	x	x	x	
9	0309	x	x	x	0309			x	x	x	x	x	
10	0310	x	x		CJ-RN-3	x			x	x	x		Station collected data for first 3 quarters of 2022, then removed starting 4th Quarter 2022
11					CJ-RN-1	x			x	x	x		Added 1st Quarter 2022. Remained for first 3 quarters of 2022, then removed starting 4th Quarter 2022
					CJ-RN-2A	x						x	Added 4th Quarter 2022 (to replace CJ-RN-2 and CJ-RN-3)
12					CJ-RN-4	x			x	x	x	x	Added 1st Quarter 2022
13					CJ-RN-5	x			x	x	x	x	Added 1st Quarter 2022
14					CJ-RN-6	x			x	x	x	x	Added 1st Quarter 2022
15					CJ-RN-7	x			x	x	x	x	Added 1st Quarter 2022
TOTAL	**10**								**11**	**11**	**11**	**10**	

X = Yes/Presence
1Q=First Quarter, 2Q = second quarter, 3Q = third quarter, 4Q = fourth quarter
MEI = Maximally Exposed Individual

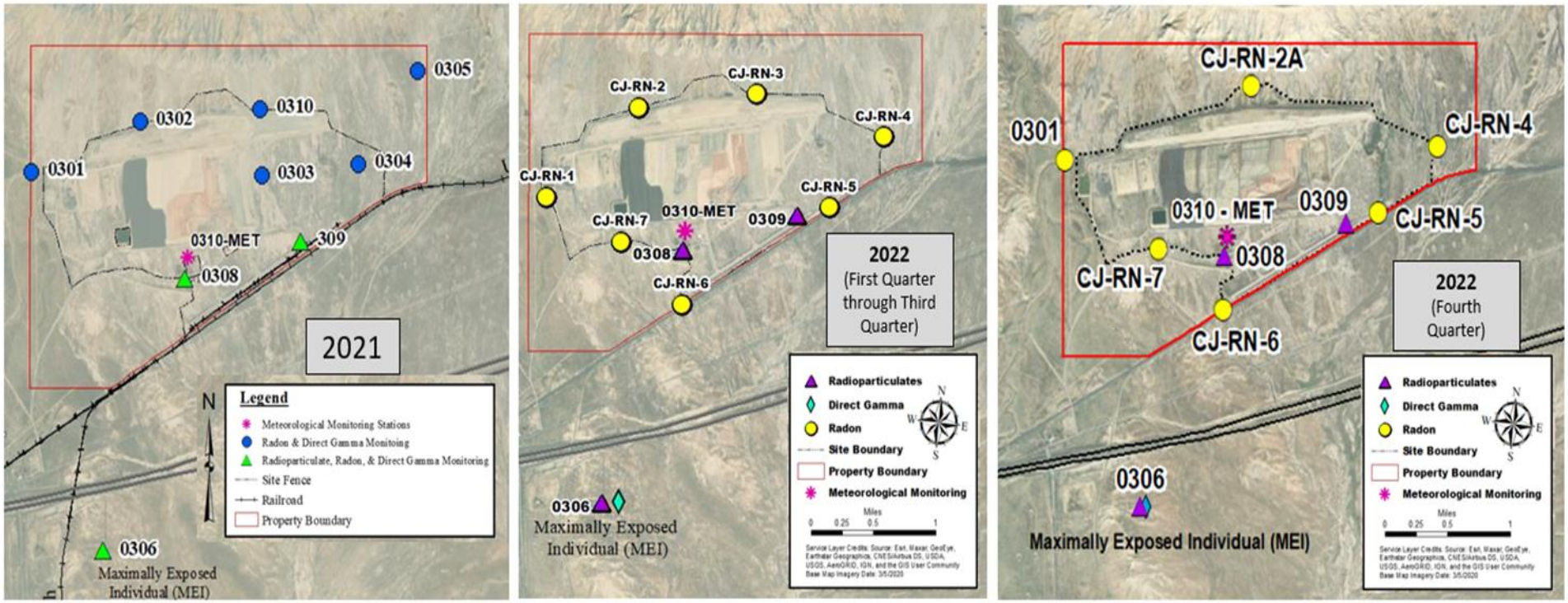


Figure 12. Comparison of 2021 and 2022 of the Environmental Monitoring Network for the Crescent Junction Site (station 0307 in Thompson Spring is the same location and is excluded from map)

4.7.3 Radiological Air Monitoring and Results

Radon

Radon is a radioactive, colorless, odorless, tasteless noble gas, which occurs naturally in minute quantities as an intermediate step in the normal radioactive decay chains through which thorium and uranium decay into various short-lived radioactive elements and lead. Radon is the immediate decay product of radium. As a noble gas, radon does not stay in the lungs when breathed in, but it can produce a radiation dose to lung tissue while it is in the lungs when present in air we breathe.

Between the two sites, radon was measured in 2022 at 12 to 13 locations (all on-site: 6 at the Moab site and 6 to 7 at the Crescent Junction site, depending on the quarter). Alpha-sensitive detectors (e.g., radon cups) exposed for a period of approximately 90 days (three months). After collection, the radon cups were sent to an off-site approved laboratory for analysis.

The background radon concentration for the Moab site is 0.6 pCi/L (updated from 0.7 pCi/L in 2021) and the Crescent Junction site is also 0.6 pCi/L (updated from 0.9 pCi/L in 2021). Both values were updated at the beginning of 2022 by the TAC.

A summary of 2022 annual average radon concentrations (with background subtracted) are shown in Table 8 for both the Moab and Crescent Junction sites. The Project's measured annual average radon emission at both the Moab and Crescent Junction site are below the limit of 3.0 pCi/L. The Project is compliant with DOE O 458.1 4f.

Table 8. 2022 Annual Radon Average Concentrations for Moab and Crescent Junction Sites

Station Number	2022 Average Radon Concentration (pCi/L) (Background subtracted)	Station Number	2022 Average Radon Concentration (pCi/L) (Background subtracted)
MOAB SITE		**CRESCENT JUNCTION SITE**	
MO-RN-1 (NE corner of site)	**0.89**	**0301** (west side, previous station location)	**0.29** [2]
MO-RN-2 (wellfield, south of Moab Wash)	**2.50**	**CJ-RN-1** (west side)	**<Background** [1]
MO-RN-3 (south end of site)	**0.84**	**CJ-RN-2** (NW side)	**<Background** [1]
MO-RN-4 (along Potash Rd)	**1.20**	**CJ-RN-2A** (north side; new location in 4Q22)	**0.21** [2]
MO-RN-5 (jct of haul road & Potash Rd)	**0.82**	**CJ-RN-3** (NE side)	**0.54** [1]
MO-RN-6 (by main entrance)	**1.65**	**CJ-RN-4** (east side)	**<Background**

Table 8. 2022 Annual Radon Average Concentrations for Moab and Crescent Junction Sites (continued)

Station Number	2022 Average Radon Concentration (pCi/L) (Background subtracted)	Station Number	2022 Average Radon Concentration (pCi/L) (Background subtracted)
MOAB SITE		**CRESCENT JUNCTION SITE**	
		CJ-RN-5 *(SE side)*	***<Background***
		CJ-RN-6 *(south side)*	***0.77***
		CJ-RN-7 *(SW side)*	***0.66***

[1] = Average is based on three quarters, not four.
[2] = Average is based on one quarter, not four.

Direct Gamma Radiation

Gamma radiation is produced by the disintegration of radioactive atomic nuclei. Considered external dose, direct gamma is used to calculate the TED along with radioparticulates.

Direct gamma is monitored for the Project's Maximally Exposed Individuals (MEIs) of the general public at Moab and Crescent Junction. The MEI for the Moab Project Site was moved at the beginning of first quarter 2022 from a residence near the northeast corner of the site to the employee housing in Arches National Park (Figure 6). The MEI for Crescent Junction remained in the same location, a private residence within one mile of the site (Figure 7).

The annual background direct gamma dose is 84 mrem for Moab and 92.5 mrem for Crescent Junction, based on three years of data collected from 2006 to 2009.

At the beginning of the first quarter 2022, the TAC initiated a representative person at the Moab Site, in conjunction with an MEI. This is not a requirement of DOE O 458.1 and the TAC stated that a representative person was included "as a best management practice." Direct gamma was monitored for this hypothetical person at the Moab Site, who rides a bike past the Site along State Route (SR) 279 (Potash Road). Three direct gamma stations were installed along SR279. It is not possible or practical to monitor if a person has the assumed living habits in the scenario presented in this representative person evaluation. However, considering the high recreational activity of the area, it is not unreasonable to assume that somebody in the local community would take part in an activity that would cause them to receive a dose from the Site while in this area.

The scenario of the representative cyclist was the following:

- For first and second quarters of 2022, it was recreational bicycling 5 days/week for 50 weeks/year. This scenario was highly unrealistic based on discussions with local cyclists.
- For third and fourth quarters of 2022, it was updated to a more plausible scenario of recreational bicycling for 2 days/week for 18 weeks/year.

During 2022, direct gamma radiation was measured at five stations (four for Moab site and one for Crescent Junction) using thermoluminescent dosimeters (TLDs) exposed for approximately 90 days (three months). The dosimeters are sent to an approved off-site laboratory for analysis.

Direct gamma is calculated for each station by using the following equation:

R1 – (T + BKG) = Quarterly Total Dose (mrem)

Where:
R1: Report dose from vendor
T: Transit dose (dose received during shipping of samples)
BKG: Background

Total dose is calculated for each direct gamma station quarterly and added together for an annual dose. See Table 9 for annual direct gamma results for both Moab and Crescent Junction sites.

Table 9. 2022 Annual Direct Gamma Dose for Moab and Crescent Junction Sites

STATION NUMBER	2022 DIRECT GAMMA ANNUAL DOSE (mrem)	COMMENTS
MOAB SITE		
MO-TLD-MEI (formerly 0118, Arches National Park)	**<Background**	**Moab Site MEI**
MO-TLD-MEI-2 (formerly 0112; SR 279)	**125.0**	**Representative person (bicyclist)**
MO-TLD-MEI-3 (formerly 0110; SR 279)	**183.0**	**Representative person (bicyclist)**
MO-TLD-MEI-4 (formerly 0109; SR 279)	**115.0**	**Representative person (bicyclist)**
CRESCENT JUNCTION SITE		
CJ MEI (south of site; east of Hwy 191)	**<Background**	**Crescent Junction MEI**

MEI = Maximally Exposed Individual
CJ = Crescent Junction

Although three representative stations are above the 100 mrem public limit (DOE O 458.1), the residency status of the individual must be considered. This dose represents 100% occupancy of this location for a year. For the representative person, it is a hypothetical person riding past the Site on a bicycle and not occupying this location. The MEI doses from both sites are indistinguishable from background. Given this information, the Moab UMTRA Project is within compliance of DOE O 458.1.

Radioparticulates

Radioparticules are small particles of radioactive material, which can become airborne during project activities such as excavation and loading of RRM, or by wind. Breathing these particles

can result in an internal radiation dose. Radioparticulates, along with direct gamma, are used to calculate the total effective dose (TED).
The radionuclides of concern on the Project are those inherent in the process of extracting uranium during the milling process when the mill was operational. However, because the radionuclides are part of the uranium decay series, which is naturally occurring, they are considered part of the emissions from the Project. Therefore, all radioparticulates measured at the project's monitoring stations are assumed to be from the Project.

Air filters were collected weekly and submitted as a composite sample on a quarterly basis. The filters were analyzed at an approved laboratory for concentrations of total uranium, thorium-230, radium-226, polonium-210, and actinium-227. Actinium-227 and protactinium-231 are assumed to be in equilibrium. Therefore, the concentration of protactinium-231 is calculated by multiplying the actinium-227 concatenation lab results by a correction factor of 0.32, which is consistent with the *Moab UMTRA Project Health Physics Plan* (DOE-EM/GJ3003).

In 2022, air samplers measured radioparticulates at the following:
- At the Moab site: nine locations total (three on-site, six off-site, including one MEI; see Figures 5 and 6)
- At the Crescent Junction site: four locations total (two on-site and two off-site, including one MEI; see Figures 7 and 8).

The radioparticulate data at the end of 2022 for the Moab and Crescent Junction sites are compiled in Table 10 below, which is considered dose from inhalation. Due to extensive changes of the air monitoring network and sampling methods, a 5-year summary was not included in this report.

Table 10. 2022 Environmental Radioparticulate Effective Doses for the Moab and Crescent Junction Sites

Station Number & Description	2022 Annual Radioparticulate Effective Dose (mrem/yr)
Moab On-Site Locations	
0102 (NE corner)	1.69
0105 (By freshwater pond)	1.89
0114 (Wellfield)	3.10
Moab Off-Site Locations	
0117 (Bar M)	1.38
0118 (MEI; Arches NP)	1.92
0119 (Matheson Wetlands)	1.33
0122 (Recycling Center)	1.27
0123 (Kane Creek)	1.34

Table 10. 2022 Environmental Radioparticulate Effective Doses for the Moab and Crescent Junction Sites (continued)

Station Number & Description	2022 Annual Radioparticulate Effective Dose (mrem/yr)
Moab Off-Site Locations	
0129 (Potash Road)	3.31
CJ On-Site Locations	
0308 (Guard Station)	1.59
0309 (SE Boundary)	2.24
CJ Off-site Locations	
0306 (MEI; South of site, by Hwy 191)	1.08
0307 (Thompson Springs)	1.74

CJ = Crescent Junction
mrem = millirem

All radioparticulate dose results from both the Moab and Crescent Junction sites are below the DOE O 458.1 limit of 100 mrem/year for the general public.

Total Effective Dose

The TED for the Project is calculated for the MEI and representative person by using the following equation:

$\gamma + P_1 =$ TED (mrem)

Where:

$\gamma =$ direct gamma dose with background subtracted (mrem)

P_1 = Radioparticulate dose (mrem)

The annual total effective doses for 2022 are below:

- for the Moab site MEI: <background + 1.92 mrem/yr = **1.92 mrem/yr**
- for the Crescent Junction site MEI: <background + 1.08 mrem/yr = **1.08 mrem/yr**

Changes and enhancements were made to the environmental monitoring program during 2022 to improve efficiency and accuracy, which resulted in the calculated annual TED decreasing compared to 2021 and prior years. The annual dose to the public will continue to decrease due to the amount of tailings at the site being removed and transported to Crescent Junction for disposal.

For the representative person, because there are no radioparticulate monitoring stations along SR279, the representative person TED is based solely on direct gamma. The 2022 TED is calculated with the following scenario:

2022 Average Annual Dose Received During Trip

- Recreational bicycling 2 days/week for 18 weeks/year.
- Estimated round trip travel distance along SR279 is 2.8 miles.
- It takes 14 minutes round trip to travel 2.8 miles.
- Occupancy time: 2 days x 18 weeks x 14 minutes = 504 minutes/year
- Total minutes in one year: 365 days x 24 hrs x 60 = 525,600 minutes/year.

Applicable Monitoring Stations:

MO-TLD-MEI-2 = 125.0 mrem/yr
MO-TLD-MEI-3 = 183.0 mrem/yr
MO-TLD-MEI-4 = 115.0 mrem/yr

Average Dose per year from these three stations = 141 mrem/yr. Therefore, the representative person dose is calculated by the following:

141 mrem/yr / 525,600 min/yr = 0.0003 mrem/min
0.0003 mrem/min x 504 min occupancy time = **0.14 mrem/yr**

All TEDs are below the 100 mrem/year limit and both sites are in compliance with DOE O 458.1, including the dose to the lens of the eye, skin, and extremities.

5.0 Environmental Non-radiological Program Information

5.1 Non-radiological Environmental Monitoring

The Project manages storm water at the sites through controls specified in site-specific storm water pollution prevention plans (see Table 1) in accordance with the Clean Water Act (33 USC 1251) and the Utah Pollutant Discharge Elimination System (UPDES) General Permit for Discharges from Construction Activities, UPDES Permit No. UTRC00000. Monitoring includes routine monthly inspections and post-precipitation inspections for precipitation 0.5" or more in a storm event. A significant flood occurred on August 20, 2022, causing much damage to the City of Moab. It had very little effect at the Moab site with only 0.66 inches of precipitation onsite.

Fugitive dust and air opacity are monitored at the sites by Project personnel certified to EPA Method 9. In accordance with Utah Administrative Code R307-205-8, fugitive dust must not exceed 20% opacity at the site boundary.

Oil storage containers are monitored for any oil leaks or spills under the *Moab UMTRA Project Spill Prevention, Control, and Countermeasure Plan* (DOE-EM/GJRAC1477) in accordance with 40 CFR 112 "Oil Pollution Prevention." Quarterly inspections are conducted at both sites.

Meteorological data, including air temperature, relative humidity, wind speed, wind direction, and precipitation, are monitored at both sites. The Moab site currently has two meteorological monitoring stations. A third meteorological station was removed in May 2022 by the Moab administration area and is planned to be reinstalled in the wellfield in 2023. Crescent Junction has two meteorological stations at or near the site (see Figures 5 and 8, respectively). These stations enable monitoring of site-specific meteorological conditions and events and provide a

valuable resource for assessing impacts resulting from any unplanned release of airborne contamination.

An extended drought in 2022 impacted the freshwater intake structure. A secondary pump was placed in the intake structure to assist with obtaining fresh water for site operations.

The EMS Core Team had quarterly meetings to monitor progress performance metrics related to the environmental objectives outlined in the EMS. The Sustainability Coordinator monitors and tracks sustainability metrics to enter into the DOE Sustainability Dashboard.

5.2 Revegetation and Weed Control Program

Revegetation efforts are focused on two main goals: 1) promoting desirable native vegetation, and 2) managing non-native weed species.

Promoting desirable native vegetation in 2022 includes the following:

- In the previously flood irrigated cottonwood plots in the wellfield (where dead trees were removed in 2021), the area was prepared for seeding, including soil preparation and building an extensive irrigation sprinkler system. Native seed mix, awarded from a Watershed Restoration Initiative grant, was used in this area. Native shrubs were grown by local nursery and planted throughout this area, along with transplanting onsite inland salt grass.
- A native plant salvage from Canyonlands National Park was conducted in summer of 2022. Approximately 100 native species were transplanted from a future construction site inside the park to the wellfield, benefitting both the Project and the Park Service.
- Continued to planted desert willow (*Chilopsis linearis*) and three-leaf sumac (*Rhus trilobata*) along the Hwy 191 cottonwood hedgerow to start replacing dying cottonwood trees.
- Continued maintaining a one-acre test plot from 2021 in the wellfield where various treatments and seed mixes are showing impressive results after just one year.
- Continued a long-term repeat photo monitoring program in the wellfield revegetation areas.
- Continued strategic partnerships with U.S. Geological Survey (USGS), National Park Service (NPS), Utah Division of Forestry, Fire, and State Lands (DNR) and Rim to Rim Restoration (RRR) to promote accomplishment of restoration goals and benefit the greater restoration community.
- Continued to participate in the Southeast Utah Riparian Partnership (SURP), a local ecological restoration group consisting of different federal, state, and local agencies, led by Rim to Rim Restoration. Under SURP, the Moab UMTRA Project applied for grants under the Watershed Restoration Initiative.
- The collaborative U.S. Geological Survey (USGS) research project continued throughout 2022 (336 experimental plots were installed in fall 2020). USGS and UMTRA staff partnered to collect the second year of data on the plots.
- Revegetation manager gave two presentations with USGS on revegetation challenges and successes to the national Society of Range Management and a local ecological restoration collaboration, the Canyon Country Working Group.

Managing non-native weed species in 2022 includes the following:

- Collaborated with the Utah Division of Natural Resources to successfully control encroaching noxious weeds (i.e., tamarisk and Russian knapweed) along a shared boundary.

- Based on previous Watershed Restoration Initiative grant award, the Moab UMTRA Project was awarded herbicide from the State of Utah to treat noxious weeds.
- Staff treated noxious weed species in 12 out of 27 revegetation management zones, including Russian knapweed (*Centaurea repens*), tamarisk (*Tamarix ramosissima*), goathead (*Tribulus terrestris*), field bindweed (*Convolvulus arvensis*), and emerging Russian olive (*Elaeagnus angustifolia*; treated in 2021).
- Utilized biocontrol for noxious weed control, releasing stem gall wasps for Russian knapweed in two different locations onsite.
- Significantly reduced weed cover, specifically kochia, through mowing at appropriate times, allowing native bunch grasses to flourish.

Refer to the *Moab UMTRA Project Revegetation and Weed Control Plan*, (DOE-EM/GJRAC1655) for more details.

5.3 Fire Protection Management and Planning

No wildland fires occurred at the sites in 2022. Dead vegetation, weeds, and windblown materials are cleared near buildings and equipment to minimize fire hazards. Weed control and vegetative debris management are performed in other areas of the sites.

A burn box (~7 cubic yard metal bin) was utilized January through April 2022 for burning vegetation debris at the Moab site. Burn box operations were conducted when the clearing index was favorable for burning within the burn window. A burn permit was received prior to every burn. A fire watch monitored the burn box at all times when it was being used. All fires were completely extinguished at the end of the day. No fires outside the burn box occurred. The burn box, which was on loan from the BLM, was returned in April of 2022 and burning operations ceased.

5.4 Recreational Hunting and Fishing

No recreational hunting or fishing is allowed on the Project sites.

6.0 Groundwater Protection Program

The groundwater beneath the Moab site was contaminated by former uranium milling operations.

The main objectives of the Groundwater Program are to reduce the ammonia and uranium contaminant mass and to protect young-of-year endangered fish species in suitable habitats of the Colorado River from site contaminants. The critical habitat is protected through groundwater extraction near the tailings pile, freshwater injection along the riverbank, and surface water diversion directly to the habitat area.

Monitoring results show the extent of contaminant plumes has not significantly changed in the past five years. Figures 13 and 14 show the ammonia and uranium plumes and surface water sampling locations at the Moab site, respectively. The ammonia concentration is highest at the toe of the tailings pile, and the uranium concentration is highest at the toe of the tailings pile and near the vicinity of the former uranium mill, just northeast of the pile. Groundwater flow is toward the southeast, discharging to the Colorado River.

No new or emerging contaminants (per- and polyfluoroalkyl substances) have been identified on-site.

In 2022, the Project initiated an investigation using a chemical reactive barrier composed of hydroxyapatite as a potential groundwater remedial alternative. Hydroxyapatite is a mineral that can uptake and remove uranium (in addition to other contaminants) from groundwater as it passes through the barrier. Bromide tracer tests and nuclear magnetic resonance logging was completed in 2022 as part of the initial phases of the investigation, which was funded by DOE and Lawrence Berkley National Laboratory. The bromide tracer tests were completed in May and August 2022 to confirm the groundwater flow direction, which is critical for the eventual placement of the hydroxyapatite barrier. The nuclear magnetic resonance logging, completed in May 2022, measured baseline subsurface conditions (e.g., pore volume and hydraulic conductivity) prior to the injection of the hydroxyapatite-forming solutions. The hydroxyapatite investigation will continue in 2023.

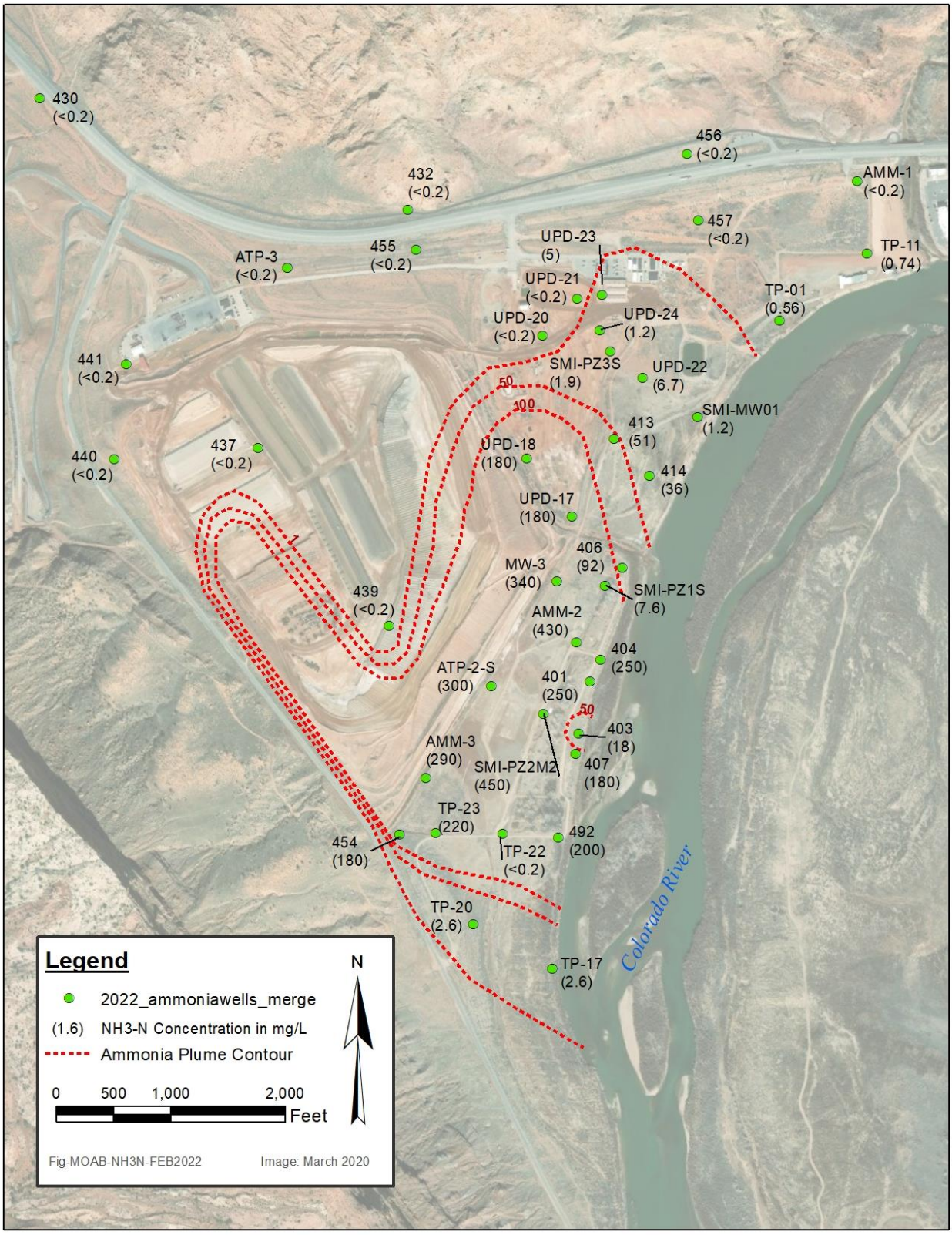


Figure 13. 2022 Ammonia Plume Contours and Select Monitoring Well Sampling Locations

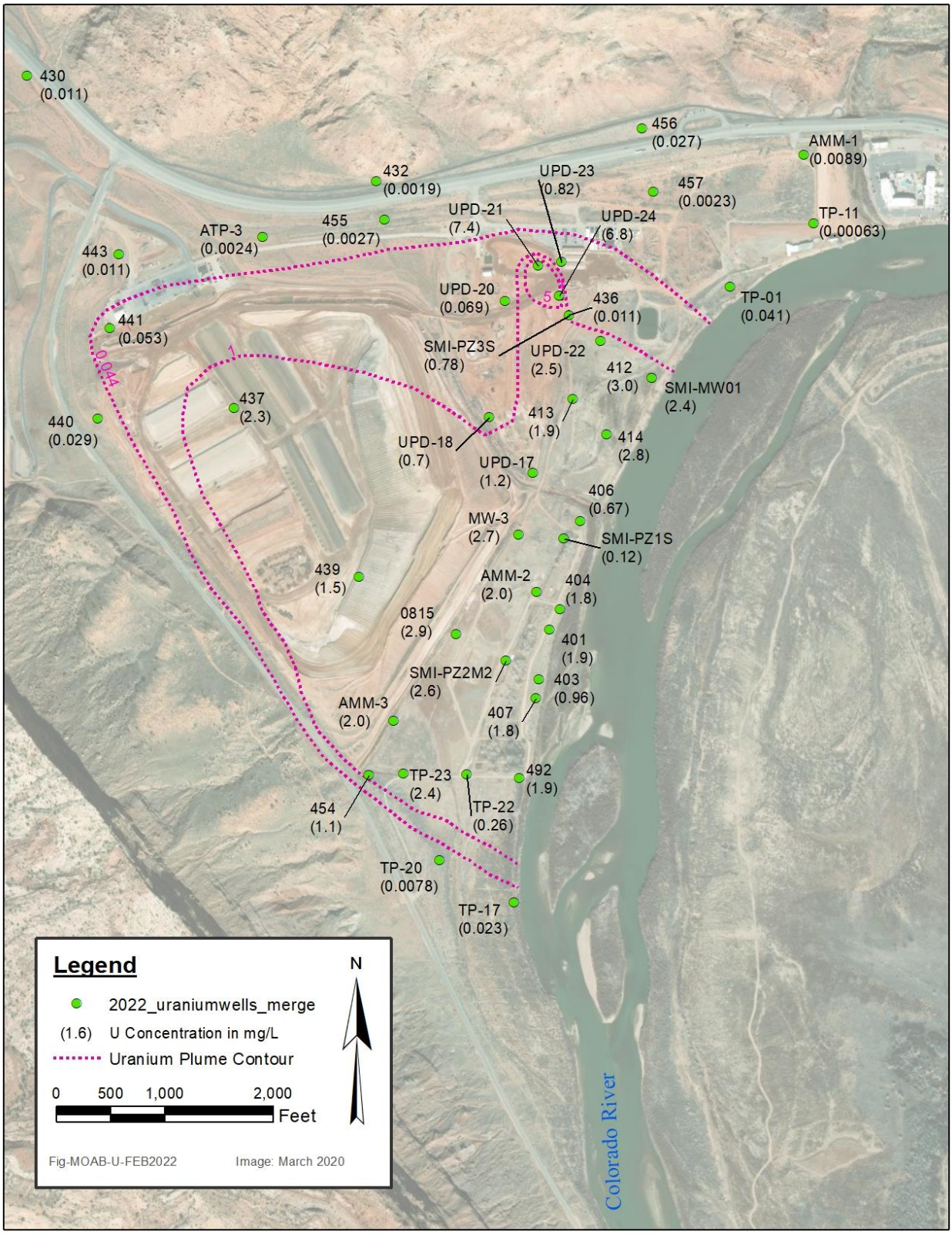


Figure 14. 2022 Uranium Plume Contours and Select Monitoring Well Sampling Locations

6.1 Groundwater

In 2022, eight extraction wells and ten injection wells were used to minimize contaminant discharge to the Colorado River. Extracted groundwater was pumped to a water storage tank located on the northeastern side of the tailings pile, where it was used as dust control inside the contamination area.

Samples were collected from extraction and monitoring wells to assess Interim Action performance July 2022, and site-wide sampling events were completed in February/March 2022 to assess contaminant plumes. Groundwater samples from the Interim Action area were primarily analyzed for ammonia and uranium. As the project continues toward closure and begins drafting the Groundwater Compliance Action Plan (GCAP), an expanded list of analytes (ammonia, arsenic, copper, manganese, selenium, sulfate, total dissolved solids, and uranium) have been added to the site-wide sampling set. Data results from sampling events are available on the Project website at www.energy.gov/em/moab/moab-umtra-homepage and in the Grand County Library public reading room in Moab.

Table 11 shows the ammonia and uranium concentrations over the past five years at representative well location 0443, an observation well upgradient of the tailings pile, extraction well 0815, downgradient of the tailings pile, and 0403, an observation well near the riverbank. See Figures 13 and 14 for well locations.

Groundwater contaminant concentrations are impacted by the Colorado River flows, especially in wells located along the riverbank. During an average runoff peak, Colorado River water flows into the subsurface and dilutes the groundwater contaminants. In an average year, the Colorado River experiences base flows from August through March. Once base flows are re-established, the contaminants tend to rebound to pre-peak flow levels. River flows especially impact the groundwater concentrations detected in samples collected from well 0403 (located on the riverbank) and to a lesser extent well 0815 (located approximately 650 ft from the riverbank).

Because the Colorado River experiences base flow the majority of the year, samples collected during this timeframe best represent the overall groundwater chemistry. For better comparison purposes and to display the concentration changes as the groundwater flows towards the river, Table 11 below provides groundwater ammonia and uranium concentrations during the river base flows.

Table 11. Representative Groundwater Well Sampling Results over Past Five Years

Year	Well 0443 (73 ft bgs)*		Well 0815 (22 - 52 ft bgs)*		Well 0403 (18 ft bgs)*	
	Ammonia Total as N (mg/L)	U (mg/L)	Ammonia Total as N (mg/L)	U (mg/L)	Ammonia Total as N (mg/L)	U (mg/L)
2018	1.0**	0.01	95	3.2	56	1.3
2019	0.1**	0.01	150	2.9	43	0.22
2020	0.2**	0.01	140	2.7	42	0.71
2021	***	0.01	110	2.7	63	1.2
2022	2.5	0.01	100	2.9	18	0.96

*denotes sample depth, ** denotes the result was at or below detection limit, *** denotes erroneous results not included

Well 0443 is not affected by contamination in the tailings pile and shows consistent ammonia and uranium results at the detection limit or representative of natural concentrations. Wells 0403 and 0815 have been affected by the tailings pile. Ammonia concentrations in samples collected from these two locations have fluctuated over the past five years, and the uranium concentrations are above the 40 CFR 192 water quality standard of 0.044 milligrams per liter (mg/L).

Table 12 summarizes the 2022 sampling efforts at the Moab site. Table 13 shows the average, median, standard deviation, ranges of results, and associated regulatory standards of analytes in surface water and groundwater samples collected in 2022.

Table 12. 2022 Groundwater Sample Collection/Analysis Summary

	Interim Action System	Groundwater Monitoring	Surface Water Monitoring
Number of Locations Sampled	15	59	7
Number of Analyses Performed	32	499	56
Percentage of MDL* Results	16%	7%	11%
Percentage of Acceptable** Results	31%	67%	100%

* Method Detection Limit
** Only accounts for results with regulatory standards (ammonia, arsenic, copper, selenium, and uranium)

Table 13. 2022 Groundwater Sample Result Summary

Analyte	Standard (mg/L)	Range of Results (mg/L)	Average (mg/L)	Median (mg/L)
Surface Water				
Ammonia Total as N	3*	<0.2 – 1.2	0.34	0.20
Uranium	0.044**	0.005 – 0.014	0.0069	0.0057
Arsenic	0.05**	0.00082 – 0.0011	0.00095	0.00095
Copper	1.3***	0.00077 – 0.0012	0.00095	0.00098
Manganese	NA	0.0095 – 0.032	0.016	0.014
Selenium	0.01**	0.0022 – 0.0032	0.0026	0.0026
Sulfate	NA	270 – 320	280	270
TDS†	NA	440 – 780	610	580
Groundwater				
Ammonia Total as N	3*	<0.2 – 1,400	139	13
Uranium	0.044**	0.00063 – 7.4	1.26	0.78
Arsenic	0.05**	<0.00012 – 0.19	0.0076	0.0014
Copper	1.3***	<0.00066 – 0.049	0.0042	0.0021
Manganese	NA	0.00031 – 11	1.69	0.54
Selenium	0.01**	<0.00066 – 0.56	0.037	0.0084
Sulfate	NA	370 – 21,000	4,725	3,900
TDS†	NA	1,200 – 77,000	16,371	7,600

* Proposed standard from *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impacts Statement*
** Standard based on Table 1 in *40 CFR 192*
*** Standard based on EPA Action Level
† Total Dissolved Solids

6.2 Surface Water

The Colorado River is the primary surface water feature. Ammonia is a concern because of its toxicity to aquatic life. The purpose of the freshwater injection and surface water diversion systems is to create a hydraulic barrier between the tailings pile and river side channels where suitable aquatic habitats can form. Approximately 9.8 million gallons of fresh water were injected into the subsurface adjacent to the Colorado River in 2022. No suitable habitat formed in the river side channels in 2022 due to lower than average river flows.

Seven surface water samples were collected on site, upriver, and downriver (see Figure 15) for laboratory analysis at base flow (March 2022) conditions. Table 14 provides information for the site-wide locations and the EPA acute and chronic ammonia criteria.

Of these surface water samples, one had ammonia concentrations that exceeded the chronic criteria. Sample concentrations did not exceeded the acute criteria. The surface water sample (CR3) exceeding the chronic criteria was collected to the south of the freshwater habitat and consisted of a large mudbank extending from shore covered in shallow water (1-2 inches deep). This area is part of the main channel of the river and was unusually warm due to the shallow depth. No dead fish were observed in the area.

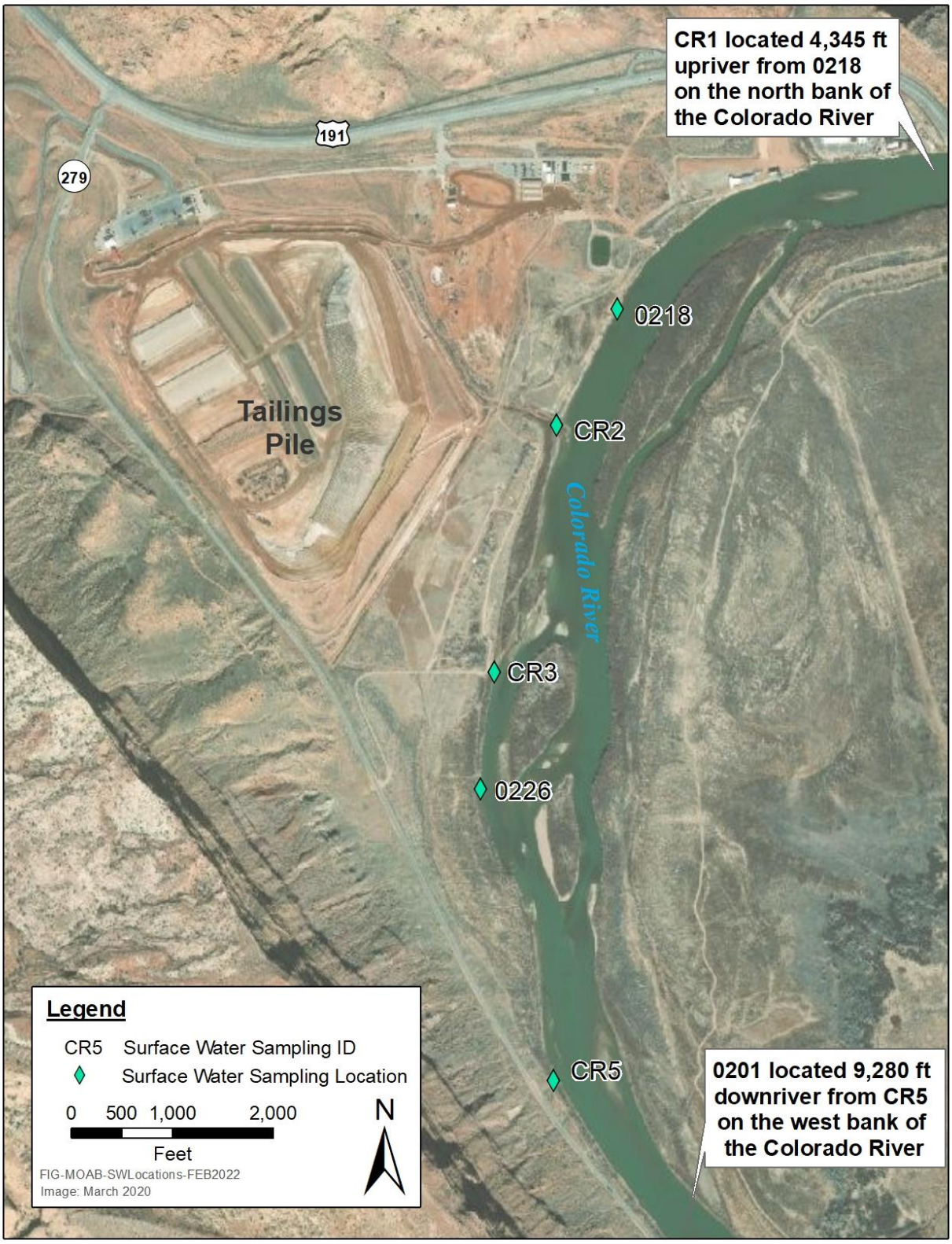


Figure 15. 2022 Site-wide Event Surface Water Sampling Locations

Table 14. 2022 Ammonia Concentrations in Site-wide Surface Water Samples Compared to EPA Criteria

Sample Location	Sample Date	Temperature (ºC)	pH	Ammonia as N (mg/L)	Acute Criteria (mg/L)*	Chronic Criteria (mg/L)**
0201	3/8/22	6.27	7.38	<0.2	15	3.5
0218	3/7/22	7.02	8.01	<0.2	5.6	1.8
0226	3/8/22	7.15	8.65	0.2	1.5	0.57
CR1	3/7/22	7.29	7.35	<0.2	15	3.5
CR2	3/7/22	8.33	8.08	<0.2	5.6	1.7
CR3	3/7/22	12.62	8.43	1.2	2.6	0.65
CR5	3/8/22	6.91	7.73	<0.2	8.1	2.6

*U.S. EPA Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater State (Effective April 2013), Table N.4., Temperature and pH-Dependent Values, Acute Concentration of Total Ammonia as N (mg/L)
**U.S. EPA Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater State (Effective April 2013), Table 6. Temperature and pH-Dependent Values, Chronic Concentration of Total Ammonia as N (mg/L)

7.0 Quality Assurance

Environmental monitoring conducted by the Moab UMTRA Project is performed in accordance with an established and comprehensive Quality Assurance Program (QAP). The QAP describes the measures used to ensure the quality of radiological and non-radiological data and complies with the requirements of American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA) consensus standards, "Quality Assurance Requirements for Nuclear Facility Applications," Title 10 Code of Federal Regulations Part 830 (10 CFR 830), "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," DOE O 414.1D Chg 2, "Quality Assurance," and DOE Office of Environmental Management (EM) "EM Quality Assurance Program" (EM-QA-001, Revision 2). These requirements are flowed down through quality assurance (QA) implementing procedures and environmental sampling and analysis plans.

The degree of application of the QA requirements is dependent on the importance of the structures, systems, and components or activities affecting the safety of the operations and the health and safety of the worker, public, or the environment. This is accomplished through the "graded approach" process, which determines the appropriate level of effort necessary to attain and document the requirements.

7.1 Laboratory Analysis and Qualification

7.1.1 Analytical Laboratories

The Project flows down QAP requirements to subcontracted, qualified analytical laboratories to ensure that the data produced is defensible, valid, reliable, and can be used to support decision-making for clean-up, remediation, and on-going operations. The following laboratories were used for analysis of environmental samples in 2022: 1) ALS Environmental, Fort Collins Colorado, for radiological and non-radiological analytes; 2) GEL, Charleston, SC, for radiological and non-radiological analytes, 3) Radonova, Lombard, Illinois, for radiological analytes; and 4) Mirion Technologies, Oak Ridge, Tennessee, for total gamma radiation dose.

All samples were analyzed according to EPA-approved methods or by standard industry methods where no EPA methods are available. In addition, environmental technicians performed field monitoring for parameters including conductivity, pH, ORP, temperature, and turbidity.

7.1.2 Laboratory Qualification

ALS Environmental was qualified under the National Environmental Laboratory Accreditation Program (NELAP); ISO 17025:2005; the Department of Energy Consolidated Audit Program (DOECAP); State of Utah Environmental Laboratory Certification Program Certification; and Perry Johnson Laboratory Accreditation Certificate of Accreditation (DoD-ELAP). Radonova was qualified under the American Association of Radon Scientists and Technologists National Radon Proficiency Program (AARST NRPP); Radon Detector Performance Testing; ISO 17205; and ISO 9001. Mirion Technologies was qualified under the Remedial Action Contractor UMTRA DOELAP Audit Program. GEL was qualified under the National Environmental Laboratory Accreditation Program (NELAP); ISO 17025:2005 Department of Energy Consolidated Audit Program (DOECAP) State of Utah Environmental Laboratory Certification Program Certification Perry Johnson Laboratory Accreditation Certificate of Accreditation (DoD-ELAP).

7.1.3 Verification and Validation

Environmental data are verified and validated. Verification includes evaluating the completeness, correctness, and compliance of data against plans/procedures, methods, and contractual requirements. Data validation is used to determine if data meet the specific technical and quality control criteria established, and to establish the usability and extent of bias of any data not meeting those criteria through the evaluation of an analytical data package. A graded approach is applied to determine validation requirements and data is validated at a level corresponding to the analytical service level (ASL) specified. Certain data may require a higher level of confidence or defensibility and are obtained by specifying a higher ASL. These data require complete validation to meet the data use requirements.

7.2 Assessments and Issues Management

Effectiveness of the Environmental Program is routinely evaluated through implementation of a formal and comprehensive assessment program that includes audits, independent assessments, external certification, and self-assessments. Deficiencies identified are promptly identified, managed thorough a robust Issues Management Program, and corrected as soon as practicable. Completion of corrective actions and their effectiveness is verified and documented.

7.3 Records Management

All documentation associated with this ASER is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Program Plan* (DOE-EM/GJ1545), which follows DOE orders, policies, and regulations for retention and maintenance of records.

8.0 References

10 CFR 1021 (Code of Federal Regulations), “National Environmental Policy Act Implementing Procedures.”

10 CFR 1022 (Code of Federal Regulations), “Compliance with Floodplain and Wetland Environmental Review Requirements.”

36 CFR 800 (Code of Federal Regulations), “National Historic Preservation Act.”

40 CFR 61 (Code of Federal Regulations), “National Emission Standards for Hazardous Air Pollutants.”

40 CFR 112 (Code of Federal Regulations), “Oil Pollution Prevention.”

40 CFR 192 (Code of Federal Regulations), “Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings.”

7 USC 136 (United States Code), Federal Insecticide, Fungicide, and Rodenticide Act.

16 USC 703-712 (United States Code), Migratory Bird Treaty Act.

16 USC 1531-1544 (United States Code), Endangered Species Act.

42 USC 85 (United States Code), Clean Air Act.

42 USC 300f (United States Code), Safe Drinking Water Act.

42 USC 2011-2021 (United States Code), Atomic Energy Act.

42 USC 7901 (United States Code), Uranium Mill Tailings Radiation Control Act.

42 USC 11001 (United States Code), Emergency Planning and Community Right-to-Know Act.

42 USC 17001 (United States Code), Energy Independence and Security Act.

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Program Plan* (DOE-EM/GJ1545).

DOE (U.S. Department of Energy), *Moab UMTRA Project Revegetation and Weed Control Plan* (DOE-EM/GJRAC1655).

DOE (U.S. Department of Energy), *Moab UMTRA Project Climate Change Vulnerabilities and Resiliency Plan* (DOE-EM/GJ2193).

DOE (U.S. Department of Energy) Order 231.1B Admin Chg 1, “Environment, Safety and Health Reporting.”

DOE (U.S. Department of Energy) Order 414.1D Chg 2, “Quality Assurance.”

DOE (U.S. Department of Energy) Order 435.1, “Radioactive Waste Management.”

DOE (U.S. Department of Energy) Order 436.1, “Departmental Sustainability.”

DOE (U.S. Department of Energy) Order 458.1 Admin Chg 4 “Radiation Protection of the Public and the Environment.”

DOE (U.S. Department of Energy), *Record of Decision for the Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah* (6450-01-P).

DOE (U.S. Department of Energy), *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement* (DOE/EIS-0355).

Executive Order 11988, “Floodplain Management.”

Executive Order 11990, “Protection of Wetlands.”

Executive Order 13751 “Safeguarding the Nation from the Impacts of Invasive Species.”

ISO (International Organization for Standardization) Standard 14001:2015, “Environmental Management Systems.”

National Council on Radiation Protection and Measurements Report No. 160. *Ionizing Radiation Exposure of the Population of the United States* (2009).

National Council on Radiation Protection and Measurements Report No. 184. *Medical Radiation Exposure of Patients in the United States* (2019).

Public Law 106-398, Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001.

Public Law 110-140, Energy Independence and Security Act of 2007.

UAC R307-205-8 (Utah Administrative Code), “Emission Standards; Fugitive Emissions and Fugitive Dust; Tailings Piles and Ponds.”

U.S. Census Bureau, *https://data.census.gov*.