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Moab UMTRA Project
Annual Site Environmental Report for Calendar Year 2021

Revision 0

September 2022

U.S. Department of Energy

Office of Environmental Management

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Revision History

Revision	Date	Description
0	September 2022	Initial issue.

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Acronyms and Abbreviations

AARST	American Association of Radon Scientists and Technologists
AEA	Atomic Energy Act
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 (Utah Division of Forestry, Fire, and State Lands)
DOE	U.S. Department of Energy
DOECAP	Department of Energy Consolidated Audit Program
DOE O	DOE Order
DOT	Department of Transportation
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
Sv	Sievert
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.

This ASER presents information pertaining to environmental activities conducted on the DOE Moab Uranium Mill Tailings Remedial Action (UMTRA) Project during calendar year 2021. 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 activities that pertain to this ASER programs including: Environmental Restoration, Environmental Compliance, Environmental Radiological Protection, Groundwater, Revegetation, and Quality Assurance (QA). Brief descriptions of these programs are provided below.

Environmental Restoration Program
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.

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 2021, 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.

Per DOE Order 436.1, DOE sites must use an ISO14001 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.

Revegetation and Weed Control
The purpose of the Revegetation and Weed Control Program at the Moab Site is to stabilize and improve soil conditions, to revegetate remediated areas with resilient, native vegetation, and to control noxious weed species. Section 3.2 covers the Moab Site Revegetation and Weed Control Program.

Environmental Radiological Protection Program
The Project monitors radiological emissions to ensure DOE activities are protective of the public and the environment. The environmental air monitoring network consists of on-site and off-site

sampling locations. The Project monitors concentrations of radon and direct gamma radiation and selected airborne radioparticulates. Samples are analyzed quarterly at 37 locations.

Radiological dose to the public did not exceed the DOE Order 458.1 dose limits from any radiological releases in 2021. Section 4.1 addresses the population dose and dose to the maximum exposed individual (MEI).

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 2021, operation and monitoring of the IA system continued.

The groundwater program is currently working on developing the 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 QA Plans, which include validation of data collection and sample analysis. Section 7.0 addresses the Moab Site QA Program.

Key Activities in 2021

The Project shipped 989,341 tons of residual radioactive material (RRM) from the Moab site to the Crescent Junction disposal site during 2021. The cumulative total through 2021 was 12.1 million tons.

Document Availability

This document may be viewed in its entirety on the DOE Moab Project website at *www.gjem.energy.gov* and in the public reading room in the Grand County Public Library in Moab. Hard copies may be obtained by contacting the Moab Federal Cleanup Director at (970) 257-2115 or at the address below.

U.S. Department of Energy
200 Grand Avenue, Suite 500
Grand Junction, CO 81501

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.*

1.0 Introduction

1.1 Site Locations

The Moab 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.

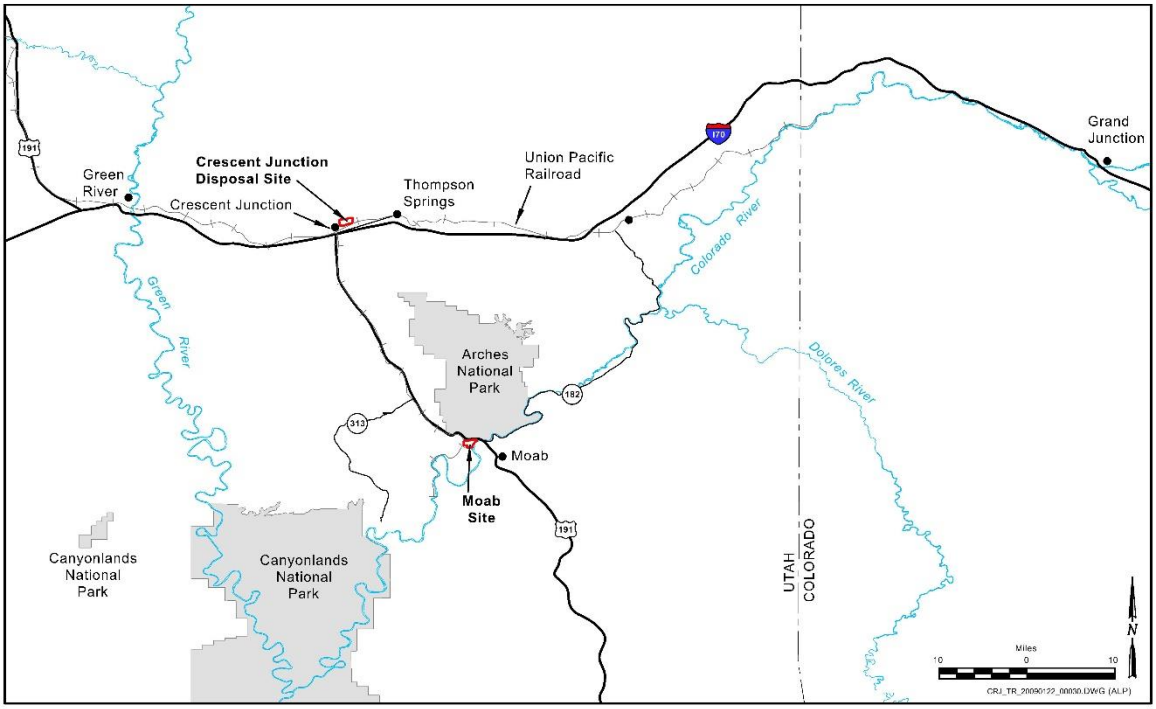

Figure 1. Location of Moab and Crescent Junction Sites

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.

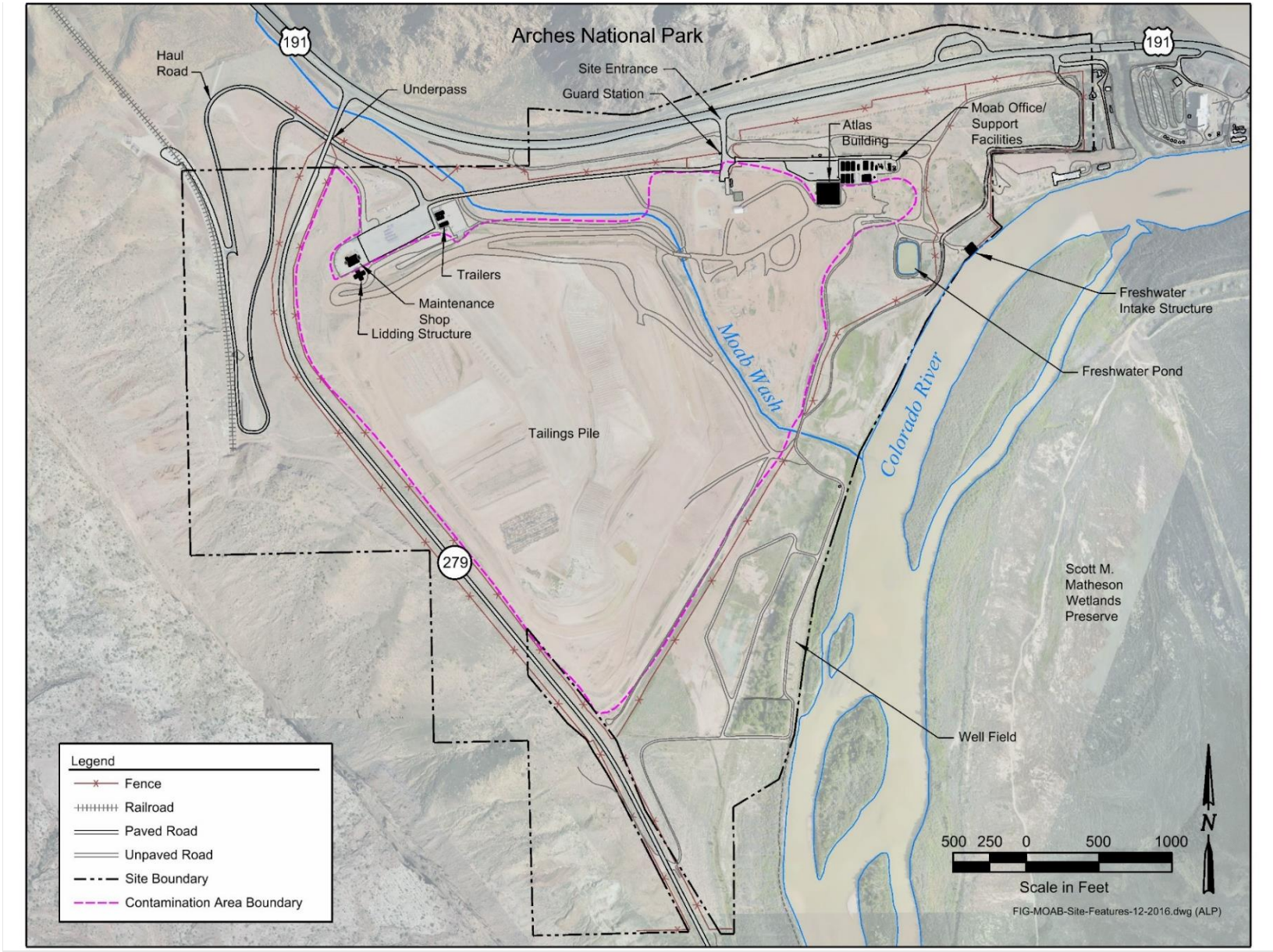

Figure 2. Moab Site Features

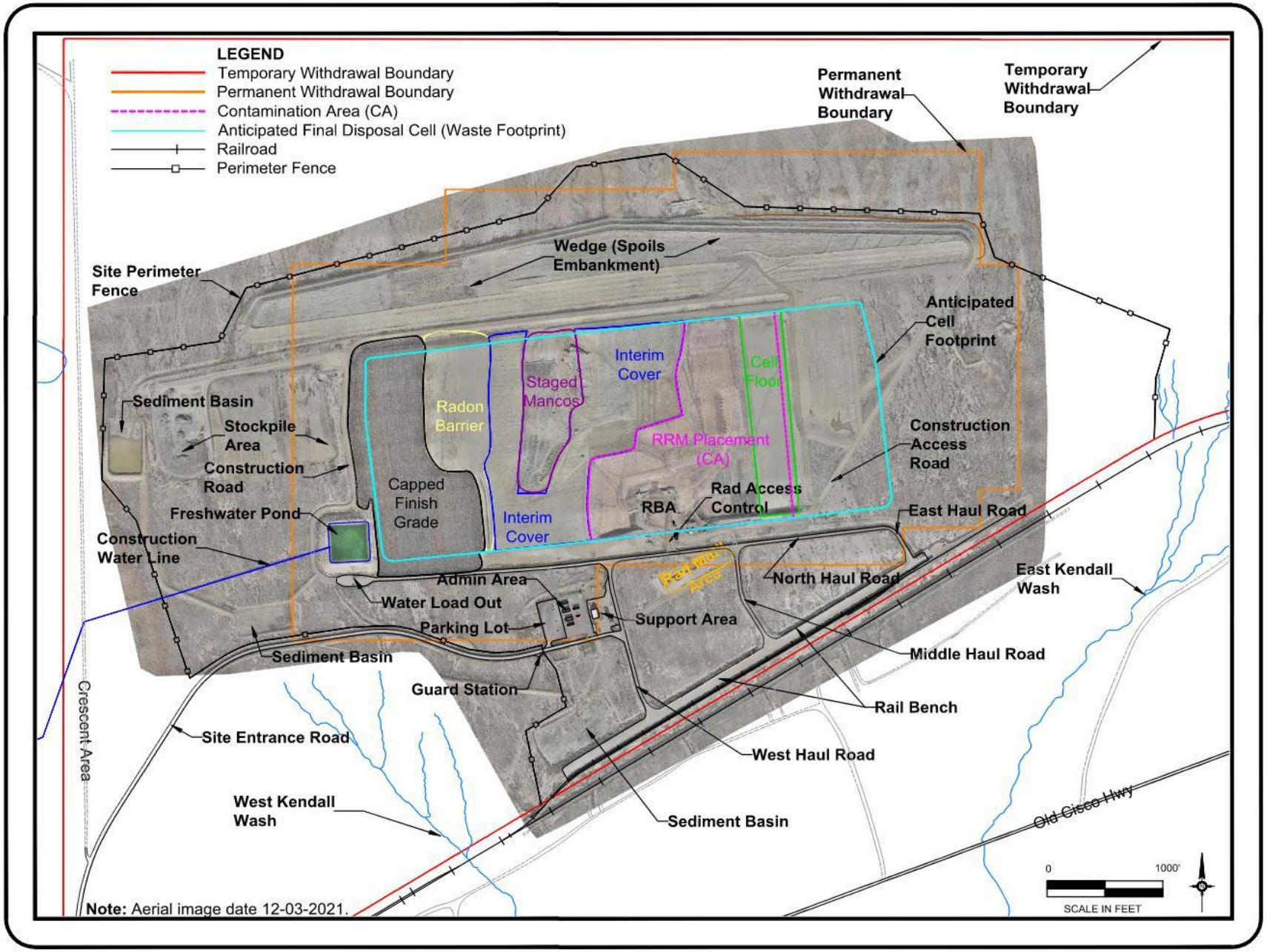

Figure 3. Crescent Junction Site Features

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 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 to 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 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 remediated areas and maintaining vegetation in remediated areas.

1.5 Environmental Setting

Meteorology
At the Moab site, the 2021 average annual temperature was approximately 60ºF. January was the coldest month, with low temperatures averaging 21ºF, and July was the warmest month, with high temperatures averaging 100ºF. The total rainfall was approximately 8.6 inches. At the Crescent Junction site, the average annual temperature was approximately 57ºF. January was the coldest month, with low temperatures averaging 27ºF, and July was the warmest month, with high temperatures averaging 86ºF. The total rainfall was approximately 7.5 inches. The Crescent Junction onsite meteorology station experienced data loss from January to August due to a dead battery. Data from an offsite station, located less than a mile away, was used to fill the data gaps.

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 about 5,366 (2021 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 about 9,669 (2021 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 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 2021. Table 1 summarizes federal and state environmental regulations and their implementation status on the Project.

2.2 Other Major Environmental Issues and Actions

DOE uses external and internal assessments, surveillances, and management assessments to evaluate environmental compliance and implement corrective actions. The Project QA organization performed and/or coordinated assessments in 2021 to verify system descriptions and compliance with procedures and regulations.

Adapting to Climate Change

The Project actively controls 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. 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

The UMTRA Project is an active remediation site that is removing a former uranium-ore processing facility and mill tailings pile off the banks of the Colorado River. A system of injection and extraction wells protect the river by reducing 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.

2.3 Continuous Release Reporting

Not applicable to the Project.

2.4 Unplanned Releases

No unplanned radiological or non-radiological releases occurred in 2021.

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	2021 Implementation Status
Environmental Restoration and Waste Management		
RCRA, FFCA	Resource Conservation and Recovery Act (RCRA) governs the generation, storage, handling, and disposal of hazardous wastes. In 1992, RCRA was amended by the Federal Facilities Compliance Act (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 2021, no RCRA wastes were generated outside the CA. The Project maintains a Very Small Quantity Generator status.
NEPA	National Environmental policy Act (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 2021, site operations were conducted in accordance with NEPA. One Categorical Exclusion was completed in 2021.
TSCA	Toxic Substance Control Act (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 2021, no TSCA wastes were generated outside the CA.
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) governs the distribution, sale, and use of pesticides. This act categorizes pesticides as either restricted or general use.	During 2021, only two herbicides sprayed onsite in 2021 were Milestone® and Garlon3A®. Other herbicides are present onsite and are safely stored. All pesticides onsite are general use.
Radiation Protection		
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 2021, the Project excavated and disposed of RRM and contaminated groundwater in compliance with 40 CFR 192.

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

Federal or State Requirement	What it Covers	2021 Implementation Status
Radiation Protection (*continued*)		
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 2021, 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 2021, 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.
Air Quality and Protection		
CAA	Clean Air Act (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 the sites.
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.	During 2021, EPA Method 9-certified individuals diligently monitored opacity and implemented controls outlined in the site fugitive dust control plans.
40 CFR 61, NESHAP	The CAA establishes emission standards for hazardous air pollutants associated with various industrial processes codified as National Emissions Standards for Hazardous Air Pollutants (NESHAP).	NESHAP regulations are not applicable to facilities subject to 40 CFR 192.
Water Quality and Protection		
33 USC 1251, CWA/NPDES	Under the Clean Water Act (CWA), the National Pollutant Discharge Elimination System (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 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. The NOI's were renewed for 2021 with Utah Department of Environmental Quality (UDEQ). During 2021, no discharges were noted under UPDES.

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

Federal or State Requirement	What it Covers	2021 Implementation Status
Water Quality and Protection (*continued*)		
Storm Water Management and EISA	Under Section 438 of Energy Independence and Security Act (EISA), federal agencies have requirements to reduce storm water runoff from federal development projects to protect water resources.	During 2021, the Project conducted monthly inspections to ensure storm water controls were intact and storm water runoff was managed according to the plans. In addition, inspections were conducted after a 0.5" or greater rainfall event, which is required by the permit.
42 USC 300f, SDWA	The Safe Drinking Water Act (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 2021, a Temporary Change Application was received from the Utah Department of Natural Resources, Division of Water Rights (see Table 2).
Other Environmental Statutes		
U.S. 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 2021, the Project remained in compliance with the Special Permit.
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 2021.
National Historic Preservation Act	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.	No impacts were noted during 2021.
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 and conducts quarterly visual inspections of the outside oil storage containers.

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

Federal or State Requirement	What it Covers	2021 Implementation Status
Other Environmental Statutes (*continued*)		
ESA	The Endangered Species Act (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 2021. Critical fish habitat was protected by interception of contaminated groundwater and injection of fresh water in wells near the Colorado River.
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 3.2 summarizes the Project's invasive weed control efforts.
MBTA	The Migratory Bird Treaty Act (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 2021, 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 has implemented an EMS that has been incorporated in contractor's ISMS to promote sound stewardship practices and to ensure compliance with this order.
42 USC 11001, EPCRA	Emergency Planning and Community Right-to-Know Act (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 reporting requirements and submitted Tier II Emergency and Hazardous Chemical Inventory Reports for 2021.

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

Federal or State Requirement	What it Covers	2021 Implementation Status
Other Environmental Statutes (*continued*)		
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 2021 were limited to seeding, mowing, irrigation, weed control, removal of dead trees, 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 2021 that could enhance jurisdictional wetlands included storm water controls, revegetation, and erosion control.

2.6 Summary of Permits

Table 2 shows the active Project permits during 2021.

Table 2. Active Permits for the Moab Project

Permits	Issuing Agency	No. of Permits
UPDES Construction General Permits: Moab UTR359185, UTRC00000 Crescent Junction UTR359187	State of Utah, Department of Environmental Quality, Division of Water Quality	2
Temporary Change Applications 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
Highway rights-of-way and encroachment permits for roads, pipelines, and gates	State of Utah, U.S. DOT	8
Special Permit SP-14283 for DOE to transport RRM and party status for the RAC	U.S. DOT	1
Scientific Research and Collecting Permit ARCH-2021-SCI-0006	National Park Service	1
Asbestos Landfill Permit	State of Utah, Department of Environmental Quality, Division of Air Quality	1
Conditional Use Permit	Grand County Council	1

3.0 Environmental Management System

The framework of the Project's 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 defines how the DOE, as implemented by the Technical Assistance Contractor (TAC) and 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 EMS are as follows:

- Implement, maintain, and continually improve the EMS.
- Execute conformance to ISO 14001:2015.
- Establish roles and responsibilities for key management and EMS positions.
- Apply a standardized method to incorporate environmental concerns into the Moab UMTRA Project utilizing the ISO 14001:2015 EMS as a guide.
- Identify and comply with all applicable environmental laws, regulations, and other requirements.
- Support and implement the Moab UMTRA Project Environmental Policy.
- Identify project-related environmental aspects and environmental objectives relative to site activities.
- Adhere to the DOE's ISMS with all work-related safety and compliance controls.

These objectives apply to everyone working on behalf of 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 uses 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 aspects 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 2021, the Project considered environmental aspects of new activities, but none were determined significant.

The Project's EMS underwent a third-party Remote Independent Conformance Review (RICR) in 2021. The RICR The RICR was performed to the requirements of DOE O 436.1, *Departmental Sustainability*, and ISO 14001:2015, *International Organization for Standardization (ISO) Environmental Management System Standard*. The RICR identified six Noteworthy Practices, zero Non-Conformances, two Observations and 11 Opportunities for Improvement. Environmental Managers on the RAC and TAC edited the EMS Manual and supporting document to address the RICR findings. EMS changes were completed and implemented in 2022 and will be reflected in the 2022 ASER.

In 2021, the EMS improved aspects in the following areas:

- Reduced risk to the facility by meeting compliance obligations.
- Greater recognition of environmental issues by presenting compliance/environmental topics to Project employees.
- Empowerment of individuals to contribute to improving the organization's environmental footprint through the Project Environmental Policy, engagement with internal stakeholders, and team meetings to discuss Project environmental issues.
- The environmental objectives were updated to include sustainability goals.
- Improved personnel health and safety through compliance training, by incorporating environmental hazards and controls into the Integrated Work Planning process, spill prevention controls, and complying with the Hazardous Communication protocol.

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 2021 EPEAT Purchaser Award and associated Three-Star Award for the purchase of 56 EPEAT registered electronics and a Gold and Prime GreenBuy Award for sustainable acquisition purchasing. This is the fourth time Moab has achieved the Gold level which is also commended with the GreenBuy Prime Award for demonstrating exceptional achievements in Sustainable Acquisition. This is the second time Moab is recognized with the GreenBuy Prime Award.

Revegetation

Revegetation efforts are focused on two main goals: 1) promoting desirable native vegetation, and 2) managing non-native weed species. In 2021, the Moab area was in a severe drought and had one of the lowest recent water years. Revegetation staff observed overall less weeds onsite (i.e., kochia and tamarisk; most likely due to drought conditions and low soil moisture) and flourishing native bunch grasses (i.e., Alkali sacaton).

Accomplishments for promoting desirable native vegetation in 2021:

- Completed felling and processing all dead trees in the previously flood irrigated cottonwood plots in the wellfield. Stumps were removed and trees were processed (chipped and mulched). Mulch was utilized for soil amendments when possible.
- Previous flood berms were removed and material was transported to underperforming areas in the wellfield. Soil preparations began in planning for spring seeding in 2022.
- Created a one-acre test plot in the wellfield where various treatments and seed mixes were tried out and evaluated. Inland salt grass was successfully transplanted from onsite in this area.
- Designed a long-term repeat photo monitoring system for the test plot. These methods will be applied to rest of this area in 2022.
- Custom seed mix was designed for the wellfield based on soil sample results and current thriving native vegetation. An order was placed with local nursery for containerized plants for next year.
- Planted approximately 57 pollinator species in "pollinator plot", including penstemon, globemallow, and daisies.
- 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.
- Based on previous Watershed Restoration Initiative grant award, the Moab UMTRA Project was awarded 250 lbs. of native seed, which was used to seed a shared boundary between State of Utah and UMTRA.
- The collaborative U.S. Geological Survey (USGS) research project continued throughout 2021 (336 experimental plots were installed in fall 2020). USGS and UMTRA staff partnered to build dripline irrigation to 168 randomly selected plots. Staff also joined together to collect baseline data on the plots.
- Partnered with Arches National Park and received 8 dump truck loads (80 cubic yards) of fill dirt that was placed in underperforming areas of the wellfield.
- Conducted two biocrust salvages to test viability for effective restoration:
  - from Arches National Park, a construction area in the Windows section. The biocrust was collected, transported, and placed in 6 different areas onsite.
  - from a construction site for O.A.R.S. river running outfitters in Spanish Valley, south of the town of Moab.
- Significantly reduced weed cover, specifically kochia, through mowing at appropriate times, allowing native bunch grasses to flourish.
- Maintained native bunch grasses by using selective herbicide (i.e., Milestone) in areas of noxious weeds (i.e., Russian knapweed).
- Continued to use burn box (on loan from the Bureau of Land Management) to burn vegetative debris too large for the chipper/shredder and to reduce trips to the landfill.

- Planted desert willow (*Chilopsis linearis*) and three-leaf sumac (*Rhus trilobata*) along the Hwy 191 cottonwood hedgerow to start replacing dying cottonwood trees.
- Learned seed collecting techniques from the National Park Service vegetation crew, which will help promote genetics of native species capable of growing in challenging conditions onsite.

Accomplishments for managing non-native weed species for 2021:

- Staff treated noxious weed species in 21 out of 27 revegetation zones.
- Focused efforts on controlling noxious weed species, starting with the smallest infestations first: Bermuda grass, Canada thistle, field bindweed, and perennial pepper weed; then onto larger infestations of Russian olive, Russian knapweed, and tamarisk.
- In 2021, over 95% of all Russian olive onsite were treated.
- Staff conducted early detection-rapid response of a new noxious species found onsite, goathead (puncturevine; *Tribulus terrestris*), which appeared after late monsoon storms.
- All 2021 revegetation staff passed test and received Pesticide Applicators License through State of Utah.
- Improved herbicide storage by moving to climate-controlled room and improving safety labeling.
- An herbicide, Garlon3A®, was approved by Health and Safety and is now being used by to control Russian olive, tamarisk, field bindweed, and elms. DOE Legacy Management came onsite and taught UMTRA staff safe methods for using Garlon3A.

Treatments and control strategies for each species are outlined in the *Moab UMTRA Project Revegetation and Weed Control Plan, Revision 8* (DOE-EM/GJTAC1655). A comprehensive weed inventory and mapping of the Moab UMTRA Project site from was conducted in 2020. In 2021, no official inventory or mapping was conducted, however, revegetation personnel visually monitored for weeds throughout the site while doing other revegetation activities.

4.0 Environmental Radiological Protection Program and Dose Assessment

4.1 Radiological Discharges and Doses

This section presents results of the calculated radiation dose to the public from Project operations in 2021. Compliance with DOE O 458.1 may be demonstrated by calculating the dose to the maximally exposed individual (MEI), the representative person or group from the public likely to receive the most radiation dose based on exposure pathways and parameters.

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 2021 public radiation dose applicable to both the Moab and Crescent Junction sites compared to the DOE public dose limit is shown in Table 3. Calculations for population dose have been updated to improve the accuracy of dose by incorporating the inverse square law into calculations and using an updated population breakdown for a 50-mile radius.

Table 3. Moab Project 2021 Public Radiation Dose

Pathway	Maximum Annual Dose to MEIs in mrem (mSv)	% of DOE 100 mrem/yr Limit	Estimated Collective (Population) Dose in person-rem (Sv)	Population Within 50 miles (~80 km)	Estimated Bkgd Radiation Population Dose in person-rem
Air	25.53 (0.255)*	25.53	10.83 (0.108)*	~7,620	664.4
Water	N/A	N/A	N/A	N/A	N/A
Other Pathways	N/A	N/A	N/A	N/A	N/A
All Pathways	28.83 (0.288)*	25.53	10.83 (0.108)*	~7,620	664.4

*Background Subtracted
Note: 1 rem = 0.01 Sv
Note: 1 mrem= 0.01 mSv
Note: 1000 mrem = 1 rem
The air pathway includes inhalation and direct gamma radiation.

4.2 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 2021, DOE did not perform any off-pile or vicinity property remediation.

4.3 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.

Moab RRM contains low levels of radioactivity, and the chemical composition (salt and pH) of the tailings pile materials limits 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 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 effects.

4.4 Unplanned Radiological Releases

No unplanned radiological releases occurred in 2021.

4.5 Environmental Radiological 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 Project's current air monitoring network measures radon, direct gamma radiation, and airborne radioparticulates at on-site and off-site locations around the

Project sites. Moab monitoring locations are shown in Figures 4 and 5. Crescent Junction locations are shown in Figure 6.

Environmental air monitoring results are used to demonstrate compliance with DOE O 458.1. DOE O 458.1 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 and its decay products (excluding background) at the site boundary, and an annual total effective dose (TED) to exceed 100 mrem above background, excluding dose from radon and its decay products.

Established background monitoring locations were sufficiently placed to ensure air quality is not influenced by airborne contaminants associated with Project operations. Data from stations 0117 and 0123 collected between 2003 and 2008 were used to establish an average background radon concentration in the Moab area of 0.7 pCi/L and a background direct gamma radiation effective dose of 82 mrem/yr.

Data collected from monitoring stations in the Crescent Junction area from 2006 to 2009, before tailings shipments began, were used to establish a background radon concentration of 0.9 pCi/L and a background direct gamma radiation effective dose of 92.5 mrem/yr. The effective background dose from inhalation of radioparticulates was not determined for both sites and was assumed to be zero.

Environmental air monitoring data are published in quarterly reports that are posted on the DOE Project website at *www.gjem.energy.gov* and are available in the Moab public reading room. End-of-year monitoring results for 2021 for the Moab site are shown in Table 4 and for Crescent Junction in Table 5. Background values have been subtracted from data. During third quarter 2021 radon and direct gamma monitoring station 0303 was permanently removed due to disposal cell expansion operations. A new station was placed to measure radon and direct gamma on the northern site boundary, 0310. Since there has not been a full year's worth of data from this station, radon and direct gamma measurements are at or below background levels for 2021 and have been noted in the table.

4.5.1 Radon

DOE O 458.1 established a limit of 3.0 pCi/L above background for radon concentrations at the DOE property boundary. During 2021, radon was measured at 37 locations (23 on site, 12 off site, and two MEIs) using alpha-sensitive detectors (e.g., radon cups). Radon cups were exposed for a period of approximately 90 days (three months). After collection, the radon cups were sent to an off-site laboratory for analysis. As shown in Tables 4 and 5, one location reached the 3.0 pCi/L annual limit but was not in exceedance of the DOE limit.

4.5.2 Direct Gamma Radiation

As uranium decays, several of the decay products emit gamma radiation. RRM at the Moab site is a source of direct gamma radiation. During 2021, direct gamma radiation was measured at the same 37 locations (23 on site, 12 off site, and two MEIs) using thermoluminescent dosimeters exposed for approximately 90 days (three months).

On collection, the dosimeters were sent to an off-site laboratory for analysis. These results (Tables 4 and 5) represent the gamma dose an individual would receive from continuously

occupying a location for an entire year. As expected, the highest results were associated with locations closest to the tailings pile. While these values are high, no member of the public occupies that area long enough to receive a dose that is above the DOE limit.

The gamma dose is combined with the air radioparticulate dose to calculate the total effective dose (Section 4.5.4). There are only 13 locations where the air radioparticulate data are collected compared to the 37 locations where gamma doses are measured. Even without adding the radioparticulate dose, it is evident based on the results provided in Table 4 that some of the Moab locations (in particular on-site locations 0109, 0110) would exceed the total effective dose limit without adding the dose associated with the radioparticulates. However, the doses represent 100% occupancy. The public does not consistently occupy any of these locations. The MEI is below the annual limit at both sites.

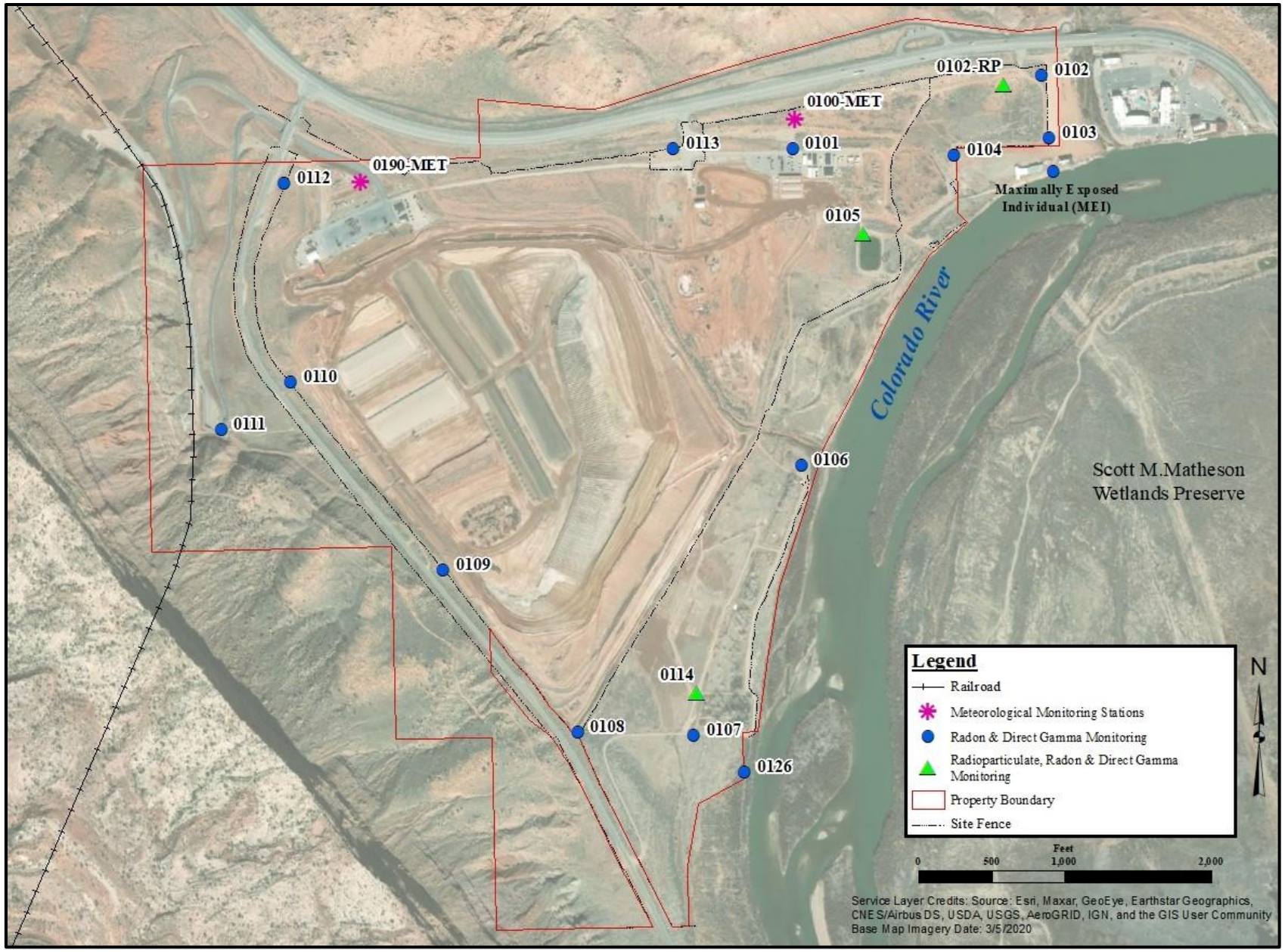

Figure 4. Moab On-site and MEI Environmental Air Monitoring Locations

Figure 5. Moab Off-site Environmental Air Monitoring Locations

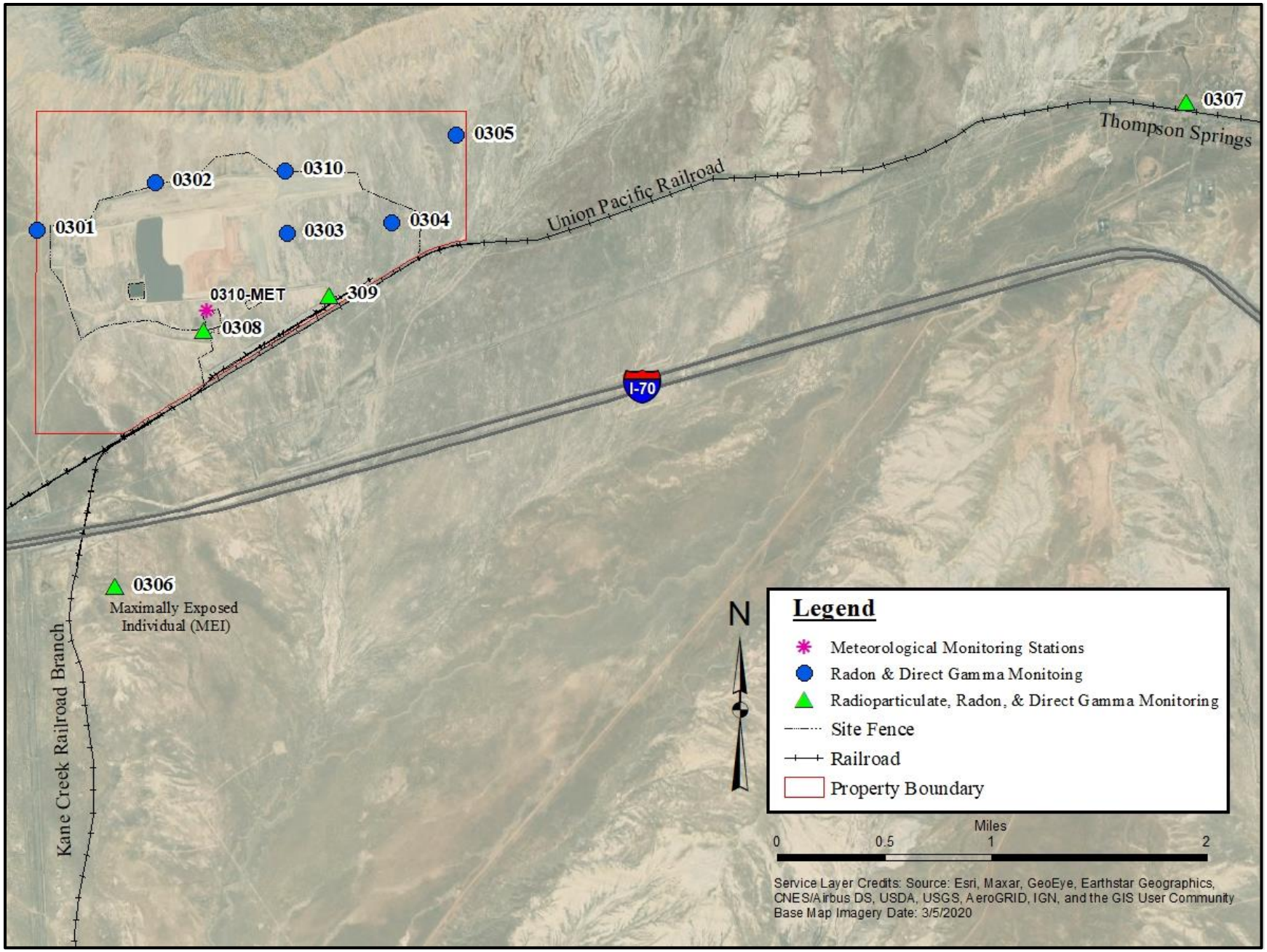

Figure 6. Crescent Junction Site Environmental Air Monitoring Locations

Table 4. Environmental Air Monitoring Data at the end of 2021 for the Moab Site

Station Number	Annual Average Radon Concentration (pCi/L)	Annual Direct Gamma Radiation Effective Dose (mrem/yr)	Annual Radioparticulate Effective Dose (mrem/yr)
On-site Locations			
0101	1.7	75	N/A
0102	0.9	27	4.07
0103	0.8	27	N/A
0104	1.6	38	N/A
0105	1.8	33	4.75
0106	2.5	71	N/A
0107	2.0	51	N/A
0108	2.5	107	N/A
0109	1.0	372	N/A
0110	0.7	310	N/A
0111	At or below background	33*	N/A
0112	0.9	119	N/A
0113	1.8	70	N/A
0114	2.4	62	6.72
0126	1.4	48	N/A
Off-site Locations			
0117	At or below background	3*	2.80
0118	At or below background	28	2.78
0119	0.2	37	3.40
0121	At or below background	16	N/A
0122	At or below background	0*	2.88
0123	At or below background	15	2.63
0124	0.4	32	N/A
0125	0.6	44	N/A
0127	0.2	29	N/A
0128	1.4	36	N/A
0129	0.8	52	7.58
MEI	0.7	25	4.07[1]

Background values were subtracted
[1]MEI dose obtained using closest monitoring station 0102.
N/A – No radioparticulate stations to calculate TED
* Annual sum based on 3 quarters due to a damaged TLDs

Table 5. Environmental Monitoring Data at the end of 2021 for the Crescent Junction Site

Station Number	Annual Average Radon Concentration (pCi/L)	Annual Direct Gamma Radiation Effective Dose (mrem/yr)	Annual Radioparticulate Effective Dose (mrem/yr)
On-site Locations			
0301	At or below background	21.5	N/A
0302	At or below background	21.5	N/A
0304	At or below background	26.5	N/A
0305	At or below background	28.5	N/A
0308	1.3	27.5	3.91
0309	0.9	42.5	5.05
0310	At or below background	24.5	N/A
Off-site Locations			
0306[1]	At or below background	13.5	2.14
0307	At or below background	26.5	1.89

Background values were subtracted
[1]MEI location
N/A – No radioparticulate stations to calculate TED

4.5.3 Radioparticulates

Although the milling process recovered about 95 percent of the uranium, the RRM contains several other naturally occurring radioactive elements. In 2021, air samplers measured radioparticulates at 13 locations (four on site, seven off site, and two MEIs).

Air filters were collected weekly and submitted as a composite sample on a quarterly basis. The filters were analyzed for specific radionuclides that are common isotopes of RRM, including total uranium, thorium-230, radium-226, polonium-210, and actinium-227. It was possible to calculate the protactinium-231 concentration based on the actinium-227 results.

During third quarter of 2021 polonium-210 results from the lab were extremely high due to low chemical yields determined by the tracer. The lab believed the tracer used fir the samples was compromised. The lab a completed a conformance review. The lab removed the compromised tracer and replaced it with a new one. Since the polonium-210 values reported from the lab is not representative of the site, those values were omitted from the final radioparticulate results.

4.5.4 Total Effective Dose

The annual total effective dose at the end of 2021 was 29.07 mrem to the Moab MEI and 22.64 mrem to the Crescent Junction MEI. These values are below the annual 100 mrem limit. Nearly all of the dose to the MEI is due to direct gamma radiation. The dose to the lens of the eye, skin, and extremities is the same as a full body dose and is below the regulatory limit of 1500 mrem in a year to the lens of the eye and 5000 mrem in a year to the skin or extremities.

Values were calculated by subtracting the background dose of 82 mrem from the Moab MEI gamma radiation dose and the background dose of 92.5 mrem from the Crescent Junction MEI, and then adding the respective radioparticulate doses.

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). Air opacity is monitored at the sites by Project personnel certified to EPA Method 9. In accordance with Utah Administrative Code R307-205-8, the fugitive dust must not exceed 20% opacity.

DOE operates two meteorological monitoring stations at the Moab site and two at or near the Crescent Junction site (see Figures 4 and 6, respectively). These stations enable DOE to monitor site-specific meteorological conditions and events and provide a valuable resource for assessing impacts resulting from any unplanned release of airborne contamination. Meteorological parameters monitored include air temperature, relative humidity, solar radiation, wind speed, wind direction, and precipitation. An extended drought in 2021 impacted the freshwater intake structure. A secondary pump had to be placed to obtain fresh water for site operations. Other than the drought, no abnormal weather events impacted the site.

5.2 Fire Protection Management and Planning

No unplanned wildland fires occurred at the sites in 2021. Dead vegetation, weeds, and windblown materials are cleared near buildings and equipment to minimize fire hazards. Weed control and limited removal of dead vegetation are performed in other areas of the sites.

For revegetation purposes, a burn box was recommended by an SME and was acquired on loan from the Bureau of Land Management. A burn box, which is a large metal bin with a separate lid, can hold approximately 7 cubic yards. It is a very efficient way of burning compared to open burning.

The burn box was utilized in 2021 for burning vegetation debris from on site, mostly logs and stumps too large for the wood-chipper / shredder. Burn box operations were conducted a when the clearing index was favorable for burning within the burn window and 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.

5.3 Recreational Hunting and Fishing

There is no recreational hunting or fishing 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.

Figures 7 and 8 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. Monitoring results show the extent of contaminant plumes has not significantly changed in the past five years. 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.

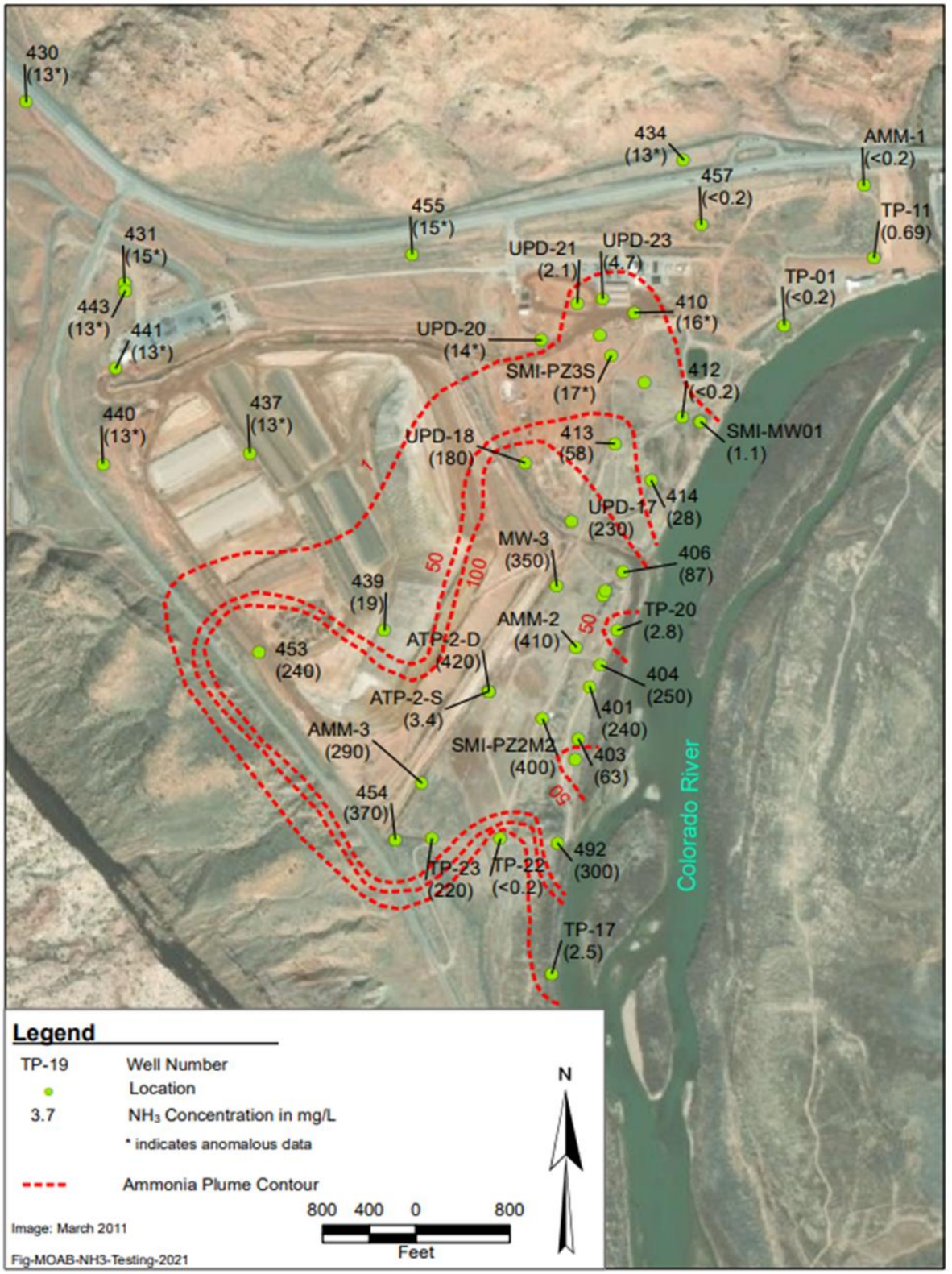

Figure 7. Ammonia Plume Contours and Select Monitoring Well Sampling Locations

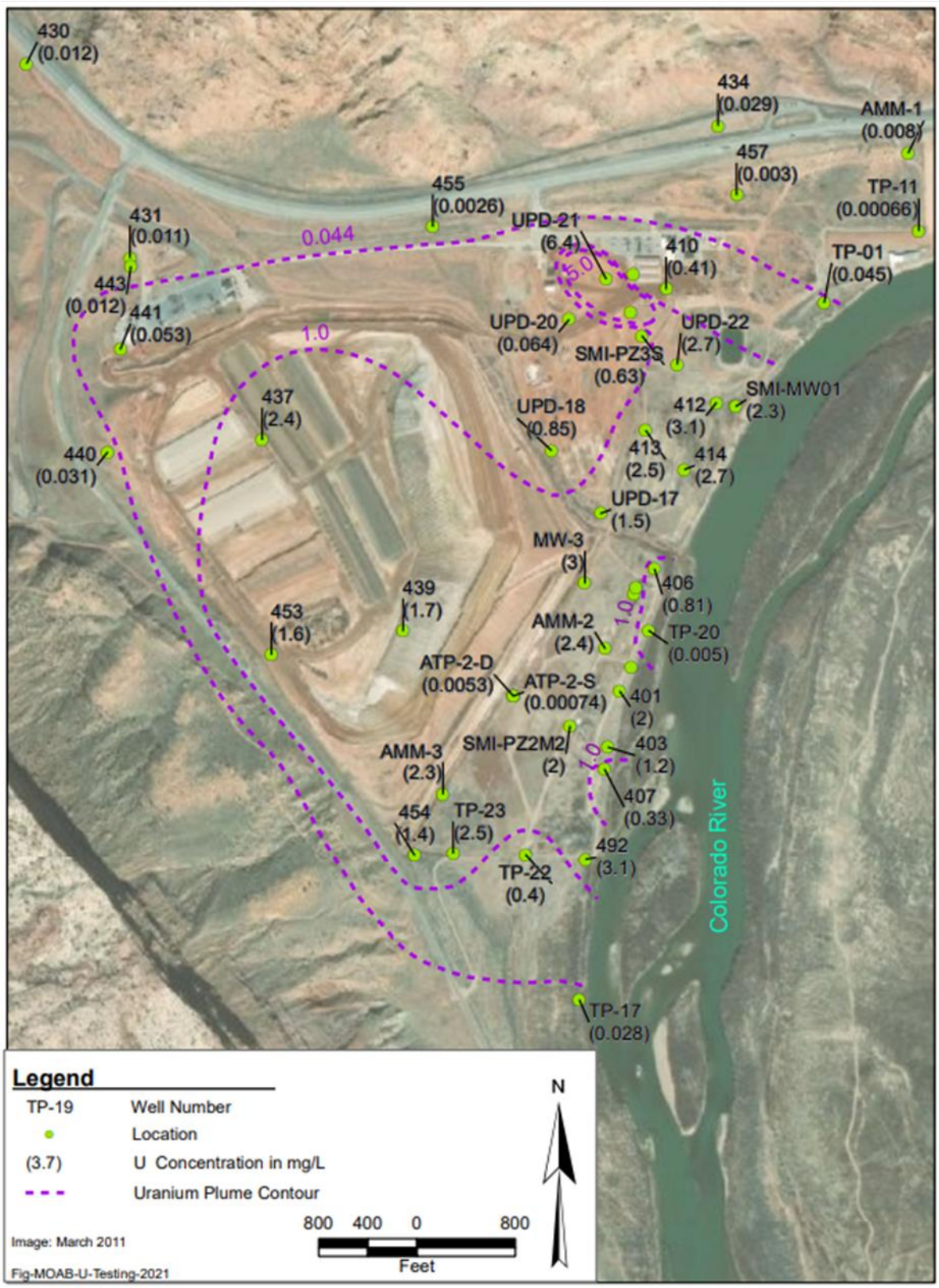

Figure 8. Uranium Plume Contours and Select Monitoring Well Sampling Locations

6.1 Groundwater

In 2021, 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 May and September 2021, and site-wide sampling events were completed in May-July 2021 to assess contaminant plumes. Groundwater samples were primarily analyzed for ammonia and uranium, with some select locations also analyzed for arsenic and selenium. Data results from sampling events are available on the Project website at www.gjem.energy.gov and in the Moab public reading room.

Table 6 shows the ammonia and uranium concentrations over the past five years at representative well location 0443, an observation well up-gradient of the tailings pile, extraction well 0815, downgradient of the tailings pile, and 0403, an observation well near the riverbank. See Figure 7 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 tends to dilute the groundwater. In an average year 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 time frame best represent the overall groundwater chemistry. For better comparison purposes and to display the concentration changes as the groundwater flows towards the river, Table 6 below provides groundwater ammonia and uranium concentrations during the river base flows.

Table 6. 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)
2016	0.1**	0.01	250	3.7	39	0.98
2017	0.1**	0.01	190	3.0	120	0.48
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

*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 7 summarizes the 2021 sampling efforts at the Moab site. Table 8 shows the ranges of results for positive detection of the most significant constituents in surface water (ammonia and uranium) and groundwater (ammonia, arsenic, selenium, and uranium) samples collected in 2021.

Table 7. 2021 Sample Collection/Analysis Summary

Surface Water Samples	
Number of Surface Water Locations	15
Number of Analyses Performed	30
Groundwater Samples	
Number of Locations	88
Number of Analyses Performed	414

Table 8. 2021 Sample Result Summary

Ranges of Results		
Analyte	**Minimum (mg/L)**	**Maximum (mg/L)**
Surface Water Samples		
Ammonia	0.001	4
Uranium	0.0022	0.048
Groundwater Samples		
Ammonia	0.2	1,200
Arsenic	0.00022	0.23
Selenium	0.00033	0.29
Uranium	0.00002	6.4

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 8.8 million gallons of fresh water was injected into the subsurface adjacent to the Colorado River in 2021. The surface water diversion system was operational between late June and the end of September, with 4.6 mil gal of freshwater diverted into habitat areas.

Eight surface water samples were collected on site, upriver, and downriver (see Figure 9) for laboratory analysis at near peak flow (June 2021) and base flow (January 2021) conditions. Another eight surface water samples were collected when a suitable habitat (Figure 10) developed. Table 9 shows the un-ionized ammonia concentration at each of these habitat locations and the corresponding EPA acute and chronic criteria, and Tables 10 and 11 provide similar information for the site-wide locations and the habitat background locations, respectively. Where applicable, 4-day average chronic criteria was applied to locations sampled over a longer time period.

Of these surface water samples collected from the suitable habitat area, eleven had ammonia concentrations that exceeded the chronic criteria. However, no levels exceeded the acute criteria. The surface water diversion manifolds were deployed to this area as soon as these elevated

concentrations were identified. All suitable habitats that developed in 2021 were constantly monitored, and no dead fish were observed.

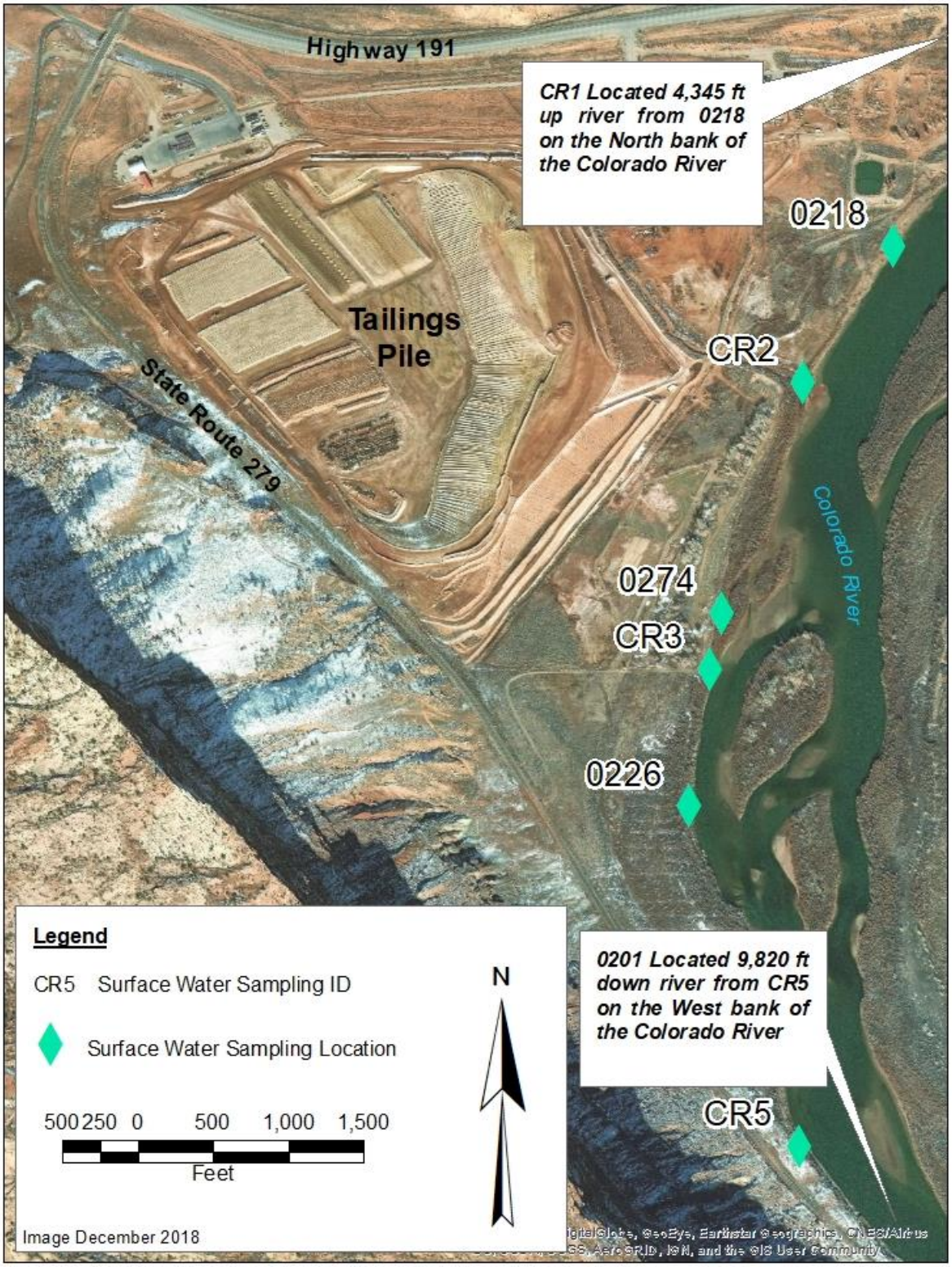

Figure 9. 2021 Site-wide Event Surface Water Sampling Locations

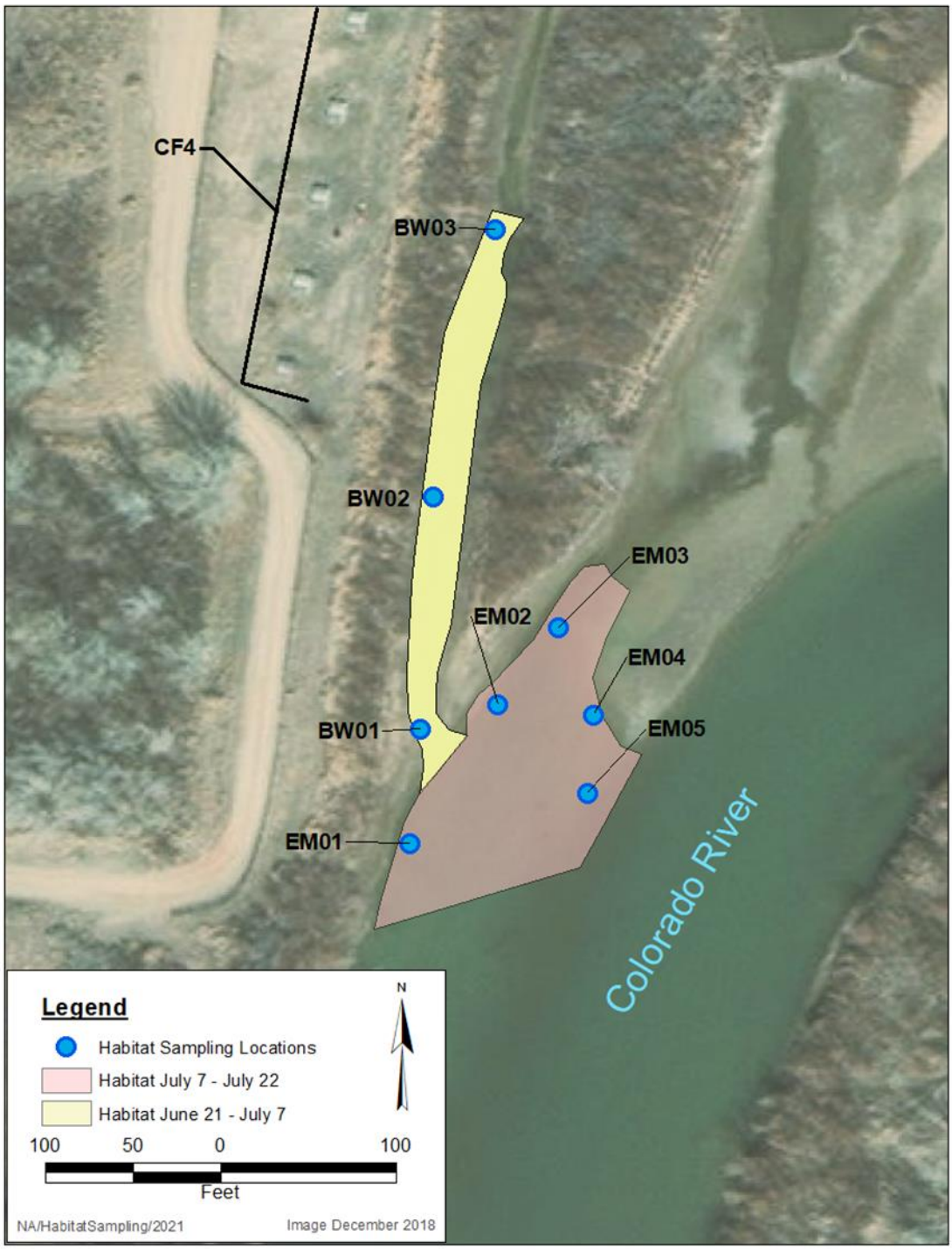

Figure 10. September 2021 Habitat Area Sampling Locations

Table 9. 2021 Ammonia Concentrations in Suitable Habitat Surface Water Samples Compared to EPA Acute and Chronic Criteria

Sample Location	Sample Date	Temperature (°C)	pH	Ammonia[1] (mg/L)	Acute Criteria[2] (mg/L)	Chronic Criteria[3] (mg/L)
BW01	6/21/2021	26.73	7.74	2.24	10	0.73
	6/28/2021	24.68	8.05	0.959	6.8	0.55
	7/7/2021	25.81	7.28	1.87	22	1.1
	7/15/2021	25.59	7.48	1.27	16	1.0
BW02	6/21/2021	26.5	7.38	9.25	16	0.96
	6/28/2021	24.43	6.98	0.05	32	1.5
	7/7/2021	28.27	7.32	0.06	17	0.97
BW03	6/21/2021	31.15	7.39	0.06	13	1.0
	6/28/2021	23.98	6.98	0.05	32	1.5
	7/7/2021	26.37	7.32	0.06	22	1.1
EM01	7/7/2021	24.47	7.31	0.65	23	1.1
	7/15/2021	23.67	7.68	1.36	13	0.88
EM02	7/7/2021	24.91	7.39	1.19	49	1.2
	7/15/2021	24.09	7.52	1.88	18	1.1
EM03	7/7/2021	23.66	7.39	1.65	23	1.2
	7/15/2021	21.94	7.39	1.48	24	1.3
EM04	7/7/2021	24.48	7.32	1.19	21	1.3
	7/15/2021	23.52	7.4	1.62	22	1.3
EM05	7/7/2021	24.82	7.39	0.64	19	1.1
	7/15/2021	24.08	7.55	1.17	18	1.1

Notes: 1= Ammonia data was obtained on-site from a HACH Sension Probe, 2 = 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)
3 = 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), *ITALIC values based on the 4-day average*

Table 10. 2021 Ammonia Concentrations in Site-wide Surface Water Samples Compared to EPA Criteria

Sample Location	Sample Date	Temperature (°C)	pH	Ammonia as N (mg/L)	Acute Criteria (mg/L)*	Chronic Criteria (mg/L)**
0201	6/10/21	20.72	7.4	<2	9.8	1.4
0218	6/10/21	20.83	7.54	<2	8.5	1.3
0226	6/10/21	24.33	8.32	4	1.6	0.38
0274	6/10/21	25.70	8.08	N/A	2.0	0.46
CR1	6/10/21	21.34	7.47	<2	8.5	1.3
CR2	6/10/21	21.59	7.62	<2	6.7	1.1
CR3	6/10/21	23.86	7.76	<0.2	4.0	0.79
CR5	6/10/21	21.77	7.49	<2	7.8	1.2

*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)
N/A= Not available

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). 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 2021: 1) ALS Environmental, Fort Collins Colorado, for radiological and non-radiological analytes; 2) Radonova, Westmont, Illinois, for radiological analytes; and 3) 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.

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 Manual* (DOE-EM/GJ1545), which follows DOE orders, policies, and regulations for retention and maintenance of records.

8.0 References

10 CFR 830A, (Code of Federal Regulations), "Nuclear Safety Management," "Quality Assurance Requirements,"

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."

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

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

33 USC 1251 (United States Code), Clean Water 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.

DOE (U.S. Department of Energy), *Moab UMTRA Project Flood and Drought Mitigation Plan* (DOE-EM/GJ1640).

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

DOE (U.S. Department of Energy), Moab UMTRA Project Revegetation and Weed Control Plan (DOE-EM/GJTAC1655).

DOE (U.S. Department of Energy) Order 210.2A, "DOE Corporate Operating Experience Program."

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.”

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

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

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*.