U.S. DEPARTMENT OF ENERGY | Legacy Management

Mexican Hat, Utah, Disposal Site
Disposal Cell Evaluation Information Sheet

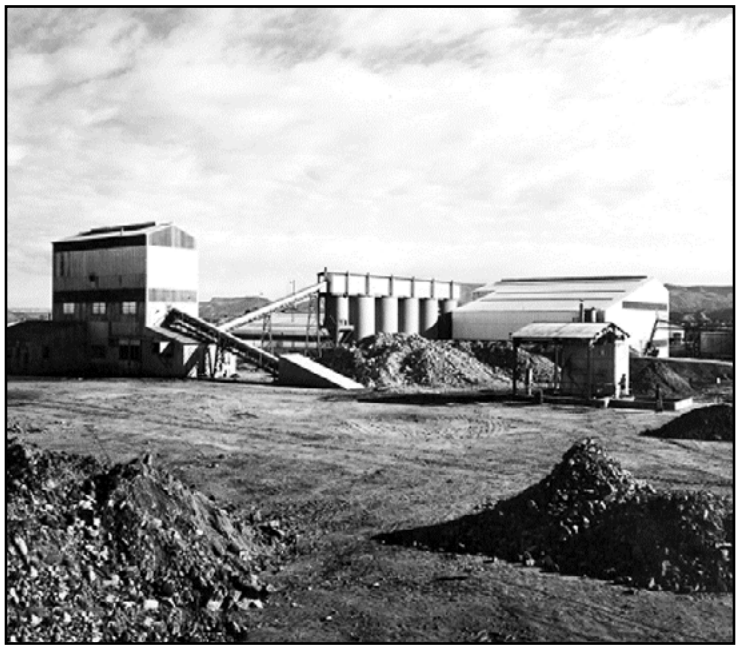
This information sheet provides information about observed disposal cell conditions and anomalies of the **Uranium Mill Tailings Radiation Control Act of 1978 Title I processing site at Mexican Hat, Utah**. This site is managed by the **U.S. Department of Energy Office of Legacy Management**.

Site Location and History

The Mexican Hat disposal site is located 1.5 miles southwest of Mexican Hat, Utah, on the Navajo Nation. Various mining establishments operated a uranium-ore processing mill on-site between 1957 and 1970, actively recovering both uranium and copper. The milling process produced radioactive tailings of predominantly sandy consistency that were stored in one of two tailings piles.

Following closure and subsequent remedial activities by the U.S. Department of Energy (DOE), radioactive materials from the tailings piles, the demolished mill structures, and 11 vicinity properties were placed in a disposal cell located at the site of the lower tailings pile. Waste materials from uranium milling operations in Cane Valley, Arizona, were also included in the disposal cell. Altogether, approximately 3.6 million cubic yards of radioactive tailings and materials were encapsulated in the disposal cell.

Per stipulations mandated by the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) and Title 10 *Code of Federal Regulations* (CFR), Section 40.27, the U.S. Nuclear Regulatory Commission (NRC) included the Mexican Hat disposal site under the general license in 1997 and DOE became the long-term management agency.



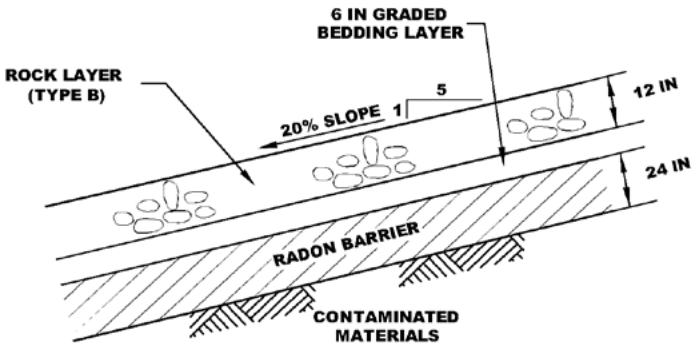
Halchita, Utah, in the 1960s.

Overall Site Design and Long-Term Management Strategy

The Mexican Hat disposal cell was designed to remain protective of human health and the environment for up to 1,000 years or, at the very least, 200 years, per 40 CFR 192.02.

Radioactive materials placed inside the cell were standardized to acceptable size parameters prior to placement, and then compacted. Based on design specifications, materials were layered with larger constituents placed lower in the disposal cell and organic material maintained at no more than 5 percent quantity by volume in any given lift. Compaction and testing were performed, meeting the 90-95 percent compaction criteria depending on location within the cell. The disposal cell cover consists of a three-part system designed to adhere to UMTRCA control standards, limiting radon gas emissions and water infiltration. A 24-inch radon barrier — consisting of 10 percent bentonite homogenized with silty/sandy material — was placed directly over the radioactive waste.

Bentonite is an engineered material commonly used in radioactive waste management because it reduces hydrologic permeability, swells, and self-seals when saturated, and results in diffusion as the dominant transport mechanism (Sellin et al. 2013). A 6-inch bedding layer was placed on top of the radon barrier consisting of sandy gravel with a few fine aggregates. The



SCHEMATIC - NOT TO SCALE

bedding layer acts as a filtering system and provides additional protection against erosion of the radon barrier. On top of the bedding material is a 12-inch layer of larger riprap (rock) keyed together to reduce lateral and horizontal water movement and further protect against erosion.

UMTRCA sites under DOE management operate with site-specific scopes that specify inspection schedules, emergency protocols, sampling frequencies, and implementation of institutional controls. Long-term stewardship and site-specific institutional controls are designed to protect human health and the environment, ensuring remediation strategies remain effective. The Long-Term Surveillance Plan (LTSP) for the Mexican Hat disposal cell requires annual inspections of the disposal cell to verify overall integrity, evaluate site infrastructure, observe security features, and conduct maintenance as needed. Since Mexican Hat came under DOE purview, annual inspections have been completed and documented.

Disposal Cell Observations

Since 1995, annual inspections at the Mexican Hat disposal cell have occurred without significant concerns. However, surface depressions were observed in the riprap cover during the March 2016 annual inspection. DOE initiated an investigation and fact-finding mission to uncover the extent of the depressions, potential causation, and evaluate corrective actions. Site inspections, engineering investigations, radiological surveys, and test pit excavations have been ongoing.

- Between April 2016 and August 2016, additional surface depressions were observed. Recommendations were made to remove surface riprap and investigate the extent and possible causation of the depressions. Radiological surveys at the areas of concern were performed and no elevated readings were detected relative to background. This provided evidence that the radon barrier remained intact, and radioactive materials were not exposed.

Depression Features on Northeast Side Slope and Approximate Area of Interim Cover Protection Area.

- During the April 2017 annual inspection, no additional changes or depressions were detected. Additional radiological surveys conducted in September 2017 reconfirmed scans in the area of concern were not elevated relative to background levels. Manual excavations of depression areas were conducted in December 2017 by the Navajo Nation Uranium Mill Tailings Remedial Action/Abandoned Mine Lands Department to determine the linear depression scale. A void was detected during that investigation, appearing to run below the bedding layer and in the top of the radon barrier layer. Radiological surveys at seven different locations — upwind, downwind, at the re-excavated void, and at other areas along the disposal cell — were performed and no elevated readings were detected relative to background. The radon barrier appeared to be intact and no radioactive materials were exposed.

Mexican Hat Test Pit.

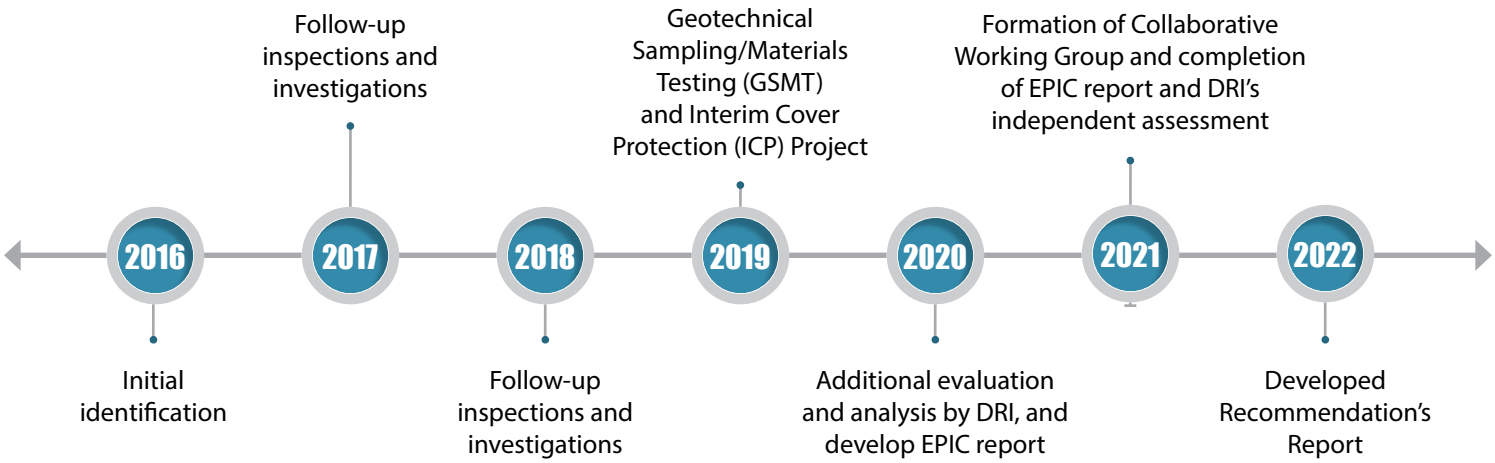
- Throughout January 2018, 13 test pits were manually excavated, comparing cover material to the original engineering specifications and performing additional radiological surveys. During these investigations, additional voids and depressions were detected, as well as apparent erosion of the radon barrier at three test pit locations. No elevated radiological readings relative to background were observed. Additional radiological surveys were conducted in April 2018 and no elevated readings were detected relative to background. Other April 2018 activities included the annual site inspection, an aerial baseline survey, a light detection and ranging (LiDAR) terrestrial survey, a settlement plate survey, and a semiannual radiological survey. No additional depressions were detected during the annual inspection and data from the aerial survey and LiDAR terrestrial survey provided a baseline for possible future changes in surface observations. Settling was not apparent based on the settlement plate survey. An August 2018 rain event triggered a LiDAR terrestrial survey; no changes in depressions were observed.
- The annual inspection was performed in April 2019 along with additional geotechnical testing of depression areas. No additional depressions were observed. The results of a geotechnical sampling event provide

a combination of preliminary causes of the depressions, including the radon barrier and bedding layer properties. The results were published in the Erosional Piping Characterization (EPIC) and Data Report.

- No additional depressions were identified during the 2020 or 2021 annual inspections.
- Workers reported, during the 2022 annual site inspection, one new depression feature on the top of the northeast side slope. Additional site visits in 2022 and 2023 noted new depressions, and flowing water under the rip rap was observed on the north side slope.

Mexican Hat Disposal Cell During the Interim Cover Protection Project.

Timeline of Internal Erosion-Related Observations & Work



Actions Implemented Since 2016

DOE implemented several investigative actions since the discovery of surface depressions in the Mexican Hat disposal cell. The primary goal is to evaluate and ensure the site remains protective of human health and the environment. Actions implemented to date include:

- Conduct annual horizontal and vertical surveys of the six disposal cell settlement plates using survey-grade GPS instruments to determine if settling is occurring.
- Initialization of plans for and performance of annual ground-based LiDAR topographic surveys of the areas of concern.
- Perform routine and event-based aerial LiDAR topographic surveys of the entire cell.
- Installation of a System Operation and Analysis at Remote Sites (SOARS)-based weather monitoring station that provides real-time five-minute rainfall observations.
- Installation of a SOARS-based camera for observation of the disposal cell.
- Installation of IRBP to temporarily manage radon barrier degradation in areas with observed voids. IRBP consists of 10 percent bentonite amended radon barrier material that was mixed and hand compacted with a jumping jack. Each IRBP location was re-covered with the original bedding and riprap material.
- Installation of radon-monitoring cups and thermoluminescent dosimeters to assure protection of human health and the environment by continuous radiological monitoring. Monitoring occurs quarterly.
- Geotechnical sampling and materials testing with analytical results and data analysis.
- Collection of radon core samples to determine the placement of radiological materials and remaining thickness of the radon barrier at select locations.
- Replacement of a 20,000-square-foot area of the northeast side slope, where depressions were detected by LiDAR with an Interim Cover Protection (ICP), which consisted of IRBP in degraded radon barrier areas, replacement of the existing bedding layer with a bedding layer that met original design specifications and then re-covered with the original riprap material.
- Improvement of site access and restrictions.
- Engagement of geotechnical engineering subject matter experts with experience in the Mexican Hat specifications, as well as long-term design and performance of disposal cell covers.

- Gathering information about historical processes.
- Engagement and collaboration with engineers and scientists from the Navajo Nation Uranium Mill Tailings Remedial Action/Abandoned Mine Lands Department, Desert Research Institute, and U.S. Army Corps of Engineers. The collaboration effort culminated in the preparation of a Recommendations Report to document the recommended next steps to determine a long-term remedy for the site.

Significant Findings and Investigation Results

Current findings from DOE activities and investigations, initiated at the Mexican Hat disposal cell since March 2016, include:

- No elevated gamma radiation or radon gas readings relative to ambient background conditions have been observed.
- No complete breach of the radon barrier is evident.
- Sediment observed in the drainage apron of the northeast side slope of the disposal cell, but its origins are undetermined. This sediment may contribute to prolonged radon barrier saturation and increased erosional piping.
- Windblown sediment accumulation observed up to 6 inches below the riprap surface at all investigation locations.
- Fine aggregates appear absent in the bedding layer at lower locations in the area of concern and overly abundant near the crest of the northeast side slope.
- Cement-like material observed between the radon barrier and the bedding layer in lower portions of the disposal cell.
- The probable maximum precipitation (PMP) event used in the original disposal cell designs was reevaluated and appears to be correct.
- Historical rain patterns, which were collected from the National Oceanic and Atmospheric Administration weather station in Mexican Hat indicate rain patterns have been below the PMP, and the original calculation remains protective.
- The physical and chemical properties of the radon barrier make it susceptible to erosion.
- The radon barrier has less-dense layers that have a higher hydraulic conductivity and risk of piping.
- Thermal processes including shrink-swell and desiccation cracking in the radon barrier provide entry points for water and exit points for sediment.
- Elevated concentrations of calcium carbonate (CaCO3) can contribute to pipe formation.
- No evidence of subsidence in areas with voids.
- No evidence of settling based on settlement plate surveys.
- No observed changes in depressions based on LiDAR terrestrial surveys.

Future Planned Investigations and Site Maintenance

DOE investigations and causational analysis of the surface depressions at the Mexican Hat disposal cell cover remain ongoing. DOE continues to conduct fact-finding and scientific investigations to analyze site conditions, determine depression and void causation, and prepare long-term remedies. Future plans include:

- Continue to evaluate the cell for changes using data from the annual aerial surveys.
- Begin to evaluate feasibility of long-term solutions.
- Perform numerical hydrology and hydraulic modeling of the cell to evaluate as-built conditions to inform the conceptual site model and evaluate potential long-term solutions against expected water flow characteristics in the cell.
- Conduct another geotechnical sampling event to answer key outstanding questions and begin to gather data to develop design concepts for a long-term remedy.

CONTACT INFORMATION

IN CASE OF AN EMERGENCY AT THE SITE, CONTACT 911

LM TOLL-FREE EMERGENCY HOTLINE: (877) 695-5322

Information about **UMTRCA Title I sites** is available at **www.energy.gov/lm/sites/lm-sites/programmatic-framework**.

For more information about the **DOE Office of Legacy Management**, visit **www.energy.gov/lm/office-legacy-management**, or contact:

U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

Email:
public.affairs@lm.doe.gov

DOE Office of Legacy Management
(970) 248-6070

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