LMS/SHP/S07834

Annual Performance Report April 2010 Through March 2011 for the Shiprock, New Mexico, Site

January 2012

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Appendix

Appendix A Supplementary Time-Trend Sparkline Plots

Abbreviations

COCs	contaminants of concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESL	Environmental Sciences Laboratory
ft	feet
GCAP	Groundwater Compliance Action Plan
gpm	gallons per minute
kg	kilogram
lb	pounds
LM	DOE Office of Legacy Management
MCL	maximum concentration limit
mg/L	milligrams per liter
amsl	above mean sea level
N	nitrogen
SDWA	Safe Drinking Water Act
Se	selenium
SOARS	System Operation and Analysis at Remote Sites
SOWP	Site Observational Work Plan
Sr	strontium
U	uranium
UMTRCA	Uranium Mill Tailings Radiation Control Act

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Executive Summary

This annual performance report evaluates the performance of the groundwater remediation system at the Shiprock, New Mexico, Disposal and Processing Site (Shiprock site) for April 2010 through March 2011. The Shiprock site, a former uranium-ore processing facility remediated under the Uranium Mill Tailings Radiation Control Act (UMTRCA), is managed by the U.S. Department of Energy (DOE) Office of Legacy Management (LM). This performance evaluation is based on an analysis of groundwater quality and groundwater level data obtained from site monitoring wells in addition to groundwater flow rates associated with the extraction wells, drains, and seeps.

Background

The Shiprock mill operated from 1954 to 1968 on property leased from the Navajo Nation. Remediation of surface contamination, including stabilization of mill tailings in an engineered disposal cell, was completed in 1986. During mill operation, nitrate, sulfate, uranium, and other milling-related constituents leached into underlying sediments and resulted in contamination of groundwater in the area of the mill site. In March 2003, DOE initiated active remediation of the groundwater using extraction wells and interceptor drains. At that time, a baseline performance report was developed (DOE 2003), which established specific performance standards for the Shiprock groundwater remediation system.

The Shiprock site is divided into two distinct areas, the floodplain and the terrace. The floodplain remediation system consists of two groundwater extraction wells, a seep collection drain, and two collection trenches (Trench 1 and Trench 2). The terrace remediation system consists of nine groundwater extraction wells, two collection drains (Bob Lee Wash and Many Devils Wash), and a terrace drainage channel diversion structure. All extracted groundwater is pumped into a lined evaporation pond on the terrace.

Compliance Strategy and Remediation System Performance Standards

The performance standards established in the Baseline Performance Report (DOE 2003) are based on the compliance strategy documented in the Groundwater Compliance Action Plan (GCAP; DOE 2002). In the GCAP, the U.S. Nuclear Regulatory Commission (NRC) approved compliance strategy for the floodplain is natural flushing supplemented by active remediation by extraction of groundwater from the floodplain aquifer adjacent to the San Juan River. However, active remediation (pumping from extraction wells and trenches) is now considered the dominant strategy for the floodplain, as the influence of natural flushing is not certain (see DOE 2010a).

DOE is reevaluating the compliance strategy for the terrace (DOE 2010a). The current objective of active remediation on the terrace is to dewater the terrace and eliminate potential exposure pathways and risks to humans and the environment. Performance standards established to meet this objective include reduction of terrace groundwater elevations and concomitant drying of seeps in Bob Lee Wash and Many Devils Wash and at the base of the escarpment (DOE 2003).

Contaminants of Concern, Remediation Goals, and Background Conditions

The contaminants of concern (COCs) for both the floodplain and terrace are ammonia (total as nitrogen), manganese, nitrate (nitrate + nitrite as nitrogen), selenium, strontium, sulfate, and

uranium. The compliance standards for nitrate, selenium, and uranium are listed in Title 40, *Code of Federal Regulations,* Part 192 (UMTRCA). Regulatory standards are not available for the remaining COCs; remediation goals for these constituents are either risk-based alternate cleanup standards or background levels. Background groundwater quality for the terrace has been very difficult to establish because wells drilled in locations considered to be suitable analogs for terrace background conditions have been dry. This report documents additional efforts to find potential background locations for the terrace, in light of recent attempts to define natural contamination in the Mancos Shale (DOE 2011b).

Contaminant Distributions and Temporal Trends

For this reporting period, 115 monitoring wells (59 on the floodplain and 56 on the terrace) and 32 surface water locations were sampled. One of the difficulties in evaluating the analytical results from this site is that the highest concentrations of individual COCs do not occur in the same location. For example, concentrations of nitrate, selenium, and sulfate are highest on the terrace in the radon borrow pit area, along the buried escarpment, and in Many Devils Wash, while the highest concentrations of uranium are generally in floodplain alluvial wells rather than in terrace alluvial wells. Ammonia concentrations are highest in the terrace borrow pit/evaporation pond area and in Mancos wells west of the disposal cell. Manganese and strontium are of less interest because most concentrations are within the range of floodplain background concentrations and, in general, no temporal trends are evident.

Contaminant concentrations continue to decrease in floodplain wells—most notably in the Trench 1 and well 1089 areas. COC concentrations in easternmost Trench 2 area wells (closest to the San Juan River) are still lower than those nearer the escarpment, demonstrating the effectiveness of the Trench 2 system. Finally, COC concentrations in samples collected from the San Juan River samples are still well below established benchmarks and are comparable to upstream (background) results.

Summary of Remediation Performance and Site Evaluation Progress

Groundwater in the floodplain system is currently being extracted from two wells (wells 1089 and 1104) adjacent to the San Juan River north of the disposal cell, the two collection trenches, and a seep collection sump. Approximately 8.6 million gallons of groundwater were extracted from the floodplain aquifer system during this performance period, yielding a cumulative total of about 74 million gallons extracted from the floodplain since March 2003.

Groundwater in the terrace system is currently being extracted from two drainage trenches (in Bob Lee and Many Devils washes) and nine wells. From April 2010 through March 2011, approximately 5.2 million gallons of groundwater were extracted from the terrace system, yielding a total cumulative volume of about 26.6 million gallons.

The cumulative volume removed from both terrace and floodplain combined (as of April 1, 2011) is approximately 101 million gallons. Estimated masses of sulfate, nitrate, and uranium removed from the floodplain and terrace well fields during this performance period were 734,000 pounds, 33,000 pounds, and 50 pounds, respectively.

The floodplain extraction system appears to be effective—as evidenced by the removal of contaminant mass from groundwater, the decreasing contaminant concentrations in many floodplain wells (most notably in the Trench 1 and well 1089 areas), and the lack of contamination in wells nearest the San Juan River (particularly in the Trench 2 area).

Terrace-wide, groundwater levels in the majority of alluvial wells sampled during this performance period declined relative to the baseline (2000–2003) period; average and maximum decreases were 2.5 ft and 7.2 ft, respectively. Decreases in some far west terrace wells could be partly or even largely attributable to the previous phasing out of irrigation in the area (circa 2003–2004). Nonetheless, declines in groundwater elevations are widespread, and many seeps on the west terrace have been dry for the last several years.

Natural phytoremediation (that is, with no human intervention) and hydraulic control using phytoremediation are ongoing at the Shiprock site. DOE began phytoremediation pilot studies in 2006 by planting native phreatophytes on the terrace between the disposal cell and the escarpment north of the disposal cell, where a uranium plume enters the floodplain, and in the radon barrier borrow pit south of the disposal cell, where nitrate levels are elevated in alluvial sediments.

Recommendations

Based on the current status of remediation progress and the findings of more recent investigations, DOE recommends the following activities to improve the performance and evaluation of the Shiprock remediation system and to minimize potential risks to human health and the environment:

- Continue to assess the floodplain-wide flow and transport processes. (Studies are in progress.)
- Update the compliance strategy for the terrace (see DOE 2010a). (DOE is proposing active remediation as the interim remediation strategy for the entire terrace.)
- Continue to monitor the fluid level in the evaporation pond (with the understanding that periodic cessation of pumping is necessary to maintain sufficient freeboard), evaluate ways to enhance evaporation, and investigate potential upgrades to the remediation system.
- Develop a specific plan for phytoremediation pending analysis of the overall findings and data when pilot studies end. (Pilot studies are in progress.)
- Continue to investigate the source of contamination in Many Devils Wash (see DOE 2011b, DOE 2011c) and focus on ways to minimize exposures and risks to contaminants in the wash.

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