DOE–EM/GJTAC2198

Office of Environmental Management – Grand Junction

Moab UMTRA Project
Plan for Continued Protection of the Colorado River

Revision 0

April 2016

U.S. Department of Energy

Office of Environmental Management

Prepared by the Technical Assistance Contractor under contract number DE-EM0002067 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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Review and Approval

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1.0 Introduction

The Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site is a former uranium ore-processing facility located approximately 3 miles northwest of the city of Moab in Grand County, Utah. The Moab mill operated from 1956 to 1984. When the processing operations ceased, an estimated 16 million (mil) tons of uranium mill tailings accumulated in an unlined impoundment. A portion of the impoundment is in the 100-year floodplain of the Colorado River. In 2001, ownership of the site was transferred to the U.S. Department of Energy (DOE). Since April 2009, tailings have been relocated by rail to a disposal cell 30 miles north, near Crescent Junction, Utah. Figure 1 shows the Moab site features including the tailings pile, well field, evaporation pond, and the Moab Wash, an ephemeral stream.

Continued excavation of the tailings has prompted removal of the evaporation pond scheduled for spring 2016. Relocating this evaporation pond to another part of the site was not practical due to the unavailability of space within the contaminated area outside of the 100-year flood plain or away from tailings removal activities. As a result, the ability to extract contaminated ground water year round is not feasible due to the lack of available storage. Consequently, the overall volume of extracted ground water will be reduced. To compensate for reduced extraction, increased freshwater injection is planned. This Plan describes efforts to continue protection of the Colorado River.

Figure 1. Moab UMTRA Project Site Features

2.0 Purpose

The purpose of this Plan is to provide a summary of ground water remediation and monitoring activities and a description of changes, in progress and planned, along with an assessment of the anticipated impacts associated with the changes. The assessment of anticipated impacts is based in part on ground water flow modeling.

3.0 Background

Contaminants, including ammonia and uranium, have emanated from the tailings pile into the shallow ground water; they have migrated downgradient and are discharging to the Colorado River adjacent to the site.

As an interim action, DOE began limited ground water remediation to remove ammonia and uranium mass in 2003, which involves extraction of contaminated ground water from on-site remediation wells and evaporation of the extracted water in a lined pond with a capacity of nearly 6 mil gallons (gal), located on top of the tailings pile.

Since 2004, another activity to protect potential suitable habitats that have developed in Colorado River side channels adjacent to the site is injection of freshwater in wells near the river and direct diversion of surface water to the side channel.

In 2005, DOE issued the *Record of Decision for the Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah* (DOE 2005), which includes the clean-up alternative to continue (and expand as necessary) its ongoing active remediation of contaminated ground water at the Moab site.

Figure 2 is a ground water surface contour map based on December 2015/January 2016 data (DOE 2016). Typical of a scenario where surface water flows through conductive alluvial sediments, shallow ground water flow is towards the river during base flow conditions. In river peak flows during spring runoff, the surface water may discharge into the ground water system if the river flows are significantly high.

Based on a ground water/surface water interaction investigation completed in 2008 (DOE 2009), this change occurs when the river flows exceed approximately 15,000 cubic feet per second (cfs) (as measured at the Cisco gaging station), which has occurred nine times between 2003 and 2015.

Ground water monitoring data have been used to delineate the ammonia and uranium plumes caused by historical site activities. Figures 3 and 4 display the shallow ammonia and uranium plumes within 50 feet (ft) of the ground water surface based on December 2015/January 2016 data, respectively (DOE 2016).

There is no standard associated with ammonia, while the uranium ground water standard of 0.044 milligrams per liter is based on Table 1 in Title 40 Code of Federal Regulations Part 192, Subpart A (40 CFR 192A), "Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites."

The extent of contamination, which was based on data collected during Colorado River base flow conditions, has not significantly changed since monitoring was initiated in 2002. Maximum concentrations observed in the vicinity of the tailings pile have shown a reduction over time (DOE 2014; DOE 2016) as shown in Figure 5.

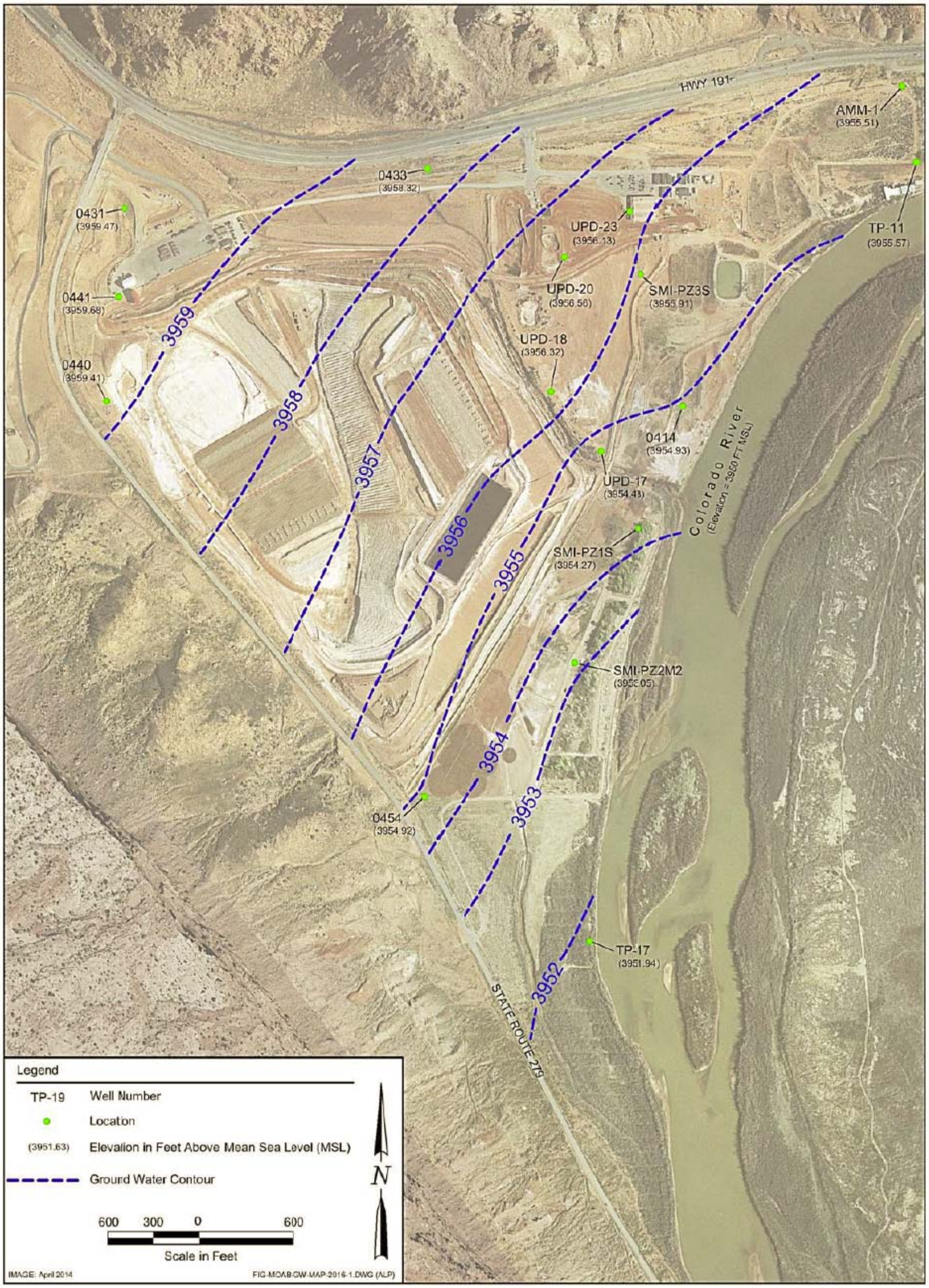

Figure 2. Ground Water Surface Contour Map during Colorado River Base Flow Conditions, December 2015/January 2016

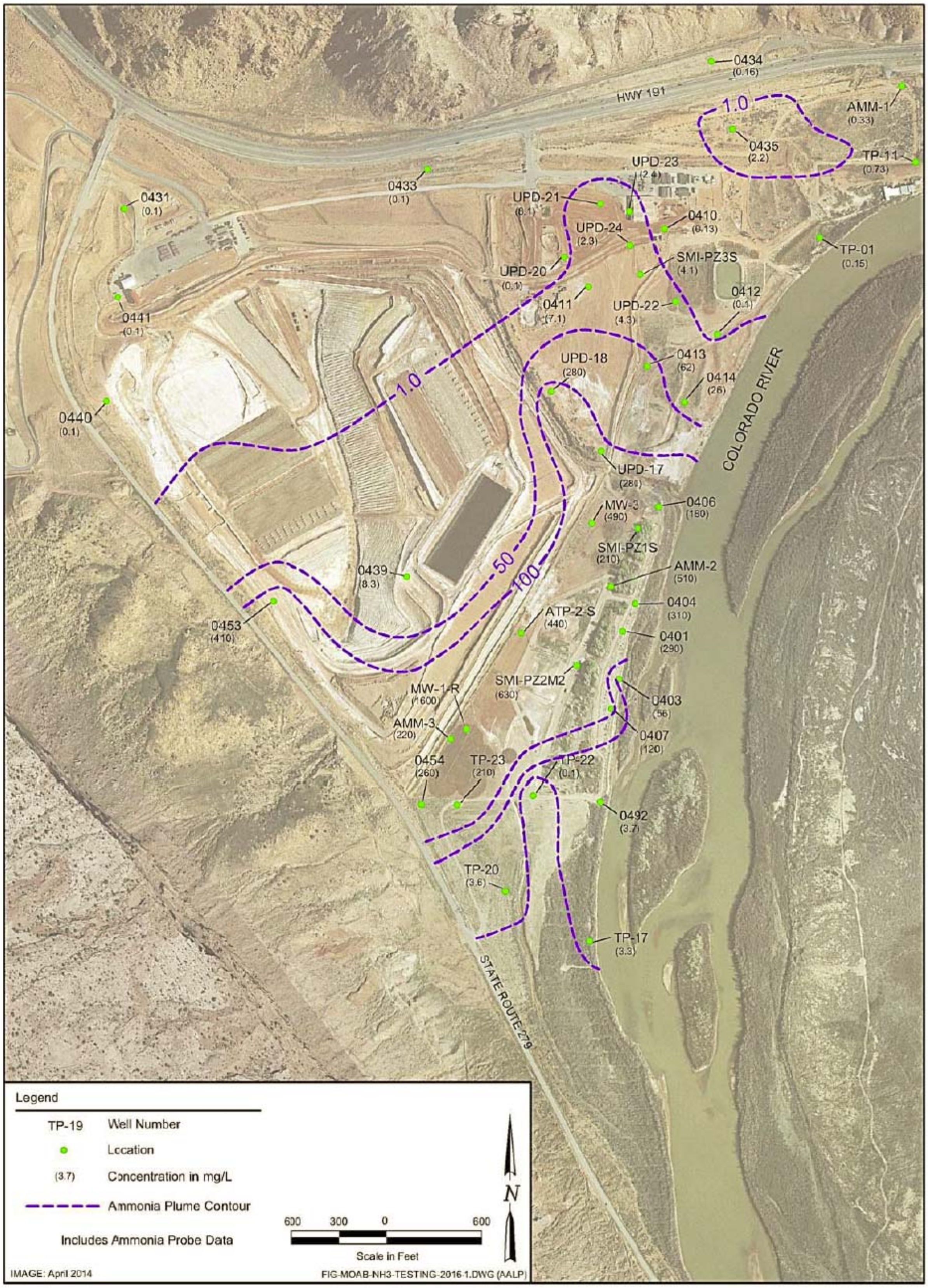

Figure 3. Ammonia Plume Contours and Sampling Results in Shallow Ground Water, December 2015/January 2016

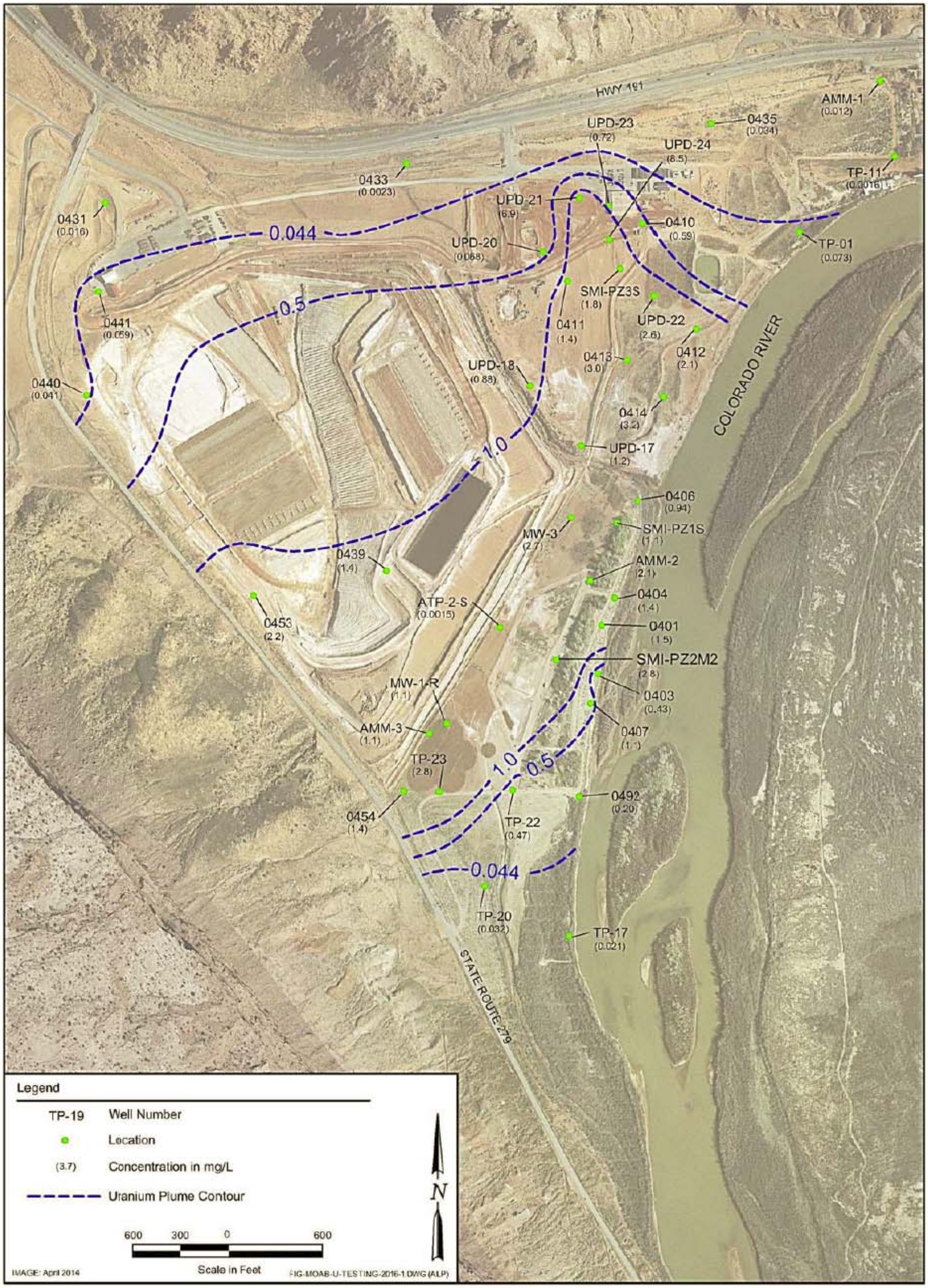

Figure 4. Uranium Plume Contours and Sampling Results in Shallow Ground Water, December 2015/January 2016

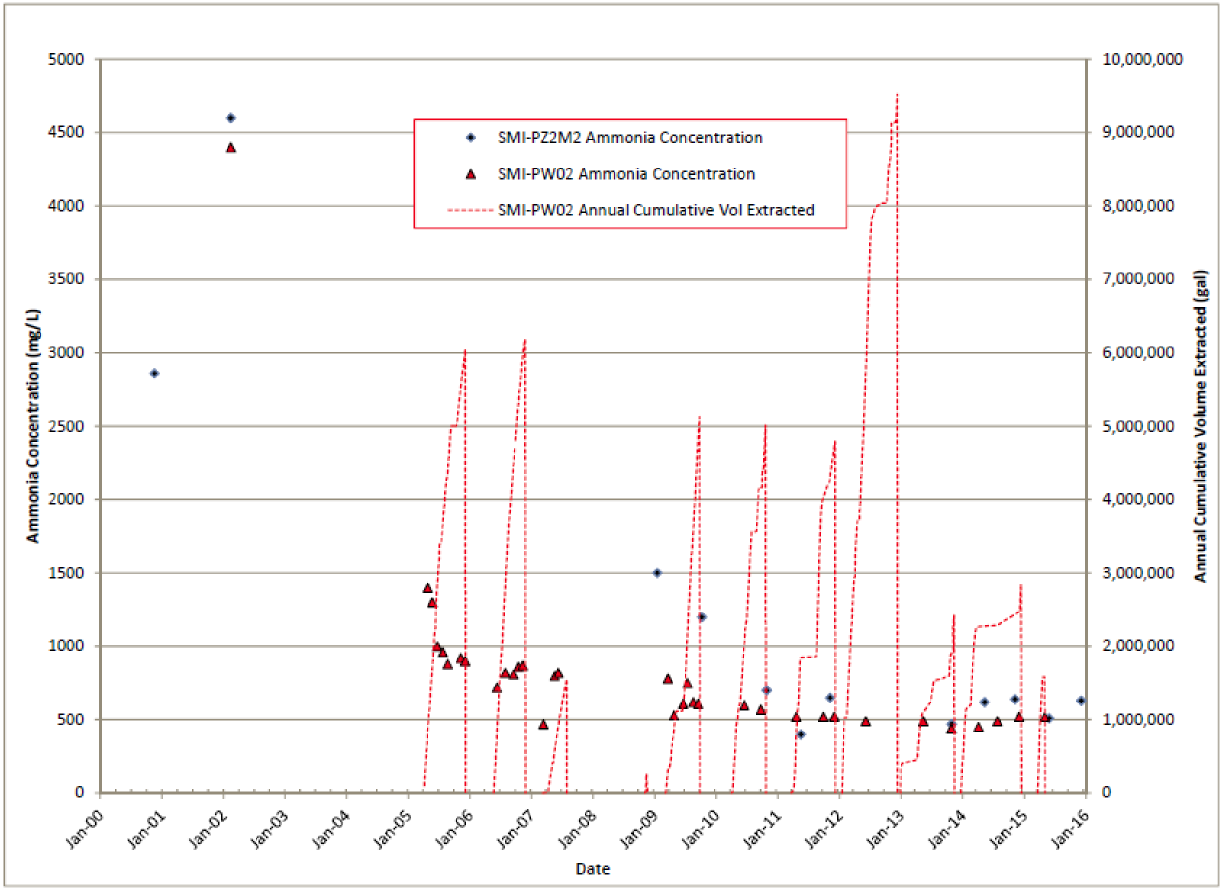

Figure 5. Ammonia Concentrations in the Vicinity of Extraction Well SMI-PW02, 2000 to 2015

4.0 Freshwater Injection

The freshwater injection system uses Colorado River water to create a hydraulic barrier between the tailings pile and the side channels where a suitable habitat may develop. The system was first operated on a limited basis along the riverbank via wells and an infiltration trench. Since September 2010, injection has been in a 300-ft-long section along the bank of the Colorado River, adjacent to a side channel that typically has the highest potential to become a suitable habitat. Through 2015, approximately 58.7 mil gal of freshwater have been injected (Figure 6).

Figure 7 displays the typical mounding that occurs while the system is operational (DOE 2015). A mound of up to 10 ft can be maintained while the system is active. Figure 8 displays the concentrations measured during 2015 (DOE 2015). On average, ground water in the upgradient direction in the shallow zone has an ammonia concentration of 250 milligrams per liter.

All monitoring wells screened over the same elevation at which water is injected (approximately 15 to 35 ft below ground surface [bgs]) have ammonia concentrations substantially below the upgradient ground water concentrations. Wells 0781, 0787, and 0791 are all screened below 35 ft bgs. Beyond system repairs and maintenance, every effort is made to continuously operate the system, with the exception of Colorado River peak runoff flows.

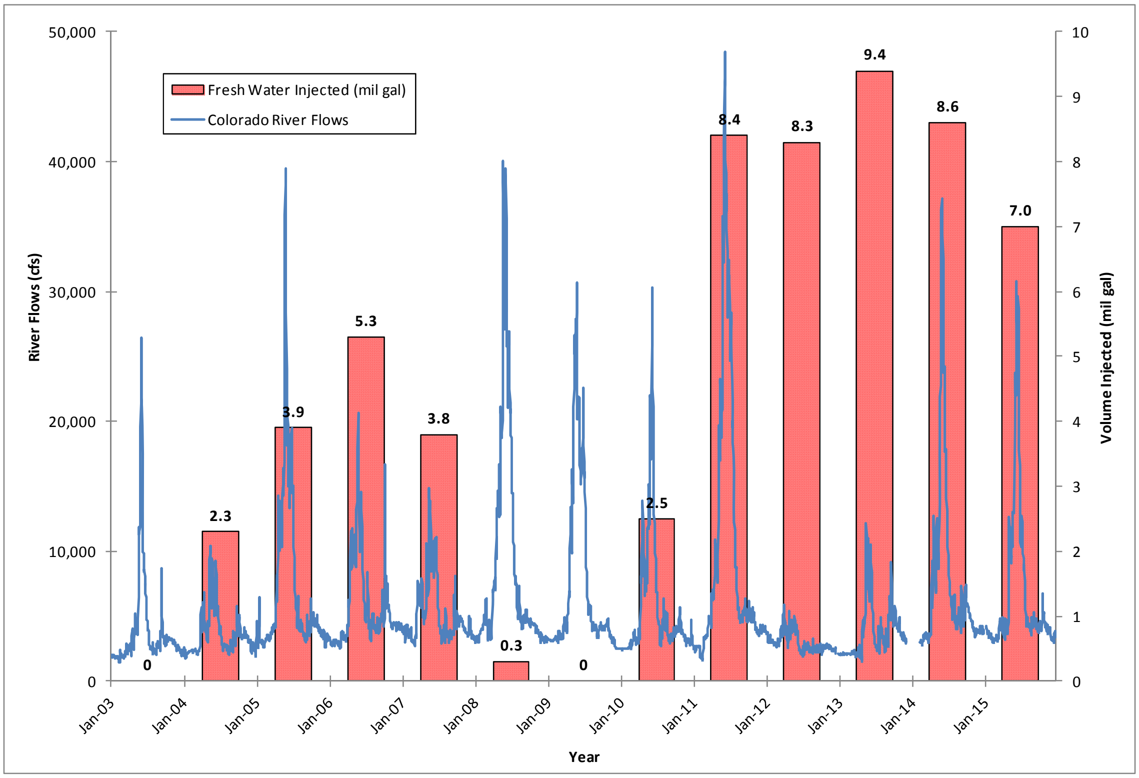

Figure 6. Injected Freshwater and Colorado River Flows, 2003 to 2015

Based on a 2008 ground water/surface water interaction investigation (DOE 2009), once river flows exceed 15,000 cfs, all injection activity is suspended because at that point, river water flows into the ground water system, producing a freshwater lens up to 35 ft thick and extends 200 ft inland.

The best results are obtained when the flows subside, and the freshwater injected extends the time this naturally occurring lens is present in the subsurface. The injection system is not expected to be impacted by other site operations, such that over the next few years, the anticipated injection volumes are approximately 9 mil gal/year.

5.0 Ground Water Extraction

Ground water extraction was initiated in 2003 from remediation wells installed along the bank of the Colorado River. In 2009, higher capacity extraction wells were installed near the toe of the tailings pile, and extraction occurred exclusively from these eight wells. All water extracted from the ground water system was directly pumped to a four-acre evaporation pond located on the top of the tailings pile.

Between 2003 and 2009, water stored in this pond fed a sprinkler system that covered the tailings pile. Having the pond installed at this location protected it from any flooding that may occur at other areas of the site and proper control of the water inside the contaminated area.

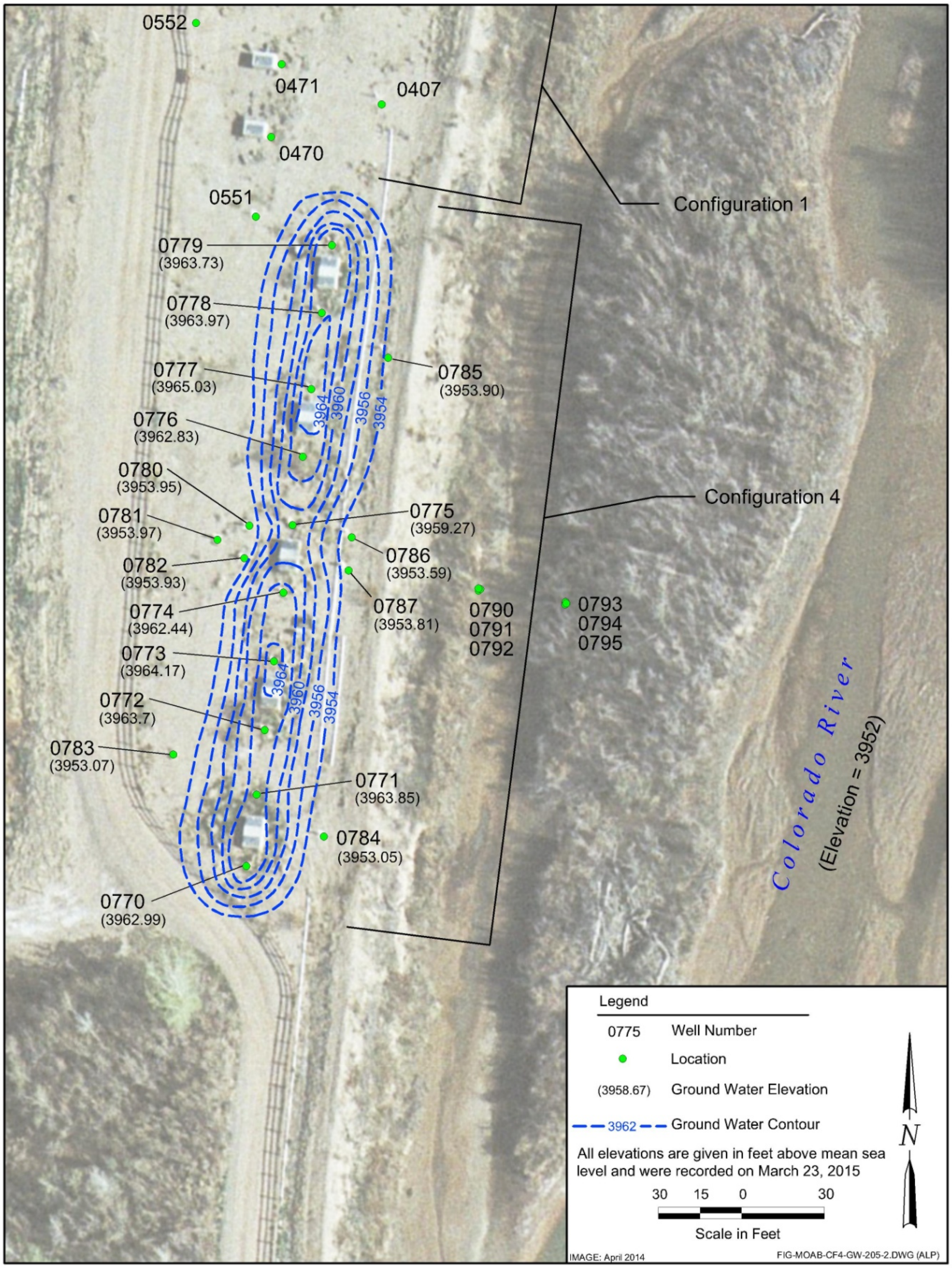

Figure 7. Typical Hydraulic Mounding Developed by Freshwater Injection System

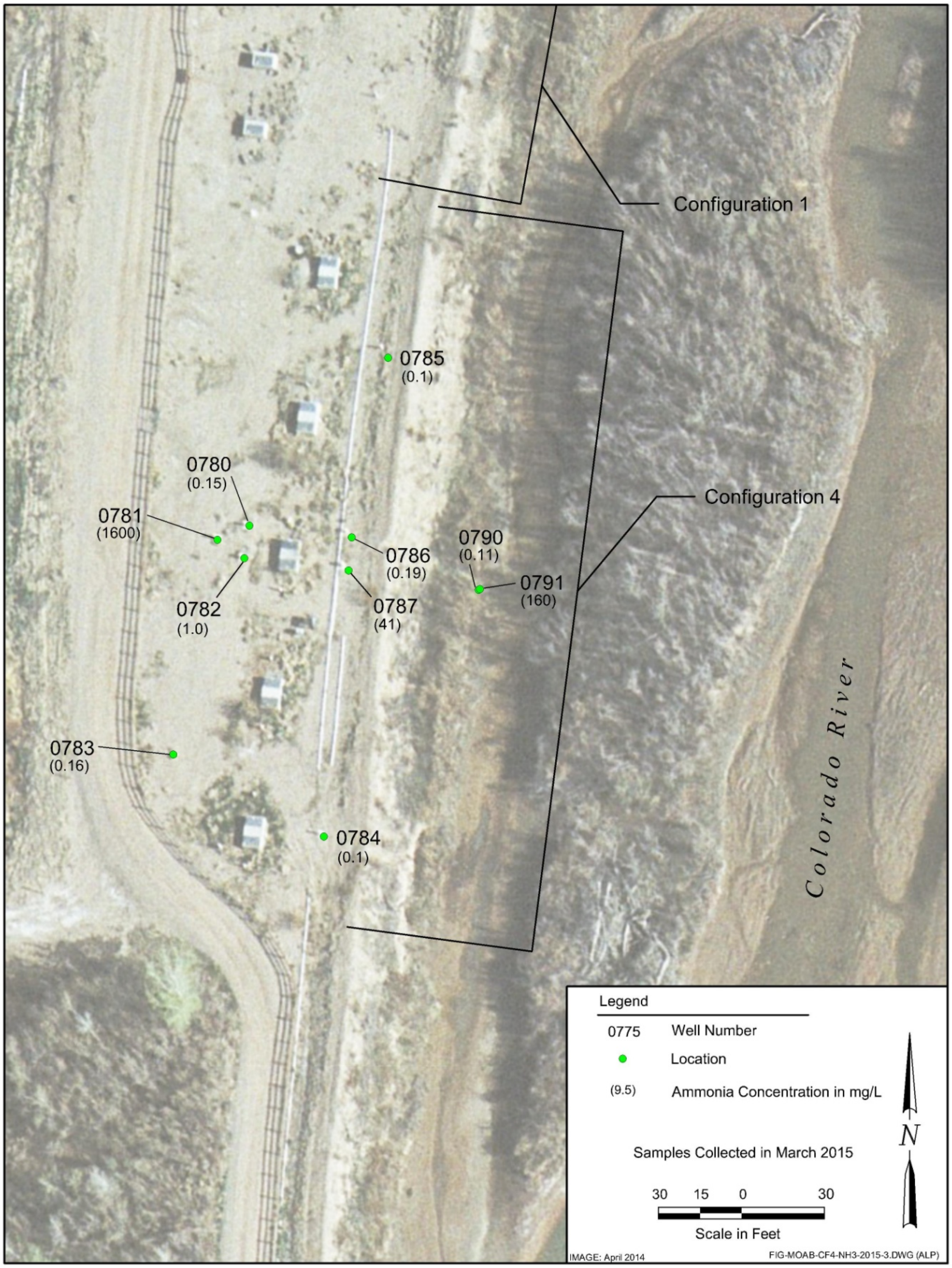

Figure 8. Ground Water Ammonia Concentrations during Freshwater Injection System Operation

From 2009 to 2015, the water stored in the pond has been used to feed two evaporator units that enhanced the evaporation of the water. The water was also pumped into a 12,000-gal elevated tank (called the Klein tank) that gravity fed the water trucks that distributed this water inside the contaminated area for dust control.

As shown on Figure 9, the volume of extracted ground water significantly decreased after 2009 in response to the removal of the sprinkler system. Between 2005 and 2009, the average annual volume extracted was 27.6 mil gal, and from 2010 through 2015, the annual average decreased to 12.6 mil gal.

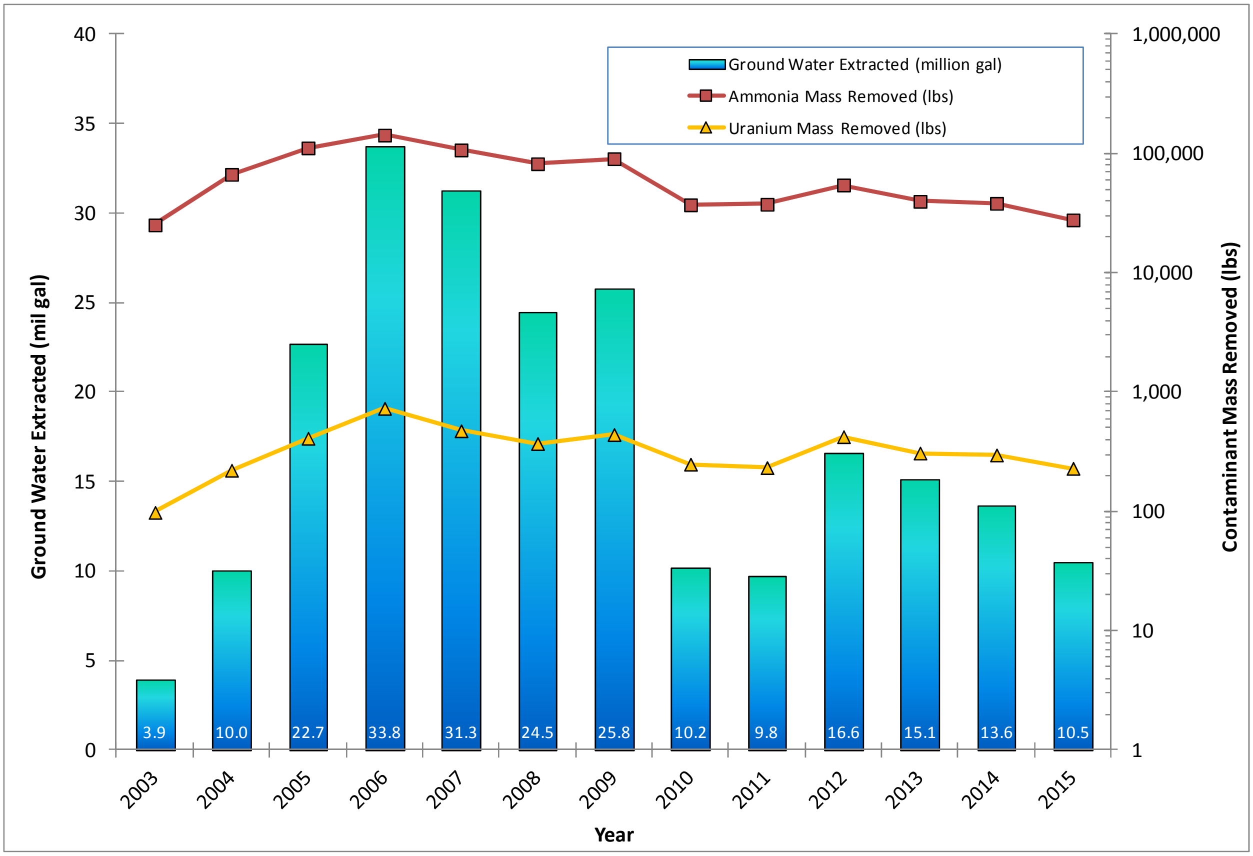

Figure 9. Annual Ground Water Extraction and Ammonia and Uranium Mass Removal, 2003 to 2015

Since 2003, approximately 228 mil gal of ground water has been extracted from the ground water system underlying the site. Associated with extraction is the removal of more than 860,000 pounds (lbs) of ammonia and nearly 4,500 lbs of uranium.

In anticipation of the removal of the pond, an extraction system modification was designed to supply water directly to the water trucks using two frac tanks to provide approximately 40,000 gal of storage to efficiently fill the Klein tank that supplies the water trucks. This system is expected to begin operation in April 2016.

Ground water extraction occurred year round from 2009 through 2015, with the water withdrawn in large volumes for dust control in the spring and summer months. By the end of the fall, the extraction rate was reduced to less than the use rate to allow enough capacity for minimal (typically approximately 25 gal per minute [gpm]) ground water extraction over the winter months, filling the pond by spring. Ground water extraction will no longer occur over the winter because of the lack of need for dust control during this time of year.

On average, water trucks have disposed of 13 mil gal annually as part of the dust suppression efforts since 2011. It is not likely that the modified extraction system will equal this annual volume because of the reduced storage capacity. In addition, in previous years when a deep snow pack developed in the high country of the Colorado River basin, the pond was left full by mid-May in anticipation of flooding of the site.

Use of the evaporation pond water allowed dust suppression efforts to continue without interruption while the ground water extraction system was temporarily shut down. With the direct pumping to the Klein tank, in the event of the site becoming flooded, all extraction will be suspended, and it will not be possible to provide extracted ground water for dust control purposes. The presence of a river intake provides continued dust control if and when contaminated ground water is not available.

Taking into account the elimination of extraction over the winter and potential impacts to the site by flooding, the anticipated 2016 minimum extracted volume is 6 mil gal.

6.0 Ground Water Flow Modeling

Ground water modeling was performed to evaluate the effects of anticipated extraction and injection changes. The evaluation was undertaken using the Moab Mill Site transient SEAWAT model developed by A. D. Laase Hydrologic Consulting in 2011 (2015). The model was modified to include the current injection and extraction wells and replacing the existing recharge zone associated with the tailings pile with ambient recharge. Changing the recharge value was done because the tailings pile naturally limited precipitation infiltration such that recharge from the pile primarily consisted of transient drainage of pore fluids. Given the age of the pile, transient drainage is minimal compared to precipitation infiltration.

The simulated contours shown in Figure 10 represent anticipated ground water elevations.

Remedial scenarios evaluated included: 1) extraction well operation, 2) injection well operation, 3) injection and extraction well operation, and 4) maximum evapotranspiration, which assumes the cottonwoods and willows are at maximum size, but without injection and extraction. An ambient simulation representing current conditions was also performed for comparison purposes. The full report, complete with all figures, will be included in the annual Ground Water Program Report for 2015, which will be completed later in 2016.

The modeling results show that operation of the extraction wells at current rates results in flow from the potential suitable habitat to the extraction wells from March through December. Operation of the injection wells at current rates results in clean injection water discharging to the potential suitable habitat from January through April and between July and December.

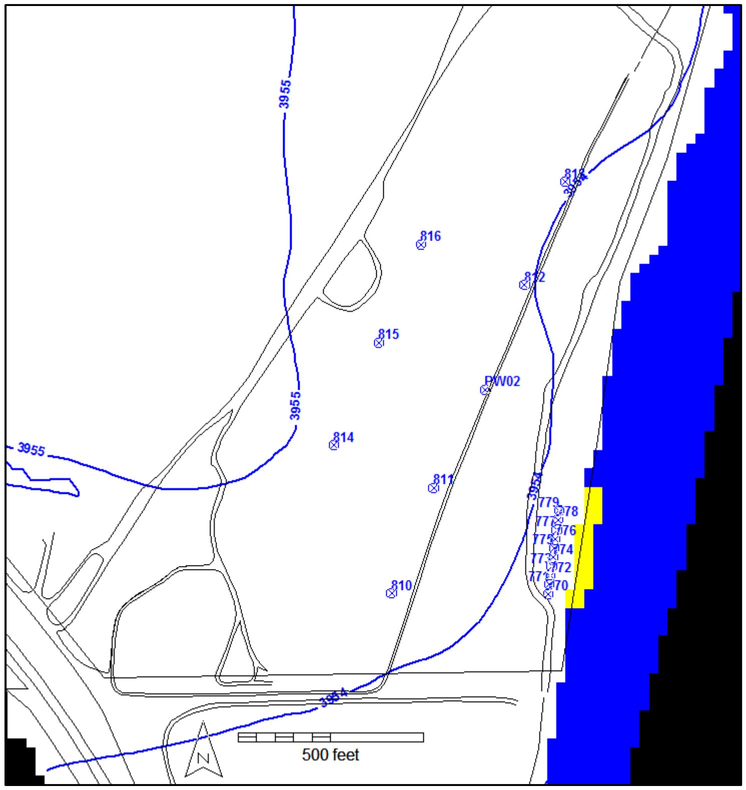

Figure 10. Ground Water Flow Model Output Displaying Injection Wells, Extraction Wells, and Simulated Ground Water Elevation Contours

In May and June, increased river levels result in water flowing from the potential suitable habitat to the shallow soils. Extraction and injection at current rates result in injection water discharging to the potential suitable habitat from January through March and between August and December. From April through July, a combination of extraction well pumping and rising river levels due to spring runoff results in flow from the potential suitable habitat to the shallow soils.

With extraction suspended between December through February, the mass balance analysis shows that during January, February, and December, ground water discharges at rates that are less than ambient rates (Table 1). The reduction in discharge volumes to the river relative to ambient conditions is due to storage effects.

7.0 Ground Water/Surface Water Monitoring

Typically, site-wide sampling events occur twice a year, when the Colorado River experiences base flow conditions (November/December) and near spring runoff peak flows (May/June). In addition, samples are collected two to three times per year in the vicinity of the ground water extraction and freshwater injection systems during operations to assess their effectiveness.

An added sampling event was completed in October/November 2015, at the end of the time period when extraction was suspended due to the planned removal of the evaporation pond. This event was designed to provide a baseline for the ground water system ammonia and uranium concentrations at the end of 2015 extraction.

Sampling will continue at the same frequency in 2016, and future sampling will be evaluated annually. If in subsequent years the results indicate an increase in contaminant concentrations or expansion of the plume area, the frequency will be increased.

Table 1. Comparison of Potential Suitable Habitat Ambient and Modified Extraction Well Operation Recharge and Discharge Volumes

Month	Ambient			Modified Extraction Well Operation		
	Inflows (gpm)	Outflows (gpm)	Inflow - Outflow (gpm)	Inflows (gpm)	Outflows (gpm)	Inflow - Outflow (gpm)
January	0.00	1.27	-1.27	0.00	0.58	-0.58
February	0.00	1.25	-1.25	0.00	0.67	-0.67
March	0.00	1.04	-1.04	0.22	0.00	0.22
April	0.00	0.08	-0.08	1.50	0.00	1.50
May	2.17	0.00	2.17	3.61	0.00	3.61
June	2.39	0.00	2.39	4.32	0.00	4.32
July	0.00	0.43	-0.43	1.18	0.00	1.18
August	0.00	1.25	-1.25	0.38	0.00	0.38
September	0.00	1.24	-1.24	0.30	0.00	0.30
October	0.00	1.09	-1.09	0.64	0.00	0.64
November	0.00	1.09	-1.09	0.36	0.00	0.36
December	0.00	1.26	-1.26	0.00	0.35	-0.35

8.0 Conclusions

The following conclusions can be made:

- Ground water flow modeling shows that the projected ground water extraction pumping scheme altered due to the removal of the evaporation pond is not significantly different compared to the previous extraction pumping scheme on the ground water flow system, and the level of protection of the Colorado River remains the same.
- A baseline of ground water sampling has been performed, and system performance will be reported in the regular annual performance report.

Despite the anticipated reduction in the volume of extracted ground water and associated contaminant mass removal from the ground water system, the potential suitable habitat areas of the Colorado River will continue to be protected from the impact of contaminated ground water discharge. Elevated ammonia concentrations in any established suitable habitat will be mitigated by freshwater diversion directly into the side channel.

9.0 References

40 CFR 192A (Code of Federal Regulations), "Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites."

A.D. Laase Hydrologic Consultants (2015), "Modeling Summary Report."

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