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Office of Environmental Management – Grand Junction

MOAB UTAH UMTRA Project

Moab UMTRA Project
2018 Groundwater Program Report

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Moab UMTRA Project 2018 Groundwater Program Report

Revision 0

Review and Approval

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Revision History

Revision	Date	Reason for Revision
0	August 2019	Initial issue.

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Acronyms and Abbreviations

ALS	ALS Environmental
bgs	below ground surface
CA	Contamination Area
CF	configuration
CFR	Code of Federal Regulations
cfs	cubic feet per second
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	feet or foot
gal	gallon or gallons
gpm	gallons per minute
IA	interim action
kg	kilograms
lb	pounds
µmhos/cm	micromhos per centimeter
mg/L	milligrams per liter
mil	million or millions
msl	mean sea level
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action

1.0 Introduction

1.1 Purpose and Scope

The purpose of the annual Groundwater Program Report is to assess the performance measures the U.S. Department of Energy (DOE) has taken to remediate groundwater at the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site and to protect endangered fish habitat in the Colorado River adjacent to the site. This report describes the Groundwater Program activities for the Moab Project during 2018 and evaluates how the groundwater system at the Moab site responds to various pumping regimes and fluctuating river flow.

1.2 Site History and Background

The Moab Project site is a former uranium ore-processing facility located approximately 3 miles northwest of the city of Moab in Grand County, Utah (Figure 1). 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 DOE. Since April 2009, tailings have been relocated by rail to a disposal cell 30 miles north, near Crescent Junction, Utah.

Site-related contaminants, including ammonia and uranium, have leached from the tailings pile into the shallow groundwater. Some of the more mobile constituents have migrated downgradient and are discharging to the Colorado River adjacent to the site.

In 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 includes the cleanup alternative to continue and expand its ongoing active remediation of contaminated groundwater at the Moab site, as necessary. As an interim action (IA), DOE began limited groundwater remediation that involves extraction of contaminated groundwater from on-site remediation wells and evaporation of the extracted water in a lined pond. Diverted river water is also injected into remediation wells to protect suitable fish habitat in riparian areas along the Colorado River.

2.0 Groundwater Program Description

The Groundwater Program at the Moab site is designed to limit ecological risk from contaminated groundwater discharging to potential endangered fish species habitat areas along the Colorado River. This protection is accomplished by removing contaminant mass with groundwater extraction wells and by freshwater injection between the river and the tailings pile to create a hydraulic barrier that reduces discharge of contaminated water to suitable habitat areas. When necessary, surface water diversion takes place in the side channel adjacent to the IA well field when the area is considered a suitable habitat for endangered young-of-year fish species.

Groundwater and surface water monitoring is performed in conjunction with injection and extraction operations and through water level and analytical data. Surface water diversion performance is measured by analytical data.

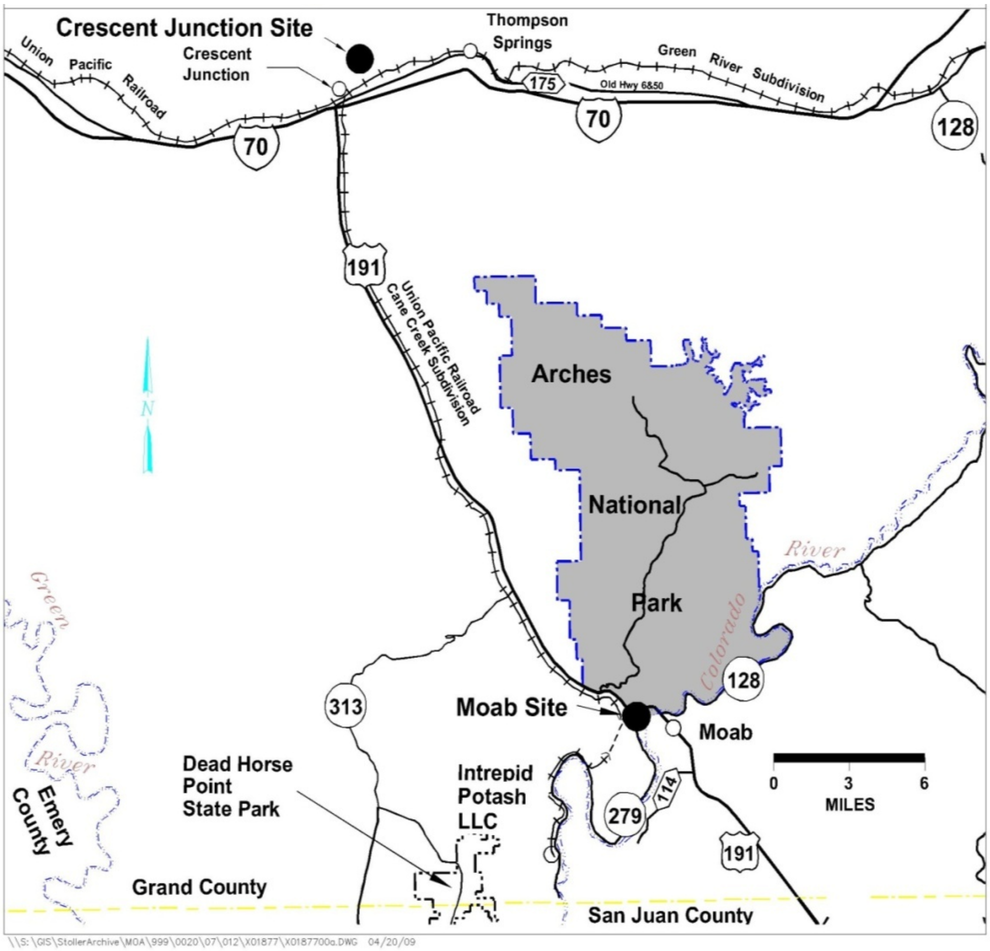

Figure 1. Location of the Moab Project Site

2.1 IA Groundwater System

DOE installed and began operating the first of several configurations (CFs) of extraction/injection wells that comprise the IA groundwater system in 2003 (Figure 2). The objectives of the IA system are to: 1) reduce the discharge of ammonia-contaminated groundwater to side channels that may be suitable habitat for endangered aquatic species, 2) remove contaminant mass through groundwater extraction, and 3) to provide performance data to select and design a final groundwater remedy.

Contaminated groundwater from the shallow plume is extracted through a series of eight extraction wells (CF5). The IA system also includes injection of diverted river water into the underlying alluvium through remediation wells (CF4) located near the western bank of the river.

A surface water diversion system is designed to deliver fresh water to any side channel adjacent to the IA well field. This diversion occurs when the channel develops into a suitable habitat for endangered young-of-year fish species and the ammonia concentrations exceed either the acute or chronic established U.S. Environmental Protection Agency (EPA) criteria. Monitoring wells are also part of the IA system for evaluation purposes. In 2018, CF4 was used for freshwater injection, and extraction operations occurred at CF5. In addition, the diversion system operated from mid-August through the end of September in 2018.

Figure 2. Location of IA Wells

2.2 Hydrology and Contaminant Distribution

The primary hydrogeologic unit present at the Moab site consists of unconsolidated alluvium and salt beds of the Paradox Formation. The alluvium at the Moab site is mostly comprised of either the Moab Wash alluvium or the Colorado River basin-fill alluvium. Moab Wash alluvium is composed of fine-grained sand, gravelly sand, and detrital material that travels down the Moab Wash and is deposited along the northwestern boundary of the site with the Colorado River basin-fill alluvium.

The basin-fill alluvium is comprised of two distinct types of material. The upper unit consists mostly of fine sand, silt, and clay and ranges in thickness up to 15 feet (ft) near the saturated zone in some areas. This shallow unit is made of overbank deposits from the Colorado River.

The lower part of the basin-fill alluvium mostly consists of a gravelly sand and sandy gravel, with minor amounts of silt and clay. This deeper, coarse alluvium pinches out to the northwest along the subsurface bedrock contact and thickens to the southwest toward the river more than 450 ft near the deepest part of the basin. The upper silty-sand unit typically has a hydraulic conductivity that ranges from 100 to 200 ft/day.

Water table contour maps indicate the groundwater in this area discharges into the Colorado River. Figure 3 was generated using data collected in May/June 2018 and exhibits how groundwater underlying the site discharges into the Colorado River. The river flow ranged from 4,890 to 6,910 cubic feet per second (cfs) when the groundwater elevations were measured. Figure 4 shows the groundwater contours in October/November 2018, when the river flow ranged from 3,030 to 3,350 cfs.

Most groundwater beneath the site contains total dissolved solids (TDS) concentrations greater than 10,000 milligrams per liter (mg/L) (brackish water and brine). A brine interface naturally occurs beneath the Moab site that is delineated at a TDS concentration of 35,000 mg/L, which is equivalent to a specific conductance of approximately 50,000 micromhos per centimeter (µmhos/cm). The interface moves laterally and vertically during the course of each year in response to stresses such as changes in river stage.

The tailings pile fluids contain TDS exceeding 35,000 mg/L, which allows this fluid sufficient density to vertically migrate downward in groundwater under previous operating conditions at the site. This former density-driven flow has created a legacy plume of dissolved ammonia that now resides below the brackish water/brine interface. The ammonia beneath the interface represents a potential long-term source of contamination to the upper alluvial groundwater system.

Since the cessation of milling operations at the site, the flux of relatively fresh water entering the site upgradient of the tailings pile may have diluted the ammonia levels in the shallow groundwater (Figures 5 and 6).

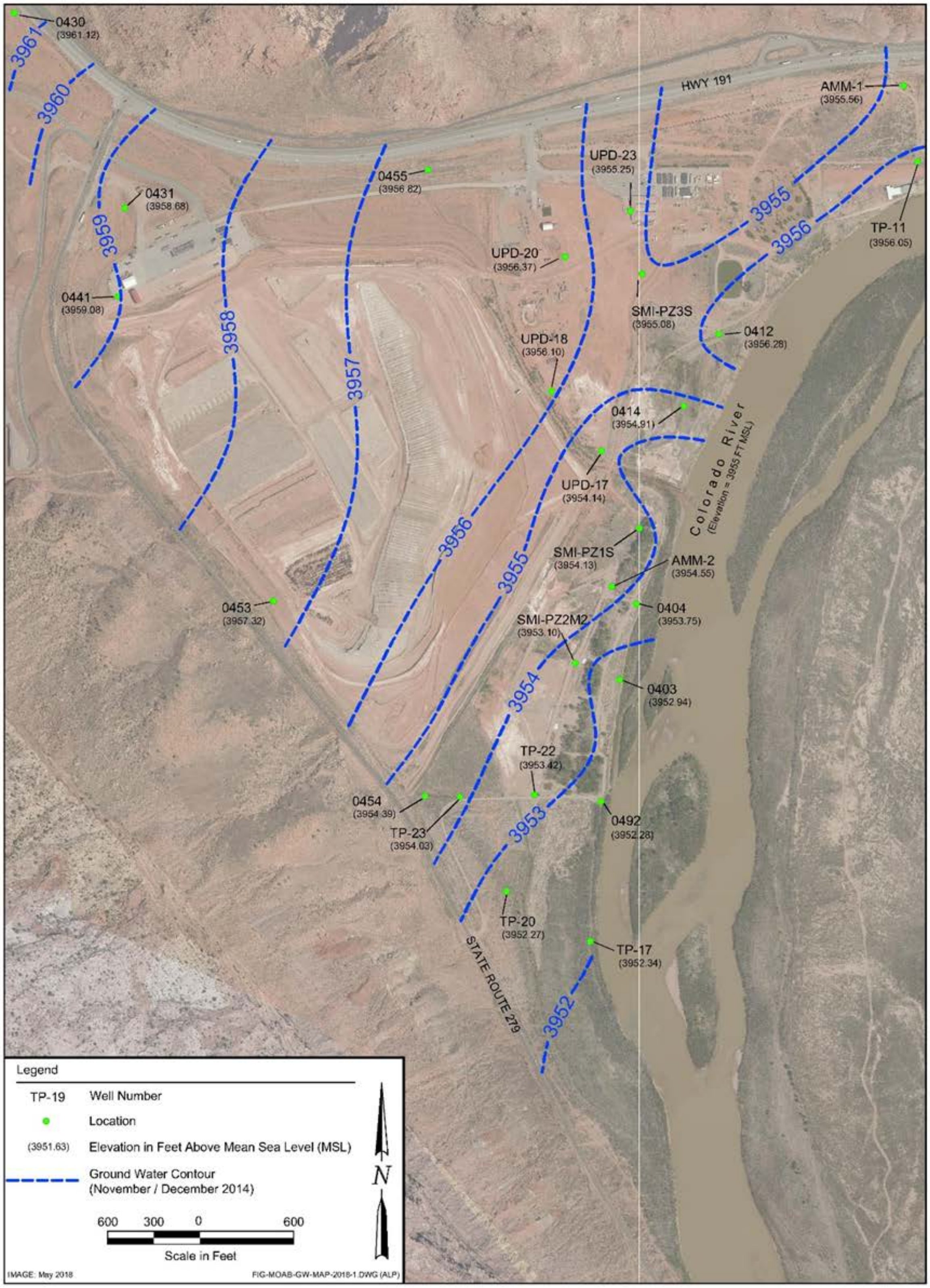

Figure 3. Site-wide Groundwater Elevations, May 24 through June 20, 2018

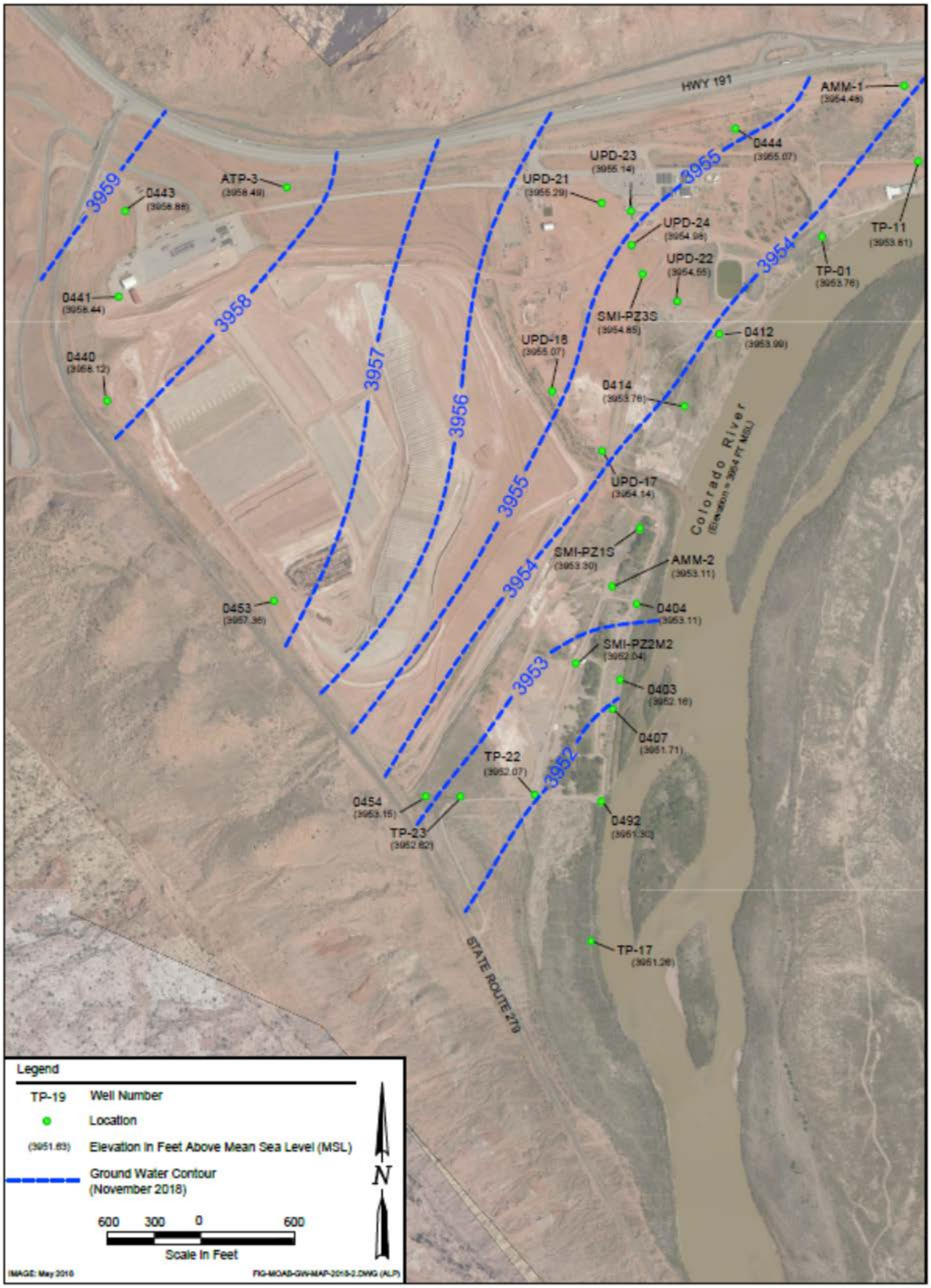

Figure 4. Site-wide Groundwater Elevations, October 31 through November 11, 2018

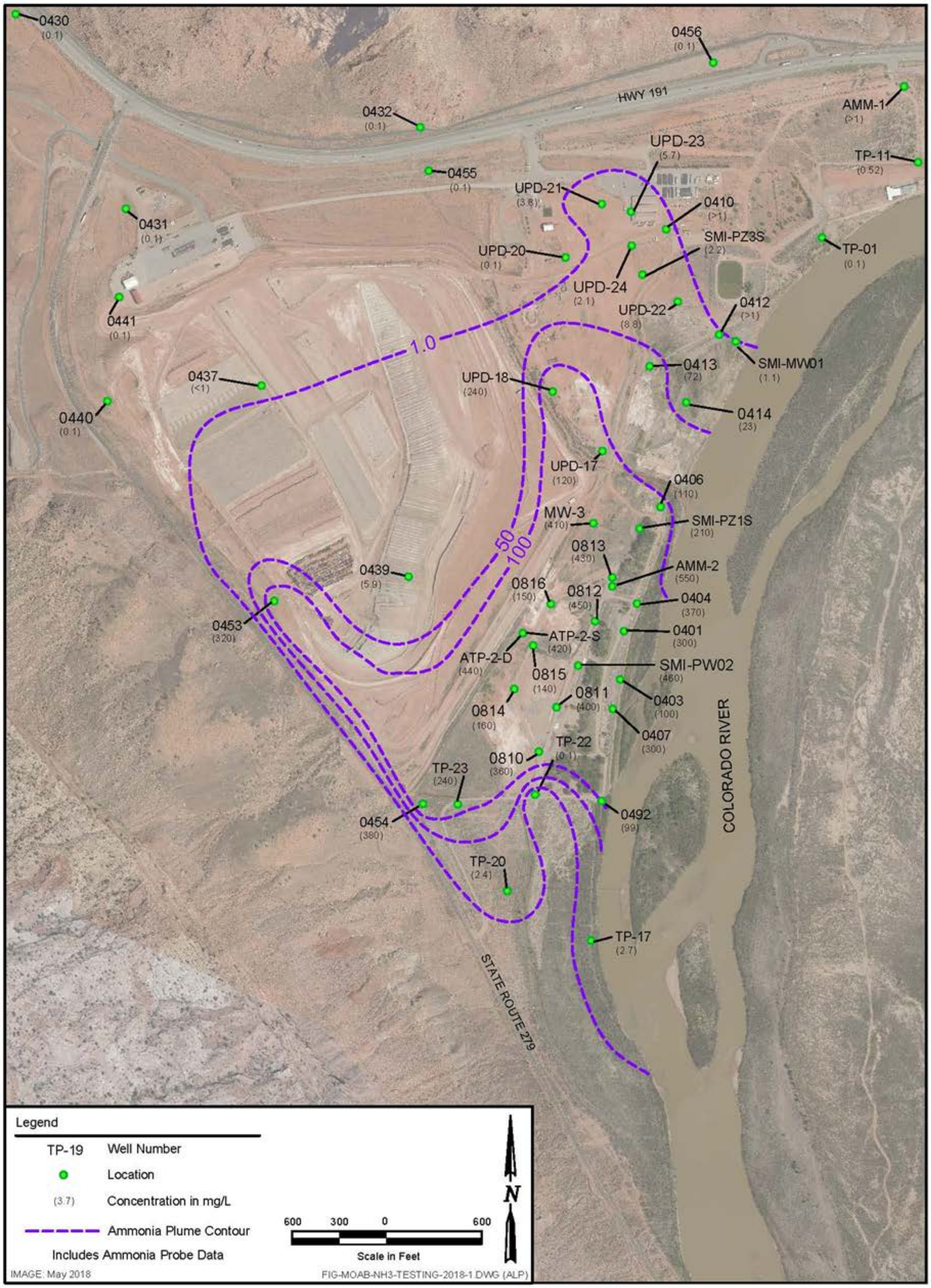

Figure 5. Ammonia Plume in Shallow Groundwater May/June 2018

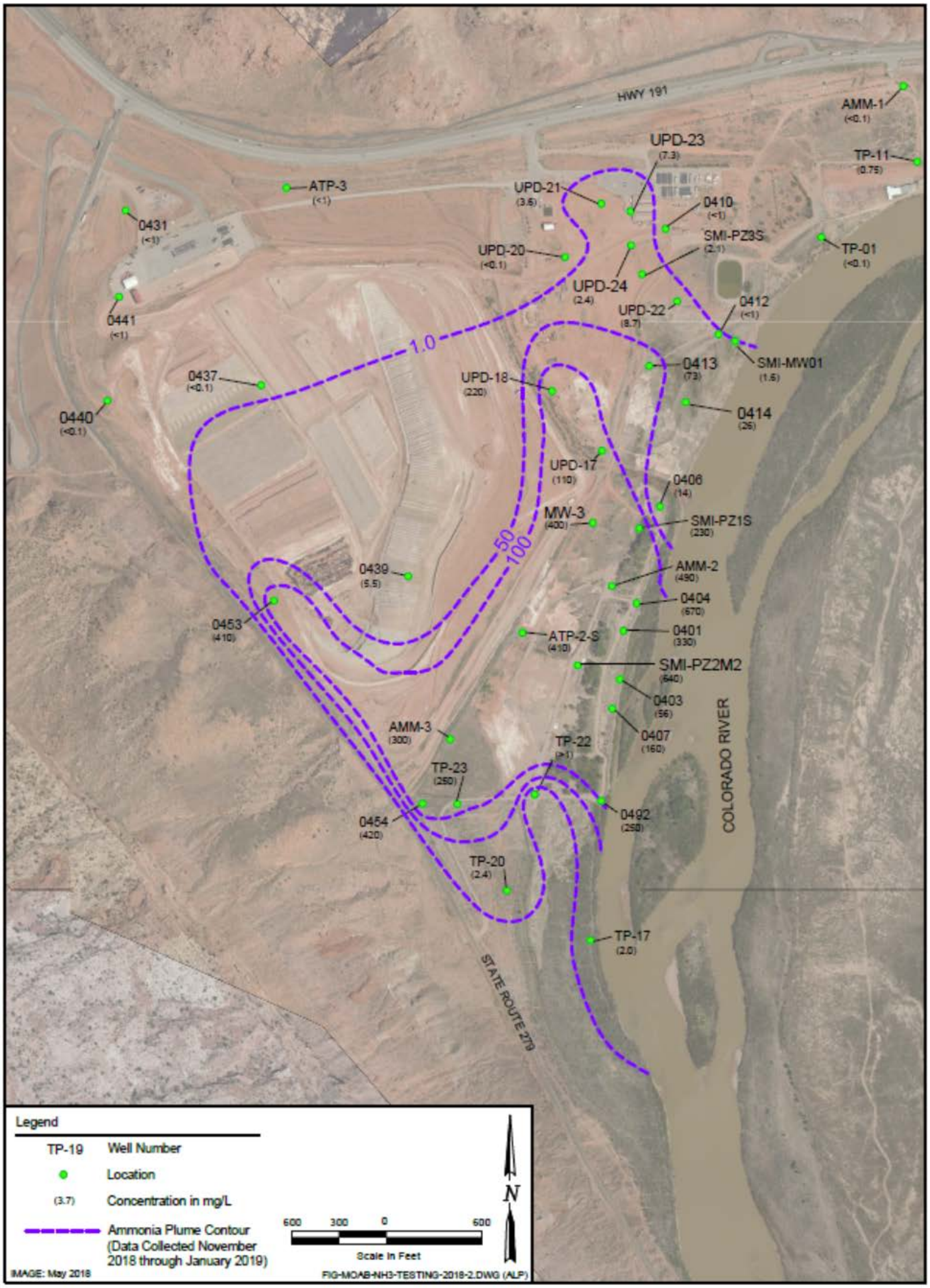

Figure 6. Ammonia Plume in Shallow Groundwater November/December 2018

Oxidation of ammonia to nitrate or nitrogen may also contribute to lower ammonia concentrations observed in the upgradient shallow groundwater beneath the tailings pile, where aerobic conditions are more likely; however, there is now flushing of the legacy plume by advective flow of fresh water due to density stratification of the brine zone. Figure 5 shows the ammonia plume in May/June 2018, and Figure 6 shows the ammonia plume in November/December 2018. The two plume maps are comparable.

There is no standard associated with ammonia, while the uranium groundwater standard of 0.044 mg/L is based on Table 1 in Title 40 Code of Federal Regulations Part 192, Subpart A (40 CFR 192A), "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites." In addition to ammonia, the other primary constituent of concern in groundwater is uranium. Figures 7 and 8 show the distribution of dissolved uranium in shallow groundwater in 2018. The uranium plumes are similar with the exception of the area near the river bank, where the concentrations become diluted during Colorado River spring runoff flows.

2.3 Surface Water/Groundwater Interaction

Previous investigations have shown that Colorado River flows impact the groundwater elevations and contaminant concentrations in the well field. For the majority of the year, when the river is experiencing baseflow (less than 5,000 cfs), groundwater discharges into the river (gaining conditions). As the river flow increases in response to the spring runoff, the river changes from gaining to losing conditions, and a freshwater lens starts to develop in the alluvium underlying the well field.

During higher flows, the groundwater gradient direction reverses in the vicinity of the riverbank, and the groundwater contaminant concentrations are diluted. Once these flows subside, the river switches back from losing to gaining, the groundwater gradient direction is re-established towards the river (to the southeast), and the freshwater lens recedes.

Figure 9 displays the groundwater elevation and the elevation of the Colorado River in 2018. The elevation of the Colorado River was calculated using the river flows from the USGS Cisco gaging station and converting them to an elevation using the site rating curve included in the *Moab UMTRA Project Flood Mitigation Plan* (DOE-EM/GJTAC1640). The Colorado River Basin experienced a severe drought in 2018, and the mean daily peak flow was only 8,170 cfs on May 15 (the average peak flow is approximately 23,000 cfs), which corresponds to an elevation of 3955.9 ft mean sea level (msl).

Between January and April 2018, the Colorado River was under gaining conditions (when the groundwater elevation was higher than the river surface elevation). In May, as the river stage increased due to the limited spring runoff, the river switched to losing conditions (with the river surface elevation higher than the groundwater elevation) and remained under those conditions through 2018. Typically, the river switches back to primarily gaining conditions, but this is a typical response to drought conditions.

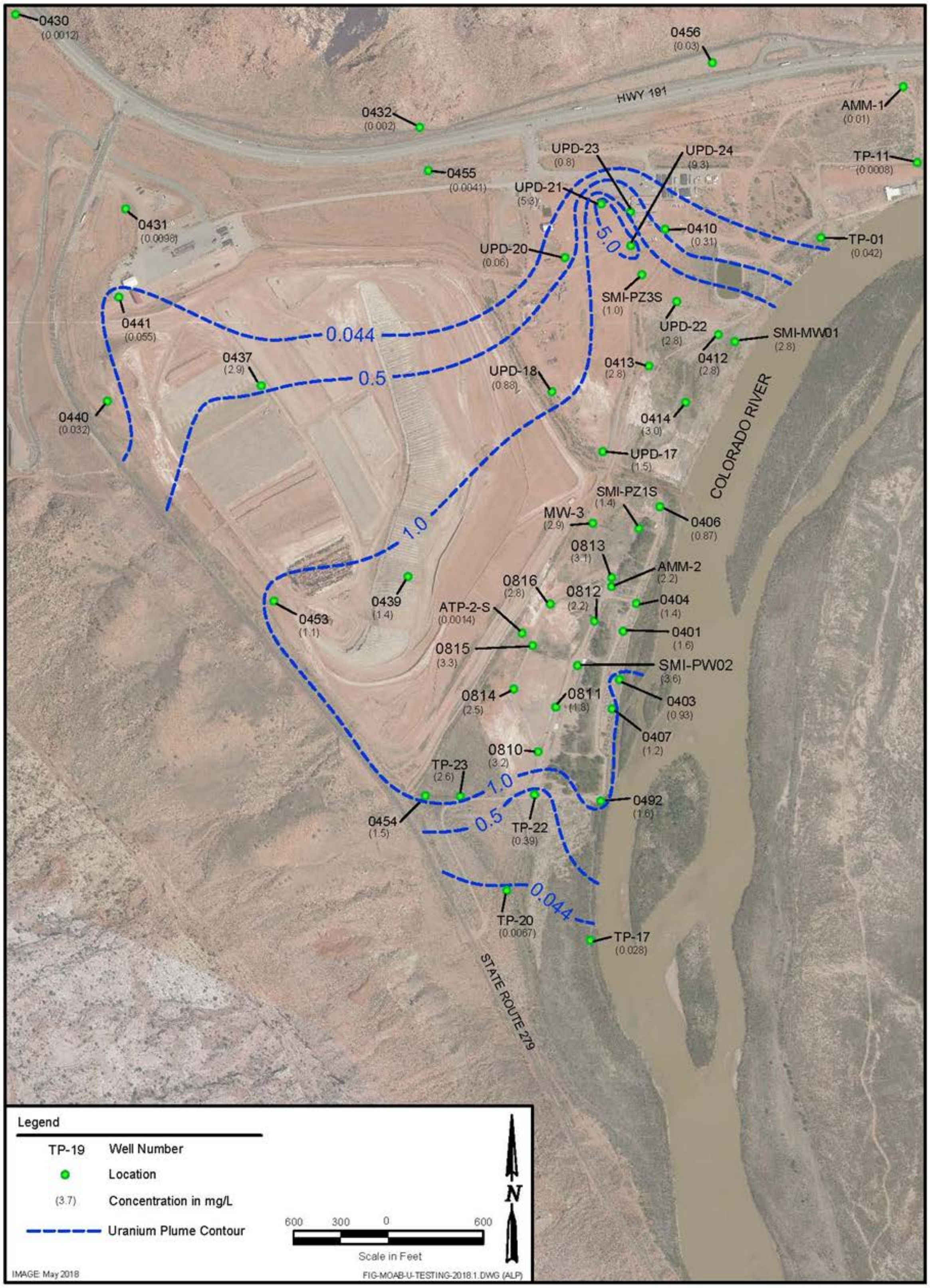

Figure 7. Uranium Plume in Shallow Groundwater May/June 2018

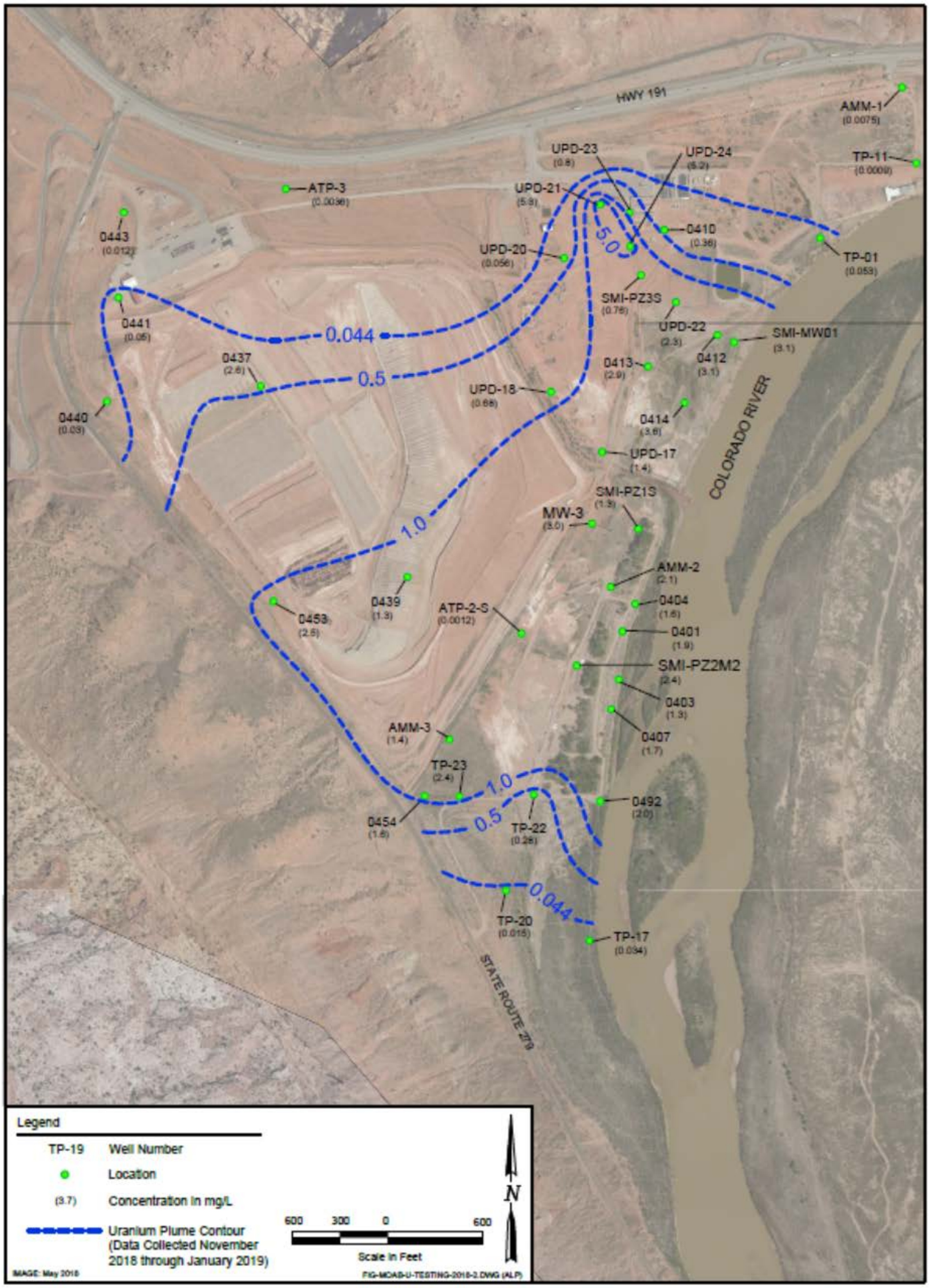

Figure 8. Uranium Plume in Shallow Groundwater November/December 2018

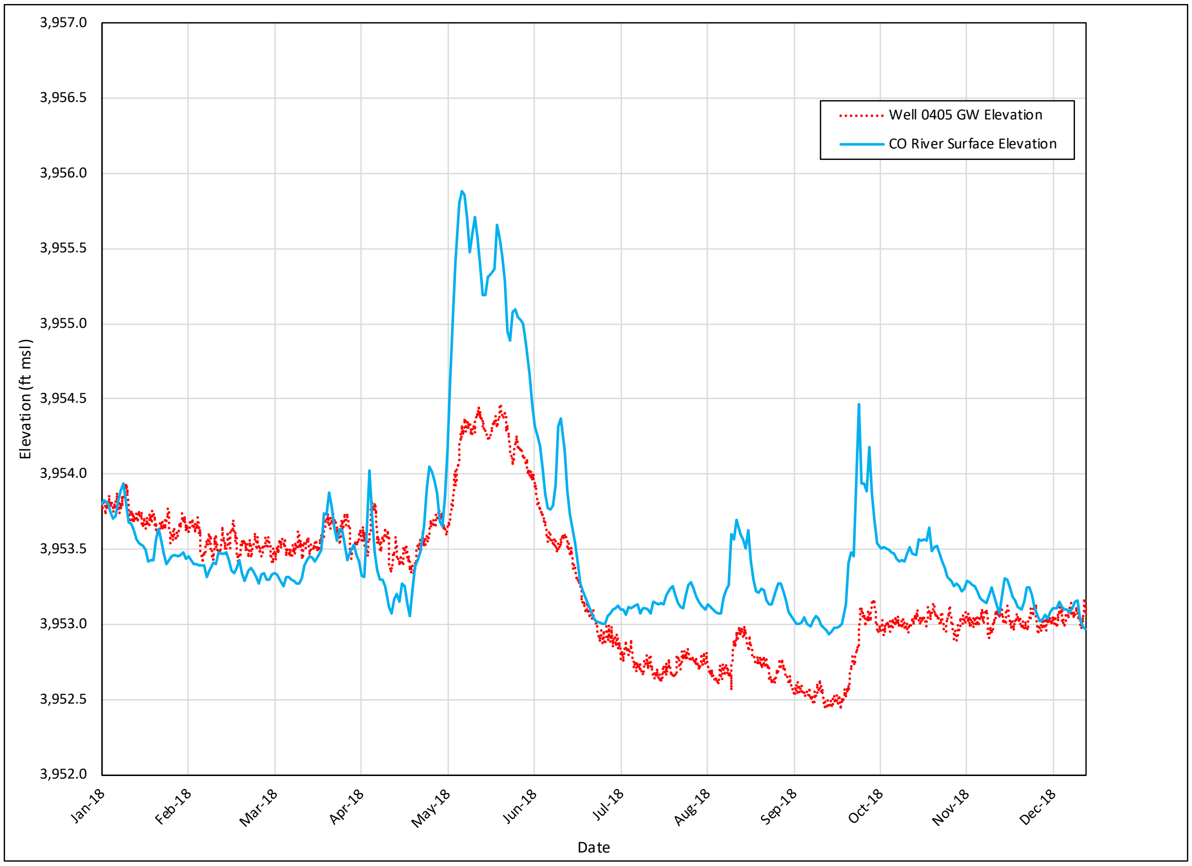

Figure 9. Groundwater Surface Elevation Compared to the Colorado River Surface Elevation 2018

3.0 Methods

Well field performance is assessed by measuring extraction/injection rates of remediation wells, measuring water levels, and the collection of samples from surface water locations, extraction wells, and monitoring wells for analytical analysis. In 2018, the IA well field operations included extraction at CF5 and injection at CF4.

3.1 Remediation Well Extraction

Each extraction well contains a flow meter that displays the instantaneous flow rate in gallons (gal) per minute (gpm), the cumulative total volume extracted (displayed at “Total 1” on the flow meter), and the net volume since the last reset of the internal memory (displayed as “Total 2” on the flow meter). Flow meter readings are manually recorded on a weekly basis during extraction operations and are used in conjunction with water quality data to evaluate the performance of the system.

When the extraction wells are sampled, the resulting ammonia and uranium concentrations are used to calculate the contaminant mass removal. The contaminated water is then used as dust suppression in the Contamination Area (CA). Any contaminants deposited as salts in the CA will eventually be removed for disposal with tailings and transported to the Crescent Junction disposal site.

3.2 Remediation Well Injection

Each injection well contains a flow meter that displays the instantaneous injection rate in gpm and the total volume. Flow meter readings are recorded manually on a weekly basis during injection operations and are used in conjunction with water level data to estimate the amount of freshwater mounding in each well.

3.3 Water Levels

Groundwater levels are recorded in the IA well field on a weekly basis during injection operations to monitor groundwater drawdown and freshwater mounding. A water level indicator is used to measure the depth to groundwater (below top of casing). Data logging equipment with pressure transducers is installed at various locations to measure water levels more frequently.

3.4 Water Quality

Selected well and surface water locations are sampled at various times, depending on the purpose of the sampling event. Before sampling, the field parameters, which include temperature, pH, and conductivity, are measured and recorded. Observation wells are primarily sampled with dedicated down-hole tubing and a peristaltic pump, while remediation wells are sampled with dedicated submersible pumps.

Water samples are collected at various depths and locations to monitor the primary contaminants of concern, ammonia (as N) and uranium. All water sampling was performed in accordance with the *Moab UMTRA Project Surface Water/Groundwater Sampling and Analysis Plan* (DOE-EM/GJTAC1830). Samples are shipped overnight to ALS Environmental (ALS) in Fort Collins, Colorado, for analysis.

4.0 Groundwater Extraction Operations and Performance

4.1 IA Operations

This section provides information regarding the IA well field extraction performance during the 2018 pumping season. This section also includes a discussion of the total groundwater extraction rate, hydraulic control, mass removal, and water quality. Appendix A contains tables of well construction information (Table A-1), chronology (Table A-2), pumping volumes (Table A-3), and mass removal (Tables A-4 and A-5).

The evaporation pond was decommissioned in 2015 as excavation of the tailings continued. An updated extraction system was installed and first utilized in May 2016 and was fully operational in June. The extraction operations are controlled by an automated system. Groundwater from extraction wells is pumped directly into two 21,000-gal frac tanks that serve as holding tanks. The water is then pumped directly into a 12,000-gal Klein tank. The water from the Klein tank is transferred to water trucks and used for dust suppression in the CA.

Extraction is controlled from a human/machine interface system, which is located in the Project 2 office trailer. Extraction operations are limited by how much water is needed for dust suppression in the CA and by weather conditions (wet weather leads to less extraction, and warm, windy weather leads to more extraction). The extraction schedule was focused on optimizing ammonia and uranium mass removal and rotating through each of the eight CF5 remediation wells. In 2018, the extraction system was re-started in mid-March and operated through mid-November, at which point it was winterized.

The associated volume of groundwater extracted by each well in CF5 is shown in Appendix A, Table A-3. Figure 10 provides a graphic summary of the cumulative volume of groundwater extracted from CF5 in 2018. A total of approximately 7.4 mil gal of water was extracted from CF5 during 2018.

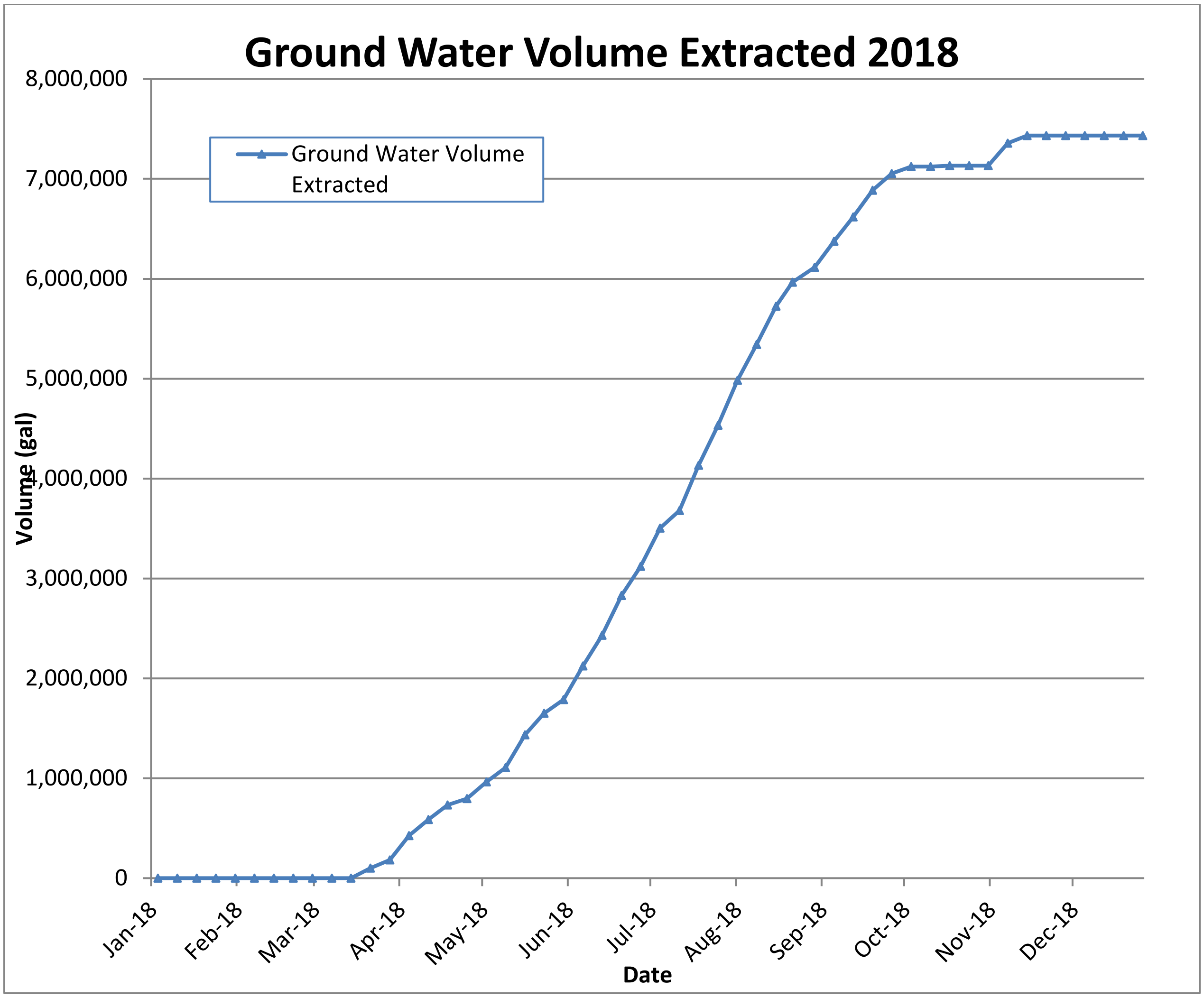

Figure 10. Cumulative Volume of Extracted Groundwater during 2018

4.2 CF5 Groundwater Volume Extracted and Contaminant Mass Removal

Monthly extraction volumes for each of the eight extraction wells are listed in Table A-3 (Appendix A). The majority of the 2018 extracted water was removed from wells 0813 (1.5 mil gal) and 0816 (1.6 mil gal). The remaining CF5 wells extracted between approximately 224,900 and 1.2 mil gal in 2018. Extraction operations were maximized in August, when 1.6 mil gal were removed from the groundwater system.

The ammonia and uranium mass removed by CF5 extraction wells in 2018 is presented in Tables A-4 and A-5 of Appendix A. These values are based on groundwater extraction volumes recorded by individual flow meters. The mass of ammonia and uranium removed from groundwater by the extraction wells was calculated by multiplying the extracted volume by the corresponding contaminant mass concentration measured in each well's discharge.

The concentrations used in these calculations were drawn from analytical data presented in Appendix C (available on the Project's SharePoint website). In 2018, a total of 20,230 pounds (lb) (9,174 kilograms [kg]) of ammonia and 179.5 lb (81.6 kg) of uranium were extracted from the groundwater.

Table A-4 in Appendix A shows that extraction wells 0813 and PW02 removed the most ammonia mass at 5,221 lb (2,368 kg) and 4,354 lb (1,975 kg), respectively. Estimated mass withdrawals of uranium at CF5 extraction wells are presented in Table A-5 in Appendix A, which shows the greatest mass of uranium was extracted from wells 0816 and PW02 at 36.8 lb (16.7 kg) and 34.2 lb (15.5 kg), respectively.

4.3 Groundwater Chemistry

Groundwater samples were collected from the CF5 extraction wells twice in 2018, in May and September/October (Table 1). Ammonia concentrations varied from 95 mg/L (Well 0815) to 460 mg/L (PW02), and the uranium concentration ranged from 1.8 mg/L (wells 0811 and 0813) to 3.6 mg/L (PW02). Specific conductance ranged from 15,067 µmhos/cm at well 0813 (northern end of CF5) to 32,790 µmhos/cm at well PW02 (in the middle of the well field).

5.0 Injection Operation and Performance

The main objective of freshwater injection is to form a hydrologic barrier between the tailings pile and the backwater channel that flows adjacent to the well field, and to dilute contaminants before groundwater discharges into the backwater channel. Freshwater injection into the CF4 wells in 2018 occurred consistently from January 30 to July 2 and sporadically in August and November primarily due to the inability to pump river water into the freshwater pond as a result of the drought conditions. In addition, it was necessary to use injection water at times in 2018 for the surface water diversion system operations.

Table 1. CF5 Ammonia and Uranium Concentrations, 2018

Location	Date	Ammonia (mg/L)	Uranium (mg/L)	Specific Conductance (µmhos/cm)
0810	05/02/18	360	3.2	30,624
	09/27/18	310	3.1	31,635
0811	05/02/18	400	1.8	19,687
	09/27/18	360	2.7	18,406
0812	05/02/18	450	2.2	16,553
	09/27/18	400	2.1	18,280
0813	05/02/18	430	3.1	15,067
	10/03/18	430	1.8	15,410
0814	05/07/18	160	3.2	20,678
	10/03/18	150	3.0	20,067
0815	05/07/18	140	3.3	19,429
	10/03/18	95	3.2	18,850
0816	05/07/18	150	2.8	21,166
	10/03/18	160	2.7	21,360
PW02	05/02/18	460	3.6	25,444
	09/27/18	420	3.2	32,790

The injection system uses Colorado River water that is diverted to a freshwater pond and is then pumped through sand and 1 to 5 micron bag filters, and injected into the remediation wells. Construction information for the CF4 wells can be found in Table B-1 of Appendix B. Table B-2 also contains a chronology of CF4 activities.

CF4 is located in the southern portion of the IA well field adjacent to a prominent side channel that typically remains open to the main channel until the river flow drops below 3,000 cfs. During 2018, this channel remained dry and never developed into a suitable habitat because of the drought conditions and corresponding extremely low river stage. Approximately 5.6 mil gal of fresh water were injected into CF4 in 2018.

5.1 Injection Performance

Injection into all 10 CF4 wells began in late January (Table B-2, Appendix B). The system ran until early July, when it was temporarily shut down due to the low river stage and the difficultly to pump water from the river into the freshwater pond. CF4 operations resumed in early August and only sporadically operated through November due to the need to use injection water for the surface water diversion system, system maintenance requirements, and the need to replace the CF4 transformer. The sand filter media was replaced in November, and injection was also suspended while the wells were re-developed by Beeman Drilling from November 19 through 29, 2018. All of the CF4 injection wells were winterized for the year in late November.

5.2 Observation Well Chemical Data Summary

Due to limited use of the injection system, groundwater samples were collected from the CF4 observation wells only during January and May 2018 to assess the effectiveness of the system (Appendix B, Table B-3). It is important to note that the January samples were collected after the injection system had been shut down for approximately one month, and the May samples were collected after the system had been consistently operational for three months (and after approximately 3.3 mil gal of fresh water had been injected).

The results are provided in Table 2, with all samples submitted to ALS for ammonia and uranium analysis, while the field parameters (temperature, pH, and specific conductance) were measured during the sample collection. Of primary concern regarding the sampling associated with the injection system performance are the ammonia concentrations due to toxicity to aquatic life.

Table 2. CF4 Observation Well Ammonia Concentrations, January and May 2018

Location	Sample Depth (ft bgs)	Upgradient or Downgradient of Injection Wells	January 2018 Ammonia Concentration (mg/L)	May 2018 Ammonia Concentration (mg/L)
0780	28	Upgradient	320	64
0781	46	Upgradient	2,800	2,800
0782	33	Upgradient	1,500	430
0783	18	Upgradient	32	1.9
0784	18	Downgradient	0.64	0.1
0785	18	Downgradient	0.29	0.1
0786	28	Downgradient	570	260
0787	36	Downgradient	2,700	2,100

ft bags bgs = feet below ground surface

The CF4 wells are screened to deliver fresh water into the subsurface from 15 to 35 feet below ground surface (ft bgs). Even after a month of no active injection, the ammonia concentrations associated with the downgradient samples collected from a depth less than 20 ft bgs (wells 0784 and 0785) were less than 1 mg/L, clearly indicating the injection system activity impacted this subsurface zone even after a month of no injection. The sample from the upgradient shallow zone (from well 0783) had an ammonia concentration of 32 mg/L, providing further evidence of the effectiveness of the system in decreasing contaminant concentrations.

Samples collected in January from wells 0780 and 0786 (28 ft bgs) and well 0782 (collected from 33 ft bgs) had ammonia concentrations ranging from 320 to 1,500 mg/L. These samples represent the conditions near the bottom of the zone where the CF4 injection wells deliver fresh water into the subsurface when the system is active. From a depth of 36 to 46 ft bgs, the ammonia concentrations ranged from 2,700 to 2,800 mg/L (wells 0781 and 0787).

The May CF4 monitoring well sampling results indicate a significant reduction in ammonia concentrations in the downgradient (east) direction, particularly in the zone above 28 ft bgs. In the upgradient direction, the groundwater system at this same depth is also impacted by freshwater injection. The highest concentrations were associated with the samples collected from a depth of 46 ft bgs (2,800 mg/L at upgradient well 0781), which is more than 10 ft below the depth at which the fresh water is injected into the subsurface.

5.3 Freshwater Mounding

Water levels were collected on a near daily basis during injection operations. To determine the amount of freshwater mounding in each well, the water level data were plotted against the water levels measured in background well 0405.

The water levels in each well were adjusted to match well 0405 during non-pumping, baseflow conditions. Tables 3 and 4 summarize the mounding data that are shown in Figures B-1 to B-10 in Appendix B for the injection wells. Mounding data were collected when the injection system was operating and not undergoing maintenance. Figures B-11 through B-18 in Appendix B illustrate the mounding data in CF4 observation wells.

Figure 11 is a contour map showing the CF4 freshwater mounding in May 2018. The highest mounding occurs within 30 ft of the injection system. Maximum mounding occurred in each injection well at varying dates in the spring and fall. The amount of mounding was dependent on the individual well efficiency and the injection rate.

Table 3 presents the maximum mounding measured in each of the injection wells and the corresponding injection rate. The maximum mounding in the CF4 observation wells is presented in Table 4 and varied from 0.1 to 1.0 ft in the upgradient wells and from 0.1 to 1.0 ft in the downgradient wells. Maximum mounding occurred on May 1 for CF4 observation wells 0780 and 0783. Maximum mounding for the remaining six CF4 observation wells occurred on February 2.

6.0 Surface Water Monitoring

In 2018, the mean daily Colorado River flow ranged from 1,480 to 8,470 cfs from January through December. The channel that flows adjacent to CF4 was not considered a suitable habitat for young-of-year fish during the monitoring season (June through September) because it has remained silted in since 2013, and the depth of water within the channel was never sufficient to meet the definition of a suitable habitat. Surface water monitoring is completed through site-wide surface water sampling. The site-wide sampling event occurs twice a year, and surface water samples are collected upgradient of the site, on site, and downgradient of the site.

6.1 Site-wide Surface Water Monitoring

Site-wide surface water sampling was conducted adjacent to the well field in June and December 2018 (locations are shown on Figure 12). These results of this sampling event can be found in the *Moab UMTRA Project Groundwater and Surface Water Monitoring January through June 2018* (DOE-EM/GJTAC2267) and *Moab UMTRA Project Groundwater and Surface Water Monitoring July through December 2018* (DOE-EM/GJTAC3011). Results are presented in Table 5.

The ammonia concentrations measured during this event were all below the respective detection limits, with all surface water ammonia concentrations are below the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations.

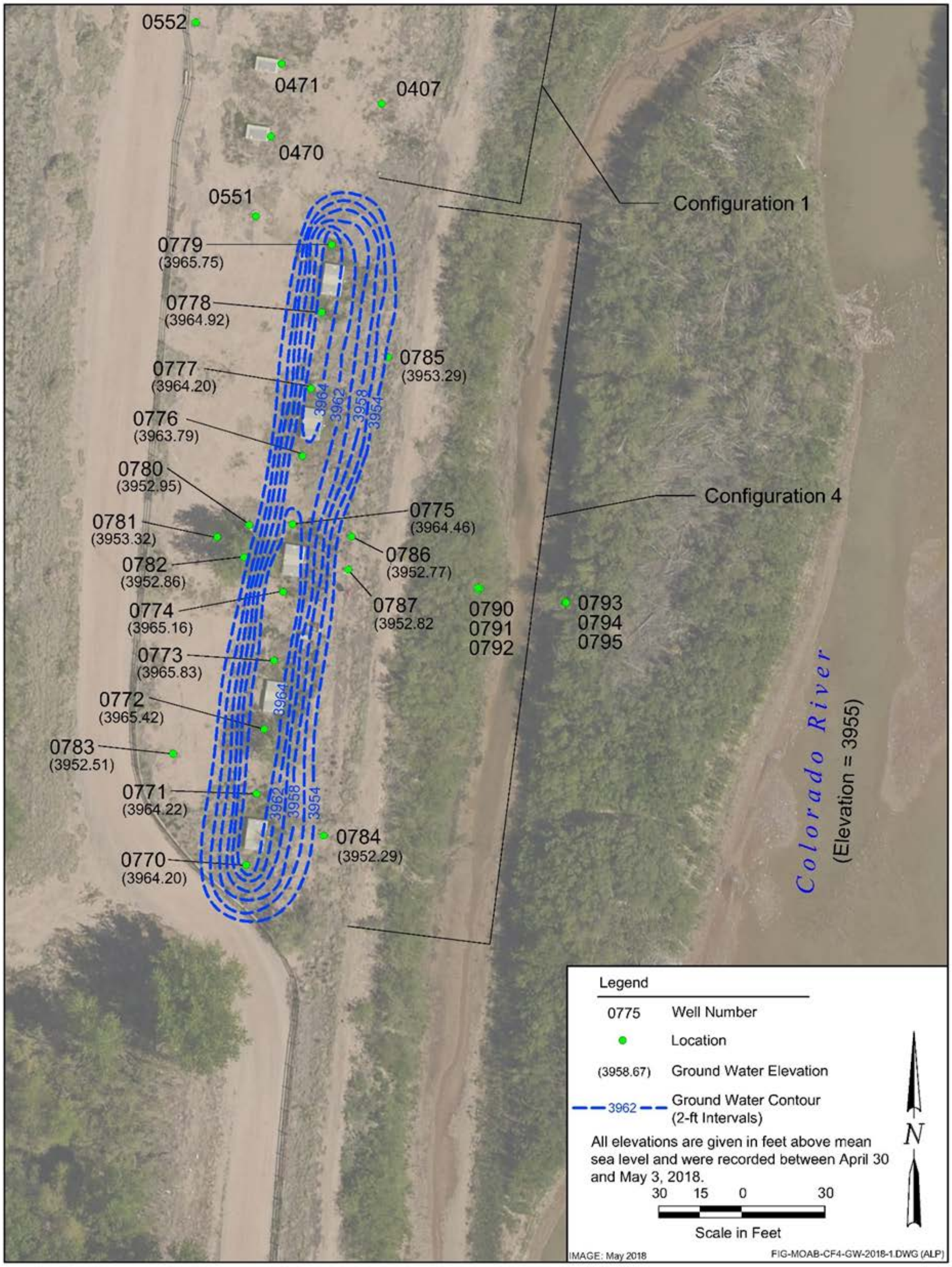

Figure 11. Freshwater Mounding at CF4 during Injection Operations May 2018

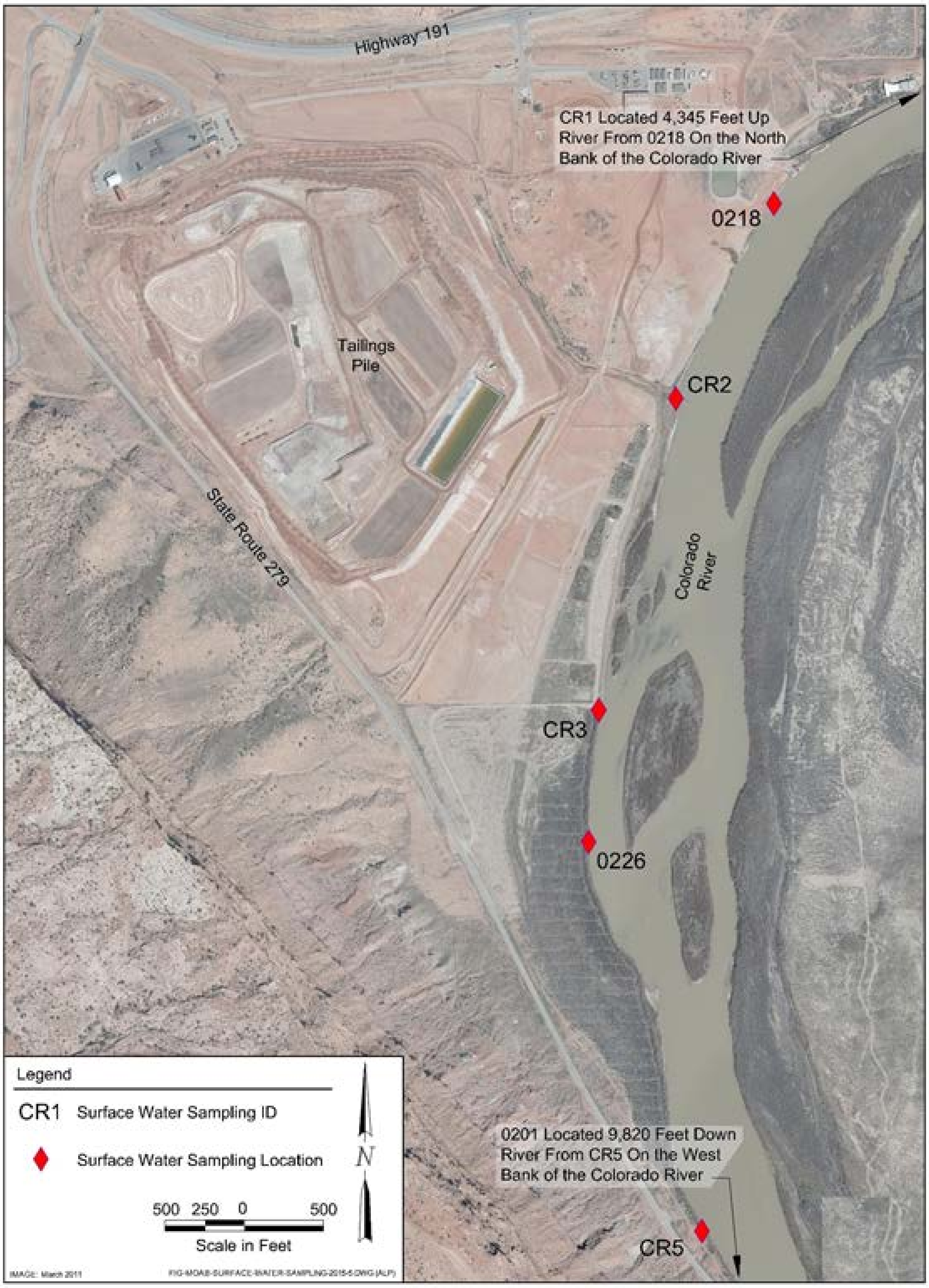

Figure 12. 2018 Site-wide Surface Water Sampling Locations

Table 3. Maximum Mounding Observed in Injection Wells

Well	Date	Type	Maximum Mounding (ft)	Injection Rate (gpm)
Configuration 4				
0770	04/2/18	Injection Well	13.2	2.8
0771	06/18/18	Injection Well	12.9	2.2
0772	5/3/18	Injection Well	14.1	3.8
0773	5/29/18	Injection Well	13.1	1.9
0774	6/13/18	Injection Well	12.9	2.1
0775	5/21/18	Injection Well	12.5	1.0
0776	5/8/18	Injection Well	13.1	4.2
0777	5/8/18	Injection Well	13.0	4.4
0778	5/24/18	Injection Well	12.5	1.8
0779	5/16/18	Injection Well	12.5	2.6

Table 4. Freshwater Mounding Observed in Observation Wells

Well	Date	Location	Maximum Mounding (ft)	Distance from Injection Source (ft)
Configuration 4				
0780	05/01/18	Upgradient	0.6	25
0781	02/06/18	Upgradient	1.0	30
0782	02/06/18	Upgradient	0.6	25
0783	05/01/18	Upgradient	0.1	30
0784	02/06/18	Downgradient	0.1	30
0785	02/06/18	Downgradient	1.0	25
0786	02/06/18	Downgradient	0.4	30
0787	02/06/18	Downgradient	0.5	30

Table 5. June and December 2018 Site-wide Surface Water Ammonia Concentrations and Comparisons to EPA Acute and Chronic Criteria

Location	Date	Temp (ºC)	pH	Ammonia as N (mg/L)	EPA - Acute Total as N (mg/L)*	EPA - Chronic Total as N (mg/L)**
0201	6/11/18	23.8	8.36	<0.1	3.4	0.32
	12/12/18	2.9	7.45	<1.0	21	3.2
0218	6/11/18	21.1	8.23	<0.1	6.0	0.54
	12/12/18	3.2	7.25	<1.0	27	3.8
0226	6/11/18	22.9	8.44	<0.1	3.8	0.34
	12/12/18	3.2	8.01	<1.0	8.8	1.8
CR1	6/11/18	20.9	8.08	<0.1	7.3	0.63
	12/12/18	2.7	7.84	<1.0	13	2.3
CR2	6/11/18	21.6	8.14	<0.1	7.3	0.59
	12/12/18	3.0	7.21	<1.0	31	4.0
CR3	6/11/18	23.7	8.40	<0.1	3.4	0.32
	12/12/18	3.5	7.61	<0.1	18	2.9
CR5	6/11/18	23.4	8.41	<0.1	3.8	0.34
	12/12/18	2.8	7.59	<1.0	18	2.9

*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)

6.2 Surface Water/Habitat Monitoring

Surface water monitoring adjacent to CF4 is typically conducted after the spring peak river flow begins to recede. The purpose is to monitor the ammonia concentrations in the side channel adjacent to the site, because the channel is a potential habitat for young-of-year endangered fish species (e.g., Colorado Pikeminnow, Razorback Sucker). In 2018, the back water channel adjacent to CF4 did not meet the definition of a habitat during the months of June through September (closed off upriver, open downriver, sufficient depth).

However, with the extremely low river flows, a suitable habitat did form to the east, off the main river channel (Figure 13). Once it was confirmed as suitable habitat, the surface water diversion system was started on August 8 and ran continuously through October 1. Initial screening samples were collected in early August, and eight surface water samples were collected from this suitable habitat area on October 1, 2018, and sent to the analytical laboratory.

These habitat sampling results were collected to confirm the surface water diversion system was effective in lowering the ammonia concentrations below the acute and chronic concentrations. As displayed in Figure 13, the BW2 locations were collected around the water's edge of the suitable habitat, while the BW3 samples were collected off the main river channel. These BW3 results are therefore considered representative of background conditions.

The results are summarized in Table 6 along with the EPA acute and chronic criteria. The pH values measured on October 1 were not indicative of those measured during the four other sampling events completed between August 28 and September 24 and were considered suspect. To determine the acute and chronic criteria, it was necessary to have a representative pH for each sample, and the average pH measured during the previous four events was used.

As shown in Table 6, the BW2 results ranged from below the 0.1 mg/L detection limit to 0.35 mg/L ammonia, and the results from the sampling of the three BW3 locations were all below the detection limit. All results were below both the acute and chronic criteria.

6.3 Surface Water Monitoring Summary

All of the surface water ammonia samples collected in 2018 were below EPA acute and chronic criteria. The CF4 side channel remained silted in, and it was dry by early July. However, a suitable habitat did develop to the east of the CF4 side channel, and samples collected on October 1, 2018, confirmed the surface water diversion system was effective at decreasing the ammonia concentrations below the EPA acute and chronic criteria.

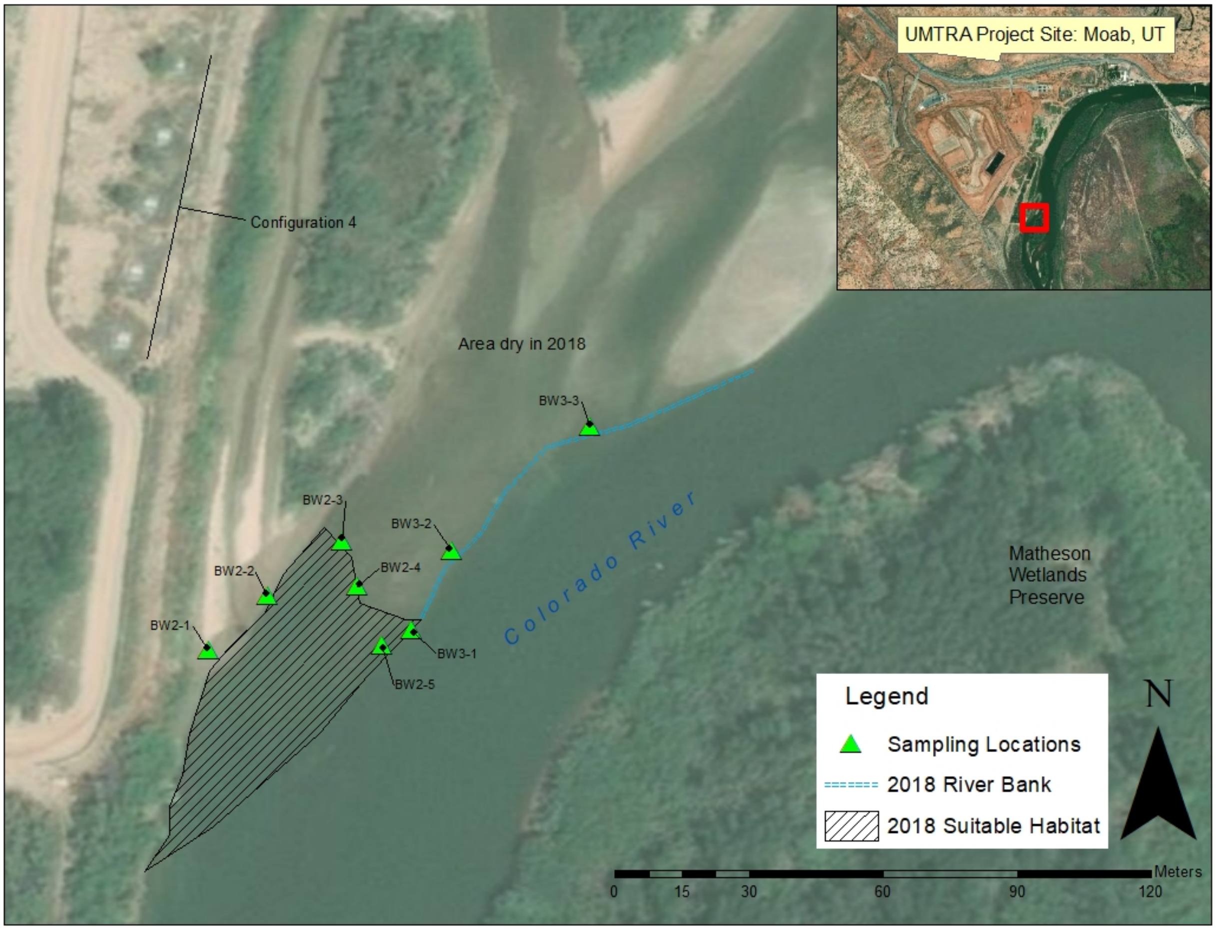

Figure 13. October 2018 Habitat Area Sampling Locations

Table 6. October 2018 Habitat Area Surface Water Ammonia Concentrations and Comparisons to EPA Acute and Chronic Criteria

Location	Date	Temp (°C)	pH[1]	Ammonia as N (mg/L)	EPA - Acute Total as N (mg/L)[2]	EPA - Chronic Total as N (mg/L)[3]
BW2-1	10/1/18	18.7	7.5	0.14	21	1.5
BW2-2	10/1/18	19.4	7.7	<0.1	15	1.2
BW2-3	10/1/18	19.9	7.8	0.17	13	1.0
BW2-4	10/1/18	19.5	8.0	0.35	8.8	0.78
BW2-5	10/1/18	18.9	8.0	0.18	8.8	0.83
BW3-1	10/1/18	18.3	8.1	<0.1	7.3	0.76
BW3-2	10/1/18	18.2	8.2	<0.1	6.0	0.65
BW3-3	10/1/18	18.2	8.2	<0.1	6.0	0.65

1 = Average pH measured the previous month prior to when the October 1 samples were collected.
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).

7.0 Investigations

7.1 Moab Sampling Events

Sampling events occurred throughout 2018. CF4 observation wells were sampled in January 2018. CF4 observation wells and CF5 extraction wells were sampled in May, and CF5 wells were sampled again in September/October 2018. Site-wide sampling events took place in May/June 2018 during the peak river flow and in November/December 2018 during baseflow conditions.

Maps of sample locations and the sample results can be found in the *Groundwater Surface Water Monitoring Report January through June 2018* and the *Groundwater Surface Water Monitoring Report July through December 2018*.

7.2 Crescent Junction Well 0205 Sampling and Recharge Monitoring

The placement of the cell cover has significantly altered the surface runoff/hydrology of the vicinity of well 0205. Before the installation of the cell cover, the majority of precipitation would evaporate with larger storm events producing surface runoff, with a very small portion slowly infiltrating over a much larger area. With the cover material in place, there is often less evaporation and more surface runoff that tends to accumulate in discrete areas of the site and provides a longer-term source of infiltration.

Water was first encountered in well 0205 in late June 2015 and has been present in the well since that time. Observations show that after a significant event or multiple precipitation events, the runoff collects into the retention ditch at the toe of the pile. As this water infiltrates into the subsurface, it likely intercepts a fracture system that is at least in part connected to the fracture observed inside well 0205 and eventually seeps into the well.

The results of water samples (Table 7) collected in February, June, and October 2018, and the results of four short-term recovery tests (completed in February, June, September, and December) were utilized to determine the source of the water. The manner in which the water elevation responds to the site precipitation (Figure 14) and the fluctuation of the recharge rate (Figure 15) suggest a connection between the water present in well 0205 and the surface runoff.

Analytical results indicate a clear distinction between the two isotopic signatures of groundwater encountered in well 0205 and Moab site groundwater that has been impacted by site operations, suggesting the water present in well 0205 is not associated with the tailings placed in the disposal cell.

Table 7. Crescent Junction Well 0205 Analyte Concentrations, 2018

Analyte	Analyte Concentration on 2/6/18	Analyte Concentration on 6/27/18	Analyte Concentration on 10/03/18
Ammonia as N	14	13	22
Arsenic	0.039#	0.039#	0.0039#
Barium	NA	NA	NA
Bicarbonate as $CaCO_3$	1,000	1,100	1,100
Boron	1.3	1.4	1.1
Bromide	20#	40#	20#
Cadmium	0.0033#	0.0033#	0.00033#
Calcium	330	370	300
Carbonate as $CaCO_3$	50#	20#	100#
Chloride	3,500	3,400	3,900
Chromium	0.0051#	0.0051#	0.012
Copper	0.0097#	0.0097#	0.0047
Fluoride	10#	20#	10#
Iron	0.049#	0.049#	0.026
Lead	0.013#	0.013#	0.0013#
Magnesium	850	1,000	1,000
Manganese	0.38	0.44	0.33
Molybdenum	0.011#	0.011#	0.013
Nitrate/ Nitrite as N	600	940	860
Potassium	50	54	71
Selenium	4.1	4.4	4.1
Sodium	10,000	10,000	9,700
Sulfate	23,000	23,000	24,000
Total Alkalinity as $CaCO_3$	1,000	1,100	1,100
Total Dissolved Solids	35,000	46,000	41,000
Uranium $_{234}$	29.7 +/- 5.4 pCi/L	31.9 +/- 5.7 pCi/L	30.1 +/- 5 pCi/L
Uranium $_{235}$	0.32 +/- 0.27 pCi/L	0.64 +/- 0.37 pCi/L	0.56 +/- 0.19 pCi/L
Uranium $_{238}$	9.3 +/- 2 pCi/L	11.9 +/- 2.4 pCi/L	9.7 +/- 1.7 pCi/L
Uranium	0.028	0.037	0.029

= Concentration at or below the detection limit, NA = Sample not analyzed for this analyte
Note: All concentrations in mg/L, except where noted

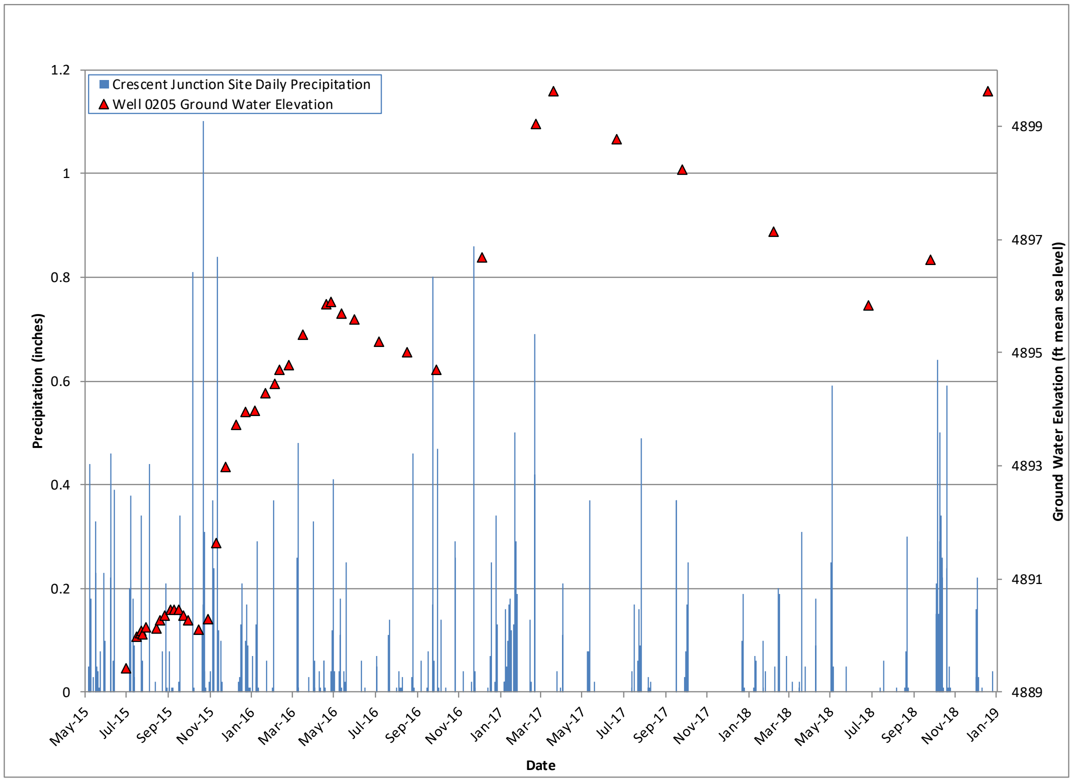

Figure 14. Crescent Junction Well 0205 Water Level Changes in Response to Precipitation through 2018

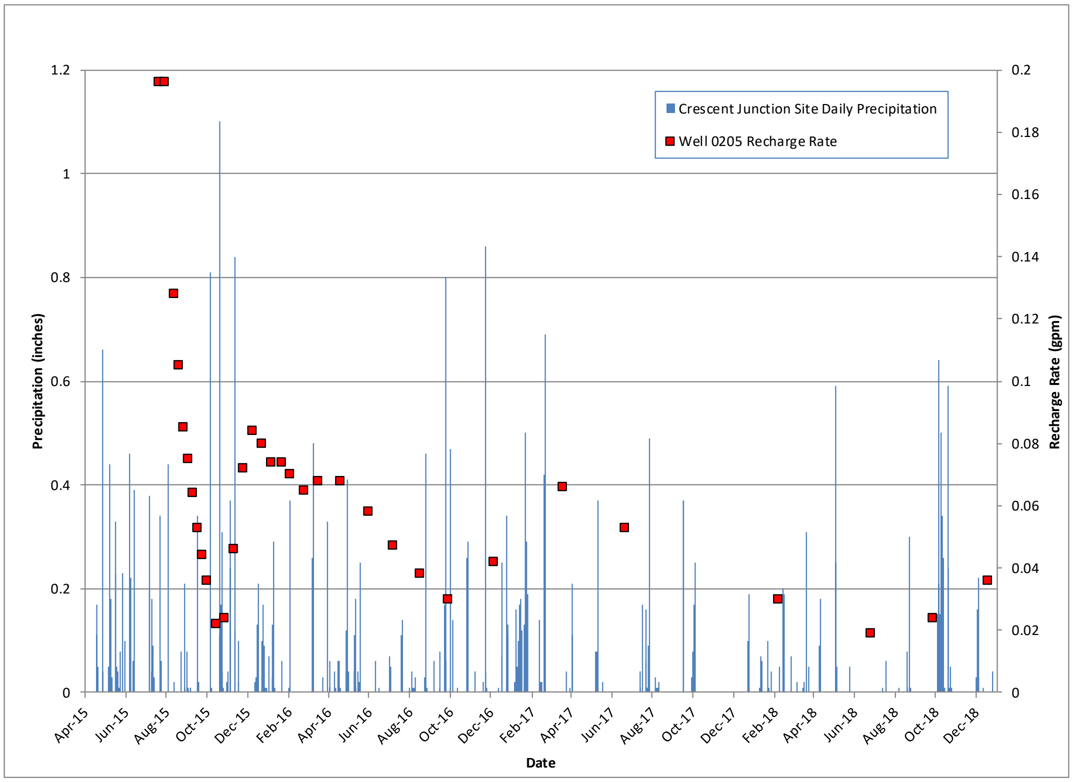

Figure 15. Crescent Junction Well 0205 Recharge Rate Changes in Response to Precipitation through 2018

8.0 Summary and Conclusions

In 2018, the IA operations focused on groundwater extraction (from CF5) and freshwater injection (CF4); the surface water diversion system was operational from August 8 through October 1 in an area located to the east of the CF4 side channel.

A total of 7.4 mil gal of water were extracted from CF5 in 2018. The extraction rate peaked in June through August, and operations continued through the fall. Each of the eight extraction wells were utilized in 2018. Figure 16 shows the ammonia and uranium mass removed and the volume of groundwater extracted from the CF5 extraction wells from 2003 through 2018.

The volume of groundwater and amount of contaminant mass removed was lower in 2018 compared to the previous year. A total of 20,230 lb of ammonia and 179.5 lb of uranium were extracted from the groundwater system in 2018.

Approximately 5.6 mil gal of fresh water were injected into CF4 in 2018. Laboratory data from the CF4 observation wells during injection operations indicate the system is effective at diluting ammonia concentrations, especially from 28 to 36 ft bgs. Specific conductance also decreases at the downgradient observation wells during freshwater injection. Site-wide surface water samples indicated the contaminants do not extend past the site boundary.

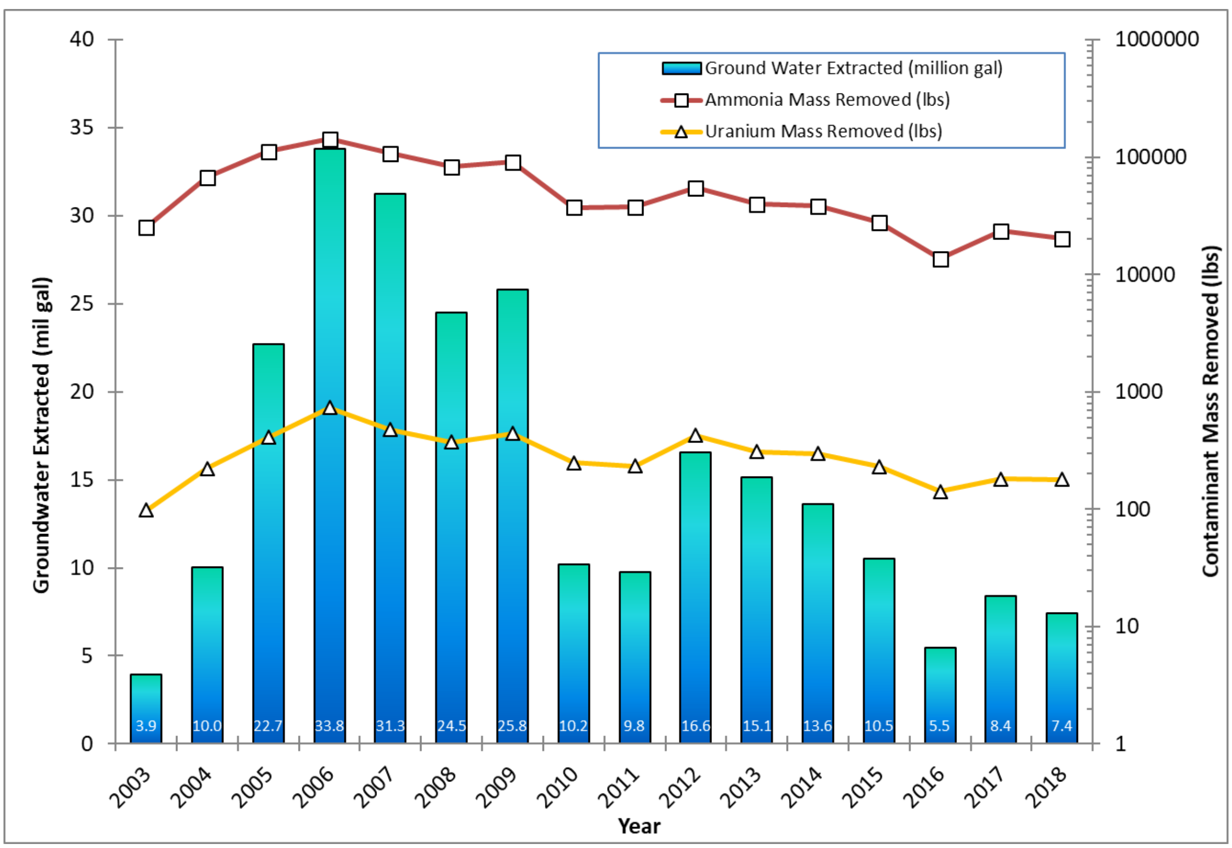

Figure 16. Groundwater Extracted Volume and Contaminant Mass Removal, 2003 through 2018

9.0 References

40 CFR 192A (U.S. Code of Federal Regulations), "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites."

DOE (U. S. Department of Energy), *Moab UMTRA Project Flood Mitigation Plan* (DOE-EM/GJTAC1640).

DOE (U.S. Department of Energy), *Moab UMTRA Project Groundwater and Surface Water Monitoring January through June 2018* (DOE-EM/GJTAC2267).

DOE (U.S. Department of Energy), *Moab UMTRA Project Groundwater and Surface Water Monitoring July through December 2018* (DOE-EM/GJTAC3011).

DOE (U.S. Department of Energy), *Moab UMTRA Project Surface Water/Groundwater Sampling and Analysis Plan* (DOE-EM/GJTAC1830).

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).

Appendix A.
Tables and Data for 2018 Groundwater Extraction

Appendix A. Tables and Data for 2018 Groundwater Extraction

Table A-1. Well Construction for CF5 Extraction Wells

Well	Well Type/Relative Depth	Diameter (in.)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
0810	Extraction	8	3,966.56	10.4 – 40.4	40.4
0811	Extraction	8	3,966.59	8.8 – 38.6	38.6
0812	Extraction	8	3,966.62	14.2 – 44.2	44.2
0813	Extraction	8	3,966.67	14.4 – 44.4	44.4
0814	Extraction	8	3,967.02	12.4 – 42.4	42.4
0815	Extraction	8	3,967.13	21.7 – 51.7	51.7
0816	Extraction	8	3,967.38	20.9 – 50.9	50.9
SMI-PW02	Extraction	4	3,965.60	20.0 – 60.0	60.3

In. = inch

Table A-2. Chronology with River Flow Range of CF5 Activities in 2018

Date	River Flow Range (cfs)	Activity
January	2,700 to 3,990	No extraction
February	2,470 to 3,210	No extraction
March	2,470 to 3,940	Restarted extraction system on March 19.
April	2,010 to 4,250	Extraction system operational in automatic mode, and manual mode on the 11-12 and 16-17. Repairs on the 24 and back to automatic on the April 25
May	3,290 to 8,470	Extraction system operational in automatic mode
June	2,200 to 6,780	Extraction system operational in automatic mode
July	1,800 to 2,630	Extraction system operational in automatic mode
August	2,060 to 3,830	Extraction system operational in automatic mode
September	1,820 to 2,690	Extraction system operational in automatic mode
October	1,890 to 5,890	Extraction system operation in automatic mode except for weeks of the 10th, 24th, and 31st due to wet/rainy site conditions
November	2,110 to 3,570	Winterization of the extraction system (well vaults, pump house, and storage tanks) occurred on Nov 13 and 14.
December	1,480 to 2,750	Winterized

Table A-3. CF5 Extraction Volumes 2018

Well	Extraction Volumes Removed (gal)												
	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Well Total
0810	0	0	29,775	91,827	48,076	277,348	228,510	229,771	178,035	15,026	57,953	0	1,156,321
0811	0	0	2,485	5,531	74,661	54,185	132	7,543	53,136	1,081	26,127	0	224,881
0812	0	0	22,967	88,529	93,309	171,595	130,167	143,521	94,336	7,160	40,013	0	791,597
0813	0	0	37,581	105,060	218,414	210,429	399,139	442,697	37,612	15,265	618	0	1,466,815
0814	0	0	8,031	13,591	148,453	97,651	53,733	99,236	104,976	8,247	32,918	0	566,836
0815	0	0	32,958	90,252	39,603	198,285	197	0	27,388	12,487	58,737	0	459,907
0816	0	0	49,347	149,748	214,911	90,567	385,014	415,493	284,879	7,244	27,981	0	1,625,184
SMI-PW02	0	0	334	69,159	150,905	236,215	213,923	242,456	159,844	13,106	56,170	0	1,142,112
MONTHLY TOTAL	0	0	183,478	613,697	988,332	1,336,275	1,410,815	1,580,717	940,206	79,616	300,517	0	
ANNUAL TOTAL													**7,433,653**

Table A-4. CF5 Ammonia Mass Removal 2018

Well	Ammonia Mass Removed (lbs)												
	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Well Total
0810	0	0	82	252	112	831	685	689	534	45	174	0	3,403
0811	0	0	10	22	303	180	0	25	177	4	87	0	808
0812	0	0	88	339	357	643	488	538	353	27	150	0	2,983
0813	0	0	128	359	775	753	1,429	1,585	135	55	2	0	5,221
0814	0	0	15	26	253	130	72	132	140	11	44	0	823
0815	0	0	49	135	63	231	0	0	32	15	68	0	594
0816	0	0	62	187	283	113	481	519	356	9	35	0	2,044
SMI-PW02	0	0	1	242	580	905	819	929	612	50	215	0	4,354
MONTHLY TOTAL:	0	0	435	1,562	2,725	3,788	3,975	4,417	2,339	215	775	0	
ANNUAL TOTAL:													**20,230**

Table A-5. CF5 Uranium Mass Removal 2017

Well	Uranium Mass Removed (lbs)												
	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Well Total
0810	0.0	0.0	0.6	1.9	1.1	7.4	6.1	6.1	4.7	0.4	1.5	0.0	30.0
0811	0.0	0.0	0.1	0.1	1.7	0.8	0.0	0.1	0.8	0.0	0.4	0.0	4.0
0812	0.0	0.0	0.4	1.5	1.5	3.1	2.4	2.6	1.7	0.1	0.7	0.0	14.2
0813	0.0	0.0	0.5	1.4	2.9	5.4	10.3	11.4	1.0	0.4	0.0	0.0	33.4
0814	0.0	0.0	0.2	0.3	3.6	2.6	1.4	2.6	2.8	0.2	0.9	0.0	14.6
0815	0.0	0.0	0.9	2.3	1.0	5.4	0.0	0.0	0.8	0.3	1.6	0.0	12.3
0816	0.0	0.0	1.0	3.0	4.6	2.1	9.0	9.7	6.6	0.2	0.7	0.0	36.8
SMI-PW02	0.0	0.0	0.0	2.0	4.5	7.1	6.4	7.3	4.8	0.4	1.7	0.0	34.2
MONTHLY TOTAL:	0.0	0.0	3.6	12.6	20.9	34.0	35.6	39.9	23.2	2.1	7.5	0.0	
ANNUAL TOTAL:													**179.5**

Appendix B.
Tables and Data for 2018 Freshwater Injection

Appendix B. Tables and Data for 2018 Freshwater Injection

Table B-1. CF4/CF1 Well Construction

Well	Well Type/ Relative Depth	Diameter (in.)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
Configuration 4					
0770	Remediation/Deep	6	3,968.86	14.9 – 34.8	35.2
0771	Remediation/Deep	6	3,969.04	15.0 – 34.9	35.3
0772	Remediation/Deep	6	3,969.21	15.2 – 35.1	35.5
0773	Remediation/Deep	6	3,969.15	15.2 – 35.1	35.5
0774	Remediation/Deep	6	3,968.77	15.5 – 35.4	35.8
0775	Remediation/Deep	6	3,969.18	15.1 – 35.0	35.4
0776	Remediation/Deep	6	3,968.97	15.2 – 35.1	35.5
0777	Remediation/Deep	6	3,968.76	15.3 – 35.2	35.6
0778	Remediation/Deep	6	3,968.93	15.1 – 35.0	35.4
0779	Remediation/Deep	6	3,968.34	15.7 – 35.6	36.0
0780	Observation/Shallow	6	3,968.45	20.3 – 30.1	30.5
0781	Observation/Deep	6	3,968.56	44.8 – 54.5	55.0
0782	Observation/Deep	6	3,968.46	31.0 – 40.8	41.2
0783	Observation/Shallow	2	3,968.82	8.6 – 18.6	19.1
0784	Observation/Shallow	2	3,968.73	9.4 – 19.4	19.9
0785	Observation/Shallow	2	3,968.24	9.6 – 19.6	19.9
0786	Observation/Shallow	6	3,968.14	20.5 – 30.3	30.7
0787	Observation/Deep	6	3,968.43	35.4 – 45.2	45.7
0790	Well Point/Shallow	1	3,953.91	2.0 – 3.0	3.0
0791	Well Point/Intermediate	1	3,953.91	4.3 – 5.3	5.3
0792	Well Point/Deep	1	3,953.91	9.3 – 10.3	10.3
0793	Well Point/Shallow	1	3,952.69	2.0 – 3.0	3.0
0794	Well Point/Intermediate	1	3,952.69	4.3 – 5.3	5.3
0795	Well Point/Deep	1	3,952.69	9.3 – 10.3	10.3

Table B-1. CF4/CF1 Well Construction (continued)

Well	Well Type/ Relative Depth	Diameter (in.)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
Configuration 1					
0470	Remediation/Intermediate	4	3966.56	10.3 - 19.7	21.3
0471	Remediation/Intermediate	4	3966.59	10.3 - 19.7	21.3
0472	Remediation/Intermediate	4	3966.62	10.3 - 19.7	21.3
0473	Remediation/Intermediate	4	3966.67	10.3 - 19.7	21.3
0474	Remediation/Intermediate	4	3967.02	10.3 - 19.7	21.3
0475	Remediation/Intermediate	4	3967.13	10.3 - 19.7	21.3
0476	Remediation/Intermediate	4	3967.38	10.3 - 19.7	21.3
0480	Observation/Shallow	4	3966.94	15.5 - 19.8	20.3
0481	Observation/Intermediate	4	3967.01	25.4 - 29.7	31.3
0483	Observation/Shallow	4	3967.00	15.5 - 19.8	20.3
0484	Observation/Intermediate	4	3967.19	25.5 - 29.8	30.3
0558	Observation/Intermediate	6	3966.85	35.0 - 45.0	45.1
0559	Observation/Shallow	1	3967.84	10.5 - 20.5	20.7
0560	Observation/Intermediate	6	3966.95	30.0 - 40.0	40.4

Table B-2. Chronology and River Flow Range of CF1/CF4 Activities in 2018

Month	River Flow Range (cfs)	Activity
January	2,700 to 3,990	Injection system was started at CF4 on January 30
February	2,470 to 3,210	Injection system actively running
March	2,470 to 3,940	Injection system actively running
April	2,010 to 4,250	Injection system shut down on April 11 due to freshwater pond turbidity. Restarted April 25
May	3,290 to 8,470	Injection system actively running
June	2,200 to 6,780	Injection system was actively running
July	1,800 to 2,630	Injection system was shut down July 2 due to RAC request; river stage below intake
August	2,060 to 3,830	Injection system started August 7 with surface diversion. Shut down injection August 9 to increase flow for surface diversion. Restarted August 28, down again August 31
September	1,820 to 2,690	Injection system and surface water diversion restarted September 4. System down for the end of September
October	1,890 to 5,890	Injection system not running for the month of October
November	2,110 to 3,570	Injection system not running until November 15. Cleaned the filter November 1 added gravel and sand on November 5 and 7. Winterized November 29
December	1,480 2,750	Injection system not running for the month of December

Table B-3. Analytical Sample Results 2018

Location	Location from Injection	Sample Depth (ft bgs)	Date	Ammonia, as N (mg/L)	Uranium (mg/L)	Specific Conductance (µmhos/cm)
780	Upgradient	28	1/23/2018	320	2.5	18,989
			4/30/2018	64	0.85	9,271
781	Upgradient	46	1/23/2018	2,800	1.4	95,727
			5/1/2018	2,800	1.7	92,075
782	Upgradient	33	1/23/2018	1,500	3	53,220
			5/1/2018	430	3	20,783
783	Upgradient	18	1/24/2018	32	0.57	5,019
			5/1/2018	1.9	0.046	1,509
784	Downgradient	18	1/24/2018	0.64	0.015	1,371
			5/1/2018	0.1	0.0082	1,405
785	Downgradient	18	1/24/2018	0.29	0.025	1,393
			5/1/2018	0.1	0.012	1,451
786	Downgradient	28	1/24/2018	570	2.6	22,479
			5/1/2018	260	1.9	17,078
787	Downgradient	36	1/24/2018	2,700	1.9	86,825
			5/1/2018	2,100	1.9	83,343

µmhos/cm = micromhos per centimeter

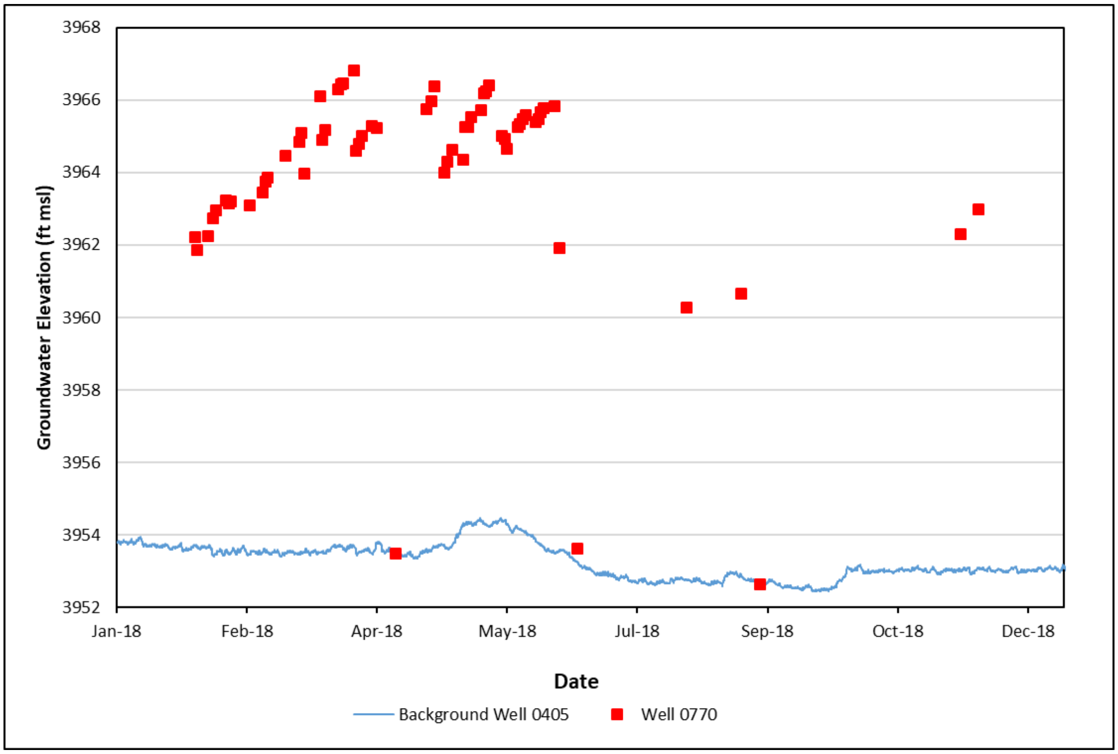

Figure B-1. Freshwater Mounding in Remediation Well 0770 during Injection

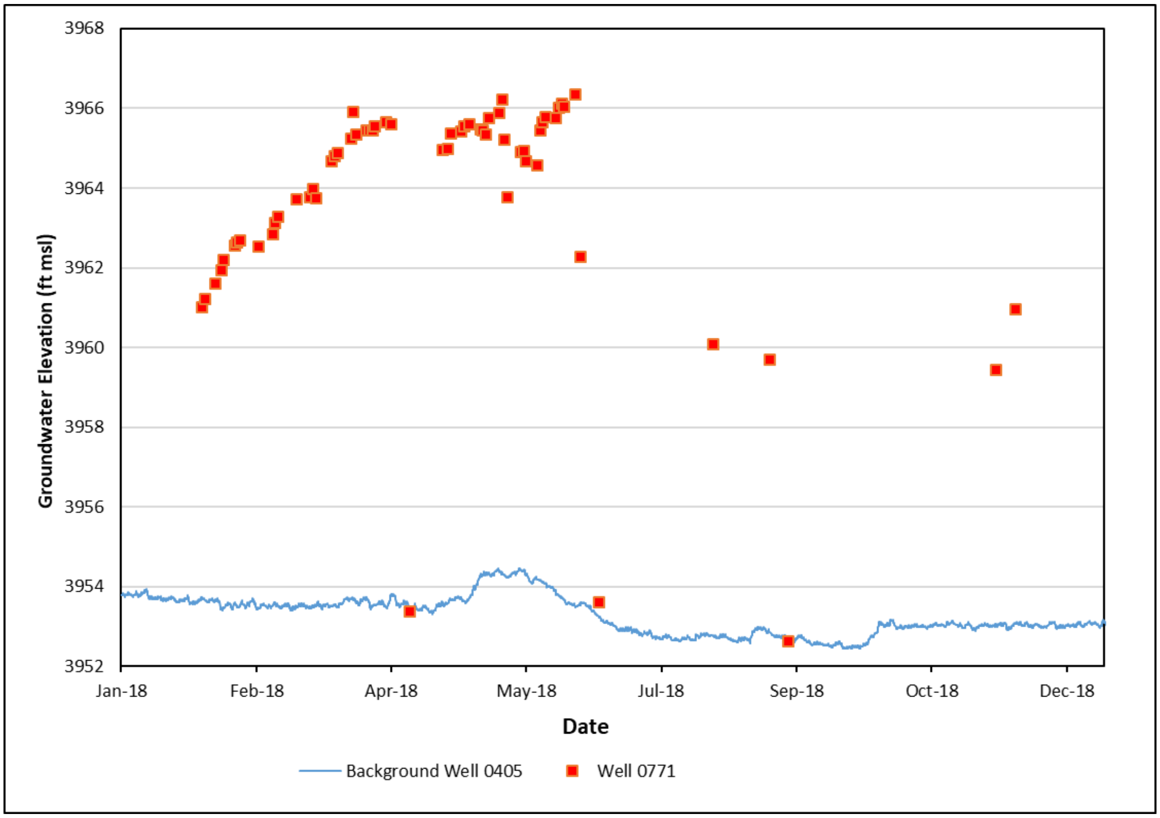

Figure B-2. Freshwater Mounding in Remediation Well 0771 during Injection

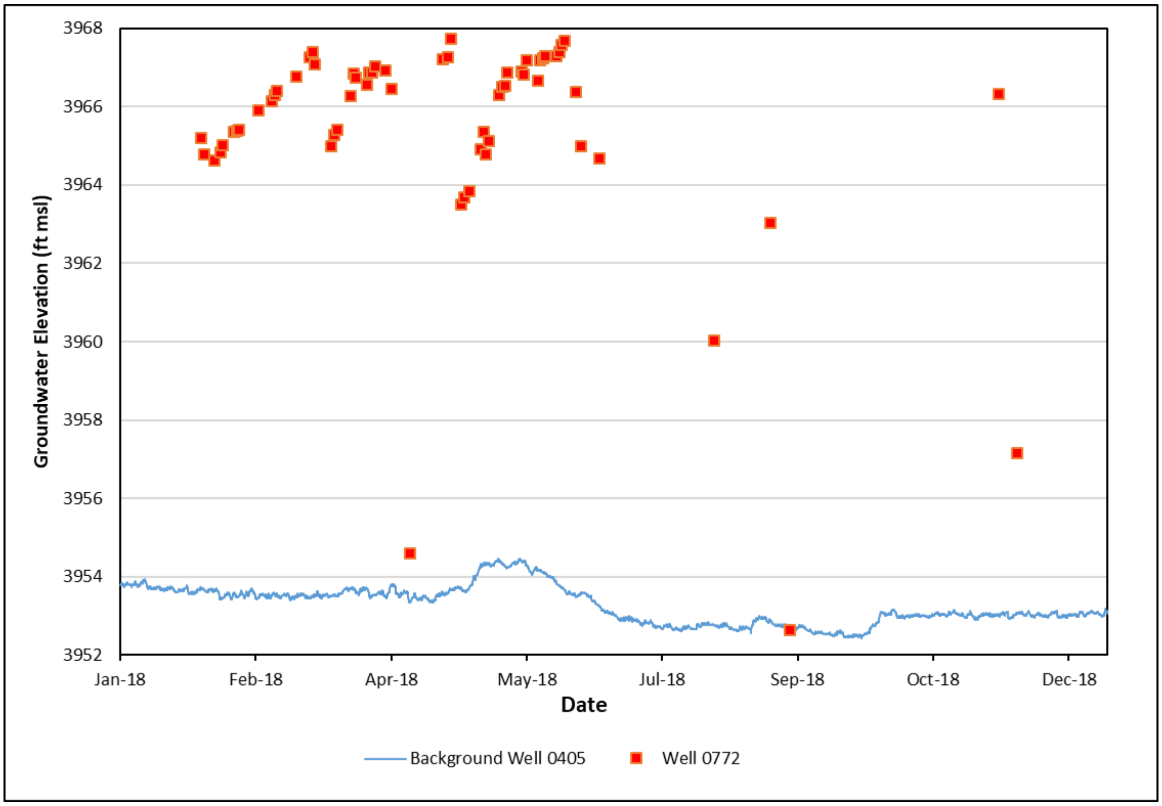

Figure B-3. Freshwater Mounding in Remediation Well 0772 during Injection

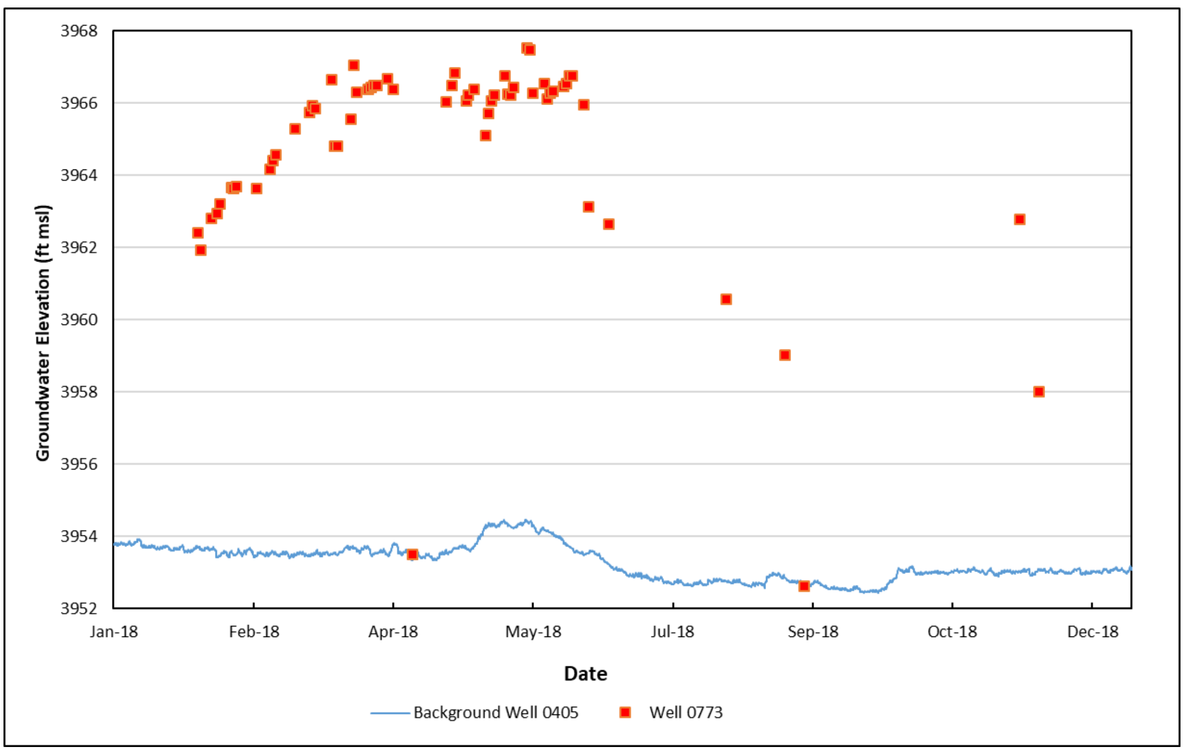

Figure B-4. Freshwater Mounding in Remediation Well 0773 during Injection

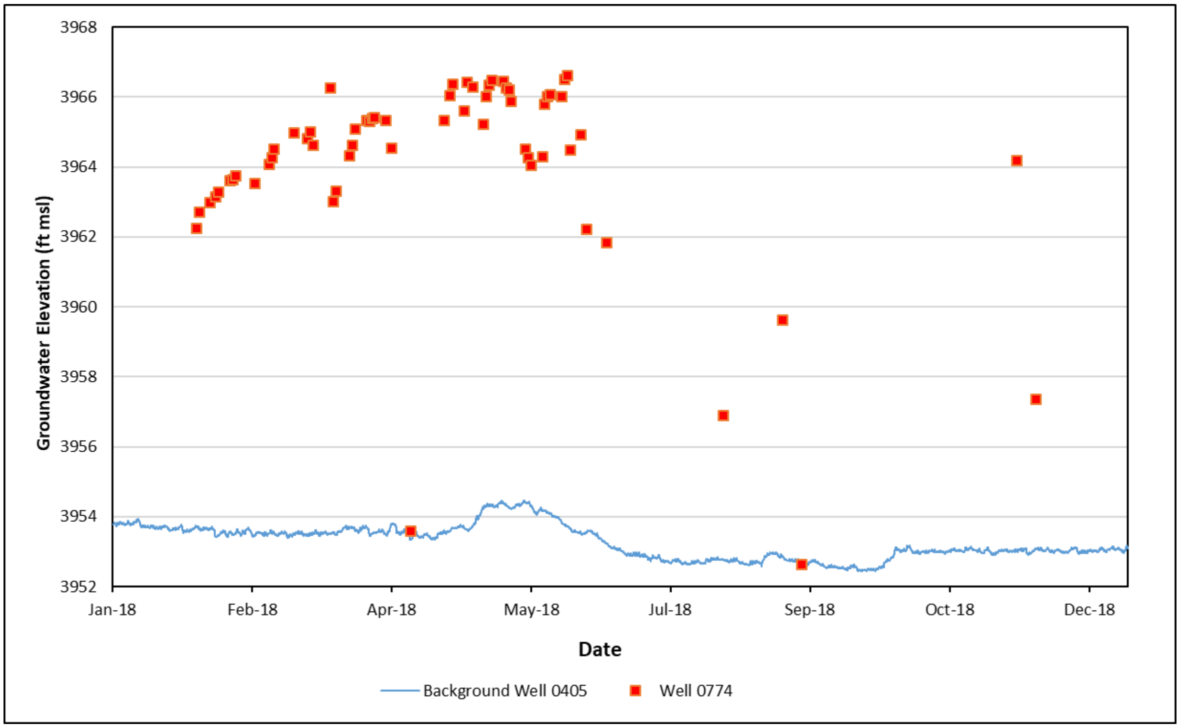

Figure B-5. Freshwater Mounding in Remediation Well 0774 during Injection

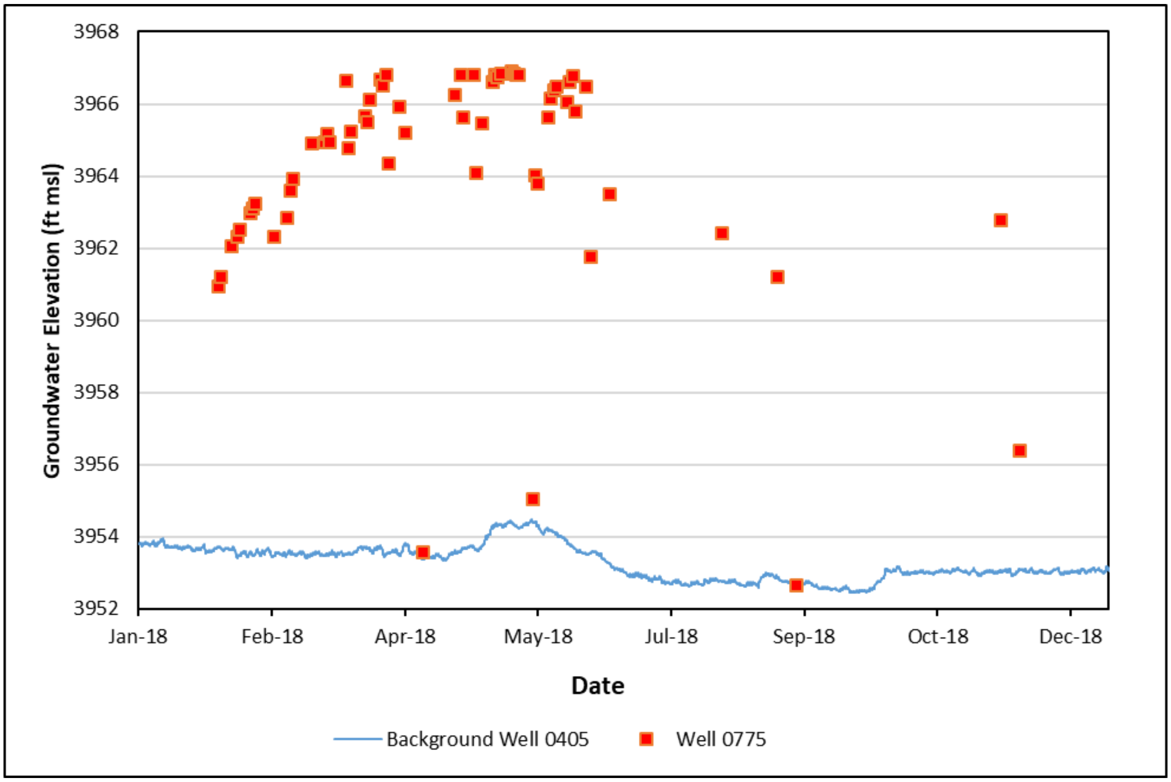

Figure B-6. Freshwater Mounding in Remediation Well 0775 during Injection

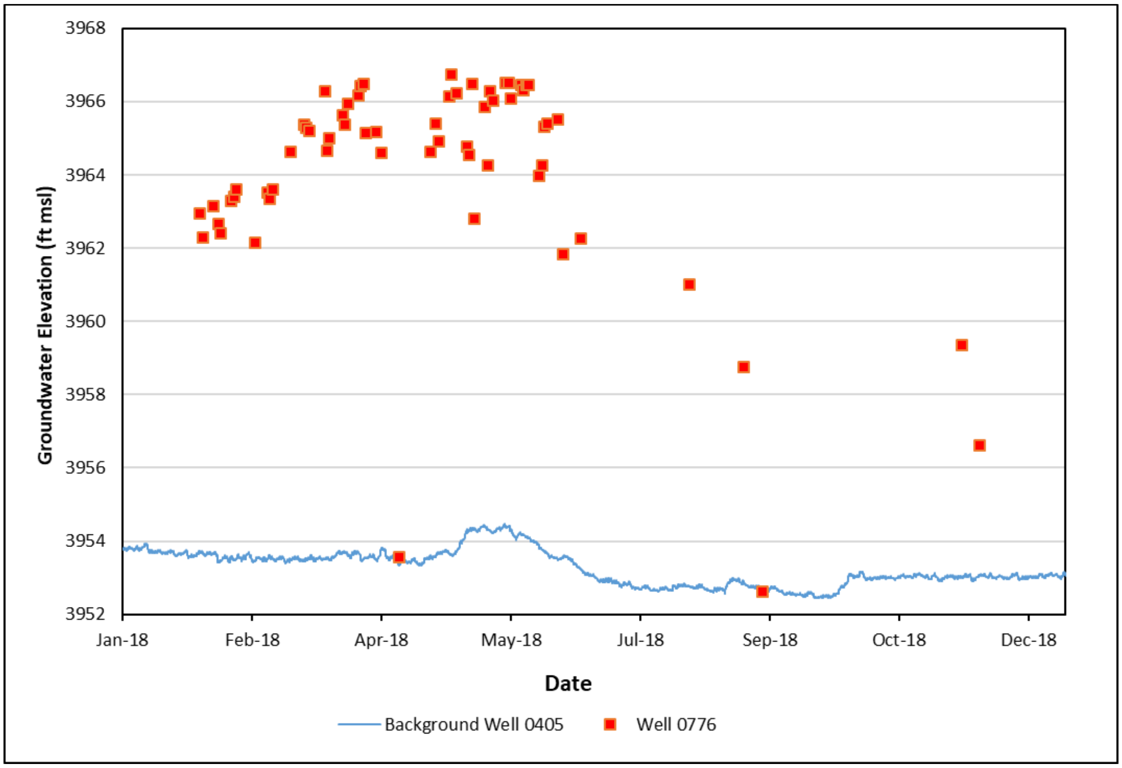

Figure B-7. Freshwater Mounding in Remediation Well 0776 during Injection

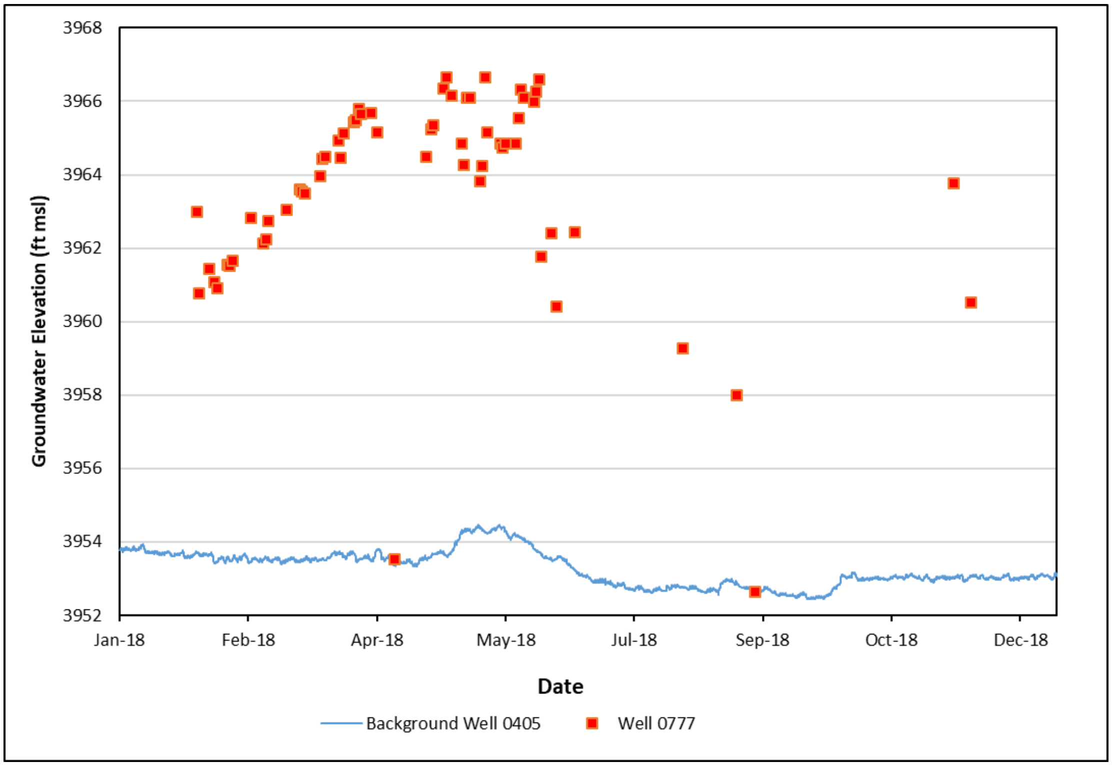

Figure B-8. Freshwater Mounding in Remediation Well 0777 during Injection

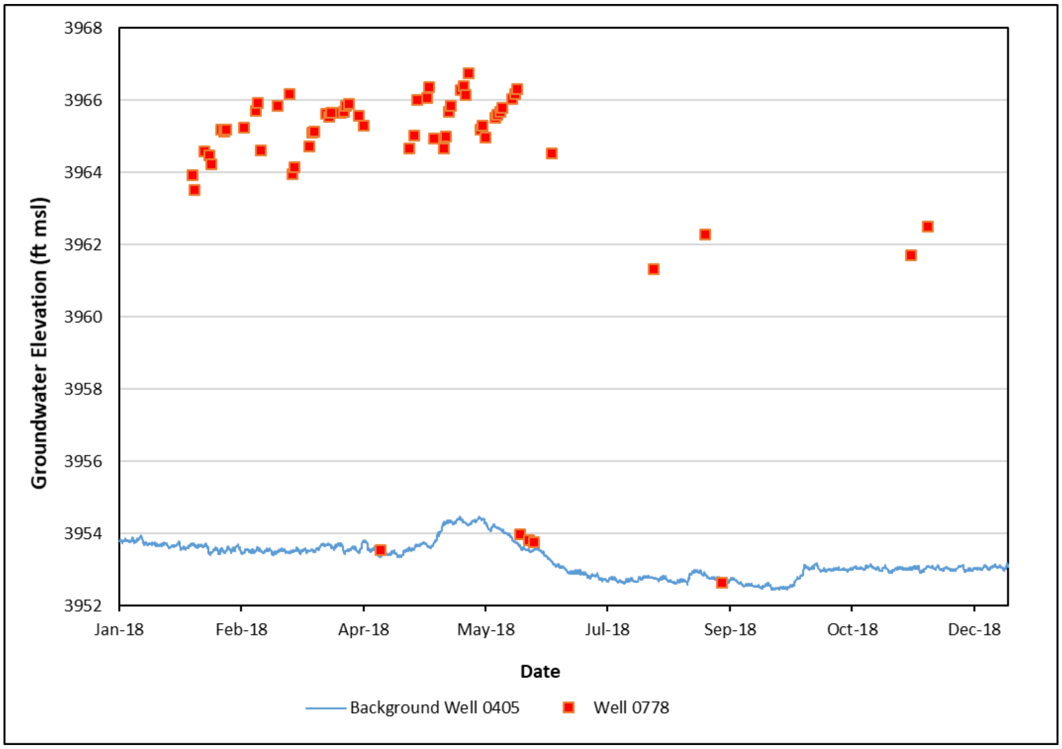

Figure B-9. Freshwater Mounding in Remediation Well 0778 during Injection

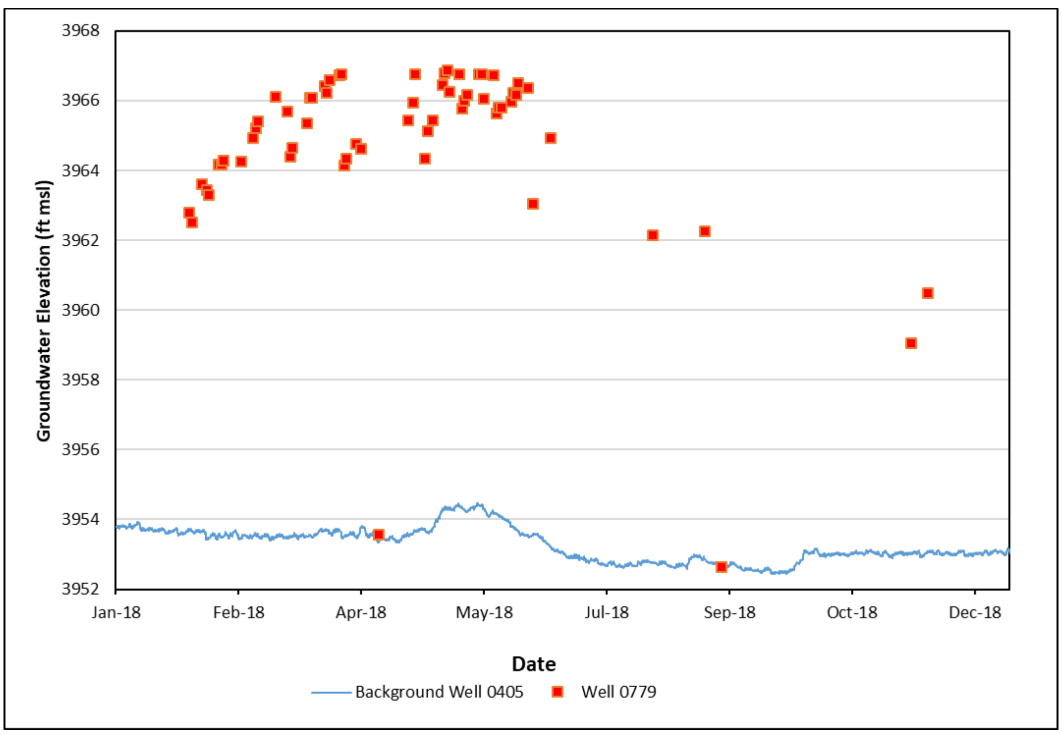

Figure B-10. Freshwater Mounding in Remediation Well 0779 during Injection

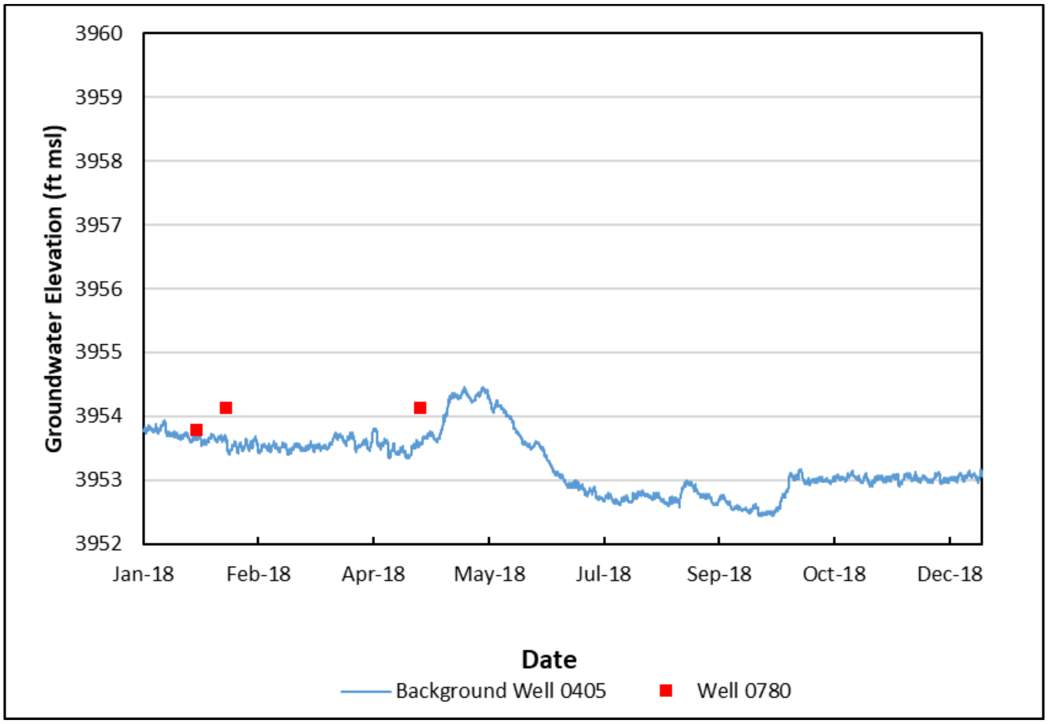

Figure B-11. Freshwater Mounding in Observation Well 0780

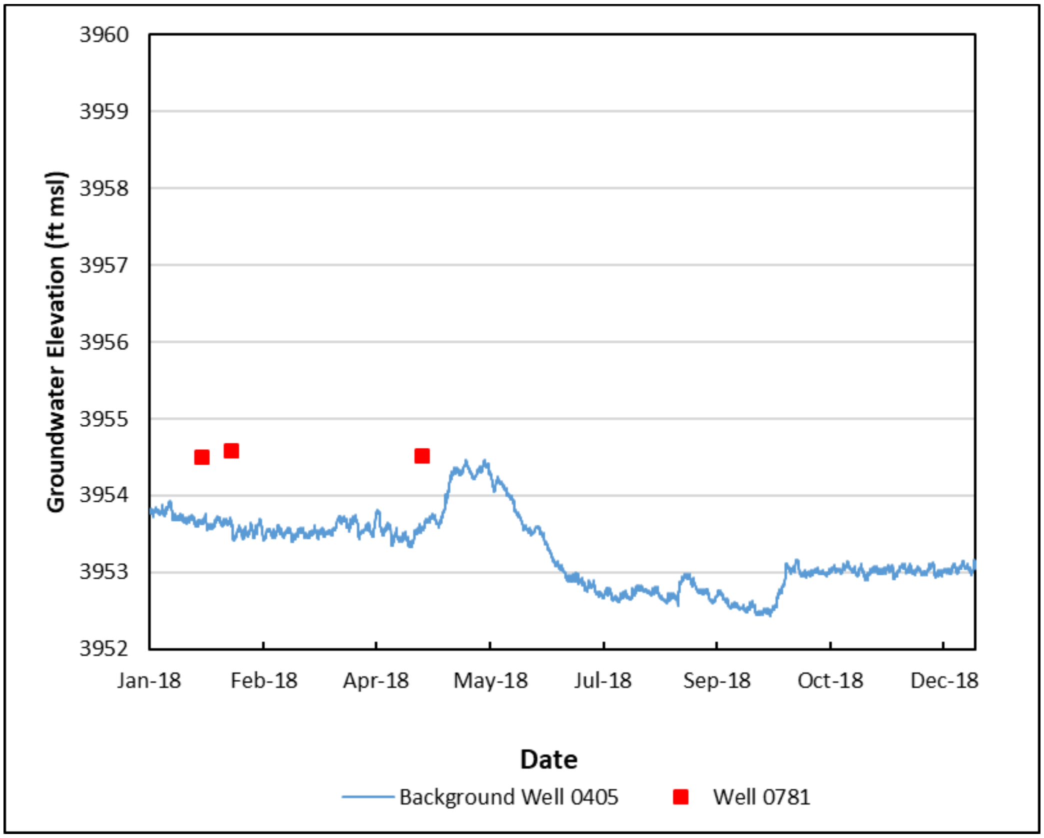

Figure B-12. Freshwater Mounding in Observation Well 0781

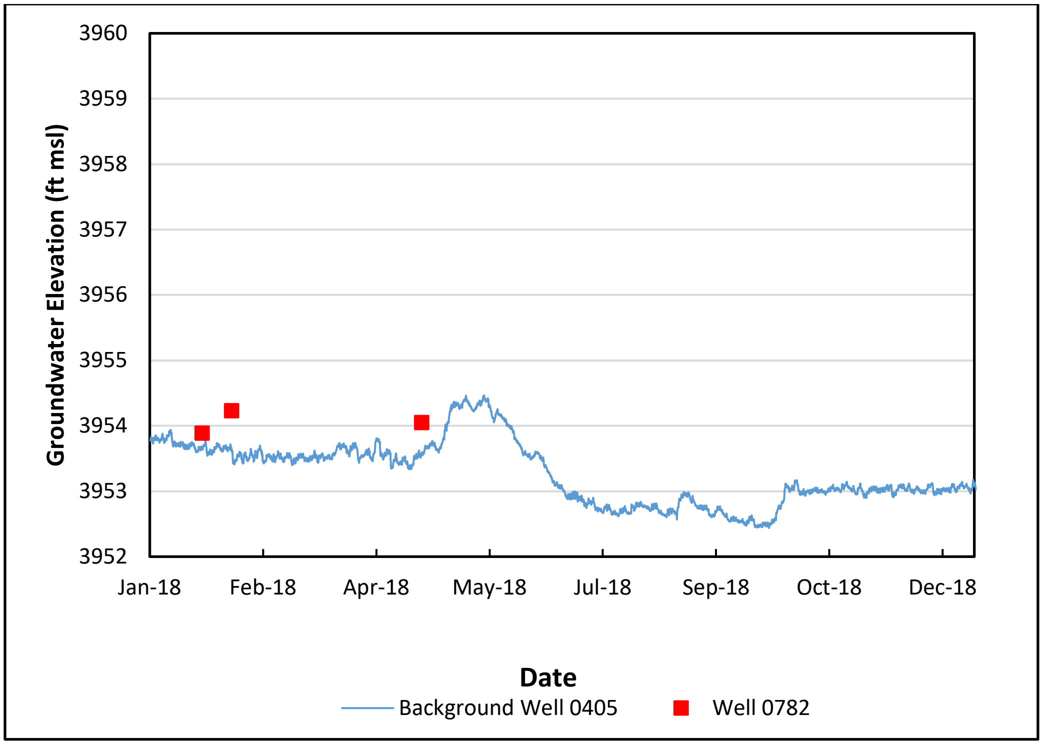

Figure B-13. Freshwater Mounding in Observation Well 0782

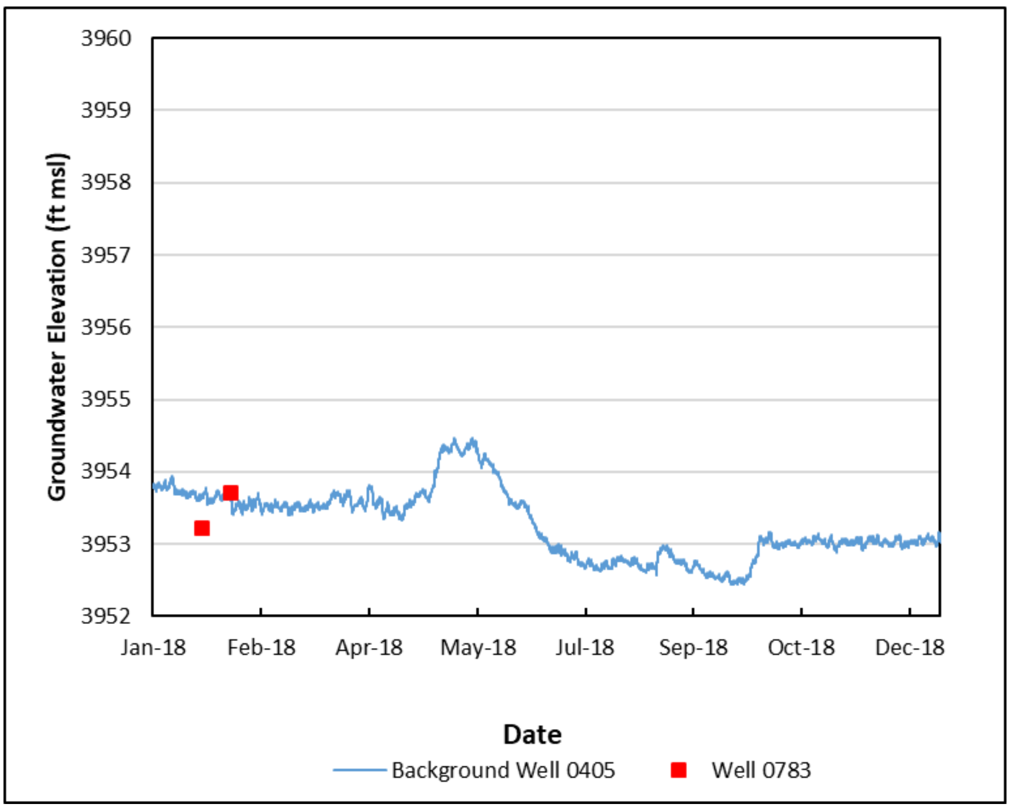

Figure B-14. Freshwater Mounding in Observation Well 0783

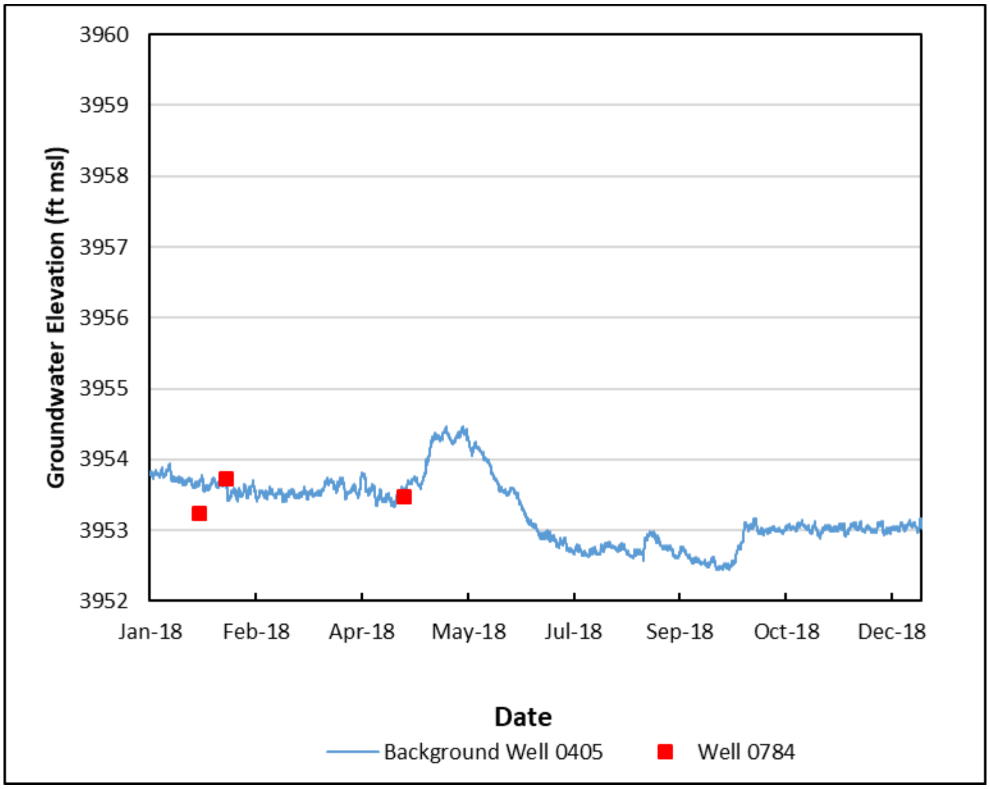

Figure B-15. Freshwater Mounding in Observation Well 0784

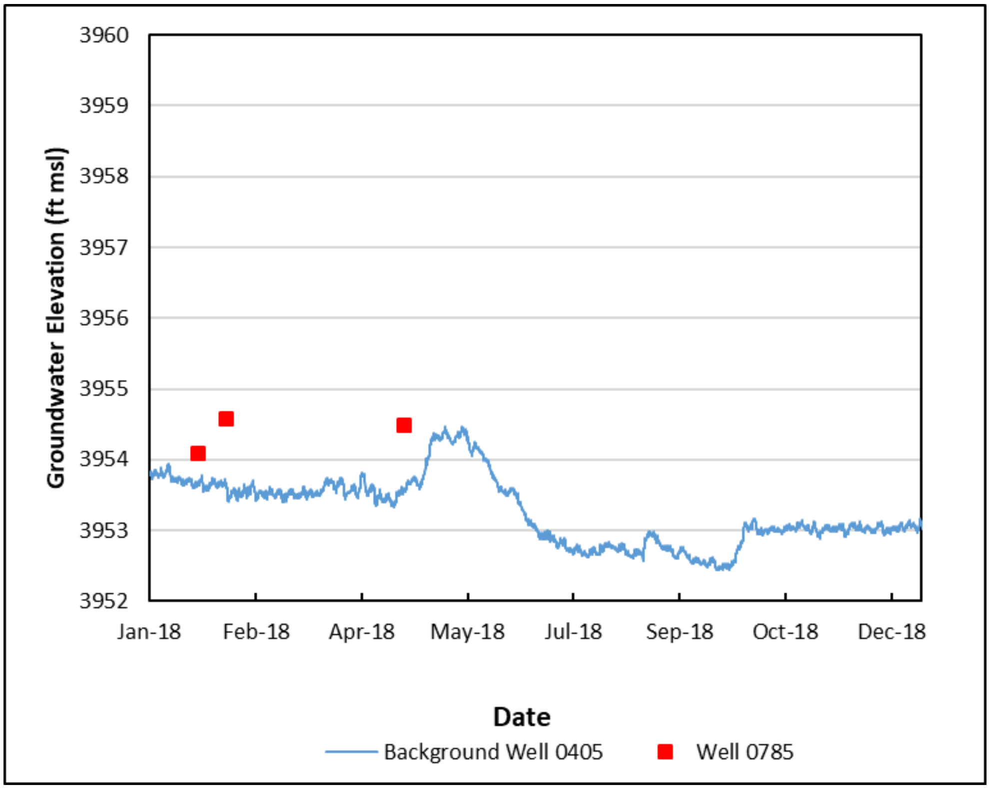

Figure B-16. Freshwater Mounding in Observation Well 0785

Appendix B. Tables and Data for 2018 Freshwater Injection (*continued*)

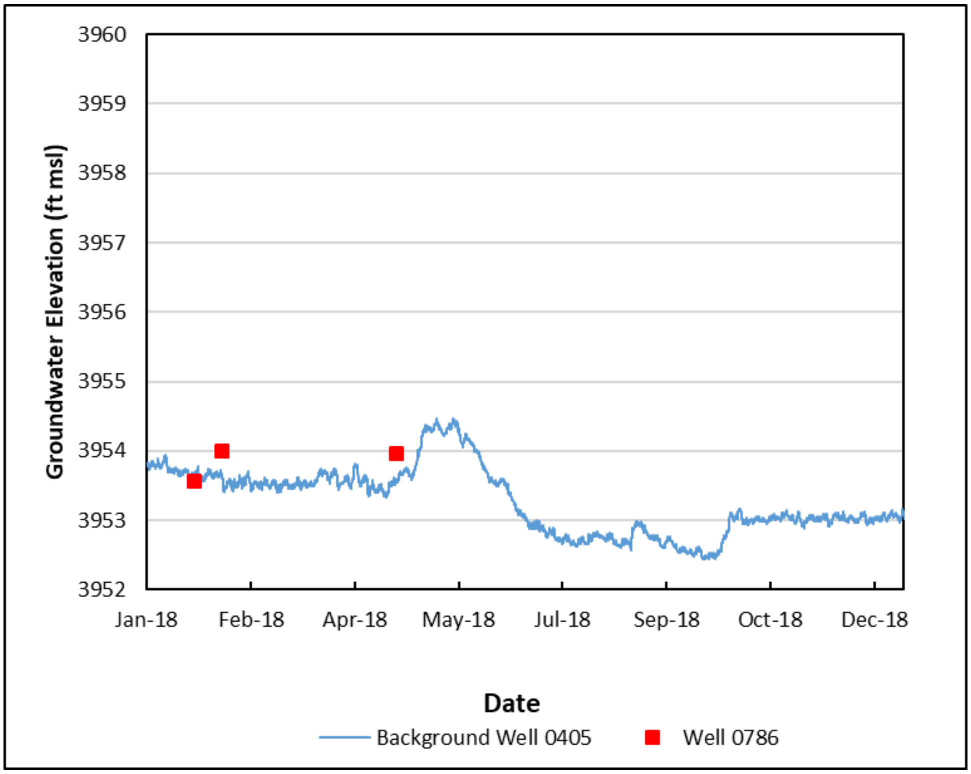

Figure B-17. Freshwater Mounding in Observation Well 0786

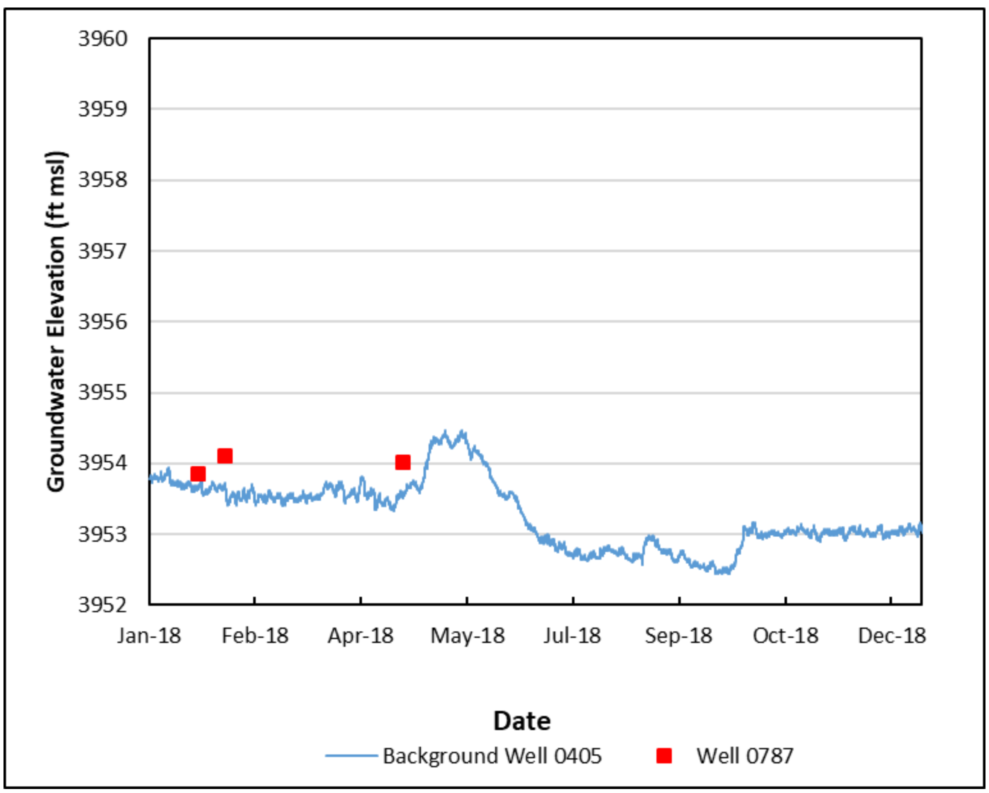

Figure B-18. Freshwater Mounding in Observation Well 0787