DOE–EM/GJTAC2267

Office of Environmental Management – Grand Junction

UMTRA Project

Moab UMTRA Project Groundwater and Surface Water Monitoring Report January through June 2018

Revision 0

November 2018

U.S. Department of Energy

Office of Environmental Management

Prepared by the Technical Assistance Contractor under contract number DE-EM0005014 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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Groundwater and Surface Water Monitoring Report January through June 2018

Revision 0

Review and Approval

11/28/18

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Date

11/23/18

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11/28/18

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Revision History

Revision	Date	Reason for Revision
0	November 2018	Initial issue.

Contents

Contents (*continued*)

Figures

Figures (*continued*)

Tables

Tables (*continued*)

Appendices

Acronyms and Abbreviations

bgs	below ground surface
CCB	continuing calibration blank
CCV	continuing calibration verification
CF	Configuration
CFR	Code of Federal Regulations
cm	centimeter
COC	chain-of-custody
CRI	reporting limit verification
DOE	U.S. Department of Energy
EB	equipment blank
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ft	feet or foot
ICB	initial calibration blank
ICP	inductively coupled plasma
ICV	initial calibration verification
IDL	instrument detection limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µmhos	micro ohms
MB	method blank
MDL	method detection limit
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
QC	quality control
r^2	correlation coefficient
RIN	report identification number
RL	reporting limit
RPD	relative percent difference
SD	serial dilution
SDG	sample data group
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action

1.0 Introduction

1.1 Purpose

The purpose of this semi-annual report is to summarize the results associated with groundwater and surface water samples collected from the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site during the first half of 2018. The results of the data validation process are also presented.

Six sampling events were completed during this time frame. The first event included the collection of samples from the monitoring wells associated with the Configuration (CF) 1 and CF4 injection wells in January 2018. All CF1 and CF4 sampling locations are shown on Figure 1. The results were intended to provide baseline groundwater contaminant concentrations for this portion of the groundwater system since the injection system had not been operating for over a month before this sampling event.

The second and fifth events were associated with the Crescent Junction well 0205 (Figure 2) sampling in February and June 2018 as part of the quarterly monitoring for the first and second quarters of 2018, respectively.

Well 0437 (Figure 3) was uncovered by the RAC on the top of the tailings pile in early 2018, and a sample was collected in March. In May 2018, the CF4 observation wells were sampled again along with the CF5 extraction wells (Figure 1). The CF5 samples were collected to determine the effectiveness of the groundwater extraction system, with the concentrations measured at each of the CF5 wells used to update the ammonia and uranium concentrations for mass removal calculations and contaminant concentration trends. Groundwater samples were collected from select CF4 monitoring wells to determine the impacts of freshwater injection in this area of the well field.

The final event started in May and was completed in July 2018. Samples were collected from a variety of site-wide groundwater and surface water locations. Groundwater and surface water sampling locations are shown on Figures 3 and 4, respectively. Site-wide groundwater sampling was conducted to assess any changes and trends in water quality. The surface water samples associated with this event were collected to assess surface water quality adjacent to the site compared to upstream and downstream water quality.

1.2 Scope

This report presents the Summary of Sampling Events and Data Assessments, including a summary of the anomalous data generated by the validation process, and results for these events. Sampling and analyses were conducted in accordance with the *Moab UMTRA Project Surface Water/Groundwater Sampling and Analysis Plan* (DOE-EM/GJTAC1830). All data validation follows criteria in the *Moab UMTRA Project Standard Practice for Validation of Laboratory Data* (DOE-EM/GJTAC1855).

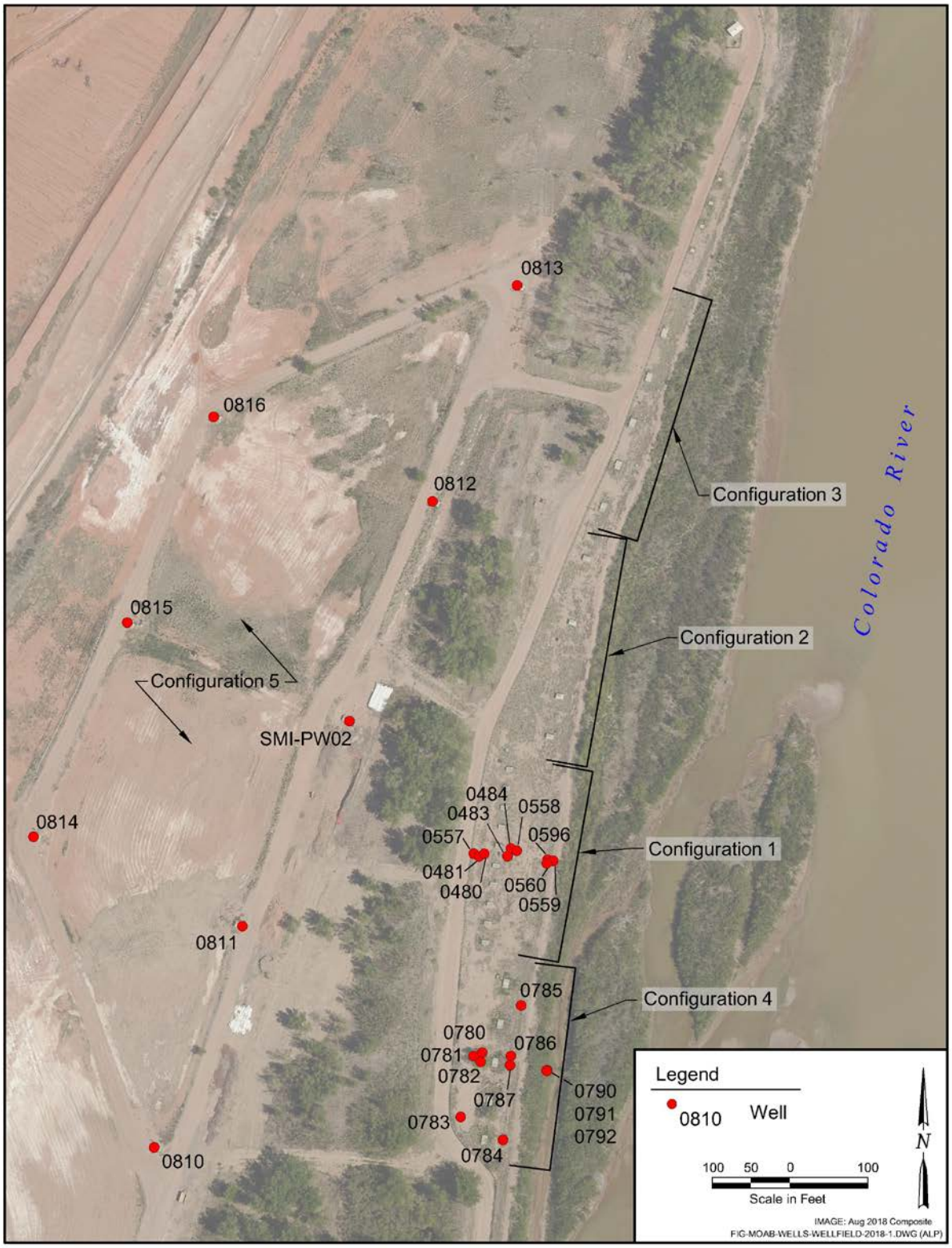

Figure 1. First Half 2018 CF1, CF4, and CF5 Groundwater Sampling Locations

Figure 2. Crescent Junction Well 0205 Sampling Location

Appendix A includes the Water Sampling Field Activities Verification, Minimums and Maximums Report, Water Quality Data, Water Level Data, and the trip report associated with the January 2018 CF1/CF4 sampling event. Appendices B, C, D, E, and F provide similar information for the February 2018 Crescent Junction, the March well 0437, the May 2018 CF4/CF5, the May/June 2018 site-wide, and the June 2018 Crescent Junction sampling events, respectively.

There were no Minimums and Maximums Reports associated with the February 2018 Crescent Junction and March well 0437 sampling events. Appendix E includes the data associated with the trip blank that was collected during the May/June 2018 Site-wide event. All Colorado River flows discussed in this document were measured from the U.S. Geological Survey Cisco gaging station number 09180500. River elevation data were collected adjacent to the site.

The Minimums and Maximums Reports were generated (by the Sample Management System and the SEEPro database) to determine if the applicable data were within a normal statistical range. The new data set was compared to the historical data to determine if the new data fall outside the historical range. The results are not considered anomalous if: (1) identified low concentrations are the result of low detection limits, (2) the concentration detected is less or more than 50 percent of historical minimum or maximum values, or (3) there were fewer than five historical samples for comparison.

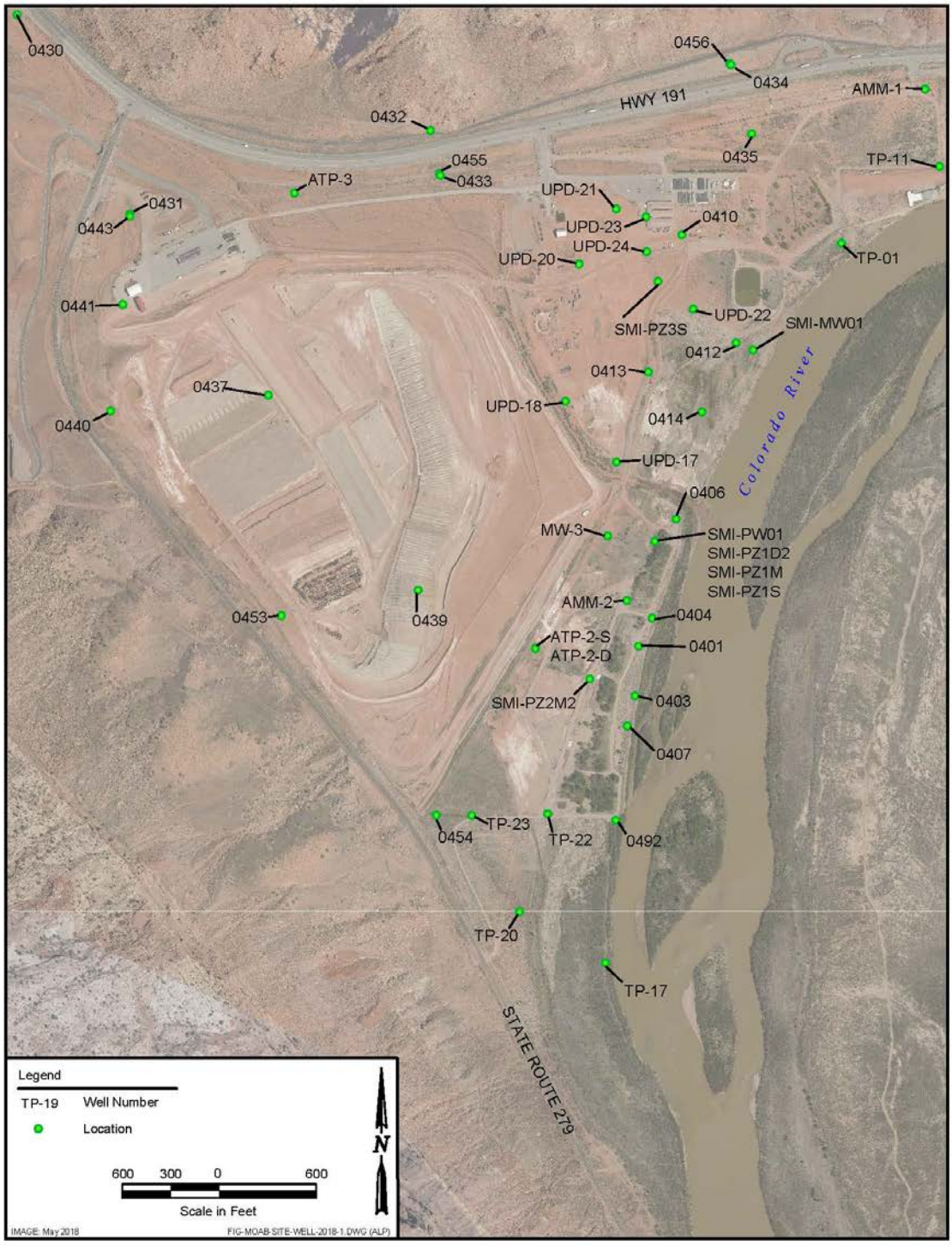

Figure 3. May/June 2018 Site-wide Groundwater Sampling Locations

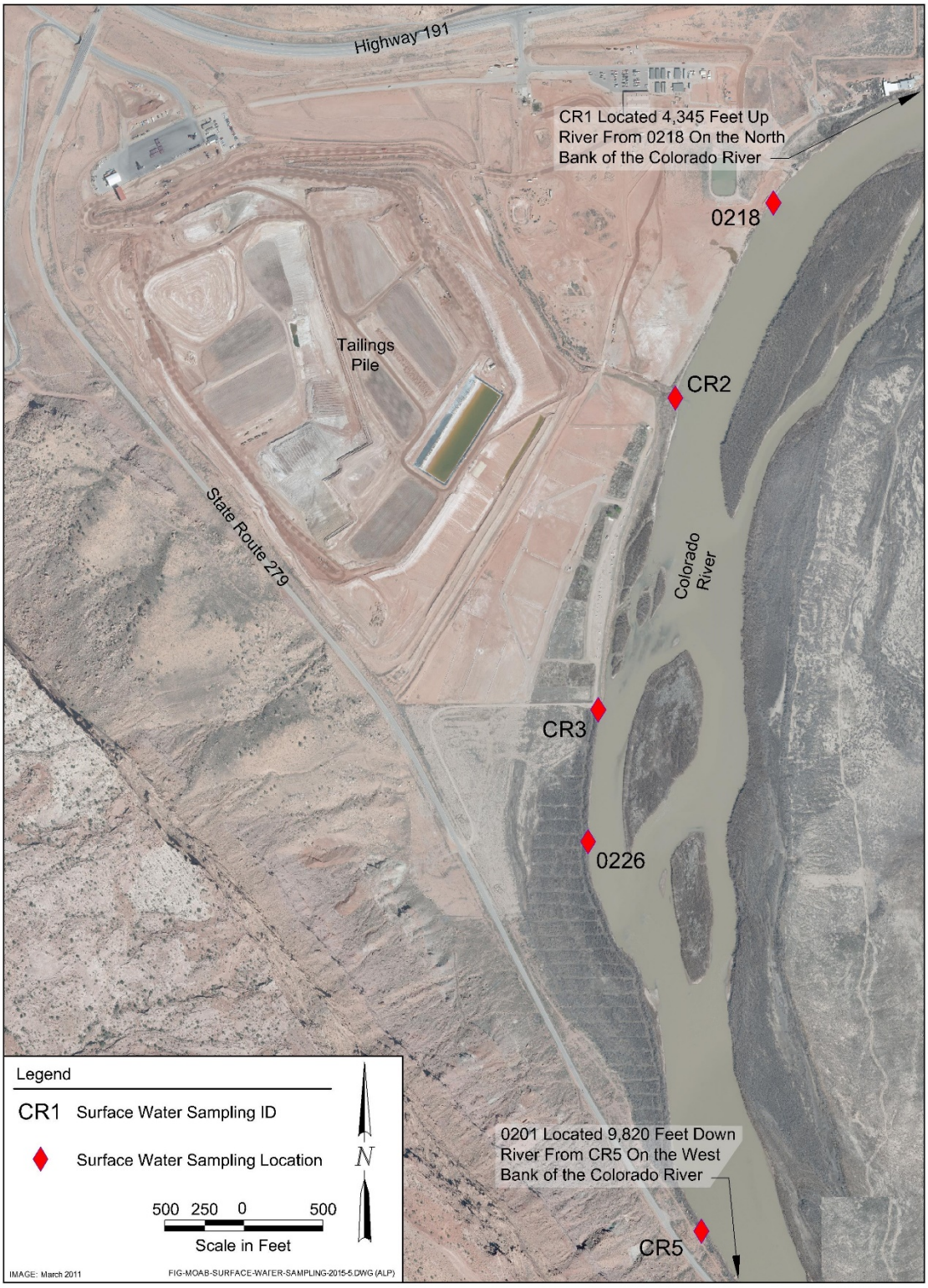

Figure 4. May/June 2018 Surface Water Sampling Locations

2.0 Summary of Sampling Events

2.1 January 2018 CF1 and CF4 Sampling Event

Groundwater samples were collected from the nine CF1 and the eight CF4 monitoring wells to measure the baseline groundwater contaminant concentrations. The freshwater injection system was shut down in late December 2017 for the holiday break, and re-started after the samples were collected at the end of January 2018. Eventually, these results would be used to determine how effectively the freshwater injection system was diluting the ammonia concentrations (CF1), and provide data regarding how long the injection of freshwater impacts the groundwater chemistry after the system is shut down (CF4).

2.2 February 2018 Crescent Junction Sampling Event

A groundwater sample was collected from well 0205 as part of the quarterly monitoring at the Crescent Junction site. If water is present in any of the four monitoring wells during a quarterly monitoring event, a sample is typically collected.

2.3 March 2018 Well 0437

Excavation activities uncovered well 0437 during February 2018. This well was last sampled in 2009 and at some point afterwards, the surface casing was damaged and covered up during removal of nearby tailings. A groundwater sample was collected from this location (after it was cleaned out and re-developed) to determine if the well still provides representative data.

2.4 May 2018 CF4 and CF5 Sampling Event

Groundwater samples were collected from the eight CF4 monitoring wells to determine how effectively the freshwater injection system was diluting the ammonia concentrations, particularly downgradient of the CF4 injection wells. Samples were also collected from the eight CF5 groundwater extraction wells to update the mass removal calculations.

2.5 May/June 2018 Site-wide Sampling Event

Fifty-seven groundwater and surface water samples were collected as part of the site-wide event. This event corresponds to the time frame when the Colorado River is generally experiencing spring runoff peak flow conditions. The 50 groundwater samples were collected from a variety of downgradient and cross-gradient locations at various depths. The locations in the vicinity of the northeastern uranium plume were also included. The seven surface water samples were collected upstream, downstream, and adjacent to the site during this event. All samples were submitted to ALS Global Laboratory for ammonia and uranium analysis.

2.6 June 2018 Crescent Junction Sampling Event

Another sample of the water contained in well 0205 was collected in June as part of the second quarter 2018 monitoring at the Crescent Junction site.

3.0 Data Assessment

The following definitions are associated with the data validation process and apply to Section 3.0. Data validation details are provided in the following sections of this report for the individual sampling events.

Laboratory Instrument Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure the instrument is capable of producing acceptable qualitative and quantitative data for all analytes. Initial calibration demonstrates the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear curve. Compliance requirements for continuing calibration checks are established to ensure the instrument continues to produce acceptable qualitative and quantitative data.

In addition, for inductively coupled plasma (ICP) analytes (uranium), reporting limit verifications (CRIs) verify the linearity of the calibration curve near the reporting limit (RL). For ICP-mass spectrometry (MS) analytes (uranium), instrument tuning and performance criteria are checked for mass calibration and resolution verifications. For ICP-MS analyte uranium, internal standards are also analyzed to indicate stability of the instruments.

Method and Calibration Blanks
Method blanks (MBs) are analyzed to assess any contamination that may have occurred during sample preparation. Both initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) are analyzed to assess instrument contamination before and during sample analysis. Depending on method requirements, detected sample results greater than the method detection limit (MDL) or instrument detection limit (IDL) were qualified "J" when the detections were less than five times the blank concentration. Non-detects were not qualified.

Equipment Blanks
An equipment blank (EB) is a sample of analyte-free media collected from a rinse of non-dedicated sampling equipment used to sample surface water. EBs are collected to document adequate decontamination of non-dedicated equipment.

Laboratory Control Sample Duplicates
Matrix spike (MS) samples may not be generated due to a limited sample volume. Instead, laboratory control sample duplicates **(**LCSDs) are performed. LCSDs that contain known concentrations of the analyte of interest are prepared in the laboratory. The results are used to demonstrate the lab is in control of the preparation and analysis of samples.

Matrix Spike and Replicate Analysis
MS sample analysis, performed at a frequency of one per 20 samples unless otherwise noted, is a measure of the ability to recover analytes in a particular matrix. The MS sample results are required to be within the recovery limits.

Laboratory Replicate Analysis
The laboratory replicate results demonstrate acceptable laboratory precision. The relative percent difference (RPD) values for the reported matrix spike duplicate (MSD) results for all other analytes should be less than 20 percent for results greater than five times the RL.

Field Duplicate Analysis
Field duplicate samples are collected and analyzed as an indication of the overall precision of the measurement process. The precision observed includes both field and laboratory precision and has more variability than laboratory replicates, which measure only laboratory performance. The duplicate results must meet the U.S. Environmental Protection Agency (EPA)-recommended laboratory duplicate criteria of less than 20 RPD for results that are greater than five times the RL.

Laboratory Control Samples
Laboratory control samples (LCSs) provide information on the accuracy of the analytical method and the overall laboratory performance, including sample preparation. Per national environmental laboratory accreditation requirements provided by the NELAC Institute, an MS may be used in place of an LCS provided the acceptance criteria are as stringent.

Metals Serial Dilution
Serial dilution (SD) samples are prepared and analyzed for the metals analyses to monitor chemical or physical interferences in the sample matrix.

Detection Limits/Dilutions
Dilutions are prepared in a consistent and acceptable manner when they are required. CRIs are re-run at the beginning of each analytical run as a measure of accuracy near the RL. CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL.

3.1 January 2018 CF1 and CF4 Sampling Event

3.1.1 Laboratory Performance Assessment
This validation was performed according to *Standard Practice for Validation of Laboratory Data*. The procedure was applied at Level 3, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

Report Identification Number (RIN)	1801099
Laboratory:	ALS Global, Fort Collins, Colorado
Sample Data Group (SDG) Numbers:	1802035
Analysis:	Metals and Inorganics
Validator:	Elizabeth Moran
Review Date:	13 September 2018

The samples were prepared and analyzed using accepted procedures as shown in Table 1.

Table 1. January 2018 CF1 and CF4 Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N, NH_3-N	EPA 350.1	EPA 350.1
Uranium	SW-846- 3005A	SW-846 6020A

Data Qualifier Summary

Analytical results were qualified as listed in Table 2. Refer to Table 3 for an explanation of the data qualifiers applied.

Table 2. January 2018 CF1 and CF4 Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
180235-1 through 180235-18	All in SDG 1802035	Uranium	J	SD-1
180235-1 through 180235-18	All in SDG 1802035	Uranium	J	MS-1
180235-1 through 180235-18	All in SDG 1802035	Uranium	J	MSD-1

"J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Table 3. January 2018 CF1 and CF4 Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
SD-1	J	U	No SDs were run during the uranium analysis.
MS-1	J	U	No MSs were run during the uranium analysis.
MSD-1	J	U	No MSDs were run during the uranium analysis.

QC = quality control; "J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Sample Shipping/Receiving

ALS Global received a total of 18 samples for RIN 1801099 in one shipment, which arrived on February 2, 2018 (UPS tracking number 1Z5W1Y510199750369). The SDG was accompanied by a chain-of-custody (COC) form.

The COC form was checked to confirm all samples were listed on the form with collection dates and times and dated signatures, indicating sample relinquishment and receipt. The sample submittal documents, including the COC forms and the sample tickets, had no errors or omissions.

Preservation and Holding Times

SDG 1802035 was received intact with a temperature of 3.2°C, which complies with requirements. All samples were received in the correct container types and had been preserved correctly for the requested analyses. All samples were analyzed within the applicable holding times.

Laboratory Instrument Calibration

Method SW-846 6020A, Uranium

The calibration for the uranium analyses were performed on February 14, 2018. The initial calibrations were all performed using three calibration standards and one blank, resulting in calibration curves with correlation coefficient (r^2) values greater than 0.995. The values of the calibration curve intercepts for uranium were positive and less than three times the IDL.

Initial calibration verification (ICV) and continuing calibration verification (CCV) checks were made at the required frequency. All calibration checks met the acceptance criteria. CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL.

The reporting limit verification (CRIs) were within the acceptance criteria range for all SDGs. Mass calibration and resolution verifications were performed at the beginning of each analytical run in accordance with the analytical procedure. Internal standard recoveries were stable and within acceptable ranges.

Method EPA 350.1, Ammonia as N

Initial calibrations for ammonia as N were performed using three calibration standards and three blanks on February 6, 2018. The calibration curve had an r^2 value greater than 0.995 and an intercept less than three times the MDL.

ICV and CCV checks were made at the required frequency. All calibration check results for all SDGs were within the acceptance criteria.

Method and Calibration Blanks

Two of the uranium CCBs were greater than the IDL; however, none of the data had to be flagged because the samples were all greater than five times the blank concentration.

Matrix Spike Analysis

There was not an MS analysis included with the uranium analysis, so all of the uranium results were flagged "J" for reason MS-1.

Laboratory Replicate Analysis

All of the ammonia MSDs were within the acceptable range, so no data were qualified. An MSD sample was not analyzed with the uranium samples, so they were flagged "J" for reason MSD-1.

Field Duplicate Analysis

A duplicate sample was collected from location 0484 (1802035-4). The duplicate results met the EPA-recommended laboratory duplicate criteria of less than 20 RPD for results greater than five times the RL.

Laboratory Control Samples

LCSs were not reported for uranium.

Metals Serial Dilution

Since no SDs were run on the uranium samples, they were flagged "J" for reason SD-1.

Detection Limits/Dilutions

Dilutions were prepared in a consistent and acceptable manner when dilutions were required. The required detection limits were achieved for all analytes.

Completeness

Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files

The EDD files arrived on March 1, 2018. The contents of the files were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

3.1.2 Minimums and Maximums Report and Anomalous Data Review

The Minimums and Maximums Report for this sampling event is located in Appendix A. Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

3.2 February 2018 Crescent Junction Sampling Event

3.2.1 Laboratory Performance Assessment

This validation was performed according to *Standard Practice for Validation of Laboratory Data*. The procedure was applied at Level 2, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN	1802100
Laboratory:	ALS Global, Fort Collins, Colorado
SDG Numbers:	1802129
Analysis:	Metals, Inorganics, Isotopic Uranium
Validator:	Elizabeth Moran
Review Date:	19 September 2017

The samples were prepared and analyzed using accepted procedures as shown in Table 4.

Data Qualifier Summary

Analytical results were qualified as listed in Table 5. Refer to Table 6 for an explanation of the data qualifiers applied.

Sample Shipping/Receiving

ALS Global received one sample for RIN 1802100 in a shipment of one cooler. The shipment (SDG 1802129) contained one groundwater sample from Crescent Junction well 0205. The temperature of the cooler was 2.4°C, and it arrived on February 8, 2018 (Tracking number 1Z5W1Y510192849641).

The COC forms were checked to confirm all samples were listed on the form with collection dates and times and dated signatures, indicating sample relinquishment and receipt. The sample submittal documents, including the COC forms and the sample tickets, had no errors or omissions.

Preservation and Holding Times

The samples were received in the correct container types and had been preserved correctly for the requested analyses. The samples were analyzed within the applicable holding time.

Case Narratives

The case narratives were reviewed, and all detects where found to be within quality-control procedures except for the following.

Matrix Spike and Replicate Analysis

For SDG 1802129, a matrix spike was performed for the ammonia as N, nitrate/nitrite as N, total dissolved solids (TDS), alkalinity, bicarbonate, carbonate, bromide, chloride, fluoride, and sulfate analyses.

For the remaining analytes, the selected QC sample was from another client and not included in the narrative, so all of the metal data were flagged "J" for reason MS-1.

Table 4. February 2018 Crescent Junction Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N, NH_3-N	EPA 350.1	EPA 350.1
Alkalinity	EPA 310.1	EPA 310.1
Bicarbonate	EPA 310.1	EPA 310.1
Carbonate	EPA 310.1	EPA 310.1
Nitrate/Nitrite as N	EPA 353.2	EPA 353.2
Bromide	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Chloride	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Fluoride	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Sulfate	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Arsenic, Barium, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Potassium, Selenium, Silver, Sodium	SW-6010B	EPA 6010B
Uranium	SW-846- 3005A	SW-846 6020A
Total Dissolved Solids	EPA 160.1	540 C
Isotopic Uranium	SOP 776/778	SOP 714

Table 5. February 2018 Crescent Junction Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1802100-1	0205	All Metals	J	MS-1

"J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Table 6. February 2018 Crescent Junction Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
MS-1	J	U	Per method requirements, matrix QC was performed for this analysis, however, a sample from this order number was not the selected QC sample, so the data was not included in the narrative.

QC = quality control; "J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Completeness

Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files

The EDD files arrived on March 23, 2018. The contents of the files were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

3.2.2 Minimums and Maximums Report and Anomalous Data Review

All concentrations were within the historical ranges, and there were no anomalous data values associated with this sampling event.

3.3 March 2018 Well 0437 Sampling Event

3.3.1 Laboratory Performance Assessment

This validation was performed according to *Standard Practice for Validation of Laboratory Data.* The procedure was applied at Level 3, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN	1803101
Laboratory:	ALS Global, Fort Collins, Colorado
SDG Numbers:	1803294
Analysis:	Metals and Inorganics
Validator:	Elizabeth Moran
Review Date:	25 September 2018

The samples were prepared and analyzed using accepted procedures as shown in Table 7. Analytical results were qualified as listed in Table 8. Refer to Table 9 for an explanation of the data qualifiers applied.

Table 7. March 2018 Well 0437 Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N	EPA 350.1	EPA 350.1
Uranium	SW-846 3005A	SW-846 6020A

Table 8. March 2018 Well 0437 Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1803294-1	0437	Uranium	J	MS-1, MSD-1, SD-1

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Table 9. March 2018 Well 0437 Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
SD-1	J	U	No SDs were run during the uranium analysis.
MS-1	J	U	No MSs were run during the uranium analysis.
MSD-1	J	U	No MSDs samples were run during the uranium analysis.

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Sample Shipping/Receiving

ALS Global received one sample for 1802101 in one shipment (SDG 1803294) that arrived in one cooler on March 14, 2018 (Tracking number 1Z5W1Y510192649698).

The SDG was accompanied by a COC form. The COC form was checked to confirm all samples were listed on the form with collection dates and times and dated signatures, indicating sample relinquishment and receipt.

The sample submittal documents, including the COC forms and the sample tickets, had no errors or omissions.

Preservation and Holding Times
SDG 1803294 was received intact with a temperature of 4.3°C, which complies with requirements. All samples were received in the correct container types and had been preserved correctly for the requested analyses. All samples were analyzed within the applicable holding times.

Laboratory Instrument Calibration

Method SW-846 6020A, Uranium
The calibration for the uranium analyses were performed on March 22, 2018. The initial calibrations were all performed using four calibration standards and one blank, resulting in calibration curves with r^2 values greater than 0.995. The values of the calibration curve intercepts for uranium were positive and less than three times the IDL.

ICV and CCV checks were made at the required frequency. All calibration checks met the acceptance criteria. CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL. The CRI verifications were within the acceptance criteria range for all SDGs.

Mass calibration and resolution verifications were performed at the beginning of each analytical run in accordance with the analytical procedure. Internal standard recoveries were stable and within acceptable ranges.

EPA 350.1, Ammonia as N
Initial calibrations for ammonia as N were performed using three calibration standards and three blanks on February 6, 2018. The calibration curve had an r^2 value greater than 0.995 and an intercept less than three times the MDL.

ICV and CCV checks were made at the required frequency. All calibration check results for all SDGs were within the acceptance criteria.

Method and Calibration Blanks
Non-detects were not qualified.

Matrix Spike Analysis
There was not an MS analysis included with the uranium analysis, so all of the uranium results were flagged “J” for reason MS-1.

Laboratory Replicate Analysis
The ammonia MSD was within the acceptable range, so no data were qualified. An MSD sample was not analyzed with the uranium sample, so it was flagged “J” for reason MSD-1.

Field Duplicate Analysis
A field duplicate was not collected with this sample.

Laboratory Control Samples
LCS results were acceptable for ammonia analyses.

Metals Serial Dilution
Since no SDs were run on the uranium sample, it was flagged "J" for reason SD-1.

Detection Limits/Dilutions
Dilutions were prepared in a consistent and acceptable manner when they were required. The required detection limits were achieved for the ammonia as N analysis.

Completeness
Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files
The EDD files arrived on March 29, 2018. The contents of the files were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

3.3.2 Minimums and Maximums Report and Anomalous Data Review
Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

3.4 May 2018 CF4 and CF5 Sampling Event

3.4.1 Laboratory Performance Assessment
This validation was performed according to *Standard Practice for Validation of Laboratory Data.* The procedure was applied at Level 3, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN	1804102
Laboratory:	ALS Global, Fort Collins, Colorado
SDG Numbers:	1805221
Analysis:	Metals and Inorganics
Validator:	Elizabeth Moran
Review Date:	17 September 2018

The samples were prepared and analyzed using accepted procedures as shown in Table 10. Analytical results were qualified as listed in Table 11. Refer to Table 12 for an explanation of the data qualifiers applied.

Table 10. May 2018 CF4 and CF5 Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N	EPA 350.1	EPA 350.1
Uranium	SW-846 3005A	SW-846 6020A

Table 11. May 2018 CF4 and CF5 Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1805221-1 through 1805221-17	All in SDG 1805221	Uranium	J	SD-1
1805221-1 through 180235-17	All in SDG 1805221	Uranium	J	MS-1
1805221-1 through 1805221-17	All in SDG 1805221	Uranium	J	MSD-1

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Table 12. May 2018 CF4 and CF5 Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
SD-1	J	U	No serial dilutions were run during the uranium analysis.
MS-1	J	U	No matrix spikes were run during the uranium analysis.
MSD-1	J	U	No matrix spike duplicate samples were run during the uranium analysis.

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Sample Shipping/Receiving

ALS Global also received 17 samples for RIN 1804102 in a shipment of one cooler, SDG 1805221. The temperature of the cooler was 2.1°C, and it arrived on May 10, 2018 (Tracking number 1Z5W1Y510194409747).

The SDG was accompanied by a COC form. The COC form was checked to confirm all samples were listed on the form with collection dates and times and dated signatures, indicating sample relinquishment and receipt. The sample submittal documents, including the COC forms and the sample tickets, had no errors or omissions.

Preservation and Holding Times

SDG 1804102 was received intact with a temperature of 2.1°C, which complies with requirements. All samples were received in the correct container types and had been preserved correctly for the requested analyses. All samples were analyzed within the applicable holding times.

Laboratory Instrument Calibration

Method SW-846 6020A, Uranium

The calibration for the uranium analyses were performed on May 17, 2018. The initial calibrations were all performed using three calibration standards and one blank, resulting in calibration curves with r^2 values greater than 0.995. The values of the calibration curve intercepts for uranium were positive and less than three times the IDL.

ICV and CCV checks were made at the required frequency. All calibration checks met the acceptance criteria.

CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL. The CRI verifications were within the acceptance criteria range for this SDG.

Mass calibration and resolution verifications were performed at the beginning of each analytical run in accordance with the analytical procedure. Internal standard recoveries were stable and within acceptable ranges.

EPA 350.1, Ammonia as N

Initial calibrations for ammonia as N were performed using six calibration standards and three blanks on May 25, 2018. The calibration curve had an r^2 value greater than 0.995 and an intercept less than three times the MDL. ICV and CCV checks were made at the required frequency. All calibration check results for all SDGs were within the acceptance criteria.

Method and Calibration Blanks

One of the uranium CCBs was greater than the IDL, however, none of the data had to be flagged, because the samples were all greater than five times the blank concentration.

Matrix Spike Analysis

There was not an MS analysis included with the uranium analysis, so all of the uranium results were flagged "J" for reason MS-1.

Laboratory Replicate Analysis

All of the ammonia MSDs were within the acceptable range, so no data were qualified. An MSD sample was not analyzed with the uranium samples, so they were flagged "J" for reason MSD-1.

Field Duplicate Analysis

A duplicate sample was collected from location SMI-PW02 (1805221-17). The duplicate results met the EPA-recommended laboratory duplicate criteria of less than 20 RPD for results that are greater than five times the RL.

Laboratory Control Samples

LCSs were not reported for uranium. Per national environmental laboratory accreditation requirements provided by the NELAC Institute, an MS may be used in place of an LCS provided the acceptance criteria are as stringent.

Metals Serial Dilution

Since no SDs were run on the uranium samples, they were flagged "J" for reason SD-1.

Detection Limits/Dilutions

Dilutions were prepared in a consistent and acceptable manner when they were required. The required detection limits were achieved for all analytes.

Completeness

Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files
The EDD files arrived on May 31, 2018. The contents of the files were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

3.4.2 Minimums and Maximums Report and Anomalous Data Review
The Minimums and Maximums Report for this sampling event is located in Appendix D. Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

3.5 May/June 2018 Site-wide Sampling Event

3.5.1 Laboratory Performance Assessment
This validation was performed according to *Standard Practice for Validation of Laboratory Data.* The procedure was applied at Level 3, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN	1805103
Laboratory:	ALS Global, Fort Collins, Colorado
SDG Numbers:	1806098, 1806406, 1806766, 1807238
Analysis:	Metals and Inorganics
Validator:	Elizabeth Moran
Review Date:	24 September 2018

The samples were prepared and analyzed using accepted procedures as shown in Table 13. Analytical results were qualified as listed in Table 14. Refer to Table 15 for an explanation of the data qualifiers applied.

Table 13. May/June 2018 Site-wide Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N	EPA 350.1	EPA 350.1
Uranium	SW-846 3005A	SW-846 6020A

Table 14. May/June 2018 Site-wide Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1807238	0431, 0443	Ammonia	J	CCB-1
1806098-1 through -23 1806406-1 through -20 1806766-1 through -8 1807238-1 through -10	All in each uranium SDG	Uranium	J	MS-1, MSD-1, SD-1
1806098-1 through -23	All in SDG 1806098	Ammonia	J	MS-2, MSD-2
1806406-1 through -20	All in SDG 1806406	Ammonia	J	MS-2, MSD-2

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Table 15. May/June 2018 Site-wide Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
CCB-1	J	U	At least one CCB was higher than the MDL, so all detects <5x the highest blank should be flagged.
SD-1	J	U	No serial dilutions were run during the uranium analysis.
MS-1	J	U	The MS sample for the sample group was from another client.
MSD-1	J	U	No MSD data was included in the narrative.
MS-2	J	U	The MS failed due to a low percent recovery.
MSD-2	J	U	The MSD failed due to a low percent recovery.

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Sample Shipping/Receiving

ALS Global received a total of 61 samples for RIN 1612089 in four shipments (Table 16).

Table 16. May/June 2018 Site-wide Sampling Event, Sample Shipping/Receiving

SDG	Number of Samples	Arrival Date	UPS Tracking Number
1806098	23	6/06/18	1Z5W1Y510195018855
1806406	20	6/19/18	1Z5W1Y510191652953
1806766	8	6/29/18	1Z5W1Y510199638464
1807238	10	7/13/18	1Z5W1Y510198652477

The four SDGs were accompanied by a COC form. The COC form was checked to confirm all samples were listed on the form with collection dates and times and dated signatures, indicating sample relinquishment and receipt. The sample submittal documents, including the COC forms and the sample tickets, had no errors or omissions.

Preservation and Holding Times

All of the SDGs were received intact. SDG 1806098 was received with a temperature of 2.8°C, SDG 1806406 was received with a temperature of 2.8°C, SDG 1806766 was received with a temperature of 1.9°C, and SDG 1807238 was received with a temperature of 5.4°C, all of which comply with requirements.

All samples were received in the correct container types and were analyzed within the applicable holding times. The ammonia samples in SDG 1806406 were subjected to a laboratory power outage, and the temperature in the refrigerator reached up to 10°C. All of the laboratory results for the samples that were impacted are comparable to past data, so the data were not flagged.

Laboratory Instrument Calibration

Method SW-846 6020A, Uranium

The initial calibrations were all performed using four calibration standards and one blank, resulting in calibration curves with r^2 values greater than 0.995. The values of the calibration curve intercepts for uranium were positive and less than three times the IDL.

ICV and CCV checks were made at the required frequency. All calibration checks met the acceptance criteria. CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL. The CRI verifications were within the acceptance criteria range for all SDGs.

Mass calibration and resolution verifications were performed at the beginning of each analytical run in accordance with the analytical procedure. Internal standard recoveries were stable and within acceptable ranges.

EPA 350.1, Ammonia as N

Initial calibrations for ammonia as N on all SDGs were performed using five calibration standards and one blank. The calibration curve had an r^2 value greater than 0.995 and an intercept less than three times the MDL.

ICV and CCV checks were made at the required frequency. All calibration check results for all SDGs were within the acceptance criteria.

Method and Calibration Blanks

Two of the CCBs on the ammonia SDG 1807238 were slightly above the MDL, and two of the sample results were <5x the highest CCB, so locations 1807238-5 (well 0431) and 1807238-9 (well 0443) were flagged "J" for reason CCB-1.

Two of the CCBs on uranium SDG 1806098 were slightly above the MDL; however, no sample results were <5x the highest CCB, so no locations had to be flagged. In addition, one CCB on the uranium SDG 1807238 was slightly above the MDL, but no data had to be flagged.

Equipment Blanks

One EB (location 2002, 1806406-15) was collected after the surface water tubing was decontaminated. No data had to be qualified.

Matrix Spike Analysis

For all of the uranium SDGs, the MS sample that was selected for QC analysis was from another client and the information was not included in the analysis, so all of the uranium data were flagged "J" for reason MS-1.

Two of the ammonia SDGs (1806098 and 1806406) had low recovery on the MS analysis, so all of the ammonia data in SDGs 1806098 and 1806406 were flagged "J" for reason MS-2.

Laboratory Replicate Analysis

The uranium SDGs did not contain an MS or MSD sample, so all of the uranium data were flagged "J" for reason MSD-1. The ammonia MSDs for SDGs 1806098 and 1806406 were flagged "J" for reason MSD-2, because of low recovery.

Field Duplicate Analysis

Duplicate samples were collected from locations MW3 (1806098-6), 0439 (1806406-14), and SMI-PZ3S (1807238-4). The duplicate results met the EPA-recommended laboratory duplicate criteria of less than 20 RPD for results that are greater than five times the RL.

Laboratory Control Samples
LCSs were not reported for uranium. Per national environmental laboratory accreditation requirements provided by the NELAC Institute, an MS may be used in place of an LCS provided the acceptance criteria are as stringent.

Metals Serial Dilution
Since no SD samples were run on the uranium samples in any of the SDGs, the uranium samples were flagged "J" for reason SD-1.

Detection Limits/Dilutions
Dilutions were prepared in a consistent and acceptable manner when they were required. The required detection limits were achieved for all analytes.

Completeness
Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files
The EDD files arrived June 30, August 14, and August 22, 2018. The contents of the files were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

3.5.2 Minimums and Maximums Report and Anomalous Data Review
The Minimums and Maximums Report for this sampling event is located in Appendix E. Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

3.6 June 2018 Crescent Junction Sampling Event

3.6.1 Laboratory Performance Assessment
This validation was performed according to *Standard Practice for Validation of Laboratory Data*. The procedure was applied at Level 2, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN	1806104
Laboratory:	ALS Global, Fort Collins, Colorado
SDG Numbers:	1806776
Analysis:	Metals, Inorganics, Isotopic Uranium
Validator:	Elizabeth Moran
Review Date:	25 September 2017

The samples were prepared and analyzed using accepted procedures as shown in Table 17. Analytical results were qualified as listed in Table 18. Refer to Table 19 for an explanation of the data qualifiers applied.

Sample Shipping/Receiving
ALS Global received one sample for RIN 1806104 in a shipment of one cooler. The shipment (SDG 1806776) contained one groundwater sample from Crescent Junction well 0205. The temperature of the cooler was 1.9°C, and it arrived on June 29, 2018 (Tracking number 1Z5W1Y510199638464).

The COC forms were checked to confirm all samples were listed on the form with collection dates and times and dated signatures, indicating sample relinquishment and receipt.

Preservation and Holding Times
The preservative listed on the COC bottle for Nitrate/Nitrite as N was incorrect, but the laboratory was able to obtain enough sample volume from the Ammonia as N bottle. The samples were analyzed within the applicable holding time.

Table 17. June 2018 Crescent Junction Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N, NH_3-N	EPA 350.1	EPA 350.1
Alkalinity	EPA 310.1	EPA 310.1
Bicarbonate	EPA 310.1	EPA 310.1
Carbonate	EPA 310.1	EPA 310.1
Nitrate/Nitrite as N	EPA 353.2	EPA 353.2
Bromide	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Chloride	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Fluoride	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Sulfate	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Arsenic, Barium, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Potassium, Selenium, Silver, Sodium	SW-6010B	EPA 6010B
Uranium	SW-846- 3005A	SW-846 6020A
Total Dissolved Solids	EPA 160.1	540 C
Isotopic Uranium	SOP 776/778	SOP 714

Table 18. June 2018 Crescent Junction Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1806776-1	0205	TDS, all Anions, all Metals	J	MS-1

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Table 19. June 2018 Crescent Junction Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
MS-1	J	U	Per method requirements, matrix QC was performed for this analysis, however, a sample from this order number was not the selected QC sample, so the data were not included in the narrative.

"J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Case Narratives
The case narratives were reviewed, and all detects where found to be within QC procedures except for the following.

Matrix Spike and Replicate Analysis
For SDG 1806776, an MS was performed for the ammonia as N, nitrate/nitrite as N analyses. For the remaining analytes, the selected QC sample was from another client and was not included in the narrative, so all of the anion, TDS, and metal data were flagged "J" for reason MS-1.

Completeness
Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files
The EDD files arrived on August 14, 2018. The contents of the files were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

3.6.2 Minimums and Maximums Report and Anomalous Data Review
The Minimums and Maximums Report for this sampling event is located in Appendix F. Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

4.0 Results

4.1 January 2018 CF1 and CF4 Sampling Event Results

The injection system was shut down on December 21, 2017, as typically done at the end of the year. The system was not restarted until January 30, 2018, after these samples were collected. Before shutting down the system, it had been consistently operational since early November 2017. Between November 1 and December 21, more than 1.2 million gallons of fresh water had been injected into the CF4 wells.

The CF1 locations were sampled to provide background data in the event injection were to occur into this area of the well field later in 2018.These CF4 locations were sampled before restarting the system to 1) determine if the impacts of injection can be detected after the system had been shut off for approximately one month, and, if there was no evidence 2) provide potential background concentrations for the upgradient and the deeper zones of the subsurface not impacted by the freshwater injection activities. All locations are provided in Figure 1.

Previous data have shown that ammonia concentrations in general increase at depth in areas of the subsurface that are not impacted by site remediation activities. The results (Figure 5) indicate in the vicinity of CF1, the subsurface had ammonia concentrations ranging from 160 to 330 milligrams per liter (mg/L) in the shallow zone.

Wells 0480, 0483, and 0559, all sampled less than 20 feet below ground surface (ft bgs), and from 410 to 490 mg/L in the samples collected at depths ranging from 21 to 28 ft bgs (wells 0481, 0484, and 0596). Ammonia concentrations ranged from 480 to 500 mg/L in the samples collected from wells 0557, 0558, and 0560, all of which were sampled from depths of 36 to 40 ft bgs. Figure 6 shows CF4 groundwater ammonia concentrations during injection.

The CF4 wells are screened and deliver fresh water into the subsurface from 15 to 35 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. 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 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).

4.2 February and June 2018 Crescent Junction Sampling Event Results

Table 20 displays the analytical results of the February and June 2018 samples collected from well 0205, along with the results from the two previous sampling events in February and June 2017. These results indicate the well 0205 analyte concentrations of the samples collected from well 0205 have generally not significantly changed in 2018, and the well continues to be recharged from the same water source after samples and short-term recovery tests have been completed.

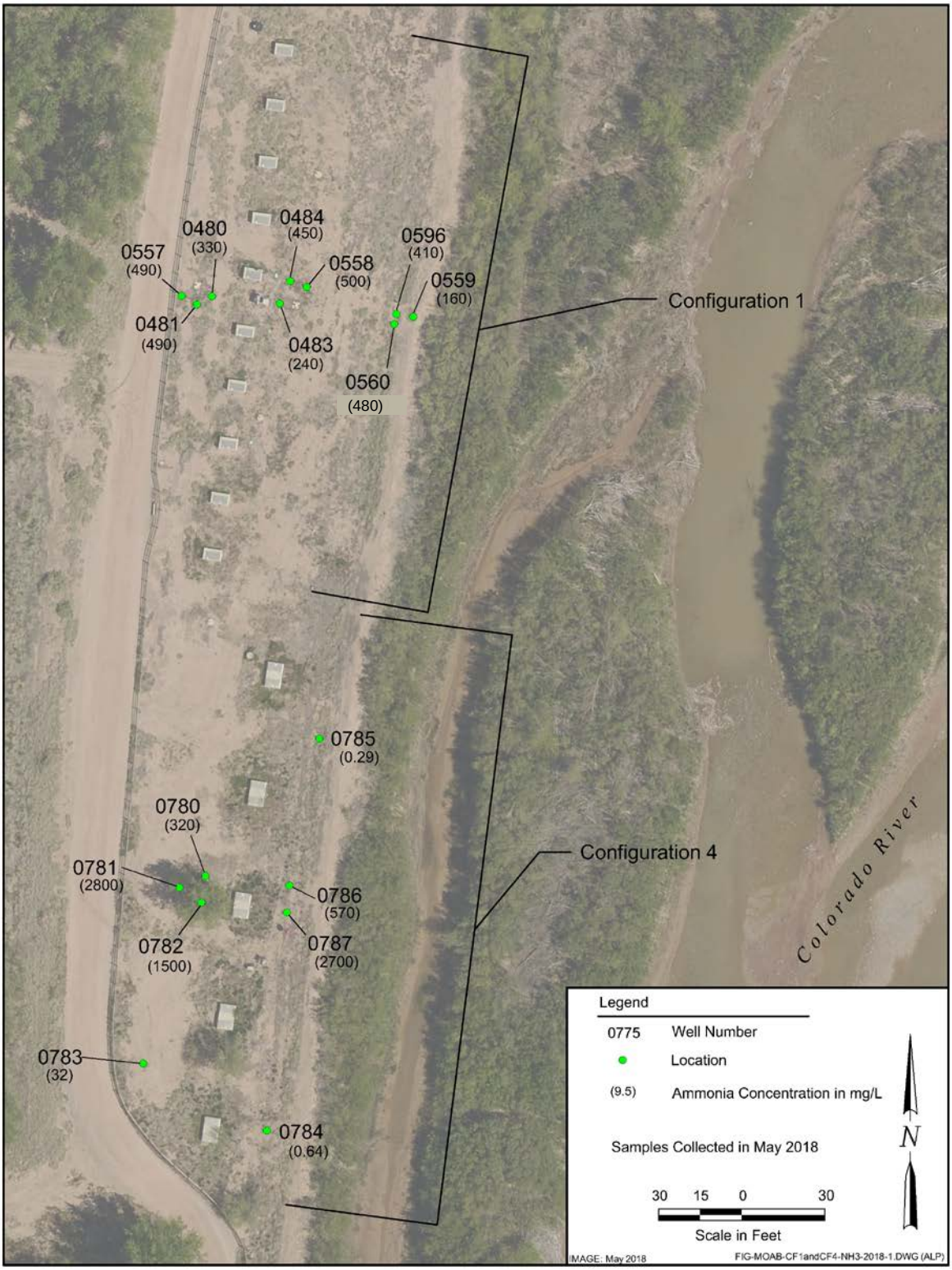

Figure 5. January 2018 CF1 and CF4 Groundwater Ammonia Concentrations

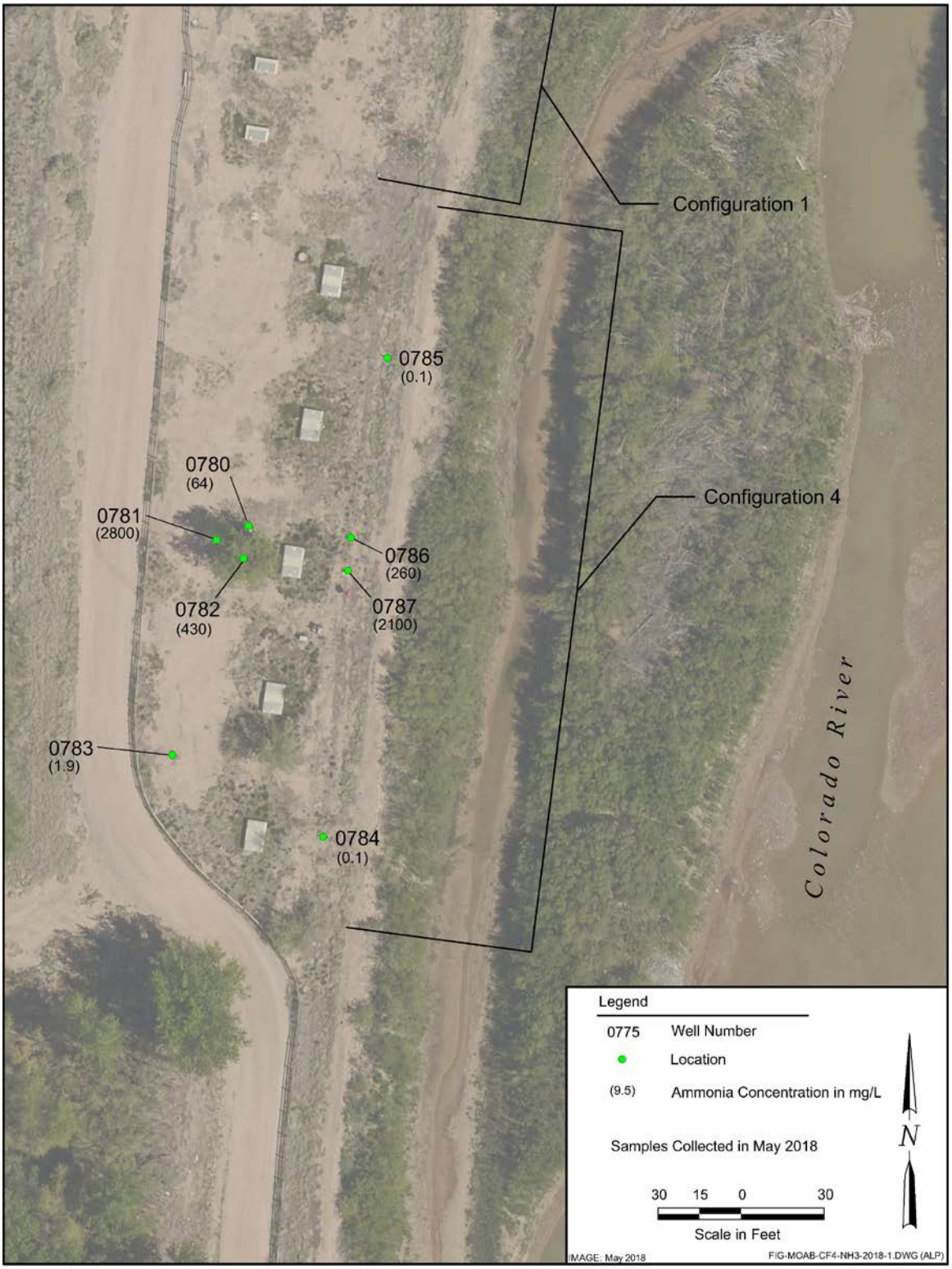

Figure 6. May 2018 CF4 Groundwater Ammonia Concentrations during Injection

Table 20. Crescent Junction Well 0205 Analyte Concentrations, February 2017 through June 2018

Analyte	Analyte Concentration on 2/22/17	Analyte Concentration on 6/20/17	Analyte Concentration on 2/6/18	Analyte Concentration on 6/27/18
Ammonia as N	15	13	14	13
Arsenic	0.039#	0.0039#	0.039#	0.039#
Barium	0.014	0.012	NA	NA
Bicarbonate as $CaCO_3$	1,000	950	1,000	1,100
Boron	1.3	1.2	1.3	1.4
Bromide	8#	10#	20#	40#
Cadmium	0.0033#	0.00033#	0.0033#	0.0033#
Calcium	370	260	330	370
Carbonate as $CaCO_3$	50#	100#	50#	20#
Chloride	3,600	3,700	3,500	3,400
Chromium	0.044	0.00051#	0.0051#	0.0051#
Copper	0.0097#	0.0016	0.0097#	0.0097#
Fluoride	4#	5#	10#	20#
Iron	0.3	7	0.049#	0.049#
Lead	0.013#	0.0013#	0.013#	0.013#
Magnesium	920	820	850	1,000
Manganese	0.53	0.3	0.38	0.44
Molybdenum	0.055	0.0022	0.011#	0.011#
Nitrate/ Nitrite as N	780	830	600	940
Potassium	53	58	50	54
Selenium	4.3	4.4	4.1	4.4
Sodium	10,000	9,700	10,000	10,000
Sulfate	22,000	24,000	23,000	23,000
Total Alkalinity as $CaCO_3$	1,000	950	1,000	1,100
Total Dissolved Solids	25,000	40,000	35,000	46,000
Uranium $_{234}$	32.5 +/- 5.5 pCi/L	27.1 +/- 4.6 pCi/L	29.7 +/- 5.4 pCi/L	31.9 +/- 5.7 pCi/L
Uranium $_{235}$	0.49 +/- 0.1 pCi/L	0.34 +/- 0.2 pCi/L	0.32 +/- 0.27 pCi/L	0.64 +/- 0.37 pCi/L
Uranium $_{238}$	11.2 +/- 2 pCi/L	9.2 +/- 1.7 pCi/L	9.3 +/- 2 pCi/L	11.9 +/- 2.4 pCi/L
Uranium	0.031	0.026	0.028	0.037

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

4.3 March 2018 Well 0437 Sampling Event Results

Well 0437 was sampled for the first time since 2009 in March 2018. This well is located inside the contamination area, and is screened in the shallow native material just below the bottom of the tailings pile. Samples were consistently collected between the time when it was installed in August 2002 through June 2009. At some point in late 2009 excavation activities resulted in the destruction of the surface completion, and it was not possible to locate the well and collect a sample after that time.

Once the well was uncovered in February 2018, all solids were removed from the bottom of the well and it was re-developed prior to the collection of the sample. This sample contained below the 1 mg/L detection limit for ammonia, and 2.6 mg/L uranium. Between September 2002 and June 2009 the ammonia concentrations ranged from below a 0.1 mg/L detection limit to 1.9 mg/L, and the uranium concentrations ranged from 2.7 to 8.3 mg/L during this same time period. These results indicate future samples from this well will provide representative water chemistry data from this area of the subsurface.

4.4 May 2018 CF4 and CF5 Sampling Event Results

Groundwater samples were also collected from the CF4 monitoring wells in May 2018, with the fresh water injection system consistently running since late January 2018 (and after approximately 3.3 mil gal of fresh water had been injected through the CF4 injection wells). Table 21 provides a comparison of the January and May 2018 sampling results.

Table 21. 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

The 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 ground water system at this same depth is also impacted by freshwater injection.

Figure 7 presents the ground water mound developed as a result of the freshwater injection system operation in May 2018. The ground water elevation data indicate there was a difference of more than 12 ft between the elevation inside the injection wells and the surrounding monitoring wells.

Groundwater samples were also collected from the CF5 extraction wells (locations also shown on Figure 1) in May 2018. The groundwater extraction system had operated on a regular basis since mid-March 2018 (approximately six weeks) when the samples were collected in May 2018.

Figure 7 shows the May 2018 CF4 Groundwater Elevation Contour Map during Injection CF5 ammonia and uranium concentrations associated with this sampling event are displayed on Figure 8.

Time versus concentration plots were generated to display the trends displayed by the CF5 extraction wells during the past seven years, which represents the approximate lifespan of the CF5 well field (extraction was started in April 2010).

Figure 9 is the time versus ammonia concentration plot for extraction wells 0810 through 0813 and SMI-PW02, all of which are located along the CF5 southeastern boundary. Figure 10 displays a time versus uranium concentration plot for the same set of wells.

Figures 11 and 12 are the time versus ammonia and uranium concentration plots, respectively, for CF5 wells 0814 through 0816 (which are located closer to the base of the tailings pile).

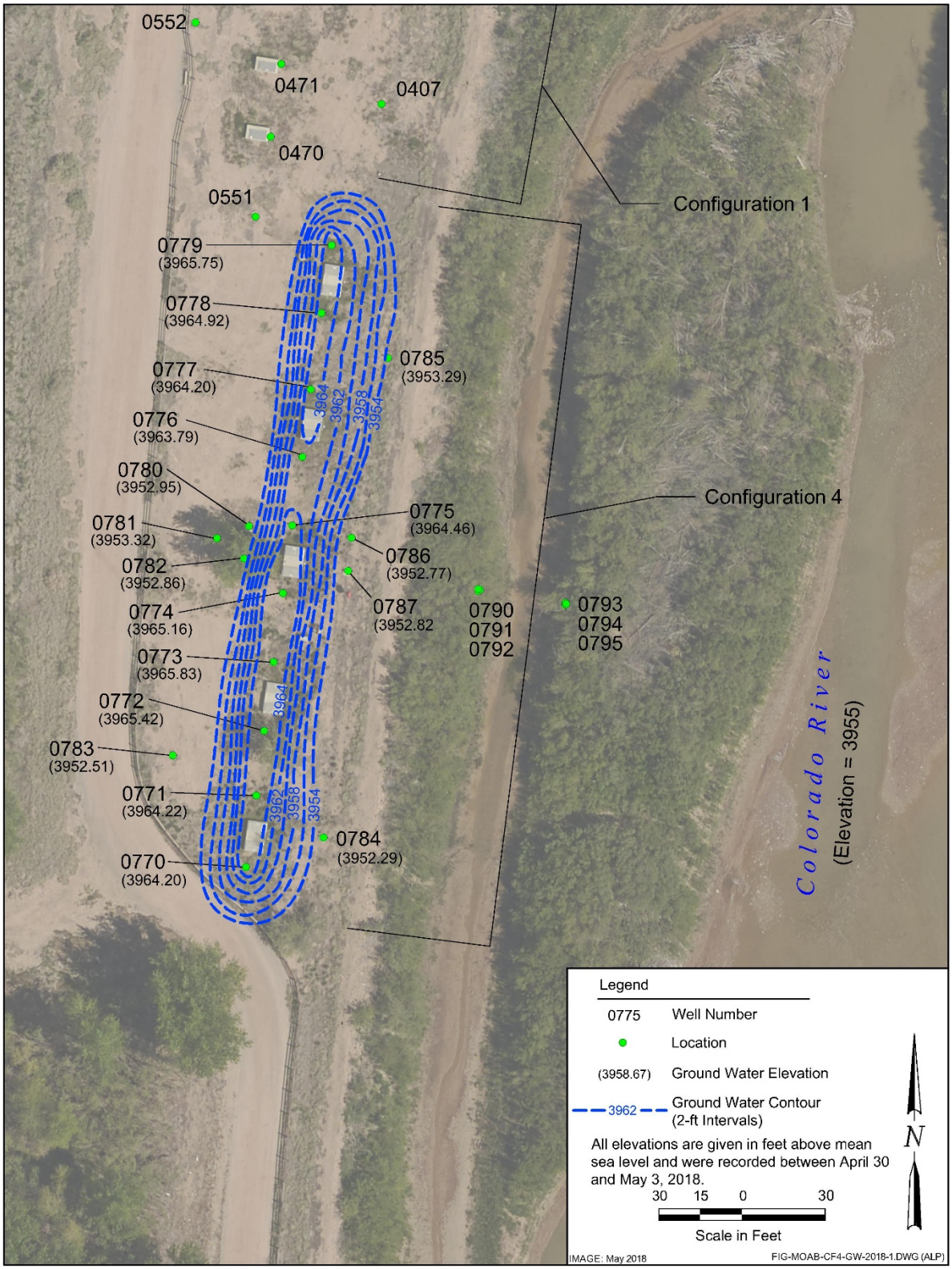

Figure 7. May 2018 CF4 Groundwater Elevation Contour Map during Injection

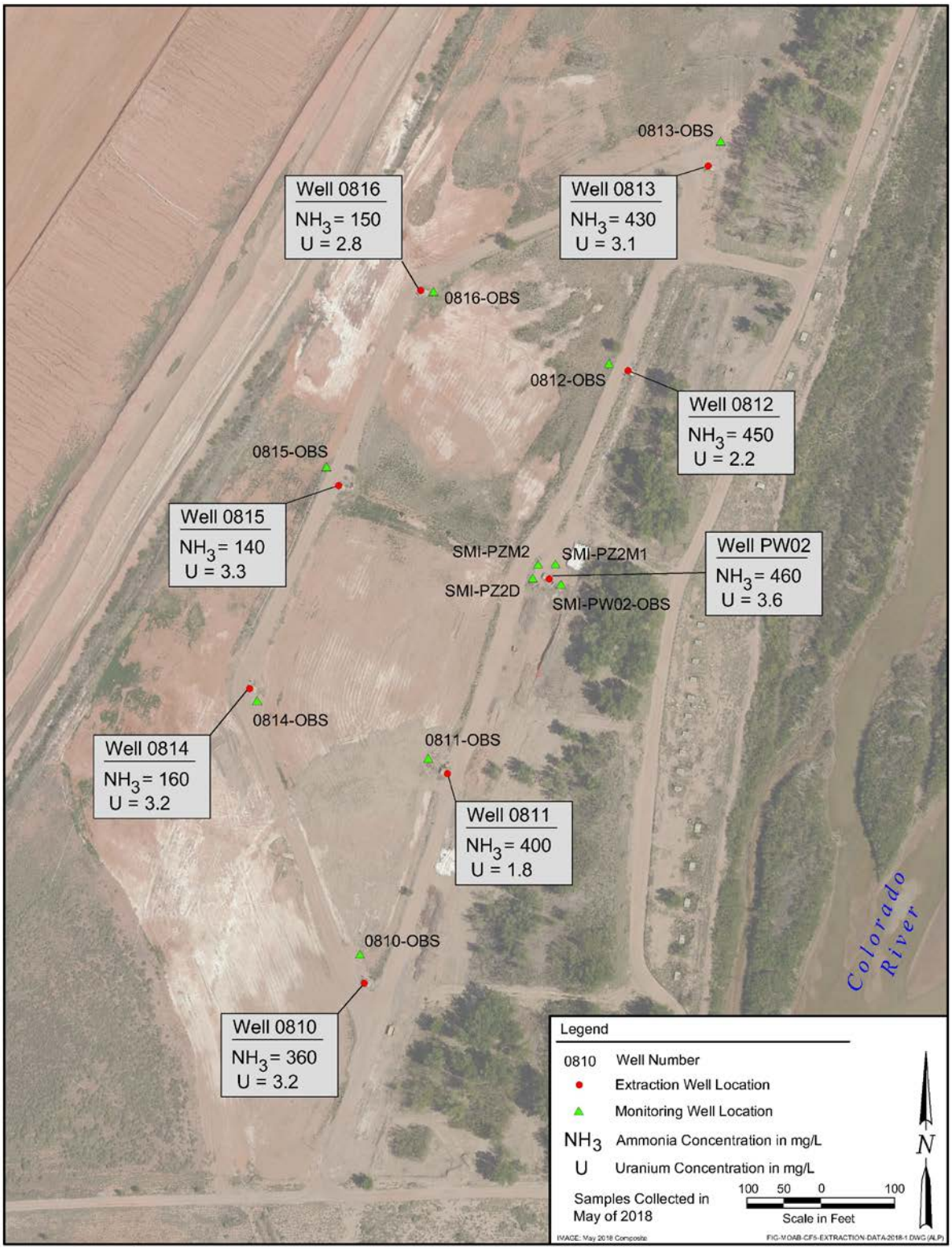

Figure 8. May 2018 CF5 Ammonia and Uranium Groundwater Concentrations

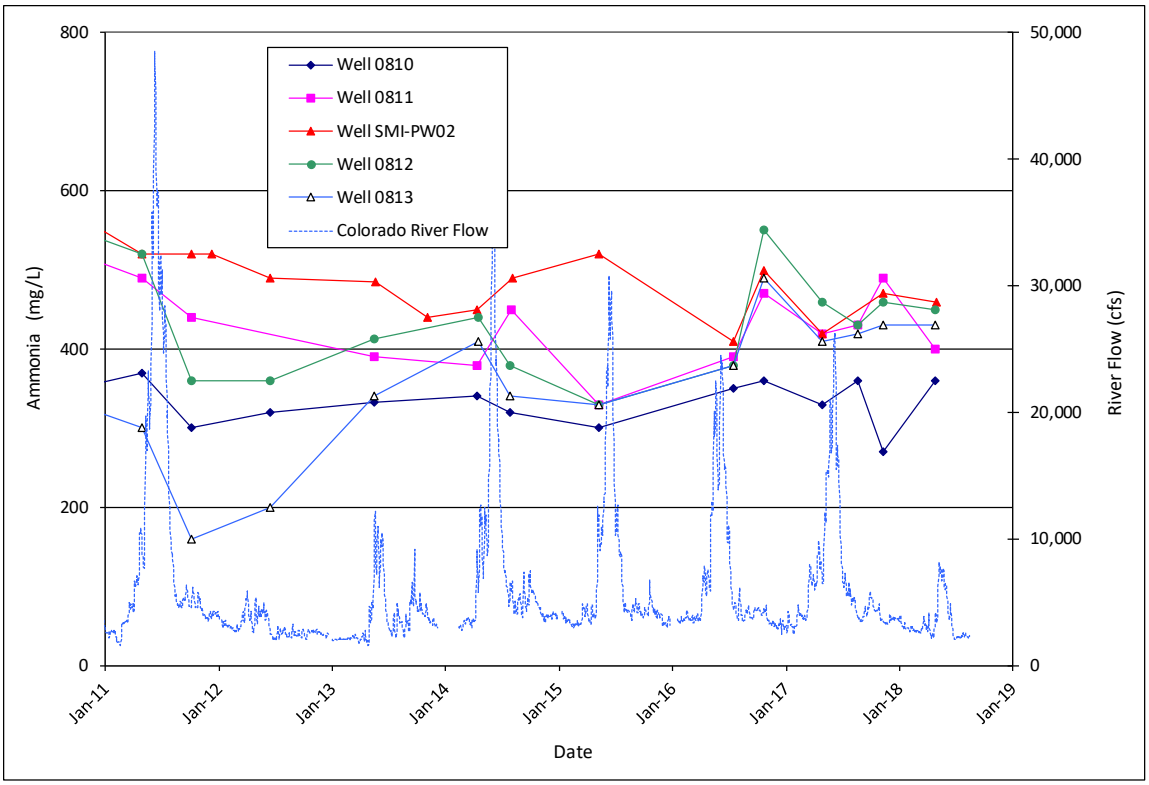

Figure 9. CF5 Extraction Wells 0810, 0811, 0812, 0813, and SMI-PW02 Time versus Ammonia Concentration Plot

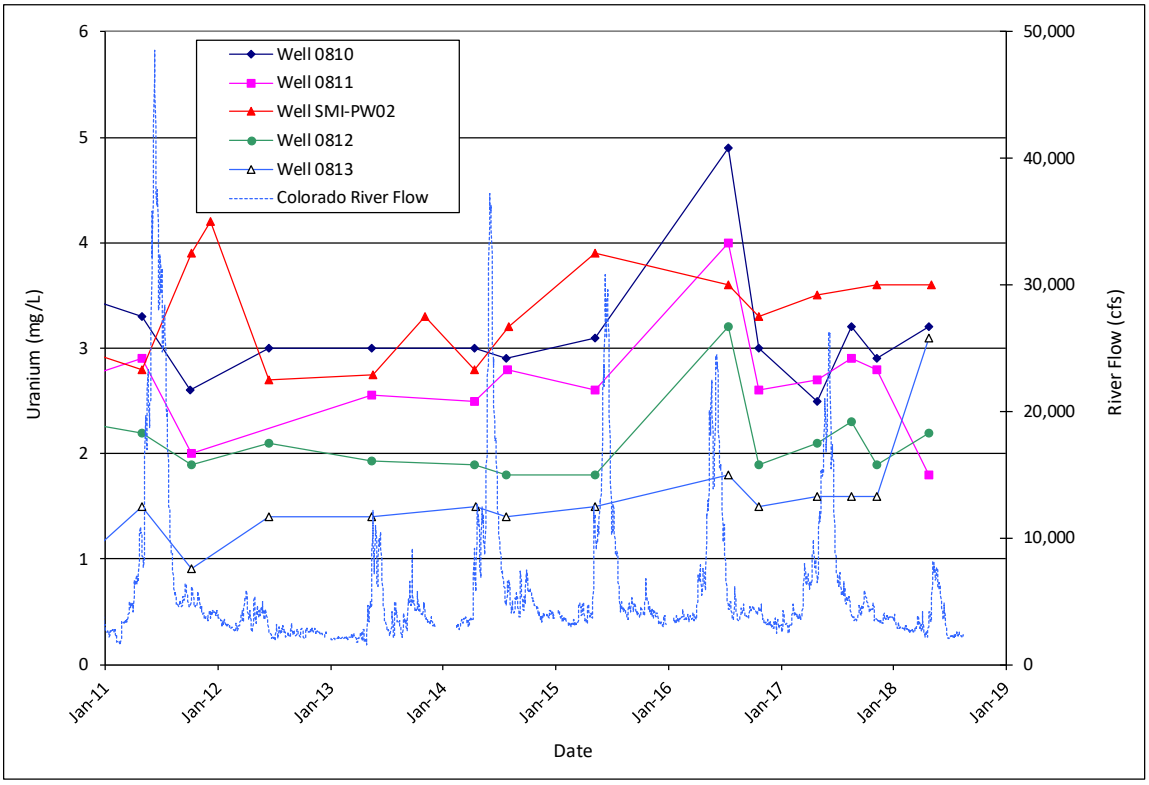

Figure 10. CF5 Extraction Wells 0810, 0811, 0812, 0813, and SMI-PW02 Time versus Uranium Concentration Plot

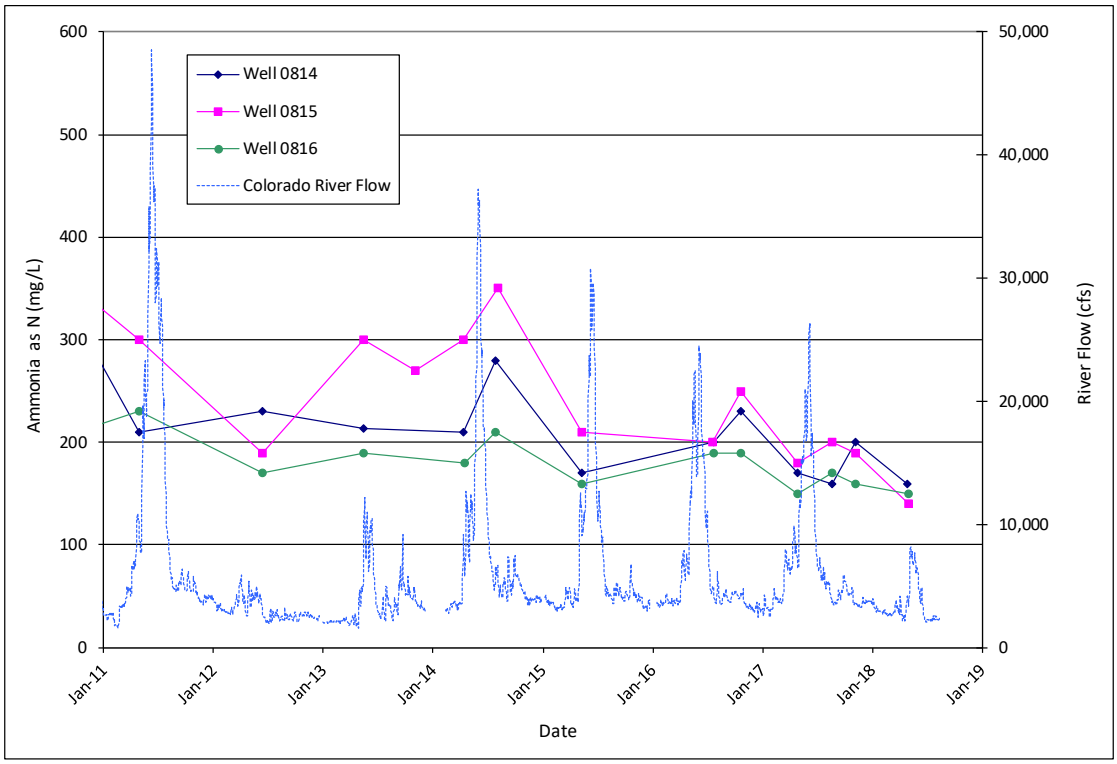

Figure 11. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Ammonia Concentration Plot

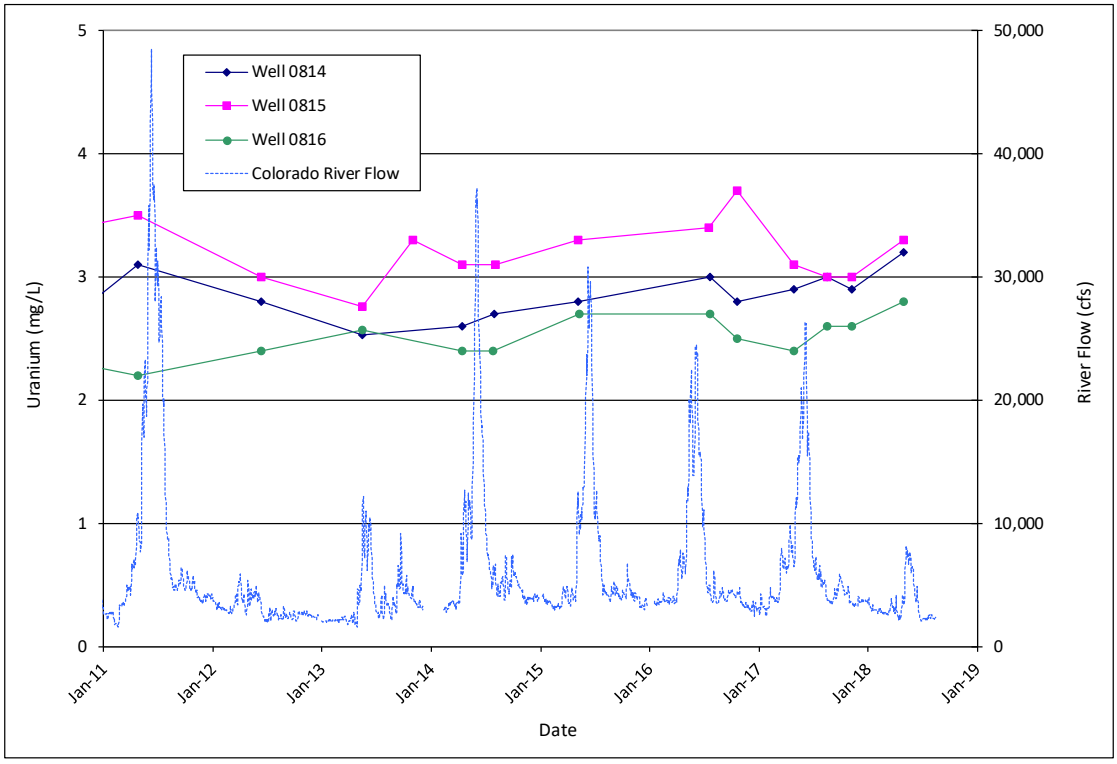

Figure 12. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Uranium Concentration Plot

As the plots exhibit, the ammonia concentrations along the CF5 southeastern boundary have ranged from 160 to 550 mg/L since 2011, with the lowest concentrations occurring after the well field was flooded from May to August 2011. Well SMI-PW02, which is located at the center of this line of wells (and near the center of the groundwater contaminant plume), has generally had the highest concentration. During the May 2018 sampling event, all of these wells had ammonia concentrations between 360 and 460 mg/L (Figure 9).

Uranium concentrations in samples from this same set of wells have, in general, been less consistent. Since October 2016, the concentrations have ranged from 1.5 to 3.6 mg/L. Since the previous event in December 2017, the uranium concentrations have significantly fluctuated based on the samples collected from locations 0811 and 0813. The concentration in the sample from well 0813 increased from 1.6 to 3.1 mg/L, while the well 0811 concentration decreased from 2.8 to 1.8 mg/L (Figure 10).

As shown in Figure 11, ammonia concentrations in the wells located closer to the base of the tailings have been gradually declining since August 2014. During the May 2018 event, the ammonia concentrations in the samples collected from each of these three locations were essentially the same (ranged from only 150 to 160 mg/L). The uranium concentrations have also been consistent, between 2.4 and 3.7 mg/L since June 2012. During the May 2018 event, the concentrations were also similar, ranging from 2.8 to 3.3 mg/L.

Taking into account all eight extraction wells, the contaminant concentrations have been higher in the samples collected from wells located along the CF5 southeastern boundary compared to the wells located along the toe of the tailings pile.

4.5 May/June 2018 Site-wide Sampling Event Results

All samples collected during this event were analyzed for both ammonia and uranium. There is no groundwater standard for ammonia; however, Table 22 presents all locations sampled that exceeded the 0.044 mg/L uranium groundwater standard. This standard is based on Table 1 in Title 40 Code of Federal Regulations Part 192 (40 CFR 192) “Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Subpart A, Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites,” assuming uranium-234 and uranium-238 activities are in equilibrium.

Table 22 also includes the locations from the other sampling events from January to June 2018 that exceeded this concentration.

To present the trends observed in the water chemistry for the site-wide locations, the site was divided into six areas. These include the northeastern base of the tailings pile, the northeastern uranium plume (which includes the PW03 cluster), the southeastern base of the tailings pile, along the southwestern boundary, along the Colorado River bank, and south of the site. In addition, because four wells from the SMI-PW01 cluster were sampled at various depths, these results are also discussed.

All results are also plotted against the Colorado River flow to determine if the river stage may impact the concentrations.

Table 22. January through June 2018 Sampling Events, Groundwater Locations Exceeding the 0.044 mg/L Uranium Groundwater Standard

Well Number	Date	Location	Sample Depth (ft bgs)	Uranium Concentration (mg/L)
0401	6/20/18	CF2	18	1.6
0403	6/20/18	CF1	18	0.93
0404	6/20/18	CF3	18	1.4
0406	6/5/18	CF1	18	0.87
0407	6/20/18	CF1	18	1.2
0410	7/11/18	NE Uranium Plume Area	23.5	0.31
0412	5/29/18	NE Uranium Plume Area	10	2.8
0413	5/29/18	NE Uranium Plume Area	10	2.8
0414	5/29/18	NE Uranium Plume Area	7.5	3
0437	3/14/18	On Tailings Pile	NA	2.6
	7/10/18			2.9
0439	6/12/18	On Tailings Pile	118	1.4
0441	6/7/18	Support Area	53	0.055
0453	6/12/18	Along SW Site Boundary	80	1.1
0454	6/4/18	Along SW Site Boundary	13	1.5
0480	1/24/2018	CF1	18	2.1
0481	1/24/2018	CF1	28	2.4
0483	1/24/2018	CF1	18	1.8
0484	1/24/2018	CF1	28	2.4
0492	6/11/18	Along S Site Boundary	18	1.6
0557	1/24/2018	CF1	40	2.5
0558	1/24/2018	CF1	36	2.7
0559	1/25/2018	CF1	19	1.5
0560	1/25/2018	CF1	36	2.5
0596	1/25/2018	CF1	25	1.9
0780	1/23/2018	CF4	28	2.5
	4/30/2018			0.85
0781	5/1/2018	CF4	48	1.7
	1/23/2018			1.4
0782	1/23/2018	CF4	33	3
	5/1/2018			3
0783	1/24/2018	CF4	18	0.57
	5/1/2018			0.046
0786	1/24/2018	CF4	28	2.6
	5/1/2018			1.9
0787	1/24/2018	CF4	36	1.9
	5/1/2018			1.9
0810	5/2/2018	CF5 Extraction Well	10 to 40	3.2
0811	5/2/2018	CF5 Extraction Well	9 to 39	1.8
0812	5/2/2018	CF5 Extraction Well	14 to 44	2.2
0813	5/2/2018	CF5 Extraction Well	14 to 44	3.1

Table 22. January through June 2018 Sampling Events, Groundwater Locations Exceeding the 0.044 mg/L Uranium Groundwater Standard (continued)

Well Number	Date	Location	Sample Depth (ft bgs)	Uranium Concentration (mg/L)
0814	5/7/2018	CF5 Extraction Well	12 to 42	3.2
0815	5/7/2018	CF5 Extraction Well	22 to 52	3.3
0816	5/7/2018	CF5 Extraction Well	21 to 51	2.8
AMM-2	5/31/18	Near CF5	48	2.2
MW-3	6/5/18	Near CF5	44	2.9
SMI-MW01	5/29/18	NE Uranium Plume Area	16	2.8
SMI-PW01	6/5/18	CF5 Vicinity	40	1.7
SMI-PW02	5/2/2018	CF5 Extraction Well	20 to 60	3.6
SMI-PZ1D2	6/5/18	CF5 Vicinity	73	1.1
SMI-PZ1M	6/5/18	CF5 Vicinity	57	2.9
SMI-PZ1S	6/5/18	CF5 Vicinity	18	1.4
SMI-PZ2M2	6/4/18	CF5 Vicinity	56	1.7
SMI-PZ3S	7/11/18	NE Uranium Plume Area	25	1
TP-22	6/4/18	NE Uranium Plume Area	17	0.39
TP-23	6/4/18	NE Uranium Plume Area	25	2.6
UPD-17	6/19/18	NE Uranium Plume Area	14	1.5
UPD-18	6/19/18	NE Uranium Plume Area	13	0.88
UPD-20	6/19/18	NE Uranium Plume Area	17	0.06
UPD-21	6/19/18	NE Uranium Plume Area	25	5.3
UPD-22	5/29/18	NE Uranium Plume Area	9	2.8
UPD-23	7/12/18	NE Uranium Plume Area	26	0.8
UPD-24	7/11/18	NE Uranium Plume Area	27	9.3

NE = northeastern; SW = southwestern

4.5.1 Northeastern Base of Tailings Pile

Figures 13 and 14 are time versus ammonia and uranium concentration plots, respectively, for locations UPD-17 and UPD-18. Historically, ammonia concentrations have displayed a general trend of higher ammonia concentrations during river base flows and, conversely, lower concentrations during the spring runoff or higher flows. The ammonia concentrations for both UPD-17 and UPD-18 decreased in response to the higher river flows compared to the previous sampling event.

The uranium concentrations also generally decrease during low river stage time periods and increase during high river stages. The results indicate this general trend, with uranium concentrations associated with both UPD-17 and -18 slightly increasing (from 1.3 to 1.5 mg/L and from 0.8 to 0.9 mg/L, respectively) during this recent sampling event.

4.5.2 Northeastern Uranium Plume Area

Due to the number of wells associated with the northeastern uranium plume, this area of the site was further subdivided into the center of the plume, the vicinity of the Atlas building, and the northeastern edge of the plume area.

4.5.3 Center of Northeastern Uranium Plume Area

Figures 15 and 16 are the time versus ammonia and uranium concentration plots, respectively, for the center of the northeastern uranium plume area, which includes locations 0411, 0413, 0414, and UPD-20. Well 0411 has not contained sufficient volume to collect a sample during the last two sampling events.

As displayed in Figure 15, the ammonia concentrations remained below the detection limit in the samples collected from well UPD-20. Ammonia concentrations in the samples collected from locations 0413 and 0414 have fluctuated in the past two years to the same degree; however, the ammonia concentration in the sample collected from 0413 increased from 58 to 72 mg/L while the concentration in the sample collected from 0414 decreased from 33 to 23 mg/L. The reason these locations deviated from this historical trend cannot be explained at this time with the data available.

The uranium concentrations in samples collected from wells 0413 and 0414 have fluctuated at approximately the same percentage since December 2014, slightly increasing during river peak flows and decreasing during river base flows (Figure 16). The uranium concentration associated with samples collected from these locations did not significantly change since the previous sampling event, and the uranium concentration in the sample collected from well UPD-20 remains lower than 0.1 mg/L.

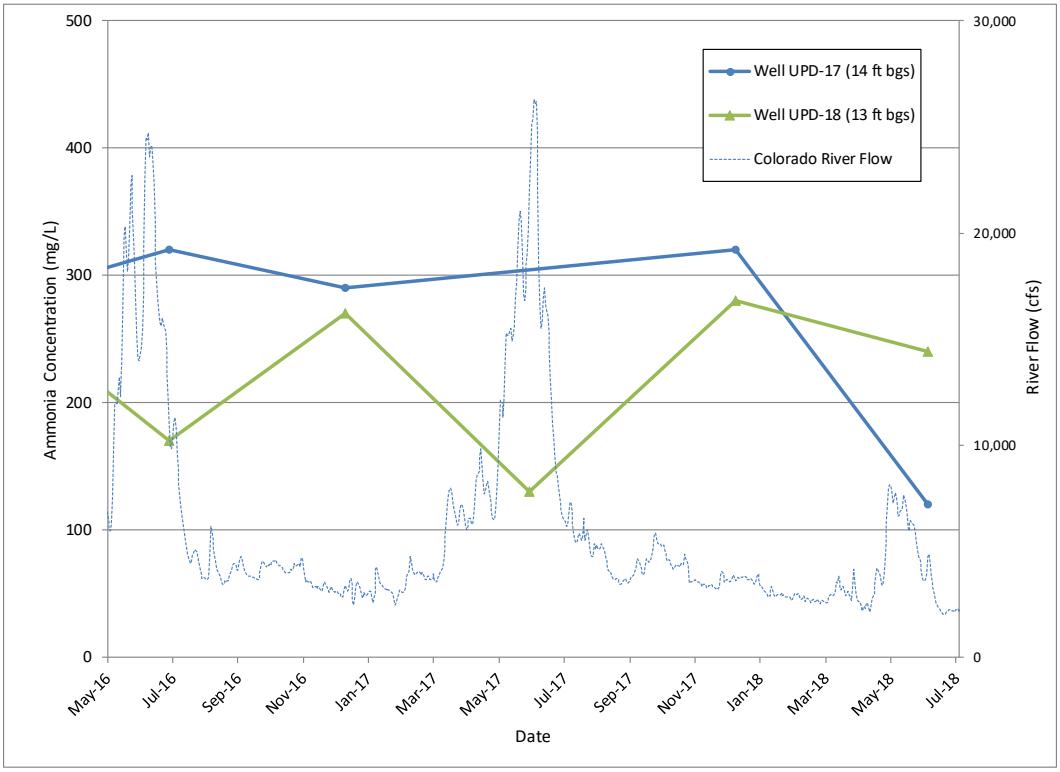

Figure 13. Wells UPD-17 and UPD-18 Time versus Ammonia Concentration Plot

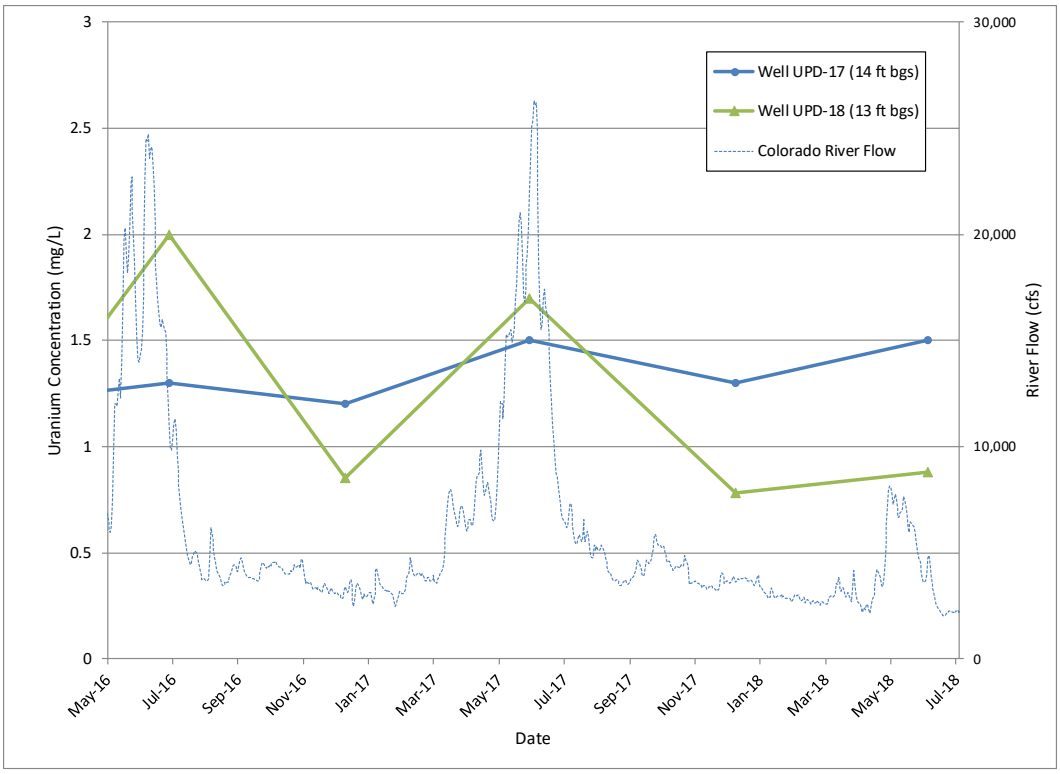

Figure 14. Wells UPD-17 and UPD-18 Time versus Uranium Concentration Plot

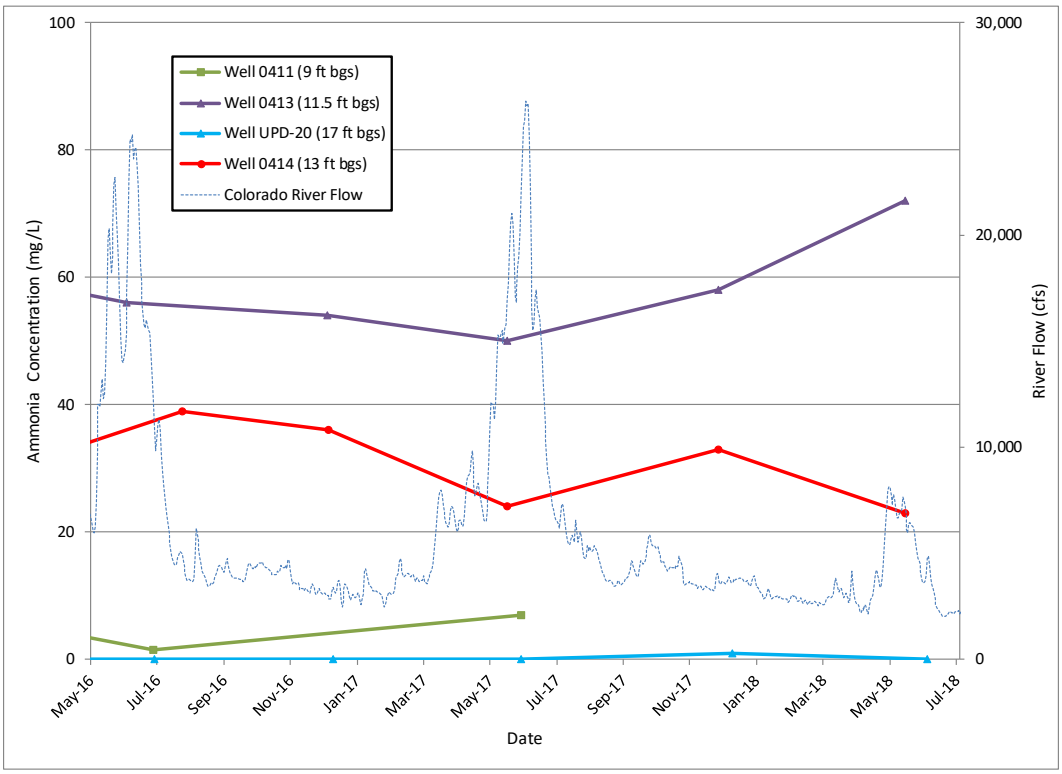

Figure 15. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Ammonia Concentration Plot

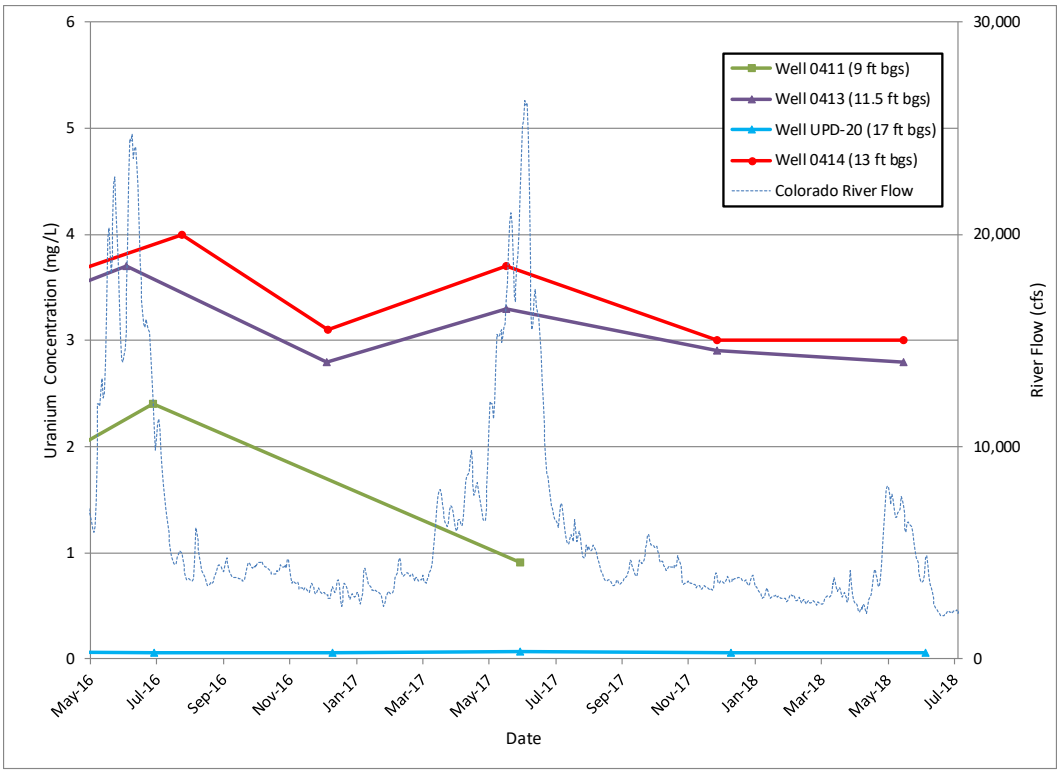

Figure 16. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Uranium Concentration Plot

4.5.4 Atlas Building Vicinity

The ammonia and uranium concentrations associated with samples collected from locations in the vicinity of the Atlas building are displayed in Figures 17 and 18, respectively. These wells include 0410, UPD-21, UPD-23, and UPD-24.

As shown in Figure 17, the ammonia concentrations in the samples collected from wells UPD-21 and UPD-23 both decreased since the previous sampling event, with UPD-23 to a lesser degree. The concentrations in the samples collected from wells 0410 and UPD-24 did not significantly change since December 2017.

The uranium concentrations in the sample from location UPD-24 historically displayed a definitive seasonal fluctuation (Figure 18). This trend was not followed with a slight increase (from 8.7 to 9.3 mg/L) in the uranium concentration during the most recent event, while the uranium concentrations in the samples collected from UPD-21 continue to show no significant change; concentrations since June 2015 have ranged from 5.3 to 6.9 mg/L. Figure 18 also displays the uranium concentrations in samples collected from wells 0410 and UPD-23 remain lower than 1.0 mg/L, with the concentration in the sample collected from well 0410 remaining below the 0.044 mg/L UMTRA standard.

4.5.5 Northeastern Edge of Uranium Plume Area

Figures 19 and 20 display ammonia and uranium concentration data for the wells located in the vicinity of the northeastern edge of the plume area (wells 0412, UPD-22, SMI-MW01, and SMI-PZ3S).

As Figure 19 exhibits, the ammonia concentrations associated with the sampling of wells UPD-22, SMI-MW01, and SMI-PZ3S all slightly decreased since the previous event. The sample collected from well 0412 was again analyzed using a higher detection limit (1.0 as opposed to 0.1 mg/L), and the increase displayed during the past year is likely a function of that. All these concentrations are below 9 mg/L ammonia.

The uranium concentrations in the samples collected from wells 0412, UPD-22, SMI-MW01, and SMI-PZ3S all were 2.8 mg/L (Figure 20). Uranium concentrations in the samples from 0412 and SMI-MW01 have displayed typical seasonal fluctuation as a result of their proximity to the riverbank; however, the 2018 low peak river flows the decreases were not as significant. The concentration in the sample collected from SMI-PZ3S has remained 1.0 mg/L since June 2016.

4.5.6 Base of Tailings Pile

The time versus ammonia and uranium concentration plots for the area near the base of the tailings pile are presented in Figures 21 and 22 for wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 (listed from south to north). As Figure 21 exhibits, the most recent sampling event ammonia results indicate locations ATP-2-D, ATP-2-S, and MW-3 have not significantly changed since the previous event.

Uranium concentrations in wells ATP-2-S (sample depth 25 ft bgs) and ATP-2-D (sample depth 88 ft bgs) have been less than 0.015 mg/L since 2010. Figure 22 suggests the uranium concentrations associated with the samples collected from well MW-3 has gradually increased from 2.6 to 2.9 mg/L since December 2016.

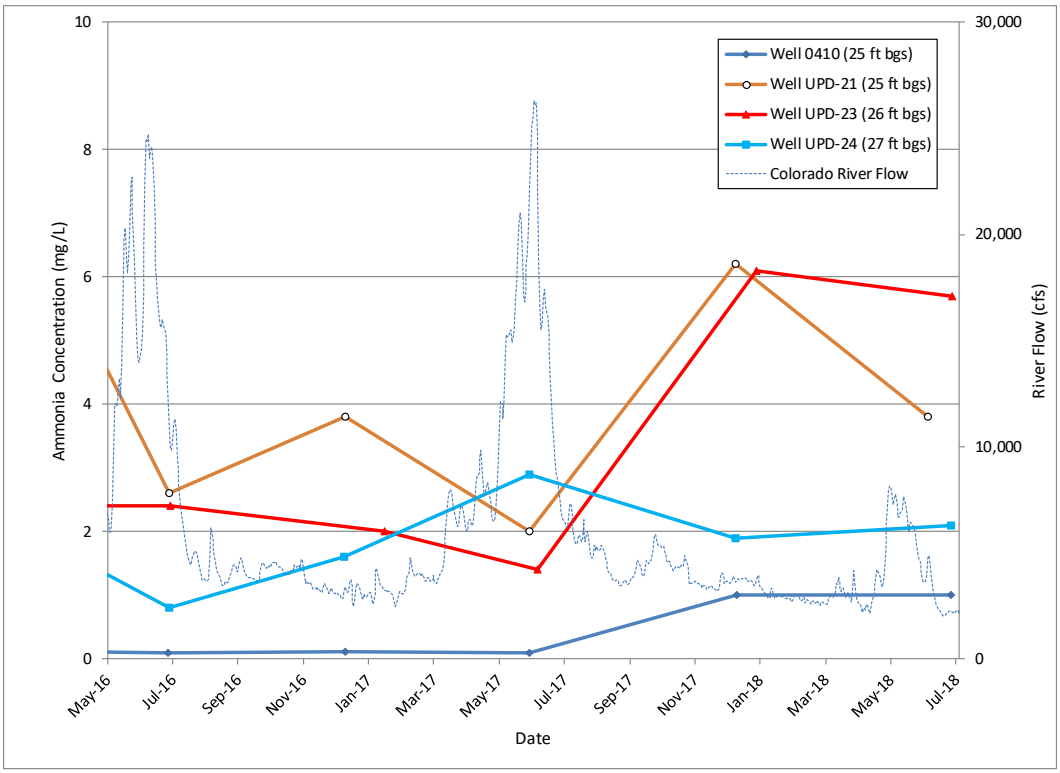

Figure 17. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Ammonia Concentration Plot

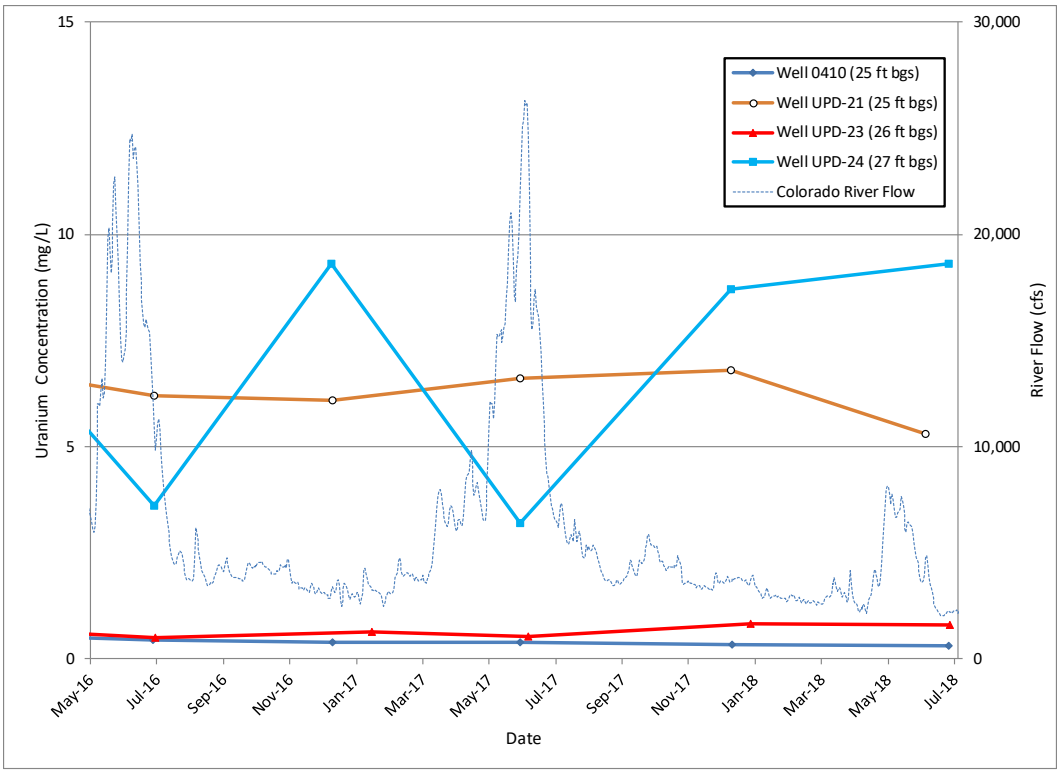

Figure 18. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Uranium Concentration Plot

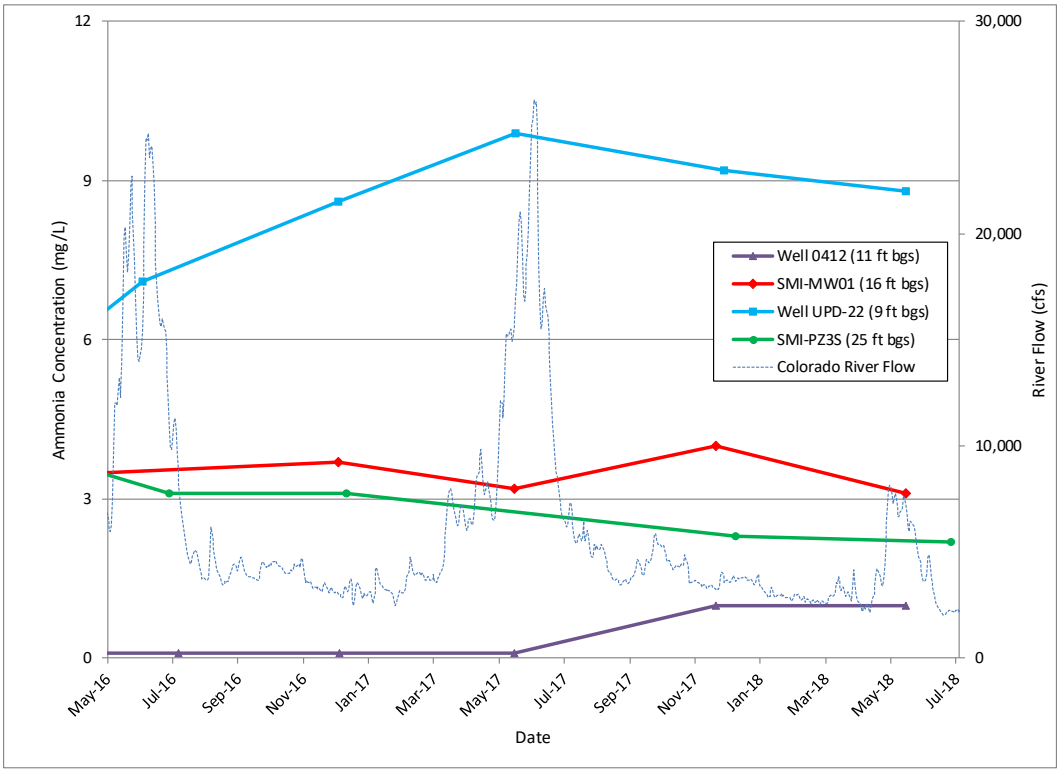

Figure 19. Northeastern Edge of Uranium Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Ammonia Concentration Plot

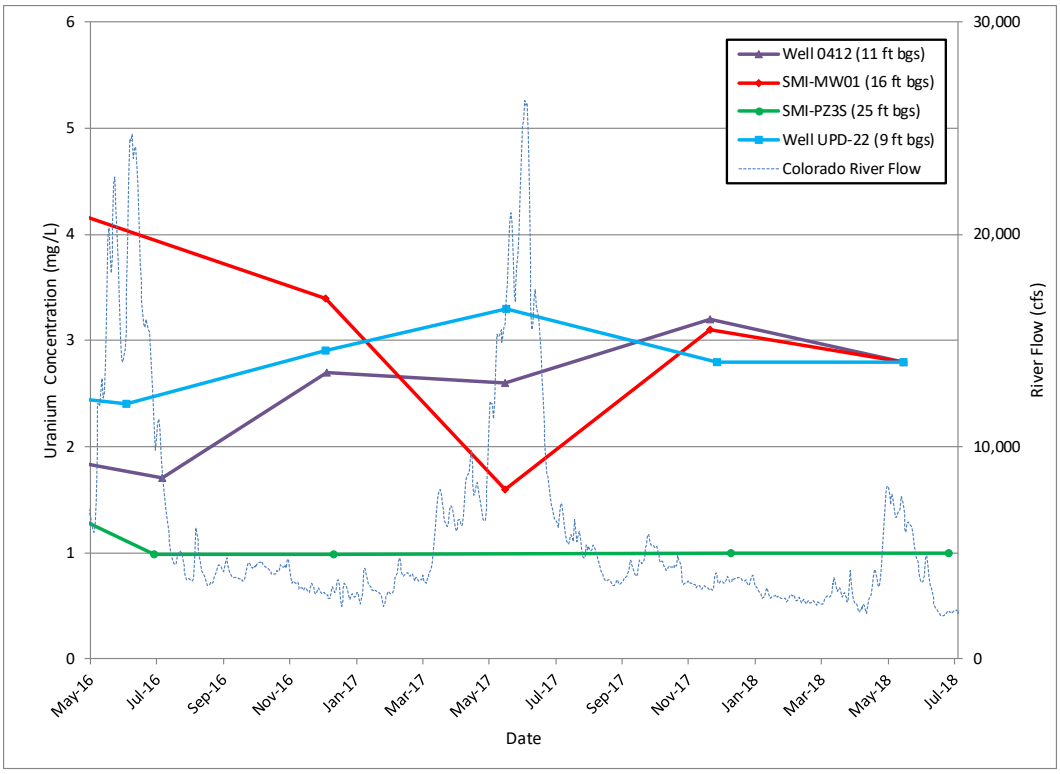

Figure 20. Northeastern Edge of Uranium Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Uranium Concentration Plot

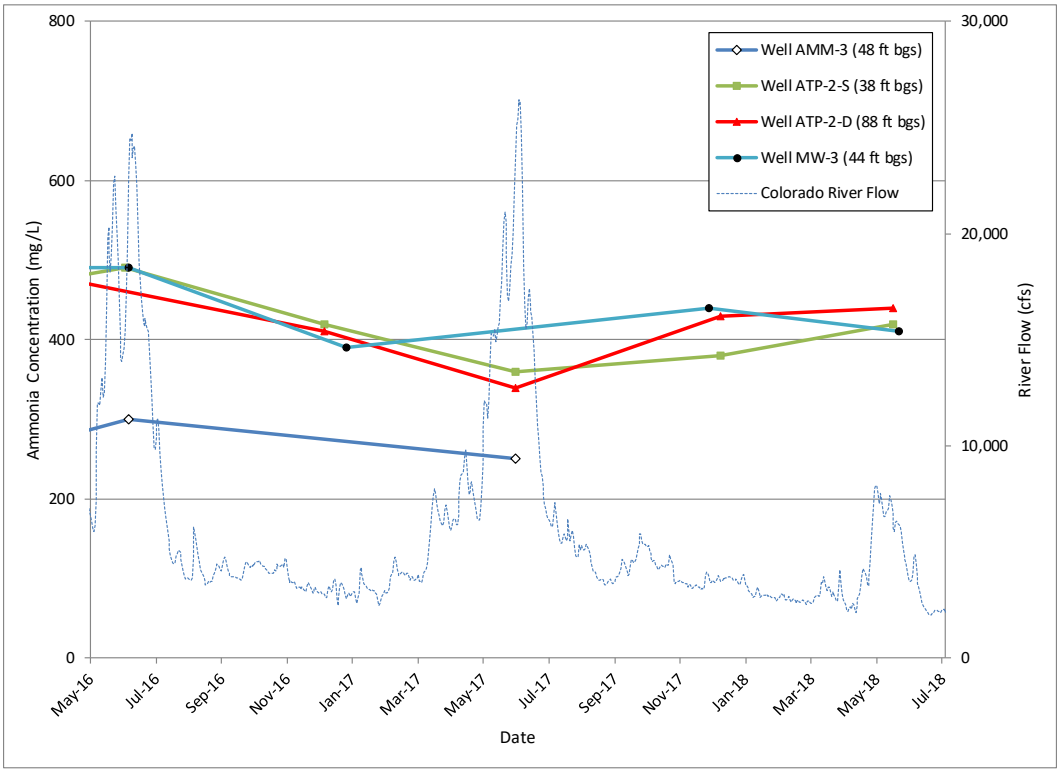

Figure 21. Base of Tailings Pile Observation Wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Ammonia Concentration Plot

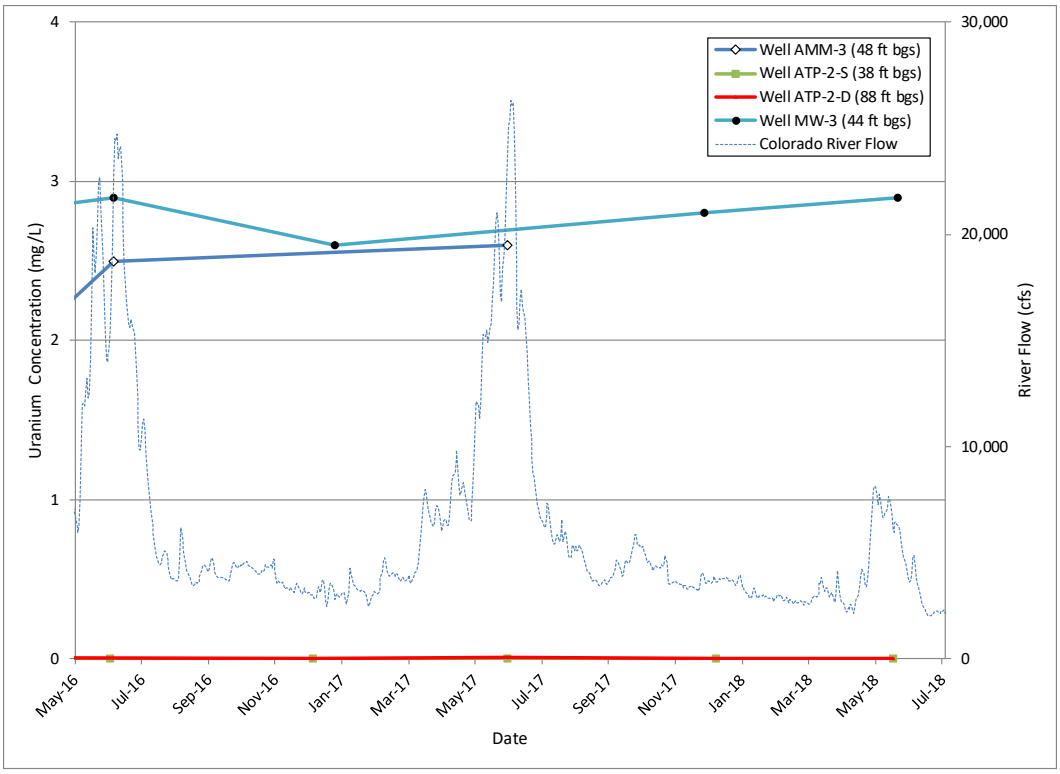

Figure 22. Base of Tailings Pile Observation Wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Uranium Concentration Plot

4.5.7 Southwestern Boundary

Figures 23 and 24 are time versus concentration plots for ammonia and uranium, respectively, for locations 0441, 0440, 0453, and 0454 (listed from northwest to southeast or from upgradient to downgradient groundwater flow direction) along the southwestern site boundary.

Both wells 0453 and 0454 ammonia concentrations (Figure 24) have seasonally fluctuated, and that trend continued during this most recent sampling event. The fact that the concentrations in the samples from these locations did not decrease as significantly as the previous two May/June sampling events may be attributed to the drought conditions and well below average spring runoff flows. Concentrations in the samples collected from wells 0440 and 0441 (the upgradient locations) have been at or below the 0.1 mg/L detection limit since 2010.

Wells 0453 and 0454 uranium concentrations (Figure 25) display a similar trend to the ammonia concentrations, with the uranium concentration measured in the samples decreasing during river spring runoff flow conditions. The sample collected from well 0440 (0.2 mg/L) exceeded the 0.044 mg/L uranium UMTRA standard for the first time in December 2017, but the July 2018 recent sampling event results (0.032 mg/L) indicate the concentration has dropped back below the UMTRA standard. The concentration associated with well 0441 (0.055 mg/L) has consistently been just above the standard since December 2013.

4.5.8 Riverbank Area

Figures 25 and 26 are the time versus ammonia and uranium concentration plots, respectively, for the locations sampled along the riverbank, presented from the south to the north (wells TP-17, 0492, 0407, 0401, 0404, and TP-01). Because these wells are located along the riverbank, their water chemistry has historically been heavily influenced by the seasonal changes of the Colorado River stage. While the ammonia concentrations associated with the samples collected from wells 0401 and 0404 decreased, the ammonia concentrations in the samples collected from wells 0407 and 0492 increased.

Since December 2016, the ammonia concentration associated with well 0407 has gradually increased from 12 to 300 mg/L. While drought conditions may be a factor, the reason for this significant increase in this particular portion of the groundwater system is not apparent at this time. The lowest ammonia concentrations were associated with the samples collected from the wells furthest to the north (well TP-01, below the 0.1 mg/L detection limit) and to the south along the site (well TP-17, 2.7 mg/L).

As displayed in Figure 25, the uranium concentrations associated with the samples collected from each of these wells, with the exception of 0492, all decreased during this most recent sampling event. The uranium concentration in the sample collected from well 0492 has gradually increased since May 2017 from 0.22 to 1.6 mg/L. As displayed in the ammonia plot, the most southern and northern wells have the lowest concentrations, both of which are below the 0.044 mg/L standard.

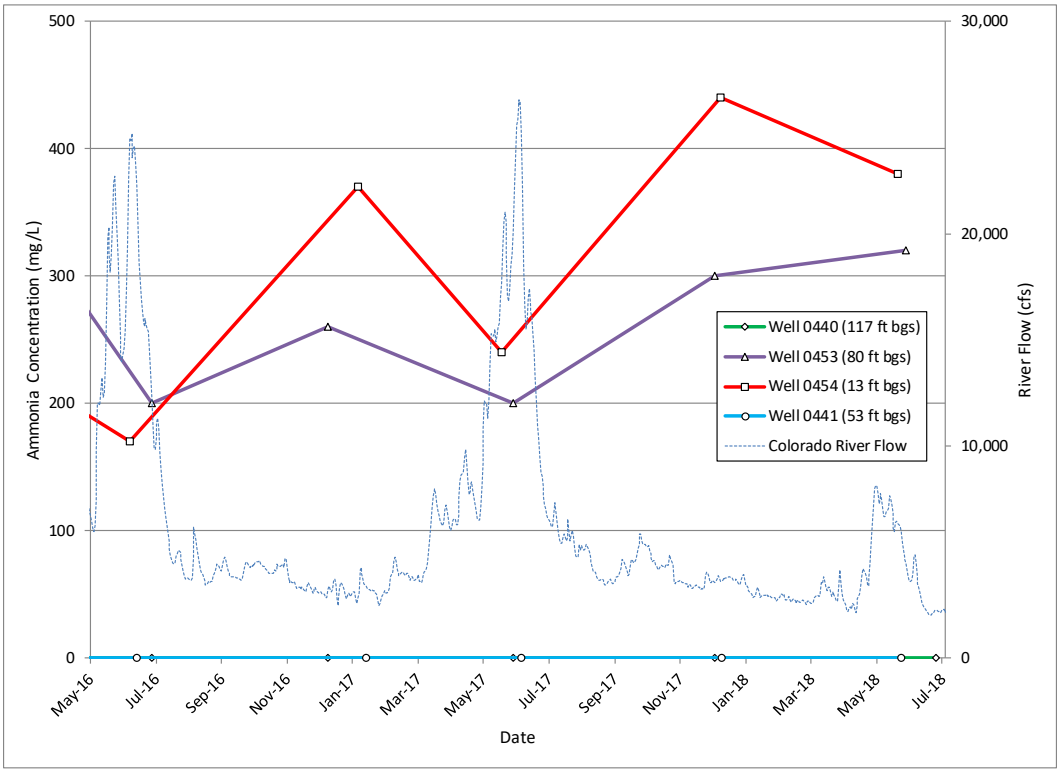

Figure 23. Southwestern Boundary Observation Wells 0453, 0454, and 0440 Time versus Ammonia Concentration Plot

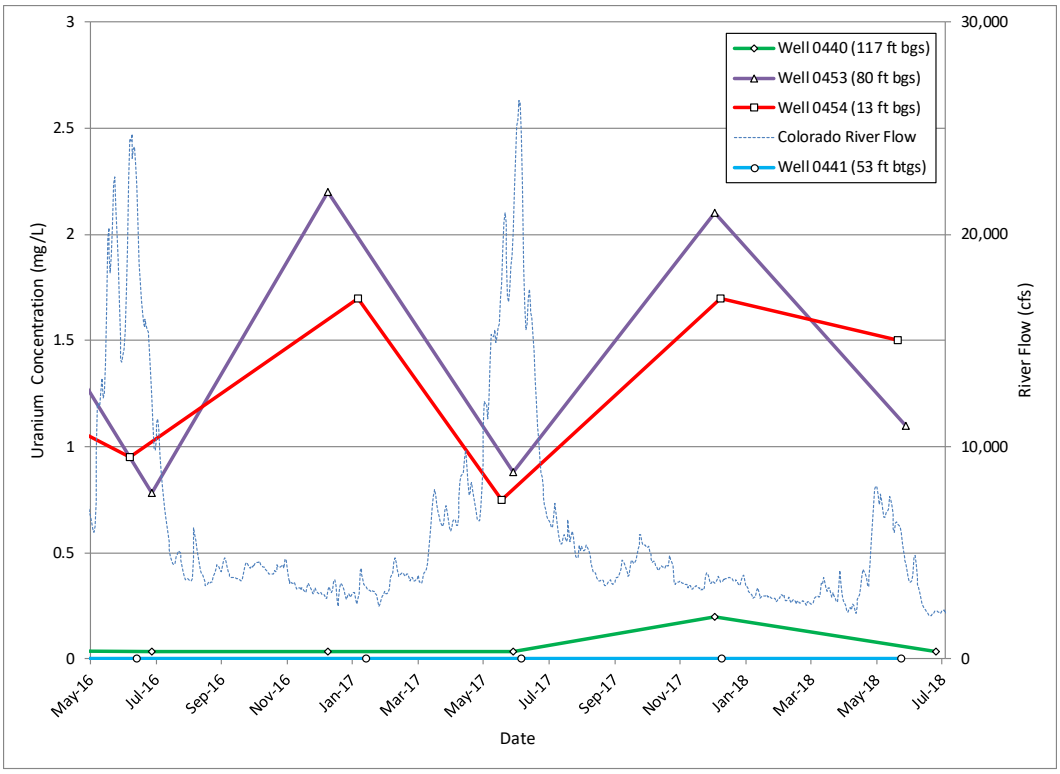

Figure 24. Southwestern Boundary Observation Wells 0453, 0454, and 0440 Time versus Uranium Concentration Plot

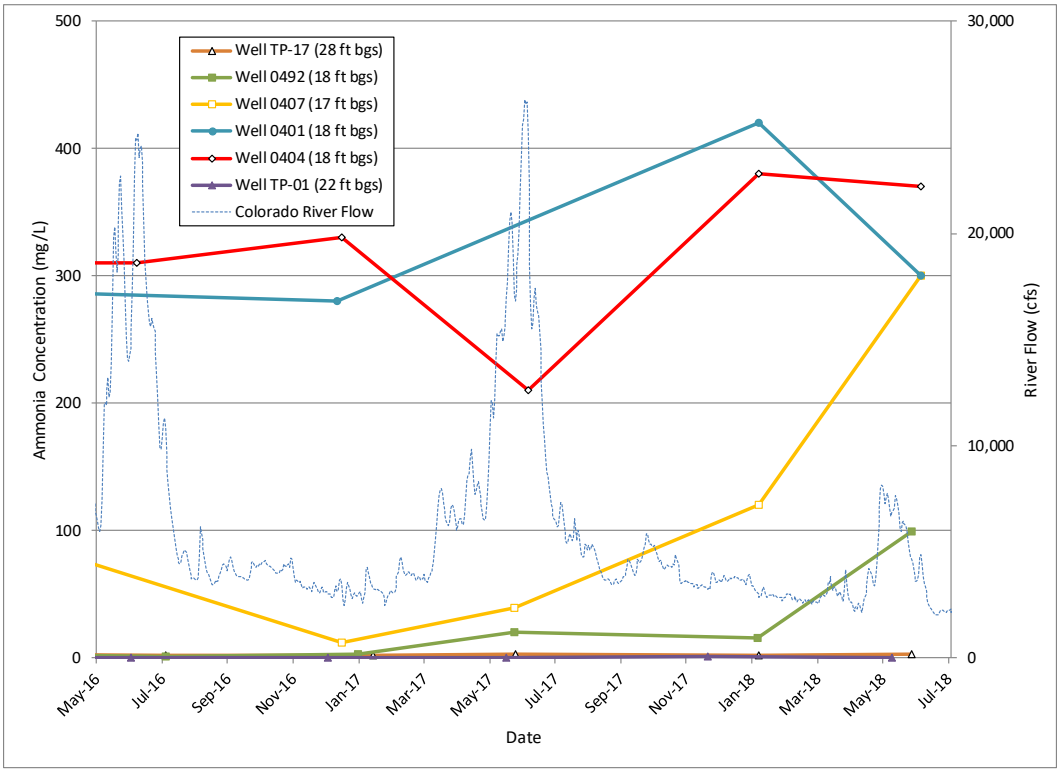

Figure 25. Riverbank Observation Wells TP-17, 0492, 0407, 0401, 0404, and TP-01 Time versus Ammonia Concentration Plot

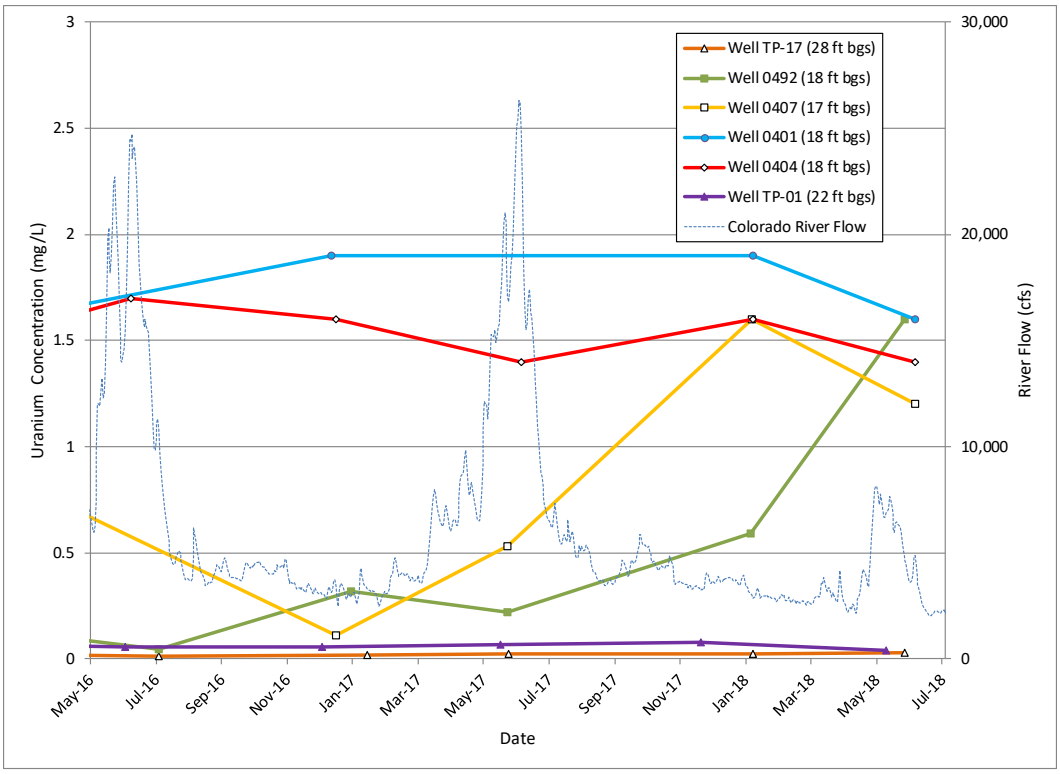

Figure 26. Riverbank Observation Wells TP-17, 0492, 0407, 0401, 0404, and TP-01 Time versus Uranium Concentration Plot

4.5.9 Southern and Off-site Areas

Figures 27 and 28 are the plots for the two locations sampled south of the site, wells TP-17 and TP-20. Well TP-17 is located along the riverbank, and TP-20 is located approximately 500 ft off the riverbank. Typically, contaminant concentrations are low in samples collected from these wells because they are located along the southern edge of the contaminant plumes.

Ammonia concentrations (Figure 27) in both wells slightly increased since the previous sampling event. Typically, wells located along the riverbank display a well-defined impact of changes in the river stage (lower concentrations in during higher runoff flows and higher concentrations during base flows). However, both wells TP-17 and TP-20 are located in the area of the site where the brine unit is very shallow, as evidenced by a specific conductance above 105,000 micro ohms per centimeter (µmhos/cm) at a depth of just 28 ft bgs and more than 120,000 µmhos/cm at a depth 32 ft bgs for wells TP-17 and -20, respectively.

The combination of the shallow brine (contaminants in general do not migrate into these areas due to groundwater density differences) and the wells located near the edge of the plume result in very low ammonia concentrations. The uranium concentrations (Figure 28) associated with the samples collected from these locations continue to remain below the 0.044 mg/L UMTRA standard since 2008.

4.5.10 SMI-PW01 Cluster

During this most recent sampling event, all four wells associated with the SMI-PW01 cluster were sampled, with samples collected from 18, 40, 57, and 73 ft bgs. Figures 29 and 30 are the plots displaying the ammonia and uranium concentrations measured at these various depths.

Contaminant concentrations tend to increase with depth in the groundwater system in this area of the site. As displayed in Figure 29, the sampling associated with this well cluster follows this trend, with the ammonia concentration increasing from 210 mg/L at a depth of 18 ft bgs to 1,500 mg/L at a depth of 73 ft bgs.

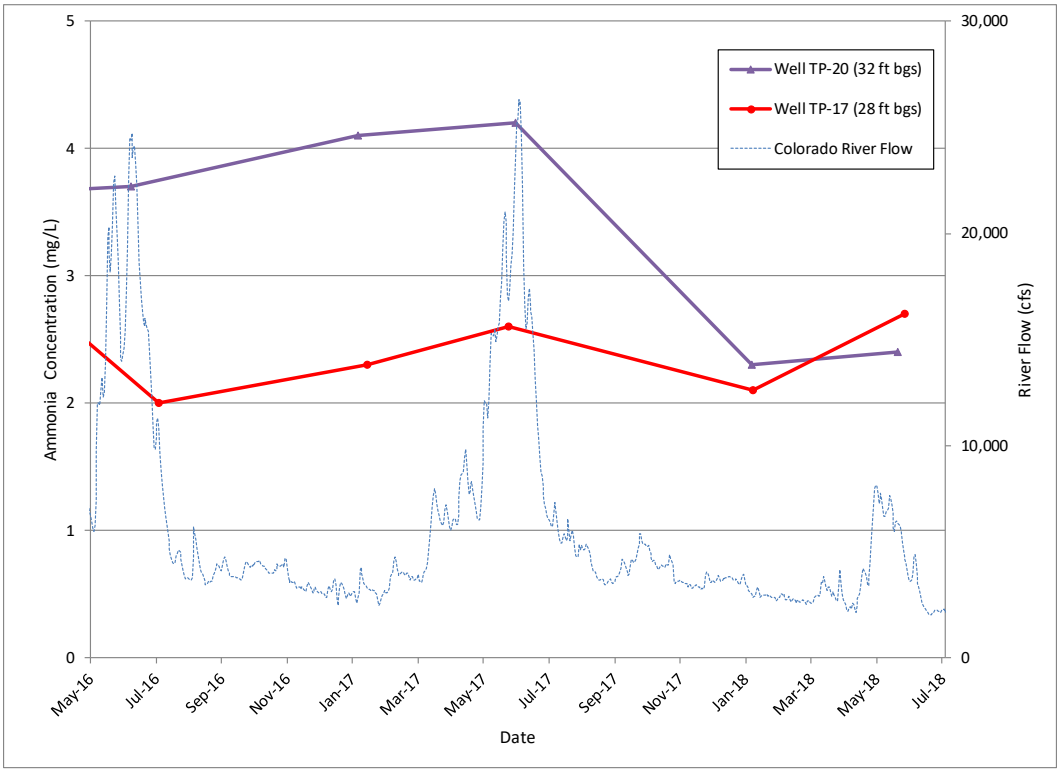

Figure 27. South of Site Observation Wells TP-17 and TP-20 Time versus Ammonia Concentration Plot

The uranium concentrations generally follow the same trend. Over the past two sampling events, the uranium concentration in the sample collected from 18 ft bgs has been higher compared to the concentration in the sample collected from 40 ft bgs (1.4 compared to 1.1 mg/L). At a depth of 73 ft bgs, the concentration was up to 2.9 mg/L.

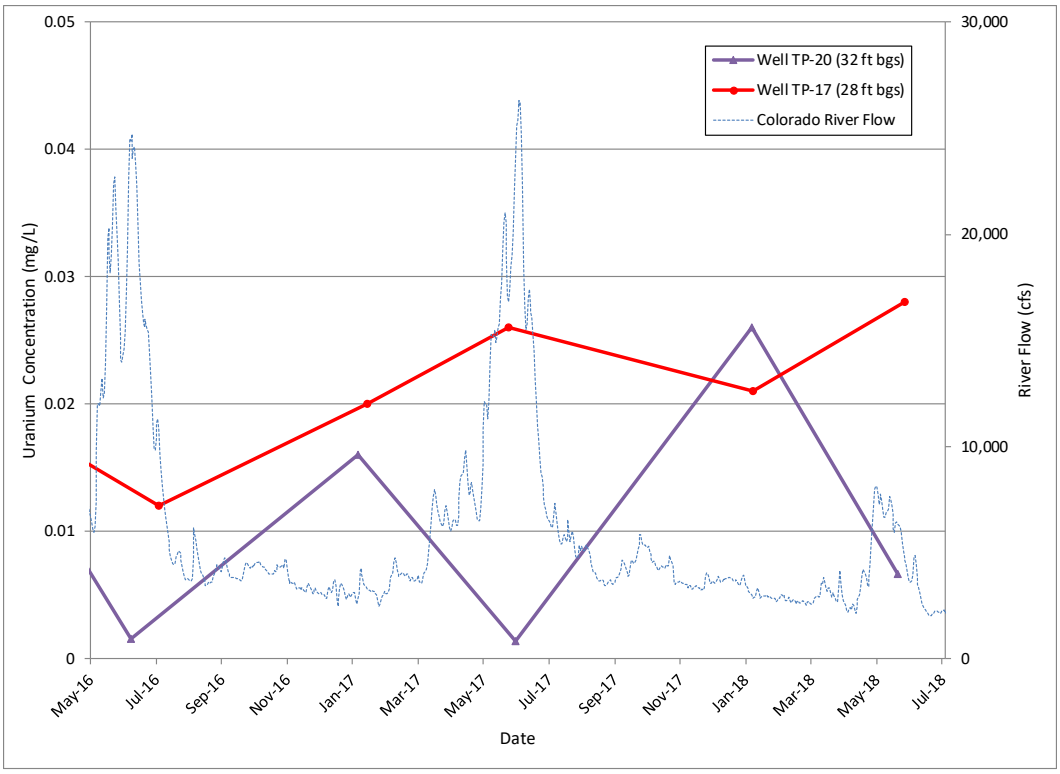

Figure 28. South of Site Observation Wells TP-17 and TP-20 Time versus Uranium Concentration Plot

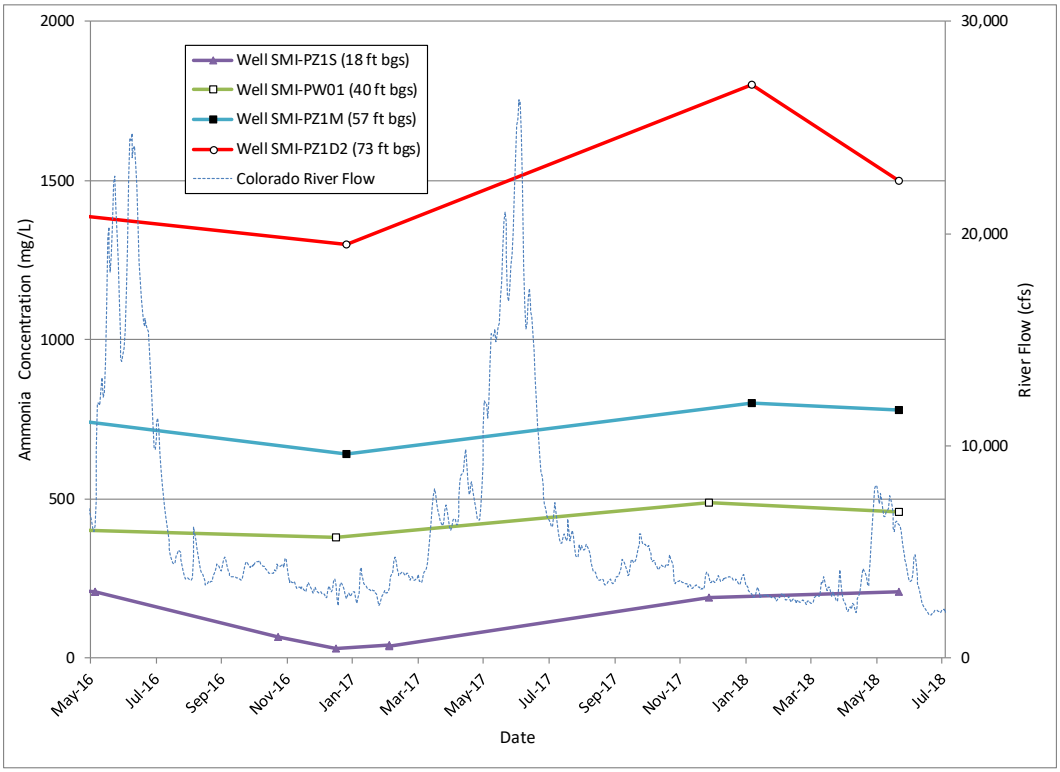

Figure 29. SMI-PW01 Well Cluster Time versus Ammonia Concentration Plot

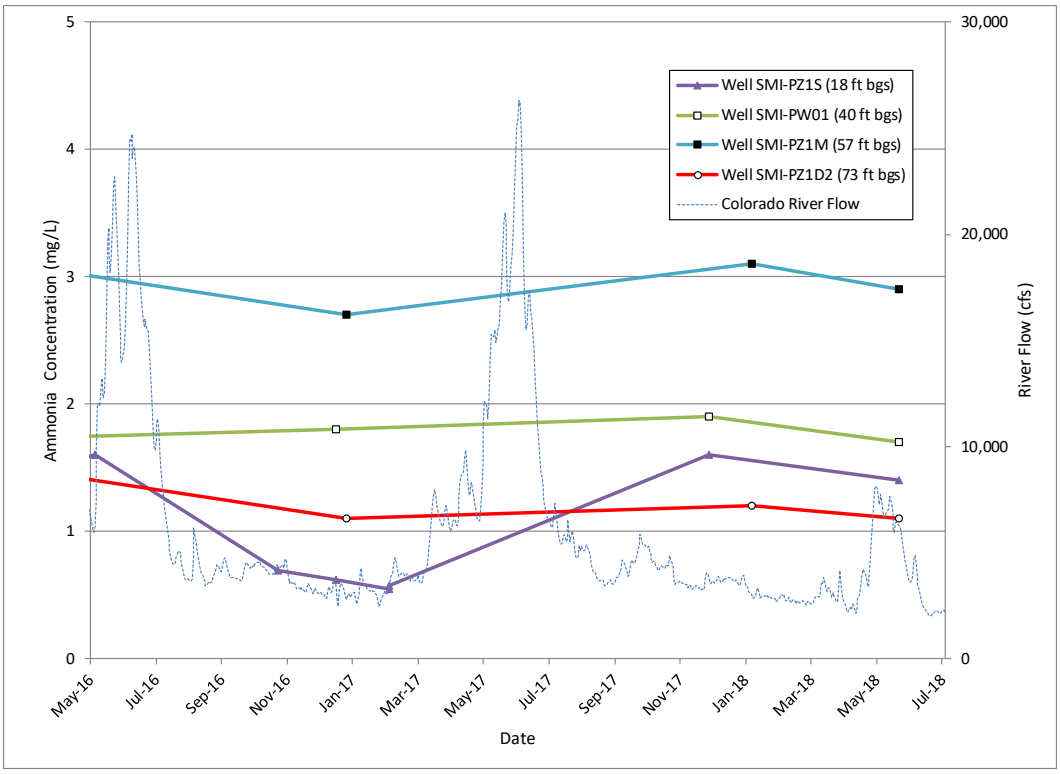

Figure 30. SMI-PW01 Well Cluster Time versus Uranium Concentration Plot

4.5.11 Surface Water Sampling Results

Table 23 presents the ammonia results from the surface water sampling as part of this sampling event, with the samples collected in mid-June 2018 from locations 0201, 0218, 0226, CR1, CR2, CR3, and CR5 (as shown in Figure 3). The ammonia concentrations and comparisons to the applicable EPA criteria for both acute and chronic concentrations (along with the temperature and pH data used to calculate these concentrations) are shown in Table 23.

Table 23. June 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
0218	6/11/18	21.1	8.23	<0.1	6.0	0.54
0226	6/11/18	22.9	8.44	<0.1	3.8	0.34
CR1	6/11/18	20.9	8.08	<0.1	7.3	0.63
CR2	6/11/18	21.6	8.14	<0.1	7.3	0.59
CR3	6/11/18	23.7	8.40	<0.1	3.4	0.32
CR5	6/11/18	23.4	8.41	<0.1	3.8	0.34

*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)

The ammonia concentrations measured during this event were below the 0.1 mg/L detection limit. All surface water ammonia concentrations are below the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations.

4.6 Groundwater Surface Elevation

Water level data were collected between May 24 and June 20, 2018, when the Colorado River mean daily flows ranged from 4,890 to 6,910 cubic feet per second, and the river stage at the southern end of the site only ranged from 3,954.4 to 3,955.3 feet above mean sea level.

Because river elevations fluctuated less than 1 ft during this time period, it was possible use this water level data collected during this time frame to generate the groundwater surface contour map displayed in Figure 31.

With the drought conditions and well below average spring runoff flows, this contour map displays how the site groundwater system responds to the river during primarily gaining conditions. Groundwater flow direction and gradient displayed in this contour map are comparable to historical contour maps generated using groundwater data collected during this same time of year.

4.7 Contaminant Distribution

Figures 32 and 33 are maps showing shallow groundwater ammonia and uranium plumes, respectively, using data collected during the May/June 2018 site-wide events. Contaminant distribution is generally comparable to previous plume maps generated using data collected during the past two years.

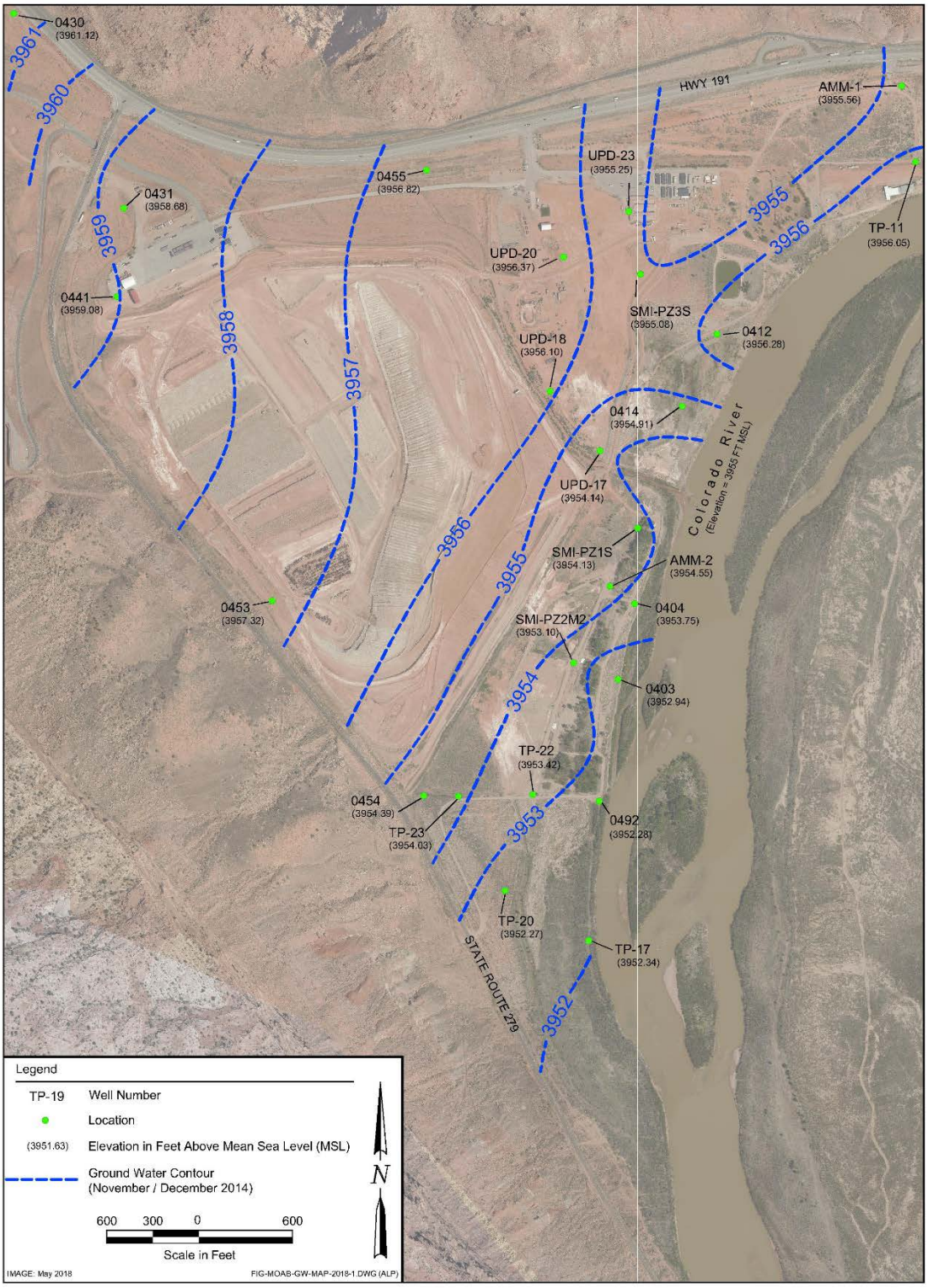

Figure 31. Site-wide Groundwater Elevations May 24 through June 20, 2018

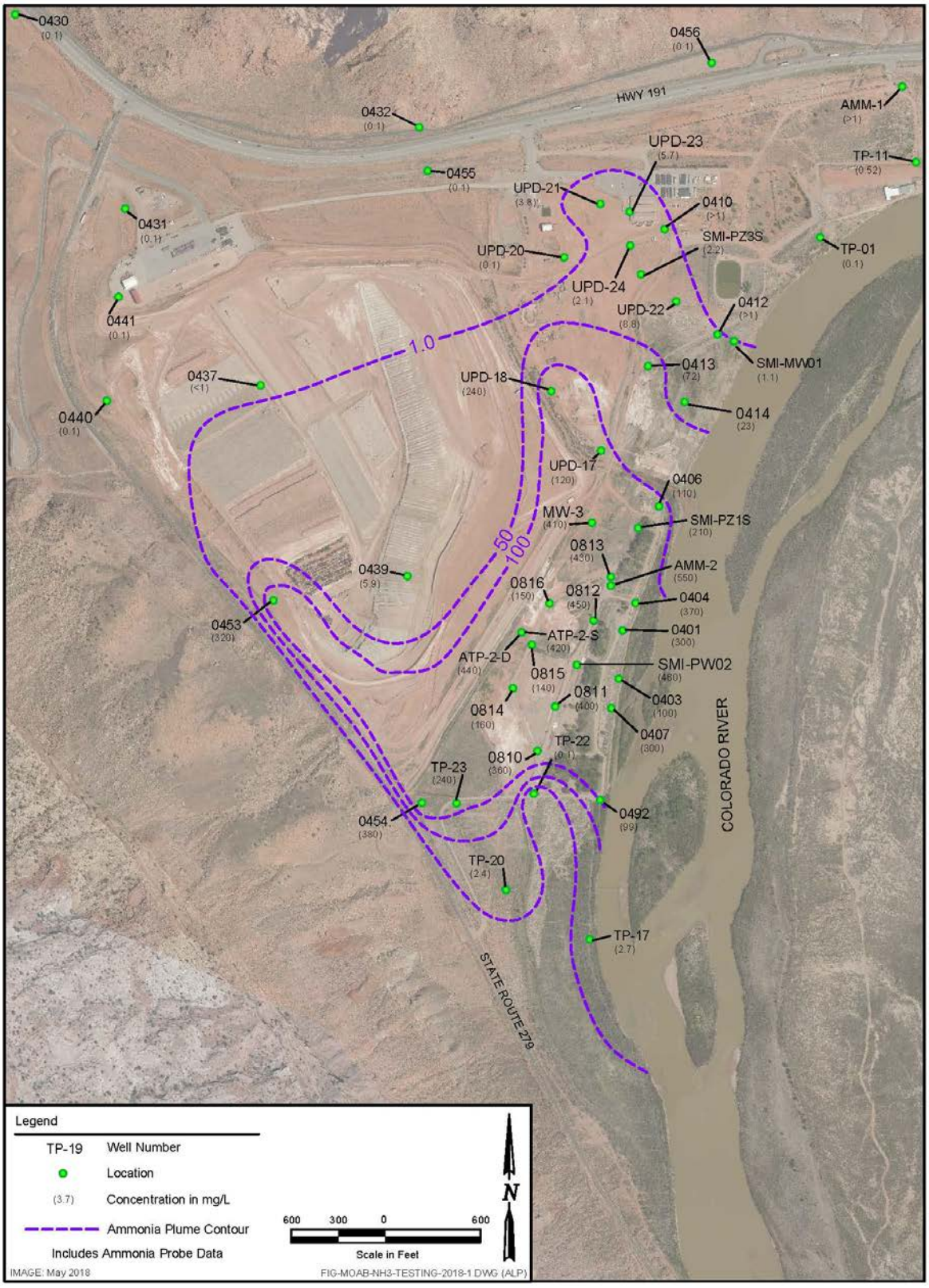

Figure 32. Ammonia Plume in Shallow Groundwater May/June 2018

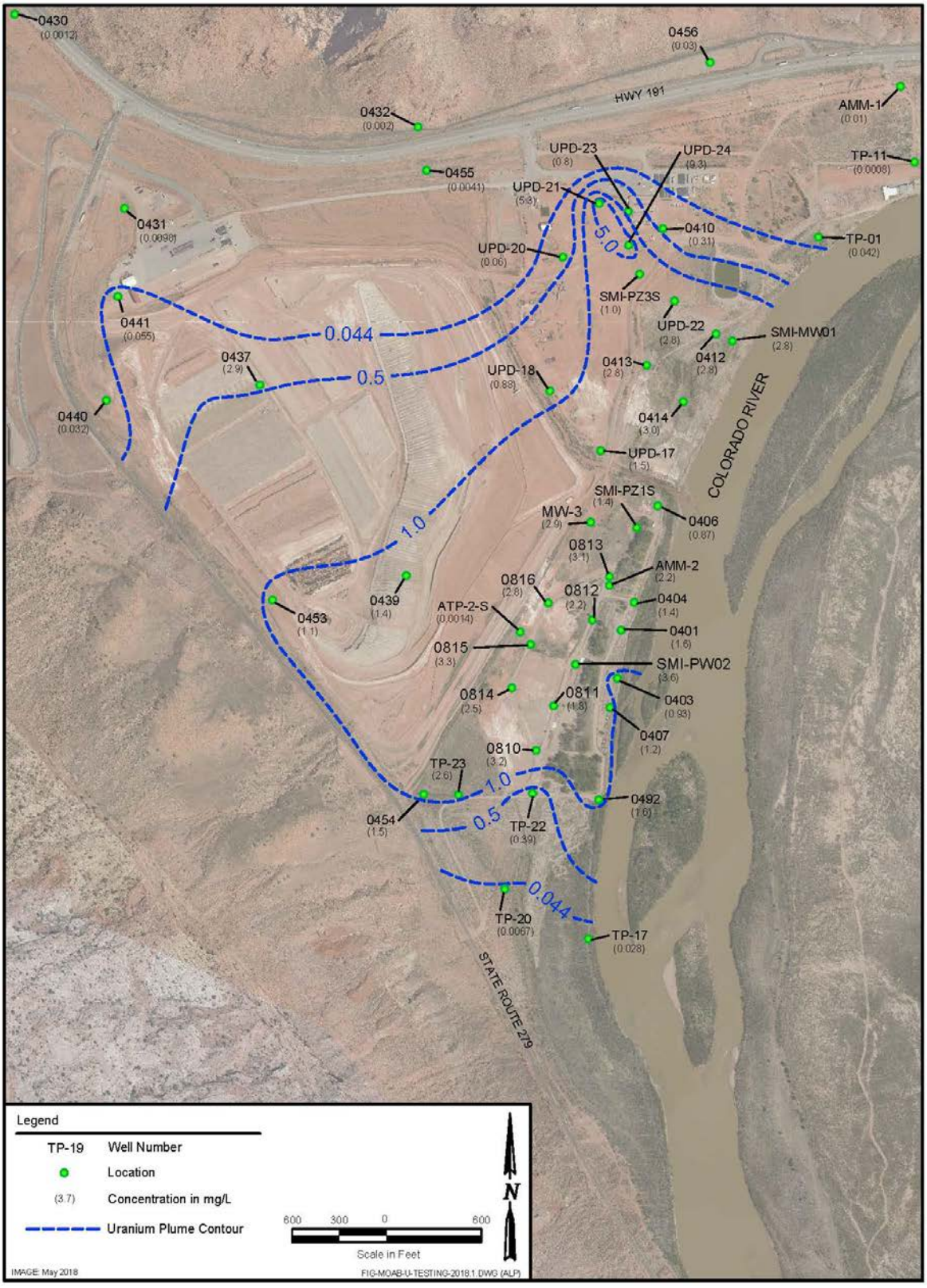

Figure 33. Uranium Plume in Shallow Groundwater May/June 2018

5.0 Conclusions

This report presents the results of sampling conducted at the Moab site between January and June 2018. The primary contaminants of interest are ammonia and uranium, and, while there is no EPA drinking water standard maximum concentration level for ammonia, the UMTRA groundwater standard for uranium is 0.044 mg/L. This uranium standard was exceeded in at least one location for each of the Moab site sampling events. Refer to Table 22 for a complete list of the Moab site locations and associated uranium concentrations that exceeded the 0.044 mg/L uranium standard. There were no anomalous data associated with any of these sampling events.

5.1 January 2018 CF1 and CF4 Sampling Events

Groundwater samples were collected in January 2018 from the CF1 and CF4 monitoring wells to 1) provide background concentrations for the upgradient and the deeper zones of the subsurface not impacted by the fresh water injection activities, and 2) determine if the impacts of injection can be detected after the system had been shut off for approximately one month. The freshwater injection system utilizing the CF4 wells was shut down in late December 2017 for the holiday break and re-started after the samples were collected at the end of January 2018. Injection into the CF1 wells had not occurred since November 2016.

Results indicate the CF1 monitoring well ammonia concentrations increase with depth, with a maximum concentration of 500 mg/L at a depth of 36 ft bgs. Uranium concentrations displayed a similar trend. In the shallow zone, the results indicate the ammonia and uranium concentrations are highest in the upgradient direction, decrease in the zone just downgradient of the injection wells, and then further decrease at the riverbank. These results suggests there exists an inherent decrease in the contaminant concentrations in the shallow subsurface moving towards the river.

The CF4 wells are screened and deliver fresh water into the zone from 15 to 35 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 has a long-term impact on this subsurface zone.

5.2 February and June 2018 Crescent Junction Sampling Events

The rationale for collecting the groundwater samples from Crescent Junction monitoring well 0205 was to help identify the source of the water present in well 0205. Sample were collected in February (as part of the quarterly monitoring for the first quarter of 2018) and June 2018 (as part of the quarterly monitoring for the second quarter of 2018). In addition to the standard analytes, the samples were also analyzed for bicarbonate as $CaCO_3$, carbonate as $CaCO_3$, total alkalinity as $CaCO_3$, uranium-234, uranium-235, and uranium-238. The analyte concentrations measured in the samples collected during the first half of 2018 indicate that well 0205 continues to be recharged from the same water source that was identified during previous sampling events.

5.3 March 2018 Well 0437 Sampling Events

This was location was sampled for the first time 2009. Results indicate the ammonia concentration of the sample collected in March was within the historical range, and the uranium concentration was just below the historical minimum. Based on these results, this well was added to the list of locations that will be sampled during all future site-wide events.

5.4 May 2018 CF4 and CF5 Sampling Events

The collection of groundwater samples from observation wells surrounding the CF4 injection wells in May 2018 was to evaluate the effectiveness of the freshwater injection system. The analytical results indicate the injection system reduced the ammonia concentrations in the groundwater system from 15 to 35 ft bgs in the vicinity of CF4 (Table 21), and the water elevation data confirmed more than 12 ft of mounding was generated from the operation of this system.

All eight CF5 wells were sampled to monitor contaminant concentration trends over time and update the contaminant concentrations used for the mass removal calculations. In general, ammonia and uranium concentrations have not significantly changed over the past two years. The data indicate the samples collected from the extraction wells located along CF5 southeastern boundary have the higher ammonia concentrations compared to the samples collected from the wells near the base of the tailings pile. No trends are apparent based on the uranium concentrations.

5.5 May/June 2018 Site-wide Sampling Event

The rationale for conducting the May/June 2018 site-wide sampling event was to collect data from the site during Colorado River peak spring runoff flows and to assess any changes or trends in the groundwater system water chemistry. The river flows were well below average due to regional drought conditions, with the peak flow less than one-third of the average peak flow. Surface water sampling was also conducted to assess surface water quality adjacent to the site compared to upstream and downstream water quality. In general, with the exception of the locations in the vicinity of the Colorado River bank, the ammonia and uranium concentrations did not significantly change since the previous site-wide sampling event in November/December 2017. Ammonia concentrations from the seven surface water samples collected during this sampling event were below the 0.1 mg/L ammonia laboratory detection limit and below the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations.

5.6 June 2018 Crescent Junction Sampling Events

Well 0205 was sampled again in June 2018 as part of the second quarter monitoring event at the Crescent Junction site. This sample was analyzed for the same analyte list as the February 2018 sample. All analyte concentrations were comparable to the concentrations detected in the previous samples.

6.0 References

40 CFR 192A (Code of Federal Regulations) Subpart A, “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 Standard Practice for Validation of Laboratory Data* (DOE-EM/GJTAC1855).

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