DOE–EM/GJTAC2251

*Office of Environmental Management – Grand Junction*

UMTRA Project

# Moab UMTRA Project Ground Water and Surface Water Monitoring Report July through December 2017

Revision 0

May 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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# Ground Water and Surface Water Monitoring Report
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**Moab UMTRA Project**
**Ground Water and Surface Water Monitoring Report July through December 2017**

**Revision 0**

## Review and Approval

5/10/18

Elizabeth Moran
TAC Technical Group/Field Manager
Date

5/10/18

Kenneth G. Pill
TAC Ground Water Manager
Date

5/14/18

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TAC Senior Program Manager
Date

## Revision History

| Revision | Date | Reason for Revision |
|---|---|---|
| 0 | May 2018 | Initial issue. |

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## Figures

**Figures (*continued*)**

## Tables



## Appendices

## Acronyms and Abbreviations

| | |
|---|---|
| bgs | below ground surface |
| CCB | continuing calibration blank |
| CCV | continuing calibration verification |
| CF | Configuration |
| CFR | Code of Federal Regulations |
| 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 |
| MB | method blank |
| MDL | method detection limit |
| mg/L | milligrams per liter |
| MS | matrix spike or mass spectrometry |
| 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 |
| 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 ground water and surface water samples collected from the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site during the second half of 2017. The results of the data validation process are also presented.

Three sampling events were completed during this time frame. The first two events were completed in August and November 2017, with samples collected from approximately the same locations. Ground water samples were collected from select Configuration (CF) 4 monitoring wells to determine the impacts of freshwater injection in this area of the well field.

Samples were also collected from the CF5 ground water extraction wells (all CF4 and CF5 locations shown on Figure 1) to determine the effectiveness of the ground water 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.

The third event started in November 2017 and was completed in January 2018. Samples were collected from a variety of site-wide ground water and surface water locations. Ground water and surface water sampling locations are shown on Figures 2 and 3, respectively.

Site-wide ground water 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/Ground Water 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).

Appendices A and B include Water Sampling Field Activities Verifications, Minimums and Maximums Reports, Water Quality Data, Water Level Data, and the trip reports associated with the August and November 2017 CF4 and CF5 sampling events, respectively. The Water Sampling Field Activities Verification, Minimums and Maximums Report, Water Quality Data, Water Level Data, and the trip report for the December 2017 Site-wide sampling event are contained in Appendix C.

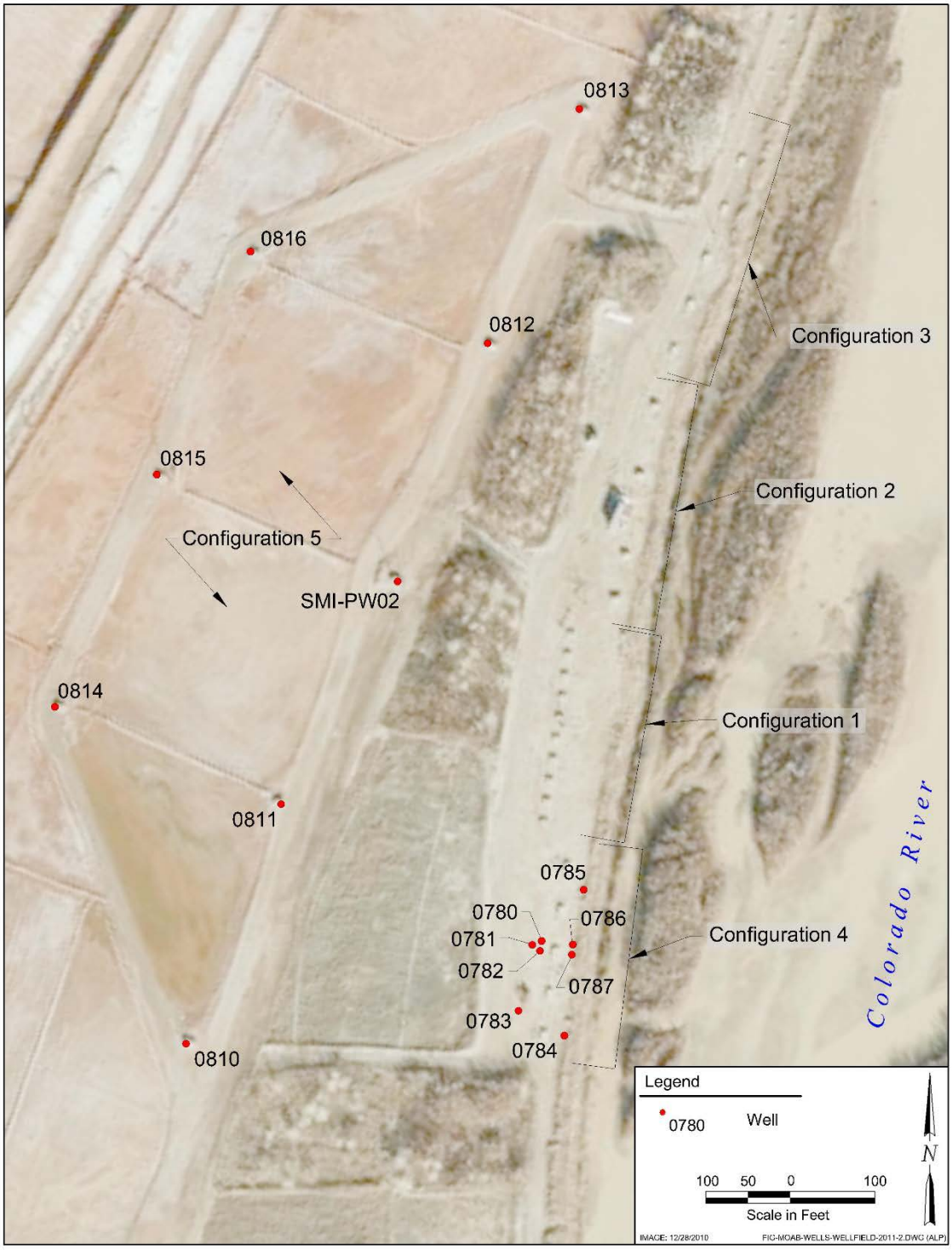


*Figure 1. August and November 2017 CF4 and CF5 Ground Water Sampling Locations*

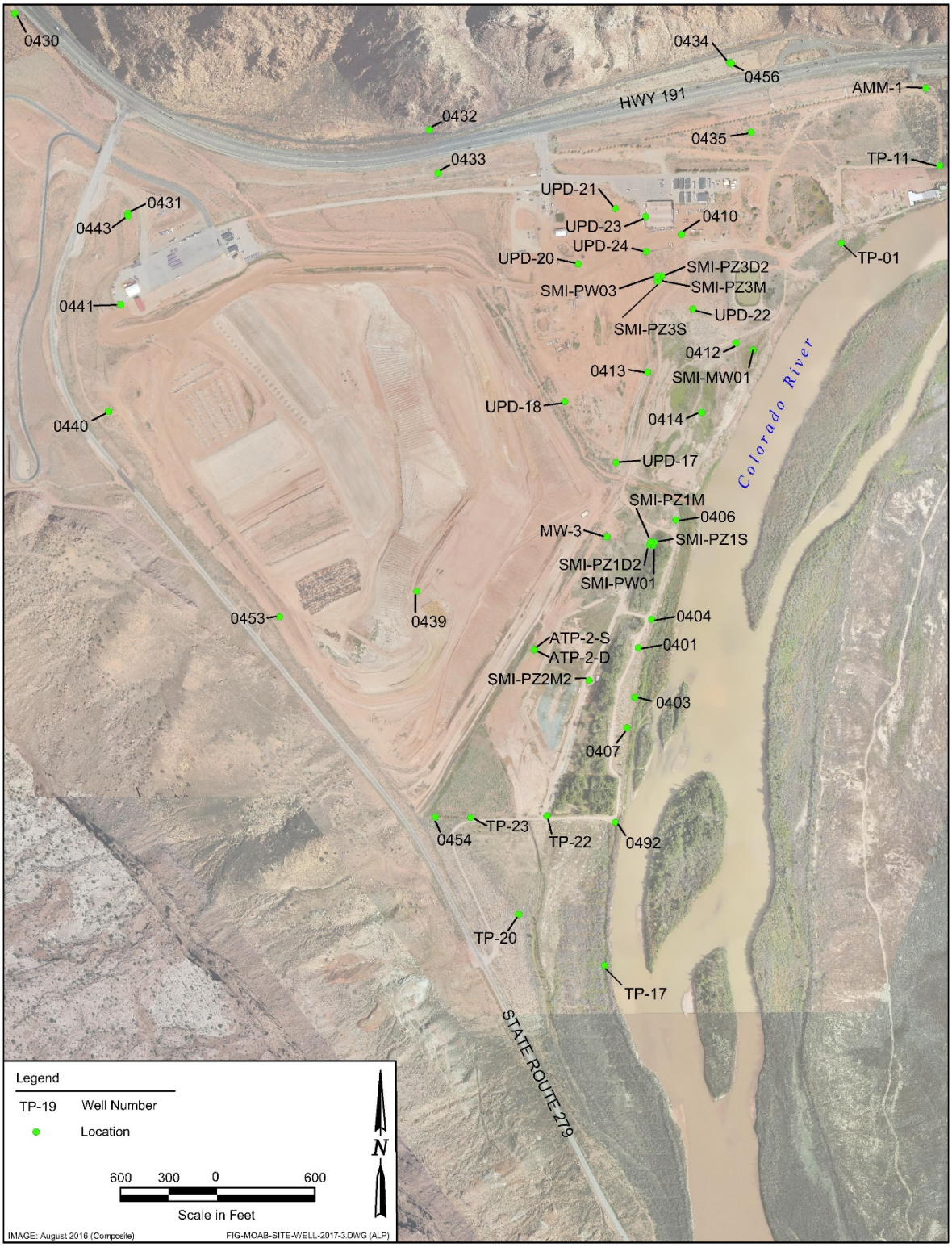


*Figure 2. November 2017 Site-wide Ground Water Sampling Locations*

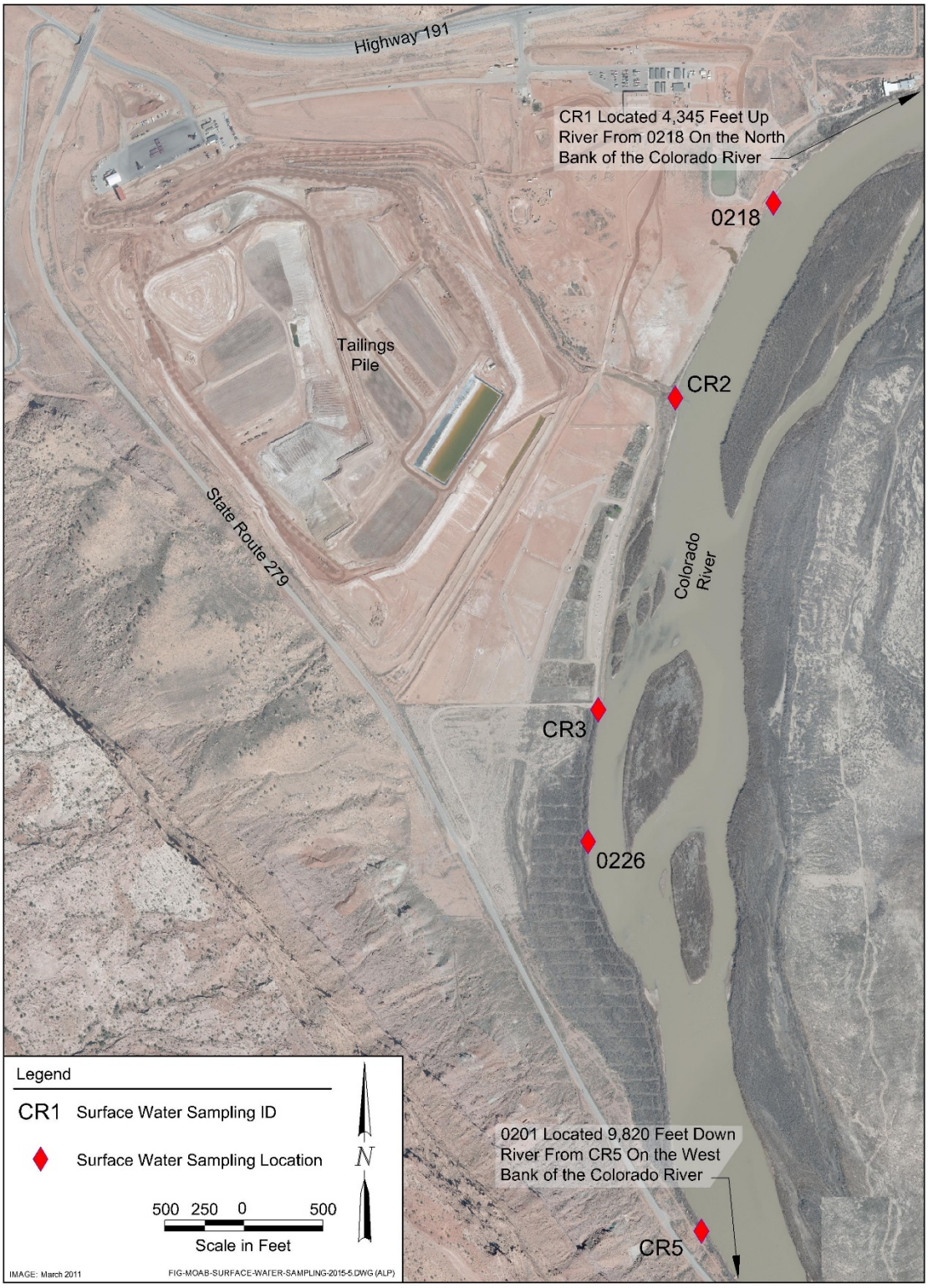


*Figure 3. November 2017 Surface Water Sampling Locations*

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 are 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.

## 2.0 Summary of Sampling Events

### 2.1 August 2017 CF4 and CF5 Sampling Event

Ground water 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. Ground water samples were collected from the eight CF5 ground water extraction wells to update the mass removal calculations.

As of August 2017, the freshwater injection system had been continuously operating for approximately six weeks. In early July 2017, the system was restarted after operations were suspended in May 2017 due to the higher river stage associated with the Colorado River spring runoff. The ground water extraction system had been operating on a regular basis since March 2017.

### 2.2 November 2017 CF4 and CF5 Sampling Event

The same locations sampled in August 2017 were again sampled in November 2017. At this time, the injection system had been running for only 2 weeks due to repairs to the sand filter. The CF5 wells were sampled just before winterizing the extraction system.

### 2.3 November 2017 Site-wide Sampling Event

Fifty-seven ground water 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 base flow conditions. The 50 ground water 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.

All samples were submitted to ALS Global laboratory for ammonia and uranium analysis. The seven surface water samples were collected upstream, downstream, and adjacent to the site during this event.

## 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 met 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 August 2017 CF4 and CF5 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) | 1708096 |
| Laboratory: | ALS Global, Fort Collins, Colorado |
| Sample Data Group (SDG) Numbers: | 1708571 |
| Analysis: | Metals and Inorganics |
| Validator: | Elizabeth Moran |
| Review Date: | 27 February 2018 |

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

*Table 1. August 2017 CF4 and CF5 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. August 2017 CF4 and CF5 Sampling Event, Data Qualifiers*

| Sample Number | Location | Analyte | Flag | Reason |
|---|---|---|---|---|
| 1708571-4 through -7 | 0783, 0784, 0785, 2000 | Ammonia | J | CCB-1 |
| 1708571 through -15 | All in SDG 1708571 | Uranium | J | SD-1 |
| 1708571 through -15 | All in SDG 1708571 | Uranium | J | MS-1 |
| 1708571-1 through -15 | All in SDG 1708571 | Uranium | J | MSD-1 |

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

*Table 3. August 2017 CF4 and CF5 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; therefore, all detects less than five times the highest blank should be flagged. |
| SD-1 | J | U | No SDs 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 were included in the narrative. |

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

## Sample Shipping/Receiving

ALS Global in Fort Collins, Colorado, received a total of 16 samples for RIN 1708096 in one shipment, which arrived on August 25, 2017 (UPS tracking number 1Z5W1Y510192694362). The SDG was accompanied by a chain-of-custody (COC) form. The COC form was checked to confirm that all of the samples were listed on the form with sample collection dates and times and that signatures and dates were present, 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 1708571 was received intact with a temperature of 3.4°C, which complies with requirements. All samples were received in the correct container types. The uranium samples for SDG 1708571 were preserved at the laboratory since the nitric acid dispenser in the ground water lab was not properly functioning. 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 September 12 and 14, 2017. All initial calibrations were performed using three calibration standards and three blanks, 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 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.

### *Method EPA 350.1, Ammonia as N*

Initial calibrations for ammonia as N were performed using six calibration standards and one blank on September 18, 2017, for SDG 17080571. 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

Three of the CCBs on the ammonia SDG 17080571were slightly above the MDL, and three of the sample location results were less than five times the highest CCB; therefore, these sample locations (1708571-4, 1708571-5, 1708571-6), were flagged "J" for reason CCB-1. All of the CCBs on the uranium SDG were below the IDL, and none of the data had to be flagged.

## Equipment Blanks

No EBs were collected during this sampling event since all samples were collected using dedicated equipment.

## Matrix Spike Analysis

The MS analysis results for ammonia were within the acceptable limits, and none of the data had to be flagged. For uranium SDG 1708571, the MS sample selected for quality control (QC) analysis was from another client, and the information was not included in the analysis; therefore, all of the uranium data on this SDG were flagged "J" for reason MS-1.

## Laboratory Replicate Analysis

The uranium SDG 17080571did not contain an MS or MSD sample; therefore, the data are flagged "J" for reason MSD-1.

## Field Duplicate Analysis

A duplicate sample was collected from location 0784 (1708571-5). The duplicate result 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.

**Metals Serial Dilution**
Since no MS samples were run on the uranium samples, there were no SD samples. The uranium samples are flagged "J" for reason SD-1.

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

**Electronic Data Deliverable Files**
The Electronic Data Deliverable (EDD) files arrived on September 23, 2017. 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 November 2017 CF4 and CF5 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 3, Data Deliverables Examination. All analyses were successfully completed.

**General Information and Validation Results**

| | |
|---|---|
| RIN | 1711097 |
| Laboratory: | ALS Global, Fort Collins, Colorado |
| SDG Numbers: | 1711399 |
| Analysis: | Metals and Inorganics |
| Validator: | Elizabeth Moran |
| Review Date: | 6 March 2018 |

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

*Table 4. November 2017 CF4 and CF5 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 5. Refer to Table 6 for an explanation of the data qualifiers applied.

*Table 5. November 2017 CF4 and CF5 Sampling Event, Data Qualifiers*

| Sample Number | Location | Analyte | Flag | Reason |
|---|---|---|---|---|
| 1711399 through -17 | All in SDG 1711399 | Uranium | J | SD-1 |
| 1711399 through -17 | All in SDG 1711399 | Uranium | J | MS-1 |
| 1711399-1 through -17 | All in SDG 1711399 | Uranium | J | MSD-1 |

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

*Table 6. November 2017 CF4 and CF5 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 | The MS sample for the sample group was from another client. |
| MSD-1 | J | U | No uranium MSD data were included in the narrative. |

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

## Sample Shipping/Receiving

ALS Global in Fort Collins, Colorado, received a total of 17 samples for RIN 1711097 in one shipment, which arrived on November 18, 2017, (UPS tracking number 1Z5W1Y510194156805). The SDG was accompanied by a COC form. The COC form was checked to confirm that all of the samples were listed on the form with sample collection dates and times and that signatures and dates were present, 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 1711399 was received intact with a temperature of 4.0°C, which complies with requirements. All samples were received in the correct container types. 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 December 7 and 8, 2017. All initial calibrations were 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 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 five calibration standards and one blank on December 8, 2017, for SDG 1711399. 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 CCB results were higher than the ID; however, the sample results were all greater than the CCBs so no data had to be flagged. All of the CCBs on the uranium SDG were below the IDL, and none of the data had to be flagged.

**Equipment Blanks**

No EBs were collected during this sampling event since all samples were collected using dedicated equipment.

**Matrix Spike Analysis**

The MS analysis results for ammonia were within the acceptable limits, and none of the data had to be flagged. For uranium SDG 1711399, the MS sample selected for QC analysis was from another client, and the information was not included in the analysis; therefore, all of the uranium data on this SDG were flagged "J" for reason MS-1.

**Laboratory Replicate Analysis**

The uranium SDG 1711399 did not contain an MSD sample; therefore, the data are flagged "J" for reason MSD-1.

**Field Duplicate Analysis**

A duplicate sample was collected from location 0780 (1711399-9). The duplicate result 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.

**Metals Serial Dilution**

Since no MS samples were run on the uranium samples, there were no SD samples. The uranium samples were flagged "J" for reason SD-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 December 23, 2017. 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
The Minimums and Maximums Report for this sampling event is located in Appendix B. Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

## 3.3 November 2017 Site-wide 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 | 1711098 |
| Laboratory: | ALS Global, Fort Collins, Colorado |
| SDG Numbers: | 1712351, 1712523, 1801281 |
| Analysis: | Metals, Inorganics, Isotopic Uranium |
| Validator: | Elizabeth Moran |
| Review Date: | 08 March 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. November 2017 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 8. November 2017 Site-wide Sampling Event, Data Qualifiers*

| Sample Number | Location | Analyte | Flag | Reason |
|---|---|---|---|---|
| 171251-8, 1712351-15 | AMM-1, TP-11 | Uranium | J | CCB-1 |
| 1712351-5 | 0440 | Ammonia | J | CCB-2 |
| 1712351-1 through -16 | All in SDG 1712351 | Uranium | J | MS-1, MSD-1, SD-1 |
| 1712523-1 through -17 | All in SDG 1712523 | | | |
| 1801281-1 through -28 | All in SDG 1801281 | | | |

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

*Table 9. November 2017 Site-wide Sampling Event, Reason Codes for Data Flags*

| Reason Code | Qualifier (Detects) | Qualifier (Non-detects) | Explanation |
|---|---|---|---|
| CCB-1, CCB-2 | J | U | At least one CCB was higher than the MDL; therefore, all detects less than five times the highest blank were flagged. |
| SD-1 | J | U | No SDs 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 were included in the narrative. |

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

## Sample Shipping/Receiving

ALS Analytics in Fort Collins, Colorado, received a total of 61 samples for RIN 1612089 in four shipments (Table 10).

*Table 10. November 2017 Site-wide Sampling Event, Sample Shipping/Receiving*

| SDG | Number of Samples | Arrival Date | UPS Tracking Number |
|---|---|---|---|
| 1712351 | 16 | 12/15/17 | 1Z5W1Y510194988836 |
| 1712523 | 17 | 12/29/17 | 1Z5W1Y510191310429 |
| 1801281 | 28 | 01/23/18 | 1Z5W1Y510194988836 |

The three SDGs were accompanied by a COC form. The COC form was checked to confirm that all of the samples were listed on the form with sample collection dates and times and that signatures and dates were present, 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 1712351 was received with a temperature of 2.0°C, SDG 1712523 was received with a temperature of 3.4°C, and SDG 1801281 was received with a temperature of 4.0°C, which comply with requirements. All samples were received in the correct container types. All samples were analyzed within the applicable holding times.

## Laboratory Instrument Calibration

### *Method SW-846 6020A, Uranium*

The initial calibrations were all performed using five calibration standards and two blanks, 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**

Eight of the CCBs on the ammonia SDG 1712351 were slightly above the MDL, and one of the sample results were less than five times the highest CCB; therefore, location 1712351-5 (well 0440) was flagged "J" for reason CCB-2.

Two of the CCBs on uranium SDG 17122351 were slightly above the MDL, and two sample results were less than five times the highest CCB; therefore, locations 1712351-8 (well AMM-1) and 1712351-15 (well TP-11) were flagged "J" for reason CCB-1.

**Equipment Blanks**

One EB (location 2003, 1801281-18) was collected after the surface water tubing was decontaminated. The sample results are at or below the RL for ammonia and uranium. No data had to be qualified.

**Matrix Spike Analysis**

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

**Laboratory Replicate Analysis**

The uranium SDGs did not contain an MS or MSD sample; therefore, all of the uranium data are flagged "J" for reason MSD-1.

**Field Duplicate Analysis**

Duplicate samples were collected from locations UPD-22 (1712351-16), 0434 (1801281-12), and 0407 (1801281-8). 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 January 17, January 31, and February 23, 2018. The contents of the EDD 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

The Minimums and Maximums Report for this sampling event is located in Appendix C. Based on the results, there were two anomalous data points associated the sample collected from locations 0440 and UPD-23. The uranium concentration in the sample collected from 0440 was higher than the historic maximum, and the ammonia concentration in the sample collected from UPD-23 was also higher than the historic maximum. Table 11 presents a summary of the results of the Minimums and Maximums Report for this event.

*Table 11. Anomalous Data Associated with the November 2017 Site-wide Sampling Event*

| Location | Sample Date | Analyte | Concentration (mg/L) | Historical Minimum (mg/L) | Historical Maximum (mg/L) | Disposition |
|---|---|---|---|---|---|---|
| 0440 | 12/13/2017 | Uranium | 0.2 | 0.0185 | 0.043 | Monitoring of this location will continue. |
| UPD-23 | 1/17/2017 | Ammonia Total as N | 6.1 | 1.4 | 3.2 | Monitoring of this location will continue. |

mg/L = milligrams per liter

## 4.0 Results

## 4.1 August and November 2017 CF4 and CF5 Sampling Event Results

Because the same locations were sampled in the two events, the results from the August and November sampling events are discussed together. The observation wells surrounding the CF4 injection wells were sampled to evaluate the effectiveness of the freshwater injection system in reducing contaminant concentrations in the subsurface underling this portion of the well field. The CF4 monitoring well locations are shown on Figure 1.

The CF4 wells are screened and deliver fresh water into the zone from 15 to 35 feet (ft) below ground surface (bgs). These wells were sampled in August after the injection system had been consistently injecting filtered fresh water into the CF4 wells since early July 2017. It was necessary to shut down the injection system to complete repairs to the sand filter between September 21 and October 30. The CF4 monitoring wells were resampled in November after the system had been running for approximately 2 weeks.

The CF4 monitoring well sampling results indicate a significant reduction in ammonia concentrations in the downgradient (east) direction, particularly in the zone above 35 ft bgs during both events. In the upgradient direction, the ground water system (down to a depth of 35 ft bgs) is also impacted by freshwater injection. The highest ammonia concentrations were associated with the samples collected upgradient of CF4 from a depth of 48 ft bgs from well 0781. The ammonia concentration results are presented on Figures 4 and 5 for the August and November sampling events, respectively.

Figures 6 and 7 present the ground water mound developed as a result of the freshwater injection system operation in August and November 2017, respectively. The ground water elevation data indicate there was a difference of more than 10 ft between the elevation inside the injection wells and the surrounding observation wells in August and more than 11 ft in November.

Ground water samples were also collected from the CF5 extraction wells (locations also shown on Figure 1) in August and November 2017. The ground water extraction system operated on a regular basis from March through November 2017. The ammonia and uranium concentrations associated with these sampling events are displayed on Figures 8 and 9, respectively. It was not possible to collect a sample from extraction well PW02 due to a pump malfunction in August, but this well was sampled in November. The sampling in November was completed just before winterizing the extraction system, with the results used to measure any changes in the contaminant concentrations during the 2017 pumping season.

Time versus concentration plots were generated to display the trends displayed by the CF5 extraction wells during the past 7 years, which represents the approximate lifespan of the CF5 well field (extraction was started in April 2010). Figure 10 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 11 displays a time versus uranium concentration plot for the same set of wells. Figures 12 and 13 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).

As the plots exhibit, the ammonia concentrations along the CF5 southeastern boundary have ranged from 160 to 550 milligrams per liter (mg/L) since 2011, with the lowest concentrations occurring after the well field was flooded from May to August 2011. Well PW02, which is located at the center of this line of wells (and near the center of the ground water plume), has generally had the highest concentration. During the November 2017 sampling event, with the exception of the sample collected from well 0810 with a concentration of 270 mg/L, all of these wells had ammonia concentrations between 430 and 490 mg/L.

Ammonia concentrations in the wells located closer to the base of the tailings have ranged from 150 to 350 mg/L since 2011, with the samples collected in August and November ranging from 150 to 200 mg/L during this time frame. Taking into account all eight extraction wells, the uranium concentrations over the past 7 years have ranged from 0.9 to 4.9 mg/L. The wells along the CF5 southeastern boundary have generally had higher concentrations compared to the wells located along the toe of the tailings pile and the wells near the center of the well field (PW02 and 0815) having elevated concentrations. In August and November 2017, the uranium concentrations for all eight wells have ranged from 1.6 to 3.6 mg/L.


*Figure 4. August 2017 CF4 Ground Water Ammonia Concentrations during Injection*


*Figure 5. November 2017 CF4 Ground Water Ammonia Concentrations during Injection*

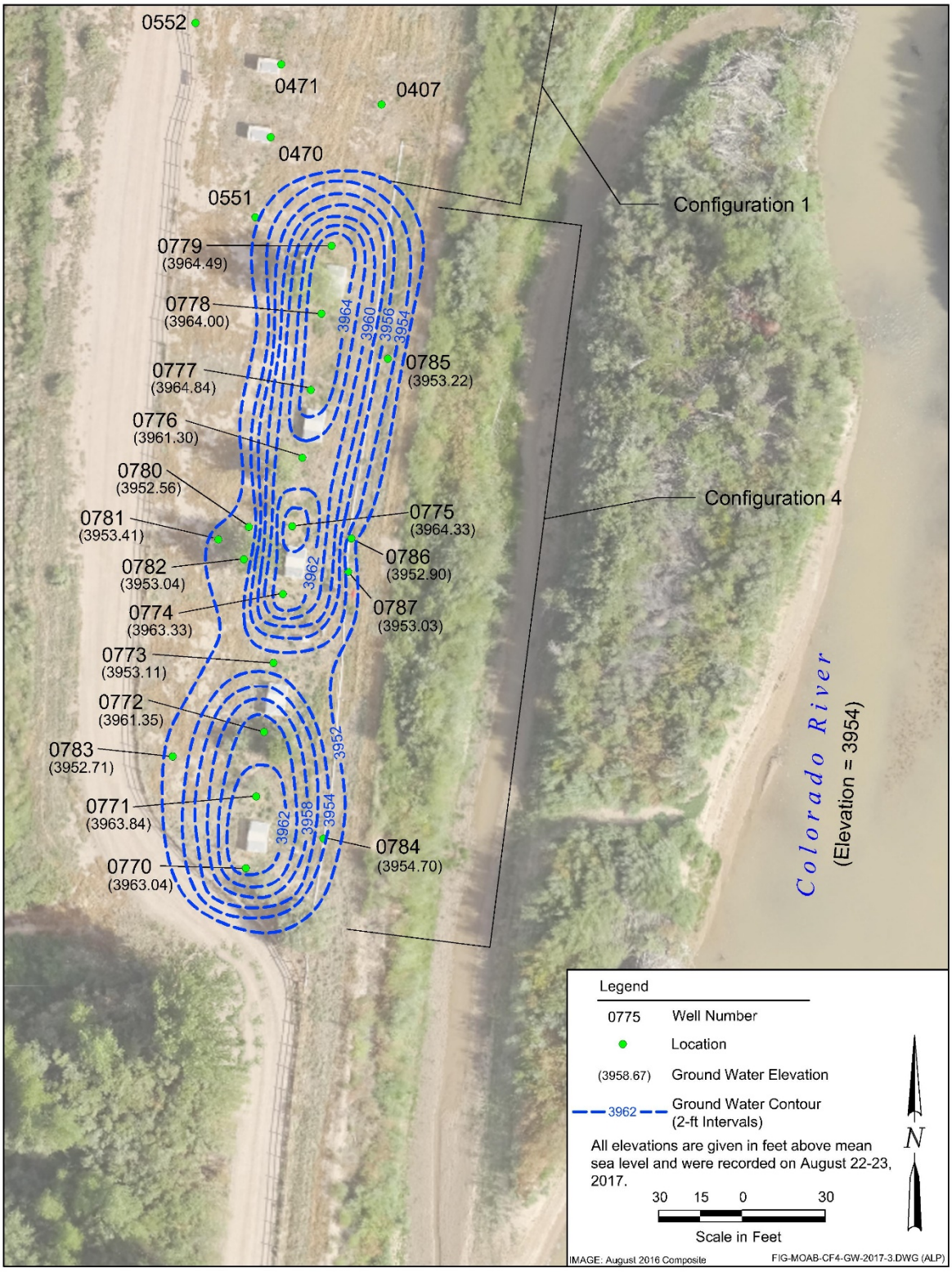


*Figure 6. August 2017 CF4 Ground Water Elevation Contour Map during Injection*

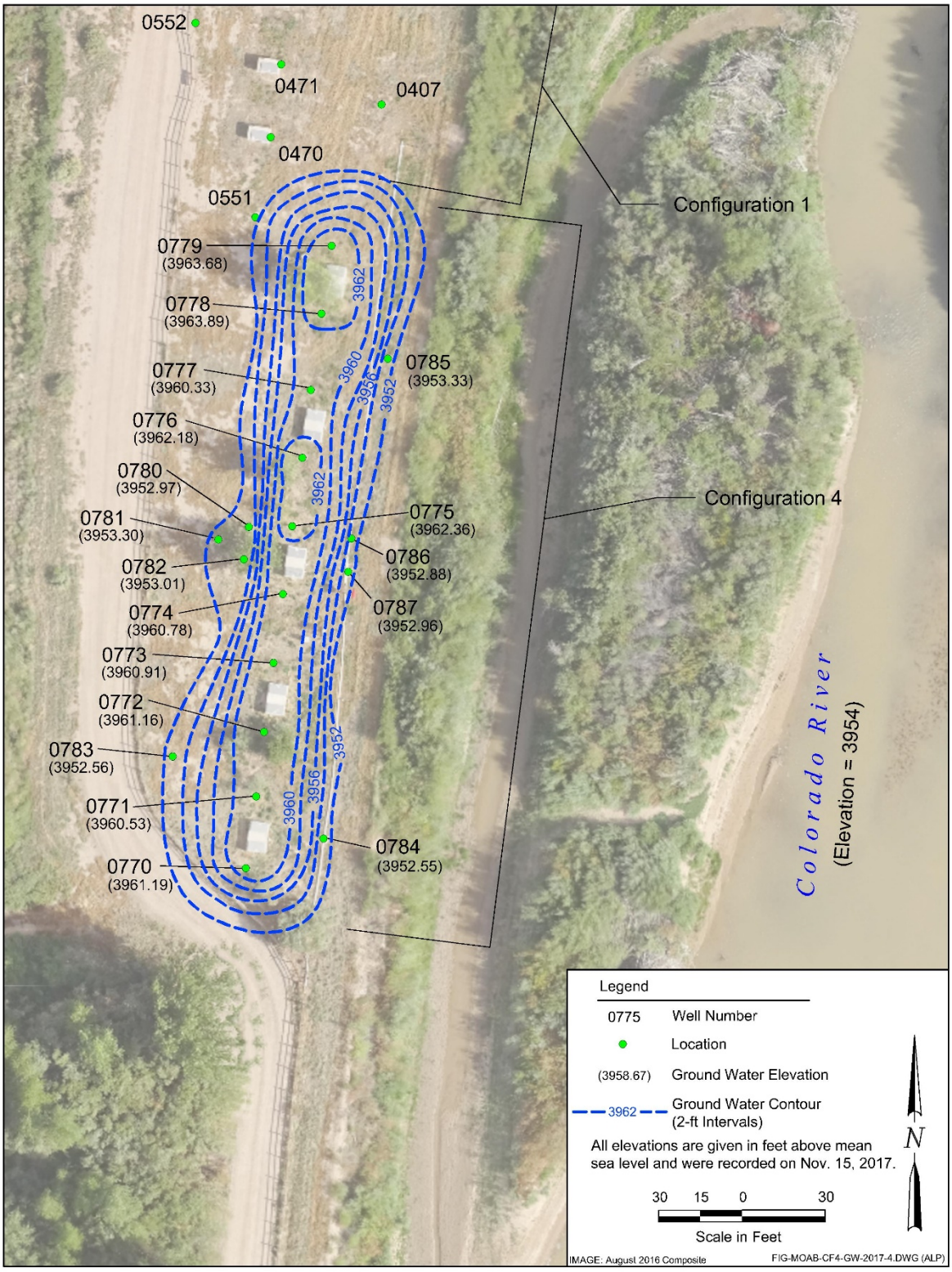


*Figure 7. November 2017 CF4 Ground Water Elevation Contour Map during Injection*

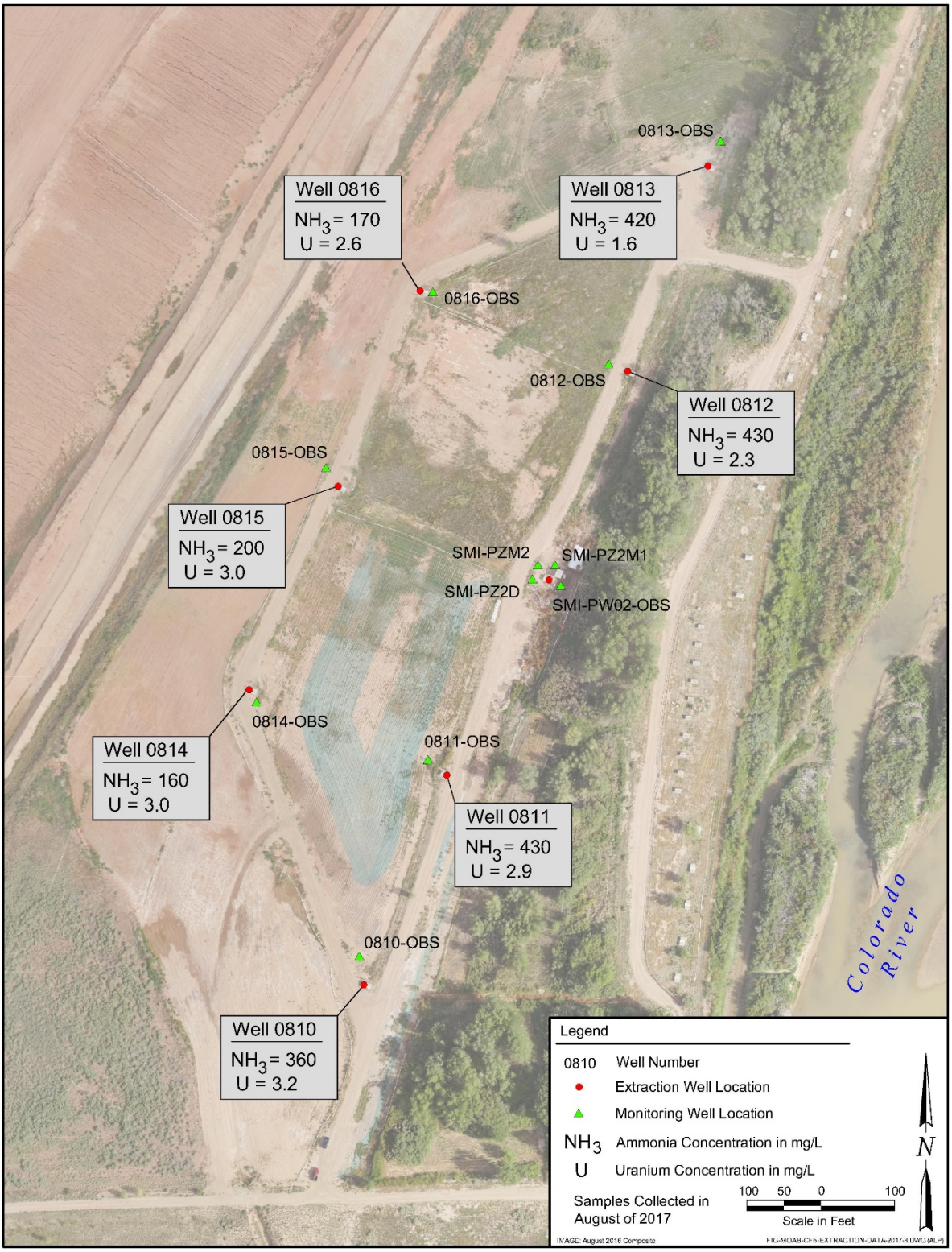


*Figure 8. August 2017 CF5 Ammonia and Uranium Ground Water Concentrations*

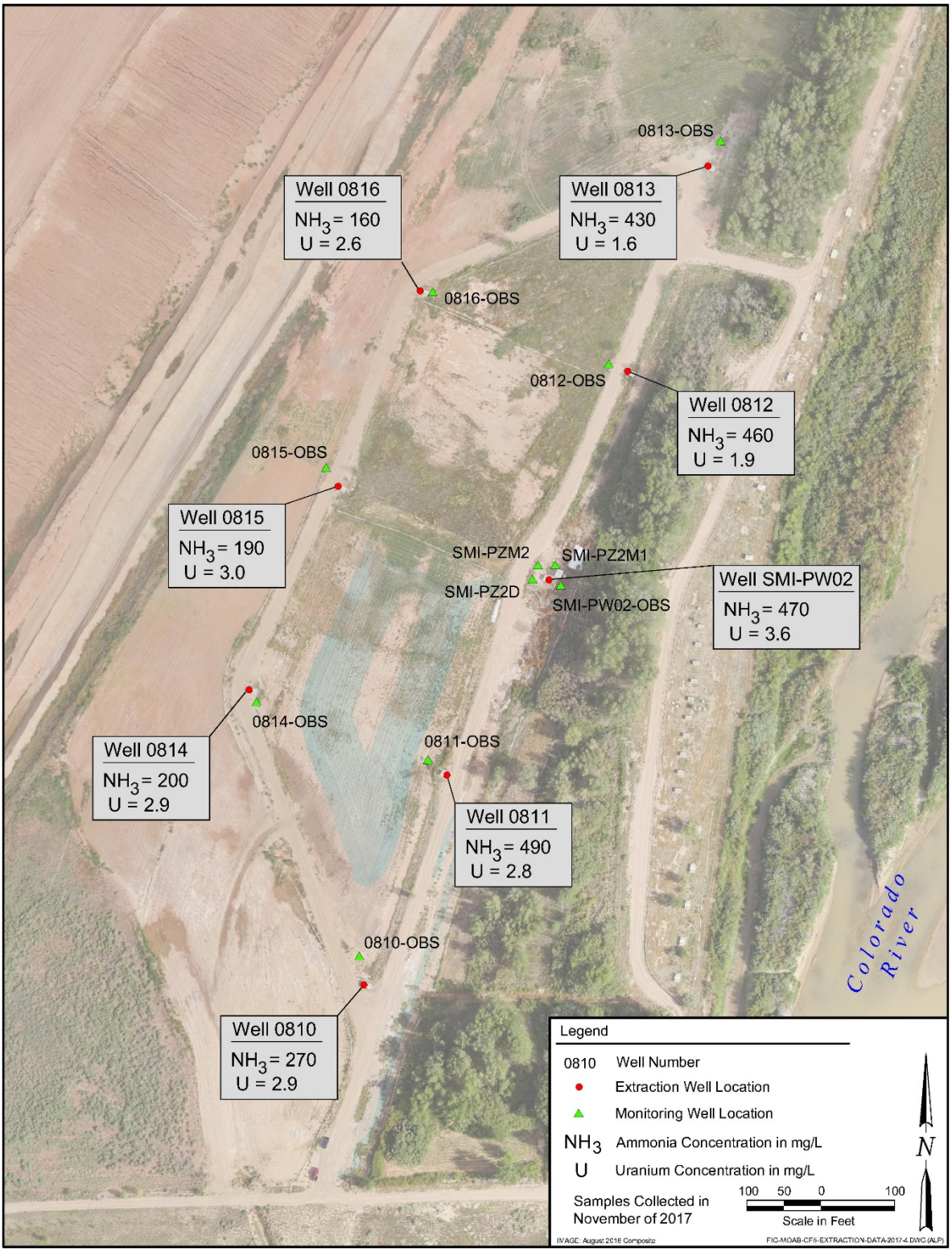


*Figure 9. November 2017 CF5 Ammonia and Uranium Ground Water Concentrations*

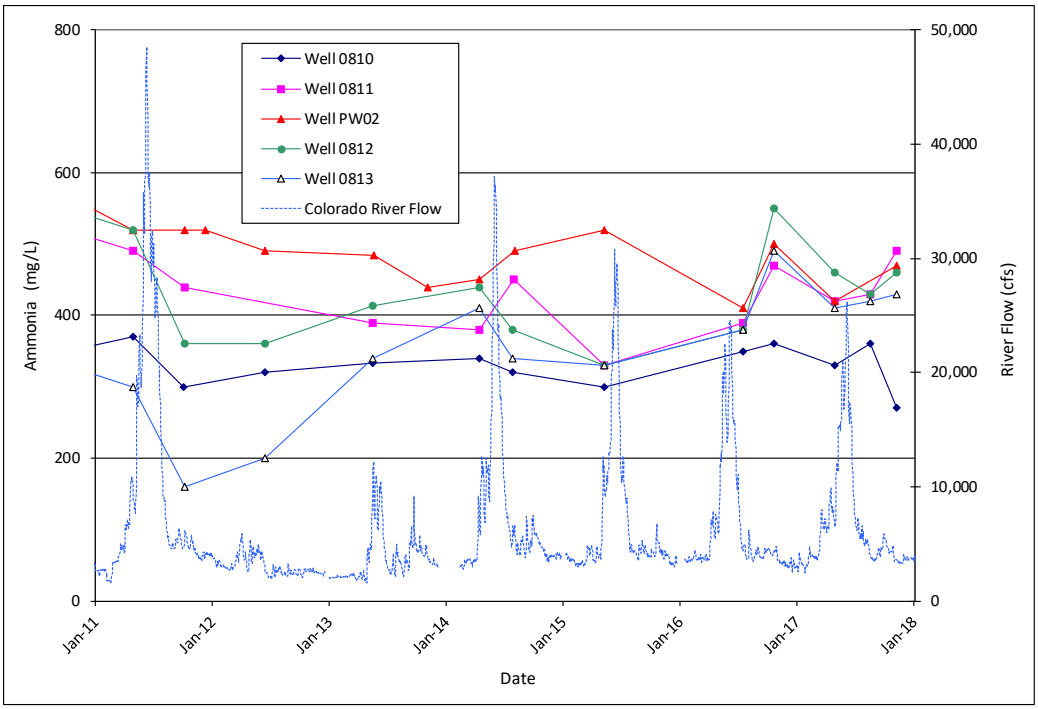


*Figure 10. CF5 Extraction Wells 0810, 0811, 0812, 0813, and PW02 Time versus Ammonia Concentration Plot*

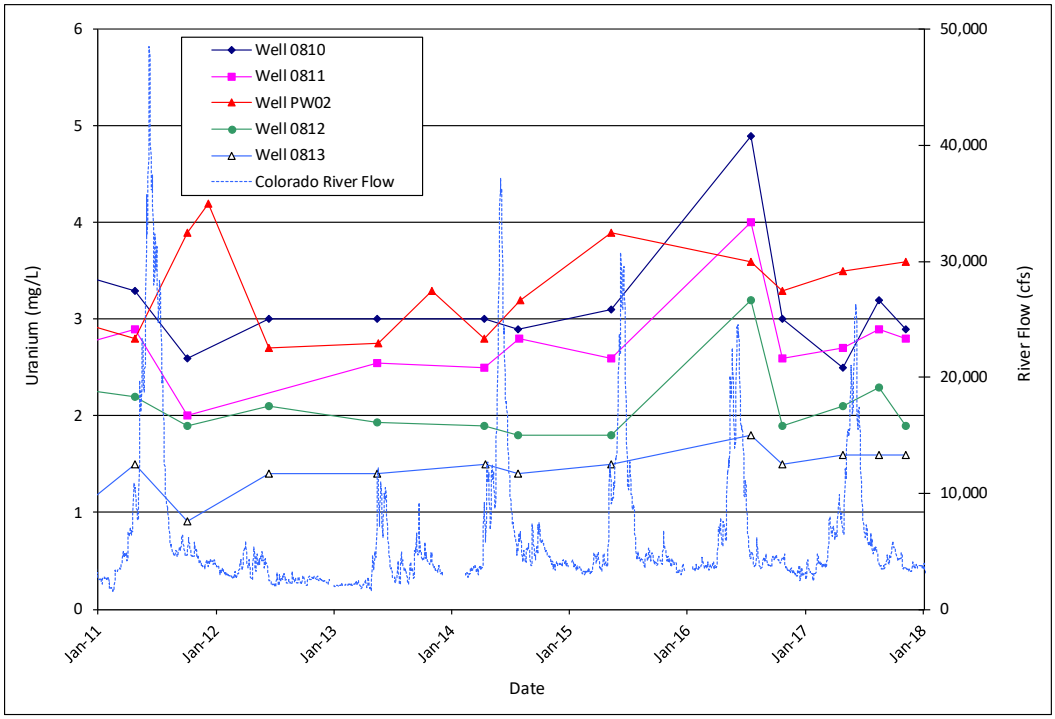


*Figure 11. CF5 Extraction Wells 0810, 0811, 0812, 0813, and PW02 Time versus Uranium Concentration Plot*

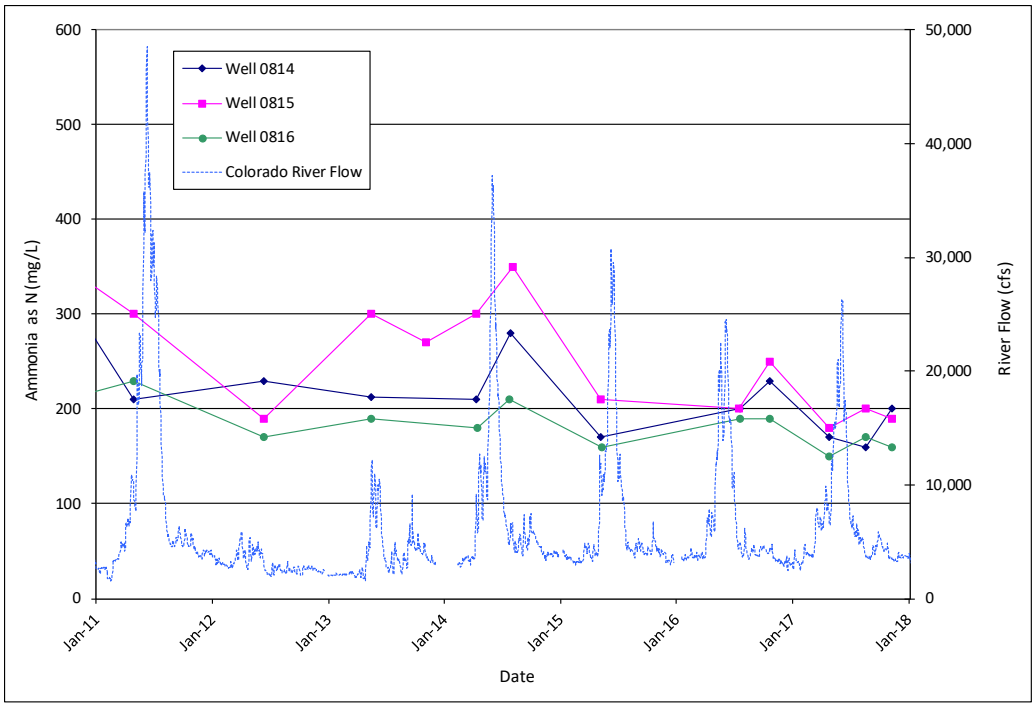


*Figure 12. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Ammonia Concentration Plot*

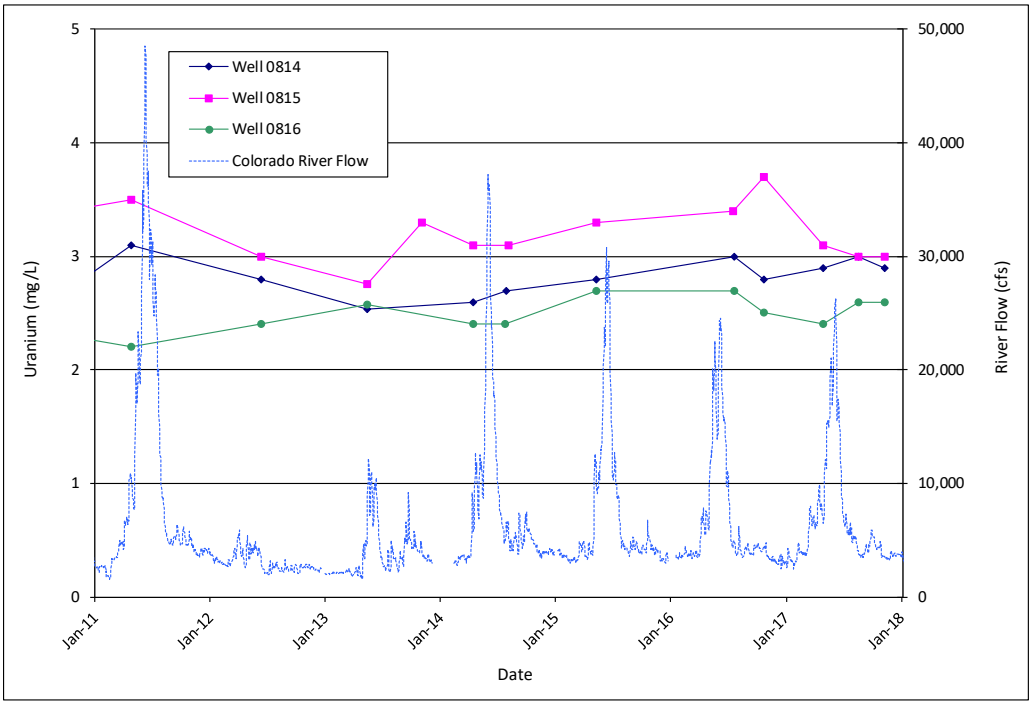


*Figure 13. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Uranium Concentration Plot*

## 4.2 December 2017 Site-wide Sampling Event Results

All samples collected during this event were analyzed for both ammonia and uranium. Table 12 presents all locations sampled that exceeded the 0.044 mg/L uranium ground water 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 12 also includes the locations from the other sampling events from July to December 2017 that exceeded this concentration.

*Table 12. July through December 2017 Sampling Events, Ground Water Locations Exceeding the 0.044 mg/L Uranium Ground Water Standard*

| Well Number | Date | Location | Sample Depth (ft bgs) | Uranium Concentration (mg/L) |
|---|---|---|---|---|
| 0401 | 1/18/2018 | CF2 | 18 | 1.9 |
| 0403 | 1/17/2018 | CF1 | 18 | 0.480 |
| 0404 | 1/18/2018 | CF3 | 18 | 1.6 |
| 0406 | 1/17/2018 | CF1 | 18 | 0.810 |
| 0407 | 1/17/2018 | CF1 | 18 | 1.6 |
| 0411 | 12/20/2017 | NE Uranium Plume Area | 8 | 0.330 |
| 0412 | 11/30/2017 | NE Uranium Plume Area | 10 | 3.2 |
| 0413 | 12/7/2017 | NE Uranium Plume Area | 10 | 2.9 |
| 0414 | 12/7/2017 | NE Uranium Plume Area | 7.5 | 3.0 |
| 0439 | 12/13/2017 | On Tailings Pile | 118 | 1.3 |
| 0440 | 12/13/2017 | Along SW Site Boundary | 117 | 0.200 |
| 0441 | 12/19/2017 | Support Area | 53 | 0.049 |
| 0453 | 12/13/2017 | Along SW Site Boundary | 80 | 2.1 |
| 0454 | 12/18/2017 | Along SW Site Boundary | 13 | 1.7 |
| 0492 | 1/16/2018 | Along S Site Boundary | 18 | 0.590 |
| 0781 | 11/15/2017 | CF4 | 48 | 0.063 |
| | 8/22/2017 | | | 2.4 |
| 0782 | 11/15/2017 | CF4 | 33 | 3.1 |
| | 8/22/2017 | | | 1.8 |
| 0783 | 11/15/2017 | CF4 | 18 | 2.2 |
| 0787 | 11/15/2017 | CF4 | 36 | 0.052 |
| | 8/22/2017 | | | 0.053 |
| 0787 | 11/15/2017 | CF4 | 36 | 0.390 |
| | 8/22/2017 | | | 2.1 |
| 0810 | 8/23/2017 | CF5 Extraction Well | 10 to 40 | 3.2 |
| | 11/13/2017 | | | 2.9 |
| 0811 | 8/23/2017 | CF5 Extraction Well | 9 to 39 | 2.9 |
| | 11/13/2017 | | | 2.8 |

*Table 12. July through December 2017 Sampling Events, Ground Water Locations Exceeding the 0.044 mg/L Uranium Ground Water Standard (continued)*

| Well Number | Date | Location | Sample Depth (ft bgs) | Uranium Concentration (mg/L) |
|---|---|---|---|---|
| 0812 | 8/23/2017 | CF5 Extraction Well | 14 to 44 | 2.3 |
| | 11/13/2017 | | | 1.9 |
| 0813 | 8/23/2017 | CF5 Extraction Well | 14 to 44 | 1.6 |
| | 11/13/2017 | | | 1.6 |
| 0814 | 8/23/2017 | CF5 Extraction Well | 12 to 42 | 3.0 |
| | 11/13/2017 | | | 2.9 |
| 0815 | 8/23/2017 | CF5 Extraction Well | 22 to 52 | 3.0 |
| | 11/13/2017 | | | 3.0 |
| 0816 | 8/23/2017 | CF5 Extraction Well | 21 to 51 | 2.6 |
| | 11/13/2017 | | | 2.6 |
| SMI-MW01 | 11/30/2017 | NE Uranium Plume Area | 16 | 3.1 |
| SMI-PW01 | 12/7/2017 | CF5 Vicinity | 40 | 1.9 |
| SMI-PW02 | 11/13/2017 | CF5 Extraction Well | 20 to 60 | 3.6 |
| SMI-PW03 | 12/20/2017 | NE Uranium Plume Area | 60 | 0.320 |
| SMI-PZ1D2 | 1/17/2018 | CF5 Vicinity | 73 | 1.2 |
| SMI-PZ1M | 1/17/2018 | CF5 Vicinity | 57 | 3.1 |
| SMI-PZ1S | 12/7/2017 | CF5 Vicinity | 18 | 1.6 |
| SMI-PZ2M2 | 12/7/2017 | CF5 Vicinity | 56 | 2.5 |
| SMI-PZ3D2 | 12/20/2017 | NE Uranium Plume Area | 78 | 0.840 |
| SMI-PZ3M | 12/20/2017 | NE Uranium Plume Area | 59 | 0.480 |
| SMI-PZ3S | 12/19/2017 | NE Uranium Plume Area | 25 | 1.0 |
| TP-01 | 11/30/2017 | NE Uranium Plume Area | 22 | 0.076 |
| TP-22 | 1/17/2018 | NE Uranium Plume Area | 17 | 0.400 |
| TP-23 | 12/18/2017 | NE Uranium Plume Area | 25 | 2.4 |
| UPD-17 | 12/19/2017 | NE Uranium Plume Area | 14 | 1.3 |
| UPD-18 | 12/19/2017 | NE Uranium Plume Area | 13 | 0.780 |
| UPD-20 | 12/19/2017 | NE Uranium Plume Area | 17 | 0.062 |
| UPD-21 | 12/19/2017 | NE Uranium Plume Area | 25 | 6.8 |
| UPD-22 | 12/7/2017 | NE Uranium Plume Area | 9 | 2.8 |
| UPD-23 | 1/17/2018 | NE Uranium Plume Area | 26 | 0.840 |
| UPD-24 | 12/19/2017 | NE Uranium Plume Area | 27 | 8.7 |

NE = northeastern; SW = southwestern

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.

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

### 4.2.1 Northeastern Base of Tailings Pile

Figures 14 and 15 are time versus ammonia and uranium concentration plots, respectively, for locations UPD-17 and UPD-18. In the past, the ammonia concentrations 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 increased in response to the lower river flows compared to the previous sampling event. The uranium concentrations 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 locations decreasing during this recent sampling event.

### 4.2.2 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.

### 4.2.3 Center of Northeastern Uranium Plume Area

Figures 16 and 17 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.

As displayed in Figure 16, the ammonia concentrations remained lower than 10 mg/L in the samples collected from wells UPD-20 and 0411. Ammonia concentrations have ranged from 50 to 62 mg/L since 2015 in samples collected from 0413, while the well 0414 concentrations have ranged from 14 to 39 mg/L during the same time period.

The uranium concentrations in samples collected from wells 0411, 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 17). The sample collected from well UPD-20 remains lower than 0.1 mg/L.

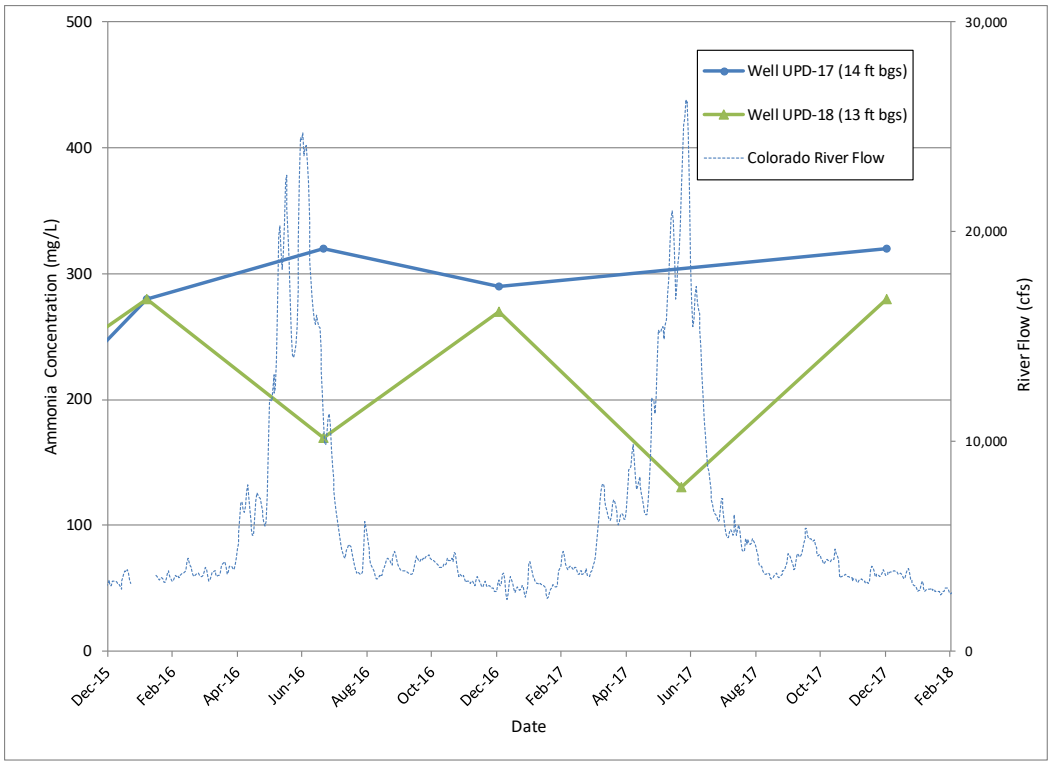


*Figure 14. Wells UPD-17 and UPD-18 Time versus Ammonia Concentration Plot*

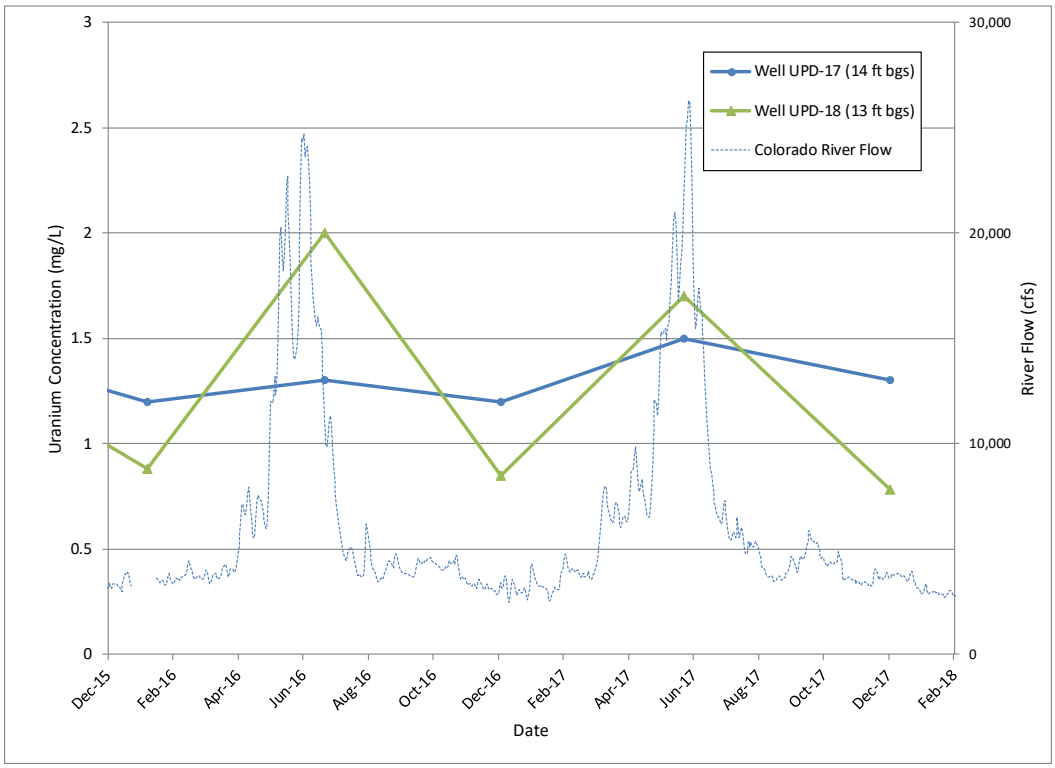


*Figure 15. Wells UPD-17 and UPD-18 Time versus Uranium Concentration Plot*

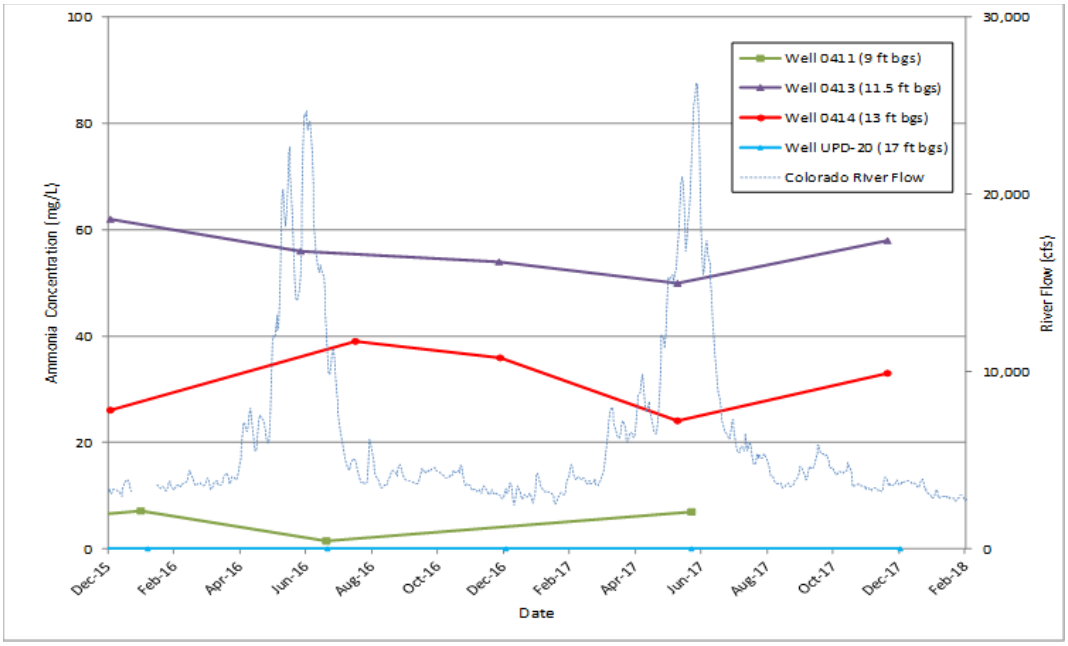


*Figure 16. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Ammonia Concentration Plot*

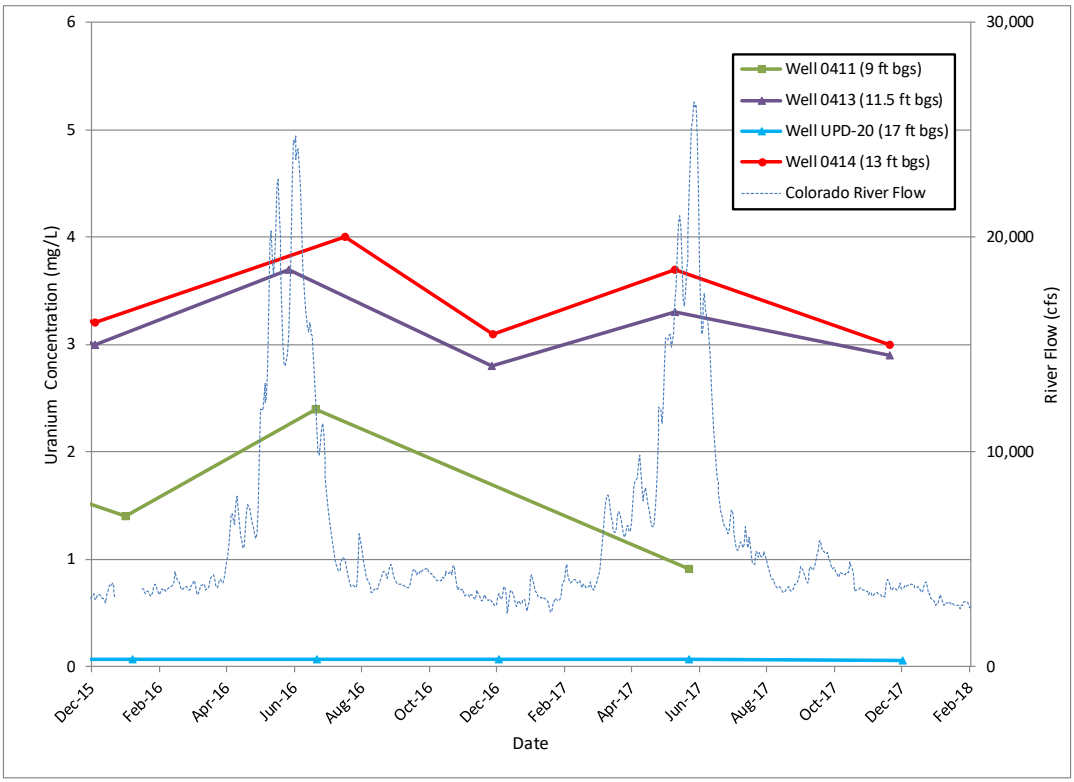


*Figure 17. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Uranium Concentration Plot*

### 4.2.4 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 18 and 19, respectively. These wells include 0410, UPD-21, UPD-23, and UPD-24.

As shown in Figure 18, the ammonia concentrations in the samples collected from wells UPD-21, UPD-23, and UPD-24 have increased significantly since the previous sampling event, almost increasing three times. The concentration in the sample collected from well 0410 also shows a significant increase, but that is a function of the detection limit used during the analysis of that sample. The sample from UPD-24 decreased during this time, staying within the historical range.

The uranium concentrations in the samples from UPD-24 continue to display a definitive seasonal fluctuation (Figure 19), while the uranium concentrations in the samples collected from UPD-21 have not significantly changed over the past 2 years. Figure 19 also displays the uranium concentrations in samples collected from wells 0410 and UPD-23 remain lower than 1.0 mg/L.

### 4.2.5 Northeastern Edge of Uranium Plume Area

Figures 20 and 21 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 20 exhibits, with the exception of the ammonia concentration in the sample collected from UPD-22 (which has more than doubled since May 2015), the concentrations have remained consistent since June 2014. The concentration in the sample collected from UPD-22 appears to have leveled off since a steady increase starting in December 2015.

All these concentrations are below 10 mg/L. The apparent increase in the ammonia concentration in well 0412 is a function of the detection limit used during the analysis of this sample, and the ammonia concentration in the sample from well SMI-MW01 remains less than 3.0 mg/L.

The uranium concentrations have not significantly fluctuated in the samples from locations UPD-22 and SMI-PZ3S over the past 2 years (Figure 21). Uranium concentrations in the samples from 0412 and SMI-MW01 have displayed typical seasonal fluctuation as a result of their proximity to the riverbank.

### 4.2.6 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 22 and 23 for wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 (listed from south to north). As Figure 22 exhibits, the most recent sampling event ammonia results indicate locations ATP-2-D, ATP-2-S, and MW-3 all slightly increased since the previous event.

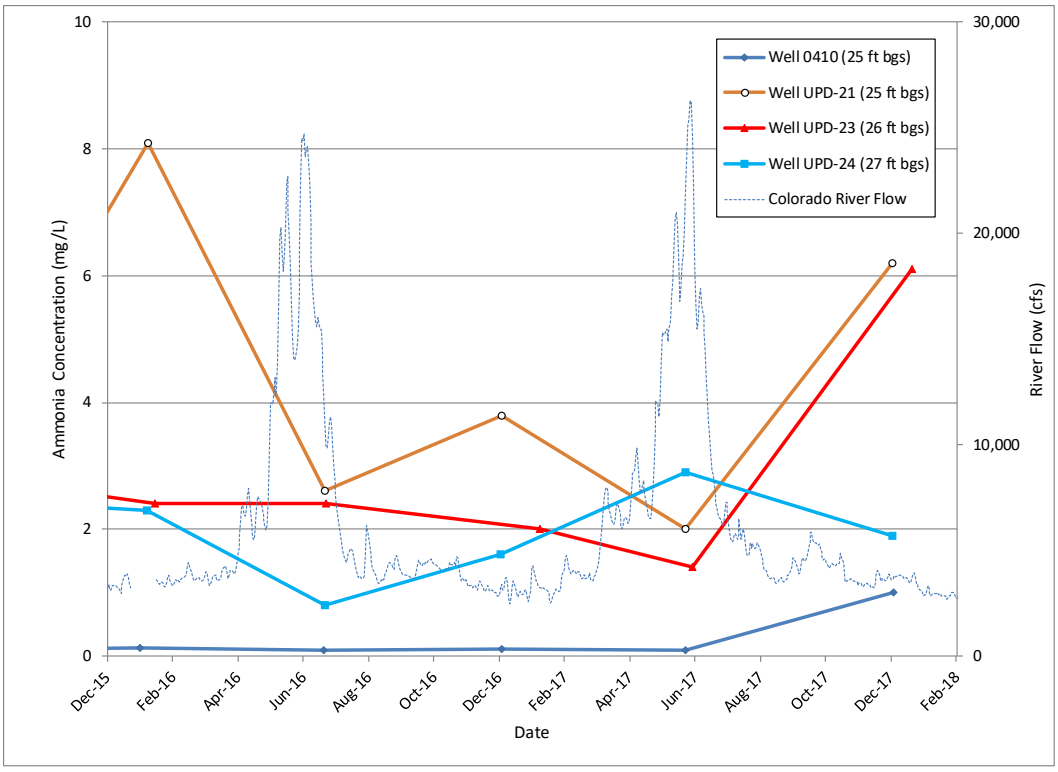


*Figure 18. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Ammonia Concentration Plot*

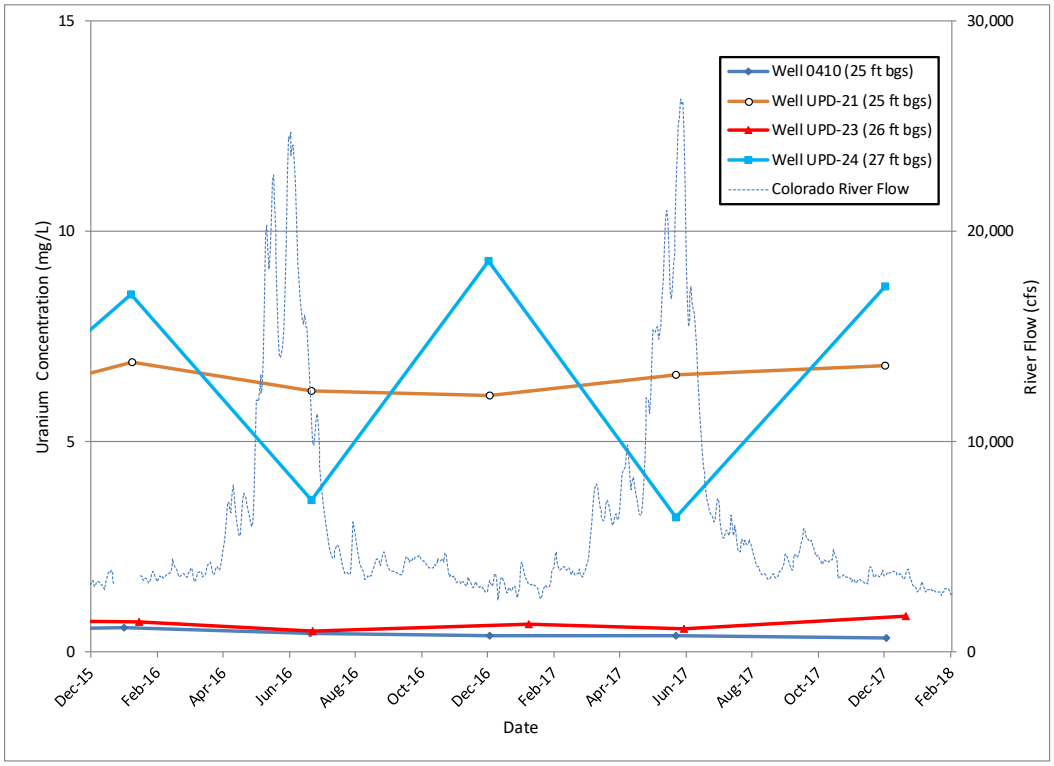


*Figure 19. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Uranium Concentration Plot*

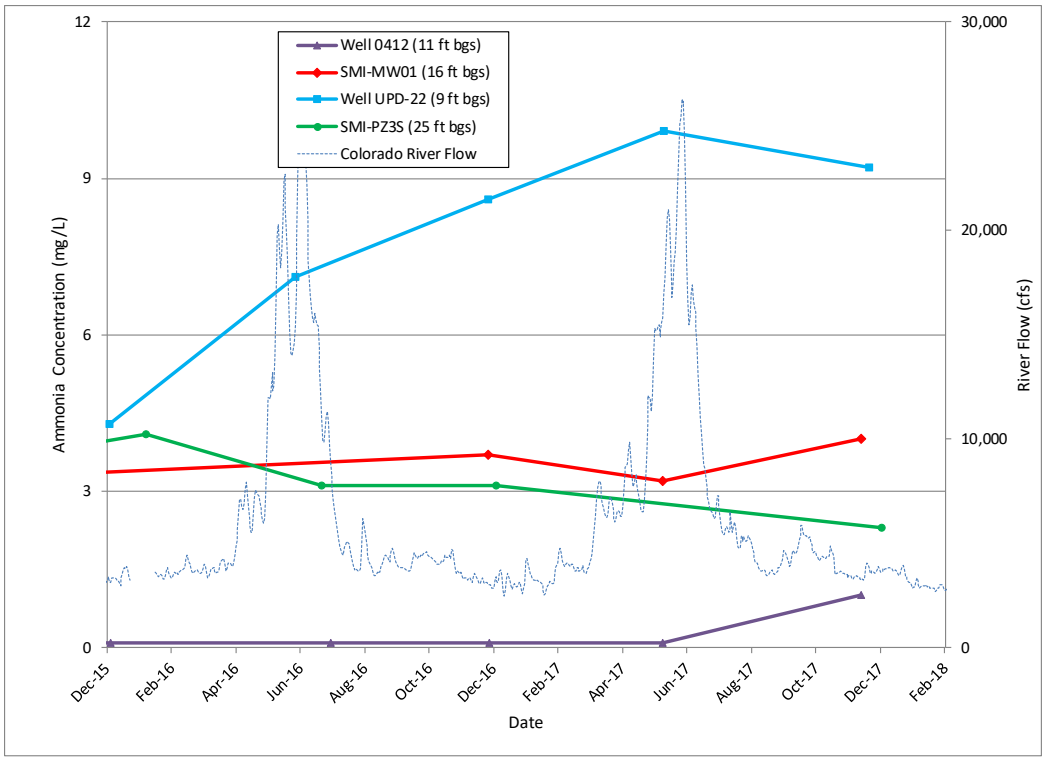


*Figure 20. Northeastern Edge of Uranium Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Ammonia Concentration Plot*

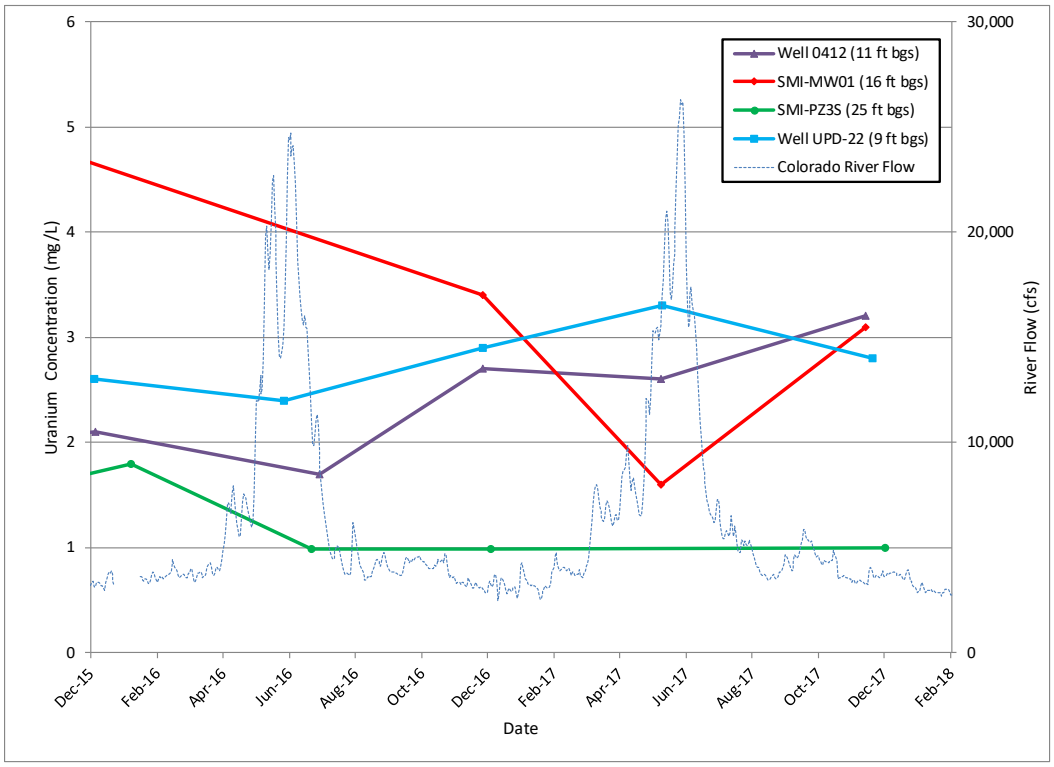


*Figure 21. Northeastern Edge of Uranium Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Uranium Concentration Plot*

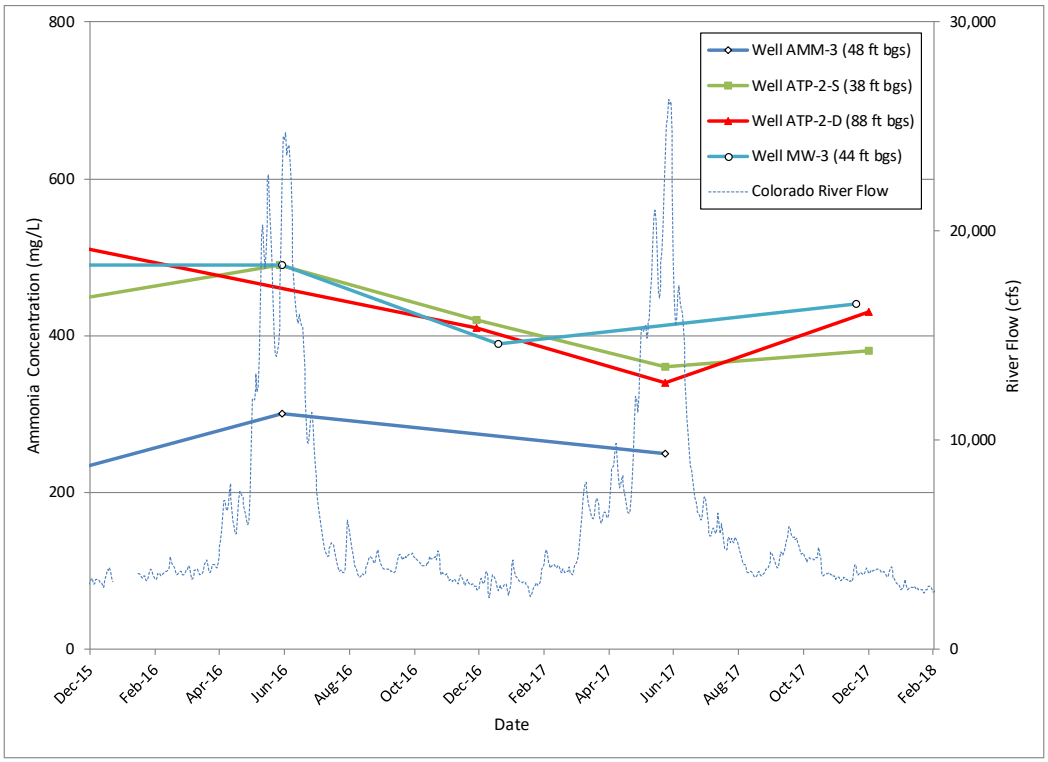


*Figure 22. Base of Tailings Pile Observation Wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Ammonia Concentration Plot*

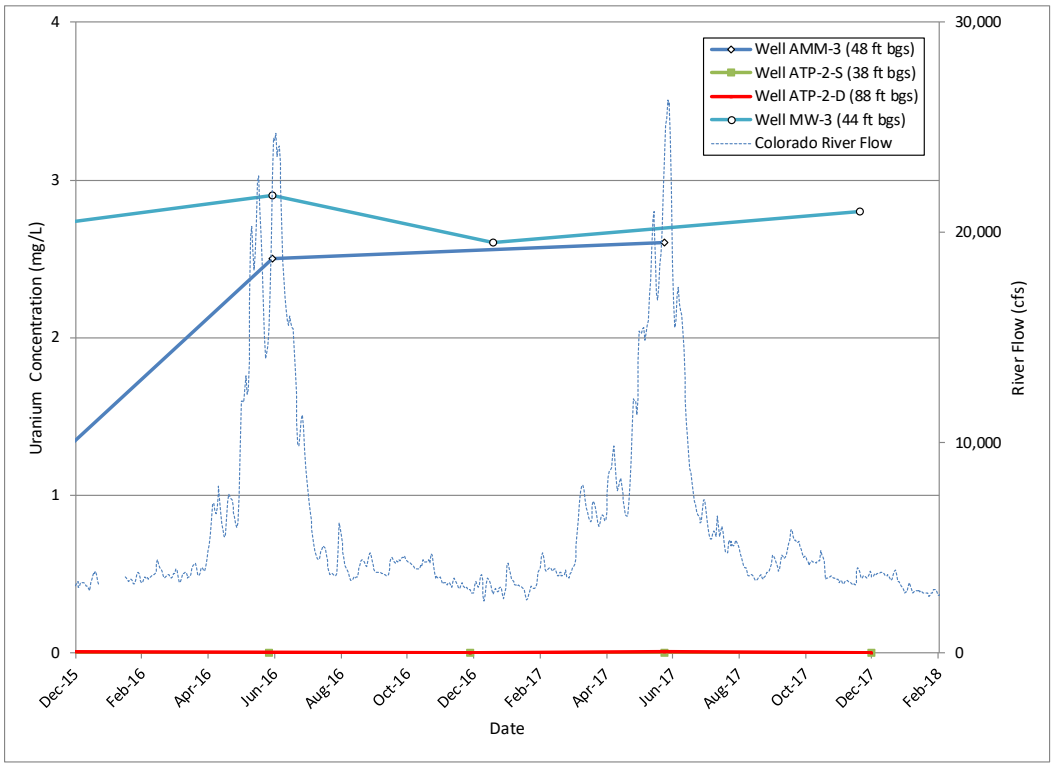


*Figure 23. Base of Tailings Pile Observation Wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Uranium Concentration Plot*

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 23 suggests the uranium concentrations associated with the samples collected from wells MW-3 and AMM-3 have not significantly changed since June 2016.

### 4.2.7 Southwestern Boundary

Figures 24 and 25 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 ground water flow direction) along the southwestern site boundary.

Since May 2015, both well 0453 and 0454 ammonia concentrations (Figure 24) have seasonally fluctuated (higher concentrations during the winter months and lower concentrations in the summer months), and that trend continued during this most recent sampling event. The concentrations in the samples collected from wells 0440 and 0441 (the upgradient locations) have been at or lower than the 0.1 mg/L detection limit since 2009.

Wells 0453 and 0454 uranium concentrations (Figure 25) display a similar trend to the ammonia concentrations, with the uranium concentration measured in the samples increasing during river base flow conditions. The sample collected from well 0440 (0.2 mg/L) exceeded the 0.044 mg/L UMTRA standard for the first time since the well was installed in 2002, while the concentration associated with well 0441 has consistently been above the standard since 2011.

### 4.2.8 Riverbank Area

Figures 26 and 27 are the time versus ammonia and uranium concentration plots, respectively, for the locations sampled along the riverbank, presented from south to north (wells 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; however, the ammonia concentrations associated with these samples have not recently followed this trend, with each location having fluctuating results. Sampling locations to the south (0492) and north (TP-01) of the plume continue to have lower concentrations.

The same can be said for the uranium concentrations, with the samples collected from wells 0492 and TP-01 in general having the lowest concentrations. The expected seasonal trend is evident for the uranium concentrations measured at locations 0404 and 0492. The sample collected from well TP-01 had uranium concentrations less than 0.1 mg/L since 2014.

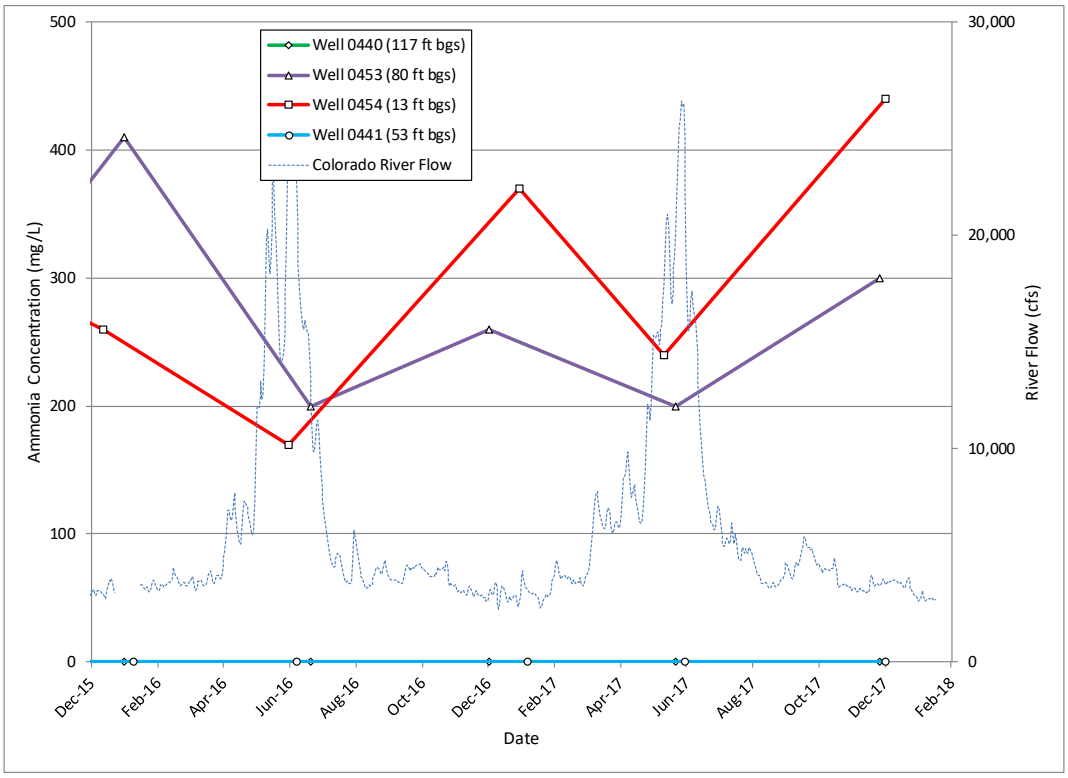


*Figure 24. Southwestern Boundary Observation Wells 0453, 0454, and 0440 Time versus Ammonia Concentration Plot*

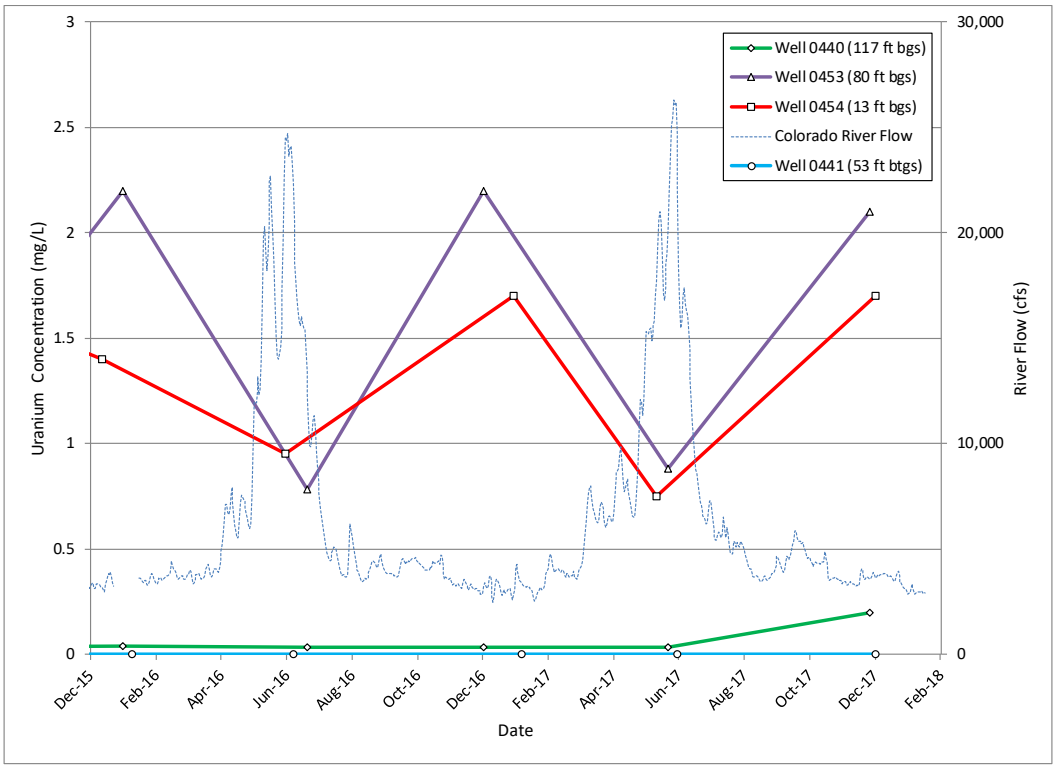


*Figure 25. Southwestern Boundary Observation Wells 0453, 0454, and 0440 Time versus Uranium Concentration Plot*

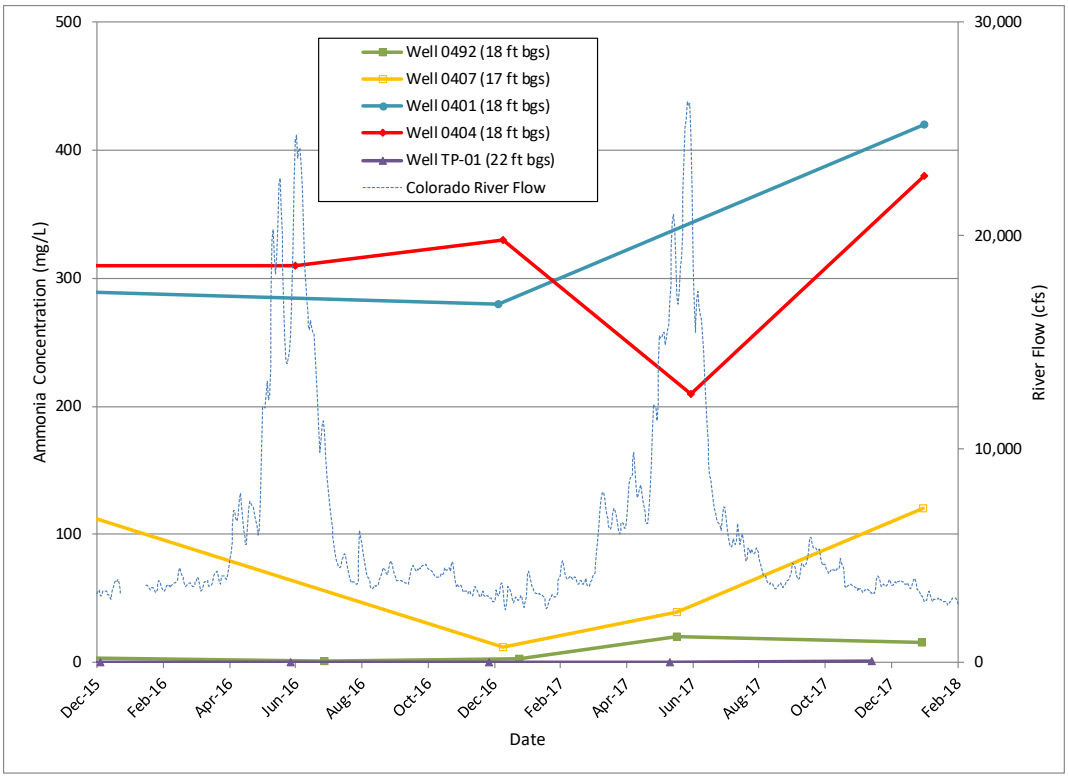


*Figure 26. Riverbank Observation Wells 0492, 0407, 0401, 0404, and TP-01 Time versus Ammonia Concentration Plot*

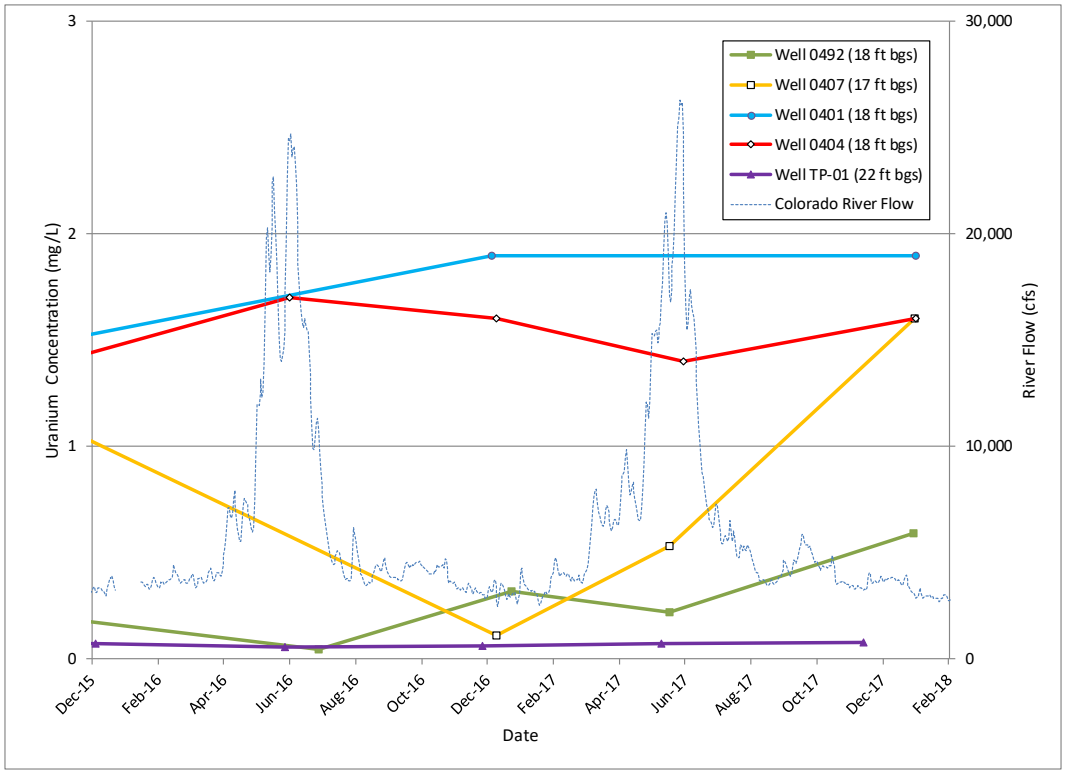


*Figure 27. Riverbank Observation Wells 0492, 0407, 0401, 0404, and TP-01 Time versus Uranium Concentration Plot*

### 4.2.9 Southern and Off-site Areas

Figures 28 and 29 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 well TP-20 is located approximately 600 ft off the bank. Typically, ammonia and uranium concentrations are low at TP-20 because it is located along the southern edge of the contaminant plumes.

Ammonia concentrations (Figure 28) in both wells decreased since the previous sampling event, and have historically displayed the impacts of the river stage. The uranium concentrations (Figure 29) continue to display seasonal fluctuations, with the concentrations below the 0.044 mg/L UMTRA standard since 2008.

### 4.2.10 Surface Water Sampling Results

Table 13 presents the ammonia results from the surface water sampling as part of this sampling event, with the samples collected in mid-January 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 13.

*Table 13. November 2017 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 | 1/16/18 | 4.1 | 8.30 | <0.1 | 4.9 | 1.1 |
| 0218 | 1/16/18 | 3.1 | 8.26 | <0.1 | 4.9 | 1.1 |
| 0226 | 1/18/18 | 3.8 | 8.43 | <0.1 | 4.1 | 0.95 |
| CR1 | 1/16/18 | 3.4 | 7.74 | <1.0 | 15 | 2.6 |
| CR2 | 1/16/18 | 3.8 | 8.30 | <0.1 | 4.9 | 1.1 |
| CR3 | 1/16/18 | 3.8 | 8.40 | 0.24 | 4.1 | 0.95 |
| CR5 | 1/16/18 | 3.0 | 8.39 | <0.1 | 4.1 | 0.95 |

*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, all of which were below than 0.1 mg/L detection limit, with the exception of the samples collected from locations CR-1 (1.0 mg/L) and CR-3 (0.24 mg/L). The sample collected from location CR-1 was analyzed using a higher detection limit (1.0 compared to 0.1 mg/L), with the concentration below the detection limit. All surface water ammonia concentrations are below the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations.

## 4.4 Ground Water Surface Elevation

Water level data were collected between November 30, 2017 and January 17, 2018, when the Colorado River mean daily flows ranged from 2,880 to 4,050 cubic feet per second, and the river stage at the southern end of the site ranged from only from 3,953.4 to 3,954.0 feet above mean sea level. Because ground water elevations do not fluctuate significantly during this time of the year while the river is experiencing base flows, water level data collected during this time frame were used to generate the ground water surface contour map displayed in Figure 30.

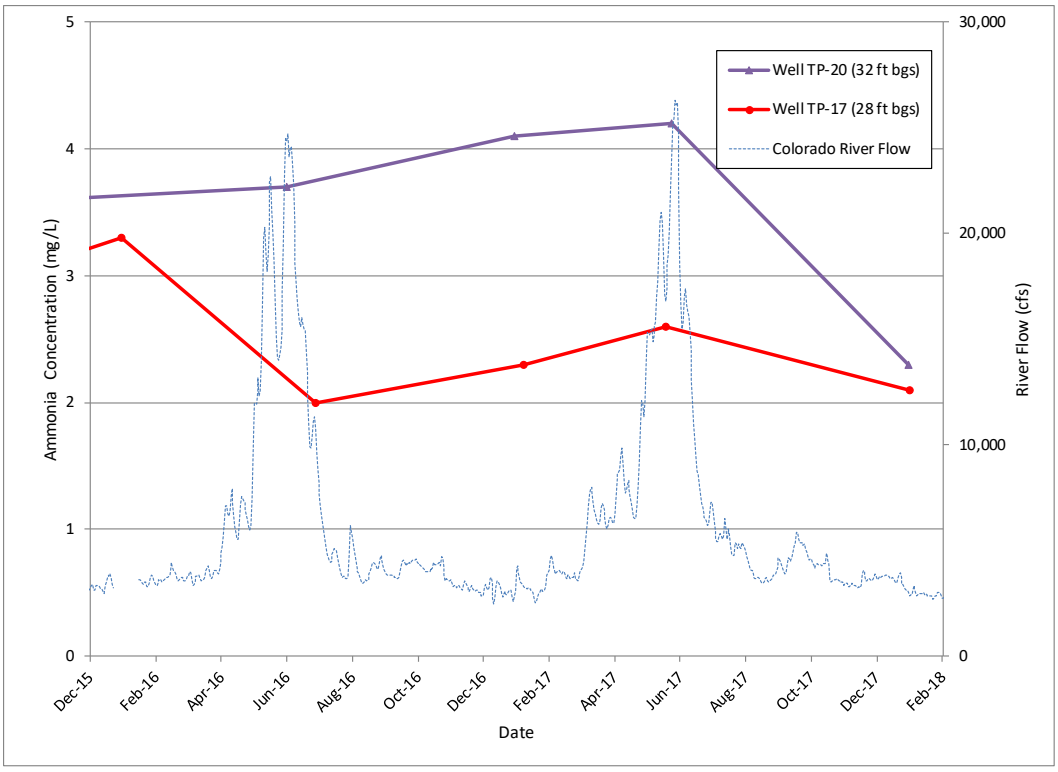


*Figure 28. South of Site Observation Wells TP-17 and TP-20 Time versus Ammonia Concentration Plot*

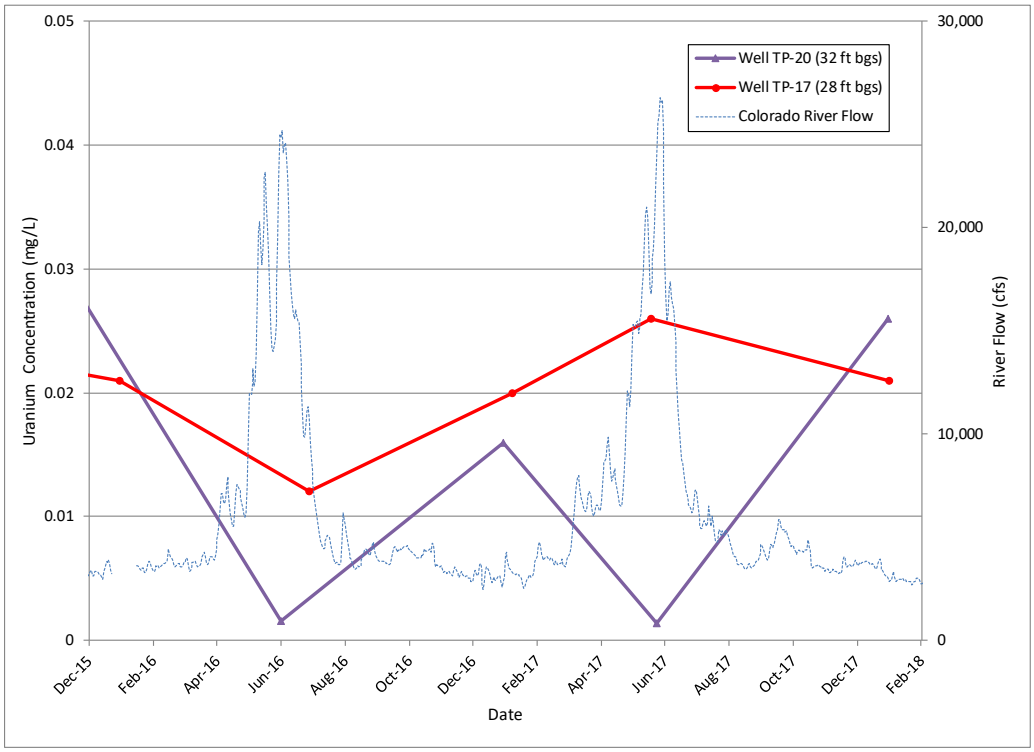


*Figure 29. South of Site Observation Wells TP-17 and TP-20 Time versus Uranium Concentration Plot*

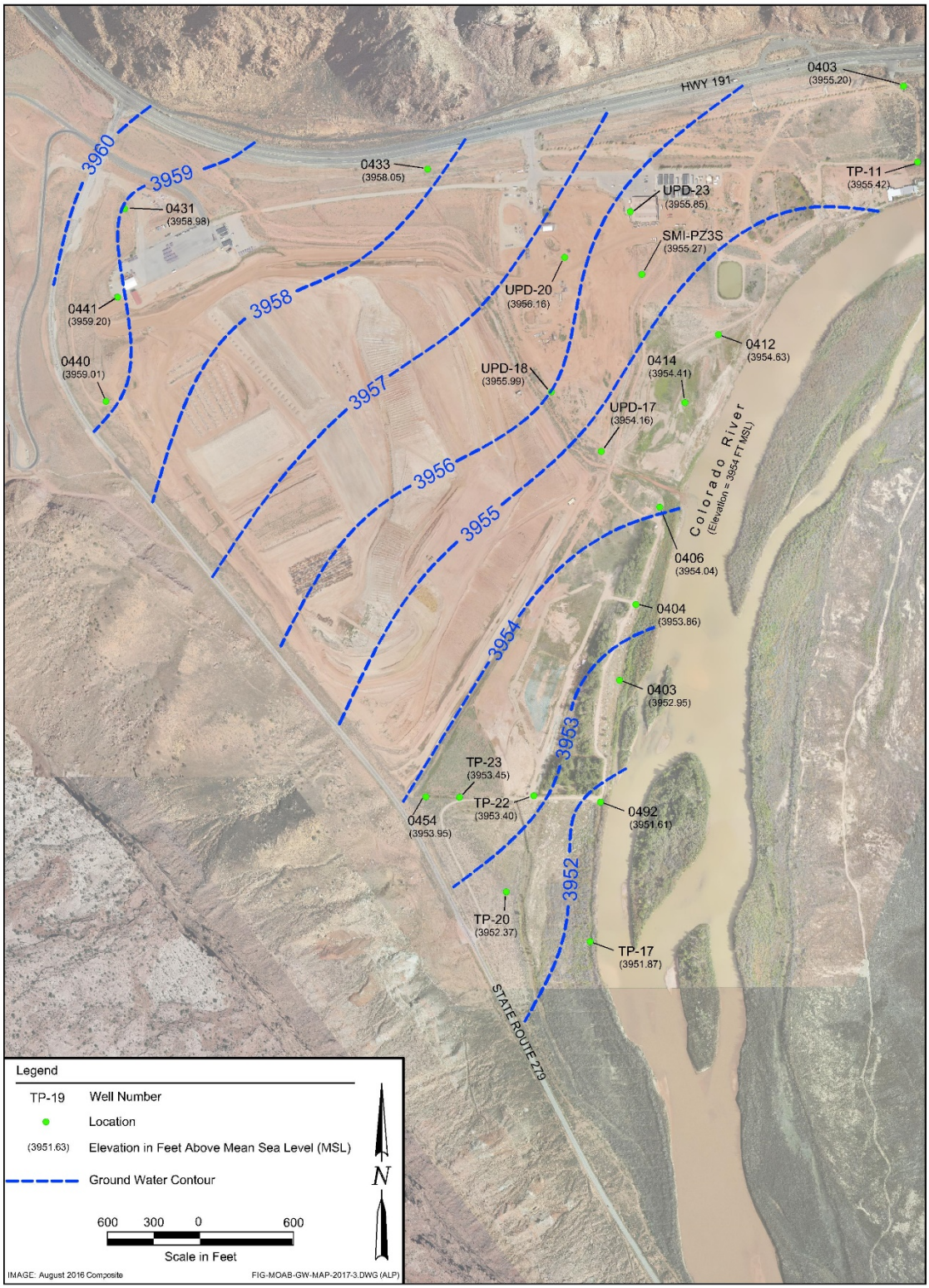


*Figure 30. Site-wide Ground Water Elevations, November 2017 through January 2018*

This contour map displays how the site ground water system responds to the river during gaining conditions. Ground water flow direction and gradient displayed in this contour map are comparable to historical contour maps generated using ground water data collected during this same time of year.

## 4.5 Contaminant Distribution

Figures 31 and 32 are maps showing shallow ground water ammonia and uranium plumes, respectively, using data collected during the November 2017 site-wide events. Contaminant distribution is generally comparable to previous plume maps generated using data collected during the past 2 years.

# 5.0 Conclusions

This report presents the results of sampling conducted at the Moab site between July and December 2017. 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 ground water 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 12 for a complete list of the Moab site locations and associated uranium concentrations that exceeded the 0.044 mg/L uranium standard.

## 5.1 August and November 2017 CF4 and CF5 Sampling Events

The collection of ground water samples from observation wells surrounding the CF4 injection wells in August and November 2017 was to further evaluate the effectiveness of the freshwater injection system. The analytical results indicate the injection system reduced the ammonia concentrations in the ground water system from 15 to 35 ft bgs in the vicinity of CF4, and the water elevation data confirmed more than 10 ft of mounding was generated from the operation of this system.

All eight CF5 wells were sampled to monitor contaminant concentration trends and update the contaminant concentrations used for the mass removal calculations. In general, ammonia and uranium concentrations have not significantly changed over the past 2 years. The data indicate the historical trend of the extraction wells located along CF5 southeastern boundary having the highest ammonia and uranium concentrations continues. Based on an analysis of these results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

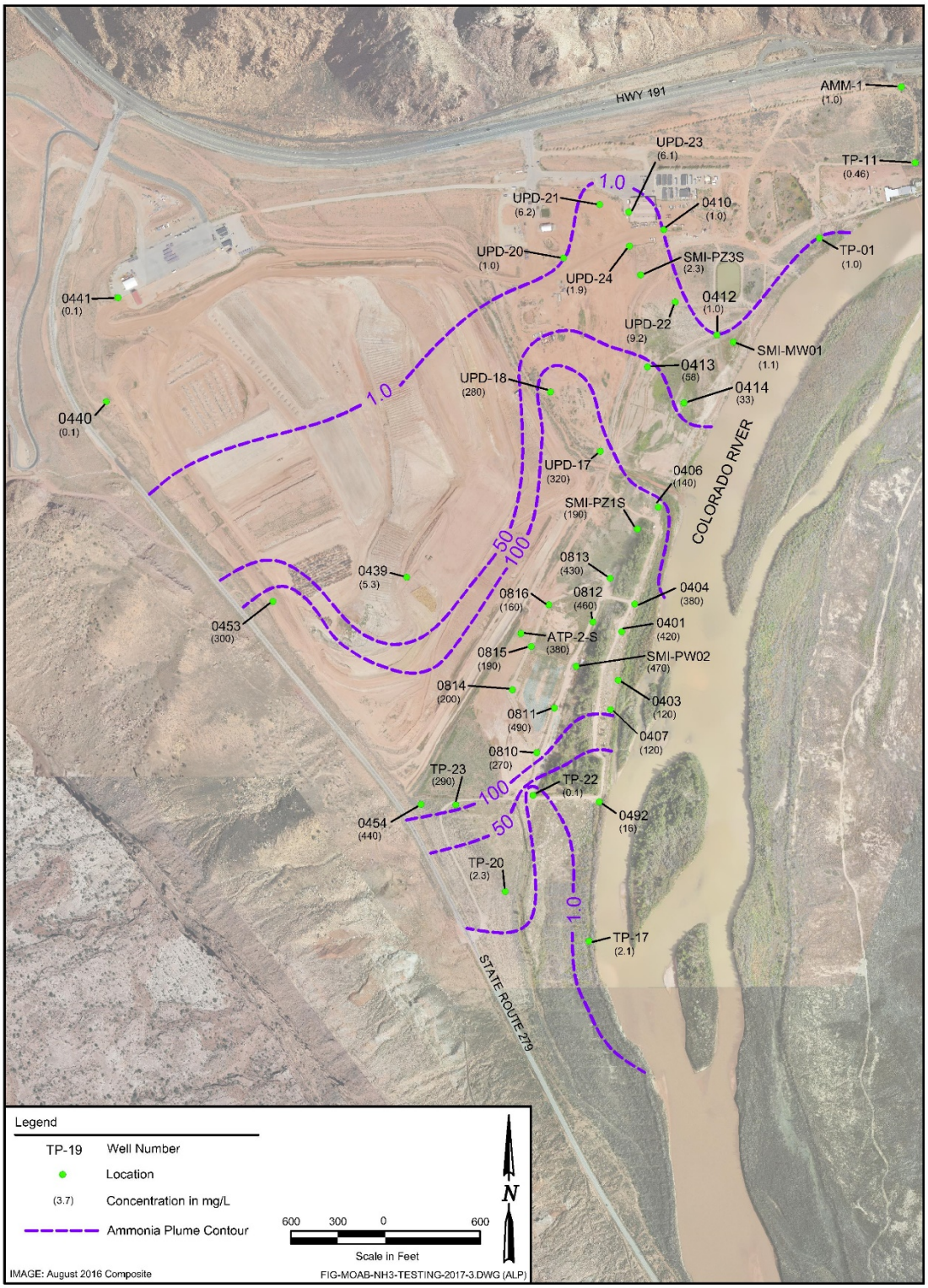


*Figure 31. Ammonia Plume in Shallow Ground Water November 2017 through January 2018*

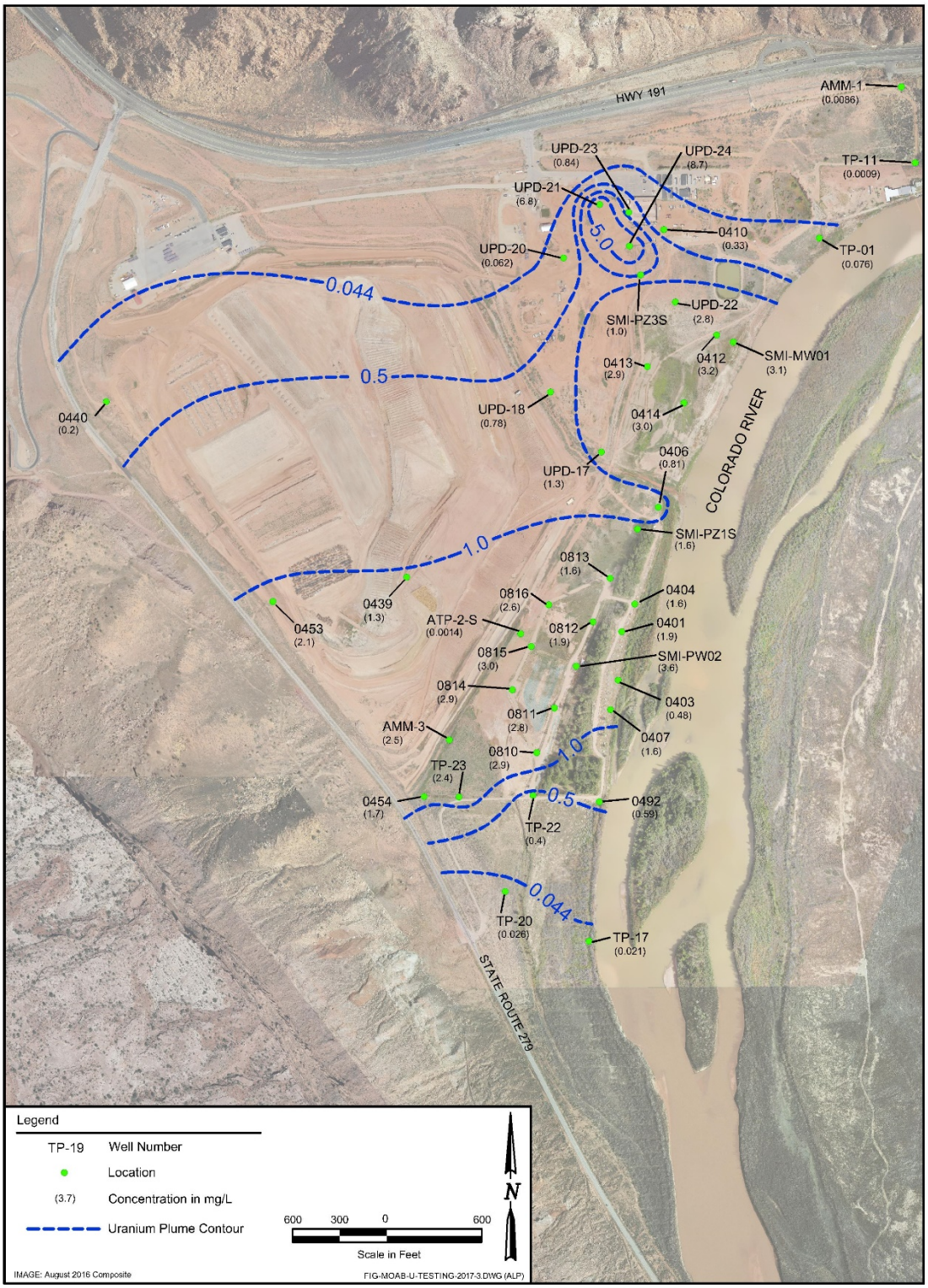


*Figure 32. Uranium Plume in Shallow Ground Water November 2017 through January 2018*

## 5.2 November 2017 Site-wide Sampling Event

The rationale for conducting the November 2017 site-wide sampling event was to collect data from the site during typical Colorado River base flows and to assess any changes or trends in the ground water system water chemistry. 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 May 2017.

There were two anomalous data points associated with the site-wide sampling event, from locations 0440 and UPD-23. The uranium concentration in the sample collected from 0440 was greater than the historic maximum, while the ammonia concentration from UPD-23 was also more than 50% above the historic maximum. Sampling will continue from these locations to determine if a trend develops.

All seven surface water samples collected during this sampling event were below the ammonia detection limit with the exception of one that had an ammonia concentration of 0.24 mg/L. The sample collected from location CR-1 was analyzed using a higher detection limit (1.0 compared to 0.1 mg/L), with the concentration below the detection limit. All surface water ammonia concentrations are below the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations.

# 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/Ground Water Sampling and Analysis Plan* (DOE-EM/GJTAC1830).