Appendix E: Representative Photographs

Appendix E: Representative Photographs

Log Yard Cap and Geologic Conditions

Photo E-1: Illustrates the double layered roller compacted concrete (RCC) and asphalt overlay that constitutes the Log Yard cap.

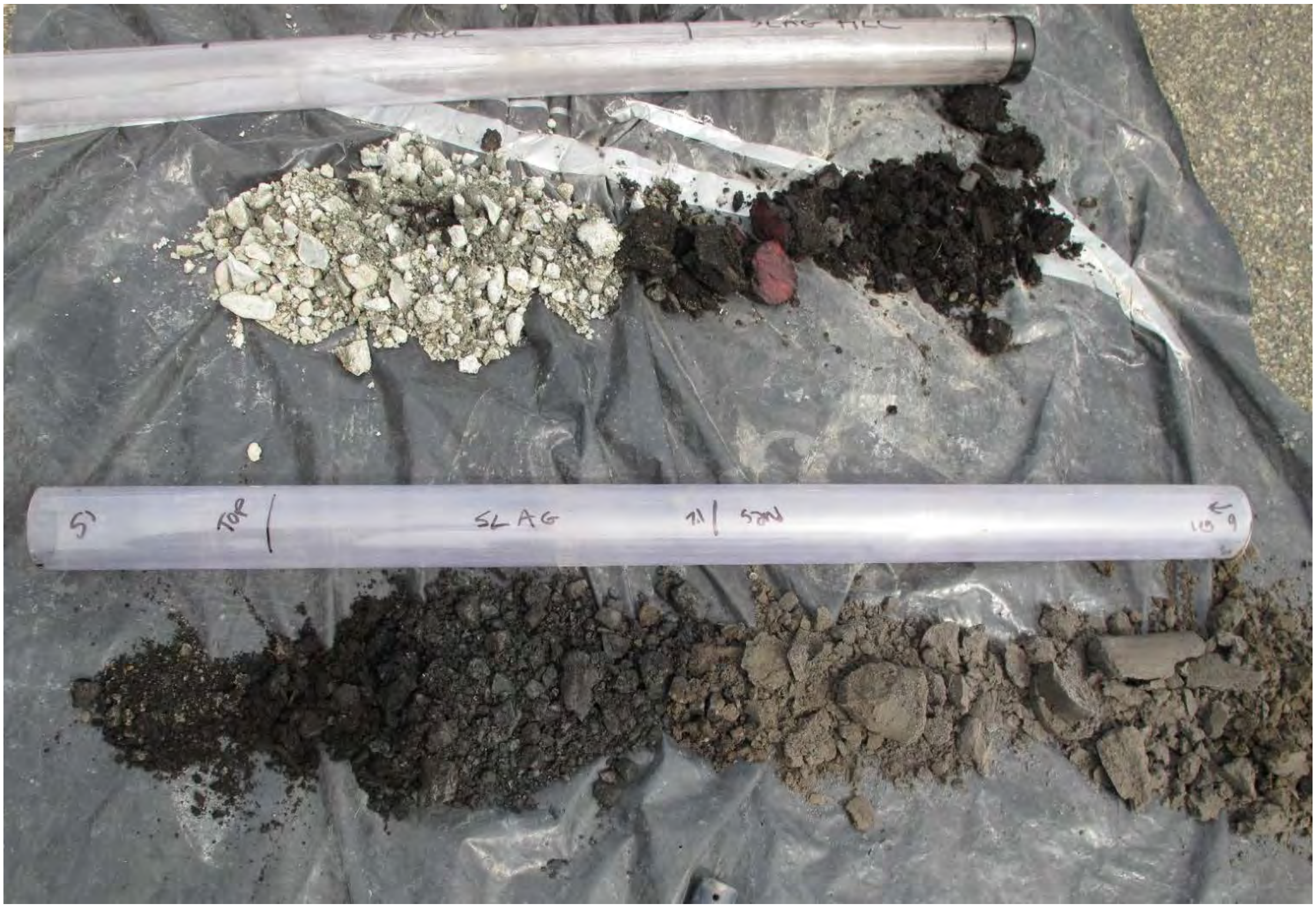

Photo E-2: Gravel Base Coarse, Fill Containing Slag, and Silty Sand (as observed in TB-7)

Appendix E: Representative Photographs

Photo E-3: Saturated slag gravel layer at base of Fill Containing Slag (as observed in MW-13)

Photo E-4: Fine-grained silty unit (as observed in MW-10)

Appendix E: Representative Photographs

Apparent Channel Contacts in TB-9 (in former Wapato Creek Channel)

Photo E-5: TB-9: A different colored (dark brown to reddish brown) poorly graded sand with rootlets, observed from 2.4 to 5 ft bgs could be evidence of the former drainage ditch, but no obvious fine-grained channel bed was observed so the unit could also just be fill material (Photo E-X). Sample was collected for archival from 2.4 to 3.4 ft bgs. Unit is underlain by the more typical dark gray poorly graded sand, indicative of the hydraulic dredge fill unit, from 5 to 7.4 ft bgs.

Photo E-6: TB-9: Apparent contact at 7.4 feet bgs between the distinctive upper poorly graded fine-grained sand (hydraulic fill) above and a fine-grained channel bed and/or overbank deposits below, with interbedded reddish brown clay, sand and silt deposits observed between 7.4 and 12 feet bgs. Soil samples were collected and analyzed from above (7.4 to 8.4 ft bgs) and below (8.8 to 9.8 ft bgs) this contact. This unit is suspected to constitute the Wapato Creek channel alignment observed through the 1950's (Appendix A.1).

Appendix E: Representative Photographs

- Photo E-7: TB-9: A two foot thick layer of dark gray to black colored clay was observed from 12 to 14 ft bgs. A sample of the clay was collected for analysis from 12 to 13 ft bgs. Underlying that clay layer was a coarser grained version of the dark grey well graded sand that is similar in appearance to the hydraulic fill but much coarser grained and without the silt observed in the hydraulic fill (Photo E-X). This may be indicative of an older Wapato channel alignment.

Appendix E: Representative Photographs

Ponding on Cap

Photo E-8: TB-9: Ponding observed on the Log Yard Cap, looking north from monitoring well MW-11 (seen in foreground)

Appendix E: Representative Photographs

Stormwater Conveyance Video and Spill Containment Vessel Photos

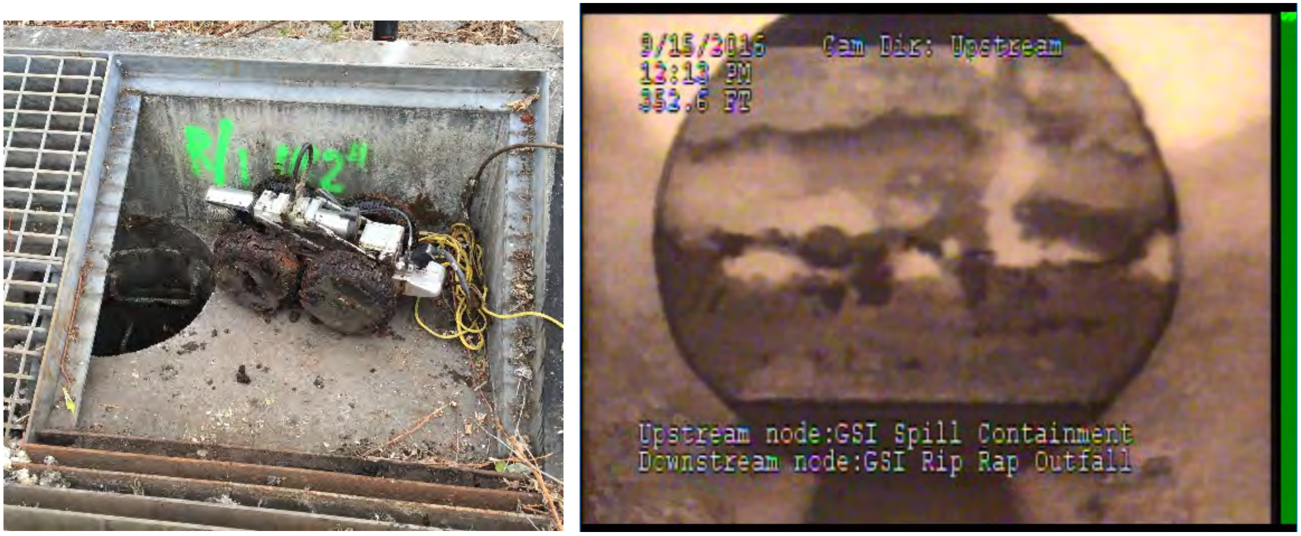

Photo E-9: Stormwater video camera (left) and an image looking upgradient at the spill containment vessel near manhole #1 (right).

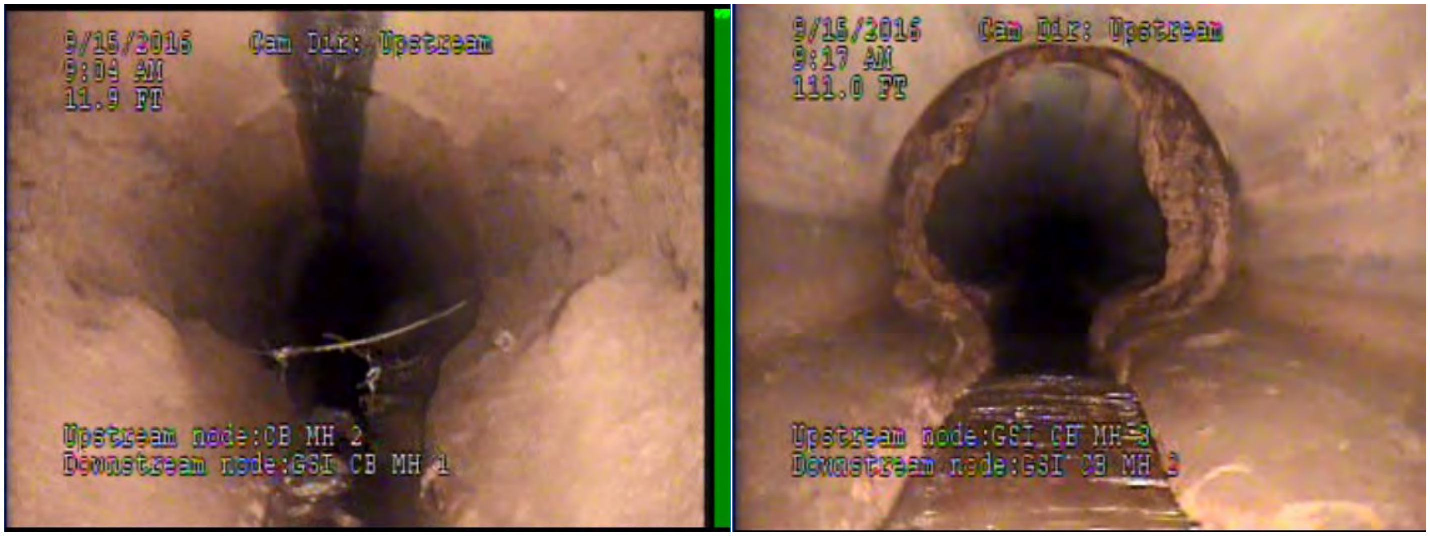

Photo E-10: Sedimentation in and evidence of leakage along joints (right) in the stormwater conveyance system.

Appendix E: Representative Photographs

Photo E-11: Leakage observed in spill containment vault in February 2017 (Event 4; left). No leakage observed in spill containment vault in August 2016 – (Event 2; right)

Appendix E: Representative Photographs

General Drilling and Upland Sampling Photos

Photo E-12: Geoprobe Drill Rig

Photo E-13: Air Rotary Drill Rig

Appendix E: Representative Photographs

Photo E-14: Marking contacts on clear Geoprobe liner prior to cutting sampling intervals

Photo E-15: Sealing soil samples in clear Geoprobe liner

Appendix E: Representative Photographs

Photo E-16: Sealing soil sample cores anoxically in nitrogen purged Mylar bags containing oxygen absorbers.

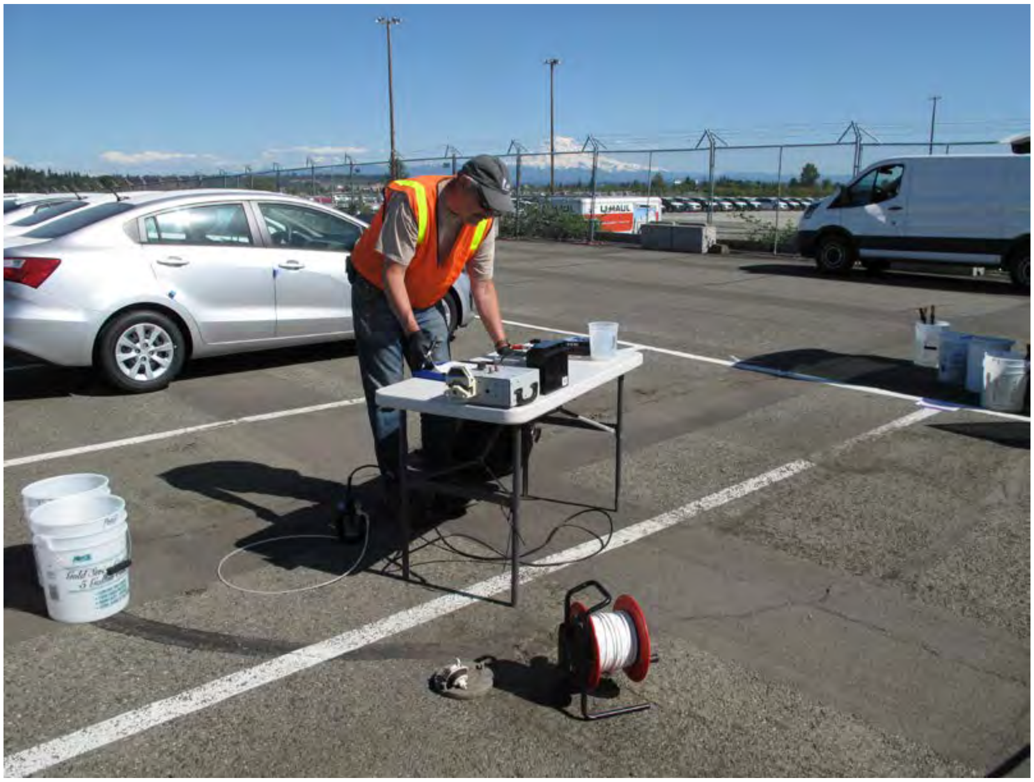

Photo E-17: Groundwater sampling on the Log Yard (Mt. Rainier in the background)

Appendix E: Representative Photographs

General Porewater and Wapato Creek Sampling Photos

Photo E-18: Nylon Mesh Diffusion Sampler (NMDS) Preparation

Photo E-19: NMDS Installation

Photo E-20: NMDS Retrieval and Sampling

Appendix E: Representative Photographs

Photo E-21: Comparison of NMDS turbidity using the 120 micron nylon mesh (left) and the 22 micron mesh (right)

Photo E-22: Outfall (OF-2) sampling in Wapato Creek

Appendix F: Data Validation Report

Data Validation Report

Parcel 15 (Portac) Investigation

Ecology Facility Site No. 1215 / Cleanup Site No. 3642

June 2017

Prepared for

Port of Tacoma and

Portac, Inc.

Prepared by

GSI
Water Solutions, Inc.

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Abbreviations and Acronyms

%R	Percent recovery
%RPD	Relative percent difference
B	Qualifier indicating the parameter was found in a blank associated with the sample
COC	Chain-of-custody
DQO	Decision Quality Objectives
DUP	Duplicate
DV	Data validation
Ecology	Department of Ecology, Washington State
EDD	Electronic data deliverable
EIM	Environmental Information Management, Washington State Department of Ecology
EPA	United States Environmental Protection Agency
GSI	GSI Water Solutions, Inc.
J	Qualifier indicating value is estimated
LCS/ LCSD	Laboratory control sample/ laboratory control sample duplicate
MDL	Method detection limit
MQO	Measurement Quality Objectives
MRL/PQL	Method reporting limits
MS/MSD	Matrix spike/matrix spike duplicate
MTCA	Model Toxics Control Act, Washington State
NFG	National Functional Guidelines for Superfund Data Review
NSDS	Nylon-screen diffusion sampler
Port	Port of Tacoma
Portac	Portac, Inc.
QA	Quality Assurance
QAAP	Quality Assurance Project Plan
R	Qualifier indicating data is rejected.
RI	Remedial Investigation
RL/PQL	Reporting limit
U	Qualifier indicating the parameter was not detected.
UJ	Qualifier indicating the parameter is estimated to be not detected.

1 Introduction

This *Data Validation Report* was prepared by GSI Water Solutions, Inc. (GSI), on behalf of the Port of Tacoma (Port) and Portac, Inc. (Portac), to document the Quality Assurance (QA) review and Level II Data Validation (DV) performed for laboratory data collected as part of the Parcel 15 Remedial Investigation (RI).

The purpose of the DV and QA review is to ensure that field sample collection, handling, and laboratory analysis conducted during the RI generated representative data that meet project-specific data objectives. The *Final Sampling and Analysis Plan* in Appendix A the *Parcel 15 RI Work Plan* (GSI 2016) (and Appendix B of the RI Report) describes the field methods used and presents the Quality Assurance Project Plan (QAPP) for the Site.

Four rounds of sample collection occurred for the RI. The first round of sampling included soil, sediment, surface water, groundwater, outfall discharge, and porewater collected in May and June of 2016. The second through fourth round of sampling included surface water, groundwater, outfall discharge, and porewater collected in August 2016, November 2016, and February 2017, respectively.

Samples were sent to Brooks Analytical Laboratory for metals analysis. Samples were sent to Test America Laboratory for analysis of metals, organic carbon, sulfide, pentachlorophenol, major cations and anions, alkalinity, nitrate and nitrite, and dioxins/furans.

Level II summary reports and data reports were provided by the laboratories for review, and are provided in Appendix C of the RI Report.

The following QA/QC review of the analytical data is based on the available documentation provided by the laboratories. The QA/QC review consisted of reviewing the following elements from provided laboratory reports and electronic data deliverables (EDDs):

- Chain-of-custody (COC) – for completeness and continuous custody; Condition of samples upon receipt
- Analysis conducted within holding times
- Laboratory blanks
- Porewater equipment blanks
- Field duplicate analysis frequency and relative percent difference
- Surrogate recoveries
- Metals split sample frequency and %RPD
- Matrix spike and matrix spike duplicate (MS/MSD) percent recoveries (%R) and relative percent difference (%RPD)
- Laboratory control and laboratory control duplicate sample (LC/LCDS) %R and %RPD
- Method detection limits (MDL) and reporting limits (RL/PQL), which in this case are identical to the practical quantitation limit (PQL)
- Analytical methods

- Laboratory narratives

The results of the QA/QC review of the laboratory reports are presented below. A summary of qualifier modifications and data validator notes by event may be found in Tables 1 through 4.

Data validation methods were consistent with EPA National Functional Guidelines for Superfund Data Review for inorganics, (EPA 2014a) organics (EPA 2014b) and dioxin/furans (EPA 2011).

Parameters not detected above the MDL are considered to be non-detects. Non-detects received a U qualifier and are presented at the RL/PQL. Estimated values received a J qualifier. A UJ qualifier is used to show the parameter concentration (reported at the RL/PQL/PQL) is estimated as not present above the method detection limit. An R qualifier was used to show that the data is rejected, and is not usable.

2 Chain-of-Custody, Sample Receipt

The following provides a summary of the review of COC procedures and sample receiving conditions. Project specific COCs were generated for water and solids, pre-printed, and filled out with sample specific IDs, collection dates and times, and requested analyses. The samples were collected and shipped to the laboratory on multiple days with multiple COCs. COC requirements and sample receiving conditions were met with the exception of the following noted discrepancies:

Event 1

- Some samples were received at a temperature above 4° C. However, samples were delivered the same afternoon as collection and may not have had time to cool before reaching the lab. Additionally, most samples were received at temperatures below 10° C and placed in cold storage at the laboratory, and were therefore not qualified.

- The container label for samples TBS002-12.5-13.5, TPS001-0.5-1.5, TPS001F-1.5-2.5, TPS002-10.5-12.5 were dated 5/18, while the COC listed a sample collection date of 5/17. These samples were logged according to the COC, which had the correct sample collection date. Additionally, the container label for sample WCTPW001B-40, did not match the COC, which listed the sample ID as WCTPW001B-10-E1. This sample was logged according to the COC, which had the correct sample ID.

- A dissolved organic carbon sample for HC002-E1 was not received by the lab. GSI approved transferring 250ml of volume from an unpreserved container to a 250ml sulfuric amber bottle on 6/2/16.

Event 2

- Test America received some samples at a temperature above 4° C. However, samples were delivered the same afternoon as collection and may not have had time to cool before reaching the lab, and therefore were not qualified. Brooks Applied Labs also received samples above 4° C, which is above the recommended temperature for the requested speciation analyses; however, as this is the recommendation and, since the temperature was close to the requirement of 4±2°C, no qualification of the data was performed.

- MW007-E2 was analyzed for alkalinity. This analysis was not originally requested on the COC.

Twelve porewater samples were analyzed and reported for trace elements by EPA Method 6010C. This analysis was not originally requested on the COC.

Event 3

Some samples were received at a temperature above 10° C. However, samples were delivered the same afternoon as collection and may not have had time to cool before reaching the lab. Samples were placed in cold storage at the laboratory, and were not qualified.

Event 4

The container label for samples, MW002-E4 and BR006-E4 did not match the COC. The samples were logged in accordance with the COC as MW002R-E4 and B006R-E4, respectively.

A total suspended solids sample for the porewater method blank was not received by the lab, and therefore the analysis was not conducted even though it was requested in the COC.

3 Analysis Holding Times

Collection dates for all samples submitted are documented on the chain of custody form. Collection and analyses dates are indicated in the laboratory reports as well. Holding times were met for all samples with the following exceptions:

Event 1

- Sulfides were analyzed outside of the hold time for all soil and sediment samples. Sulfide is a geochemical indicator, not a contaminant. The low bias does not significantly affect data usability.

- One pentachlorophenol sample was analyzed outside of the recommended hold time for pentachlorophenol.

- Nitrite in one groundwater sample, and five surface water samples was analyzed outside of the recommended hold time.

- Total petroleum hydrocarbons, which were analyzed for on two archived soil samples, were analyzed outside of the recommended hold time.

All Event 1 samples analyzed outside of the recommended hold times are J qualified for potential low bias.

Event 2

Event 2 samples were analyzed within the recommended hold time.

Event 3

Event 3 samples were analyzed within the recommended hold time.

Event 4

- Nitrate and Nitrite in five porewater samples and two groundwater samples were analyzed outside of the recommended hold time. Event 4 samples analyzed outside of the recommended hold times are J qualified for potential low bias.

4 Laboratory Blanks

Blanks are prepared by the laboratory and analyzed to check for the possibility that the sample may become contaminated during the analysis process. Blanks were analyzed for all analytical tests requested. All blank data were acceptable with the following exceptions:

Event 1

- Chloride was detected in blank(s) associated with the following groundwater samples:
    - MW004-E1, MW003-E1, MW503-E1, MW002R-E1, MW001-E1, TBGW003-E1, TBGW005-E1, TBGW007-E1, TBGW507-E1.
- Calcium was detected in blank(s) associated with the following porewater samples:
    - WCTPW001B-40-E1, WCTPW001B-10-E1, WCTPW001A-40-E1, WCTPW001A-10-E1, WCTPW002B-40-E1, WCTPW002B-10-E1, WCTPW002A-40-E1, WCTPW002A-10-E1, WCTPW003B-10-E1 and WCTPW003A-10-E1.
- Dioxin/Furans were detected in blank(s) associated with the following sediment samples:
    - MWS005R-10.5_11.5, TPS002-0.5_1.5, TPS001-0.5_1.5, TPS001-0.5_1.5, TPS001F-1.5_2.5, TPS001F-1.5_2.5.
- Arsenic was detected above the RL/PQL of 0.040 ug/L in a continuing calibration blank bracketing samples MW011-E1 and MW001-E1. These samples were reanalyzed in a new batch. No qualification of the data was necessary.

Blank qualifiers associated with these samples were dropped when sample results were ten times greater than the RL/PQL, and assigned a J flag when the result was above the reporting limit, but less than ten times greater than the reporting limit. Samples detected at concentrations between the MDL and RL were assigned a U flag and reported at the RL/PQL.

Event 2

- Pentachlorophenol was detected in blank(s) associated with the following porewater, field method blank and groundwater samples:
    - WCTPW5MB-E2, WCTPW004B-40-E2, WCTPW004B-10-E2, WCTPW004A-40-E2WCTPW004A-10-E2, MW006R-E2, MW005R-E2.

- Calcium was detected in blank(s) associated with the following surface water samples:
    - WCTSW001B-E2, WCTSW002B-E2, WCTSW003B-E2, WCTSW501B-E2, BWSW001-E2, USSW001-E2.
- Dissolved Iron was detected in a blank associated with surface water sample WCTSW001B-E2.

Blank qualifiers associated with these samples were dropped when sample results were ten times greater than the RL/PQL, and assigned a J flag when the result was above the reporting limit, but less than ten times greater than the reporting limit. Samples detected at concentrations between the MDL and RL were assigned a U flag and reported at the RL/PQL.

Event 3

- Pentachlorophenol was detected in blank(s) associated with the following groundwater, surface water and field blank samples:
    - B005R-E3, B505R-E3, MW002R-E3, MW005R-E3, MW001-E3, MW003-E3, MW004-E3, MW006R-E3, PWMB-E3, WCTSW004B-E3.

Blank pentachlorophenol qualifiers associated with these samples were dropped when sample results were ten times greater than the RL/PQL, and assigned a J flag when the result was above the reporting limit, but less than ten times greater than the reporting limit. Samples detected at concentrations between the MDL and RL were assigned a U flag and reported at the RL/PQL.

- Calcium was detected in blank(s) associated with the following porewater and surface water samples:
    - BWSW001-E3, USSW001-E3, WCTPW001A-10-E3, WCTPW001B-10-E3, WCTPW002A-10-E3, WCTPW002B-10-E3, WCTPW003A-10-E3, WCTPW003B-10-E3, WCTSW001B-E3, WCTSW002B-E3, WCTSW003B-E3.
- Dissolved Iron was detected in a blank associated with groundwater samples B005R-E3 and MW007-E3.

Blank calcium and dissolved iron qualifiers associated with these samples were dropped as sample results were at least 10 times greater than the RL/PQL.

Event 4

- Pentachlorophenol was detected in the laboratory method blank associated with sample MW002R-E4 at a concentration of 0.128 µg/L. The blank was detected at a concentration of 6 times greater than the contract required reporting limit, but 60 times lower than the reported sample concentration. The laboratory reported B qualifier was dropped for this sample. No qualifier was issued in place of the B qualifier.
- Dissolved organic carbon was detected in blanks associated with the following samples:

  - MW010-E4, MW012-E4, MW013-E4, MW507-E4, OF3-E4, MW003-E4, MW005R-E4, MW006R-E4, MW007-E4, MW008-E4, MW009-E4, USSW001-E4, WCTPW001A-10-E4, WCTPW001B-10-E4, WCTPW002A-10-E4, WCTSW001B-E4, WCTSW002B-E4, WCTSW003B-E4, WCTSW004B-E4, MW004-E4B001R-E4, B003R-E4, B005R-E4, B006R-E4, B505R-E4, BWSW001-E4, HC002-E4, MW001-E4, MW002R-E4.

- Total organic carbon was detected in blanks associated with the following samples:
  - MW010-E4, MW013-E4, MW003-E4, MW005R-E4, MW006R-E4, B001R-E4, B003R-E4, B005R-E4, B505R-E4, HC002-E4.
- Dissolved Iron was detected in a blank associated with groundwater samples B005R-E4 and MW007-E4.

Blank qualifiers associated with these samples were dropped when sample results were ten times greater than the RL/PQL, and assigned a J flag when the result was above the reporting limit, but less than ten times greater than the reporting limit.

5 Porewater Equipment Blanks

Porewater equipment blanks were prepared using the same materials and methods as the field deployed nylon screen diffusion samplers (NSDS). The 16-oz lab provided glass jars were filled with laboratory provided, nitrogen, purged in DI water and then covered by the nylon mesh, which was held in place by the hand cut jar ring. The blank samples were then placed in the same bucket and transported to the field with the other field NSDS. The method blank samples were not deployed in the sediment but rather sampled in the field using the same sampling techniques as the field retrieved NSDS samples. The porewater method blanks were analyzed to assess the potential of cross-contamination of samples due to unknown material quality (e.g., the nylon mesh) and/or insufficient decontamination of sampling equipment. A summary of porewater equipment blank results are shown in Table 5.

Event 1

Porewater equipment sample WCTPW5MB-E1 was processed with porewater samples for the following parameters:

- Arsenic (Dissolved), Arsenic (Total), Dissolved Organic Carbon, Iron (Dissolved), Manganese (Dissolved), Nitrate as N, Nitrite as N, Sulfide, Total Organic Carbon, Total Suspended Solids.
  - Arsenic (Dissolved), Arsenic (Total), Iron (Dissolved), Nitrite as N, Nitrate as N and Sulfide were not detected at concentrations above the RL/PQL.
  - For Total Suspended Solids, less than 2.5 mg of dried residue could be obtained from the 1L sample, so the sample could not be analyzed for this parameter.
  - Dissolved Organic Carbon, Manganese (Dissolved) and Total Organic Carbon were detected in this sample. Associated porewater samples did not receive a qualifier as these parameters were detected at a concentration of less than 10x greater than the RL/PQL.

Event 2

Porewater equipment sample WCTPW5MB-E2 was processed with porewater samples for the following parameters:

- Arsenic (Dissolved), Arsenic (Total), Dissolved Organic Carbon, Iron (Dissolved), Manganese (Dissolved), Pentachlorophenol, Sulfide, Total Organic Carbon.
    - Arsenic (Dissolved), Arsenic (Total), Dissolved Organic Carbon, Iron (Dissolved), Manganese (Dissolved), Sulfide and Total Organic Carbon were not detected at concentrations above the RL/PQL.
    - Pentachlorophenol was detected in this sample, however this detection is likely due to the presence of pentachlorophenol in the lab blank at a concentration of 0.0724 ug/L. This data was flagged with a J qualifier.

Event 3

Porewater equipment sample PWMB-E3 was processed with porewater samples for the following parameters:

- Arsenic (Dissolved), Arsenic (Total), Dissolved Organic Carbon, Iron (Dissolved), Manganese (Dissolved), Pentachlorophenol, Sulfide, Total Organic Carbon.
    - Arsenic (Dissolved), Arsenic (Total), Dissolved Organic Carbon, Iron (Dissolved), Pentachlorophenol, Sulfide, Total Organic Carbon were not detected at concentrations above the RL/PQL.
    - Manganese (Dissolved) was detected in this sample at a concentration slightly above the RL/PQL. Associated porewater samples did not receive a qualifier as these parameters were detected at a concentration of less than 10x greater than the RL/PQL.

Event 4

Porewater equipment sample PWMB-E4 was processed with porewater samples for the following parameters:

- Arsenic (Dissolved), Arsenic (Total), Dissolved Organic Carbon, Iron (Dissolved), Manganese (Dissolved), Pentachlorophenol, Sulfide, Total Organic Carbon, Suspended Solids.
    - Arsenic (Total), Manganese (Dissolved), Sulfide and Total Suspended Solids were not detected at concentrations above the RL/PQL.
    - Arsenic (Dissolved), Dissolved Organic Carbon, Iron (Dissolved), Pentachlorophenol and Total Organic Carbon was detected in in this sample at concentrations slightly above the RL/PQL. Associated porewater samples did not receive a qualifier as these parameters were detected at a concentration of less than 10x greater than the RL/PQL.

The low-level detections observed in the porewater method blanks did not result in any significant bias, indicating that the porewater sampling equipment and sampling protocols were appropriate choices to meet project objectives.

6 Field Duplicate Analysis Frequency and Relative Percent Difference

Field duplicates were collected to assess precision by measuring the %RPD between a sample and it's duplicate. Results from the analysis of a field duplicate sample also test laboratory precision, therefore the %RPD between the sample and the field replicate provides an indication of both the field and laboratory precision. A field duplicate is a second aliquot of a field sample collected into a separate container and submitted to the laboratory as a separate sample. Field duplicate samples were blind-labeled with a "500" sample number prefix and preserved and handled as if they were typical samples.

- Duplicate samples were collected at a frequency of at least 5 percent (1/20) for water samples during each of the four sampling events. Given the volume restrictions and added difficulties collecting porewater samples, groundwater was the dominant matrix relied upon for collection of these field QC samples. Surface water duplicates were also collected during Events 1 and 2 but dropped during Events 3 and 4 to expedite completion of in-water work during the low-tides, which only occurred during non-daylight hours.

- Due to the need to keep the soil and sediment cores under anoxic conditions in the field, the targeted core intervals were sealed in-tact for laboratory and field duplicates were not collected. Laboratory replicates were however performed as part of laboratory QA/QC procedures. Out of the 522 soil and sediment sample data points only two lab duplicate %RPDs were outside of acceptable limits. The two samples with %RPDs that fell outside of acceptable limits at 57% (MWS013-12.5-13) and 94% (TBS009-12-13) may have decreased precision due to laboratory homogenization, sample preparation, or analytical procedures. Heterogeneity in the sample matrix used for analysis may also contribute to the differences observed between the laboratory replicates.

Analytical results for the field duplicates are provided in Table 6 for the sake of comparison. In general, the RPD between the parent and duplicate sample were less than 35 percent and were acceptable. While not flagged based on the RPDs, field duplicates with greater than 35% RPD are highlighted in Table 6. Of the 207 RPDs calculated for each analyte and sample combination, 13 (i.e. 6%) of those RPDs were greater than 35 percent. Nine of the 13 RPDs above 35% can likely be attributed to laboratory methods, and reporting non-detects at the PQL/RL, rather than the MDL. Four of the RPDs greater that 35 percent may be due to sample matrix variability or field procedures. Field procedures were confirmed to be in accordance with the SAP and field sample precision is considered adequate and reasonable. Only the parent sample results are used in the data analysis, analyte concentration maps, and results presented in the RI Report.

7 Metals Split Samples

To assess comparability of metals results between laboratories, additional sample volume was collected into separate containers and submitted to Test America, for analysis of total arsenic and dissolved arsenic, iron, and manganese for comparison to the primary metals results received from

Brooks Applied Labs. Results for the split samples are shown in Table 7. RPDs ranged from 1 to 188% for total and dissolved arsenic with greater variability between labs observed at relatively low concentrations (<30 ug/). Increased RPDs in porewater are likely due to collecting the split aliquots from separate individual NMDS containers, which also reflects the heterogeneity of the environment. Porewater splits excluded, the RPD for dissolved iron and manganese ranges from 5 to 29% and 1 to 18% respectively, which is generally acceptable. Given the specialty nature of Brooks Applied Labs, this lab was relied upon as the primary lab for the metals analyses and speciation testing. The Brooks results therefore are used in the data analysis, analyte concentration maps, and results presented in the RI report.

8 Surrogate Recoveries

Surrogates are chemically similar to target analytes being extracted, and are used to determine extraction efficiency of the target analyte. Surrogate recoveries were within acceptable limits for all sampling events.

9 Matrix Spike/Matrix Spike Duplicates

Event 1

- Dissolved Organic Carbon for sample WCTPW003A-10-E1, and Total Organic Carbon for samples TBGW004-E1 and B005R-E1 were outside of acceptable MS/MSD limits. These data received a J flag.

- Pentachlorophenol for soil sample MWS005R-10.5_11.5 was outside of acceptable MS/MSD limits. This data was J qualified.

Event 2

- Bromide and Chloride for groundwater sample MW012-E2 were outside of acceptable MS/MSD limits. Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits. These data were J-flagged.

Event 3

- Percent recovery of matrix spike samples for dissolved organic carbon, and sulfate for sample B006R-E3, and MW007-E3 were 76% and 119%, respectively which exceed limits for the method. These data were J-flagged, and data usability is not significantly affected.

- Fluoride and nitrite as N matrix spike percent recoveries associated with sample WCTPW001A-10-E3 were both 0%. These analytes were reported as not detected by Test America but rejected (“R” Flag) during data validation due to the low matrix spike recoveries and are not usable for the purposes of the RI.

Event 4

- Percent recovery MS/MSD samples exceeded method limits for associated samples: USSW001-E4, OF2-E4 and HC002-E4. Ortho-phosphate, dissolved organic carbon, dissolved bromide, dissolved chloride, dissolved nitrate, dissolved nitrite and dissolved sulfate were affected. MS/MSD Percent recoveries were as low as 75% and as high as 133%. Detected results received a J qualifier. Non-detected data did not receive a J qualifier as MS/MSD percent recoveries were above the method limit.

10 Laboratory Control Sample / Duplicate Laboratory Control Samples/ Laboratory Duplicate samples

Laboratory control samples were used by the laboratory to assess the accuracy of the analytical equipment in analyzing all requested analytes. The sample is prepared from the analyte-free matrix, which is then spiked with known levels of the constituents of interest (i.e., a standard). The concentrations are measured, and the results are compared to the known spiked levels. This comparison is expressed as percent recovery.

A laboratory control sample duplicate is a second analysis of a sample. A second bottle or aliquot of a sample is prepared along with the original. It is analyzed and compared to the first to assess the precision of the analytical method.

The laboratory control samples, and laboratory duplicate sample %R and %RPDs were within the acceptability criteria with the following exceptions:

Event 1

- The %RPD of method duplicates performed on samples MWS013-12.5-13.5 and TBS009-12-13 were elevated. Both the samples and the DUPs were re-analyzed, and the re-analyses confirmed the RPDs of 57% and 94%. The native sample results received a J qualifier for duplicate imprecision.

- The %RPD of the LCS and LCSD for Pentachlorophenol, associated with sample TBS009-7.4_8.4, TBS009-8.8_9.8 and TBS009-12_13, was recovered outside control limits. However, individual recoveries met the acceptance criteria, so no data qualifier was added.

Event 2

- No corrective action or qualification of the data was deemed necessary based on LCS/LCSD recoveries.

Event 3

- Pentachlorophenol LCS/LCDs associated with sample WCTPW004A-10-E3 was analyzed at 5x dilution due to a spike solution error made by the lab. Data is correctly reported and did not receive a qualifier based LCS/LCDs being outside of acceptable limits.

Event 4

- No corrective action or qualification of the data was deemed necessary based on LCS/LCSD recoveries.

11 Analytical Methods

A total of 81 groundwater, 9 groundwater duplicates, 46 porewater, 4 porewater method blanks, 17 sediment, 2 sediment duplicates, 24 soil, 8 stormwater/dry-weather flow, 24 surface water and 2 surface water duplicate samples were collected. All samples were analyzed according to methods specified in the Parcel 15 Sampling and Analysis Plan for one or more of the following:

- Pentachlorophenol by EPA Method 8270D SIM;
- Dissolved sulfide by Standard Method 4500 S2D;
- Sulfide by EPA method 9034;
- Major cations (calcium, magnesium, potassium and sodium) by EPA Method 6010C;
- Major anions (bromide, chloride, fluoride and sulfate), nitrite as N and nitrate and N by EPA Method 300.0;
- Ortho-phosphate by EPA Method 365.1;
- Total and dissolved organic carbon and dissolved alkalinity by Standard Method SM5310B or EPA Method 9060;
- Total arsenic, dissolved arsenic, dissolved iron and dissolved manganese by EPA Method 3020A or by Method 1638/6020 Mod (ICP-QQQ-MS);
- Arsenic III, arsenic V, dimethylarsinic acid and monomethylarsonic acid by Method BAL-1400/BAL-4111/BAL-4112 (IC-ICP-CRC-MS);
- Dissolved ferrous iron by Standard Method 3500B;
- Dioxins/Furans by EPA Method 1613B.

12 Method Detection Limits

Method detection limits are the minimum concentration of a chemical compound that can be measured and reported that the compound is present, and is based on instrumentation abilities and sample matrix. Reporting limits by the laboratory and are based on the low standard of the initial calibration curve or low-level calibration check standard, and represent the concentration that can be accurately quantified. In some cases, the RL/PQL and MDL are raised due to dilutions or matrix interferences. RL/PQLs are generally consistent with industry standards.

The laboratory reported sample results to the RL/PQL, and MDL. Analytical results that fell between the RDL and MDL are qualified as estimated and are J flagged in the report tables. Non-detected results are reported at the associated RL/PQL and are U flagged in report tables.

The laboratory elevated MDL/RL/PQLs for the following samples:

Event 1

- SVOCs analyzed by 8270 SIM and 8270D SIM were diluted by the lab due to the nature of the sample. Elevated SVOC reporting limits are provided for the sample MWS005R-10.5_11.5 and associated MS/MSDs.

- Some analyses may have been diluted out of the following EPA Method 300.0 samples, which required multiple dilutions due to high concentrations of chloride:
    - WCTSW001B-E1, WCTSW002B-E1, WCTSW003B-E1, USSW001-E1, BWSW001-E1, B001R-E1, HC002-E1, MW012-E1 and MW009-E1.

Event 2

- The following samples have an elevated Sulfide RL/PQL as samples were diluted by the lab due the dark matrix color:
    - MW007-E2, MW009-E2, sample B-005R-E2, B-505R-E2, HC002-E2, MW008-E2, MW010-E2 and MW510-E2.

- Some analyzes may have been diluted out of the following EPA Method 300.0 porewater samples, which required multiple dilutions due to high concentrations of chloride:
    - WCTPW001A-10-E2, WCTPW001A-40-E2, WCTPW001B-10-E2, WCTPW001B-40-E2, WCTPW002A-10-E2, WCTPW002A-40-E2, WCTPW002B-10-E2, WCTPW002B-40-E2, WCTPW003A-40-E2, WCTPW003B-10-E2, WCTPW003B-40-E2, WCTPW003A-10-E2.

Event 3

- Pentachlorophenol in sample MW002R-E3 was diluted to bring the concentration within the calibration range and has an elevated RL/PQL.

Event 4

- Test America began observing frequent detections of pentachlorophenol in blank samples in Event 2, and continued to detect pentachlorophenol in blank samples for Events 3 and 4. In December 2016, EPA revised the Definition and Procedure for the Determination of the Method Detection Limit from 40 CFR 136 to address such blank detection issues. Test America was in the process of determining new MDLs while processing Event 4 samples, therefore RLs were elevated above the CRQL specified in the QAAP. Moving forward Test America has set the RL for pentachlorophenol using 8270SIM and 1 L volumes to 0.215 ug/L, and the PQL to 1ug/L. Further details on the new MDLs and RLs may be seen in Attachment 1 of this report.

13 Other

Event 1

- The sum of Total recoverable Arsenic, dissolved Arsenic, and Arsenic speciation did not match up with the dissolved Arsenic result for sample TBGW007-E1.
- Dissolved metals sample, B003R-E1 contained a significant amount of particulates. This sample was re-filtered by the lab upon request.
- The metals speciation analysis indicates reducing sample matrices are present. Ferric Iron to Ferrous Iron conversion was present in all samples Ferrous Iron was analyzed for.

Event 2

- Dissolved Arsenic results were greater than the associated Total Arsenic results for a number of samples. Samples were reanalyzed confirming the initial analysis. No indication of sample container mix-up was reported by the lab. The following samples were affected:
    - MW008-E2, WCTPW001B-10-E2, WCTPW001B-40-E2, WCTPW002A-10-E2, WCTPW002A-40-E2, WCTPW002B-40-E2, WCTPW003B-40-E2

Event 3

- Chloride was present in a number of porewater samples at a concentration greater than the instrument can accurately measure. The following chloride samples were affected, and received a J flag:
    - WCTPW003A-10-E3, WCTPW001A-10-E3, WCTPW001B-10-E3, WCTPW002A-10-E3, WCTPW002B-10-E3, WCTPW003B-10-E3

Event 4

- No other data quality issues are available to note for Event 4.

14 Data Quality, Completeness, and Usability

Overall, the data reported are of good quality and the results for the applicable QA/QC procedures that were used by the laboratory during the analysis of the samples are generally acceptable.

Data completeness (i.e., the total number of acceptable field sample results [non-rejected data] points compared to the total number of field sample results generated, excluding laboratory quality control samples) for the samples submitted to the laboratory for analysis is 99.95 percent since two of the total 3722 results were rejected (R) due to a MS/MSD %R of zero. With the exception of the rejected fluoride and Nitrite as N results, all data is considered complete and usable for its intended purpose.

15 References

EPA 2014a. EPA National Functional Guidelines for Inorganic Superfund Data Review (EPA-540-R-014-002). United Sates Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington DC. August 2014.

EPA 2014b. EPA National Functional Guidelines for Organic Superfund Data Review (EPA-540-R-013-001). United Sates Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington DC. August 2014.

EPA 2011. National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins and Chlorinated Dibenzofurancs (EPA-540-R-011-016). United Sates Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington DC. September 2011.

GSI 2016. Parcel 15 RI Work Plan, Ecology Facility Site No. 1215 / Cleanup Site No. 3642. GSI Water Solutions, Inc., Portland, OR. 2011.

TABLES 1-4

Data Validation Summaries for Events 1 through 4

Table 1
Event 1 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
TPS001F-1.5_2.5	None	Blank qualifiers associated with these samples were dropped. Sample results were ten times greater than the RL/PQL.	1,2,3,4,6,7,8-HpCDD
TPS001-0.5_1.5			
MWS005R-10.5_11.5			1,2,3,4,6,7,8-HpCDF
TBGW007-E1			Chloride
MW004-E1			
TBGW005-E1			
TBGW003-E1			
MW001-E1			
TBGW507-E1			
MW503-E1			
MW003-E1			
TPS001-0.5_1.5			OCDD
TPS001F-1.5_2.5			
MWS005R-10.5_11.5			OCDF
TPS002-0.5_1.5	J	Blank qualifiers associated with these samples were assigned a J flag. The result was above the reporting limit, but less than ten times greater than the reporting limit.	1,2,3,4,6,7,8-HpCDD
TPS001-0.5_1.5			1,2,3,4,6,7,8-HpCDF
TPS001F-1.5_2.5			
WCTPW003A-10-E1			Calcium
WCTPW002A-10-E1			
WCTPW001A-40-E1			
WCTPW002A-40-E1			
WCTPW002B-10-E1			
WCTPW001B-40-E1			
WCTPW001A-10-E1			
WCTPW001B-10-E1			
WCTPW003B-10-E1			
WCTPW002B-40-E1			
MW002R-E1			Chloride
TPS002-0.5_1.5			OCDD
MWS005R-10.5_11.5			
TPS001-0.5_1.5			OCDF
TPS001F-1.5_2.5			

Table 1
Event 1 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
TPS002-0.5_1.5	U	Blank qualifiers associated with these samples were detected at concentrations between the MDL and RL. These data were assigned a U flag and reported at the RL/PQL.	1,2,3,4,6,7,8-HpCDF
TPS001-0.5_1.5			
TPS001F-1.5_2.5			
TPS001-0.5_1.5			1,2,3,4,7,8-HxCDF
TPS001F-1.5_2.5			
TPS001-0.5_1.5			
TPS001F-1.5_2.5			
TPS001-0.5_1.5			1,2,3,7,8,9-HxCDD
TPS001F-1.5_2.5			
TPS002-0.5_1.5			2,3,4,6,7,8-HxCDF
TBGW005-E1			Monomethylarsonic acid
TBGW003-E1			
TBGW507-E1			
TBGW007-E1			
TPS002-0.5_1.5			OCDF
WCTSD001B-40_50	J	Duplicate precision was not within acceptance criteria. Result is estimated.	Arsenate
MWS005R-10.5_11.5	U	Elevated RL. No qualifier needed.	1,2,3,4,7,8,9-HpCDF & 1,2,3,4,7,8-HxCDD
MWS005R-10.5_11.5			1,2,3,6,7,8-HxCDD
TPS002-0.5_1.5	J	Estimated Maximum Possible Concentration	1,2,3,6,7,8-HxCDF
TPS002-0.5_1.5			1,2,3,7,8,9-HxCDD
TPS002-0.5_1.5			2,3,4,6,7,8-HxCDF
B005R-E1	None	Hold time is 15 Minutes. Parameter measured beyond specified holding time.	PH
MW001-E1			
MW002R-E1			
MW003-E1			
MW004-E1			
MW005R-E1			
MW006R-E1			
MW503-E1			
TBGW009-E1			
WCTPW003A-40-E1			
WCTPW003B-40-E1			
WCTPW004A-10-E1			
WCTPW004A-40-E1			
WCTPW004B-10-E1			
WCTPW004B-40-E1			
WCTSW004B-E1			
WCTSW504B-E1			

Table 1
Event 1 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
B005R-E1	J	MS/MSD recovery is outside acceptance limits.	Total Organic Carbon
MWS005R-10.5_11.5			Pentachlorophenol
TBGW004-E1			Total Organic Carbon
WCTPW003A-10-E1			Dissolved Organic Carbon
MWS005R-10.5_11.5		Parameter concentration above calibration range.	OCDD
MWS010-12_13		Sample prepped beyond the specified holding time.	Nitrate as N & Nitrite as N
MWS013-12.5_13.5			Nitrite as N
TBS003-14_15			Sulfide
TPS001-0.5_1.5			
TPS001F-1.5_2.5			
WCTSD001A-0_10			
WCTSD001A-40_50			
WCTSD001B-0_10			
WCTSD002A-0_10			
WCTSD002B-0_10			
WCTSD002B-40_50			Diesel Range Organics and Gasoline
WCTSD003A-0_10			Motor Oil
WCTSD003A-40_50			Diesel Range Organics and Gasoline
WCTSD003B-0_10			Mercury
WCTSD003B-40_50			Motor Oil
WCTSD004A-0_10			Sulfide
WCTSD004A-40_50			Sulfide
WCTSD004B-0_10			
WCTSD004B-0_10			
WCTSD004B-40_50			

Table 1
Event 1 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
BWSW001-E1	UJ	Sample prepped beyond the specified holding time.	Sulfide
MW007-E1			
MWS007-9_10			
MWS009-11_12			
MWS012-11.5_12.5			
TBS005-17_18			
TBS007-16.5_17.5			
TPS001-0.5_1.5			
TPS001F-1.5_2.5			
TPS001F-1.5_2.5			Pentachlorophenol
WCTSD001B-40_50			Sulfide & Total Organic Carbon
WCTSD002A-36_46			Sulfide
WCTSW001B-E1			Nitrite as N
WCTSW002B-E1			
WCTSW003B-E1			
TPS001TB-12_13	None	Sample received above 4°C. Samples were delivered the same afternoon as collection and may not have had time to cool before reaching the lab. No qualifier needed.	Arsenic (Total) and Iron (Total)
WCTSD003A-0_10			
WCTSD003B-0_10			
WCTSD004B-0_10			

Notes:

J = Value is estimated.

U = Parameter was not detected. Method reporting limit is presented as parameter concentration.

UJ = Parameter is estimated as not present above the method detection limit. Method reporting limit is presented as parameter concentration.

Table 2
Event 2 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
MW005R-E2	J	Blank qualifiers associated with these samples were assigned a J flag. The result was above the reporting limit, but less than ten times greater than the reporting limit.	Pentachlorophenol
MW006R-E2			
WCTPW5MB-E2			
WCTSW001B-E2			Iron (Dissolved)
WCTPW004A-10-E2	U	Blank qualifiers associated with these samples were detected at concentrations between the MDL and RL. These data were assigned a U flag and reported at the RL/PQL.	Pentachlorophenol
WCTPW004A-40-E2			
WCTPW004B-10-E2			
WCTPW004B-40-E2			
WCTSW001B-E2	None	Blank qualifiers associated with these samples were detected at concentrations between the MDL and RL. These data were assigned a U flag and reported at the RL/PQL.	Calcium
WCTSW002B-E2			
WCTSW003B-E2			
WCTSW501B-E2			
BWSW001-E2			
USSW001-E2			
MW012-E2	J	MS/MSD recovery is outside acceptance limits.	Chloride
MW012-E2			Bromide

Notes:

J = Value is estimated.

U = Parameter was not detected. Method reporting limit is presented as parameter concentration.

Elevated reporting limits and sample receipt issues for Event 2 are presented in the Data Validation Report

Table 3
Event 3 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
MW001-E3	J	Blank qualifiers associated with these samples were assigned a J flag. The result was above the reporting limit, but less than ten times greater than the reporting limit.	Pentachlorophenol
MW004-E3			
MW006R-E3			
B005R-E3	U	Blank qualifiers associated with these samples were detected at concentrations between the MDL and RL. These data were assigned a U flag and reported at the RL/PQL.	
B505R-E3			
MW003-E3			
PWMB-E3			
WCTSW004B-E3			
MW002R-E3	None	Blank qualifiers associated with these samples were dropped. Sample results were ten times greater than the RL/PQL.	
MW005R-E3			
BWSW001-E3	None	Blanks detected above the MDL, but below the RL. Parameter detected above the RL. B qualifier dropped.	Calcium
WCTSW001B-E3			
WCTSW002B-E3			
WCTSW003B-E3			
USSW001-E3			
WCTPW001A-10-E3			
WCTPW001B-10-E3			
WCTPW002A-10-E3			
WCTPW002B-10-E3			
WCTPW003A-10-E3			
WCTPW003B-10-E3			
B005R-E3			Iron (Dissolved)
MW007-E3			
WCTPW001A-10-E3	J	Parameter concentration above calibration range.	Chloride
WCTPW001B-10-E3			
WCTPW002A-10-E3			
WCTPW002B-10-E3			
WCTPW003A-10-E3			
WCTPW003B-10-E3			
WCTPW001A-10-E3	UJ	Matrix spike %R 30-74%	Ortho-Phosphate
BWSW001-E3		Matrix spike %R 30-75%	Sulfide
WCTPW001A-10-E3	R	Matrix spike %R=0, and ND Table 19 NFG (inorganics)	Fluoride
WCTPW001A-10-E3			Nitrite as N
B006R-E3	J	Matrix spike %R = 76%	Dissolved Organic Carbon
MW007-E3		Matrix spike %R =119%	Sulfate

Notes:

J = Value is estimated.

U = Parameter was not detected. Method reporting limit is presented as parameter concentration.

UJ = Parameter is estimated as not present above the method detection limit. Method reporting limit is presented as parameter concentration.

R = Data is rejected

Table 4
Event 4 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
B001R-E4	UJ	Sample prepped beyond the specified holding time.	Nitrate as N
HC002-E4			
WCTPW001A-10-E4			
WCTPW001B-10-E4			
WCTPW002B-10-E4			
WCTPW003A-10-E4			
WCTPW003B-10-E4			
B001R-E4			Nitrite as N
HC002-E4			
WCTPW001A-10-E4			
WCTPW001B-10-E4			
WCTPW002B-10-E4			
WCTPW003A-10-E4			
WCTPW003B-10-E4			
WCTPW002A-10-E4	J		Nitrate as N
WCTPW002A-10-E4			Nitrite as N
USSW001-E4	U	MS/MSD high. Result not detected. Qualifier dropped.	Bromide
USSW001-E4		MS/MSD high. Result not detected. Qualifier dropped.	Nitrite as N
USSW001-E4	J	MS %R high. %R~188-133	Fluoride
WCTSW001B-E4			Arsenic (Dissolved)
USSW001-E4			Chloride
USSW001-E4			Nitrate as N
USSW001-E4			Sulfate
HC002-E4		MS %R low. %R ~75%	Ortho-Phosphate
OF2-E4		MS %R low. %R=84	Dissolved Organic Carbon

Table 4
Event 4 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
B001R-E4	J	Blank qualifiers associated with these samples were assigned a J flag. The result was above the reporting limit, but less than ten times greater than the reporting limit.	Dissolved Organic Carbon
B003R-E4			
B005R-E4			
B505R-E4			
BWSW001-E4			
HC002-E4			
MW002R-E4			
MW004-E4			
MW005R-E4			
MW006R-E4			
MW007-E4			
MW013-E4			
MW507-E4			
OF3-E4			
USSW001-E4			
WCTPW001B-10-E4			
WCTPW002A-10-E4			
WCTSW001B-E4			
WCTSW002B-E4			
WCTSW003B-E4			
WCTSW004B-E4			
B001R-E4			Total Organic Carbon
B003R-E4			
B005R-E4			
B505R-E4			
HC002-E4			
MW003-E4			
MW005R-E4			
MW006R-E4			
MW013-E4			
B006R-E4	None	Blank qualifiers associated with these samples were dropped. Sample results were ten times greater than the RL/PQL.	Dissolved Organic Carbon
MW001-E4			
MW003-E4			
MW008-E4			
MW009-E4			
MW010-E4			
MW012-E4			
WCTPW001A-10-E4			
B005R-E4			Iron (Dissolved)
MW007-E4			
MW002R-E4			Pentachlorophenol
MW010-E4			Total Organic Carbon

Table 4
Event 4 Data Validation Summary

Sample ID	Data Validator Assigned Qualifier	Data Validator Comment	Analyte(s)
WCTPW001A-10-E4	None	RL is elevated due to a dilution.	Bromide
WCTPW001B-10-E4			
WCTPW002A-10-E4			
WCTPW002B-10-E4			
WCTPW003A-10-E4			
WCTPW003B-10-E4			
B001R-E4			Chloride
MW009-E4			
MW010-E4			
MW012-E4			
WCTPW001A-10-E4			
WCTPW001B-10-E4			
WCTPW002A-10-E4			
WCTPW002B-10-E4			
WCTPW003A-10-E4			
WCTPW003B-10-E4			
MW007-E4			Sulfate
MW012-E4			
MW507-E4			
WCTPW001A-10-E4			
WCTPW001B-10-E4			
WCTPW002A-10-E4			
WCTPW002B-10-E4			
WCTPW003A-10-E4			
WCTPW003B-10-E4			

Notes:

J = Value is estimated.

U = Parameter was not detected. Method reporting limit is presented as parameter concentration.

UJ = Parameter is estimated as not present above the method detection limit. Method reporting limit is presented as parameter concentration.

Table 5. Porewater Equipment Blanks Sample Results

	Event #	***Units***	**1**	**2**	**3**	**4**
	Sample ID		**WCTPW5MB-E1**	**WCTPW5MB-E2**	**PWMB-E3**	**PWMB-E4**
Analyte	Total Organic Carbon	*mg/L*	9.3	0.55 J	0.22 J	5.6
	Total Suspended Solids	*mg/L*	--	--	--	4.2 U
	Dissolved Organic Carbon	*mg/L*	8.8	0.32 J	0.33 J	5.4
	Arsenic (Dissolved)	*ug/L*	1.01 U	0.04 U	0.012 J	0.056
	Arsenic (Total)	*ug/L*	2.02 U	1.01 U	1.01 U	1.01 U
	Iron (Dissolved)	*ug/L*	21.5 U	0.86 U	4.04 U	1.16
	Manganese (Dissolved)	*ug/L*	2.62	0.064 U	0.163	0.045 J
	Pentachlorophenol	*ug/L*	--	0.11 J	0.084 U	0.089
	Sulfide	*mg/L*	0.05 U	0.05 U	0.05 U	0.05 U
	Nitrate as N	*mg/L*	0.13 J	--	--	--
	Nitrite as N	*mg/L*	0.4 U	--	--	--

Notes:

mg/L = milligrams per liter
ug/L = micrograms per liter
-- = not measured
J = Estimated result
U = Non-detected result, reported at the PQL
PQL = Practical quantitation limit

Table 6 Field Duplicate Sample Results

Sample Type	Location	Sample Matrix	Sample ID	General Parameters			Metals and Speciation data										Pentachlorophenol	pH	Cations			
				Total Organic Carbon	Total Suspended Solids	Dissolved Organic Carbon	Arsenic (Total)	Arsenic (Dissolved)	Arsenate	Arsenite	Cacodylic acid	Monomethyl-arsonic acid	Iron (Dissolved)	Ferric iron	Ferrous iron	Manganese (Dissolved)			Calcium	Magnesium	Potassium	Sodium
			Units	**mg/L**	**mg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**SU**	**mg/L**	**mgL**	**mg/L**	**mg/L**
Event 1																						
Parent	Sawmill	Groundwater	MW003-E1	38		40	11.1	11.1					48000	12500	35500	1420	0.89	6.74	66	32	2.6 J	37
Duplicate		Groundwater	MW503-E1	38		40	10.6	10.8					47700	11300	36500	1430	0.86	6.68	66	31	2.5 J	37
			Percent Difference	*0%*		*0%*	*5%*	*3%*					*1%*	*10%*	*3%*	*1%*	*3%*	*1%*	*0%*	*3%*	*4%*	*0%*
Parent	Sawmill	Groundwater	MW006R-E1	23		24	1.75 J	2.13					48000			6120	1	6.41				
Duplicate		Groundwater	MW506R-E1	24		24	1.825 J	1.97					48700			6360						
			Percent Difference	*4%*		*0%*	*4%*	*8%*					*1%*			*4%*						
Parent	Logyard	Groundwater	TBGW007-E1	71		81	373	202	272	73.6	2.1 U	2.3 U	0	61100	73700	4820			58	56	75	340
Duplicate		Groundwater	TBGW507-E1	69		80	205	212	199	37.2	2.1 U	2.3 U	0	61400	73500	4810			61	58	78	340
			Percent Difference	*3%*		*1%*	*58%*	*5%*	*31%*	*66%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*			*5%*	*4%*	*4%*	*0%*
Parent	Sawmill	Surface Water	WCTSW004B-E1	3		2.5	0.92 J	0.432 J					201	194	7 J	65.2	0.021 U	7.41	19	16	4.6	64
Duplicate		Surface Water	WCTSW504B-E1	2.5		2.3	1.16 J	0.456 J					166	88.7	77.1	64.1	0.072	7.39	19	17	4.8	65
			Percent Difference	*18%*		*8%*	*23%*	*5%*					*19%*	*74%*	*167%*	*2%*	*110%*	*0%*	*0%*	*6%*	*4%*	*2%*
Event 2																						
Parent	Sawmill	Groundwater	B005R-E2	19	2 U	18	1.06 U	0.521 J					32200			1060	0.049					
Duplicate		Groundwater	B505R-E2	18	4.8	18	1.06 U	40.4 U					31800			1070	0.051					
			Percent Difference	*5%*	*82%*	*0%*	*0%*	*195%*					*1%*			*1%*	*4%*					
Parent	Logyard	Groundwater	MW010-E2	54	42	65	33700	32000	10700	23400	210 U	230 U	0			5220			85	30	29	72
Duplicate		Groundwater	MW510-E2	56	62	65	34700	28200	10200	24000	210 U	230 U	0			5290			88	31	30	74
			Percent Difference	*4%*	*38%*	*0%*	*3%*	*13%*	*5%*	*3%*	*0%*	*0%*	*1%*			*1%*			*347%*	*3%*	*3%*	*3%*
Parent	Logyard	Surface Water	WCTSW001B-E2	4.1	110	3.1	9.88	1.97 J					447			128			42	91	31	720
Duplicate		Surface Water	WCTSW501B-E2	4.4	110	3.3	7.29	1.76					441			126			43	93	32	720
			Percent Difference	*7%*	*0%*	*6%*	*30%*	*11%*					*1%*			*2%*			*2%*	*2%*	*3%*	*0%*
Event 3																						
Parent	Sawmill	Groundwater	B005R-E3	17	2 U	15	1.70	0.44 J					27600			1010	0.088 U					
Duplicate		Groundwater	B505R-E3	17	2 U	15	1.72	0.305 J					27800			1040	0.087 U					
			Percent Difference	*0%*	*0%*	*0%*	*1%*	*36%*					*1%*			*3%*	*1%*					
Parent	Logyard	Groundwater	MW007-E3	12	55	23	15.6	13.2	9.71	3.75	1.05 U	1.15 U	59100			2770			53	30	24	37
Duplicate		Groundwater	MW507-E3	13	60	21	14.7	14.7	8.00	4.33	1.05 U	1.15 U	61100			2850			59	35	24	39
			Percent Difference	*8%*	*9%*	*9%*	*6%*	*11%*	*19%*	*14%*	*0%*	*0%*	*3%*			*3%*			*11%*	*15%*	*0%*	*5%*
Event 4																						
Parent	Sawmill	Groundwater	B005R-E4	17 J	3.2	17 J	0.317 J	1.01 U					25700			951	0.43					
Duplicate		Groundwater	B505R-E4	16 J	2.8	16 J	1.01 U	1.01 U					25900			944	0.09 U					
			Percent Difference	*6%*	*13%*	*6%*	*104%*	*0%*					*1%*				*131%*					
Parent	Logyard	Groundwater	MW007-E4	6.1	5.2	5.1 J	0.951 J	1.14	0.221 J	0.591	0.077 J	0.575 U	1880			781			18	8.6	15	7.1
Duplicate		Groundwater	MW507-E4	7.6	3.8	5.4 J	0.93 J	1.08	0.183 J	0.641	0.088 J	0.575 U	1860			868			18	9	16	7.5
			Percent Difference	*22%*	*31%*	*6%*	*2%*	*5%*	*19%*	*8%*	*13%*	*0%*	*1%*			*11%*			*0%*	*5%*	*6%*	*5%*

Notes:

mg/L = milligrams per liter

ug/L = micrograms per liter

J = Estimated result

U = Non-detected result, reported at the PQL.

PQL = Practical quantitation limit

Duplicates with a relative percent difference (RPD) greater than the 35% are highlighted.

Table 6 Field Duplicate Sample Results

Sample Type	Location	Sample Matrix	Sample ID	Anions											
				Bromide	Chloride	Fluoride	Nitrate as N	Nitrite as N	Ortho-Phosphate	Sulfate	Sulfide	Alkalinity as Bicarbonate	Alkalinity as Carbonate	Alkalinity as Hydroxide	Alkalinity, Total
			Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Event 1															
Parent	Sawmill	Groundwater	MW003-E1	0.5 U	23	0.91	0.2 U	0.4 U	1.3	0.73 J	0.05 U	330	5 U	5 U	330
Duplicate		Groundwater	MW503-E1	0.5 U	23	0.9	0.2 U	0.4 U	1.4	0.76 J	0.05 U	330	5 U	5 U	330
			Percent Difference	*0%*	*0%*	*1%*	*0%*	*0%*	*7%*	*4%*	*0%*	*0%*	*0%*	*0%*	*0%*
Parent	Sawmill	Groundwater	MW006R-E1								0.01 J				
Duplicate		Groundwater	MW506R-E1								0.012 J				
			Percent Difference								*19%*				
Parent	Logyard	Groundwater	TBGW007-E1	1.1	130	0.81	0.2 U	0.4 U	0.17	0.48 J	0.05 U	920	5 U		
Duplicate		Groundwater	TBGW507-E1	1.1	150	0.81	0.2 U	0.4 U	0.16	0.51 J	0.05 U	910	5 U		
			Percent Difference	*0%*	*14%*	*0%*	*0%*	*0%*	*6%*	*6%*	*0%*	*1%*	*0%*		
Parent	Sawmill	Surface Water	WCTSW004B-E1	0.5 U	120	0.09 J	2.1	0.4 U	0.1	23	0.05 U	96	5 U		
Duplicate		Surface Water	WCTSW504B-E1	0.5 U	120	0.09 J	2	0.4 U	0.1 U	23	0.05 U	100	5 U		
			Percent Difference	*0%*	*0%*	*0%*	*5%*	*0%*	*0%*	*0%*	*0%*	*4%*	*0%*		
Event 2															
Parent	Sawmill	Groundwater	B005R-E2								1 U				
Duplicate		Groundwater	B505R-E2								1 U				
			Percent Difference								*0%*				
Parent	Logyard	Groundwater	MW010-E2	0.5 U	11	0.43	0.2 U	0.4 U	1.4	1.2 U	1 U	660	5 U	5 U	660
Duplicate		Groundwater	MW510-E2	0.5 U	11	0.43	0.56	0.4 U	1.4	1.2 U	1 U	660	5 U	5 U	660
			Percent Difference	*0%*	*0%*	*0%*	*95%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Parent	Logyard	Surface Water	WCTSW001B-E2	4.5	1500	0.24 J	1.7	0.4 U	0.1 U	180	0.05 U	140	5 U	5 U	140
Duplicate		Surface Water	WCTSW501B-E2	4.6	1500	0.22	1.7	0.4 U	0.1 U	180	0.05 U	130	5 U	5 U	130
			Percent Difference	*2%*	*0%*	*9%*	*0%*	*0%*	*0%*	*0%*	*0%*	*7%*	*0%*	*0%*	*7%*
Event 3															
Parent	Sawmill	Groundwater	B005R-E3								0.047 J				
Duplicate		Groundwater	B505R-E3								0.028 J				
			Percent Difference								*51%*				
Parent	Logyard	Groundwater	MW007-E3	0.5 U	26	0.73	0.13 J	0.4 U	0.1 U	95 J	0.05 U	310	5 U	5 U	310
Duplicate		Groundwater	MW507-E3	0.5 U	25	0.71	0.2 U	0.4 U	0.1 U	95	0.05 U	370	5 U	5 U	370
			Percent Difference	*0%*	*4%*	*3%*	*42%*	*0%*	*0%*	*0%*	*0%*	*18%*	*0%*	*0%*	*18%*
Event 4															
Parent	Sawmill	Groundwater	B005R-E4								0.05 U				
Duplicate		Groundwater	B505R-E4								0.05 U				
			Percent Difference								*0%*				
Parent	Logyard	Groundwater	MW007-E4	0.1 U	3.56	0.359	U U	0.1 U	0.11	44.2	0.05 U	70	5 U	5 U	70
Duplicate		Groundwater	MW507-E4	0.1 U	3.56	0.362	U U	0.1 U	0.12	43.9	0.05 U	70	5 U	5 U	70
			Percent Difference	*0%*	*0%*	*1%*		*0%*	*9%*	*1%*	*0%*	*0%*	*0%*	*0%*	*0%*

Notes:

mg/L = milligrams per liter

ug/L = micrograms per liter

J = Estimated result

U = Non-detected result, reported at the PQL.

PQL = Practical quantitation limit

Duplicates with a relative percent difference (RPD) greater than the 35% are highlighted.

Table 7. Metals Split Sample Results

Sample_ID	Location	Sample Matrix	Event #	Units	Metals Split			Metals Split			Metals Split			Metals Split		
					Arsenic (Dissolved)			Arsenic (Total)			Iron (Dissolved)			Manganese (Dissolved)		
					Parent (Brooks)	Split (Test America)	*Percent Difference*	Parent (Brooks)	Split (Test America)	*Percent Difference*	Parent (Brooks)	Split (Test America)	*Percent Difference*	Parent (Brooks)	Split (Test America)	*Percent Difference*
MW013-E1	Logyard	Groundwater	1	ug/L	34300	36000	5%	33700	34000	1%	113000	120000	6%	6340	6500	2%
TBGW001-E1	Logyard	Groundwater	1	ug/L	102	100	2%	151	140	8%	3480	2600	29%	1060	1000	6%
MW010-E2	Logyard	Groundwater	2	ug/L	32000	34000	6%	33700	38000	12%	143000	160000	11%	5220	5400	3%
MW007-E3	Logyard	Groundwater	3	ug/L	13.2	16	19%	15.6	12	26%	59100	78000	28%	2770	3100	11%
MW007-E4	Logyard	Groundwater	4	ug/L	1.14	1.6 J	34%	0.951 J	1.4 J	38%	1880	2100	11%	781	820	5%
WCTPW001B-40-E1	Logyard	Porewater Deep	1	ug/L	3.81	43	167%	11.4	--	--	9660	18000	60%	1140	1200	5%
WCTPW001B-10-E1	Logyard	Porewater Shallow	1	ug/L	2.27	35	176%	26.5	28	6%	562	12000	182%	1280	820	44%
WCTPW001B-10-E3	Logyard	Porewater Shallow	3	ug/L	15.8	13	19%	20.6	14	38%	7420	6700	10%	1680	810	70%
WCTPW001B-10-E4	Logyard	Porewater Shallow	4	ug/L	13.4	19	35%	17	26	42%	13700	6500	71%	1430	610	80%
WCTSW001B-E2	Logyard	Surface Water	2	ug/L	1.97	2.8 J	35%	9.88	3.5 J	95%	447	560 J	22%	128	130	2%
WCTSW001B-E3	Logyard	Surface Water	3	ug/L	0.922 J	1.5 J	48%	11.9	9.1	27%	777	910	16%	130	110	17%
WCTSW001B-E4	Logyard	Surface Water	4	ug/L	0.506 J	2 J	119%	11.2	17	41%	630	750	17%	117	130	11%
MW003-E1	Sawmill	Groundwater	1	ug/L	11.1	12	8%	11.1	13	16%	48000	51000	6%	1420	1700	18%
B005R-E2	Sawmill	Groundwater	2	ug/L	0.521 J	17	188%	1.06 U	2.1 J	66%	32200	35000	8%	1060	1100	4%
B005R-E3	Sawmill	Groundwater	3	ug/L	0.44 J	5 U	168%	1.7	5 U	99%	27600	30000	8%	1010	1000	1%
B005R-E4	Sawmill	Groundwater	4	ug/L	1.01 U	5 U	133%	0.317 J	5 U	176%	25700	27000	5%	951	880	8%
TPS001-0.5_1.5	Sawmill	Soil	1	ug/L	--	--		3.93	3.4	14%	--	--		--	--	
TPS001F-1.5_2.5	Sawmill	Soil	1	ug/L	--	--		27.5	43	44%	--	--		--	--	

Notes:

-- = not measured

ug/L = micrograms per liter

J = Estimated result

U = Non-detected result reported at the PQL.

PQL= Practical quantitation limit

ATTACHMENT 1

Test America Reporting Limit for Pentachlorophenol

Jacob Gorski

From:	Cruz, Sheri <Sheri.Cruz@testamericainc.com>
Sent:	Tuesday, June 6, 2017 3:24 PM
To:	Jacob Gorski
Subject:	PCP MDLs

Test America (TA) began observing frequent detections of pentachlorophenol (PCP) in blank samples using Method 8270 SIM for Event 2, and continued to detect PCP in blank samples for Events 3 and 4. In December 2016, EPA revised the Definition and Procedure for the Determination of the Method Detection Limit from 40 CFR 136, Appendix B to address such blank detection issues. Under revision 2, the new definition of the MDL is as follows: "The MDL is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results." (EPA 821-R-16-006 December 2016) The reporting limit (RL) must be higher than MDL and must be at or above the low point in the calibration curve.

EPA considers this change important because as detector sensitivity improves, the background contamination of the laboratory, consumable supplies, and equipment can be more important in determining the detection limit than the sensitivity of the instrument.

Samples used to calculate the MDL are representative of laboratory performance throughout the year, rather than on a single date. Each instrument can display differences in performance for any given compound based on many different factors, including, age of the instrument, column in use, tuning practices etc. so the current MDL and RL for PCP may change. However, TA attempts to set the RL at a level high enough so that that it will not need adjustment.

Based on EPA's revisions to 40 CFR 136, TA has set the MDL for PCP using 8270SIM and 1 L volumes to 0.215 ug/L, and the RL to 1 ug/L, as shown in the table below:

Analyte	3520 MDL (ug/L)	RL (ug/L)
1-Methylnaphthalene	0.016	0.1
2-Methylnaphthalene	0.02	0.1
Acenaphthene	0.006	0.1
Acenaphthylene	0.044	0.2
Anthracene	0.007	0.1
Benzo[a]anthracene	0.006	0.1
Benzo[a]pyrene	0.035	0.1
Benzo[b]fluoranthene	0.006	0.1
Benzo[g,h,i]perylene	0.076	0.2
Benzo[k]fluoranthene	0.013	0.1
Chrysene	0.006	0.1
Dibenz(a,h)anthracene	0.006	0.1
Fluoranthene	0.013	0.1
Fluorene	0.013	0.1
Indeno[1,2,3-cd]pyrene	0.006	0.1
Pentachlorophenol	0.215	1
Phenanthrene	0.019	0.1
Pyrene	0.009	0.1

SHERI CRUZ

Project Manager

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

5755 8th Street East
Tacoma, WA 98424
Tel: 253-922-2310 | Dir 253.248.4960
www.testamericainc.com

Appendix G: Terrestrial Ecological Evaluation (TEE) Waiver Form

DEPARTMENT OF
ECOLOGY
State of Washington

Voluntary Cleanup Program

Washington State Department of Ecology
Toxics Cleanup Program

TERRESTRIAL ECOLOGICAL EVALUATION FORM

Under the Model Toxics Control Act (MTCA), a terrestrial ecological evaluation is necessary if hazardous substances are released into the soils at a Site. In the event of such a release, you must take one of the following three actions as part of your investigation and cleanup of the Site:

1. Document an exclusion from further evaluation using the criteria in WAC 173-340-7491.
2. Conduct a simplified evaluation as set forth in WAC 173-340-7492.
3. Conduct a site-specific evaluation as set forth in WAC 173-340-7493.

When requesting a written opinion under the Voluntary Cleanup Program (VCP), you must complete this form and submit it to the Department of Ecology (Ecology). The form documents the type and results of your evaluation.

Completion of this form is not sufficient to document your evaluation. You still need to document your analysis and the basis for your conclusion in your cleanup plan or report.

If you have questions about how to conduct a terrestrial ecological evaluation, please contact the Ecology site manager assigned to your Site. For additional guidance, please refer to www.ecy.wa.gov/programs/tcp/policies/terrestrial/TEEHome.htm.

Step 1: IDENTIFY HAZARDOUS WASTE SITE

Please identify below the hazardous waste site for which you are documenting an evaluation.

Facility/Site Name: Parcel 15 (Port of Tacoma)

Facility/Site Address: 4215 SR 509 - North Frontage Road, Tacoma, WA 98421

Facility/Site No: 1215	VCP Project No.: 3642

Step 2: IDENTIFY EVALUATOR

Please identify below the person who conducted the evaluation and their contact information.

Name: Steven Kuhlmeier	Title: Civ/Env Engineer

Organization: GSI Water Solutions, Inc.

Mailing address: 55 SW Yamhill St, Ste 300

City: Portland	State: OR	Zip code: 97204
Phone: 971-200-8529	Fax:	E-mail: skuhlmeier@gsiws.com

Step 3: DOCUMENT EVALUATION TYPE AND RESULTS

A. Exclusion from further evaluation.

1. Does the Site qualify for an exclusion from further evaluation?

☒ Yes — *If you answered **"YES,"** then answer **Question 2**.*

☐ No or Unknown — *If you answered **"NO" or "UKNOWN,"** then skip to **Step 3B** of this form.*

2. What is the basis for the exclusion? *Check all that apply. Then skip to **Step 4** of this form.*

Point of Compliance: WAC 173-340-7491(1)(a)

☐ All soil contamination is, or will be,* at least 15 feet below the surface.

☐ All soil contamination is, or will be,* at least 6 feet below the surface (or alternative depth if approved by Ecology), and institutional controls are used to manage remaining contamination.

Barriers to Exposure: WAC 173-340-7491(1)(b)

☒ All contaminated soil, is or will be,* covered by physical barriers (such as buildings or paved roads) that prevent exposure to plants and wildlife, and institutional controls are used to manage remaining contamination.

Undeveloped Land: WAC 173-340-7491(1)(c)

☐ There is less than 0.25 acres of contiguous# undeveloped± land on or within 500 feet of any area of the Site and any of the following chemicals is present: chlorinated dioxins or furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, or pentachlorobenzene.

☐ For sites not containing any of the chemicals mentioned above, there is less than 1.5 acres of contiguous# undeveloped± land on or within 500 feet of any area of the Site.

Background Concentrations: WAC 173-340-7491(1)(d)

☐ Concentrations of hazardous substances in soil do not exceed natural background levels as described in WAC 173-340-200 and 173-340-709.

* An exclusion based on future land use must have a completion date for future development that is acceptable to Ecology.

± "Undeveloped land" is land that is not covered by building, roads, paved areas, or other barriers that would prevent wildlife from feeding on plants, earthworms, insects, or other food in or on the soil.

"Contiguous" undeveloped land is an area of undeveloped land that is not divided into smaller areas of highways, extensive paving, or similar structures that are likely to reduce the potential use of the overall area by wildlife.

B. Simplified evaluation.

1. Does the Site qualify for a simplified evaluation?

☐ Yes *If you answered **"YES,"** then answer **Question 2** below.*

☐ No or Unknown *If you answered **"NO"** or **"UNKNOWN,"** then skip to **Step 3C** of this form.*

2. Did you conduct a simplified evaluation?

☐ Yes *If you answered **"YES,"** then answer **Question 3** below.*

☐ No *If you answered **"NO,"** then skip to **Step 3C** of this form.*

3. Was further evaluation necessary?

☐ Yes *If you answered **"YES,"** then answer **Question 4** below.*

☐ No *If you answered **"NO,"** then answer **Question 5** below.*

4. If further evaluation was necessary, what did you do?

☐ Used the concentrations listed in Table 749-2 as cleanup levels. *If so, then skip to **Step 4** of this form.*

☐ Conducted a site-specific evaluation. *If so, then skip to **Step 3C** of this form.*

5. If no further evaluation was necessary, what was the reason? *Check all that apply. Then skip to **Step 4** of this form.*

Exposure Analysis: WAC 173-340-7492(2)(a)

☐ Area of soil contamination at the Site is not more than 350 square feet.

☐ Current or planned land use makes wildlife exposure unlikely. Used Table 749-1.

Pathway Analysis: WAC 173-340-7492(2)(b)

☐ No potential exposure pathways from soil contamination to ecological receptors.

Contaminant Analysis: WAC 173-340-7492(2)(c)

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations that exceed the values listed in Table 749-2.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations that exceed the values listed in Table 749-2, and institutional controls are used to manage remaining contamination.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays, and institutional controls are used to manage remaining contamination.

C. Site-specific evaluation. A site-specific evaluation process consists of two parts: (1) formulating the problem, and (2) selecting the methods for addressing the identified problem. Both steps require consultation with and approval by Ecology. *See* WAC 173-340-7493(1)(c).

1. Was there a problem? *See* WAC 173-340-7493(2).

☐ Yes *If you answered **"YES,"** then answer **Question 2** below.*

☐ No *If you answered **"NO,"** then identify the reason here and then skip to **Question 5** below:*

☐ No issues were identified during the problem formulation step.

☐ While issues were identified, those issues were addressed by the cleanup actions for protecting human health.

2. What did you do to resolve the problem? *See* WAC 173-340-7493(3).

☐ Used the concentrations listed in Table 749-3 as cleanup levels. *If so, then skip to **Question 5** below.*

☐ Used one or more of the methods listed in WAC 173-340-7493(3) to evaluate and address the identified problem. *If so, then answer **Questions 3 and 4** below.*

3. If you conducted further site-specific evaluations, what methods did you use? *Check all that apply. See* WAC 173-340-7493(3).

☐ Literature surveys.

☐ Soil bioassays.

☐ Wildlife exposure model.

☐ Biomarkers.

☐ Site-specific field studies.

☐ Weight of evidence.

☐ Other methods approved by Ecology. If so, please specify:

4. What was the result of those evaluations?

☐ Confirmed there was no problem.

☐ Confirmed there was a problem and established site-specific cleanup levels.

5. Have you already obtained Ecology's approval of both your problem formulation and problem resolution steps?

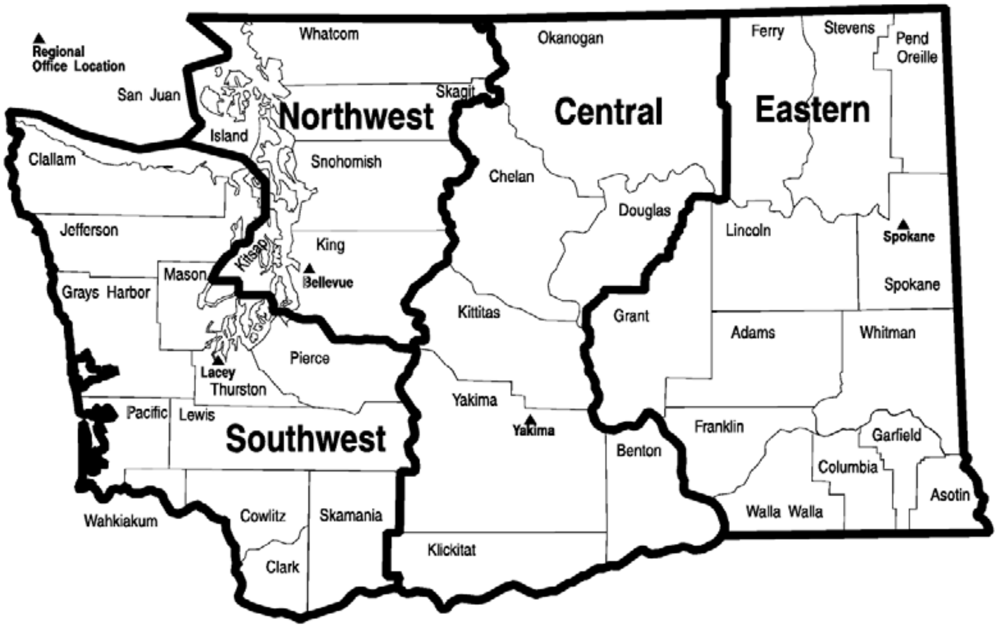
☐ Yes If so, please identify the Ecology staff who approved those steps:

☐ No

Step 4: SUBMITTAL

Please mail your completed form to the Ecology site manager assigned to your Site. If a site manager has not yet been assigned, please mail your completed form to the Ecology regional office for the County in which your Site is located.

Northwest Region: Attn: VCP Coordinator 3190 160th Ave. SE Bellevue, WA 98008-5452	**Central Region:** Attn: VCP Coordinator 1250 West Alder St. Union Gap, WA 98903-0009
Southwest Region: Attn: VCP Coordinator P.O. Box 47775 Olympia, WA 98504-7775	**Eastern Region:** Attn: VCP Coordinator N. 4601 Monroe Spokane WA 99205-1295



Appendix H

Specialized Geochemical Testing Results and Fate and Transport Evaluation, Parcel 15 (Portac), Tacoma, Washington

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

June 28, 2017

416 NE Dallas Street, Camas, Washington 98607 • (360) 566-7119

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Acronyms and Abbreviations

As(III)	Arsenite
As(V)	Arsenate
BAT	Batch adsorption tests
Eh	Redox Potential of Standard Hydrogen Electrode
Fe(II)	Ferrous iron
Fe(III)	Ferric iron
Ferrihydrite	$Fe(OH)_3$
FS	Feasibility Study
FSTM	Feasibility Study Technical Memorandum
Goethite	FeOOH
K_D	Distribution coefficient
LLNL	Lawrence Livermore National Laboratory
L/kg	liters per kilogram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MTCA	Model Toxics Control Act
ORP	Oxidation-Reduction Potential
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	Surface complexation model
Scorodite	$FeAsO_4{:}2H_2O$
Site	Parcel 15
S:L	Solid-to-liquid ratio
Symplesite	$Fe_3(AsO_4)_2$
TEAP	Terminal Electron Accepting Process
ug/L	micrograms per liter

Executive Summary

This appendix to the RI Report presents the results of an evaluation of soil, sediment, groundwater, and porewater data collected to identify geochemical processes that affect the fate and transport of arsenic at Parcel 15 (the Site).

Elevated concentrations of arsenic in soil and groundwater is associated with the historical use of slag as ballast in the Log Yard. Groundwater concentrations within the Log Yard are highest in an upland area where slag-containing fill is interacting with perched water. As shown in Figure ES-1, groundwater arsenic concentrations in this area average 41,238 ug/L (41.2 mg/L).

The fate and transport of arsenic during groundwater flow towards Wapato Creek depends on the potential for sequestration by soil minerals via precipitation, co-precipitation, and/or adsorption (Figure ES-2). At the relatively-low arsenic concentrations found in most groundwater, fate and transport is predominantly controlled by adsorption-desorption reactions, which involve the binding of arsenic to the surfaces of soil minerals, particularly iron oxyhydroxide minerals, which are ubiquitous in soils and sediments (Section 2). Within the Log Yard, arsenic fate and transport is additionally controlled by interactions between arsenic and dissolved iron, the latter of which is significantly elevated due to the presence of relatively-reducing redox conditions, which stabilize dissolved ferrous iron in groundwater. High iron concentrations promote iron arsenate mineral precipitation and arsenic co-precipitation, both of which can effectively immobilize arsenic (Figure ES-2). The prevalence of precipitation and co-precipitation processes increase as arsenic concentrations increase.

Evidence for arsenic attenuation includes the occurrence of elevated soil concentrations beneath the source area (Figure ES-3), and dramatically-lower groundwater concentrations immediately downgradient of it (Figure ES-1). In addition, laboratory testing and geochemical modeling (described in Section 3) demonstrate arsenic precipitation, co-precipitation, and adsorption processes are all occurring. The importance of different attenuation processes along the downgradient (west-to-east) transect shown in Figure ES-1 includes the following:

- Log Yard Source Area: In source area groundwater, the primary attenuation process for arsenic is iron arsenate mineral precipitation (Figure ES-1). Evidence for precipitation includes (1) the identification of these minerals in induced precipitation tests using Site groundwater (Sections 4), and (2) groundwater that is approximately saturated by (or in equilibrium with) various iron arsenates (Section 5).

  Arsenic is also being attenuated by adsorption to, and co-precipitation with, iron oxyhydroxides and mixed Fe(II)/Fe(III) layered hydroxides (such as green rust) in the source area. Adsorption was directly demonstrated in batch adsorption tests (BAT) using Site soils (Section 4.4). Also, evidence for co-precipitation includes the removal of arsenic along with green rust-type phases in anaerobic-arsenite induced precipitation tests (Section 4.3). Finally, sequential extraction tests found that most arsenic in source area soils is associated with insoluble (co-precipitated) mineral fractions (Section 4.2).

- Log Yard Groundwater: In groundwater located downgradient of the source area (and containing lower arsenic concentrations), the primary arsenic attenuation process is likely adsorption; however, co-precipitation and/or mineral precipitation also occur (Figure ES-1). Attenuation was directly demonstrated by sequential extraction tests on Log Yard soils, which found a significant amount of arsenic in the exchangeable (adsorbed) fraction (F2) and the oxide and residual (co-precipitated) fractions (F4-F5) (Figure ES-3) (Section 4.2). Whereas adsorption is likely ubiquitous (as demonstrated by significant arsenic adsorption in the BAT in all Site soils and sediments), co-precipitation is more-likely in areas where redox gradients are present. For example, co-precipitation could occur in shallow groundwater where vadose zone infiltration is potentially causing the mixing between more-oxidized vadose zone porewater and groundwater (leading to iron oxyhydroxide and/or green rust precipitation and arsenic co-precipitation).

- Transition Zone and Shallow Porewater: The fate and transport of arsenic near of Wapato Creek is affected by terminal electron accepting processes (TEAPs) and groundwater mixing (Section 2). TEAPs in shallow porewater are microbiologically-mediated reactions that can cause reductive dissolution of iron oxyhydroxides and release of adsorbed arsenic in shallow sediments at rates that produce naturally-high dissolved concentrations (note: re-precipitation (and sequestration) of arsenic is also possible higher in the sediment profile, near the sediment-water interface). By contrast, groundwater mixing with surface water can significantly decrease arsenic concentrations in nearshore groundwater and porewater. The effect of mixing is to additionally introduce oxygenated surface water into the subsurface, which promotes the oxidation of ferrous iron and its subsequent precipitation as ferric (including iron arsenate minerals and iron oxyhydroxide minerals containing arsenic).

  Evidence that arsenic attenuation is occurring near Wapato Creek includes the formation of iron arsenate and iron oxyhydroxide in the induced precipitation tests conducted on Site groundwater under aerobic conditions (Section 4.3). In addition, arsenic adsorption by iron oxyhydroxides was demonstrated in the BAT, and found to be significant in shallow sediments (Section 4.4).

In the future, groundwater redox conditions are likely to remain iron-reducing, due to ferrous iron mineral buffers and ongoing degradation of organics from wood waste and natural humic matter (Section 6). Therefore, the same attenuation processes identified in this study are predicted to continue. Even if all wood waste were to be removed from the Site, reducing conditions would likely persist in the groundwater for an extended period (i.e., hundreds of years), and attempting to modify the Site groundwater conditions (i.e., to create oxidizing conditions) may be unsuccessful because reducing conditions will tend to result in “rebound” to current conditions.

Factors that might improve observed attenuation performance will be further evaluated in the FS. These may include reducing leaching in the upland source areas, flattening groundwater gradients, or adding iron-containing media along the groundwater flow path.

Section 1
Introduction

1.1 Site Background

Parcel 15 (the Site) consists of an approximately 52-acre parcel of land in an industrial area between Interstate 5 and Commencement Bay, in Tacoma, Washington (Figure 1-1). Portac, Inc. and its predecessors leased the Site from the Port of Tacoma beginning in 1974, and vacated the Site in 2009. The Site consists of two functionally distinct historical areas: the former sawmill area (Sawmill) in the southwestern part of the property; and the former log yard area (Log Yard) occupying the remainder of the Site. This study focuses primarily on the Log Yard and the fate and transport of arsenic in groundwater and porewater.

During operation of the Log Yard, slag from the former ASARCO smelter was used as ballast (e.g., road base) to stabilize surface soils. During the 1980s, it was found both at this site and other similar log yards utilizing slag as ballast that leaching of arsenic from slag and wood waste resulted in elevated arsenic concentrations in stormwater runoff. The Log Yard was capped pursuant a 1988 Order on Consent to protect surface water quality. This action was also expected to minimize risks associated with contaminated groundwater present at the Site.

Under subsequently-promulgated MTCA regulations (WAC 173-340), further evaluations were required for the Log Yard to determine if Site conditions comply with current regulatory standards.

1.2 Study Objectives

The present Remedial Investigation (RI) Report was developed to comply with a requirement of the MTCA Agreed Order (AO) executed by Ecology, the Port, and Portac. That order required development of a remedial investigation/feasibility study (RI/FS) to determine what remedial actions are necessary to comply with current MTCA regulations. As part of the Site investigations leading up to the RI, a data gaps memorandum was developed to identify data gaps that may require further investigation prior to preparation of the RI Report and the Feasibility Study Technical Memorandum (FSTM). It was concluded that a significant data gap was site-specific arsenic geochemistry and attenuation data along potential migration pathways from groundwater in the Log Yard to porewater in the adjacent Wapato Creek (GSI & SSPA, 2016).

This appendix to the RI Report presents the results of an evaluation of soil, sediment, groundwater, and porewater data collected to identify geochemical processes that affect the fate and transport of arsenic at the Site, including adsorption and mineral precipitation/co-precipitation reactions. The findings of this study are intended to support the Feasibility Study (FS) evaluation of cleanup alternatives for the Log Yard.

1.3 Study Design

The following data were collected to help understand arsenic fate and transport processes occurring in groundwater and porewater within the Log Yard:

1) General groundwater/porewater chemistry (e.g., pH, and major cations and anions);

2) Groundwater/porewater redox chemistry, including iron (Fe(II)/Fe(III)) and arsenic (As(III)/As(V)) element speciation;
3) Solid-phase arsenic and iron concentrations;
4) Solid-phase iron and arsenic speciation (via sequential extractions);
5) Solid-phase adsorption potential (via batch adsorption tests);
6) Groundwater mineral precipitation potential (via induced precipitation tests).

The selected analytes are consistent with EPA guidance on site characterization for evaluating natural attenuation of arsenic in groundwater (U.S. EPA, 2007a & 2007b). Results from the laboratory analyses were used to document ongoing arsenic attenuation processes and to evaluate the stability of those processes over the long-term.

1.4 Report Outline

The remaining sections of this report discuss the following topics:

- **Section 2** introduces the technical basis for the geochemical topics discussed throughout this report (including redox geochemistry and arsenic attenuation processes).
- **Section 3** describes the laboratory methods used to identify arsenic speciation and attenuation processes in Site soils and sediments. It also discusses geochemical modeling used to interpret these data.
- **Section 4** summarizes laboratory results and implications for arsenic attenuation at the Site.
- **Section 5** summarizes geochemical modeling results and compares those results to the findings of laboratory testing.
- **Section 6** presents the summary and conclusions, including a description of arsenic attenuation processes, and a discussion of how these processes are likely to behave over the long-term.

Section 2
Technical Background

This section provides technical background relating to the geochemical concepts and processes discussed in this report.

2.1 Geochemical Concepts

2.1.1 Redox Geochemistry

The term “redox” is an abbreviation for “reduction-oxidation,” which is a chemical reaction that transfers electrons between two redox-sensitive elements. In redox reactions, the net charge (or valence) of one element increases, while the valence of the other is reduced. Redox reactions are important because the mobility of many elements (including arsenic) depends on their predominant valence state.

In this report, valence is represented using Roman numerals following an element’s name (with larger numbers representing a higher effective charge or redox state). The following redox-sensitive elements (and their predominant valences in groundwater) are discussed:

- Arsenic: As(III) and As(V) (arsenite and arsenate, respectively). Arsenic predominantly occurs in groundwater as dissolved oxyanionic complexes ($H_2AsO_4^-$ or $HAsO_4^{-2}$ under oxidizing conditions) and hydroxide complexes (H_3AsO_3 under reducing conditions[1]).
- Iron: Fe(II) and Fe(III) (ferrous and ferric iron, respectively). Ferrous iron is relatively soluble compared to ferric iron, which forms insoluble iron oxides and oxyhydroxides such as goethite and ferrihydrite.
- Manganese: Mn(II), Mn(III), and Mn(IV). Of these potential valences, Mn(II) is most soluble. Oxidized manganese species are an important oxidant for As(III) in porewater.
- Oxygen: O(-II) and O(0). O(-II) represents the predominant valence state of oxygen (which is present in water and other compounds). O(0) occurs in limited quantities as dissolved O_2 gas.
- Sulfur: S(-II), S(0), and S(VI). S(-II) (also known as sulfide) occurs primarily as H_2S or HS^-, depending on pH. S(0) is elemental sulfur that sometimes occurs in reduced sediments. S(VI) is the predominant species in most water (present as sulfate, SO_4^{-2}).

2.1.2 Eh-pH Diagrams

Eh, or redox potential, measures the activity of electrons in groundwater as follows:

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[1] Thioarsenic (sulfur-containing) species may additionally occur under sulfate-reducing conditions with depleted iron concentrations (Vlassopoulos et al., 2010).

$$Eh = \frac{2.303RT}{F} pe \qquad (2\text{-}1)$$

where R is the gas constant, T is the absolute temperature, F is the Faraday constant, and pe is the negative-log activity of the electron. When Eh is low, conditions favor high electron activity and redox-sensitive elements tend to be in their more reduced state. Due to the large differences in concentrations of redox-sensitive elements, the equilibrium Eh of a system is often poised (or buffered) by the presence of a dominant redox-sensitive element (such as Fe).

pH-Eh diagrams are useful for evaluating attenuation processes because they display the predominant chemical species of an element (including dissolved and immobile/attenuating solid-phase species) over a wide range of possible Eh-pH conditions in water. For example, Figure 2-1 shows individual Eh-pH diagrams for iron and arsenic, using an initial composition of groundwater monitoring well MW-7, but with initial iron and arsenic concentrations of 100 mg/L and 50 mg/L, respectively[2]. The different fields in the plot identify the primary dissolved species under the prescribed pH and Eh condition (no solid-phase species were included in the calculations for Figure 2-1). The red lines separate oxidized and reduced species. Finally, the symbols represent field-measured Eh and pH of different waters. The following useful results for the understanding arsenic fate and transport are illustrated in the figure:

- Groundwater is more geochemically-reduced (lower Eh) than porewater (red and blue symbols, respectively).
- Most groundwater and porewater is poised within the stability field of ferrous iron; therefore, ferrous iron is the predominant species in Site groundwater and porewater.
- Groundwater is close to the As(V)/As(III) redox boundary; therefore, both arsenite and arsenate occur in Site waters[3].

2.1.3 TEAPs

Terminal electron-accepting processes (TEAPs) are microbiologically-mediated reactions that convert redox-sensitive elements from their oxidized to reduced forms, while simultaneously oxidizing organic carbon. TEAPs are largely driven by molecular hydrogen (H_2), which is derived from the fermentation of natural (or anthropogenic) organic matter. In each TEAP, microorganisms obtain energy by transferring electrons from H_2 to naturally-occurring electron acceptors (such as oxygen, nitrate, iron (III), manganese (IV), sulfate, and carbon dioxide).

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[2] MW-7 was used because it was the groundwater selected for the induced precipitation tests. MW-7 has relatively-low arsenic concentrations, but high iron concentrations (0.021 and 107 mg/L, respectively, in Figure 4-1).

[3] Although most water is shown to be within the stability field of arsenate, these results do not imply As(V) occurs at higher concentrations than As(III) at the Site. In fact, there is a known bias in arsenic speciation determined from ORP electrodes—relative As(V) concentrations based on Eh measurements made with an ORP electrode have been shown to be higher than IC-ICP-MS arsenic speciation analyses (U.S. EPA 2008).

Significantly, each TEAP has a different affinity for H_2 uptake, with microbes that respire using more electrochemically-positive electron acceptors (such as dissolved oxygen) able to survive at lower H_2 levels in groundwater (Lovley and Goodwin, 1988). TEAPs occur in a sequence based on metabolic efficiency (i.e. potential energy yield) of the associated redox reaction[4,5] (Figure 2-2; *left* panel). Aerobic respiration is followed by denitrification, manganese reduction, iron reduction, sulfate reduction, and finally, methanogenesis. Arsenate reduction to arsenite typically occurs between iron and sulfate reduction (Smedley and Kinniburgh, 2002).

In the absence of directly measuring H_2 concentrations in groundwater, TEAPs can be inferred from concentrations of redox-sensitive elements. For example, the absence of dissolved oxygen but presence of nitrate is consistent with nitrate reduction being the predominant TEAP (i.e. aerobic respiration has already consumed all available O_2, and the next most-thermodynamically-favorable TEAP is nitrate reduction) (Figure 2-2; *middle* panel). Of importance to understanding arsenic fate and transport is the occurrence of elevated concentrations of dissolved iron in groundwater (and low sulfide), which is consistent with iron-reducing conditions being the predominant TEAP. In fact, iron-reducing conditions predominate at the Site, and are likely attributable to the biodegradation of wood waste and the presence of natural humic matter. Under iron-reducing conditions dissolved ferrous iron is stable and available to react with arsenic. Also, the reductive dissolution of amorphous ferric-iron minerals can occur.

2.2 Groundwater Attenuation Processes

2.2.1 Mineral Precipitation

As concentrations of dissolved aqueous species that comprise a mineral increase, the tendency for the mineral to precipitate out of groundwater and porewater is enhanced. This tendency is defined mathematically by a value called the saturation index (SI), which is expressed on a logarithmic scale as the ratio of the concentration of ions in solution to the concentration required for mineral precipitation to occur. SI values greater than or approximately equal to zero represent groundwater that is saturated or supersaturated (under these conditions, there is a thermodynamic driving force for mineral precipitation to occur). Conversely, values less than zero imply that a mineral is unstable, and if present in aquifer soils, will dissolve into groundwater[6].

Mineral precipitation is important because it can potentially lead to arsenic sequestration (and immobilization) by direct incorporation into the crystal lattice of the precipitating mineral

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[4] Following O_2-reduction are (1) NO_3 and Mn(IV) reduction (H_2 concentrations <0.05 nM/L), (2) Fe(III) reduction (H_2 <0.2 nM/L), (3) SO_4 reduction (H_2 <1-1.5 nM/L), and finally (4) methanogenesis (H_2 <7-10 nM/L) (Lovley and Goodwin 1988).

[5] There is overlap in all adjacent TEAPs. For example, there are cases where S(IV) reduction may precede Fe(III) reduction if the ferric iron mineral participating in the reaction is a more-crystalline (i.e. more thermodynamically-stable) form such as goethite (Postma and Jakobsen, 1996).

[6] In most cases, mineral precipitation and dissolution are kinetically-constrained (as opposed to strictly equilibrium processes). This means that they can be slow, and therefore, potentially less significant than predicted by equilibrium geochemical models.

(Figure 2-3; *middle* panel). This process is largely driven by changes in geochemical conditions (such as Eh, pH, and concentrations of dissolved constituents). In the example, the presence of adequate quantities of dissolved ferric iron (Fe^{+3}) and arsenate (as AsO_4^{-3}) drives the precipitation of an immobile iron-arsenate mineral ($FeAsO_4$).

Factors affecting the rates, extent, and stability of precipitation include the following:

- Relative Concentrations of Reactants: If the concentration of one species participating in the reaction is very high, the other can be lower, and mineral precipitation will still occur. This is potentially-important at the Site because iron concentrations are consistently high in most Site groundwater (which is likely caused by buffering by previously-precipitated iron minerals).
- Weathering of Precipitates: Amorphous minerals typically precipitate first, with subsequent aging resulting in more-immobile, crystalline minerals. Whereas amorphous ferric or ferrous arsenates will typically precipitate in laboratory experiments, more-crystalline (insoluble) forms may be more prevalent in soils.
- Redox Changes and Mineral dissolution: At the Site, certain iron-arsenate mineral may re-dissolve over time due to lower arsenic concentrations or changes in the redox state of groundwater. However, to the extent that conditions become more oxidizing, ferrous arsenate may dissolve and re-precipitate as even more-insoluble ferric arsenate (since ferric minerals are generally less soluble than ferrous). Mineral dissolution is typically a very slow process, with rates that decline orders of magnitude over time due to the development of surface coatings and the removal of the most-soluble mineral crystal edges and defects (White and Brantley, 2003).

2.2.2 Co-Precipitation

Co-precipitation is a common natural process whereby arsenic is incorporated or scavenged at trace concentrations into a mineral structure as it forms. The example in Figure 2-3 (*left* panel) shows the co-precipitation of arsenic with an iron oxyhydroxide mineral. Arsenic is also known to co-precipitate with other iron oxides (Tokoro et al., 2010) and pyrite (Rittle et al., 1995). Co-precipitation is important because the minerals responsible for arsenic encapsulation are often significantly more insoluble than arsenate or arsenite minerals, as shown in Figure 2-3. Co-precipitated arsenic therefore tends to be nearly insoluble/immobile, which is reflected in its release in only residual and refractory fractions of sequential extraction tests (Section 3.2.2).

2.2.3 Adsorption

Dissolved arsenic can be attenuated in uncontaminated soils by adsorption, which refers to the adherence (or binding) of arsenic to soil particles. Arsenic can be adsorbed by clays (Goldberg and Glaubig, 1988; Goldberg, 2002), aluminum oxides (Airi et al., 2001), manganese oxides (Appelo and Postma, 1999), and iron oxides and hydroxides (Dixit et al., 2003); however, crystalline and amorphous iron hydroxides (such as goethite and ferrihydrite) most commonly control arsenic concentrations in groundwater (Sadiq, 1997). Iron hydroxides are generally abundant in all soils, occurring as discrete particles and coatings on soil grains. In mixed redox environments like Site groundwater (where Fe(II) and Fe(III) co-occur at appreciable concentrations), arsenic can also be adsorbed to green rusts (Jönsson and Sherman, 2008).

The extent of arsenic adsorption observed depends on many factors. For example, ferrihydrite has greater surface area and density of adsorption sites for arsenic than goethite (Dixit et al., 2003). Also, pH is an important variable, since adsorption primarily occurs in response to the electrostatic attraction between negatively-charged dissolved arsenic oxyanions (e.g. AsO_4^{-3}) and positively-charged mineral surfaces (and a positive electrostatic surface charge develops on minerals as groundwater pH decreases). Ionic strength and the concentration of competing ions are additionally important, since there are a finite number of adsorption sites for the different competing dissolved ions. Finally, groundwater redox is a critical factor since some iron oxyhydroxides (such as ferrihydrite) are unstable under strongly-reducing conditions. Under some conditions, mineral dissolution and desorption (or release) of arsenic to groundwater can occur due to the reductive dissolution of ferrihydrite.

2.3 Processes Typically Occurring in Sediments

Many physical and geochemical processes can occur in sediments and underlying transition zone soils, affecting arsenic availability and dissolved concentrations:

- In natural sediments, porewater arsenic concentrations are often controlled by adsorption and desorption by iron oxyhydroxides, with TEAPs significantly affecting the stability of these minerals. As shown in Figure 2-2 (left panel), a sequence of TEAPS occur within the sediment bioactive zone, a relatively-restricted depth-interval (measured in centimeters) near the sediment-water interface. Within this interval, dissimilatory reduction can lead to the dissolution of amorphous iron- and manganese-oxides, and to the concomitant release of adsorbed arsenic from sediments. Consequently, naturally-high iron and arsenic concentrations can occur in porewater (Figure 2-2; left and right panel, respectively), depending on initial sediment arsenic concentrations and the activity of sediment microbes. Arsenic can also be re-adsorbed to, or co-precipitated with, iron and manganese oxyhydroxides that re-precipitate near the sediment-water interface due to reactions between dissolved ferrous iron (and manganese) and dissolved oxygen from surface water above (via diffusion and/or bioturbation).
- Near the base of the bioactive zone (where sulfate reduction or methanogenesis may be occurring), arsenic can precipitate or co-precipitate with sulfides (O’Day et al., 2004), thereby causing arsenic concentrations to be lower than in the zone of dissimilatory iron reduction (Figure 2-2; right panel).
- The concentrations of arsenic in sediment and transition zone can also be affected by tidal mixing. This mixing can introduce surface water into the sediments and underlying transition zone soils, thereby reducing arsenic concentrations in sediment porewater prior to discharging to surface water (Yim and Mohsen, 1992; Bessinger and Mohsen, 2008).
- Tidal mixing can also introduce significant quantities of oxygen into sediments and transition zone soils. To the extent that groundwater is iron-reducing (with abundant ferrous iron), reactions between tidally-introduced oxygen can cause significant iron oxyhydroxide precipitation and the sequestration of groundwater arsenic via adsorption and/or co-precipitation (Jung et al., 2009; Datta et al., 2009).

Under these circumstances, arsenic concentrations in porewater can be significantly less than upgradient (reducing) groundwater and significantly less than concentrations predicted by mixing processes alone.

Section 3
Methods

This section briefly describes the geochemical samples collected, the batch testing methods used, and the selected approaches to geochemical modeling.

3.1 Sample Descriptions

This investigation focused on soil, sediment, groundwater, and porewater along three east-to-west trending transects in the westernmost part of the Site near Wapato Creek (Figure 3-1). The most-upgradient location in each of the transects was selected to coincide with areas of observed perched groundwater and elevated groundwater arsenic concentrations (Figure 3-2). Because the transects approximately parallel groundwater flow (based on groundwater elevations shown in Figure 1-1), they represent potential groundwater pathways from an upgradient "source area" to Wapato Creek.

Soil, sediment, groundwater, and porewater were collected at multiple locations along each transect. Sample types and individual sample names discussed in this report include the following (from east-to-west) (Figure 3-1):

- Groundwater/soil source samples (B-1R [no soil available], MW-10, MW-13);
- Groundwater/soil upland samples (TB-3, TB-5, and TB-7);
- Groundwater/soil nearshore samples (MW-7, MW-9, MW-12);
- Transition zone (40 cm) porewater: Deep porewater samples were collected from the transition zone in pairs (A = east, B = west) at locations WCT-1, WCT-2, WCT-3 and WCT-4;
- Sediment porewater from bioactive zone (10 cm): Sediment porewater samples (10 cm) were collected in pairs (A = east, B = west) at stations WCT-1, WCT-2, WCT-3 and WCT-4; and,
- Sediment and Transition Zone Soils: Samples of surface sediment (10cm) and transition zone soils (40 cm) were collected at locations WCT-1B, WCT-2B, WCT-3B and WCT-4B.

As discussed in the main body of the RI Report, groundwater and porewater samples were collected during four monitoring events between May of 2016 and February of 2017; also, saturated soil and sediment samples were collected during a single event in May of 2016. All sampling utilized anoxic procedures to minimize the potential for sample oxidation (see Sampling and Analysis Plan (SAP), which is provided as Appendix B of the RI Report). Soils and sediments were processed by the laboratory in an anoxic glove box, and batch testing performed in an anoxic chamber.

3.2 Laboratory Analysis

3.2.1 General Geochemistry

General geochemical parameters for groundwater and porewater that are discussed in this report include pH, major cations and anions, arsenic and iron concentrations, and iron and arsenic redox speciation (Fe(II)/Fe(III) and As(III)/As(V), respectively). The primary soil and sediment testing parameters discussed are arsenic and iron concentrations.

3.2.2 Sequential Extraction Analysis

Sequential extraction analysis is a laboratory batch test that is performed on soils and sediments to determine the speciation of arsenic and iron between different chemical forms. Sequential extractions consist of subjecting a sample to a sequence of chemical digestion steps designed to release operationally-defined fractions representing specific mineral-bound species. To the extent that arsenic (or iron) is released during a specific digestion (as measured in the extraction fluid), it is assigned to the targeted mineral phase for that fraction. Sequential extractions are recommended by the EPA to identify the speciation of arsenic between adsorbed, precipitated, and co-precipitated mineral forms (U.S. EPA, 2007b).

In this study, samples were subjected to a five-step extraction procedure adapted from methods published by Dhoum and Evans (1998), Keon et al. (2001), and Wenzel et al. (2001). Details of the sequential extraction procedure are provided in Attachment 2B of the Sampling and Analysis Plan (SAP), which is provided as Appendix B of the RI Report. The following operationally-defined mineral fractions were targeted: (F1) soluble; (F2) exchangeable (strongly adsorbed); (F3) amorphous; (F4) crystalline; and (F5) residual (Figure 3-3). After each extraction step, pH and concentrations of arsenic, iron, and manganese were measured in the extraction solution.

In general, extraction solutions F1 and F2 represent arsenic associated with adsorbed or soluble forms. By contrast, extraction solutions F3 through F5 represent co-precipitated arsenic. Although iron-arsenate minerals are soluble enough under the prescribed test conditions (i.e. a low solid-to-liquid ratio (S:L)) to be associated with extraction solution F1, these minerals dissolve slowly in the absence of a rigorous digestion fluid. Consequently, iron-arsenate minerals could be associated with multiple extraction solutions.

3.2.3 Induced Precipitation Tests

Description of the induced precipitation tests is provided in Appendix I of the RI Report. The objectives of the tests were to (1) understand the conditions leading to arsenic mineral precipitation in groundwater under different redox conditions, and (2) determine the chemical composition of mineral precipitates formed.

Each induced precipitation test consisted of spiking groundwater (from MW-7) with either disodium hydrogen arsenate (Na_2HAsO_4) or sodium arsenite ($NaAsO_2$) at a target a concentration of 100 milligrams per liter (mg/L) arsenic (note: this concentration is the same order of magnitude as maximum concentrations at the Site, and potentially-reflects levels of arsenic in slag leachate prior to mineral precipitation). After groundwater spiking was completed, each sample was incubated at ambient temperature with continuous stirring for a period of six days under either aerobic or anaerobic conditions. The combination of the different arsenate or arsenite spikes and aerobic or anaerobic incubations, resulted in the following four induced precipitation tests being performed[7]:

- Aerobic Arsenate;
- Aerobic Arsenite;
- Anaerobic Arsenate; and,
- Anaerobic Arsenite.

Following incubation, groundwater was filtered through 0.45-micron and subsequently 0.1-micron filters to remove the precipitates formed[8]. Filtered groundwater was then analyzed to determine changes in iron and arsenic concentrations during the tests. The precipitate from each solution was dried under a nitrogen atmosphere and submitted for mineral identification using the following methods:

- X-ray diffraction (XRD), which determines bulk mineralogy of crystalline phases of precipitates;
- Fourier-transform infrared spectroscopy (FTIR), which determines chemical bonds and functional groups present in precipitates;
- Scanning electron microscopy (SEM), which characterizes precipitate surface details and uses wavelength dispersive spectroscopy (WDS) to map determine compositions; and,
- Transmission electron microscopy (TEM), which allows chemical characterization of precipitates at the atomic scale.

3.2.4 Batch Adsorption Tests

Batch adsorption tests (BAT) were conducted on Site soils and sediments to determine adsorption rates and the sorption potential of solids. Post-processing of BAT results was also performed to determine soil and sediment sorption potential under *in-situ* conditions, and the type of minerals controlling adsorption.

Detailed descriptions of BAT procedure are provided in EPA’s Batch Type Procedures for Estimating Soil Adsorption of Chemicals (U.S. EPA, 1992), and in Attachment 2A of the Sampling and Analysis Plan (SAP), which is provided as Appendix B of the RI Report. In summary, BAT consisted of spiking a synthetic groundwater (0.025 M NaCl, pH of 6.5) with 1 mg/L of arsenite and measuring the change in concentration of arsenic in the suspension as a function of solid-to-liquid ratio (1:4 to 1:200) and time (48-168 hours) under controlled-anoxic conditions.

Post-processing of results included normalization of dissolved concentrations by the amount of soil/sediment used in each test to determine mass-normalized adsorbed arsenic

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[7] An unspiked, anaerobic control sample consisting of groundwater from MW-7 was also tested.

[8] Anaerobic tests were filtered under a nitrogen atmosphere.

concentrations (in units of milligrams-per-kilogram, or mg/kg). Post-processing of data also included the development of adsorption isotherms and the calibration of a surface complexation model (SCM) to these results. The development of a SCM makes it possible to predict the long-term effects of adsorption on the fate and transport of arsenic under *in-situ* conditions.

3.3 Geochemical Modeling

3.3.1 Eh-pH Diagrams

Eh-pH diagrams were used to identify significant attenuation processes inferred from groundwater and porewater chemistry. Results were compared to those processes identified in the laboratory batch tests.

As discussed in Section 2.1.2, Eh-pH diagrams illustrate the predominant iron and arsenic species (dissolved, solid-phase, and/or adsorbed) for a prescribed set of conditions (Eh, pH, water chemistry, and arsenic or iron concentration). By plotting measured groundwater and porewater data on the diagrams, it is possible to infer whether a species identified in the diagram is likely to predominate at the Site. Mineral precipitation is indicated by groundwater and porewater Eh-pH data that plot within the stability field of an arsenic-bearing mineral. Similarly, arsenic co-precipitation is indicated by data that plot within the stability field of an iron-bearing mineral that is known to co-precipitate arsenic (e.g. iron oxyhydroxides). Finally, adsorption is indicated by data that plot within the stability field of surface-complexed arsenic species.

Eh-pH diagrams were constructed using the geochemical software PhreePlot (Kinniburgh and Cooper, 2009). Requisite input parameters included water composition, the total concentration of the constituent to plot, and mineral phases/surface sites to consider (Section 2.1.2) (note: conditions used to construct each diagram are reported on the diagrams, themselves). As discussed above, groundwater and porewater samples were plotted in the Eh-pH diagrams using field measurements[9].

3.3.2 Speciation Calculations

Because Eh-pH diagrams are semi-quantitative (i.e. the geochemical input parameters may not apply equally to every groundwater and porewater sample plotted on them), speciation calculations were performed to understand the potential for attenuation in individual groundwater and porewater samples from Event 1. These calculations were performed using a geochemical equilibrium model, which utilizes the compositional data from individual water samples to predict the distribution of elements (such as iron and arsenic) between dissolved species, adsorbed species, and mineral phases. An important model output was the SI for various arsenic- and iron-bearing

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[9] Eh was calculated from ORP by assuming a 200-mV difference between the ORP electrode and the Standard Hydrogen Electrode (SHE) (which is the reference electrode for Eh).

minerals—these results were used to identify minerals that are present at the Site, or have a thermodynamic potential to precipitate at the Site ($SI \geq 0$).

Speciation calculations were performed using the United States Geological Survey (USGS)-supported geochemical model PHREEQC[10] (Parkhurst and Appelo, 1999). This model requires a thermodynamic database of reaction constants and the chemical composition of each water sample. This study utilized the Lawrence Livermore National Laboratory (LLNL) thermodynamic database (Delany et al., 1990), which was modified by Bessinger et al. (2012) to include an internally-consistent set of equilibrium reaction constants for dissolved arsenic species[11] (Vlassopoulos et al., 2010).

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[10] PHREEQC is based on chemical thermodynamics and the energetics of possible chemical reactions are supplied to the program through the thermodynamic database. PHREEQC uses this information, along with the total elemental compositions of the system being modeled, to minimize the overall energy of the system subject to any additional constraints. PHREEQC simultaneously solves expressions relating the mass of each element to its distribution between different forms (mass balance equations), expressions representing the Gibbs free energy change of prescribed reactions (mass action equations), and an expression for electrical neutrality (the charge balance equation). PHREEQC can simulate several types of geochemical processes, including aqueous phase reactions, ion exchange reactions, surface complexation reactions, and mineral precipitation and dissolution reactions. Reactions can be represented as either equilibrium or kinetically-controlled.

[11] Also added to the thermodynamic database was a range in solubility constants for ferrous arsenite (Masue-Slowey et al., 2014)

Section 4
Laboratory Results

This section of the report discusses Site geochemistry and the attenuation processes identified through Site characterization and batch testing.

4.1 General Geochemistry

4.1.1 Groundwater

Groundwater is reducing, with arsenic and iron predominantly occurring as As(III) (arsenite) and Fe(II) (ferrous), respectively (Table 4-1). Reducing conditions are likely caused by the biodegradation of wood waste and other natural organic matter, consistent with relatively high dissolved organic carbon (DOC) concentrations in groundwater (e.g. >10 mg/L in all groundwater; >100 mg/L in the source area) (Figure 4-1a).

As shown in Figure 4-1b, there is a significant decrease in arsenic concentrations in groundwater from east-to-west. This result is consistent with arsenic primarily originating from slag[12] and significant arsenic attenuation occurring along a flowpath transport towards Wapato Creek. The highest arsenic concentrations at the Site (>10 mg/L) occur in source area monitoring wells[13] (B-1R, MW-10, MW-13), which are locations where perched water is present at elevations contacting the slag-containing fill (Figure 3-2). By contrast, arsenic concentrations in downgradient, upland groundwater (TB-3, TB-5, and TB-7) are between two and three orders of magnitude lower. Also, arsenic concentrations in nearshore groundwater (MW-7, MW-9, MW-12) are between 0.01 and 0.1 mg/L.

Iron concentrations in upland and nearshore groundwater are more uniform than arsenic, with average concentrations between 100 and 150 mg/L (Figure 4-1c). These concentrations are significantly higher than typically reported in natural groundwater, and are attributable to site-specific geochemical conditions. The elevated iron concentrations can result in buffering by ferrous iron minerals in the aquifer. Concentrations of iron are elevated both in areas with elevated arsenic concentrations as well as in other areas.

4.1.2 Porewater

The geochemistry of porewater in Wapato Creek indicates the presence of a dynamic biogeochemical environment characterized by steep redox gradients (due to TEAPs) and highly-variable porewater chemistry. Steep redox gradients and associated variability in porewater

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[12] To the extent that biodegradation is occurring, a fraction of arsenic and iron in groundwater is attributable to TEAPs and the release of arsenic and iron from a non-slag source (i.e. naturally-occurring (ferric) iron oxyhydroxides).

[13] The average arsenic concentration in source area groundwater (B-1R, MW-10, and MW-13) for Events 1 through 4 was 41.2 mg/L. By comparison, the average concentration at TB-3, TB-5, and TB-7 was 0.235 mg/L, and the average concentration at MW-7, MW-9, MW-12 was 0.037 mg/L.

chemistry are common in natural sediments (Sections 2.3 and 2.4). As shown in Figure 4-1d, there is a high degree of variability in porewater Eh (100-400 mV), which is consistent with the co-occurrence of oxygen (and arsenate) and more-reduced species (ferrous iron, arsenite, and sulfide) (Tables 4-1 and 4-2). There is also a high degree of mixing in porewater indicated by chloride concentrations that are intermediate between Blair waterway and groundwater samples (Figure 4-1e and Table 4-1).

Arsenic concentrations are relatively-low in sediment porewater (10 cm) and transition zone porewater (40 cm). Arsenic concentrations in most samples are less than 0.010 mg/L (e.g. during Event 1, higher concentrations were only detected in stations WCT-1A-40 and WCT-1B-40 (0.0188 and 0.049 mg/L, respectively)) (Figure 4-1b; Table 4-1). An important feature of these samples is that the ferrous iron concentrations were also the highest of Site porewater (35.5 and 20.6 mg/L, respectively, for Event 1) (Figure 4-1c; Table 4-1).

4.1.3 Soil

Concentrations of arsenic in slag-containing fill have been previously shown to exceed 2,000 mg/kg. Testing described in this appendix was limited to soils underlying that soil layer.

Concentrations of arsenic concentrations in deeper soils decrease significantly within the Log Yard from upgradient to downgradient locations (Figure 4-2a). For example, the highest concentrations occur at MW-10 (237 mg/kg) (Table 4-3). By contrast, soil samples downgradient of this location are more than two orders of magnitude lower (1.55 and 1.23 mg/kg at TB-5 and MW-9, respectively, which is less than natural background in Washington (90 percentile natural background arsenic concentrations = 7.3 mg/kg; WSDE (1994) and RI Report Table 6-1)). High soil arsenic concentrations in the source area are consistent with localized transport (i.e., leaching) and subsequent attenuation of arsenic in that area.

4.1.4 Sediments

Arsenic concentrations in bioactive zone sediments (2.28 to 13.6 mg/kg; Table 4-3 and Figure 4-2a) are similar to established natural background (11 mg/kg; RI Report Table 6-2). These low sediment arsenic concentrations indicate that ongoing groundwater discharges to Wapato Creek have not adversely impacted sediment quality to-date.

4.2 Sequential Extraction Analysis

As discussed in Section 3.2, sequential extraction tests are an EPA-approved method for identifying arsenic attenuation processes in soils and sediments. The sequential extraction test method selected for this study was designed to liberate arsenic from the following five operationally-defined mineral fractions: soluble (F1); exchangeable (F2); amorphous (F3); crystalline (F4); and residual (F5). The soluble and exchangeable forms (F1 and F2) represent more-mobile fractions (e.g. porewater and adsorbed arsenic) (Figure 3-3). By contrast, fractions F3 through F5 represent more-immobile minerals (including co-precipitated arsenic).

A summary of arsenic concentrations between different operationally-defined fractions is provided in Table 4-4 and Figure 4-3. For the sample collected in the Transect 2 source area (MW-10), arsenic was present in all mineral fractions, with the greatest proportions found in the exchangeable (F2) and amorphous (F3) fractions (Figure 4-3a). As discussed in Section 3.2.2, the exchangeable fraction was extracted with a solution designed to liberate arsenic adsorbed to iron oxyhydroxides. Also, the amorphous fraction was extracted with a strong base, and represents arsenic liberated by the decomposition of soil components that can be dissolved under basic (high pH) conditions (including arsenic incorporated in the mineral structure of poorly crystalline iron oxides and sulfides). Based purely on mineral solubility (for the S:L ratios used in the tests), a ferrous or ferric arsenate mineral would have been expected to dissolve in the soluble fraction (F1); however, due to time-dependent dissolution kinetics (Harvey et al., 2006), iron-arsenic-bearing minerals could have dissolved continuously in several fractions, including soluble (F1), exchangeable (F2), and amorphous (F3). Consequently, the exact chemical form of arsenic in MW-10 cannot be precisely determined—it is present as a combination of adsorbed, precipitated, and co-precipitated forms. The high soil arsenic concentrations in fractions F2 through F5 in MW-10 demonstrate significant arsenic attenuation by soil minerals has occurred in the source area.

Arsenic concentrations in other soils and sediments at the Site are more than an order of magnitude lower than the source areas (Figure 4-3b). As discussed above (Section 4.1), arsenic concentrations in these samples are within background levels, and therefore, measured arsenic speciation likely represent natural distributions. In these samples, arsenic is mostly present in the exchangeable (adsorbed) fraction, which is consistent with lower corresponding groundwater (and porewater) arsenic concentrations favoring adsorption over direct iron-arsenic-bearing mineral precipitation. There is still a significant co-precipitated arsenic concentration in most samples (F3, F4, and F5), which is important because it implies that a significant fraction of the arsenic resides in relatively-immobile mineral forms.

The presence of arsenic-sequestering minerals is also inferred from the iron sequential extraction results[14] (Figure 4-3c), with most iron associated with digestions designed to liberate crystalline oxides (F4) and residual (F5) forms. Minerals targeted by these extractions include goethite and magnetite, which are known to sequester arsenic (Dixit et al., 2003). Arsenic attenuation in the presence of iron minerals includes adsorption and co-precipitation.

4.3 Induced Precipitation Tests

An initial set of batch adsorption tests was conducted following the procedure described in Section 3.2, except that Site groundwater from MW-7 was used instead of synthetic groundwater. During this test, it was observed that a reddish-orange precipitate formed, despite the use of protocols designed to minimize exposure to air (and thus limit potential oxidation of ferrous iron to insoluble ferric oxyhydroxide). During this test, sampling handling was performed inside a glove box, but tumbling of the prepared sample was performed outside of the glove box[15], and sample oxidation could not be precluded.

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[14] Note that the presence of iron arsenate minerals would be undetectable in Figure 4-3c because the amount precipitated would be such a small relative fraction of the total amount of iron in the samples.

[15] Tumbling in subsequent batch adsorption tests using synthetic groundwater was performed in a glove box.

In the initial BAT, 98% of iron (53 mg/L) and 90% of arsenite (1.0 mg/L) precipitated out of solution. This molar ratio of iron-to-arsenic removed was 0.014, which is similar to the ratio expected for adsorption onto precipitating iron species.

Based on the observed propensity for iron mineral precipitation in BAT using Site groundwater (with low initial arsenic), induced precipitation testing was performed to further evaluate the conditions leading to precipitation of iron and arsenic from groundwater in the source area (with high initial arsenic), and to do so under strict sampling, analysis, and testing procedures that may have been absent in the original BAT. The induced precipitation tests were designed to simulate *in-situ* geochemical conditions in groundwater, and were conducted in a manner that made it possible to collect and identify the mineral precipitates formed (Section 3.2.3). Tests consisted of adding an arsenate- or arsenite-spike (100 mg/L of arsenic) to groundwater from MW-7 under both aerobic and anaerobic conditions (for a total of four experiments and one anoxic control) (Section 3.2.3).

General results of the induced precipitation tests included the following:

1) There was a change in groundwater color and clarity indicating mineral precipitation had occurred in each of the four experiments (Figure 4-4).
2) The amount of arsenic precipitated varied between 10 and 31% of the total spike added, and was constrained in at least three of the four experiments by the amount of iron available for mineral formation (between 94 and 100% of the iron was consumed in these experiments) (Table 4-5). In the anaerobic arsenite experiment, a final arsenic concentration of 78.2 mg/L was reported, with 8.1 mg/L of iron still available for reaction.
3) The ratio of iron-to-arsenic removed in the three experiments with the highest iron removal varied between 1.3 and 1.6 (Table 4-5), which is within the range expected for the formation of Fe(III)- or Fe(II)-arsenates (1.0 and 1.5, respectively).
4) The final ratio of iron-to-arsenic removed in the anaerobic arsenite experiment was 3.5, which is higher than the molar ratio of the other tests. This ratio was also significantly-higher than might be expected solely for a distinct iron-arsenic mineral to have formed[16] (Table 4-5).

Results from the evaluation of the mineral precipitates formed include the following:

1) X-ray diffraction (XRD): The precipitate formed in the aerobic arsenate spiked solution had spectra consistent with ferrihydrite. Precipitates in the other three tests were X-ray amorphous, indicating they were dominated by non-crystalline or poorly crystalline phases.

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[16] The Fe:As ratio on bulk samples (i.e. determined either from the ratio precipitated in induced precipitation tests or identified in SEM/WDS spectra) are likely affected by the co-occurrence of iron minerals and iron-arsenic minerals, which biases the ratio high. For example, the ratio precipitated for the anaerobic arsenate experiment was 1.4, which could indicate the presence of a mixture of Fe(III)-arsenate (Fe:As = 1.0) with either Fe(II)-arsenate (Fe:As = 1.5) or ferrihydrite.

2) Fourier-transform infrared spectroscopy (FTIR): The bonds identified by FTIR included arsenic-oxygen bonds, carbon-oxygen bonds, and hydroxyl or water groups in each test. The precipitate from the arsenite spiked solutions also had a peak consistent with arsenic-oxygen-iron (Figure 4-5).

3) Scanning electron microscopy (SEM): The precipitates inspected at high magnification were found to consist of very fine-scale (nanometer) individual particulates (Figure 4-6). Each sample had a homogeneous composition, and the samples were composed predominantly of oxygen, iron, and arsenic.

4) Transmission electron microscopy (TEM): The predominant materials observed in the anaerobic arsenate precipitate were poorly-crystalline platelets (Figure 4-6), primarily composed of arsenic, iron, and oxygen, and consistent with ferrihydrite. The molar Fe:As ratio on targeted minerals in the anaerobic arsenate precipitate was 1.1, which is similar to Fe(II)-arsenate (Table 4-5). In the anaerobic arsenite experiment, precipitates exhibited greater crystallinity than the arsenate, and the d-spacing for the most-crystalline mineral evaluated was potentially-consistent with green rust.

In summary, the following minerals were identified or inferred under each test condition by the method identified in parentheses:

- Aerobic arsenate: Ferrihydrite (XRD); Amorphous Fe(III)-arsenate (Fe:As ratio precipitated in tests)
- Aerobic arsenite: Amorphous Fe(III)-arsenate (Fe:As ratio precipitated in tests)
- Anaerobic arsenate: Ferrihydrite (TEM); Amorphous Fe(III)-arsenate (Fe:As ratio precipitated in tests); Fe(II)-arsenate (Fe:As ratio in TEM)
- Anaerobic arsenite: As-Fe-Green rust solid solution and/or Fe(II)-arsenite (FTIR)

In summary, the induced precipitation tests demonstrate that arsenic minerals will form in groundwater under both aerobic and anaerobic conditions. The species that form include Fe(III)-arsenates under aerobic conditions, and Fe(III)- and Fe(II)-arsenates under anaerobic conditions[17]. Although there is uncertainty whether a distinct ferrous arsenite mineral precipitated in the anaerobic arsenite test[18] (or if arsenic mostly co-precipitated with green rust), either process results in arsenic attenuation. Further discussion of potential mineral precipitation in Site groundwater using geochemical modeling is provided in Section 5.3.

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[17] These results are generally consistent with the expected solubility of arsenate minerals. For example, the final iron and arsenic concentrations in the aerobic tests fall along the solubility curve for Fe(III) arsenate (scorodite) under oxidative conditions (Figure 4-7; red line); also, the final iron and arsenic concentrations in the anaerobic arsenate experiment fall along the solubility curve for Fe(III)-arsenates under more-reducing conditions (blue, dashed line).

[18] The final reported pH was too low for the ferrous arsenite mineral identified by Masue-Slowey et al. (2014) to be stable.

4.4 Batch Adsorption Tests

Batch adsorption tests consisted of spiking synthetic groundwater with arsenic (as arsenite) at 1 mg/L and measuring the amount adsorbed as a function of the solid-to-liquid ratio and time. Per EPA guidance (U.S. EPA, 1992), an equilibration time should result in a <5% change in the amount adsorbed over a 24-hour time interval. As shown in Figure 4-8, the selected equilibration time of 168 hours resulted in a change of 6.5% and 2.6%, respectively (Figure 4-8). It is important to note that because adsorption was still occurring at the end of the adsorption tests, BAT results represent a conservative estimate of total adsorption potential by Site soils and sediments.

BAT results are reported in Table 4-6. The amount of arsenic adsorbed by soils and sediments was generally found to increase with the S:L ratio used, which is consistent with an increase in the number of adsorption sites in the suspension. The exception to this generalization was the source sample (MW-10), which exhibited net desorption of arsenic at a S:L of 4:1. As discussed above (Section 4.2), MW-10 had the highest initial arsenic concentration of any soil and it is therefore likely that desorption occurred in the BAT due to the high initial loading of arsenic on soil sorption sites (note: partial dissolution of iron-arsenate minerals may have also occurred).

Langmuir sorption isotherms were developed per EPA guidance to develop a relationship between adsorbed and dissolved arsenic concentrations and to estimate an adsorption maximum for arsenic. As shown in Figure 4-9, most BAT could be fit using a Langmuir adsorption model, with a maximum adsorption capacity for arsenic to be between 21 and 500 mg/kg for soils and 87 and 2,000 mg/kg for sediments. The higher adsorption capacity for sediments is consistent with the higher iron content and in-situ distribution coefficients of sediments (Figures 4-2b and 4-2d, respectively).

Because pH in synthetic groundwater did not remain at the target pH of 6.5 to 7.0 during the BAT (due to mineral dissolution and low buffering capacity of the bicarbonate-free, synthetic groundwater), results were fit to a surface complexation model (SCM), which explicitly accounts for pH-dependent adsorption[19]. Fitting of the experimental data to a SCM was accomplished using the geochemical software PhreePlot (Kinniburgh and Cooper, 2009), which is a code that combines PHREEQC with an optimization subroutine that minimizes the weighted sum of squares of residuals between observed and predicted concentrations. PhreePlot explicitly includes adsorption to iron oxyhydroxides using a thermodynamic database of adsorption constants for dissolved species (including arsenic) onto hydrous ferric hydroxide (HFO). Fitting was done by assuming the quantity of iron oxyhydroxide minerals available for adsorption was the same as that measured in the sequential extraction tests (F3 and F4); however, the number of adsorption sites in the

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[19] Surface complexation models (SCM) are tools that have been developed to predict the adsorption of arsenic by minerals such as iron hydroxides (Dzombak and Morel, 1990; Dixit et al., 2003). These models account both for observed pH- and concentration-dependence of arsenic sorption. In addition, because SCMs have been incorporated into geochemical reactive transport models, it is possible to simulate the transport and fate of arsenic in soils where iron hydroxides are present (Parkhurst and Appelo 1999). Examples from the scientific literature where SCM-based geochemical models have been employed to understand arsenic concentrations in groundwater include Charlet et al. (2007) and Postma et al. (2007). An important component in these studies was the quantification of the amount of arsenic bound to iron hydroxides (using laboratory sequential extraction methods).

samples was treated as a calibration parameter, and was varied between estimates for ferrihydrite and goethite (Dixit et al. 2003).

The SCM successfully fit most experimental data (Figure 4-9) using an average site density of 0.019 moles-sites/mole-Fe (Table 4-6). This site density is approximately the same as has been estimated for goethite (0.016 moles-sites/mole-Fe; Dixit et al., 2003), which implies goethite is likely a dominant mineral attenuating arsenic via adsorption in most experiments (and at the Site).

Section 5
Geochemical Modeling

This section of the report discusses geochemical modeling that was performed for Site groundwater and porewater to further interpret the empirical studies described in Section 4. Specifically, this section compares model-predicted minerals to those identified during batch testing.

5.1 Introduction

Laboratory batch testing has demonstrated that arsenic at the Site is subject to mineral precipitation, co-precipitation, and adsorption processes. Geochemical modeling was performed to independently-evaluate the importance of different attenuation processes under different conditions at the Site. To the extent that model results are validated by empirical, laboratory data, the models may then be used to further explore chemical fate and transport under other conditions (in support of FS alternatives evaluations).

As discussed in Section 3.3, geochemical modeling predicts the equilibrium speciation of arsenic and iron between dissolved, adsorbed, and mineral forms using a thermodynamic database and Site chemistry as input. The following two types of geochemical models were used in this study: 1) Eh-pH diagrams, which display individual groundwater and porewater samples relative to predominant species inferred from field-measured pH and ORP; and 2) speciation calculations, which predict individual minerals that should be stable in soils and sediments based on the complete chemistry of individual water samples[20].

5.2 Eh-pH Diagrams

Site groundwater and porewater data are plotted on two Eh-pH diagrams for iron in Figure 5-1a. Site groundwater is more reducing (Eh lower) than porewater, which is consistent with previously-discussed groundwater chemistry and the greater relative proportion of As(III) in groundwater (Table 4-1). Groundwater is also generally within the stability field of siderite (ferrous carbonate, $FeCO_3$), whereas porewater is generally within the stability field of the ferric oxyhydroxide mineral, ferrihydrite (*left* diagram). For the case where goethite is included in the Eh-pH calculations (*right* diagram), it is predicted to be the predominant form of iron in equilibrium with all site waters. This prediction is consistent with (1) the sequential extraction results (which found most iron was associated with crystalline (oxide) and residual fractions; Section 4.2,) and (2) the BAT (which found arsenic adsorption could be simulated using a SCM

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[20] Speciation calculations are necessitated by the fact that Eh-pH diagrams represent graphical projections of species stability onto two dimensions (Eh and pH), when in fact, species stability is a function of numerous chemical variables that are only explicitly accounted for in these calculations.

for goethite; Section 4.4). These results are important because they indicate that arsenic co-precipitation with (and/or adsorption to) goethite can occur in all Site groundwater and porewater.

Groundwater and porewater is also within the stability field of Fe(III)- and Fe(II)-arsenate minerals (scorodite and symplesite, respectively) when arsenic concentrations are high[21] (Figure 5-1b, *left* plot). In contrast, at relatively-low arsenic concentrations (0.05 mg/L; representative of downgradient locations), arsenic is not predicted to precipitate as an iron arsenate mineral in groundwater, but could precipitate as ferric arsenate (scorodite) in sediment porewater[22] (Figure 5-1b, *right* plot). In summary, these results indicate iron arsenates are important for arsenic attenuation is some Site waters, but that the extent of precipitation is concentration dependent (precipitation processes increase with increasing arsenic concentrations).

Arsenic is also predicted to be adsorbed by iron oxyhydroxides (goethite and/or ferrihydrite) in all groundwater and porewater samples[23] (Figure 5-2). Although adsorption is a potentially-reversible process (i.e. it slows (or retards) arsenic migration), it can allow other processes, such as tidal mixing or precipitation reactions to be more-effective at reducing arsenic levels below MTCA standards in sediment porewater than in the absence of adsorption.

5.3 Speciation Calculations

PHREEQC was used to calculate saturation indices for iron and arsenic minerals included in the thermodynamic database. SI values near zero (or greater than zero) indicate that groundwater is saturated or supersaturated with respect to a mineral, respectively. This can lead to mineral precipitation and arsenic precipitation or co-precipitation[24].

Because SI values depend on the abundance of specific dissolved species (such as dissolved ferrous and ferric iron), it was necessary to evaluate the reportedly-high ferric iron concentrations in Site groundwater and porewater (Table 4-1) prior to performing speciation calculations. This was accomplished by comparing reported concentrations in groundwater and porewater to those predicted from the ORP electrode (which typically responds to the iron redox couple in the samples). As shown in Figure 5-3, reported ferric iron concentrations were, in most cases, several orders of magnitude greater in groundwater and porewater than estimated from ORP. This result

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[21] By contrast, ferrous arsenite minerals are only predicted to predicted to be stable in alkaline water with a higher pH than Site waters

[22] Dissolved oxygen was reported in all porewater samples, and therefore, could potentially oxidize ferrous iron (Table 4-2), causing iron-arsenate precipitation at concentrations as low as 0.05 mg/L).

[23] Adsorption reactions were modeled in this study using the Dzombak and Morel (1990) surface complexation model (SCM) (which is the default thermodynamic surface adsorption model in the LLNL database). To the extent that Fe(III)-oxyhydroxides are reduced to magnetite via TEAPs, it is important to note that magnetite also adsorbed arsenic (Dixit et al., 2003).

[24] Values near (or slightly less than) zero indicate groundwater may already be buffered by a mineral, given the uncertainty in thermodynamic data.

could be related to mobilization of ferric iron colloids during sampling or to oxidation during sampling, transport, and/or laboratory preparation. Because reported ferric iron in groundwater and most porewater were predicted to be significantly higher than occurs *in-situ*, all subsequent geochemical model calculations used reported dissolved iron concentrations (instead of individually reported ferrous and ferric iron concentrations) during model simulations, thus allowing the model to predict the speciation between ferrous and ferric iron[25].

Under Site conditions for iron, groundwater and porewater are both predicted to be saturated or supersaturated by siderite ($FeCO_3$) and iron oxyhydroxides (such as ferrihydrite and goethite). This is expected along Transects 1 through 3 (*left* panels in Figures 5-4a through 5-4c). Also, the primary difference between groundwater and porewater is that the more-oxidizing conditions present in porewater means Fe(III) oxyhydroxides are more supersaturated (siderite less saturated), which is consistent with Eh-pH diagrams for iron (Figure 5-1a). Also, in deep porewater at WCT-3B-40, which had detectable sulfide, pyrite (FeS_2) is predicted to occur.

Arsenic is predicted to be buffered both by ferrous and ferric arsenate minerals (e.g. symplesite and scorodite, respectively) in the primary groundwater source area[26,27] (B-1R, MW-10, and MW-13) (*right* panels in Figures 5-4a through 5-4c). Although iron arsenates are not predicted to occur in downgradient soils or sediments, Fe(III) arsenates could precipitate in areas of fluctuating redox potential (where dissolved ferrous iron is episodically oxidized to insoluble, ferric iron). Areas of the Site where redox is most-variable include (1) shallow groundwater influenced by vadose zone infiltration, and (2) porewater (and groundwater) in nearshore areas subject to tidal mixing. As shown in Figure 5-5, Site waters are below the critical solubility curve for scorodite for an Eh of 110 mV (and this mineral is therefore not predicted to be stable); however arsenic and iron concentrations are above the solubility curve (i.e. supersaturated) for water containing oxygen (Eh of 820 mV).

5.4 Model Implications

Eh-pH diagrams and geochemical speciation calculations using reported groundwater and porewater chemistry predict the same results as were observed during the laboratory batch tests. These attenuation processes include the following:

1) **Arsenic Mineral Precipitation.** Dissolved arsenic occurs as both As(III) (arsenite) and As(V) (arsenate) species in Site groundwater and porewater. Geochemical modeling predicts that arsenate concentrations are high enough in the source area (B-1R, MW-10, and MW-13) to cause the precipitation of both Fe(II)- and Fe(III)-arsenate minerals. This result is consistent with the induced

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[25] By contrast, speciation calculations for arsenic were based on reported As(III) and As(V) concentrations.

[26] The SI for these minerals is approximately zero.

[27] Although ferrous arsenite is not predicted to be stable, it has been hypothesized that these minerals could form on the surfaces of iron oxyhydroxides (Raven et al. 1998), which is a process not included in the geochemical model.

precipitation tests, which demonstrated iron arsenate mineral precipitation in three of the four tests.

2) **Arsenic Co-precipitation.** Geochemical modeling predicts that iron oxyhydroxides and carbonates are saturated or supersaturated in Site groundwater and porewater. This result is important because arsenic is known to co-precipitate with iron oxides/oxyhydroxides, sulfides, and green rust. Precipitation of iron-bearing minerals is consistent with higher iron concentrations in source area samples than nearshore soils (and higher concentrations in shallow sediments where iron oxyhydroxide precipitation occurs due to ferrous iron oxidation during mixing with surface water). Also, sequential extraction analyses confirm that most iron, and a significant fraction of arsenic, is associated with the operationally-defined fractions that dissolve amorphous and crystalline iron minerals (F3 through F5). Finally, the induced precipitation tests tentatively identified green rust (with either a significant amount of co-precipitated arsenic or the presence of an unidentified ferrous arsenite mineral).

3) **Arsenic Adsorption.** Geochemical modeling predicts that arsenic will be adsorbed by all Site soils and sediments. This result is consistent with the sequential extraction results, which show that the predominant association of arsenic is the exchangeable (adsorbed) soil/sediment fraction (F2). Batch adsorption tests additionally confirm significant adsorption of dissolved arsenite onto iron oxyhydroxides (such as goethite) in all Site soils and sediments.

Section 6
Summary and Conclusions

This section of the report summarizes the arsenic fate and transport processes at the Site, as determined from Site characterization data, geochemical testing, and model predictions. Included are discussions on arsenic geochemistry, arsenic sources, Site attenuation processes, and implications for long-term fate and transport.

6.1 Arsenic Geochemistry

Arsenic is a naturally-occurring element that is ubiquitous in all groundwater, porewater, and surface water. Naturally-occurring arsenic concentrations depend on numerous geochemical factors, including pH, redox potential, and concentrations of other constituents (such as iron and sulfur) that react with it (Smedley and Kinniburgh, 2002). Typical background concentrations for surface water and groundwater in Washington are 0.005 and 0.008 mg/L, respectively (RI Report Table 6-3); however, naturally-higher concentrations are not uncommon (Welch, 2000). Background concentrations for upland soil and Puget Sound marine sediments are 7.3 mg/kg and 11 mg/kg, respectively (RI Report Tables 6-1 and 6-2).

The fate and transport of arsenic in groundwater depends on its propensity to be sequestered by soil minerals via mineral precipitation, co-precipitation, and/or adsorption (U.S. EPA 2007b). At the relatively-low concentrations found in most groundwater, fate and transport is predominantly controlled by adsorption-desorption reactions, which involve the binding of arsenic to the surfaces of soil minerals. Arsenic adsorption is enhanced by the presence of iron oxides/oxyhydroxides, manganese and aluminum oxides, clay minerals, and natural organic matter (Smedley and Kinniburgh, 2002). Of these, partitioning of arsenic to iron oxides and oxyhydroxides (e.g. ferrihydrite, hematite, goethite, and magnetite) is commonly the most important control on concentrations in groundwater due to the abundance of these minerals and their stability over a broad range of Eh-pH conditions (Figure 5-1). The most adsorbent of the iron minerals is ferrihydrite, which forms in more-oxidized waters. In cases where ferrihydrite is present, arsenic concentrations are typically low (Smedley and Kinniburgh, 2002).

The fate and transport of groundwater arsenic is strongly affected in tidally-influenced sediment and transition zone environments by the following processes:

- Tidal Mixing: One effect of tidal fluctuations is physical mixing between groundwater, porewater, and surface water, which directly reduces dissolved concentrations of constituents such as arsenic. The extent of mixing varies with groundwater velocity and tidal amplitudes and can reduce contaminant concentrations significantly (Yim and Mohsen, 1992; Bessinger and Mohsen 2008).
- Iron oxidation and precipitation: To the extent that groundwater is iron-reducing with abundant ferrous iron (which is the case at the Site), reactions between tidally-introduced oxygen can cause significant iron oxyhydroxide precipitation and the sequestration of groundwater arsenic within nearshore porewater and groundwater via adsorption and co-precipitation (Jung et al. 2009; Datta et al., 2009). Under

these circumstances, arsenic concentrations can be significantly lower than upgradient groundwater, and lower than predicted by mixing processes alone.

- Sediment Microbial Activity: The fate and transport of arsenic in sediment porewater is strongly-controlled by sequestration by iron oxyhydroxides, with TEAPs significantly affecting the relative partitioning between porewater and sediments (Figure 2-2). As discussed in Sections 2.1.3 and 2.3, TEAPS create steep redox gradients that promote both oxyhydroxide mineral dissolution and precipitation within a relatively-restricted depth range near the sediment-water interface. Dissolved arsenic concentrations can be naturally-high in sediments where iron reduction is occurring (depending on initial sediment arsenic concentrations and the extent of microbial activity). At greater depths (and lower redox potentials), arsenic can be sequestered by sulfides, resulting in lower concentrations than those depths where dissimilatory iron reduction is active (Figure 2-2).

6.2 Arsenic and Iron Behavior in the Source Area

Arsenic concentrations in groundwater at the Site are highest in upland areas where slag-containing fill interacts with observed perched water. For example, the average arsenic concentrations in monitoring wells B-1R, MW-10, and MW-13 is 41.2 mg/L, but decreases approximately 200-fold along the migration pathway to the next most-downgradient set of monitoring wells (TB-3, TB-5, and TB-7) (0.24 mg/L) (Figure 6-1). These data indicate that there is significant arsenic attenuation occurring in the immediate vicinity of the arsenic source areas.

In contrast to arsenic concentrations which vary widely, iron concentrations are more-uniform across the site. Average concentrations in upgradient-to-downgradient monitoring wells are 115 mg/L (B-1R, MW-10, and MW-13), 159 mg/L (TB-3, TB-5, and TB-7), and 138 mg/L (MW-7, MW-9, and MW-12), respectively (Table 4-1). These concentrations are significantly higher than typically occur in groundwater, even under iron-reducing conditions. The availability of iron can therefore support a variety of attenuation processes in both the source area and downgradient areas[28].

6.3 Arsenic Attenuation Processes

Significant arsenic attenuation is occurring at the Site via arsenic mineral precipitation, co-precipitation, and adsorption. All three processes were demonstrated to occur in laboratory testing, and all three processes were similarly predicted by geochemical modeling. The importance of different attenuation processes along the downgradient (west-to-east) transect shown in Figure 6-1 includes the following:

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[28] As noted in Section 4.1, wood waste and natural humate biodegradation necessarily implies that a fraction of arsenic and iron in groundwater is attributable to TEAPs and release from naturally-occurring (ferric) iron oxyhydroxides.

- Source Area Attenuation: In source area groundwater, the primary attenuation process for As(V) (arsenate) is likely iron arsenate mineral precipitation. Evidence for precipitation includes (1) groundwater that is approximately saturated by (or in equilibrium with) various iron arsenate minerals (Figure 5-4), and (2) the identification of iron arsenate minerals in the induced precipitation tests conducted under aerobic conditions (and in the anaerobic test using an arsenate spike) (Section 4.3).

  By comparison, the primary attenuation process for As(III) (arsenite) in the source areas is likely co-precipitation with iron oxyhydroxides and/or mixed Fe(II)/Fe(III) layered hydroxides such as green rust. Evidence that As(III) is co-precipitating (as opposed to precipitating as ferrous arsenite) includes the following: 1) Site groundwater is predicted to be undersaturated with respect to ferrous arsenite[29]; 2) arsenite in the anaerobic precipitation test was removed at much lower relative ratios (to iron) than the other induced precipitation tests (Table 4-5); 3) green rust-type phases were tentatively identified in the anaerobic arsenite precipitation test via TEM (Section 4.3); and 4) sequential extraction tests verify that arsenic occurs (at concentrations significantly higher than background) in insoluble mineral fractions[30] (F3 through F5) (Figure 6-2).

- Downgradient Areas: In groundwater located downgradient of the source area and containing lower arsenic concentrations, the primary arsenic attenuation process is likely adsorption; however, co-precipitation and mineral precipitation are also possible (Figure 6-1). This conclusion is consistent with the sequential extraction test results, which found a significant amount of arsenic in the exchangeable (adsorbed) fraction (F2) and the oxide and residual (co-precipitated) fractions (F4-F5) (Figure 6-2). Whereas adsorption is likely ubiquitous (as demonstrated by significant arsenic adsorption in the BAT in all Site soils and sediments), co-precipitation is more-likely to occur in areas where redox gradients are present. For example, co-precipitation could occur in shallow groundwater where vadose zone infiltration is potentially causing the mixing between more-oxidized vadose zone porewater and groundwater (leading to iron oxyhydroxide and/or green rust precipitation and arsenic co-precipitation).

- Sediment porewater and nearshore areas: Arsenic attenuation processes within sediment porewater and tidally-mixed groundwater near Wapato Creek include adsorption, co-precipitation, and/or arsenate mineral precipitation. The fate and transport of arsenic in these environments is also affected by TEAPs and tidal mixing. The latter can significantly decrease arsenic concentrations in nearshore groundwater and porewater, and can introduce oxygenated surface water into

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[29] This statement assumes that ferrous arsenite minerals have the same solubility as those identified by Masue-Slowey et al. (2014).

[30] These insoluble/residual phases likely include crystalline iron oxides.

porewater and groundwater. The introduction of oxygen causes precipitation of iron minerals. Arsenic co-precipitation and arsenate mineral precipitation were both demonstrated to occur in the aerobic precipitation tests (Section 4.3).

6.4 Implications for Long-Term Fate and Transport

Current groundwater geochemistry within the Site is controlled largely by the extent of iron in groundwater, which tends to precipitate as iron oxyhydroxides, carbonates, and Fe(II)/Fe(III) layered hydroxides such as green rust. These minerals are now buffering ferrous iron concentrations. Because groundwater is relatively-reducing, ferrous iron is stable, and is present both within the groundwater source areas and along the migration pathway toward Wapato Creek[31].

In contrast to iron, groundwater arsenic concentrations are highly variable. Concentrations are elevated in the source area, but are rapidly attenuated along downgradient migration pathways (Figure 6-1). This concentration gradient is due, in part, to the occurrence of high levels of iron in groundwater and soils available to react with it. As demonstrated by batch testing, iron-arsenic reactions lead to iron arsenate mineral precipitation, arsenic co-precipitation, and adsorption to iron-bearing minerals. These processes together reduce the amount of arsenic that is available to migrate toward porewater and sediments along Wapato Creek.

In the future, groundwater chemistry is likely to remain iron-reducing due to ferrous iron mineral buffers and ongoing degradation of organics from wood waste and natural humic matter. Therefore, the same attenuation processes identified in this study are predicted to continue. Even if all wood waste were to be removed from the Site, reducing conditions would likely persist in the groundwater for an extended period of time (i.e., hundreds of years). Attempting to modify Site groundwater conditions (i.e., to create oxidizing conditions) is not recommended, as the reducing conditions will tend to result in “rebound” to current conditions.

The long-term fate of arsenic at the Site will continue to be shaped by precipitation, co-precipitation, adsorption and mixing processes that have been shown to be occurring at the Site under reducing conditions. Factors that can be evaluated in the FS and that might improve observed attenuation performance include the following:

- Reducing source-area leaching rates: Changes to source area conditions (e.g., through capping enhancements or targeted dewatering of perched areas) could potentially reduce arsenic concentrations generated in source-area groundwater.
- Flattening of groundwater gradients: Flattening of groundwater gradients (e.g., by reducing recharge within the Log Yard area or conducting targeted dewatering of perched areas) could lengthen groundwater transport times between the source area

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[31] Iron concentrations are significantly lower in sediment porewater compared to nearshore and source area groundwater. This reflects the combined effects of tidal mixing and oxidative precipitation of ferric iron minerals in nearshore areas.

and Wapato Creek. This would, in turn, increase the amount of time available for precipitation, co-precipitation and adsorption reactions to occur. It would also increase the extent of groundwater mixing occurring in nearshore areas (i.e., by reducing the rate of groundwater flux into tidally-mixed zones), and correspondingly increase the relative availability of oxygenated waters in those nearshore areas.

- Adding iron-containing media: Though dissolved iron concentrations are high throughout the Site, the introduction of additional iron-containing media into groundwater could be used to enhance rates of precipitation, co-precipitation and adsorption reactions and ensure that iron concentrations remain higher than those required to inhibit arsenic migration over the very long-term. This could be performed either by injecting iron-containing media, or by constructing a permeable reactive barrier backfilled with porous iron-containing media.

Section 7
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FIGURES

Sample Matrix	Location IDs	Average Dissolved Arsenic Concentration (ug/L)
Source Area Groundwater	B-1R, MW-10, MW-13	41,238
Intermediate Groundwater	TB-3, TB-5, TB-7	235
Nearshore Groundwater	MW-7, MW-9, MW-12	37
Transition Zone Porewater	WCT-1, WCT-2, WCT-3 (40-50 cm bml)	24
Bioactive Zone Porewater	WCT-1, WCT-2, WCT-3 (0-10 cm bml)	11
Surface Water	WCT-1, WCT-2, WCT-3 (0-10 cm aml)	1

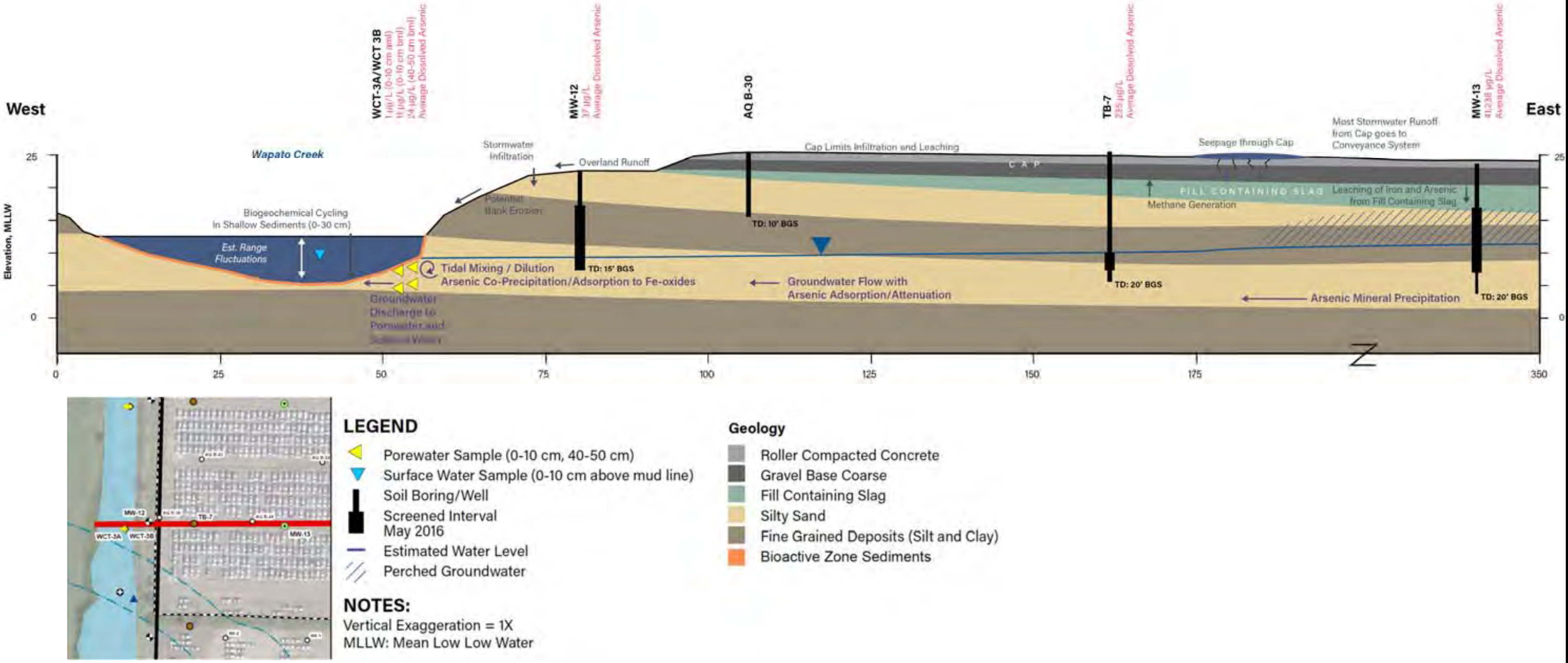


Figure ES-1. Geochemical Conceptual Site Model, Geological Cross Section B-B' (Transect 3)

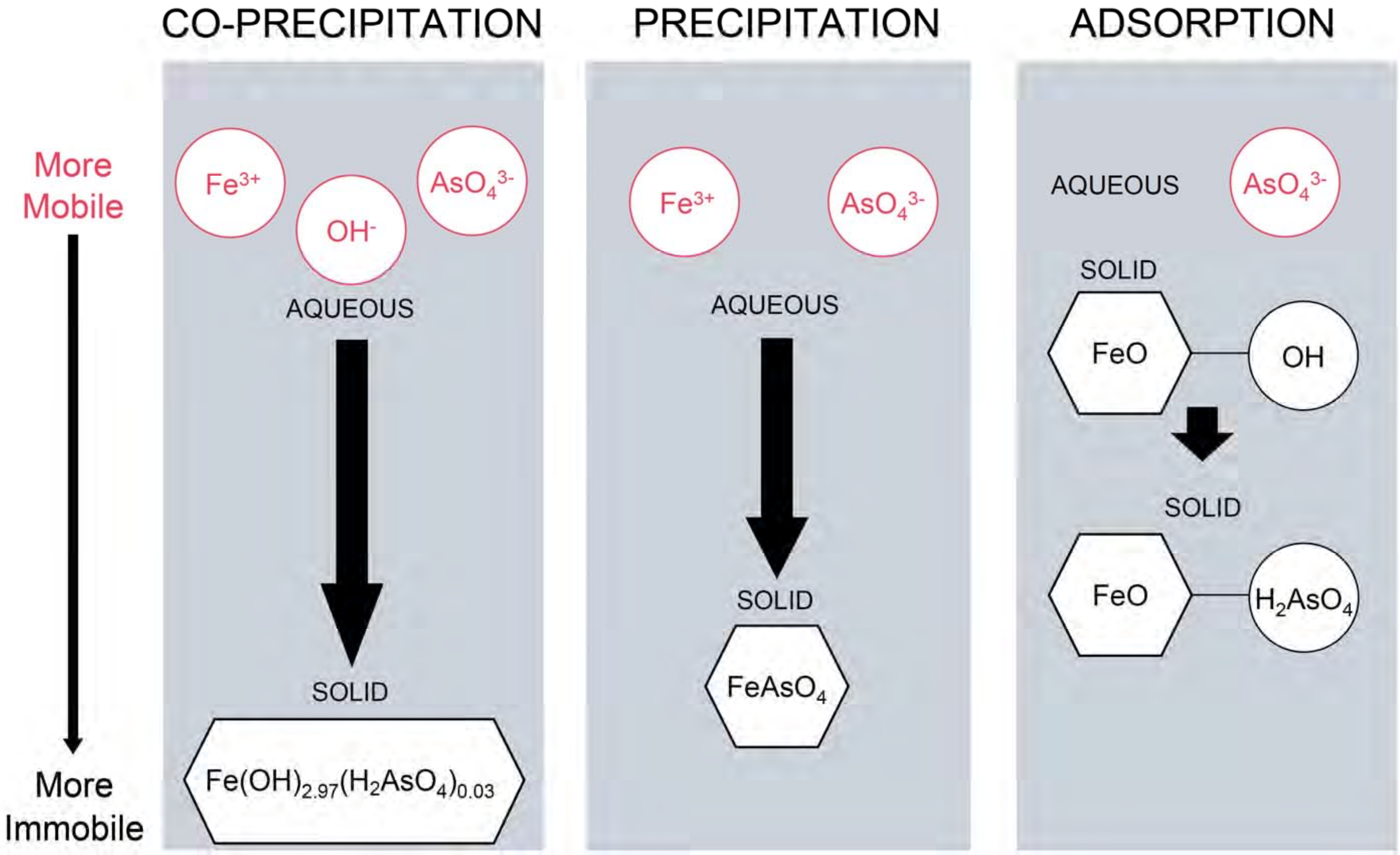


Figure ES-2. Examples of Arsenic-Specific Attenuation Processes in Groundwater and Porewater

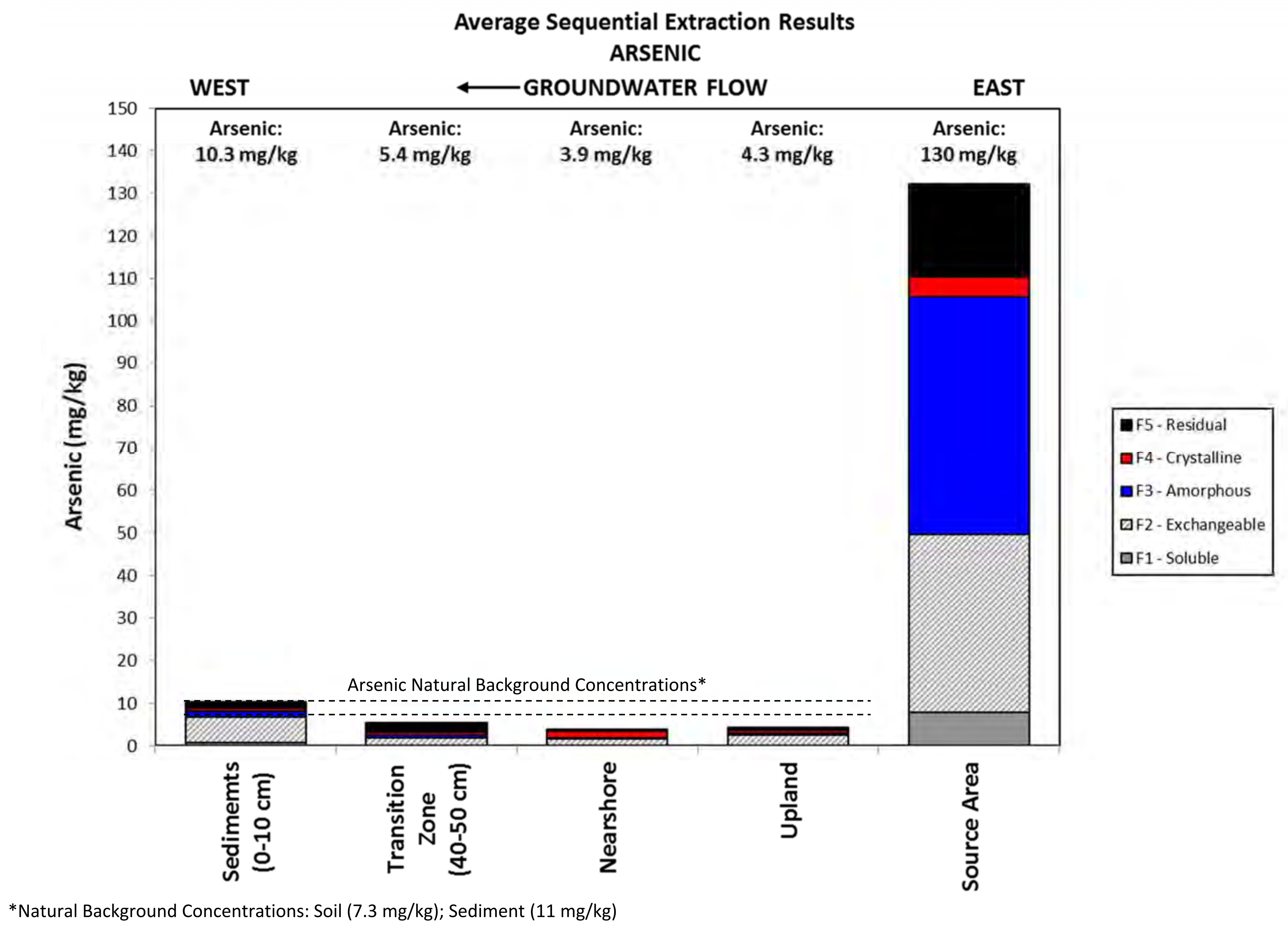
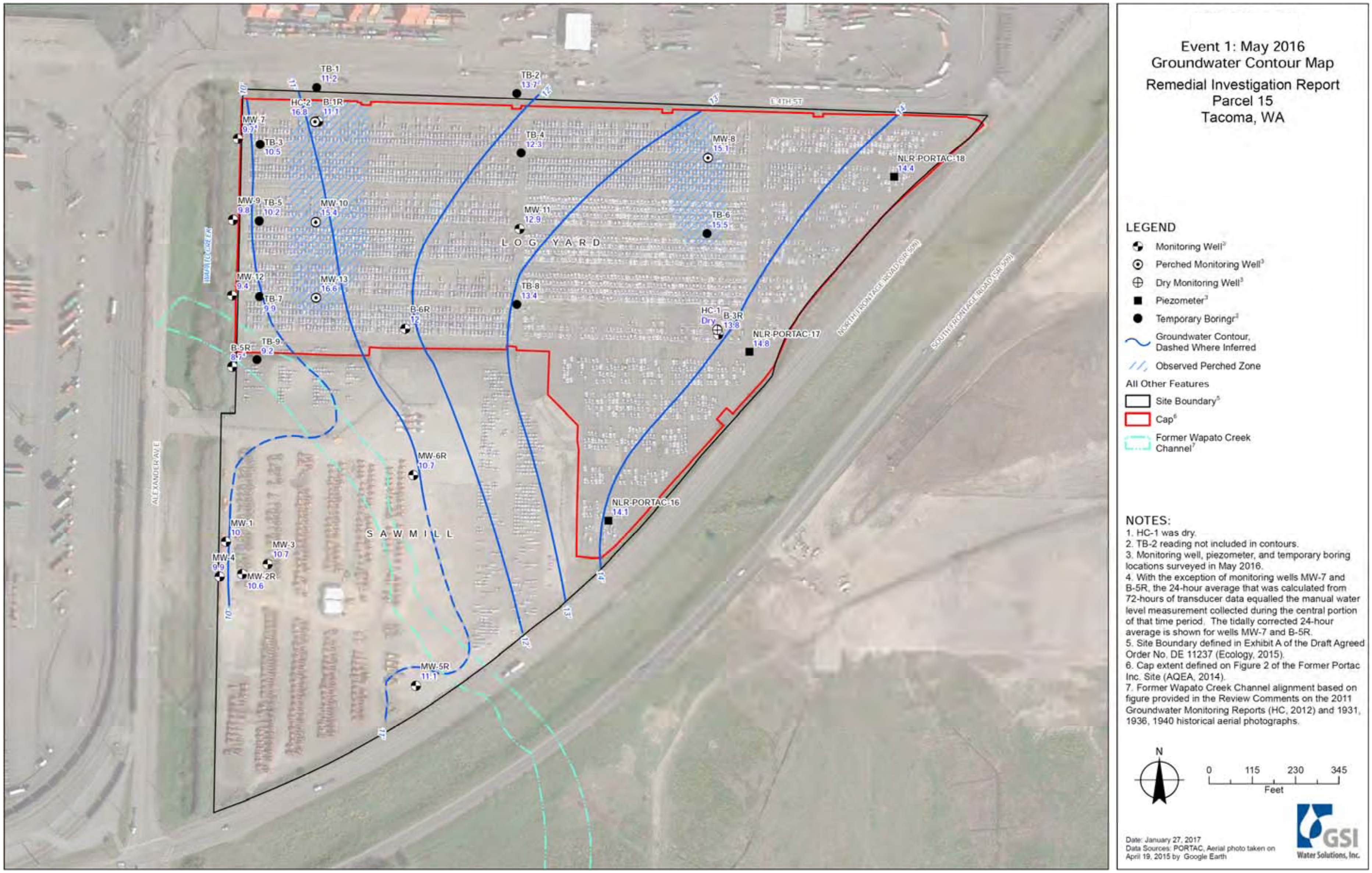


Figure ES-3. Average Distribution of Arsenic in Operationally-Defined Mineral Phases as Determined by Sequential Extraction Analysis



NOTES:
1. HC-1 was dry.
2. TB-2 reading not included in contours.
3. Monitoring well, piezometer, and temporary boring locations surveyed in May 2016.
4. With the exception of monitoring wells MW-7 and B-5R, the 24-hour average that was calculated from 72-hours of transducer data equalled the manual water level measurement collected during the central portion of that time period. The tidally corrected 24-hour average is shown for wells MW-7 and B-5R.
5. Site Boundary defined in Exhibit A of the Draft Agreed Order No. DE 11237 (Ecology, 2015).
6. Cap extent defined on Figure 2 of the Former Portac Inc. Site (AQEA, 2014).
7. Former Wapato Creek Channel alignment based on figure provided in the Review Comments on the 2011 Groundwater Monitoring Reports (HC, 2012) and 1931, 1936, 1940 historical aerial photographs.

Date: January 27, 2017
Data Sources: PORTAC, Aerial photo taken on April 19, 2015 by Google Earth

GSI Water Solutions, Inc.

Figure 1-1. Plan View Map Showing Site Monitoring Wells and Event 1 Groundwater Contours

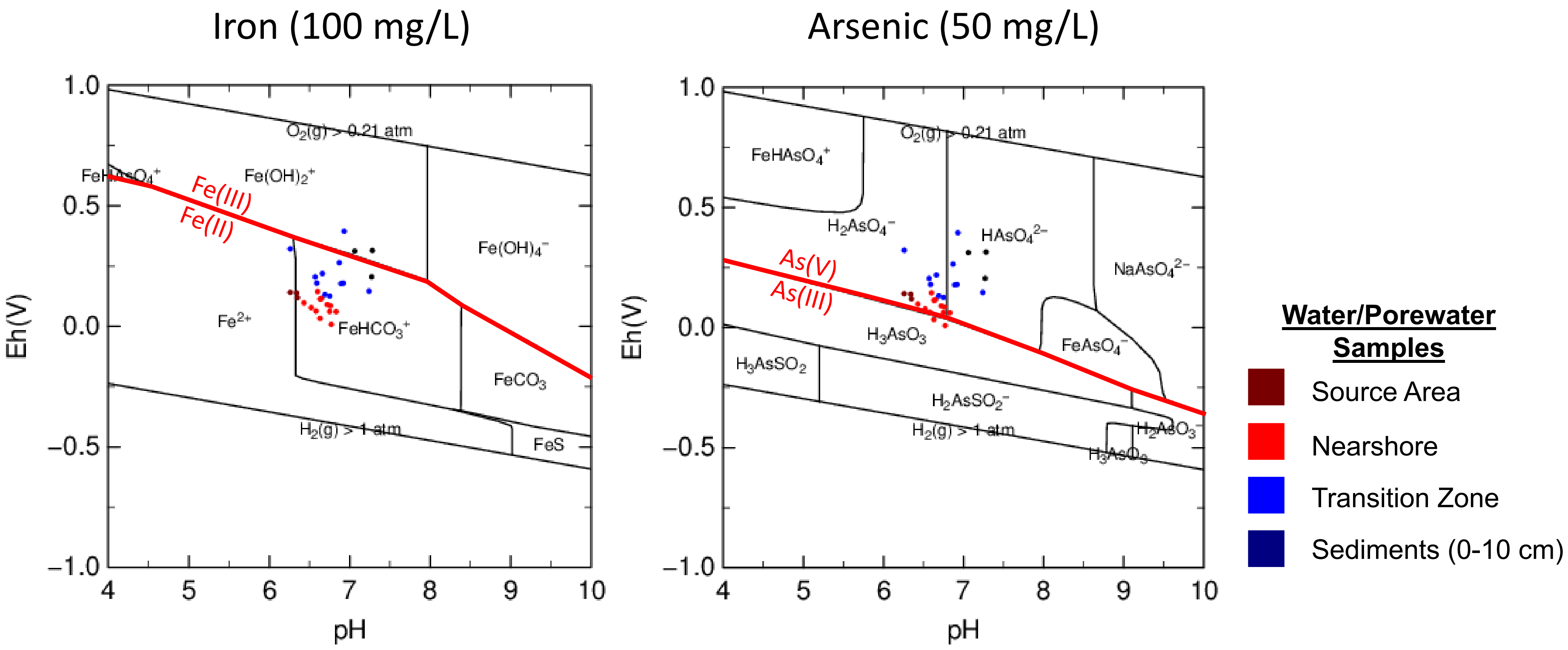
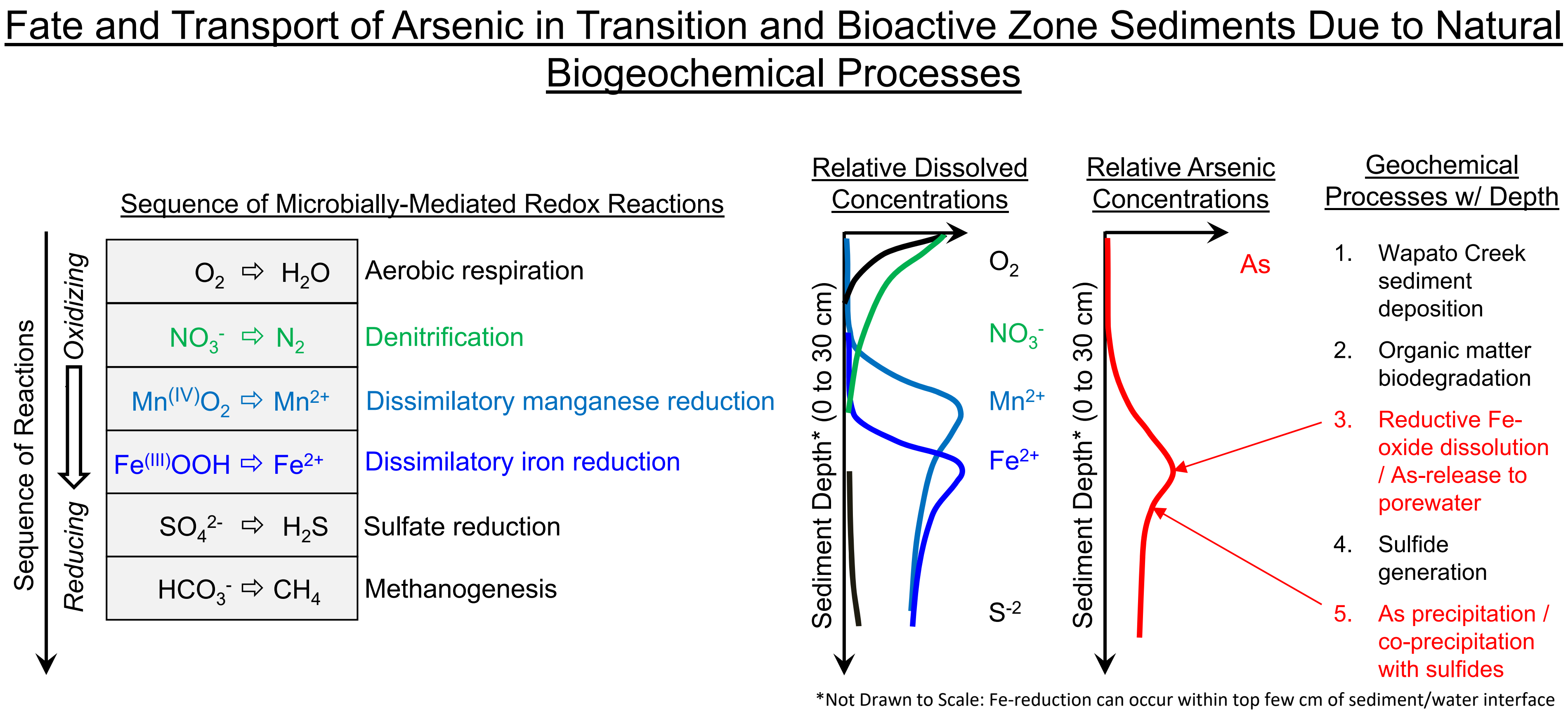


Figure 2-1. Eh-pH Diagram for Iron (*left*) and Arsenic (*right*) Showing Groundwater and Porewater Relative to the Stability Fields of Aqueous Species



Fate and Transport of Arsenic in Transition and Bioactive Zone Sediments Due to Natural Biogeochemical Processes

Sequence of Microbially-Mediated Redox Reactions

O_2 ⇨ H_2O	Aerobic respiration
NO_3^- ⇨ N_2	Denitrification
$Mn^{(IV)}O_2$ ⇨ Mn^{2+}	Dissimilatory manganese reduction
$Fe^{(III)}OOH$ ⇨ Fe^{2+}	Dissimilatory iron reduction
SO_4^{2-} ⇨ H_2S	Sulfate reduction
HCO_3^- ⇨ CH_4	Methanogenesis

Geochemical Processes w/ Depth

1. Wapato Creek sediment deposition
2. Organic matter biodegradation
3. Reductive Fe-oxide dissolution / As-release to porewater
4. Sulfide generation
5. As precipitation / co-precipitation with sulfides

*Not Drawn to Scale: Fe-reduction can occur within top few cm of sediment/water interface

Figure 2-2. Sequence of Terminal Electron-Accepting Processes (TEAPs) (*left*) and Resultant Dissolved Constituent Concentrations in Sediments (*right*)

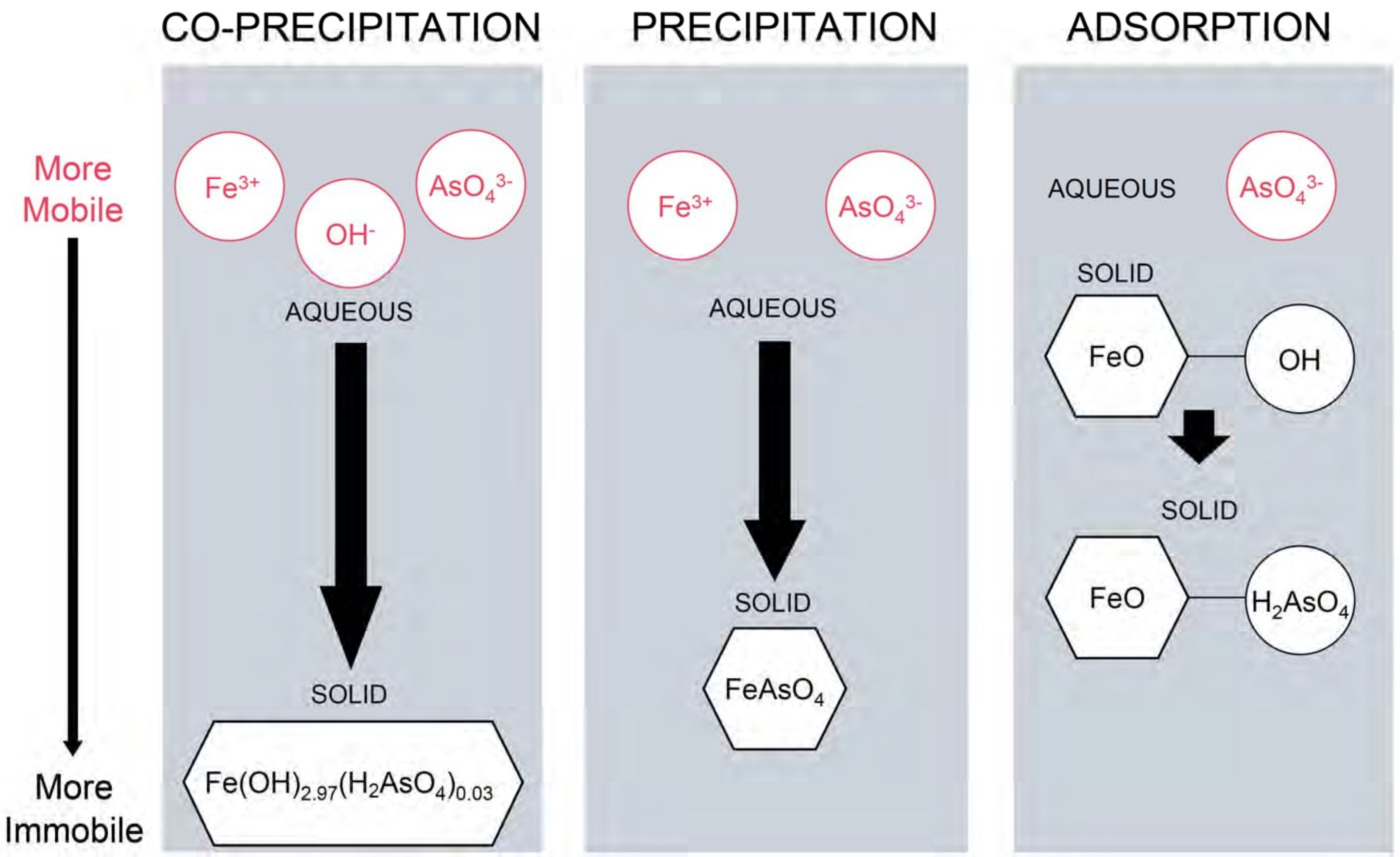


Figure 2-3. Examples of Arsenic-Specific Attenuation Processes in Groundwater and Porewater

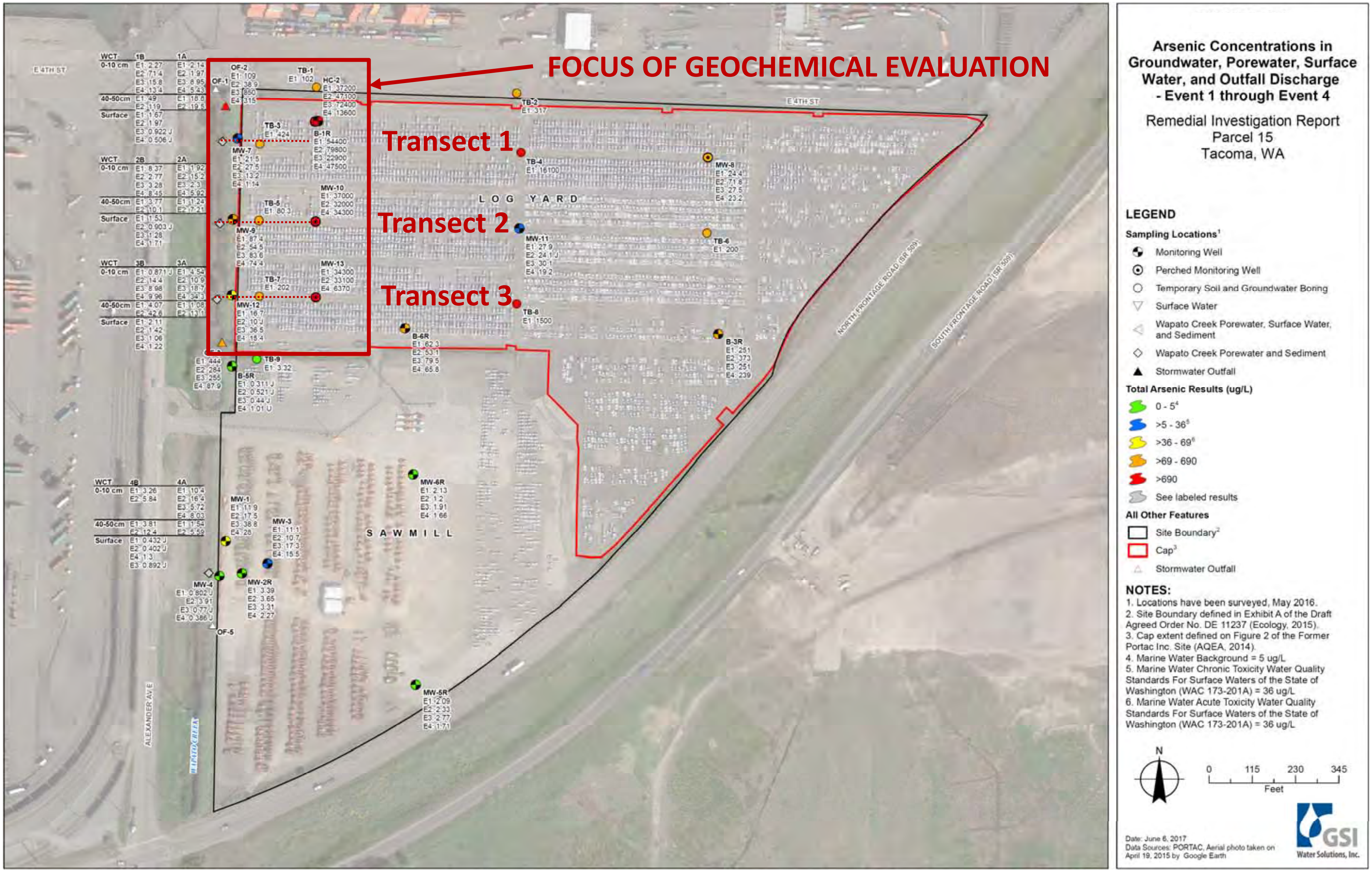


Figure 3-1. Plan View Map Showing Dissolved Arsenic Concentrations and Transects Evaluated in Geochemical Evaluations

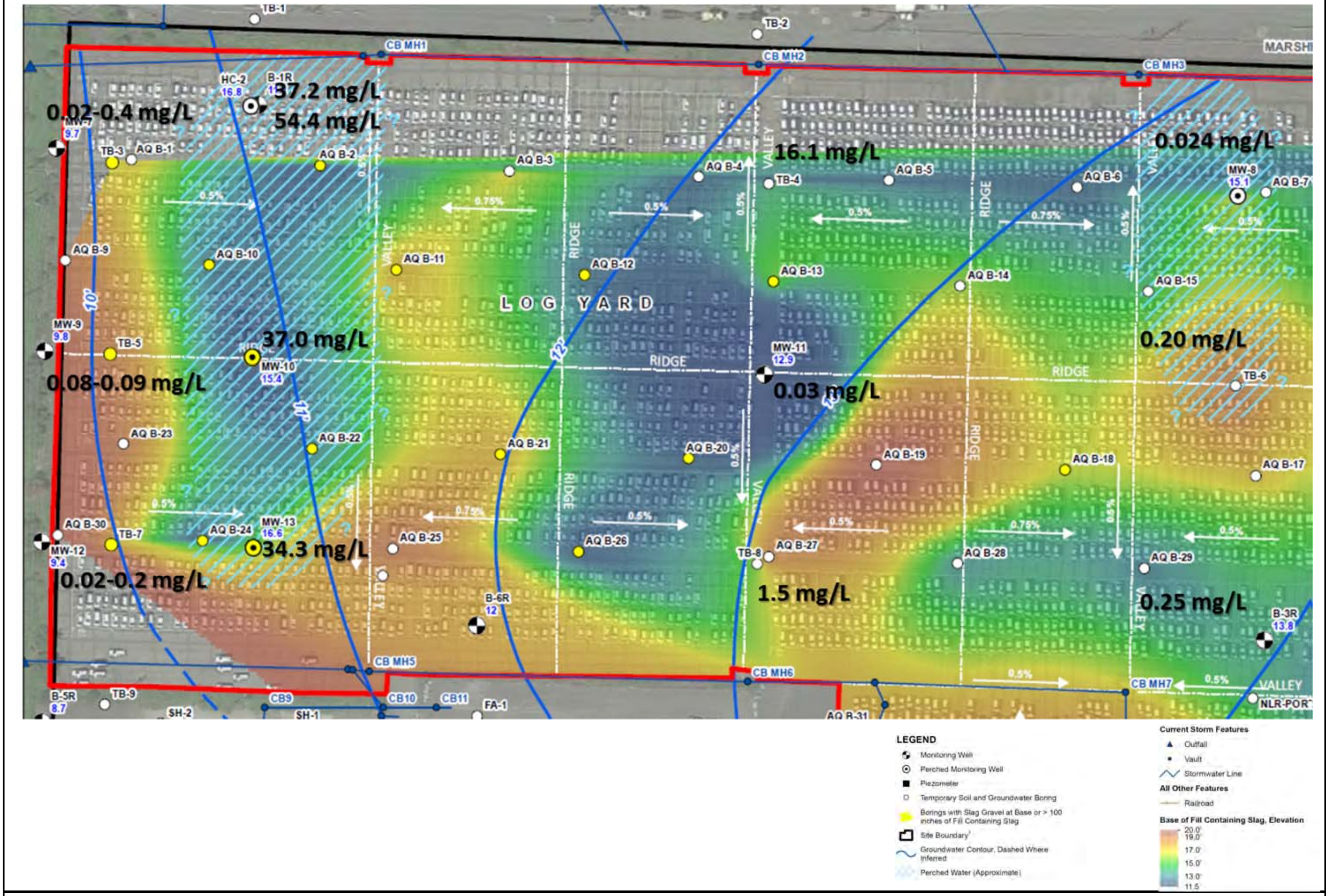
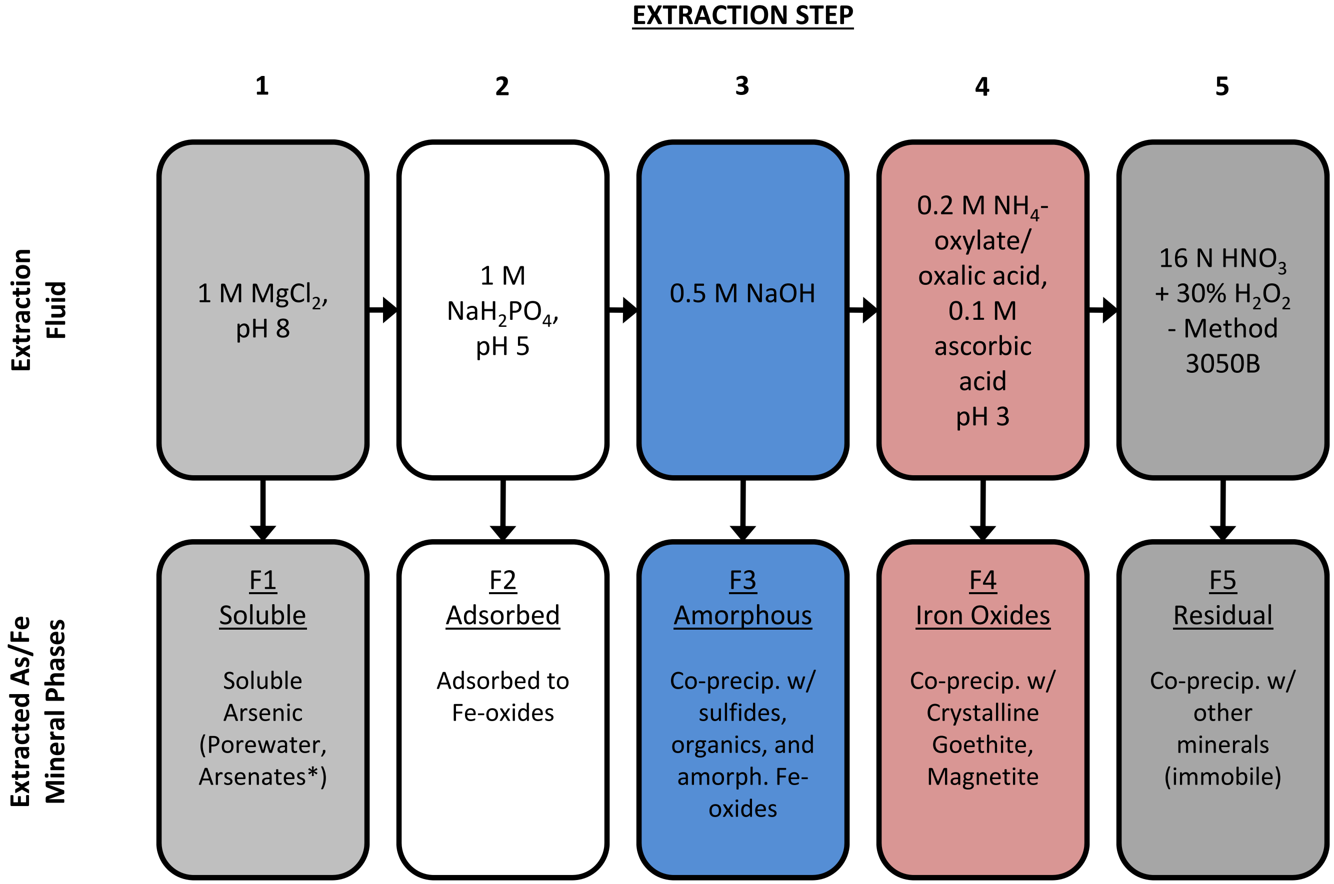


Figure 3-2. Plan View Map Showing Base of the Fill Containing Slag and Event 1 Groundwater Arsenic Concentrations



*Based purely on mineral solubility (for the S:L ratios used in the tests), a ferrous or ferric arsenate mineral is predicted to dissolve in the soluble fraction (F1); however, due to time-dependent dissolution kinetics (Harvey et al., 2006), iron-arsenic-bearing minerals can dissolved continuously in several fractions, including soluble (F1), exchangeable (F2), and amorphous (F3).

Figure 3-3. Description of Sequential Extraction Fluids Used to Quantify the Abundance of Arsenic in Operationally-Defined Mineral Phases

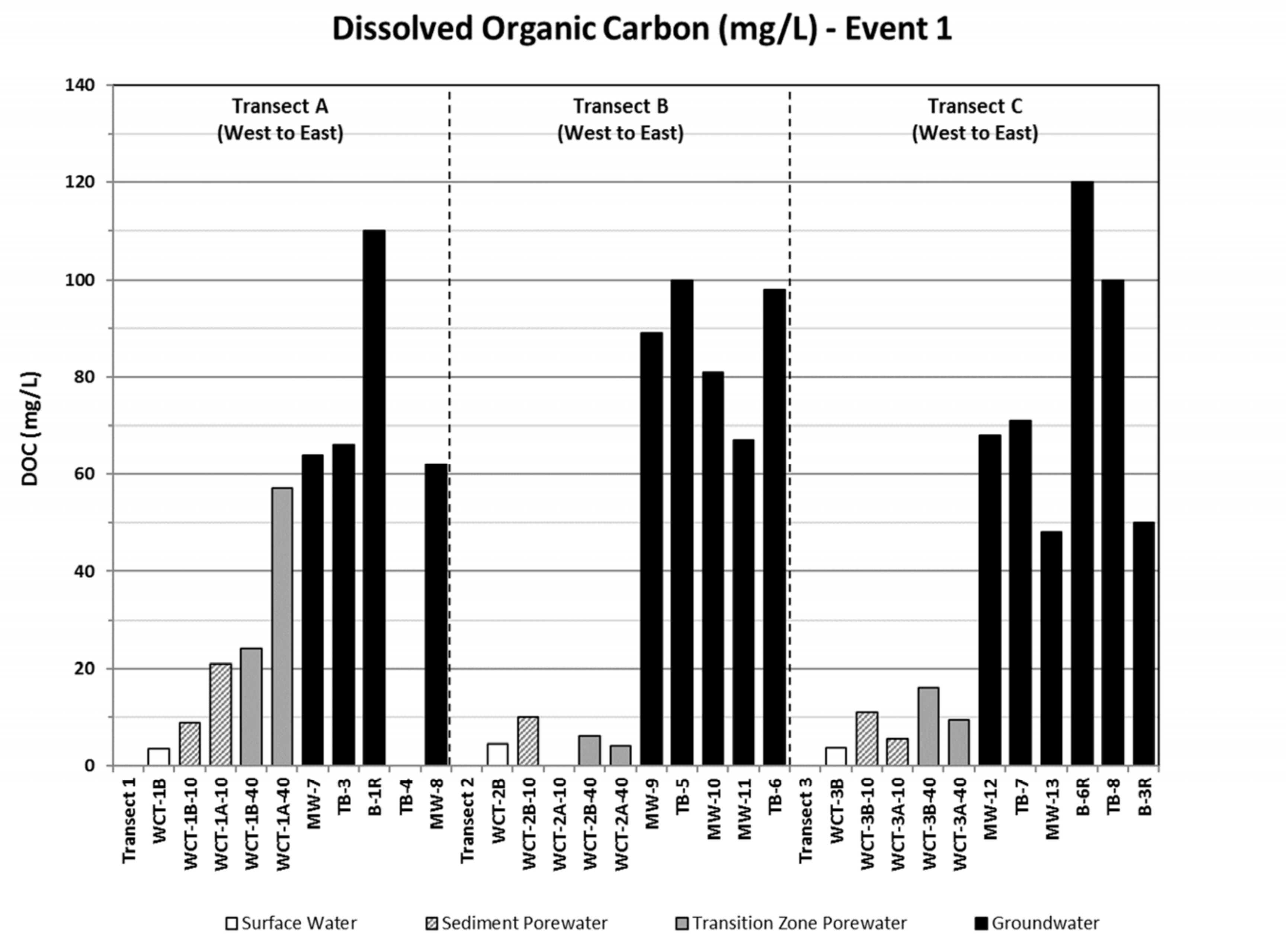


Figure 4-1. Event 1 Surface Water, Groundwater, and Porewater Chemistry Results: a) TOC

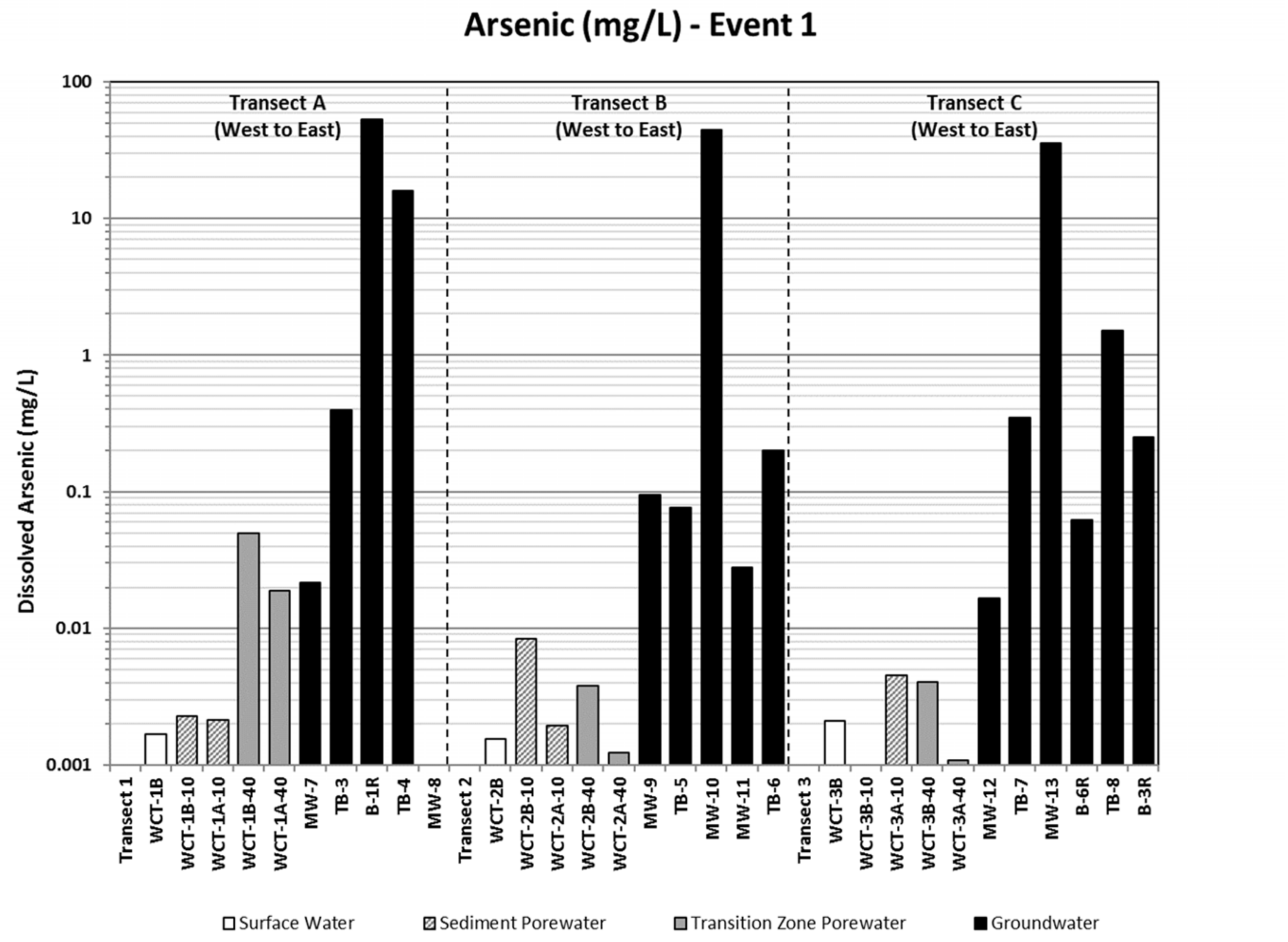


Figure 4-1. Event 1 Surface Water, Groundwater, and Porewater Chemistry Results: b) Arsenic

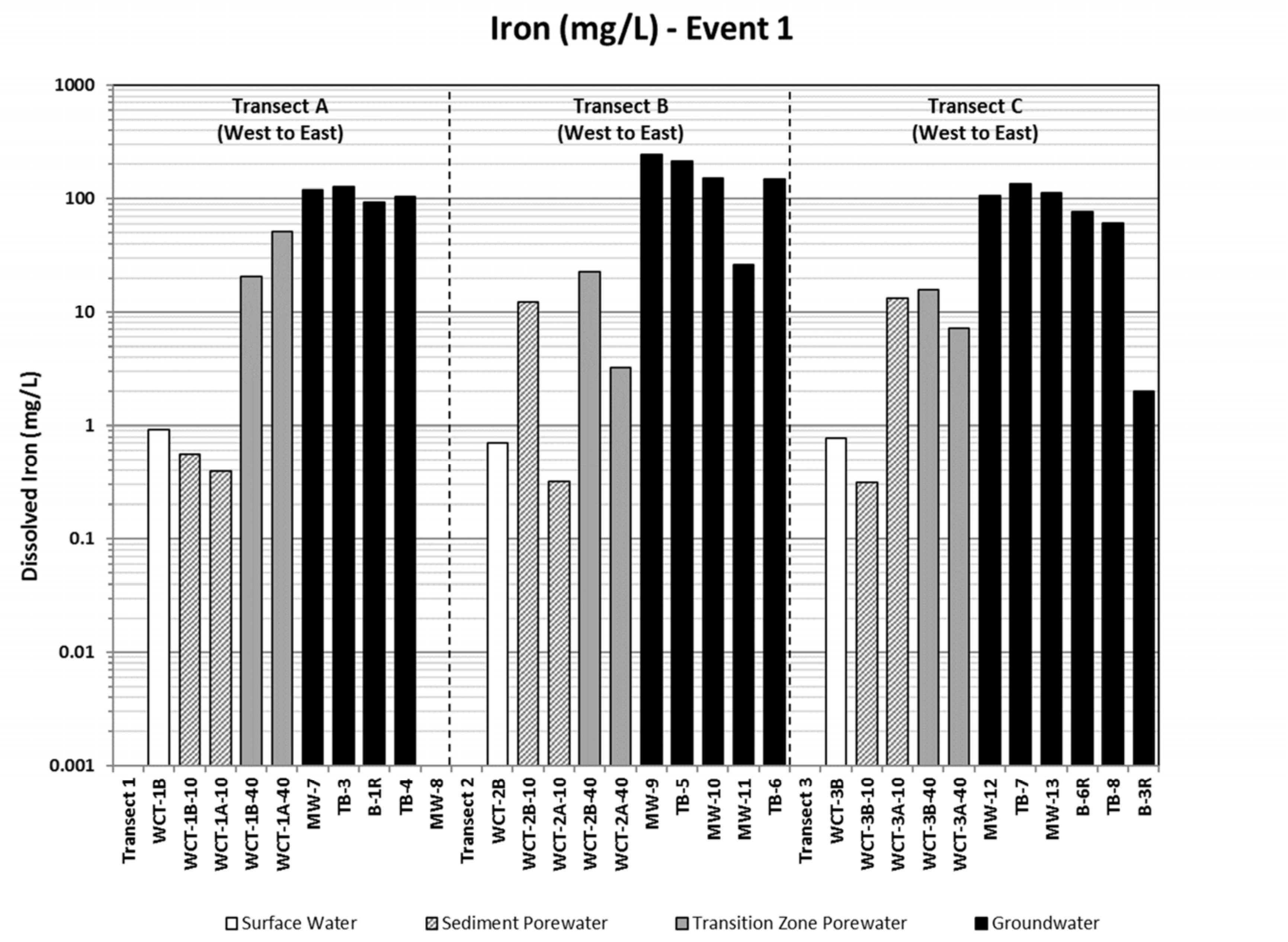


Figure 4-1. Event 1 Surface Water, Groundwater, and Porewater Chemistry Results: c) Iron

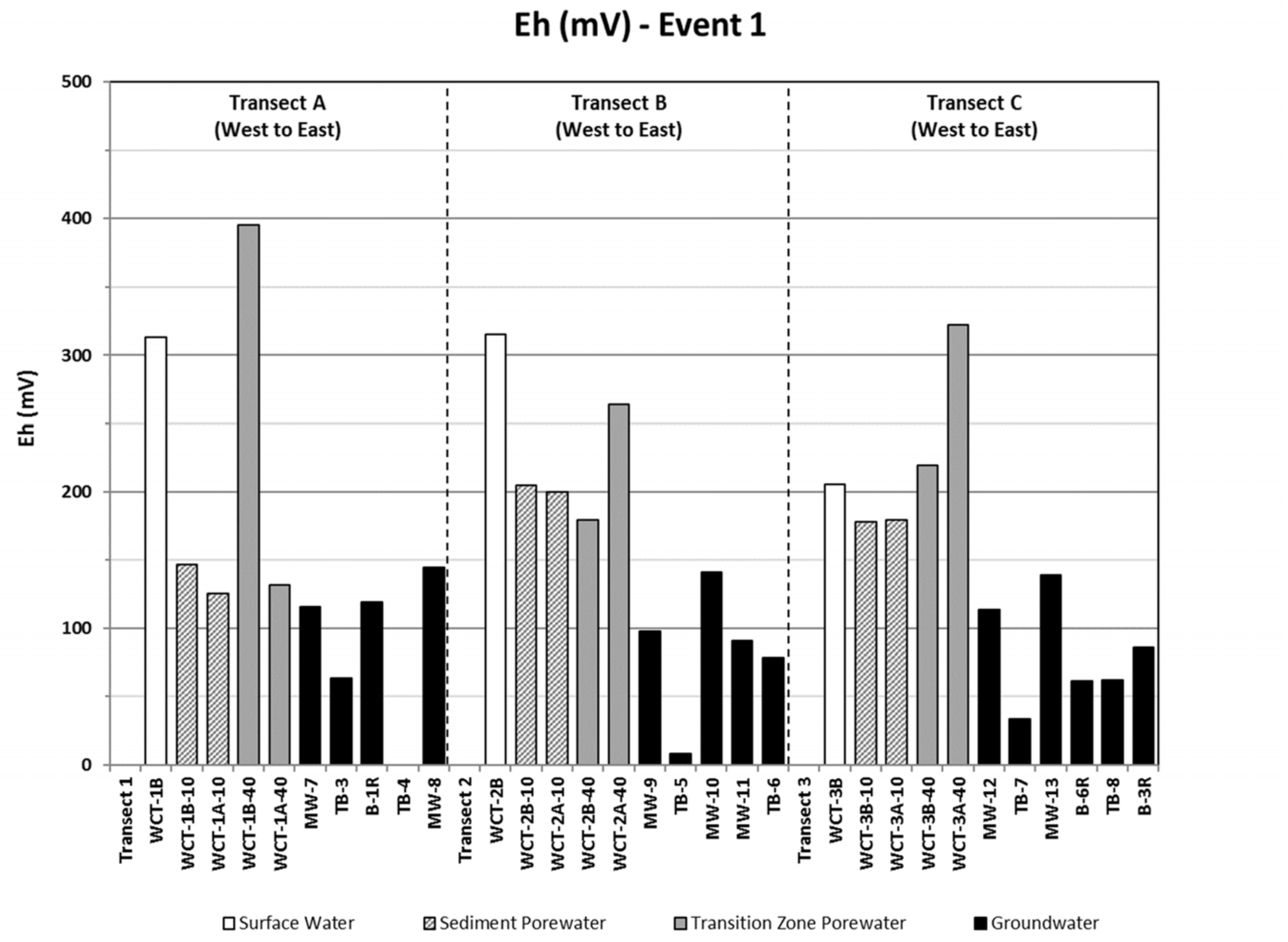


Figure 4-1. Event 1 Surface Water, Groundwater, and Porewater Chemistry Results: d) Eh

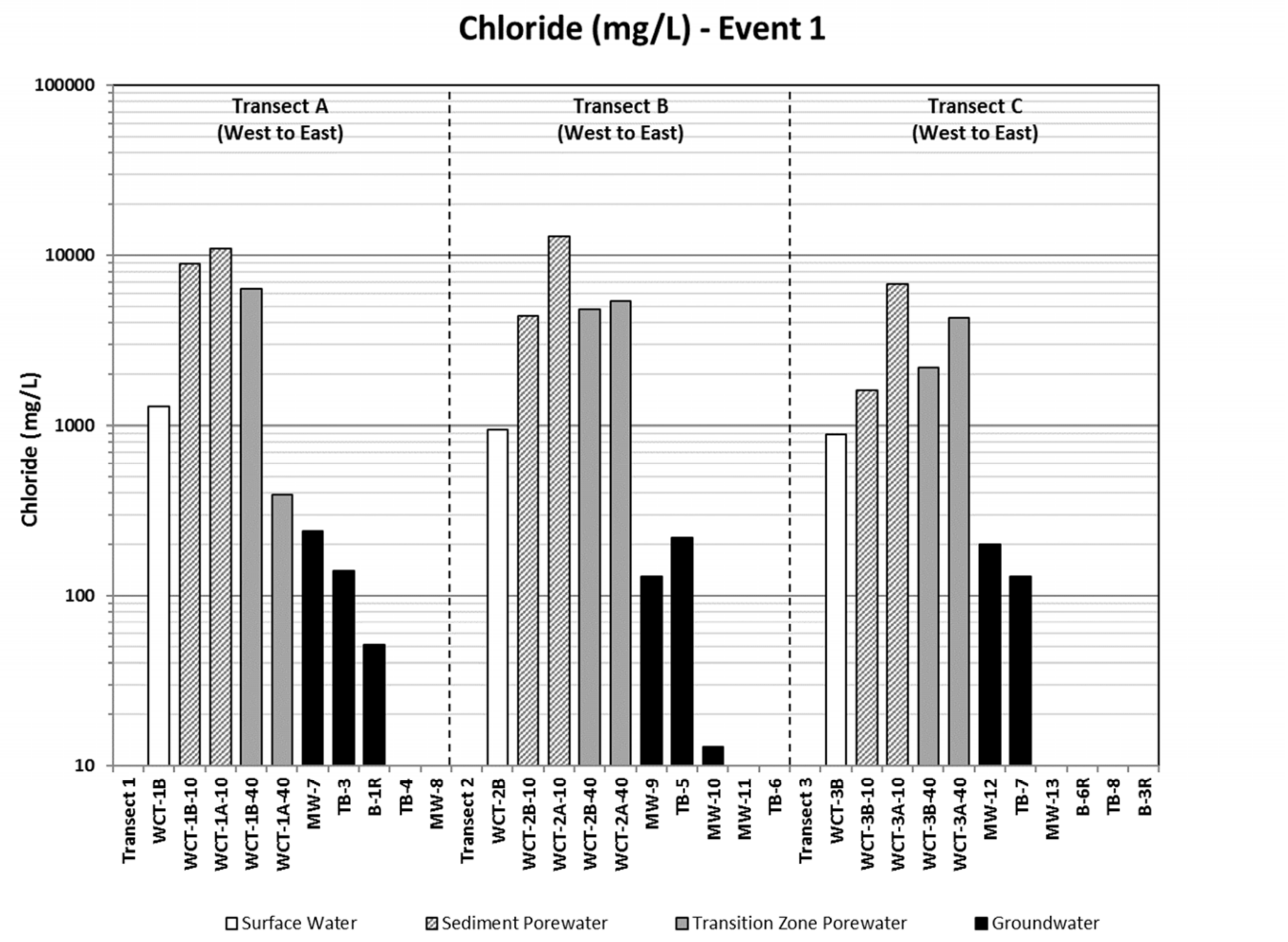


Figure 4-1. Event 1 Surface Water, Groundwater, and Porewater Chemistry Results: e) Chloride

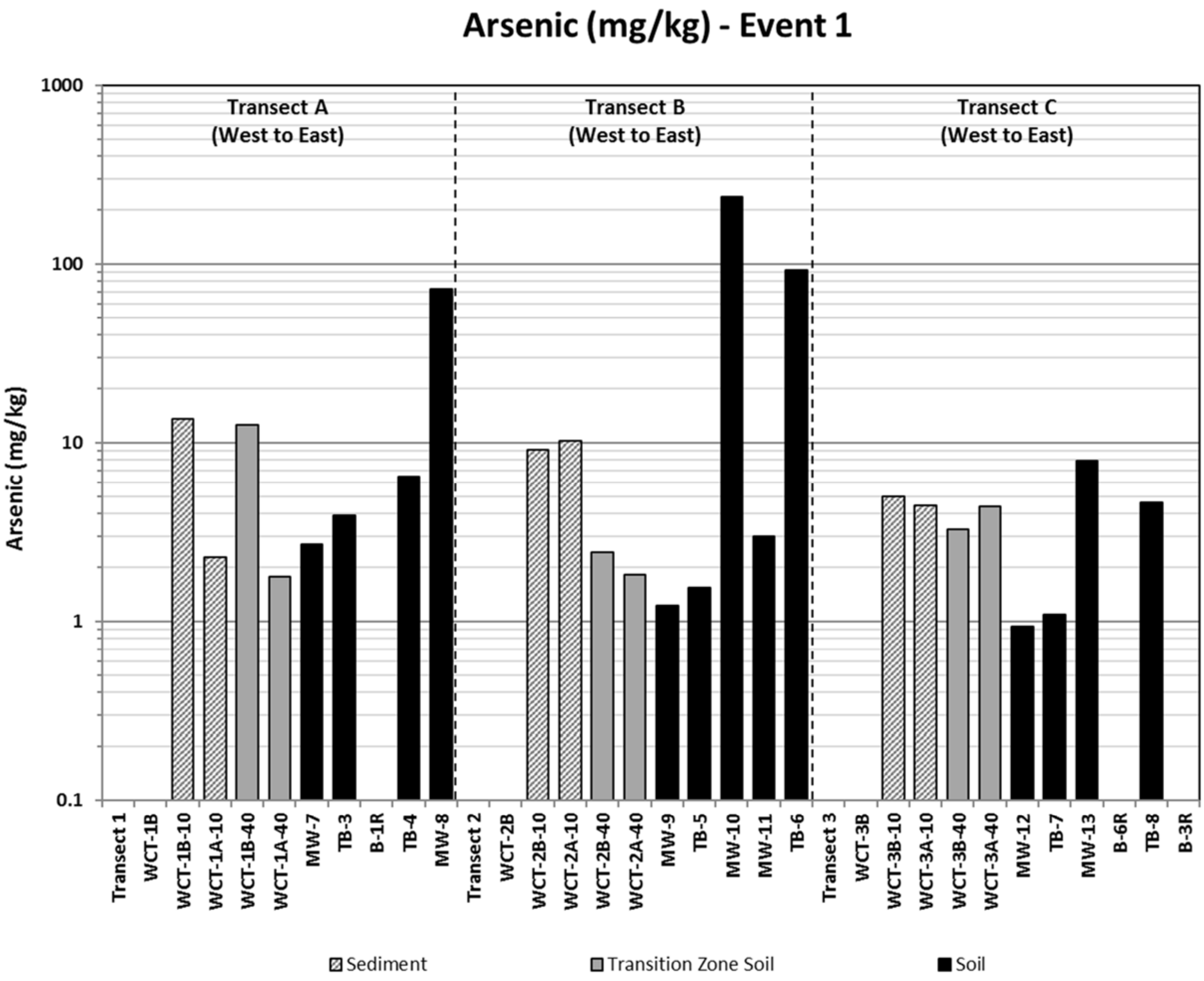


Figure 4-2. Event 1 Soil and Sediment Chemistry Results: a) Arsenic

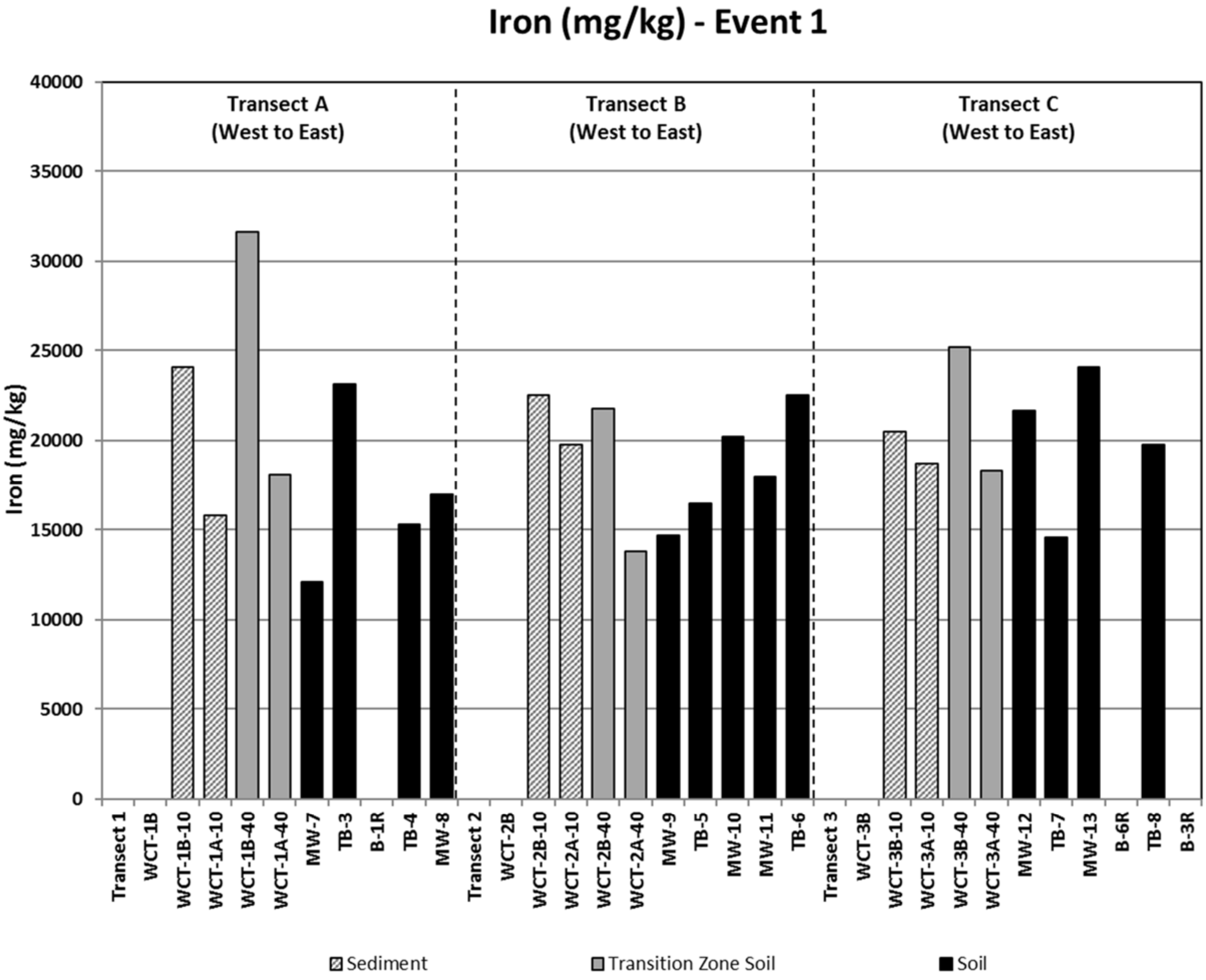


Figure 4-2. Event 1 Soil and Sediment Chemistry Results: b) Iron

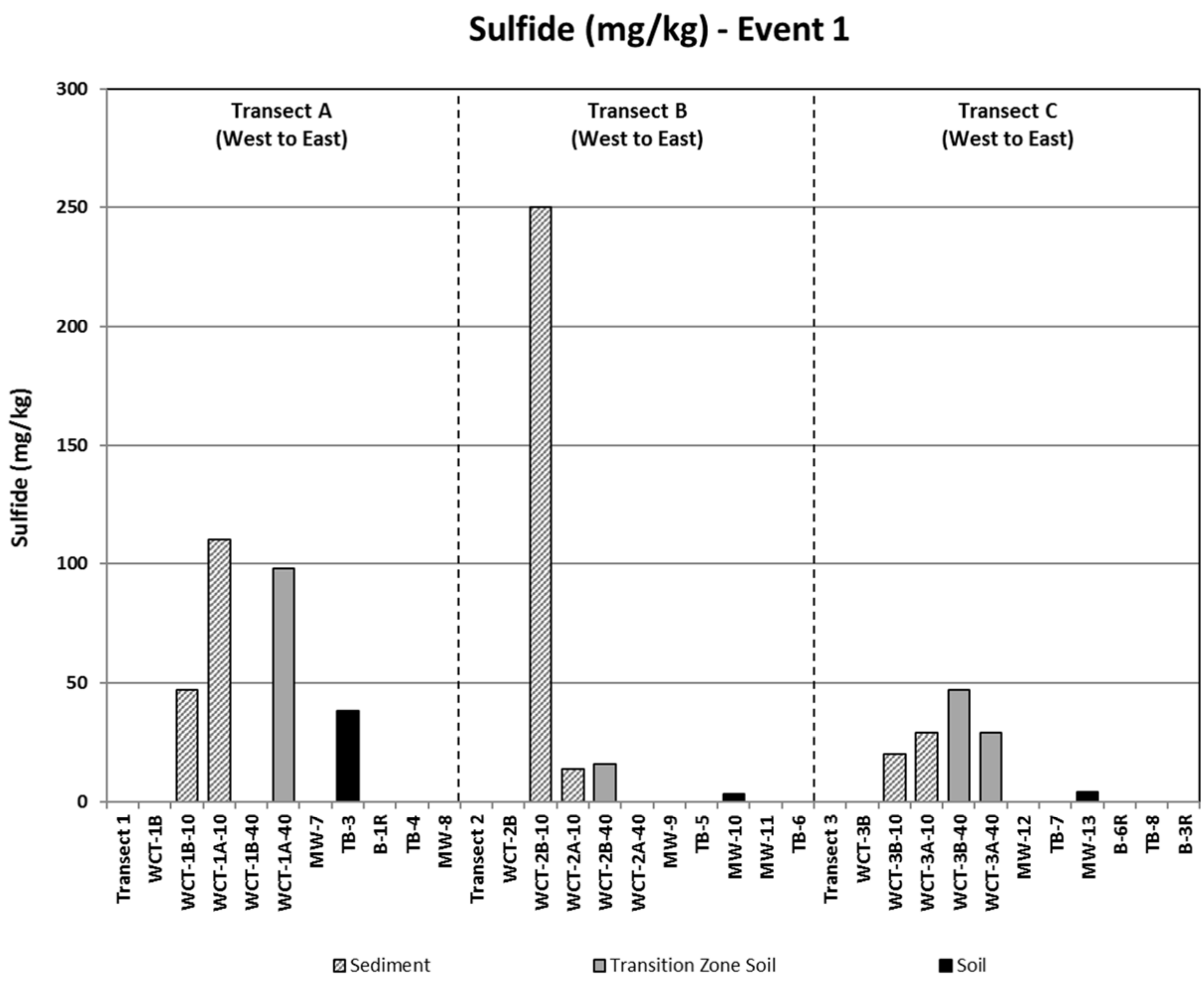
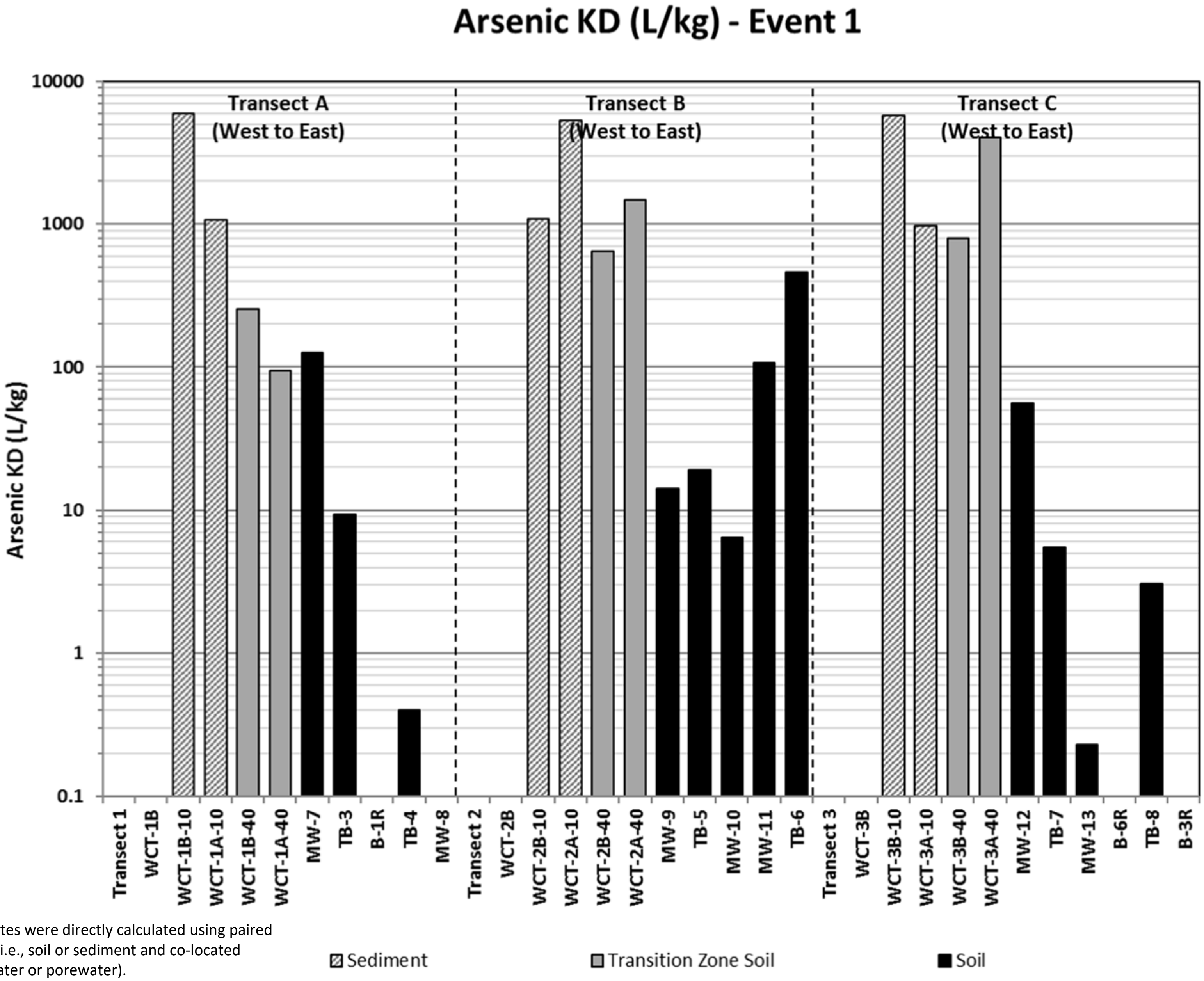


Figure 4-2. Event 1 Soil and Sediment Chemistry Results: c) Sulfide



Notes:
K_D estimates were directly calculated using paired samples (i.e., soil or sediment and co-located groundwater or porewater).

Figure 4-2. Event 1 Soil and Sediment Chemistry Results: d) Arsenic Distribution Coefficient (K_D)

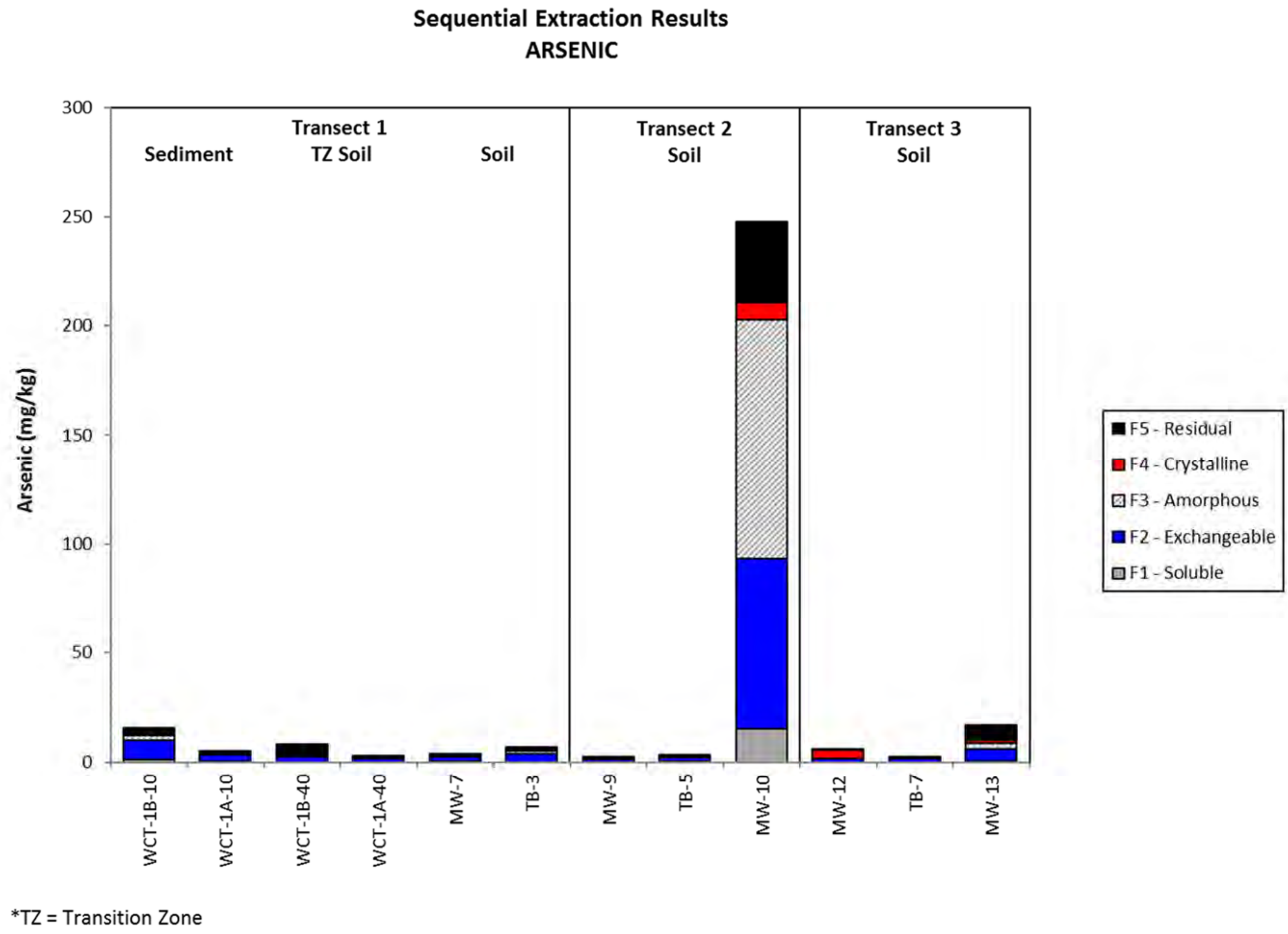


Figure 4-3. Relative Distribution of Constituents in Operationally-Defined Mineral Phases as Determined by Sequential Extraction Analysis: a) Arsenic (MW-10)

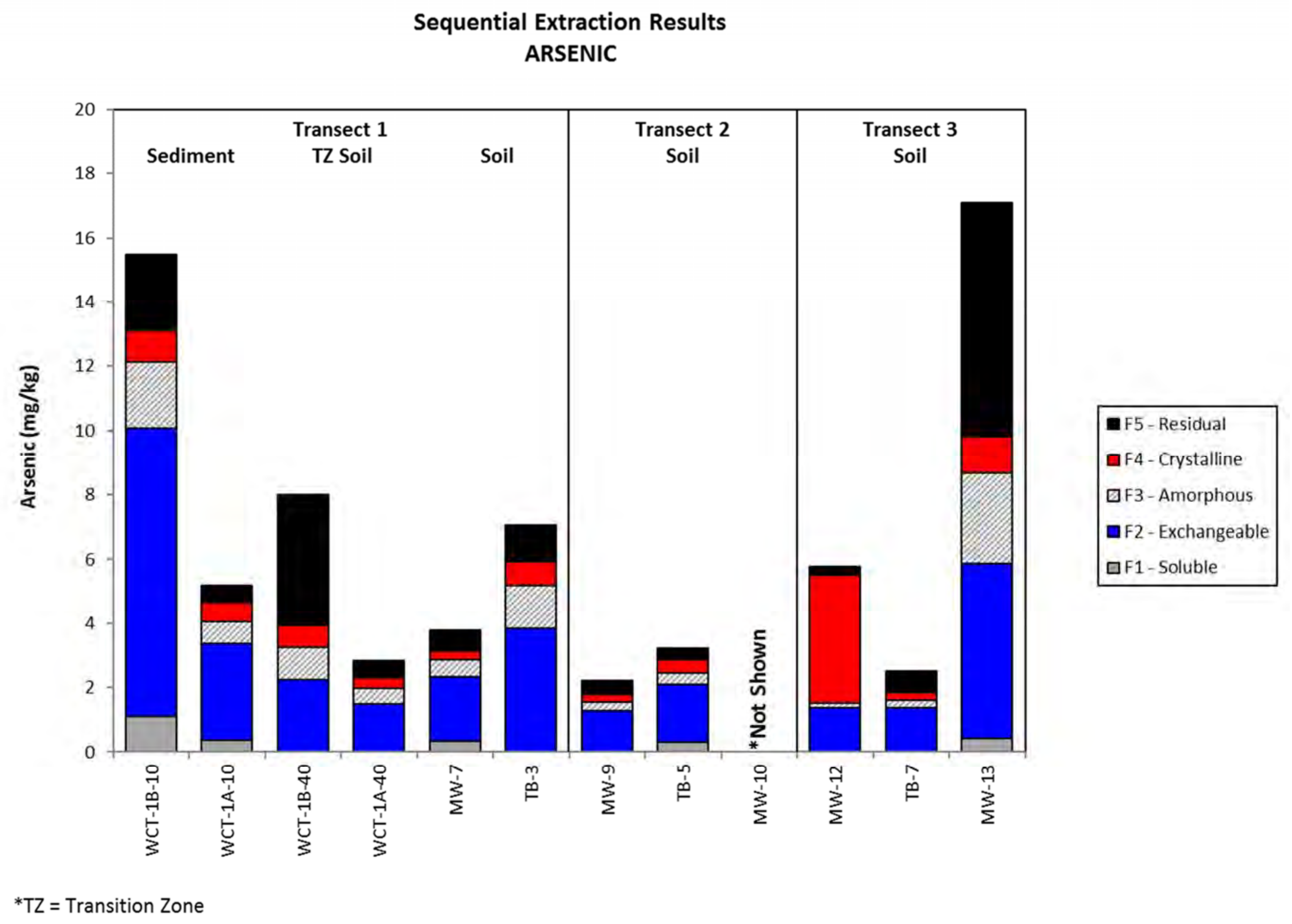


Figure 4-3. Relative Distribution of Constituents in Operationally-Defined Mineral Phases as Determined by Sequential Extraction Analysis: b) Arsenic

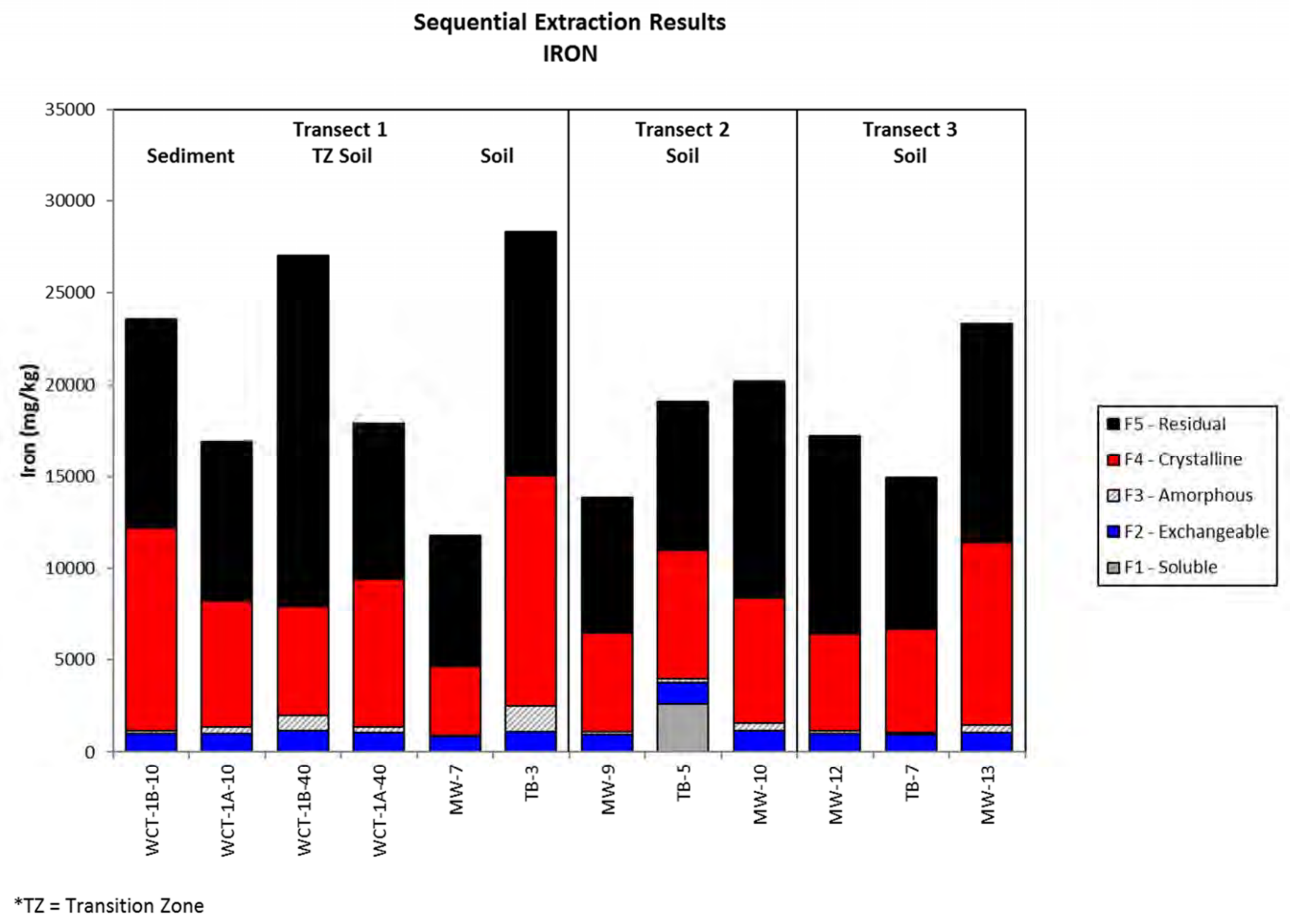


Figure 4-3. Distribution of Constituents in Operationally-Defined Mineral Phases as Determined by Sequential Extraction Analysis: c) Iron

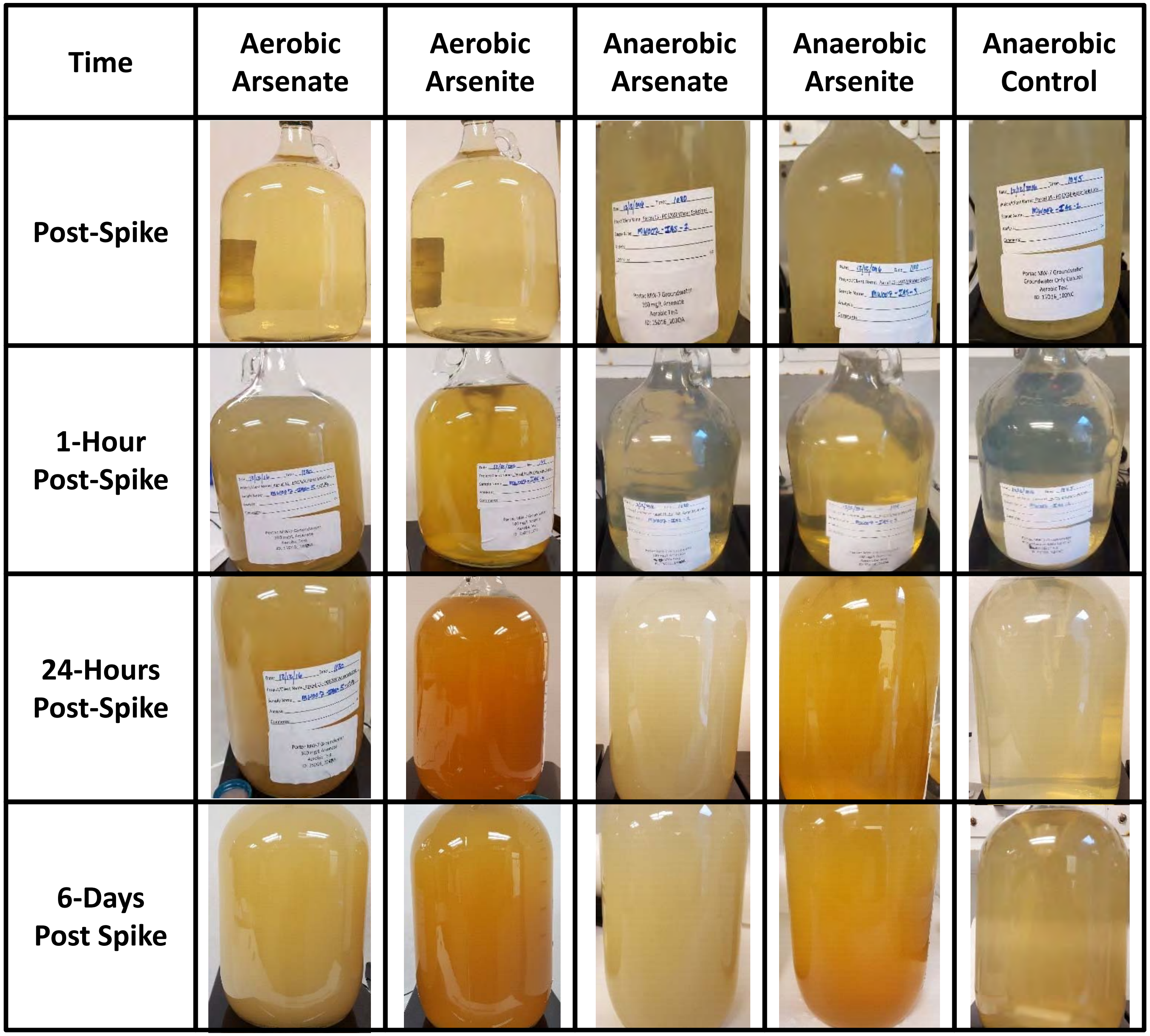
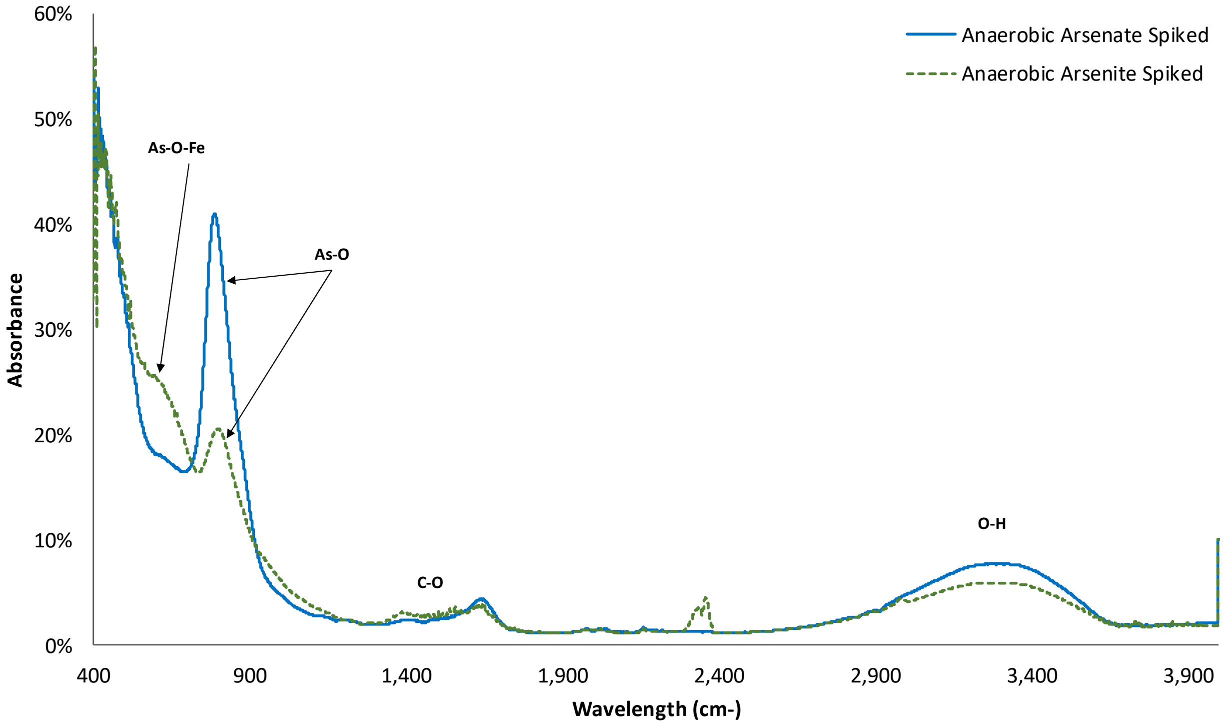
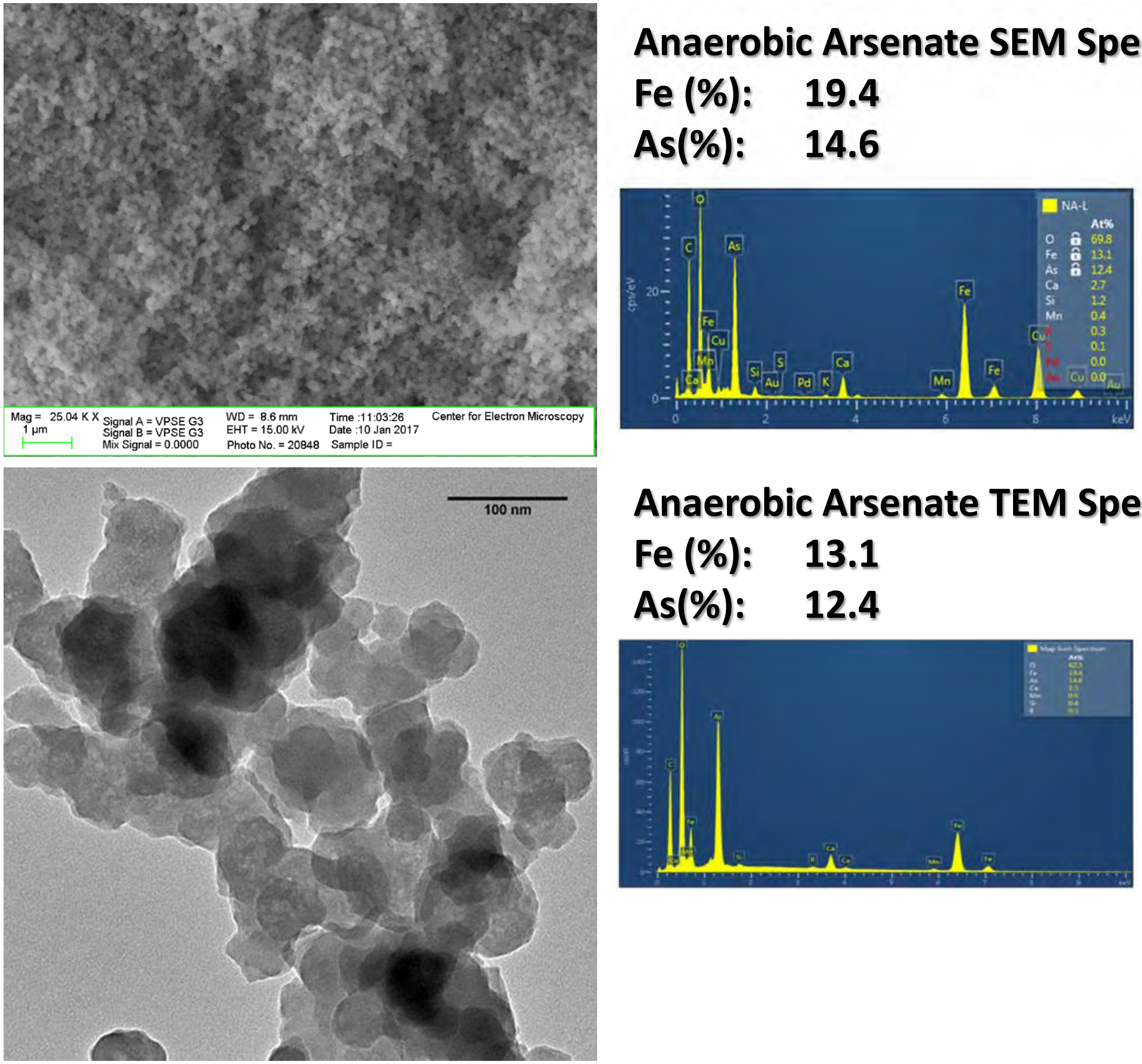


Figure 4-4. Photographs from Induced Precipitation Tests as a Function of Time



Note:
Functional groups identified by FTIR include arsenic-oxygen-iron bonds (As-O-Fe) only in the precipitates from the arsenite-spiked samples, arsenic-oxygen bonds (As-O) in all precipitates, carbonate functional groups (C-O) in all precipitates, and formula water or hydroxyl groups (O-H) in all precipitates.

Figure 4-5. Functional Groups Identified by Fourier Transform Infrared Spectroscopy



Anaerobic Arsenate SEM Spectrum:

Fe (%): 19.4

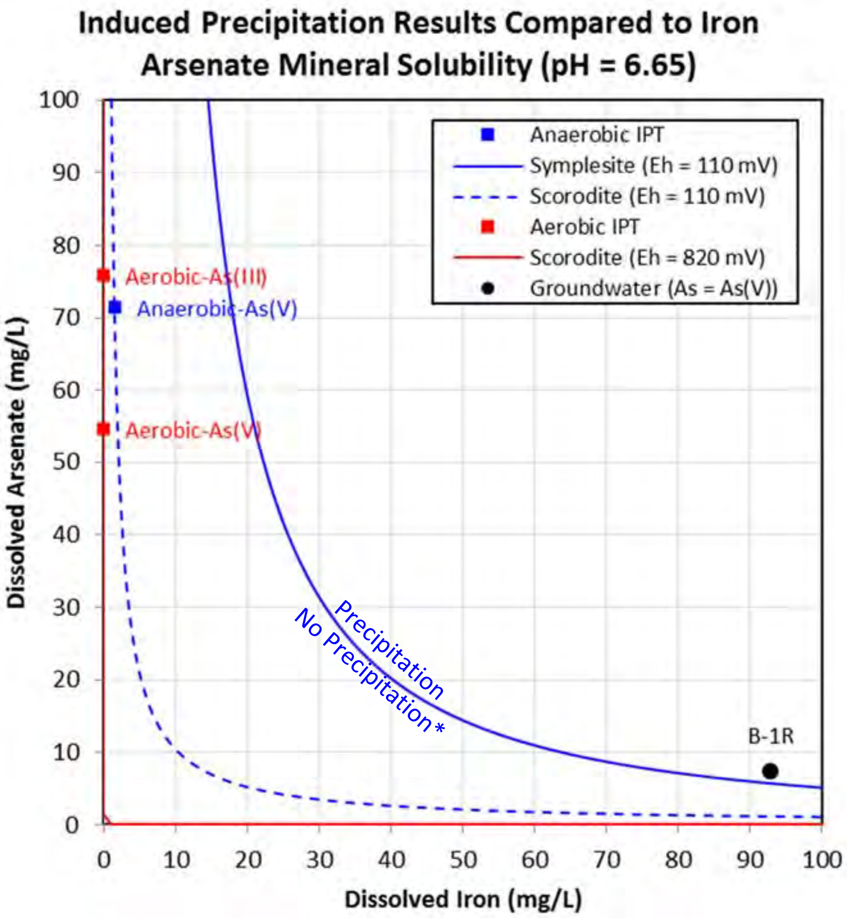
As(%): 14.6

Anaerobic Arsenate TEM Spectrum:

Fe (%): 13.1

As(%): 12.4

Figure 4-6. Scanning Electron Microscopy (*top*) and Transmission Electron Microscopy (*bottom*) Images and Spectra



Notes:

*Mineral solubility curves display the combination of iron and arsenic concentrations required for a mineral to be stable (and/or precipitate). Induced precipitation test concentration data that plot on or above a specific curve have sufficient concentrations for the mineral represented by the curve to be stable (and/or precipitate). In this plot, the aerobic tests are on (or above) the line for scorodite (for Eh = 820 mV); and, the anaerobic arsenate test is on the solubility curve for scorodite. Also shown is groundwater sample B-1R, which is above the solubility curve for symplesite under anaerobic conditions (Eh = 110 mV).

Figure 4-7. Comparison of Dissolved Arsenic and Iron Concentrations in Induced Precipitation Tests to Mineral Solubility Curves for Fe(II)-Arsenate

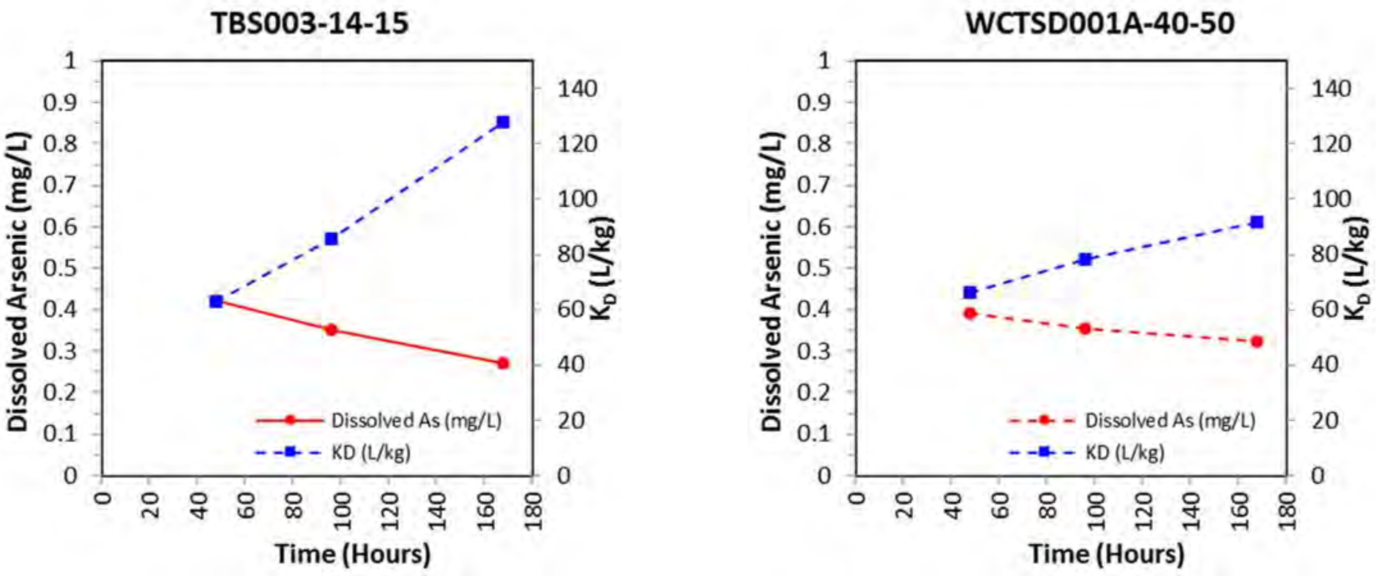


Figure 4-8. Dissolved Arsenic Concentrations and Distribution Coefficients (K_D) in Batch Adsorption Tests as a Function of Time

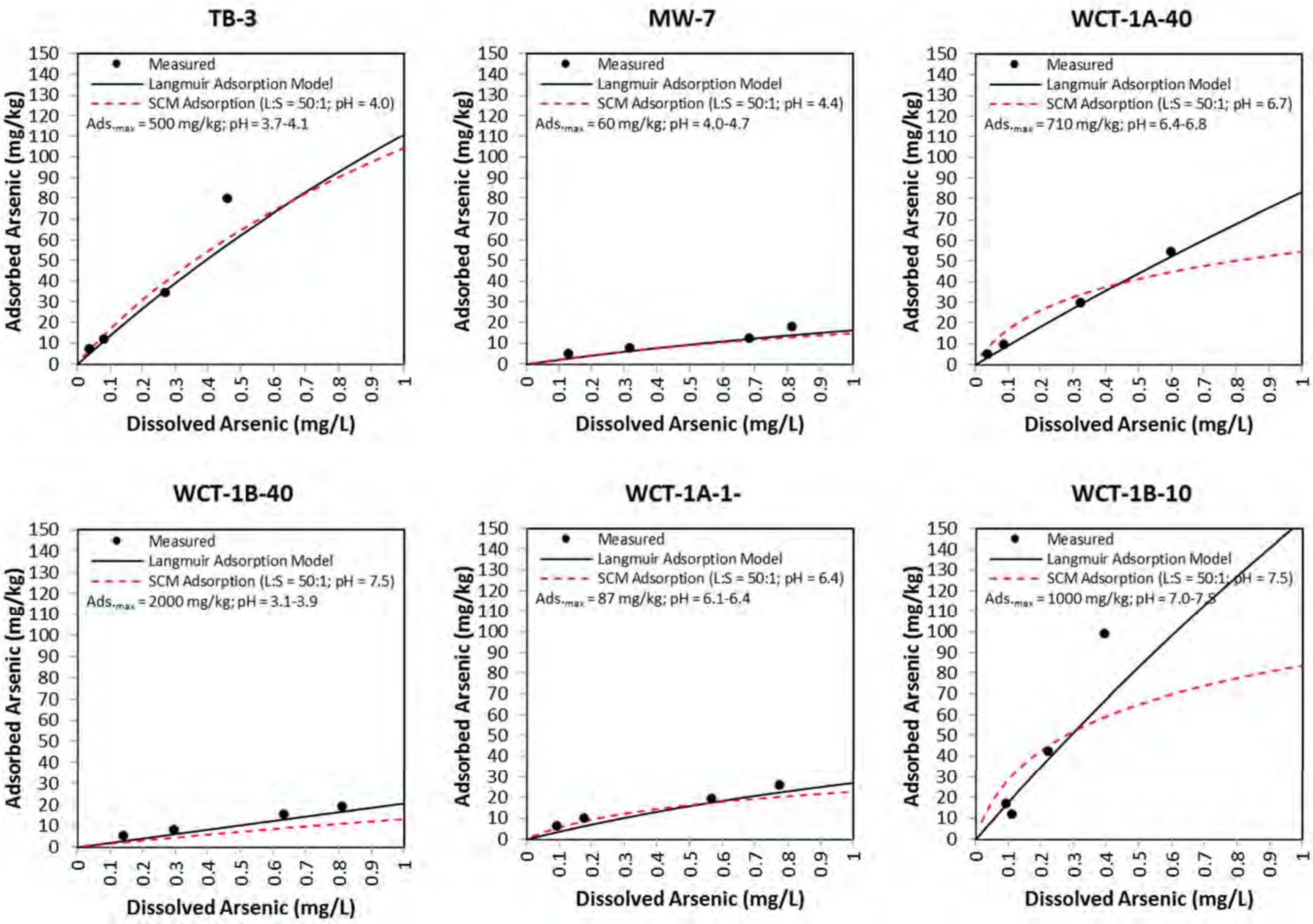


Figure 4-9. Comparison Between Measured and Model-Predicted Dissolved Arsenic Concentrations in Batch Adsorption Tests: a) Transect 1

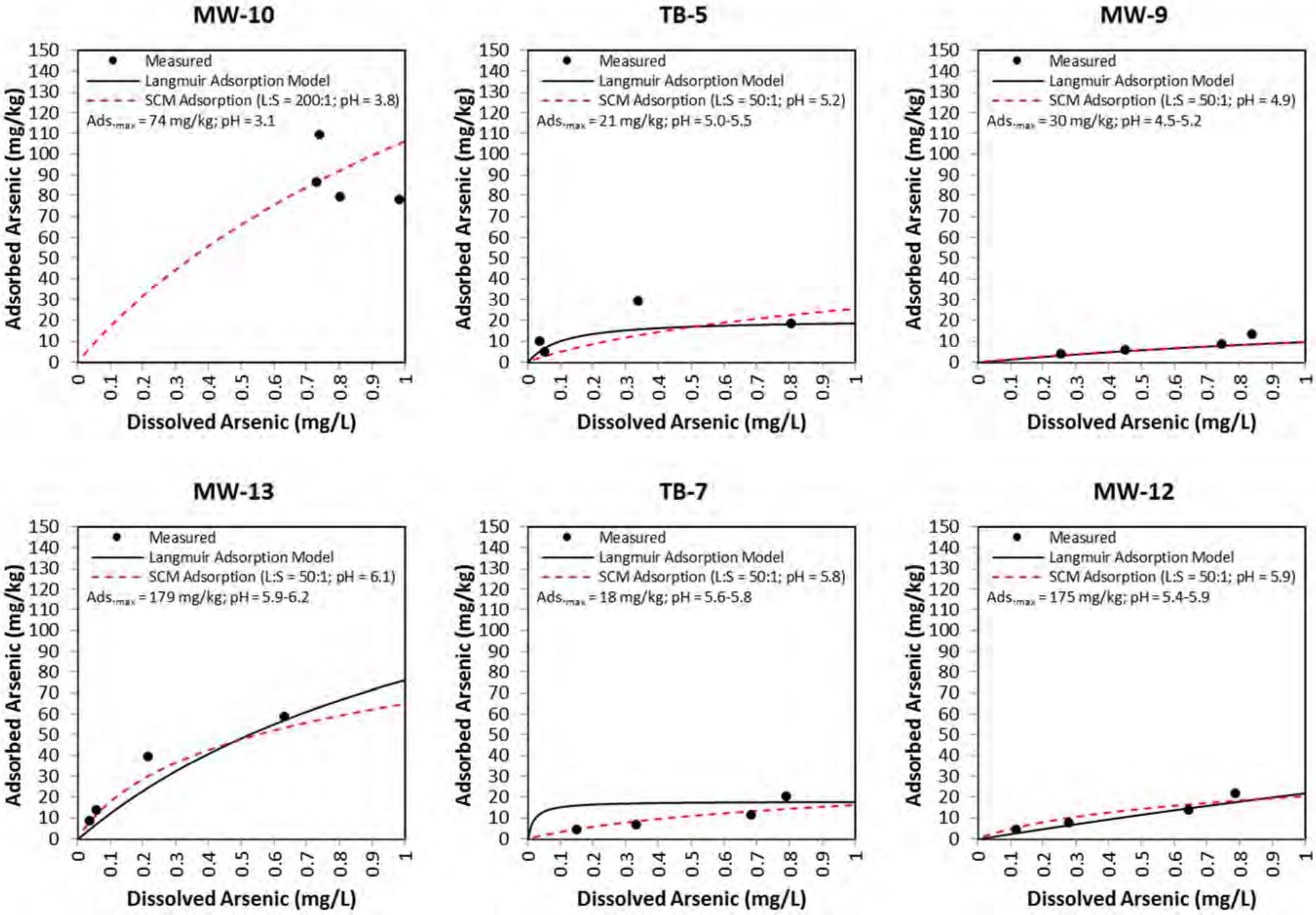
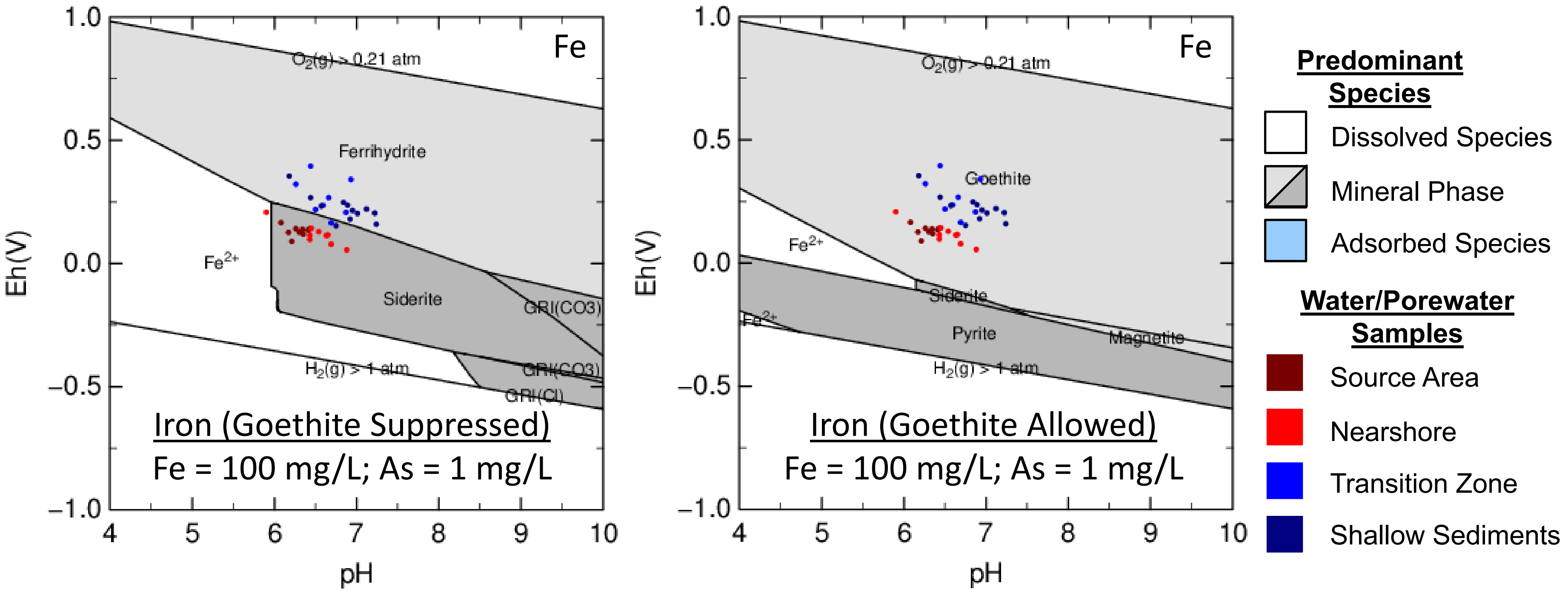
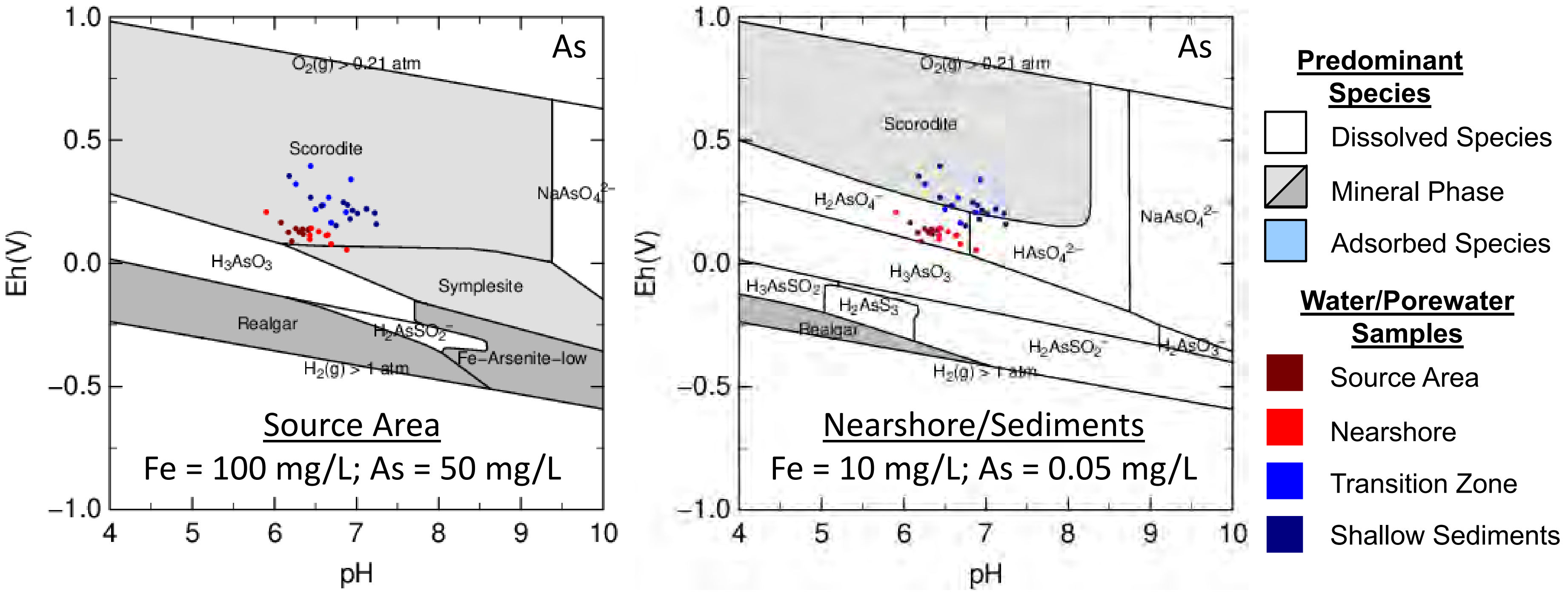


Figure 4-9. Comparison Between Measured and Model-Predicted Dissolved Arsenic Concentrations in Batch Adsorption Tests: b) Transect 2 (*top*) and Transect 3 (*bottom*)



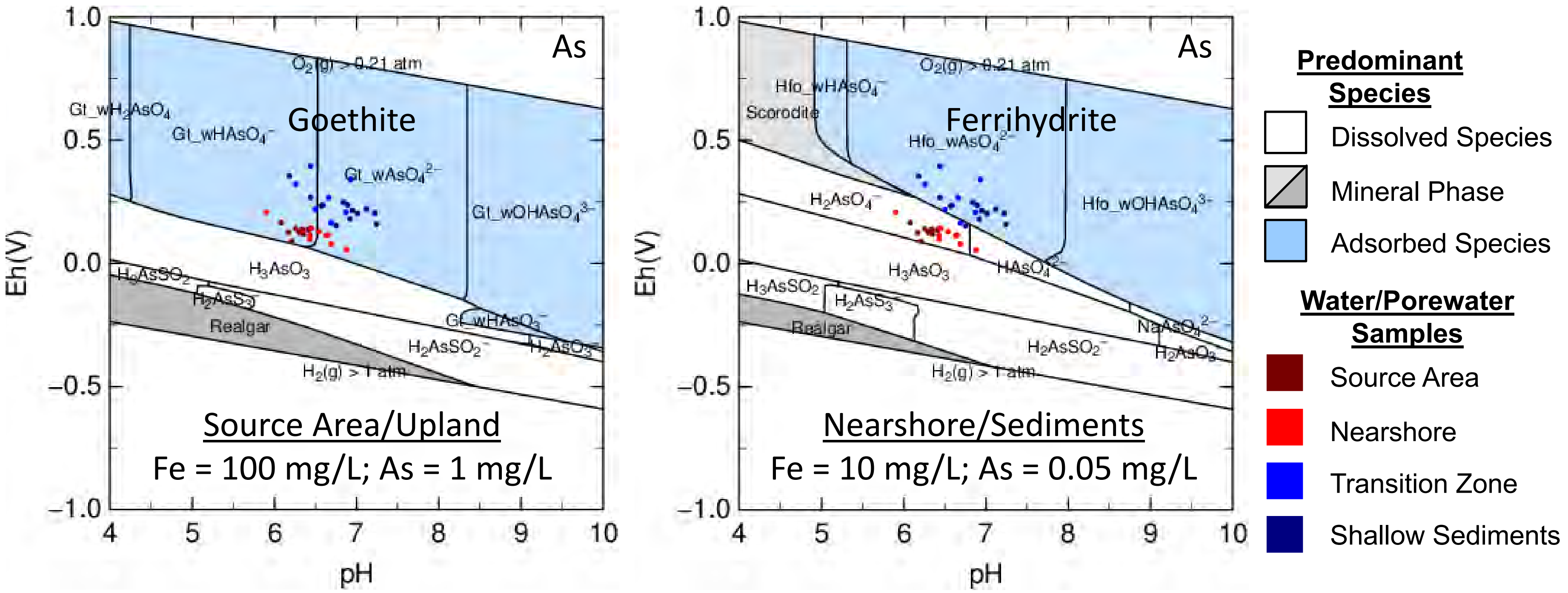
Note:
Eh-pH diagram based on chemistry of MW-7 with Fe and As concentrations shown above.

Figure 5-1. Eh-pH Diagram for Showing Groundwater and Porewater Relative to the Stability Fields of Minerals and Aqueous Species for: a) Iron



Note:
Eh-pH diagram based on chemistry of MW-7 with Fe and As concentrations shown above. Adsorbed species not included.

Figure 5-1. Eh-pH Diagram for Showing Groundwater and Porewater Relative to the Stability Fields of Minerals and Aqueous Species for: b) Arsenic



Note:
Eh-pH diagram based on chemistry of MW-7 with Fe and As concentrations shown above.

Figure 5-2. Eh-pH Diagram for Showing Groundwater and Porewater Relative to the Stability Fields of Minerals, Aqueous, and Adsorbed Species for Arsenic

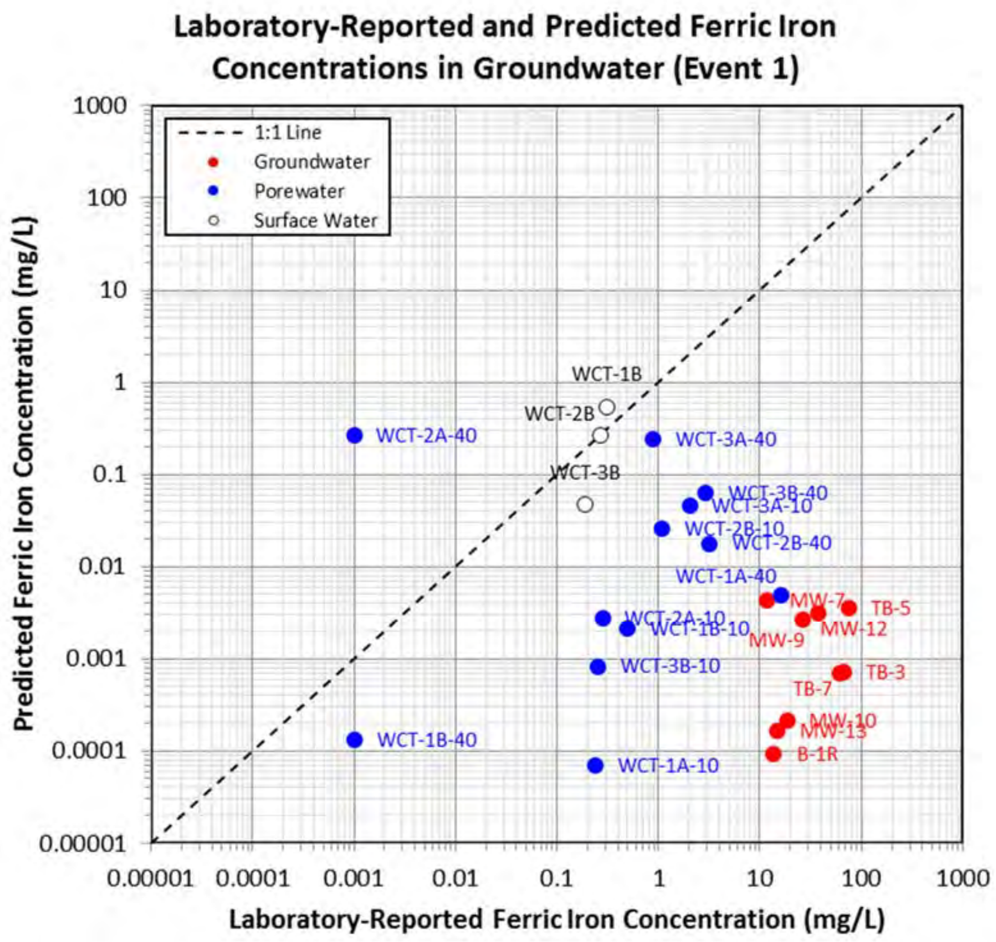
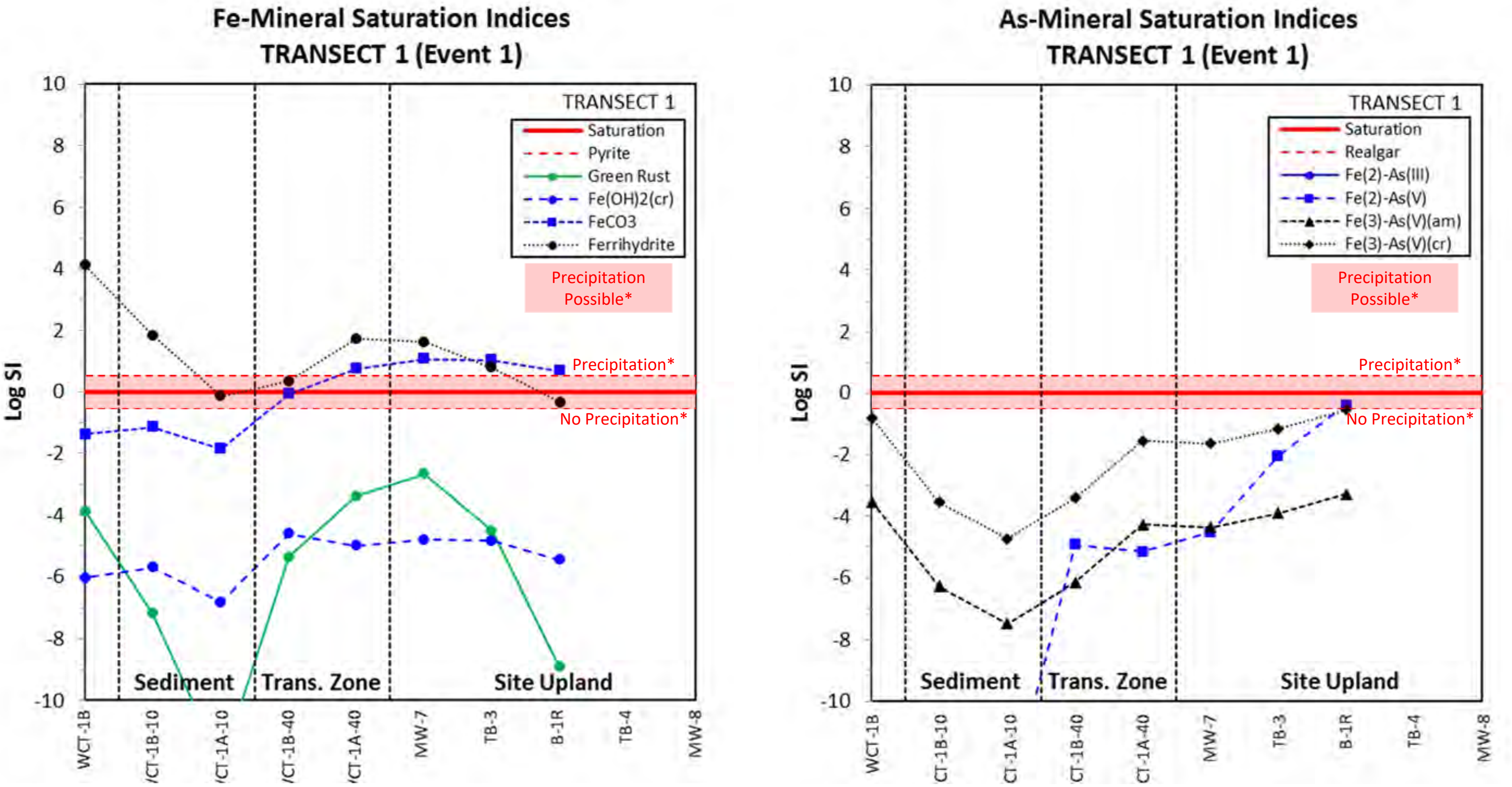
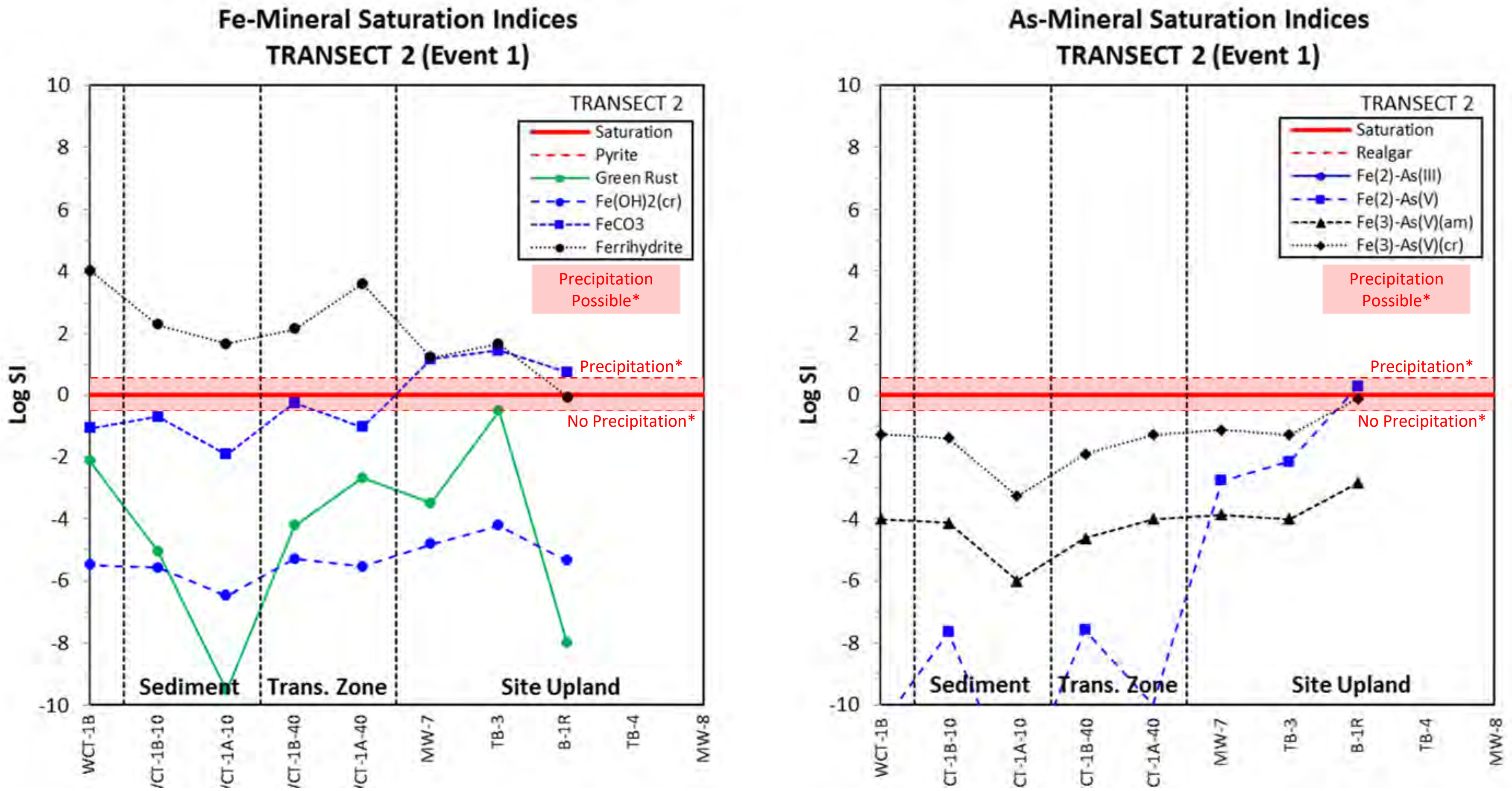


Figure 5-3. Comparison Between Measured Ferric Iron Concentrations in Groundwater and Predicted Concentrations from Equilibrium Speciation



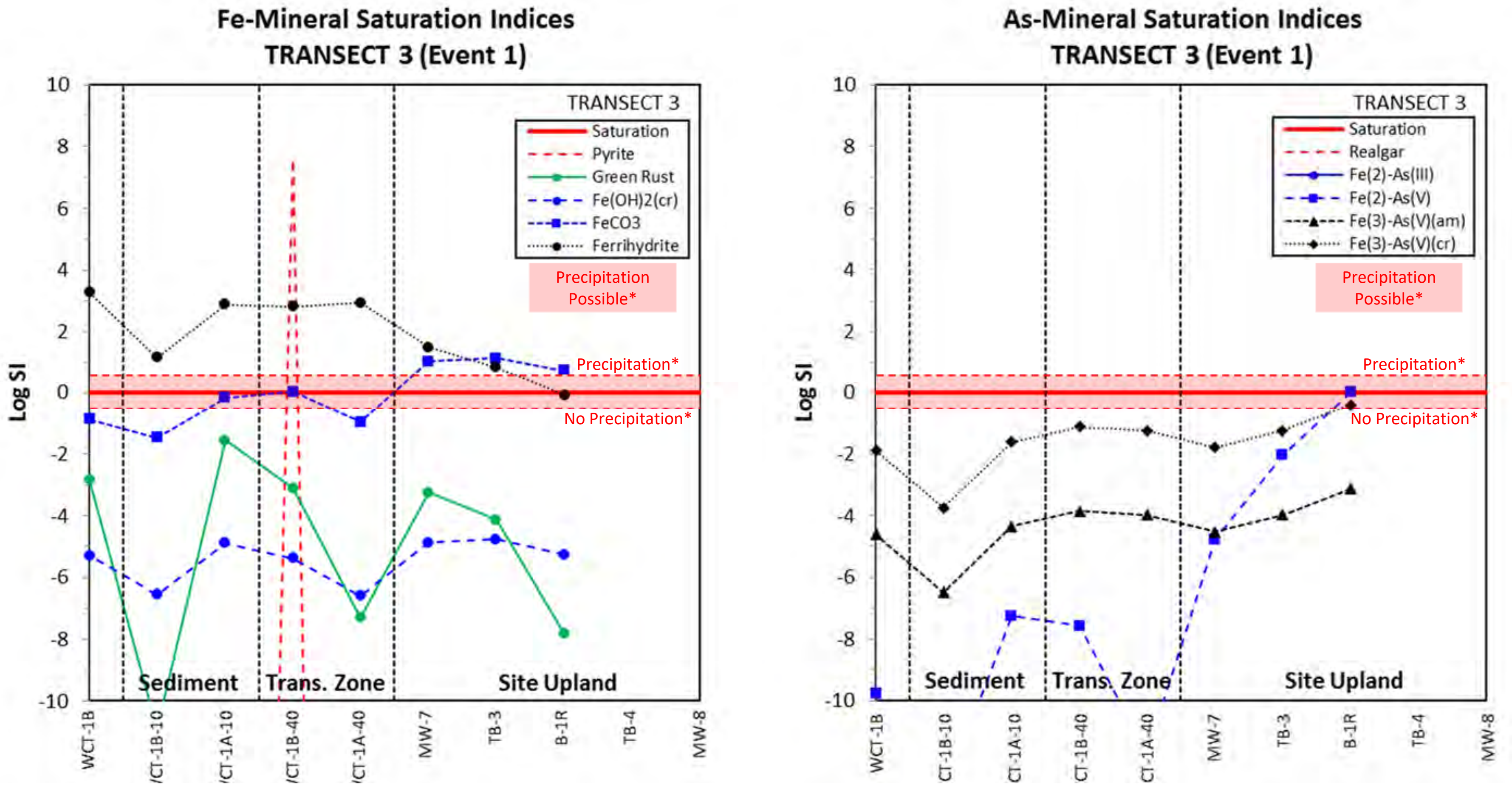
Notes:
Speciation calculations for arsenic based on reported As(III) and As(V) concentrations.
Speciation calculations for iron based on reported iron concentrations (redox speciation based on reported Eh).
Fe(2)-As(III) = Ferrous Arsenite; Fe(2)-As(V) = Ferrous Arsenate (Symplesite); Fe(3)-As(V) = Ferric Arsenate (Scorodite or FeAsO4(am)).
*Log SI values near zero (red shading) and greater than zero indicate the mineral is stable and potentially present (and/or precipitating) at the sampling location; Lower (negative) log SI values indicate mineral precipitation is less likely at the sampling location unless there is an increase in the dissolved iron and/or arsenic concentrations.

Figure 5-4. Model-Predicted Mineral Saturation Indices in Groundwater and Porewater for Iron (*left*) and Arsenic (*right*): a) Transect 1



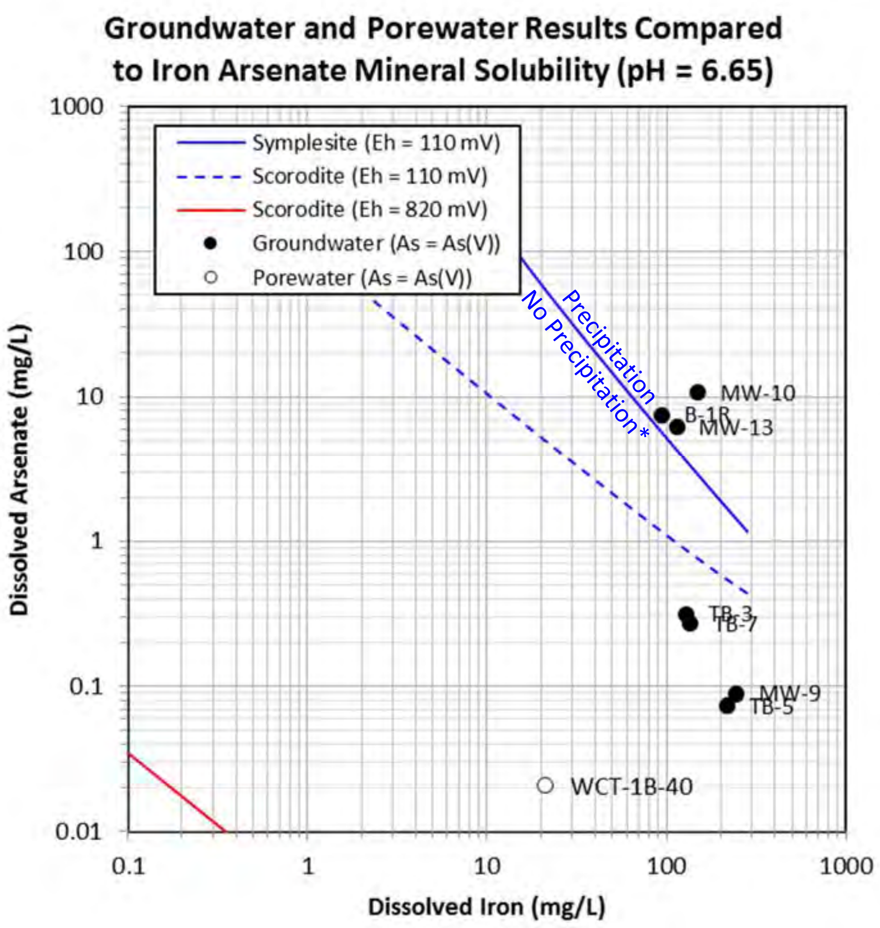
Notes:
Speciation calculations for arsenic based on reported As(III) and As(V) concentrations.
Speciation calculations for iron based on reported iron concentrations (redox speciation based on reported Eh).
Fe(2)-As(III) = Ferrous Arsenite; Fe(2)-As(V) = Ferrous Arsenate (Symplesite); Fe(3)-As(V) = Ferric Arsenate (Scorodite or FeAsO4(am)).
*Log SI values near zero (red shading) and greater than zero indicate the mineral is stable and potentially present (and/or precipitating) at the sampling location; Lower (negative) log SI values indicate mineral precipitation is less likely at the sampling location unless there is an increase in the dissolved iron and/or arsenic concentrations.

Figure 5-4. Model-Predicted Mineral Saturation Indices in Groundwater and Porewater for Iron (*left*) and Arsenic (*right*): b) Transect 2



Notes:
Speciation calculations for arsenic based on reported As(III) and As(V) concentrations.
Speciation calculations for iron based on reported iron concentrations (redox speciation based on reported Eh).
Fe(2)-As(III) = Ferrous Arsenite; Fe(2)-As(V) = Ferrous Arsenate (Symplesite); Fe(3)-As(V) = Ferric Arsenate (Scorodite or FeAsO4(am)).
*Log SI values near zero (red shading) and greater than zero indicate the mineral is stable and potentially present (and/or precipitating) at the sampling location; Lower (negative) log SI values indicate mineral precipitation is less likely at the sampling location unless there is an increase in the dissolved iron and/or arsenic concentrations.

Figure 5-4. Model-Predicted Mineral Saturation Indices in Groundwater and Porewater for Iron (*left*) and Arsenic (*right*): c) Transect 3



Notes:

*Mineral solubility curves display the combination of iron and arsenic concentrations required for a mineral to be stable (and/or precipitate). Groundwater and porewater data that plot above a specific curve have sufficient concentrations for the mineral represented by the curve to be stable (and/or precipitate). In this plot, B-1R, MW-10, and MW-13 are above the curves of two iron arsenate minerals (symplesite and scorodite); by comparison, the other samples shown in the plot only lie above the curve for scorodite (for the case where Eh is equal to 820 mV (i.e., water is oxygenated)).

Figure 5-5. Comparison of Dissolved Arsenate and Iron Concentrations in Groundwater to Mineral Saturation Indices for Fe(II)-Arsenate

Sample Matrix	Location IDs	Average Dissolved Arsenic Concentration (ug/L)
Source Area Groundwater	B-1R, MW-10, MW-13	41,238
Intermediate Groundwater	TB-3, TB-5, TB-7	235
Nearshore Groundwater	MW-7, MW-9, MW-12	37
Transition Zone Porewater	WCT-1, WCT-2, WCT-3 (40-50 cm bml)	24
Bioactive Zone Porewater	WCT-1, WCT-2, WCT-3 (0-10 cm bml)	11
Surface Water	WCT-1, WCT-2, WCT-3 (0-10 cm aml)	1

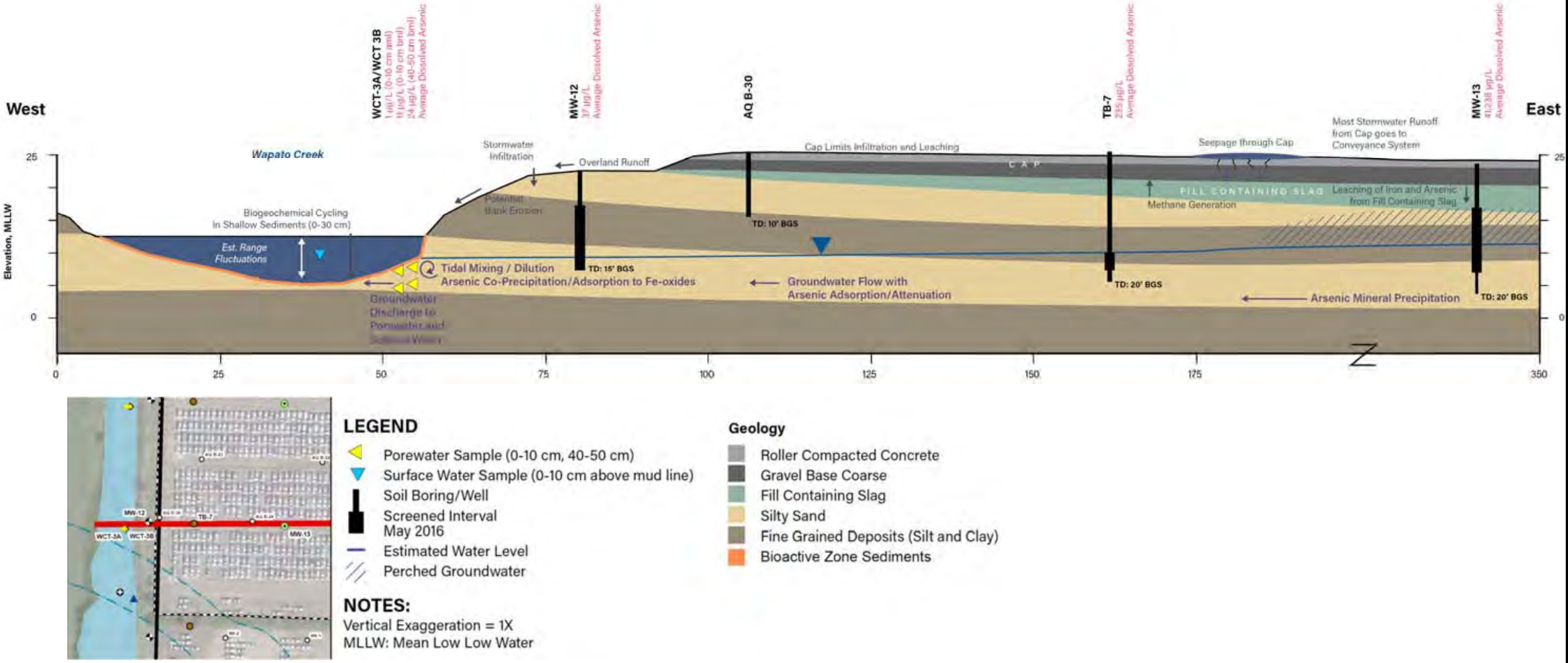


Figure 6-1. Geochemical Conceptual Site Model, Geological Cross Section B-B' (Transect 3)

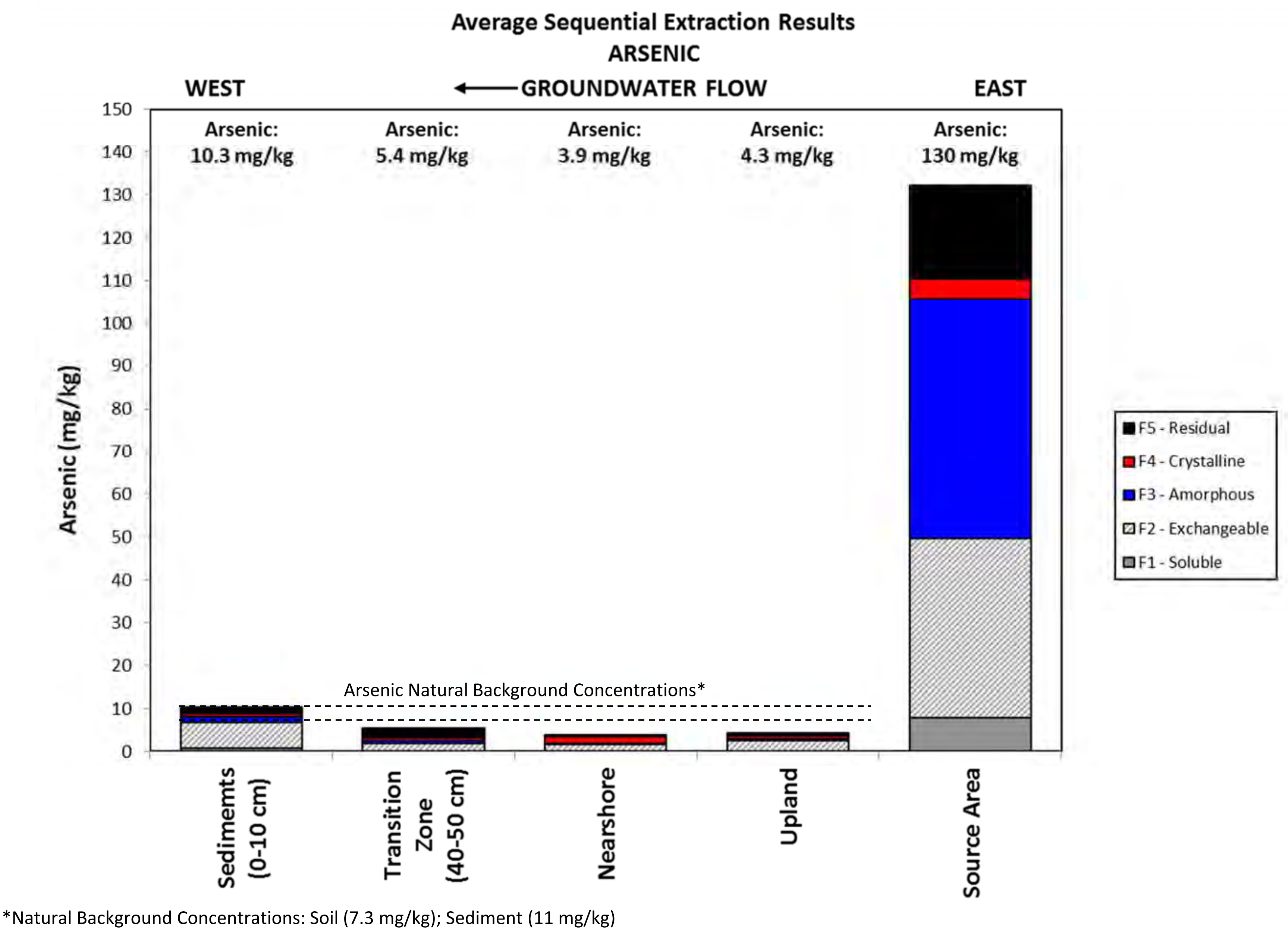


Figure 6-2. Average Distribution of Arsenic in Operationally-Defined Mineral Phases as Determined by Sequential Extraction Analysis

TABLES

Table 4-1. Analytical Results for Groundwater, Porewater, and Surface Water

Station ID (and Sample Depth for Porewater)	General Parameters			Metals and Speciation data										Cations				Anions											
	Total Organic Carbon	Total Suspended Solids	Dissolved Organic Carbon	Arsenic (Total)	Arsenic (Dissolved)	Arsenate	Arsenite	Cacodylic acid	Monomethylarsonic acid	Iron (Dissolved)	Ferric iron	Ferrous iron	Manganese (Dissolved)	Calcium	Magnesium	Potassium	Sodium	Bromide	Chloride	Fluoride	Nitrate as N	Nitrite as N	Ortho-Phosphate	Sulfate	Sulfide	Alkalinity as Bicarbonate	Alkalinity as Carbonate	Alkalinity as Hydroxide	Alkalinity, Total
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Groundwater																													
B-1R-E1	110	--	100	75.6	54.4	7.54	45.7	0.42 U	0.46 U	92.8	13.3	79.5	2.08	120	59	52	100	0.5 U	51	0.98	0.2 U	0.4 U	0.64	1.2 U	0.05 U	760	5 U	5 U	760
B-1R-E2	94	25	110	66.3	79.8	1.75 J	8.01	2.1 U	2.3 U	122	--	--	1.96	110	52	52	100	0.5 U	42	0.69	0.2 U	0.4 U	1.9	1.2 U	1 U	750	5 U	5 U	750
B-1R-E3	89	200	88	70.4	72.4	12.9	45.5	1.05 U	1.15 U	104	--	--	1.86	100	53	53	120	0.52	51	0.75	0.11 J	0.4 U	0.78	0.53 J	0.05 U	840	5 U	5 U	840
B-1R-E4	96 J	170	90 J	60	47.5	10	40.2	0.105 U	0.115 U	116	--	--	1.63	100	53	49	110	0.461	51.1	0.866	0.100 UJ	0.100 UJ	1.4	2.74	0.05 U	700	5 U	5 U	700
B-3R-E1	50	--	51	0.346	0.251	--	--	--	--	2	--	--	0.438	--	--	--	--	--	--	--	--	--	--	--	0.022 J	--	--	--	--
B-3R-E2	49	4.2	59	0.403	0.373	--	--	--	--	11.1	--	--	0.558	--	--	--	--	--	--	--	--	--	--	--	1 U	--	--	--	--
B-3R-E3	51	3	55	0.264	0.251	--	--	--	--	11.1	--	--	0.597	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
B-3R-E4	51 J	4.2	50 J	0.266	0.239	--	--	--	--	10.4	--	--	0.574	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
B-6R-E1	120	--	100	0.061	0.0623	--	--	--	--	76.5	--	--	1.24	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
B-6R-E2	98	2.8	110	0.0691	0.0531	--	--	--	--	70.5	--	--	1.25	--	--	--	--	--	--	--	--	--	--	--	1 U	--	--	--	--
B-6R-E3	100	42	100 J	0.123	0.0795	--	--	--	--	81.9	--	--	1.42	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
B-6R-E4	93	18	92	0.074	0.0658	--	--	--	--	77.7	--	--	1.41	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
HC-2-E1	130	--	140	43.3	37.2	9.25	34.7	0.42 U	0.46 U	162	27	135	4.78	69	20	28	55	0.5 U	10	1.2	0.2 U	0.4 U	0.5	0.55 J	0.05 U	540	5 U	5 U	540
HC-2-E2	110	160	120	48.4	47.1	12.5	39.6	0.21 U	0.23 U	166	--	--	5.05	73	20	32	60	0.5 U	12	0.83	0.2 U	0.4 U	2.1	1.2 U	1 U	550	5 U	5 U	550
HC-2-E3	--	--	75	23.8	22.9	3.33	16.2	0.42 U	0.46 U	104	--	--	3.83	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
HC-2-E4	69 J	72	70 J	14	13.6	2.55	9.52	0.105 U	0.115 U	116	--	--	3.41	47	15	19	40	0.100 U	3.23	0.643	0.100 UJ	0.100 UJ	0.26 J	4.08	0.05 U	260	5 U	5 U	260
MW-7-E1	64	--	66	0.0208	0.0215	--	--	--	--	118	11.5	107	7.18	160	110	37	200	0.49 J	240	1.2	0.14 J	4 UJ	0.12	0.71 J	0.05 U	940	5 U	5 U	940
MW-7-E2	79	87	80	0.0257	0.0275	0.0305	0.00092 J	0.00105 U	0.00115 U	123	--	--	7.98	150	100	38	260	1.9	260	0.97	0.16 J	0.4 U	0.14	1.2	0.5 U	1100	5 U	5 U	1100
MW-7-E3	12	55	23	0.0156	0.0132	0.00971	0.00375	0.00105 U	0.00115 U	59.1	--	--	2.77	53	30	24	37	0.5 U	26	0.73	0.13 J	0.4 U	0.1 U	95 J	0.05 U	310	5 U	5 U	310
MW-7-E4	6.1	5.2	5.1 J	0.00095 J	0.00114	0.00022 J	0.000591	0.00007 J	0.00057 U	1.88	--	--	0.781	18	8.6	15	7.1	0.100 U	3.56	0.359	0.100 U	0.100 U	0.11	44.2	0.05 U	70	5 U	5 U	70
MW-8-E1	62	--	68	0.0284	0.0244	--	--	--	--	74.1	--	--	2.04	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
MW-8-E2	60	140	69	0.0128	0.0718	--	--	--	--	68.3	--	--	1.81	--	--	--	--	--	--	--	--	--	--	--	1 U	--	--	--	--
MW-8-E3	59	160	64	0.029	0.0275	--	--	--	--	61.8	--	--	1.87	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
MW-8-E4	61	130	55	0.0293	0.0232	--	--	--	--	70.5	--	--	2.12	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
MW-9-E1	89	--	93	0.0728	0.0874	0.0902	0.00492	0.00017 J	0.00115 U	243	26	217	4.45	78	65	30	130	0.87	130	0.98	0.2 U	0.4 U	0.1 U	0.58 J	0.05 U	830	5 U	5 U	830
MW-9-E2	100	160	100	0.0537	0.0545	0.0508	0.00311 J	0.0042 U	0.0046 U	201	--	--	4.96	92	88	37	190	1.8	160	0.97	0.26	0.4 U	0.17	1.2 U	0.5 U	880	5 U	5 U	880
MW-9-E3	66	150	60	0.0958	0.0836	0.0455	0.0402	0.00024 J	0.00115 U	225	--	--	3.25	50	31	21	61	0.69	47	0.87	0.2 U	0.4 U	0.1 U	9.9	0.05 U	660	5 U	5 U	660
MW-9-E4	45	170	42	0.0825	0.0744	0.0742	0.0024	0.00016 J	0.00026 J	207	--	--	2.99	44	25	18	32	0.262	19.4	0.912	1.79	0.100 U	0.13	1.06	0.05 U	430	5 U	5 U	430
MW-10-E1	81	--	75	45.8	37	10.8	33.7	0.42 U	0.46 U	149	18.4	131	6.28	150	100	35	190	0.5 U	13	0.67	0.2 U	0.4 U	0.5	0.59 J	0.05 U	650	5 U	5 U	650
MW-10-E2	54	42	65	33.7	32	10.7	23.4	0.21 U	0.23 U	143	--	--	5.22	85	30	29	72	0.5 U	11	0.43	0.2 U	0.4 U	1.4	1.2 U	1 U	660	5 U	5 U	660
MW-10-E3	82	160	81	53.5	55.4	13.9	30.6	1.05 U	1.15 U	170	--	--	6.27	100	36	32	81	0.5 U	10	0.43	0.2 U	0.4 U	0.72	0.54 J	0.05 U	750	5 U	5 U	750
MW-10-E4	61	170	53	34.5	34.3	7.79	22.8	0.105 U	0.115 U	123	--	--	6.78	100	36	32	73	0.147	9.57	0.415	0.100 U	0.100 U	0.64	0.501	0.05 U	520	5 U	5 U	520
MW-11-E1	67	--	70	0.0299	0.0279	--	--	--	--	25.9	--	--	1.76	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
MW-11-E2	62	1200	64	0.0343	0.0241 J	--	--	--	--	55.2	--	--	2.54	--	--	--	--	--	--	--	--	--	--	--	1 U	--	--	--	--
MW-11-E3	60	290	60	0.0268	0.0301	--	--	--	--	56.6	--	--	2.72	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
MW-11-E4	48	65	48	0.0203	0.0192	--	--	--	--	81.6	--	--	3.3	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
MW-12-E1	68	--	85	0.0185	0.0167	--	--	--	--	107	36.5	70.4	6.54	62	60	50	310	0.69	200	1.5	0.2 U	0.4 U	0.1 U	0.52 J	0.05 U	920	5 U	5 U	920
MW-12-E2	75	37	84	0.0147	0.01 J	0.0139	0.00031 J	0.00105 U	0.00021 J	105	--	--	6.61	64	63	55	310	1.7 J	190 J	1.2	0.2 U	0.4 U	0.1	1.2 U	1 U	920	5 U	5 U	920
MW-12-E3	64	130	64	0.0392	0.0365	0.029	0.0032	0.00024 J	0.00115 U	138	--	--	7.13	93	41	38	37	0.5 U	14	0.62	0.2 U	0.4 U	0.1 U	28	0.05 U	650	5 U	5 U	650
MW-12-E4	47	190	52	0.0175	0.0154	0.0137	0.00119	0.00018 J	0.00057 U	126	--	--	5.87	84	40	32	72	0.403	47.8	0.778	0.460	0.100 U	0.12	7.35	0.05 U	490	5 U	5 U	490
MW-13-E1	48	--	43	33.7	34.3	6.22	29.7	0.42 U	0.46 U	113	14.8	98.7	6.34	110	37	35	78	0.5 U	7.5	0.2 U	0.2 U	0.4 U	0.31	0.48 J	0.05 U	550	5 U	5 U	550
MW-13-E2	42	130	46	36.8	33.1	10.4	26.5	0.21 U	0.23 U	118	--	--	6.68	100	25	22	68	0.5 U	9	0.22	0.2 U	0.4 U	1.8	1.2 U	1 U	620	5 U	5 U	620
MW-13-E3	19	81	22	8.63	8.28	1.2	7.13	0.21 U	0.23 U	63.2	--	--	5.75	86	18	12	63	0.5 U	0.9 U	0.2 U	0.2 U	0.4 U	0.24	1.2 U	0.05 U	520	5 U	5 U	520
MW-13-E4	23 J	97	22 J	6.54	6.37	0.798	5.09	0.105 U	0.115 U	61.5	--	--	5	72	17	10	44	0.100 U	2.12	0.110	0.100 U	0.100 U	0.27	3.34	0.05 U	320	5 U	5 U	320
TB-1-E1	10	--	11	0.151	0.102	--	--	--	--	3.48	--	--	1.06	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
TB-2-E1	8.3	--	8.4	0.295	0.317	--	--	--	--	19.2	--	--	6.29	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
TB-3-E1	66	--	83	0.364	0.424	0.317	0.0818	0.00525 U	0.00575 U	127	66.2	60.6	3.69	110	75	34	190	1.2	140	1	0.2 U	0.4 U	0.16	1.1 J	0.05 U	800	5 U	--	--
TB-4-E1	60 J	--	11	22.5	16.1	--	--	--	--	104	--	--	3.49	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
TB-5-E1	100	--	110	0.116	0.0803	0.0744	0.00262	0.00105 U	0.00115 U	215	74.5	140	5.22	83	95	65	220	2	220	1.1	0.2 U	0.4 U	0.13	0.47 J	0.05 U	840	5 U	--	--
TB-6-E1	98	--	9.9	0.228	0.2	--	--	--	--	147	--	--	2.76	--	--	--	--	--	--	--	--	--	--	--	0.011 J	--	--	--	--
TB-7-E1	71	--	81	0.373	0.202	0.272	0.0736	0.0021 U	0.0023 U	135	61.1	73.7	4.82	58	56	75	340	1.1	130	0.81	0.2 U	0.4 U	0.17	0.48 J	0.05 U	920	5 U	--	--

Table 4-1. Analytical Results for Groundwater, Porewater, and Surface Water

Station ID (and Sample Depth for Porewater)	General Parameters			Metals and Speciation data										Cations				Anions											
	Total Organic Carbon	Total Suspended Solids	Dissolved Organic Carbon	Arsenic (Total)	Arsenic (Dissolved)	Arsenate	Arsenite	Cacodylic acid	Monomethylarsonic acid	Iron (Dissolved)	Ferric iron	Ferrous iron	Manganese (Dissolved)	Calcium	Magnesium	Potassium	Sodium	Bromide	Chloride	Fluoride	Nitrate as N	Nitrite as N	Ortho-Phosphate	Sulfate	Sulfide	Alkalinity as Bicarbonate	Alkalinity as Carbonate	Alkalinity as Hydroxide	Alkalinity, Total
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
TB-8-E1	100	--	100	1.67	1.5	--	--	--	--	61	--	--	1.33	--	--	--	--	--	--	--	--	--	--	--	0.05 U	--	--	--	--
Bioactive Zone Porewater (10 cm bml)																													
WCT-1A-10-E1	21	--	26	0.0227	0.00214	--	--	--	--	0.396	0.237	0.159	0.222	200 J	550	160	3800	50 U	11000	20 U	20 U	40 U	0.1 U	1800	0.05 U	170	5 U	5 U	170
WCT-1A-10-E2	20	290	13	0.0408	0.00197	--	--	--	--	1.17	--	--	0.102	260	750	240	6300	500 U	23000	200 U	200 U	400 U	0.1 U	3900	0.05 U	75	5 U	5 U	75
WCT-1A-10-E3	30	170	12	0.0109	0.00895	--	--	--	--	20	--	--	2.5	190	570	160	4500	36 J	7000 J	0.2 R	0.2 U	0.4 R	0.1 UJ	1600	0.05 U	340	5 U	5 U	340
WCT-1A-10-E4	39	180	22	0.00756	0.00543	--	--	--	--	10.8	--	--	0.653	100	320	100	2900	9.84	2760	0.607	0.100 UJ	0.100 UJ	0.1 U	427	0.05 U	420	5 U	5 U	420
WCT-1B-10-E1	8.7	--	14	0.0265	0.00227	--	--	--	--	0.562	0.487	0.0748	1.28	130 J	360	130	3100	50 U	8900	20 U	20 U	40 U	0.1 U	1600	0.05 U	190	5 U	5 U	190
WCT-1B-10-E2	11	110	9.8	0.0562	0.0714	0.0238	0.0504	0.00105 U	0.00115 U	20.8	--	--	0.95	170	480	180	4300	500 U	7100	200 U	200 U	400 U	0.1 U	1600	0.05 U	150	5 U	5 U	150
WCT-1B-10-E3	3.9	67	3.8	0.0206	0.0158	--	--	--	--	7.42	--	--	1.68	82	240	94	2200	50 U	4900 J	20 U	20 U	40 U	0.1 U	530	0.05 U	110	5 U	5 U	110
WCT-1B-10-E4	4	39	5 J	0.017	0.0134	--	--	--	--	13.7	--	--	1.43	56	160	64	1500	12.0	3390	0.282	0.100 UJ	0.100 UJ	0.19	407	0.05 U	83	5 U	5 U	83
WCT-2A-10-E1	--	--	2.4	--	0.00192	--	--	--	--	0.321	0.281	0.0397	1.27	150 J	420	130	3400	50 U	13000	20 U	20 U	40 U	0.1 U	2300	0.05 U	100	5 U	5 U	100
WCT-2A-10-E2	2.4	80	2.2	0.00374	0.0152	--	--	--	--	5.34	--	--	0.971	250	740	260	6400	500 U	12000	200 U	200 U	400 U	0.1 U	2500	0.05 U	110	5 U	5 U	110
WCT-2A-10-E3	1.7	28	1.6	0.00869	0.0023	--	--	--	--	1.11	--	--	0.454	220	700	250	6200	73	9900 J	20 U	20 U	40 U	0.1 U	3300	0.05 U	88	5 U	5 U	88
WCT-2A-10-E4	2.4	24	4 J	0.00748	0.00592	--	--	--	--	2.1	--	--	0.163	180	570	190	5300	32.6	9360	0.100 U	0.130 J	0.452 J	0.17	1520	0.05 U	110	5 U	5 U	110
WCT-2B-10-E1	10	--	5.3	0.0281	0.00837	--	--	--	--	12.3	1.06	11.2	0.442	120 J	350	120	2800	50 U	4400	20 U	20 U	40 U	0.1 U	560	0.05 U	88	5 U	5 U	88
WCT-2B-10-E2	4.2	72	2.2	0.0047	0.00277	--	--	--	--	9.92	--	--	0.126	130	400	140	3300	500 U	9900	200 U	200 U	400 U	0.1 U	2100	0.22	68	5 U	5 U	68
WCT-2B-10-E3	3.4	31	3.2	0.00533	0.00328	--	--	--	--	12.4	--	--	0.525	160	500	170	4400	36 J	7700 J	20 U	20 U	40 U	0.1 U	1400	0.05 U	91	5 U	5 U	91
WCT-2B-10-E4	3.3	47	4.1	0.0103	0.00845	--	--	--	--	23.8	--	--	0.502	140	410	110	3200	20.5	5520	0.100 U	0.100 UJ	0.100 UJ	0.11	800	0.05 U	44	5 U	5 U	44
WCT-3A-10-E1	5.4	--	6.1 J	0.00563	0.00454	--	--	--	--	13.2	2.02	11.2	4.27	160 J	330	100	2300	50 U	6800	20 U	20 U	40 U	0.1 U	920	0.05 U	140	5 U	5 U	140
WCT-3A-10-E2	4.4	300	4.8	0.0131	0.0109	--	--	--	--	7.34	--	--	0.321	170	500	170	5000	500 U	8800	200 U	200 U	400 U	0.28	2000	0.05 U	130	5 U	5 U	130
WCT-3A-10-E3	3.4	39	3.2	0.0203	0.0187	--	--	--	--	16	--	--	1.11	210	640	240	6100	40 J	9300 J	20 U	20 U	40 U	0.1 U	1600	0.05 U	97	5 U	5 U	97
WCT-3A-10-E4	3.3	55	5.8	0.0331	0.0343	0.0114	0.0128	0.00052 U	0.00057 U	40.1	--	--	0.958	110	300	110	2900	25.0	6700	0.100 U	0.100 UJ	0.100 UJ	0.1 U	1180	0.05 U	250	5 U	5 U	250
WCT-3B-10-E1	11	--	13	0.0368	0.00087 J	--	--	--	--	0.313	0.25	0.0631	1.08	31 J	71	34	560	50 U	1600	20 U	20 U	40 U	0.1 U	190	0.05 U	240	5 U	5 U	240
WCT-3B-10-E2	25	190	18	0.131	0.0144	--	--	--	--	34.9	--	--	3.85	120	240	85	1600	500 U	3400	200 U	200 U	400 U	0.1 U	1100 J	0.05 U	240	5 U	5 U	240
WCT-3B-10-E3	10	100	7.4	0.0112	0.00898	--	--	--	--	22.8	--	--	2.98	90	210	87	1800	50 U	3800 J	20 U	20 U	40 U	0.1 U	380	0.05 U	150	5 U	5 U	150
WCT-3B-10-E4	4.3	86	4.3	0.0143	0.00996	--	--	--	--	11.5	--	--	1.65	53	100	48	1000	6.47	2030	0.216	0.100 UJ	0.100 UJ	0.1 U	161	0.05 U	110	5 U	5 U	110
Transition Zone Porewater (40 cm bml)																													
WCT-1A-40-E1	57	--	59	0.0281	0.0188	--	--	--	--	51.5	16	35.5	3.24	73 J	65	27 J	270	0.5 U	390	0.89	0.11 J	0.4 U	0.1 U	13	0.05 U	710	5 U	5 U	710
WCT-1A-40-E2	20	310	18	0.0172	0.0195	--	--	--	--	25.7	--	--	1.85	59	70	32	320	0.5 U	670	0.2 U	20 U	40 U	0.1 U	95	0.083	440	5 U	5 U	440
WCT-1B-40-E1	24	--	5.8	0.0742	0.049	0.021	0.0285	0.00105 U	0.00115 U	21.2	3 U	20.6	1.81	80 J	200	79	1800	50 U	6400	20 U	20 U	40 U	0.1 U	1000	0.05 U	91	5 U	5 U	91
WCT-1B-40-E2	10	380	11	0.0801	0.119	0.0458	0.0728	0.0021 U	0.0023 U	29.1	--	--	1.22	77	190	79	1700	500 U	3400	200 U	200 U	400 U	0.1 U	990 J	0.055	310	5 U	5 U	310
WCT-2A-40-E1	4.1	--	4.9	0.00296	0.00124	--	--	--	--	3.27	0.75 U	3.27	0.133	76 J	220	98	1900	50 U	5400	20 U	20 U	40 U	0.1 U	690	0.05 U	68	5 U	5 U	68
WCT-2A-40-E2	3.3	330	2.9	0.00522	0.00721	--	--	--	--	18.3	--	--	0.248	210	600	220	5400	500 U	11000	200 U	200 U	400 U	0.1 U	2200	0.16	80	5 U	5 U	80
WCT-2B-40-E1	6.1	--	7.7	0.00615	0.00377	--	--	--	--	22.7	3.09	19.6	0.446	120 J	320	100	2600	50 U	4800	20 U	20 U	40 U	0.1 U	610	0.05 U	140	5 U	5 U	140
WCT-2B-40-E2	3.3	270	3.7	0.0065	0.0101	--	--	--	--	25.6	--	--	0.382	84	240	110	2300	500 U	8200	200 U	200 U	400 U	0.1 U	1900	0.036 J	90	5 U	5 U	90
WCT-3A-40-E1	9.3	3400	2.2	0.0073	0.00108	--	--	--	--	7.09	0.876	6.22	3.8	210	500	160	3800	50 U	4300	20 U	20 U	40 U	0.15	540	0.05 U	260	5 U	--	--
WCT-3A-40-E2	14	550	11	0.0126	0.0131	--	--	--	--	39.2	--	--	4.78	110	230	84	1500	500 U	5600	200 U	200 U	400 U	0.1 U	1500	0.05 U	300	5 U	5 U	300
WCT-3B-40-E1	16	3800	12	0.0101	0.00407	--	--	--	--	15.7	2.83	12.9	2.64	51	87	37	650	50 U	2200	20 U	20 U	40 U	0.21	230	0.097	310	5 U	--	--
WCT-3B-40-E2	18	540	35	0.0155	0.0426	0.0118	0.0316	0.00105 U	0.00115 U	17.5	--	--	1.05	36	72	46	720	250 U	1800	100 U	100 U	200 U	0.1 U	510 J	0.15	430	5 U	5 U	430
Surface Water																													
WCT-1B-E1	3.6	--	3.6	0.0028	0.00167	--	--	--	--	0.917	0.311	0.606	0.217	41	83	27	670	50 U	1300	20 U	1.2	40 UJ	0.1 U	200	0.05 U	130	5 U	5 U	130
WCT-1B-E2	4.1	110	3.1	0.00988	0.00197	--	--	--	--	0.56 J	--	--	0.128	42	91	31	720	4.5	1500	0.24	1.7	0.4 U	0.1 U	180	0.05 U	140	5 U	5 U	140
WCT-1B-E3	6	210	6.4	0.0119	0.00092 J	--	--	--	--	0.777	--	--	0.13	39	73	25	570	3	900	1.8	0.91	0.4 U	0.1 U	140	0.05 U	130	5 U	5 U	130
WCT-1B-E4	6.3	190	4.5 J	0.0112	0.0005 J	--	--	--	--	0.63	--	--	0.117	23	31	12	250	0.5 U	450	0.2 U	0.2 U	0.4 U	0.1 U	61	0.05 U	62	5 U	5 U	62
WCT-2B-E1	4.4	--	3.3	0.00449	0.00153	--	--	--	--	0.702	0.266	0.437	0.169	33	59	19	420	50 U	950	20 U	1.4	40 UJ	0.11	130	0.05 U	120	5 U	5 U	120
WCT-2B-E2	3.8	49	3.7	0.00395	0.0009 J	--	--	--	--	0.495	--	--	0.118	38	77	26	580	3.8	1200	0.19 J	1.8	0.4 U	0.1 U	150	0.05 U	130	5 U	5 U	130
WCT-2B-E3	5.8	92	6.3	0.00335	0.00128	--	--	--	--	0.885	--	--	0.109	30	45	16	330	1.7	580	0.2 U	0.94	0.4 U	0.1 U	87	0.05 U	120	5 U	5 U	120
WCT-2B-E4	5.7	51	4.5 J	0.00423	0.00171	--	--	--	--	0.724	--	--	0.108	20	23	7.9	150	0.5 U	250	0.2 U	0.2 U	0.4 U	0.1 U	32	0.05 U	62	5 U	5 U	62
WCT-3B-E1	3.8	--	3.3	0.00845	0.00211	--	--	--	--	0.781	0.192	0.589	0.179	35	59	19	430	50 U	890	20 U	1.4	40 UJ	0.1	140	0.05 U	120	5 U	5 U	120
WCT-3B-E2	3.2	37	2.8	0.00301	0.00142	--	--	--	--	0.564	--	--	0.111	37	74	25	570	3.6	1100	0.17 J	1.8	0.4 U	0.1 U	140	0.05 U	130	5 U	5 U	130
WCT-3B-E3	5.3	30	5.7	0.00164	0.00106	--	--	--	--	0.834	--	--	0.11	43	88	31	720	3.9	1200	3.5	0.89	0.4 U	0.1 U	170	0.05 U	130	5 U	5 U	130
WCT-3B-E4	5.3	54	4.9 J	0.00166	0.00122	--	--	--	--	0.669	--	--	0.106	22	30	10	200	1	360	0.2 U	1.1	0.4 U	0.1 U	54	0.05 U	61	5 U	5 U	61

Table 4-1. Analytical Results for Groundwater, Porewater, and Surface Water

Station ID (and Sample Depth for Porewater)	General Parameters			Metals and Speciation data										Cations				Anions											
	Total Organic Carbon	Total Suspended Solids	Dissolved Organic Carbon	Arsenic (Total)	Arsenic (Dissolved)	Arsenate	Arsenite	Cacodylic acid	Monomethylarsonic acid	Iron (Dissolved)	Ferric iron	Ferrous iron	Manganese (Dissolved)	Calcium	Magnesium	Potassium	Sodium	Bromide	Chloride	Fluoride	Nitrate as N	Nitrite as N	Ortho-Phosphate	Sulfate	Sulfide	Alkalinity as Bicarbonate	Alkalinity as Carbonate	Alkalinity as Hydroxide	Alkalinity, Total
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L

Notes:

-- = not measured

mg/kg = milligrams per kilogram

mg/L = micrograms per liter

J = result is less than the reporting limit but greater than or equal to the maximum detection limit (MDL) and the concentration is an approximate value

U = Result is less than or equal to the MDL or client requested reporting limit (CRRL). Result reported as MDL or CRRL.

Table 4-2. Event 1 Water Sample Field Parameters

Location ID	Location	Sample Date	Temperature (°C)	Specific Conductivity (μS/cm)	Dissolved Oxygen (mg/L)	pH	pH from Event 2	Oxidation Reduction Potential (mV)	Turbidity (NTU)	Purge Rate (mL/min)
Groundwater, Monitoring Wells										
B-1R	Log Yard	6/1/16 15:00	16.1	1,572	0.23	6.35	6.41	-80.9	26.1	150
B-3R	Log Yard	5/31/16 18:10	17.0	4,260	0.09	6.76	6.80	-114.3	7.9	125
B-5R	Sawmill	6/1/16 9:30	15.7	544	0.41	6.43	6.50	-39.7	8.2	150
B-6R	Log Yard	6/1/16 11:25	15.9	2,223	0.17	6.83	6.78	-138.7	12.9	200
HC-2	Log Yard	6/1/16 16:20	16.0	1,110	0.15	6.11	6.23	-76.8	10.4	350
MW-1	Sawmill	5/31/16 18:55	15.1	799	0.71	6.60	6.63	-75.7	7.1	380
MW-2R	Sawmill	5/31/16 16:45	12.9	859	0.41	12.01	11.72	-77.6	0.7	250
MW-3	Sawmill	5/31/16 16:20	15.6	694	0.64	6.70	6.59	-86.2	12.3	550
MW-4	Sawmill	5/31/16 18:45	15.1	135	0.28	5.71	6.12	167.7	9.9	200
MW-5R	Log Yard	5/31/16 13:55	15.5	486	0.45	6.44	6.36	-40.7	3.3	260
MW-6R	Sawmill	5/31/16 14:30	14.5	718	0.20	6.26	6.53	-56.8	28.6	670
MW-7	Log Yard	6/1/16 17:45	15.7	2,342	0.36	6.65	6.88	-83.8	34.9	150
MW-8	Log Yard	6/1/16 15:40	19.3	2,163	0.49	6.60	6.63	-55.2	58.3	125 [1]
MW-9	Log Yard	6/1/16 17:50	13.9	2,004	0.16	6.43	6.69	-102.4	11.5	350
MW-10	Log Yard	6/1/16 14:30	16.3	1,360	0.42	6.26	6.17	-58.8	395	275
MW-11	Log Yard	5/31/16 15:40	18.7	2,224	0.04	6.72	6.77	-109.0	2.1	150
MW-12	Log Yard	6/1/16 16:20	14.8	2,012	0.81	6.63	6.45	-86.5	12.3	400
MW-13	Log Yard	6/1/16 12:45	16.6	1,115	0.36	6.34	6.30	-61.4	9.8	400
Groundwater, Temporary Borings										
TB-1	Log Yard	5/16/16 12:50	15.7	1,173	0.16	7.08	--	-137.8	--	100
TB-2	Log Yard	5/16/16 15:20	15.0	545	0.22	6.63	--	-107.1	--	200
TB-3	Log Yard	5/17/16 10:50	16.7	2,012	0.16	6.58	--	-136.3	--	110
TB-4	Log Yard	5/12/16 18:05	--	--	--	--	--	--	--	75 [2]
TB-5	Log Yard	5/17/16 13:05	18.4	2,441	0.17	6.77	--	-191.8	--	75
TB-6	Log Yard	5/12/16 14:45	21.1	2,762	0.19	6.52	--	-121.9	--	75
TB-7	Log Yard	5/17/16 16:45	18.0	2,278	0.22	6.63	--	-166.5	--	125
TB-8	Log Yard	5/13/16 10:45	19.0	7,065	0.19	6.75	--	-138.0	--	75
TB-9	Sawmill	5/13/16 13:40	14.7	3,447	0.59	6.05	--	-27.2	--	250
Surface Water										
Blair WW	--	6/1/15 14:30	17.3	28,931	15.42	8.57	8.33	263.8	3.8	275
WCT-1B	Log Yard	6/1/16 9:15	14.8	3,773	8.27	7.15	7.06	112.5	10.1	320
WCT-2B	Log Yard	6/1/16 10:45	16.7	2,593	8.47	7.23	7.28	114.8	25.0	350
WCT-3B	Log Yard	6/1/16 10:30	16.0	2,625	7.39	7.07	7.27	5.2	--	500
WCT-4B	Sawmill	6/3/16 12:20	18.2	559	8.08	7.49	7.66	63.2	--	500 [3]
USS1	--	6/1/16 12:00	14.3	199	11.11	7.71	7.68	239.0	--	-- [4]

Table 4-2. Event 1 Water Sample Field Parameters

Location ID	Location	Sample Date	Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH	pH from Event 2	Oxidation Reduction Potential (mV)	Turbidity (NTU)	Purge Rate (mL/min)
Porewater										
WCT-1A-10	Log Yard	6/2/16 0:00	16.9	23,241	1.13	9.67	6.75	-74.0	--	--
WCT-1A-40	Log Yard	6/2/16 0:00	16.0	2,987	1.28	9.96	6.69	-68.0	--	--
WCT-1B-10	Log Yard	6/2/16 0:00	15.7	22,751	1.08	8.78	7.24	-53.7	--	--
WCT-1B-40	Log Yard	6/2/16 0:00	14.4	8,921	2.45	6.44	6.93	195.1	--	--
WCT-2A-10	Log Yard	6/3/16 0:00	--	--	--	--	6.95	--	--	--
WCT-2A-40	Log Yard	6/2/16 0:00	16.7	23,445	3.90	10.56	6.87	64.1	--	--
WCT-2B-10	Log Yard	6/2/16 0:00	15.3	7,185	2.10	9.45	6.57	4.9	--	--
WCT-2B-40	Log Yard	6/2/16 0:00	15.1	17,539	1.85	10.45	6.59	-20.3	--	--
WCT-3A-10	Log Yard	6/2/16 0:00	19.8	8,421	4.60	11.31	6.92	-20.5		--
WCT-3A-40	Log Yard	6/2/16 0:00	15.4	29,184	5.35	6.26	--	121.9	> 1,000	--
WCT-3B-10	Log Yard	6/2/16 0:00	18.7	7,487	1.99	9.30	6.89	-22.1	--	--
WCT-3B-40	Log Yard	6/2/16 0:00	15.9	5,803	3.05	6.50	6.66	19.2	> 1,000	--
WCT-4A-10	Sawmill	6/3/16 0:00	22.6	3,204	2.39	6.65	6.54	-50.6	34.2	--
WCT-4A-40	Sawmill	6/3/16 0:00	19.0	520	2.31	6.52	6.98	-39.0	> 1,000	--
WCT-4B-10	Sawmill	6/3/16 0:00	19.6	12,904	2.44	6.85	6.77	-19.8	82.7	--
WCT-4B-40	Sawmill	6/3/16 0:00	19.9	4,039	1.84	6.69	7.02	-36.0	--	--
Outfalls										
OF-2	W.Creek	5/17/16 12:05	12.6	15,221	6.82	--	7.3	--	--	--
OF-3	W.Creek	5/17/16 12:05	NM	NM	NM	NM	8.060	NM	NM	--

Notes:

> = greater than (exceeds meter range)

°C = degree Celsius

µS/cm = microSiemen per centimeter

mg/L = milligram per liter

mL/min = milliliter per minute

mV = millivolt

NTU = nephelometric turbidity unit

1 MW-8 purged dry on 5/31/2016 and sampled on 6/1/2016.

2 Field parameters not collected at TB-4 due to poor recharge in temporary boring.

3 Sample collection started on 6/1/2016 but was not completed due to lack of charged battery for pump. Collection finished on 6/3/2016.

4 Field parameters measure by lowering probe module, with weighted protective case, into current.

Table 4-3. Event 1 Analytical Results for Soil and Sediment

Sample ID[1]	General Parameters			Grain Size						Primary Site-Related Metals (and Speciation Data)					
	%TS	Total Organic Carbon	Sulfide	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Arsenic (Total)	Arsenate	Arsenite	Cacodylic acid	Monomethylarsonic acid	Iron (Total)
	%	mg/kg	mg/kg	%	%	%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Soil															
MW-7	84.68	550 J	5.9 UJ	0	0	13.6	73.2	10.4	2.7	2.69	0.98	0.06 U	0.06 U	0.009 J	12100
MW-8	81.99	5600	--	--	--	--	--	--	--	72.9	--	--	--	--	17000
MW-9	77.88	1100 J	6.4 UJ	0	0	0.1	49.9	46.3	3.7	1.23	0.40	0.06 U	0.06 U	0.07 U	14700
MW-10	74.1	12000	3.2 J	0	0	1.2	13.8	61.2	23.7	237	124	0.65 U	0.16 J	0.58 J	20200
MW-11	76.39	6500	--	--	--	--	--	--	--	2.98	--	--	--	--	18000
MW-12	79.01	580 J	6.2 UJ	0	0	0.3	81.4	18.4	0	0.936	0.34	0.06 U	0.07 U	0.08 U	21700
MW-13	73.48	6400	4.2 J	0	0	0.3	29.9	45	24.8	7.91 J	1.63	0.02 J	0.01 J	0.02 J	24100
TB-1	84.45	1200 J	--	--	--	--	--	--	--	12.7	--	--	--	--	24200
TB-2	80.48	380 J	--	--	--	--	--	--	--	7.68	--	--	--	--	26200
TB-3	72.82	22000	38 J	1.1	0.6	1.5	14.7	45.4	36.8	3.92	0.94	0.009 J	0.06 U	0.02 J	23100
TB-4	79.81	4100	--	--	--	--	--	--	--	6.46	--	--	--	--	15300
TB-5	72.82	1700 J	6.7 UJ	0	0	0	53.6	42.7	3.6	1.55	0.72	0.07 U	0.07 U	0.08 U	16500
TB6	79.54	5700	--	--	--	--	--	--	--	92.3	--	--	--	--	22500
TB-7	86.9	1100 J	6.3 UJ	0	0	0.2	71.1	26.8	1.9	1.1	0.44	0.05 U	0.06 U	0.06 U	14600
TB-8	71.64	11000	--	--	--	--	--	--	--	4.6	--	--	--	--	19800
Bioactive Zone Sediment (0 - 10 cm bml)															
WCT-1A-10	71.52	5700	110 J	0	1.2	4.1	50	26.7	18	2.28	1.11	0.06 U	0.07 U	0.01 J	15800
WCT-1B-10	70.52	10000	47 J	0	0	1.2	61	32.6	5.1	13.6	9.14	0.07 U	0.009 J	0.09 J	24100
WCT2A-10	68.7	9300	14 J	0.8	1.7	1.9	56.8	32.3	6.5	10.3	--	--	--	--	19800
WCT-2B-10	65.74	15000	250 J	0	0.2	2.8	79.5	6.7	10.8	9.08	--	--	--	--	22500
WCT-3A-10	71.13	4700	29 J	0	0.1	0.5	44.7	44.9	9.8	4.49	--	--	--	--	18700
WCT-3B-10	76.5	3600	20 J	0	0.1	2	62.1	29.3	6.6	5.01	--	--	--	--	20500
WCT-4A-10	69.99	7300	64 J	0	0.2	1.2	12.1	71.9	14.6	2.53	--	--	--	--	20000
WCT-4B-10	74.3	6200	11 J	0	1.1	1.7	28.6	60.1	8.6	6.21	--	--	--	--	25200
Transition Zone Sediment (40 - 50 cm bml)															
WCT-1A-40	74.27	4800	98 J	0	0	0.4	16.6	73	10.1	1.78	0.48	0.06 U	0.07 U	0.07 U	18100
WCT-1B-40	49.02	22000	13 UJ	0.5	0.7	3.8	38.5	46.2	10.3	12.6	1.10 J	0.10 U	0.11 U	0.03 J	31600
WCT2A-40	75.31	4200	6.7 UJ	--	--	--	--	--	--	1.84	--	--	--	--	13800
WCT-2B-40	68.13	9900	16 J	0.1	0.2	6.2	63.7	25.5	4.3	2.43	--	--	--	--	21800
WCT-3A-40	76.21	3700	29 J	0	0.1	1.1	23.3	63.5	12.1	4.41	--	--	--	--	18300
WCT-3B-40	66.39	11000	47 J	0	0.1	0.6	14.4	68.2	16.7	3.27	--	--	--	--	25200
WCT-4A-40	69.03	8400	43 J	0	0.1	1.5	15.1	66.2	17.1	2.6	--	--	--	--	22100
WCT-4B-40	71.83	4900	41 J	0	0	0.5	4.8	74.3	20.3	3.72	--	--	--	--	31300

Notes:

-- = not measured
MWS = monitoring well soil boring sample
TBS = temporary boring soil sample
TPS = test pit soil sample
mg/kg = milligrams per kilogram

[1] Sample ID includes two components separated by a hyphen. The first component contains the sample type abbreviation followed by the station ID or monitoring wells number, with leading zeros for ease of management. The second component includes the start and end depth in feet below ground surface with an underscore between them.

Table 4-4. Sequential Extraction Procedure Test Results

		Arsenic (mg/kg)					Iron (mg/kg)				
		Soluble	Exchang.	Amorph.	Crystal.	Residual	Soluble	Exchang.	Amorph.	Crystal.	Residual
Transect	Sample	F1	F2	F3	F4	F5	F1	F2	F3	F4	F5
Transect 1	TB-3	0.0	3.8	1.3	0.7	1.1	0.0	1130	1400	12500	13300
	MW-7	0.3	2.0	0.5	0.3	0.6	0.0	830	82	3720	7140
	WCT-1A-40	0.0	1.5	0.5	0.3	0.5	0.0	1080	292	8030	8520
	WCT-1A-10	0.4	3.0	0.7	0.6	0.5	0.0	1010	351	6850	8720
	WCT-1B-40	0.0	2.3	1.0	0.7	4.1	0.0	1140	875	5920	19100
	WCT-1B-10	1.1	9.0	2.0	1.0	2.4	0.0	991	189	11000	11400
Transect 2	MW-10	15.2	78.3	109	8.2	36.7	0.0	1180	412	6810	11800
	TB-5	0.3	1.8	0.4	0.4	0.4	2630	1130	185	7060	8090
	MW-9	0.0	1.3	0.3	0.2	0.4	0.0	941	188	5360	7370
Transect 3	MW-13	0.4	5.5	2.8	1.1	7.3	0.0	1070	423	9920	11900
	TB-7	0.0	1.4	0.3	0.2	0.7	0.0	973	88	5630	8240
	MW-12	0.0	1.4	0.1	4.0	0.3	0.0	1030	115	5270	10800

Notes: Non-detect values replaced with zero in the table.

Table 4-5. Induced Precipitation Test Results

			Aerobic Arsenate		Aerobic Arsenite		Anaerobic Arsenate		Anaerobic Arsenite		Anaerobic Control	
Type	**Parameter**	**Units**	**Initial Pre-Spike**	**Final Day 6**	**Initial Pre-Spike**	**Final Day 6**	**Initial Pre-Spike**	**Final Day 6**	**Initial Pre-Spike**	**Final Day 6**	**Initial Pre-Spike**	**Final Day 6**
Water	pH	s.u.	5.9	8.28	5.86	8.23	5.93	6.32	6.09	6.4	5.77	6.04
	ORP	mV	-21.5	100	-4.2	113	-27.9	15.4	-53.6	-29.1	-1.3	-6.3
	Dissolved Oxygen	mg/L	4.5	7.5	5.2	4.9	1.7	1.5	1.6	1.5	2	1.6
	Specific Conductance	µS/cm	628	609	579	580	473	545	535	521	425	368
	Arsenic	mg/L	79.4	54.5	103	75.8	94.3	71.4	86.7	78.2	0.00216	0.00389
		% Removed		31		26		24		10		
	Iron	mg/L	24.1	0.024	32.3	0.041	24.7	1.58	30	8.14	20.4	14.3
		% Removed		100		100		94		73		
Water	Molar Ratio Removed	Fe:As		1.3		1.6		1.4		3.5		
Solid-TEM	Molar Ratio	Fe:As						1.1		1.7-4.8		

Notes: Mineral Molar Fe:As Ratios: Fe(II)-Arsenite (0.8); Fe(III)-Arsenate (Scorodite) (1.0); Fe(II)-Arsenate (Symplesite) (1.5)

Table 4-6. Batch Adsorption Test Results

	BAT Results				Sample Geochemistry				Surface Complexation Model	
Sample Name	L:S Ratio	pH s.u.	Dissolved As (mg/L)	Adsorbed As (mg/kg)	Total As mg/kg	SEP 2 - As mg/kg	Total Fe %	SEP 3-4 - Fe %	Sites (mol/mol-Fe)	As Sorption mg/kg
MW-7	4	4.01	0.130	3.1	2.7	2.0	1.2	0.4	0.023	57
	10	4.21	0.316	5.8						
	50	4.43	0.684	10.5						
	200	4.70	0.813	16.2						
MW-9	4	4.54	0.253	2.6	1.2	1.3	1.5	0.6	0.012	45
	10	4.66	0.452	4.4						
	50	4.85	0.745	7.6						
	200	5.17	0.837	11.9						
MW-10	4	3.00	0.983	-0.3	237.0	78.3	2.0	0.7	0.027	74
	10	3.12	0.802	1.0						
	50	3.44	0.730	8.3						
	200	3.84	0.740	31.0						
MW-12	4	5.54	0.117	3.1	0.9	1.4	2.2	0.5	0.013	46
	10	5.78	0.277	6.2						
	50	5.88	0.644	12.3						
	200	5.42	0.788	20.7						
MW-13	4	5.92	0.036	3.4	7.9	5.5	2.4	1.0	0.018	123
	10	6.12	0.057	8.4						
	50	6.14	0.215	34.0						
	200	6.23	0.632	53.3						
TB-3	4	3.66	0.038	3.4	3.9	3.8	2.3	1.4	0.042	370
	10	3.80	0.080	8.1						
	50	3.97	0.270	30.7						
	200	4.12	0.460	76.3						
TB-5	4	5.03	0.052	3.4	1.6	1.8	1.7	0.7	0.015	74
	10	5.09	0.037	8.6						
	50	5.21	0.338	27.4						
	200	5.47	0.805	17.0						
TB-7	4	5.63	0.150	3.0	1.1	1.4	1.5	0.6	0.011	57
	10	5.80	0.331	5.7						
	50	5.76	0.683	10.3						
	200	5.66	0.789	19.0						
WC1A-10	4	6.14	0.093	3.2	2.3	3.0	1.6	0.7	0.010	48

Table 4-6. Batch Adsorption Test Results

Sample Name	BAT Results				Sample Geochemistry				Surface Complexation Model	
	L:S Ratio	pH s.u.	Dissolved As (mg/L)	Adsorbed As (mg/kg)	Total As mg/kg	SEP 2 - As mg/kg	Total Fe %	SEP 3-4 - Fe %	Sites (mol/mol-Fe)	As Sorption mg/kg
	10	6.44	0.176	7.2						
	50	6.37	0.566	16.3						
	200	6.42	0.774	23.1						
WC1A-40	4	6.44	0.036	3.4	1.8	1.5	1.8	0.8	0.017	95
	10	6.55	0.088	8.0						
	50	6.68	0.323	28.1						
	200	6.81	0.599	53.3						
WC-1B-10	4	6.97	0.111	3.1	13.6	9.0	2.4	1.1	0.018	57
	10	7.26	0.094	8.0						
	50	7.50	0.222	33.3						
	200	7.46	0.394	90.0						
WC-1B-40	4	3.07	0.142	3.0	12.6	2.3	3.2	0.7	0.029	127
	10	3.21	0.295	6.0						
	50	3.50	0.632	13.4						
	200	3.85	0.812	16.8						
				AVERAGE =	**23.9**	**9.3**	**2.0**	**0.8**	**0.019**	**98**

Attachments

BROOKS APPLIED LABS
18804 North Creek Parkway, Ste 100, Bothell, WA 98011 • USA • T: 206 632 6206 F: 206 632 6017 • info@brooksapplied.com

October 27, 2016

GSI Water Solutions, Inc.
ATTN: Erin Carroll Hughes
55 SW Yamhill St. Suite 300
Portland OR 97204
echughes@gsiws.com

RE: Project GSI-PR1601b Client Project: Parcel 15 – POT (603.002.010)

Ms. Carroll Hughes,

On May 11th through May 20th, 2016, Brooks Applied Labs (BAL) received forty (40) soil/sediment samples. The temperature of samples received on May 20th, in Cooler 6, was 7.5 °C and exceeded the recommended temperature range of 0 – 4 °C ± 2 °C. The temperature of all other shipments were within the recommended limits. All samples were received and stored according to BAL SOPs and EPA methodology.

Shortly after receipt, all submitted core samples were unpacked in a glove box maintained under anoxic conditions, split into appropriate sample containers, and then stored according to BAL SOPs. All sample fractions designated for sequential extraction were frozen pending the client's decision on which samples to analyze. On August 10, 2016 the client notified BAL that twelve (12) samples required sequential extraction. This report only contains the results for the twelve samples for which the client requested sequential extraction.

Sequential Extraction

Prior to the sequential extraction, each soil was dried in a glove box maintained under anoxic conditions and then sieved using a 2mm mesh size. A sequential extraction procedure selected by the client, consisting of five discrete extraction steps, was then applied to each resulting sample homogenate.

Upon completion of each extraction step, separate aliquots of each extract were split for pH determination and for total metals quantitation. All fractions designated for total metals quantitation were preserved to a pH <2 by addition of concentrated nitric acid. The resulting extract fractions were analyzed as described herein.

A matrix duplicate (MD) was carried through each extraction step to evaluate the precision of the applied methods and the homogeneity of the submitted samples. Due to the nature of the sequential extraction, no matrix spikes could be performed during the extraction. Instead, an analytical spike set was prepared for each extraction step at the time of analysis to demonstrate the accuracy of the applied methods. All spike results presented in this report are for these analytical spikes prepared at the time of analysis.

Complete details of the extraction procedure were provided to BAL by the client, but the extraction fluids used and the associated target fractions were as follows:

Fraction Number	Target Elemental Fraction	Extraction Fluid
F1	Soluble	1 M $MgCl_2$, pH 8
F2	Exchangeable (Strongly Adsorbed)	1 M NaH_2PO_4, pH 5
F3	Amorphous oxides/As-sulfide/Organic Bound	0.1 M NaOH
F4	Iron Oxide	0.2 M ammonium oxalate/oxalic acid with 0.1 M ascorbic acid, pH 3
F5	Residual/Fe-sulfides	16 N HNO_3 + 30% H_2O_2 + 12 N HCl

It should be noted that during the preparation of F3 (Batch B162116), a significant quantity of the filtered extract for the matrix duplicate was inadvertently spilled during one of the extract generation steps. Only the filtered extract was lost, so the matrix duplicates for subsequent fractions were not affected. Since the matrix duplicate extract for F3 was no longer representative of the source sample due to the volume loss, no results have been reported for this duplicate.

Total Metals Quantitation of the SEP Extracts

An aliquot of each extract was directly analyzed for As, Fe, and Mn using inductively coupled plasma triple quadrupole mass spectrometry (ICP-QQQ-MS). The ICP-QQQ-MS uses advanced interference removal techniques to ensure accuracy of the sample results. For more information, please visit the Interference Reduction Technology section on our website.

The relative percent differences (RPDs) for several matrix duplicate sets were above the control limit of 30%. The elevated RPDs were as follows: B162114-DUP1 for Mn (61%) in F1; B162115-DUP1 for As (191%) in F2; B162117-DUP1 for As (173%) in F4; and B162118-DUP1 for As (158%) and Fe (36%) in F5. Additionally, while the RPD could not be calculated for As for B162114-DUP1 since the duplicate result was less than the detection limit, there was a significant discrepancy between the native result (15.18 mg/kg) and duplicate (< 0.279 mg/kg). Although all samples had been sieved prior to extraction, the obtained data suggest that the source sample MWS010-12-13 is heterogeneous in terms of its distribution of As, Fe, and Mn. The affected native sample results for which elevated RPDs were obtained have been qualified **M** to indicate this observed variability.

The internal standard recoveries for all batches in Sequence 1601121 exceeded the control limit of 125%. The recoveries of As, Mn, and Fe in each CCV and each analytical spike that was spiked above the associated native concentration were within acceptance limits, despite the elevated internal standard recoveries. Since these acceptable recoveries for As, Mn, and Fe demonstrate that the internal standards were appropriately correcting for the observed instrument drift, no further corrective action or qualification of the data was required. The reported sample results are deemed representative of the samples.

pH Measurement

The pH of extracts F1 and F2 were measured via a modified SM2540B using a calibrated pH electrode. The pH of extracts F3 through F5 were measured using pH paper due to the fact that the pH electrode broke during the preparation of the sequential extraction.

The measured pH values of each fraction were as follows:

Sample ID	F1	F2	F3	F4	F5
MWS007-9-10	8.06	5.24	12.5	2.9	< 2
MWS009-11-12	7.88	5.30	12.8	3.2	< 2
MWS010-12-13	7.61	5.33	12.8	3.2	< 2
MWS012-11.5-12.5	8.45	5.21	12.8	3.2	< 2
MWS013-12.5-13.5	7.34	5.30	12.8	2.9	< 2
TBS003-14-15	7.28	5.29	12.8	2.9	< 2
TBS005-17-18	7.94	5.35	12.5	2.9	< 2
TBS007-16.5-17.5	8.59	5.26	12.5	2.9	< 2
WCTSD001A-0-10	7.92	5.33	12.5	3.2	< 2
WCTSD001A-40-50	8.07	5.34	12.5	3.2	< 2
WCTSD001B-0-10	7.60	5.30	12.8	2.9	< 2
WCTSD001B-40-50	7.26	5.18	12.5	3.2	< 2
-BLK1	8.76	5.29	12.8	2.9	< 2
-BLK2	8.80	5.30	12.5	2.9	< 2
-BLK3	8.80	5.33	12.5	3.2	< 2
-BLK4	8.81	5.30	12.5	2.9	< 2
-DUP1	7.16	5.28	12.5	3.2	< 2

All data was reported without further qualification and all other associated quality control sample results met the acceptance criteria.

The results were *not* method blank corrected, as described in the calculations section of the relevant BAL SOPs, and were evaluated using reporting limits adjusted to account for sample aliquot size. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

Instances where the matrix spike/matrix spike duplicate (MS/MSD) sets were spiked at a concentration less than 25% of the native sample result or recovered below the MDL, the recoveries were not reported (**NR**).

BAL, an accredited laboratory, certifies that the reported results of all analyses for which BAL is NELAP accredited meet all NELAP requirements. For more information please see the *Report Information* page in your report. Please feel free to contact me if you have any questions regarding this report.

Sincerely,

Ben Wozniak

Ben Wozniak
Project Manager
ben@brooksapplied.com

Report Information

Laboratory Accreditation

BAL is accredited by the *National Environmental Laboratory Accreditation Program* (NELAP) through the State of Florida Department of Health, Bureau of Laboratories (E87982) and is certified to perform many environmental analyses. BAL is also certified by many other states to perform environmental analyses. For a current list of our accreditations/certifications, please visit our website at <http://www.brooksapplied.com/resources/certificates-permits/>. Results reported relate only to the samples listed in the report.

Field Quality Control Samples

Please be notified that certain EPA methods require the collection of field quality control samples of an appropriate type and frequency; failure to do so is considered a deviation from some methods and for compliance purposes should only be done with the approval of regulatory authorities. Please see the specific EPA methods for details regarding required field quality control samples.

Common Abbreviations

BAL	Brooks Applied Labs	**MS**	matrix spike
BLK	method blank	**MSD**	matrix spike duplicate
BS	laboratory fortified blank	**ND**	non-detect
CAL	calibration standard	**NR**	non-reportable
CCB	continuing calibration blank	**N/C**	not calculated
CCV	continuing calibration verification	**PS**	post preparation spike
COC	chain of custody record	**REC**	percent recovery
D	dissolved fraction	**RPD**	relative percent difference
DUP	duplicate	**SCV**	secondary calibration verification
IBL	instrument blank	**SOP**	standard operating procedure
ICV	initial calibration verification	**SRM**	standard reference material
MDL	method detection limit	**T**	total fraction
MRL	method reporting limit	**TR**	total recoverable fraction

Definition of Data Qualifiers

(Effective 9/23/09)

J	Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
E	An estimated value due to the presence of interferences. A full explanation is presented in the narrative.
H	Holding time and/or preservation requirements not met. Result is estimated.
J-1	Estimated value. A full explanation is presented in the narrative.
J-M	Duplicate precision (RPD) for associated QC sample was not within acceptance criteria. Result is estimated.
J-N	Spike recovery for associated QC sample was not within acceptance criteria. Result is estimated.
M	Duplicate precision (RPD) was not within acceptance criteria. Result is estimated.
N	Spike recovery was not within acceptance criteria. Result is estimated.
R	Rejected, unusable value. A full explanation is presented in the narrative.
U	Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
X	Result is not BLK-corrected and is within 10x the absolute value of the highest detectable BLK in the batch. Result is estimated.

These qualifiers are based on those previously utilized by Brooks Applied Labs, those found in the EPA SOW ILM03.0, Exhibit B, Section III, pg. B-18, and the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review; USEPA; January 2010. These supersede all previous qualifiers ever employed by BAL.

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
MWS007-9-10	1635047-01	Soil/Sediment	Sample	05/11/2016	08/26/2016
MWS009-11-12	1635047-02	Soil/Sediment	Sample	05/11/2016	08/26/2016
MWS010-12-13	1635047-03	Soil/Sediment	Sample	05/10/2016	08/26/2016
MWS012-11.5-12.5	1635047-04	Soil/Sediment	Sample	05/12/2016	08/26/2016
MWS013-12.5-13.5	1635047-05	Soil/Sediment	Sample	05/10/2016	08/26/2016
TBS003-14-15	1635047-06	Soil/Sediment	Sample	05/17/2016	08/26/2016
TBS005-17-18	1635047-07	Soil/Sediment	Sample	05/17/2016	08/26/2016
TBS007-16.5-17.5	1635047-08	Soil/Sediment	Sample	05/17/2016	08/26/2016
WCTSD001A-0-10	1635047-09	Soil/Sediment	Sample	05/18/2016	08/26/2016
WCTSD001A-40-50	1635047-10	Soil/Sediment	Sample	05/18/2016	08/26/2016
WCTSD001B-0-10	1635047-11	Soil/Sediment	Sample	05/18/2016	08/26/2016
WCTSD001B-40-50	1635047-12	Soil/Sediment	Sample	05/18/2016	08/26/2016

Batch Summary

Analyte	Lab Matrix	Method	Prepared	Analyzed	Batch	Sequence
%TS	Soil/Sediment	SM 2540G	08/26/2016	09/07/2016	B162109	N/A
%TS	Soil/Sediment	SM 2540G	09/28/2016	10/04/2016	B162113	N/A
As(F1)	Soil/Sediment	EPA 6020B Mod	09/08/2016	09/30/2016	B162114	1601121
As(F2)	Soil/Sediment	EPA 6020B Mod	09/13/2016	10/01/2016	B162115	1601121
As(F3)	Soil/Sediment	EPA 6020B Mod	09/19/2016	10/01/2016	B162116	1601121
As(F4)	Soil/Sediment	EPA 6020B Mod	09/23/2016	10/01/2016	B162117	1601121
As(F5)	Soil/Sediment	EPA 6020B Mod	09/27/2016	10/01/2016	B162118	1601121
Fe(F1)	Soil/Sediment	EPA 6020B Mod	09/08/2016	09/30/2016	B162114	1601121
Fe(F2)	Soil/Sediment	EPA 6020B Mod	09/13/2016	10/01/2016	B162115	1601121
Fe(F3)	Soil/Sediment	EPA 6020B Mod	09/19/2016	10/01/2016	B162116	1601121
Fe(F4)	Soil/Sediment	EPA 6020B Mod	09/23/2016	10/01/2016	B162117	1601121
Fe(F5)	Soil/Sediment	EPA 6020B Mod	09/27/2016	10/01/2016	B162118	1601121
Mn(F1)	Soil/Sediment	EPA 6020B Mod	09/08/2016	09/30/2016	B162114	1601121
Mn(F2)	Soil/Sediment	EPA 6020B Mod	09/13/2016	10/01/2016	B162115	1601121
Mn(F3)	Soil/Sediment	EPA 6020B Mod	09/19/2016	10/01/2016	B162116	1601121
Mn(F4)	Soil/Sediment	EPA 6020B Mod	09/23/2016	10/01/2016	B162117	1601121
Mn(F5)	Soil/Sediment	EPA 6020B Mod	09/27/2016	10/01/2016	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS007-9-10										
1635047-01	%TS	Soil/Sediment	NA	97.27		0.06	0.21	%	B162109	N/A
1635047-01	As(F1)	Soil/Sediment	dry	0.335	J	0.247	0.616	mg/kg	B162114	1601121
1635047-01	As(F2)	Soil/Sediment	dry	1.99	J	1.17	2.47	mg/kg	B162115	1601121
1635047-01	As(F3)	Soil/Sediment	dry	0.538	J	0.092	0.616	mg/kg	B162116	1601121
1635047-01	As(F4)	Soil/Sediment	dry	0.281	J	0.185	0.616	mg/kg	B162117	1601121
1635047-01	As(F5)	Soil/Sediment	dry	0.631		0.032	0.205	mg/kg	B162118	1601121
1635047-01	Fe(F1)	Soil/Sediment	dry	≤ 27.7	U	27.7	55.5	mg/kg	B162114	1601121
1635047-01	Fe(F2)	Soil/Sediment	dry	830		15.4	30.8	mg/kg	B162115	1601121
1635047-01	Fe(F3)	Soil/Sediment	dry	82.2		26.2	52.4	mg/kg	B162116	1601121
1635047-01	Fe(F4)	Soil/Sediment	dry	3720		7.55	15.1	mg/kg	B162117	1601121
1635047-01	Fe(F5)	Soil/Sediment	dry	7140		6.68	13.4	mg/kg	B162118	1601121
1635047-01	Mn(F1)	Soil/Sediment	dry	1.24		0.416	0.832	mg/kg	B162114	1601121
1635047-01	Mn(F2)	Soil/Sediment	dry	3.60		0.385	0.770	mg/kg	B162115	1601121
1635047-01	Mn(F3)	Soil/Sediment	dry	≤ 0.462	U	0.462	0.924	mg/kg	B162116	1601121
1635047-01	Mn(F4)	Soil/Sediment	dry	15.3		2.00	4.01	mg/kg	B162117	1601121
1635047-01	Mn(F5)	Soil/Sediment	dry	60.4		0.175	0.349	mg/kg	B162118	1601121
MWS009-11-12										
1635047-02	%TS	Soil/Sediment	NA	90.28		0.08	0.26	%	B162113	N/A
1635047-02	As(F1)	Soil/Sediment	dry	≤ 0.261	U	0.261	0.651	mg/kg	B162114	1601121
1635047-02	As(F2)	Soil/Sediment	dry	1.28	J	1.24	2.61	mg/kg	B162115	1601121
1635047-02	As(F3)	Soil/Sediment	dry	0.285	J	0.098	0.651	mg/kg	B162116	1601121
1635047-02	As(F4)	Soil/Sediment	dry	0.243	J	0.195	0.651	mg/kg	B162117	1601121
1635047-02	As(F5)	Soil/Sediment	dry	0.410		0.034	0.217	mg/kg	B162118	1601121
1635047-02	Fe(F1)	Soil/Sediment	dry	≤ 29.3	U	29.3	58.6	mg/kg	B162114	1601121
1635047-02	Fe(F2)	Soil/Sediment	dry	941		16.3	32.6	mg/kg	B162115	1601121
1635047-02	Fe(F3)	Soil/Sediment	dry	188		27.7	55.4	mg/kg	B162116	1601121
1635047-02	Fe(F4)	Soil/Sediment	dry	5360		7.98	16.0	mg/kg	B162117	1601121
1635047-02	Fe(F5)	Soil/Sediment	dry	7370		7.06	14.1	mg/kg	B162118	1601121
1635047-02	Mn(F1)	Soil/Sediment	dry	6.95		0.440	0.879	mg/kg	B162114	1601121
1635047-02	Mn(F2)	Soil/Sediment	dry	8.86		0.407	0.814	mg/kg	B162115	1601121
1635047-02	Mn(F3)	Soil/Sediment	dry	≤ 0.489	U	0.489	0.977	mg/kg	B162116	1601121
1635047-02	Mn(F4)	Soil/Sediment	dry	22.4		2.12	4.23	mg/kg	B162117	1601121
1635047-02	Mn(F5)	Soil/Sediment	dry	63.5		0.185	0.369	mg/kg	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS010-12-13										
1635047-03	%TS	Soil/Sediment	NA	86.43		0.08	0.26	%	B162113	N/A
1635047-03	As(F1)	Soil/Sediment	dry	15.2	M	0.272	0.680	mg/kg	B162114	1601121
1635047-03	As(F2)	Soil/Sediment	dry	78.3	M	1.29	2.72	mg/kg	B162115	1601121
1635047-03	As(F3)	Soil/Sediment	dry	109		0.102	0.680	mg/kg	B162116	1601121
1635047-03	As(F4)	Soil/Sediment	dry	8.24	M	0.204	0.680	mg/kg	B162117	1601121
1635047-03	As(F5)	Soil/Sediment	dry	36.7	M	0.035	0.227	mg/kg	B162118	1601121
1635047-03	Fe(F1)	Soil/Sediment	dry	≤ 30.6	U	30.6	61.2	mg/kg	B162114	1601121
1635047-03	Fe(F2)	Soil/Sediment	dry	1180		17.0	34.0	mg/kg	B162115	1601121
1635047-03	Fe(F3)	Soil/Sediment	dry	412		28.9	57.8	mg/kg	B162116	1601121
1635047-03	Fe(F4)	Soil/Sediment	dry	6810		8.33	16.7	mg/kg	B162117	1601121
1635047-03	Fe(F5)	Soil/Sediment	dry	11800	M	7.37	14.7	mg/kg	B162118	1601121
1635047-03	Mn(F1)	Soil/Sediment	dry	20.0	M	0.459	0.918	mg/kg	B162114	1601121
1635047-03	Mn(F2)	Soil/Sediment	dry	14.9		0.425	0.850	mg/kg	B162115	1601121
1635047-03	Mn(F3)	Soil/Sediment	dry	2.01		0.510	1.02	mg/kg	B162116	1601121
1635047-03	Mn(F4)	Soil/Sediment	dry	28.8		2.21	4.42	mg/kg	B162117	1601121
1635047-03	Mn(F5)	Soil/Sediment	dry	84.3		0.193	0.385	mg/kg	B162118	1601121
MWS012-11.5-12.5										
1635047-04	%TS	Soil/Sediment	NA	89.59		0.08	0.26	%	B162113	N/A
1635047-04	As(F1)	Soil/Sediment	dry	≤ 0.264	U	0.264	0.660	mg/kg	B162114	1601121
1635047-04	As(F2)	Soil/Sediment	dry	1.38	J	1.25	2.64	mg/kg	B162115	1601121
1635047-04	As(F3)	Soil/Sediment	dry	0.132	J	0.099	0.660	mg/kg	B162116	1601121
1635047-04	As(F4)	Soil/Sediment	dry	3.98		0.198	0.660	mg/kg	B162117	1601121
1635047-04	As(F5)	Soil/Sediment	dry	0.291		0.034	0.220	mg/kg	B162118	1601121
1635047-04	Fe(F1)	Soil/Sediment	dry	≤ 29.7	U	29.7	59.4	mg/kg	B162114	1601121
1635047-04	Fe(F2)	Soil/Sediment	dry	1030		16.5	33.0	mg/kg	B162115	1601121
1635047-04	Fe(F3)	Soil/Sediment	dry	115		28.0	56.1	mg/kg	B162116	1601121
1635047-04	Fe(F4)	Soil/Sediment	dry	5270		8.08	16.2	mg/kg	B162117	1601121
1635047-04	Fe(F5)	Soil/Sediment	dry	10800		7.15	14.3	mg/kg	B162118	1601121
1635047-04	Mn(F1)	Soil/Sediment	dry	16.7		0.445	0.891	mg/kg	B162114	1601121
1635047-04	Mn(F2)	Soil/Sediment	dry	42.8		0.412	0.825	mg/kg	B162115	1601121
1635047-04	Mn(F3)	Soil/Sediment	dry	1.03		0.495	0.990	mg/kg	B162116	1601121
1635047-04	Mn(F4)	Soil/Sediment	dry	30.1		2.14	4.29	mg/kg	B162117	1601121
1635047-04	Mn(F5)	Soil/Sediment	dry	81.2		0.187	0.374	mg/kg	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS013-12.5-13.5										
1635047-05	%TS	Soil/Sediment	NA	86.51		0.08	0.26	%	B162113	N/A
1635047-05	As(F1)	Soil/Sediment	dry	0.419	J	0.278	0.696	mg/kg	B162114	1601121
1635047-05	As(F2)	Soil/Sediment	dry	5.45		1.32	2.78	mg/kg	B162115	1601121
1635047-05	As(F3)	Soil/Sediment	dry	2.81		0.104	0.696	mg/kg	B162116	1601121
1635047-05	As(F4)	Soil/Sediment	dry	1.13		0.209	0.696	mg/kg	B162117	1601121
1635047-05	As(F5)	Soil/Sediment	dry	7.27		0.036	0.232	mg/kg	B162118	1601121
1635047-05	Fe(F1)	Soil/Sediment	dry	≤ 31.3	U	31.3	62.6	mg/kg	B162114	1601121
1635047-05	Fe(F2)	Soil/Sediment	dry	1070		17.4	34.8	mg/kg	B162115	1601121
1635047-05	Fe(F3)	Soil/Sediment	dry	423		29.6	59.1	mg/kg	B162116	1601121
1635047-05	Fe(F4)	Soil/Sediment	dry	9920		8.52	17.0	mg/kg	B162117	1601121
1635047-05	Fe(F5)	Soil/Sediment	dry	11900		7.54	15.1	mg/kg	B162118	1601121
1635047-05	Mn(F1)	Soil/Sediment	dry	60.3		0.470	0.939	mg/kg	B162114	1601121
1635047-05	Mn(F2)	Soil/Sediment	dry	67.2		0.435	0.869	mg/kg	B162115	1601121
1635047-05	Mn(F3)	Soil/Sediment	dry	5.69		0.522	1.04	mg/kg	B162116	1601121
1635047-05	Mn(F4)	Soil/Sediment	dry	114		2.26	4.52	mg/kg	B162117	1601121
1635047-05	Mn(F5)	Soil/Sediment	dry	139		0.197	0.394	mg/kg	B162118	1601121
TBS003-14-15										
1635047-06	%TS	Soil/Sediment	NA	80.79		0.06	0.21	%	B162109	N/A
1635047-06	As(F1)	Soil/Sediment	dry	≤ 0.290	U	0.290	0.726	mg/kg	B162114	1601121
1635047-06	As(F2)	Soil/Sediment	dry	3.83		1.38	2.90	mg/kg	B162115	1601121
1635047-06	As(F3)	Soil/Sediment	dry	1.34		0.109	0.726	mg/kg	B162116	1601121
1635047-06	As(F4)	Soil/Sediment	dry	0.742		0.218	0.726	mg/kg	B162117	1601121
1635047-06	As(F5)	Soil/Sediment	dry	1.14		0.037	0.242	mg/kg	B162118	1601121
1635047-06	Fe(F1)	Soil/Sediment	dry	≤ 32.7	U	32.7	65.3	mg/kg	B162114	1601121
1635047-06	Fe(F2)	Soil/Sediment	dry	1130		18.1	36.3	mg/kg	B162115	1601121
1635047-06	Fe(F3)	Soil/Sediment	dry	1400		30.8	61.7	mg/kg	B162116	1601121
1635047-06	Fe(F4)	Soil/Sediment	dry	12500		8.89	17.8	mg/kg	B162117	1601121
1635047-06	Fe(F5)	Soil/Sediment	dry	13300		7.86	15.7	mg/kg	B162118	1601121
1635047-06	Mn(F1)	Soil/Sediment	dry	54.0		0.490	0.980	mg/kg	B162114	1601121
1635047-06	Mn(F2)	Soil/Sediment	dry	19.8		0.454	0.907	mg/kg	B162115	1601121
1635047-06	Mn(F3)	Soil/Sediment	dry	1.71		0.544	1.09	mg/kg	B162116	1601121
1635047-06	Mn(F4)	Soil/Sediment	dry	30.5		2.36	4.72	mg/kg	B162117	1601121
1635047-06	Mn(F5)	Soil/Sediment	dry	98.8		0.206	0.411	mg/kg	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
TBS005-17-18										
1635047-07	%TS	Soil/Sediment	NA	90.73		0.08	0.26	%	B162113	N/A
1635047-07	As(F1)	Soil/Sediment	dry	0.319	J	0.269	0.673	mg/kg	B162114	1601121
1635047-07	As(F2)	Soil/Sediment	dry	1.77	J	1.28	2.69	mg/kg	B162115	1601121
1635047-07	As(F3)	Soil/Sediment	dry	0.369	J	0.101	0.673	mg/kg	B162116	1601121
1635047-07	As(F4)	Soil/Sediment	dry	0.415	J	0.202	0.673	mg/kg	B162117	1601121
1635047-07	As(F5)	Soil/Sediment	dry	0.360		0.035	0.224	mg/kg	B162118	1601121
1635047-07	Fe(F1)	Soil/Sediment	dry	2630		30.3	60.6	mg/kg	B162114	1601121
1635047-07	Fe(F2)	Soil/Sediment	dry	1130		16.8	33.7	mg/kg	B162115	1601121
1635047-07	Fe(F3)	Soil/Sediment	dry	185		28.6	57.2	mg/kg	B162116	1601121
1635047-07	Fe(F4)	Soil/Sediment	dry	7060		8.25	16.5	mg/kg	B162117	1601121
1635047-07	Fe(F5)	Soil/Sediment	dry	8090		7.29	14.6	mg/kg	B162118	1601121
1635047-07	Mn(F1)	Soil/Sediment	dry	25.7		0.455	0.909	mg/kg	B162114	1601121
1635047-07	Mn(F2)	Soil/Sediment	dry	12.8		0.421	0.842	mg/kg	B162115	1601121
1635047-07	Mn(F3)	Soil/Sediment	dry	0.786	J	0.505	1.01	mg/kg	B162116	1601121
1635047-07	Mn(F4)	Soil/Sediment	dry	28.7		2.19	4.38	mg/kg	B162117	1601121
1635047-07	Mn(F5)	Soil/Sediment	dry	68.9		0.191	0.382	mg/kg	B162118	1601121
TBS007-16.5-17.5										
1635047-08	%TS	Soil/Sediment	NA	96.02		0.08	0.26	%	B162113	N/A
1635047-08	As(F1)	Soil/Sediment	dry	≤ 0.250	U	0.250	0.624	mg/kg	B162114	1601121
1635047-08	As(F2)	Soil/Sediment	dry	1.37	J	1.19	2.50	mg/kg	B162115	1601121
1635047-08	As(F3)	Soil/Sediment	dry	0.255	J	0.094	0.624	mg/kg	B162116	1601121
1635047-08	As(F4)	Soil/Sediment	dry	0.216	J	0.187	0.624	mg/kg	B162117	1601121
1635047-08	As(F5)	Soil/Sediment	dry	0.666		0.032	0.208	mg/kg	B162118	1601121
1635047-08	Fe(F1)	Soil/Sediment	dry	≤ 28.1	U	28.1	56.2	mg/kg	B162114	1601121
1635047-08	Fe(F2)	Soil/Sediment	dry	973		15.6	31.2	mg/kg	B162115	1601121
1635047-08	Fe(F3)	Soil/Sediment	dry	88.0		26.5	53.1	mg/kg	B162116	1601121
1635047-08	Fe(F4)	Soil/Sediment	dry	5630		7.65	15.3	mg/kg	B162117	1601121
1635047-08	Fe(F5)	Soil/Sediment	dry	8240		6.76	13.5	mg/kg	B162118	1601121
1635047-08	Mn(F1)	Soil/Sediment	dry	3.14		0.421	0.843	mg/kg	B162114	1601121
1635047-08	Mn(F2)	Soil/Sediment	dry	14.0		0.390	0.780	mg/kg	B162115	1601121
1635047-08	Mn(F3)	Soil/Sediment	dry	≤ 0.468	U	0.468	0.936	mg/kg	B162116	1601121
1635047-08	Mn(F4)	Soil/Sediment	dry	21.1		2.03	4.06	mg/kg	B162117	1601121
1635047-08	Mn(F5)	Soil/Sediment	dry	65.9		0.177	0.354	mg/kg	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
WCTSD001A-0-10										
1635047-09	%TS	Soil/Sediment	NA	92.89		0.08	0.26	%	B162113	N/A
1635047-09	As(F1)	Soil/Sediment	dry	0.377	J	0.258	0.645	mg/kg	B162114	1601121
1635047-09	As(F2)	Soil/Sediment	dry	2.99		1.23	2.58	mg/kg	B162115	1601121
1635047-09	As(F3)	Soil/Sediment	dry	0.689		0.097	0.645	mg/kg	B162116	1601121
1635047-09	As(F4)	Soil/Sediment	dry	0.593	J	0.194	0.645	mg/kg	B162117	1601121
1635047-09	As(F5)	Soil/Sediment	dry	0.529		0.033	0.215	mg/kg	B162118	1601121
1635047-09	Fe(F1)	Soil/Sediment	dry	≤ 29.0	U	29.0	58.1	mg/kg	B162114	1601121
1635047-09	Fe(F2)	Soil/Sediment	dry	1010		16.1	32.3	mg/kg	B162115	1601121
1635047-09	Fe(F3)	Soil/Sediment	dry	351		27.4	54.9	mg/kg	B162116	1601121
1635047-09	Fe(F4)	Soil/Sediment	dry	6850		7.91	15.8	mg/kg	B162117	1601121
1635047-09	Fe(F5)	Soil/Sediment	dry	8720		6.99	14.0	mg/kg	B162118	1601121
1635047-09	Mn(F1)	Soil/Sediment	dry	4.34		0.436	0.871	mg/kg	B162114	1601121
1635047-09	Mn(F2)	Soil/Sediment	dry	14.3		0.403	0.807	mg/kg	B162115	1601121
1635047-09	Mn(F3)	Soil/Sediment	dry	1.39		0.484	0.968	mg/kg	B162116	1601121
1635047-09	Mn(F4)	Soil/Sediment	dry	32.0		2.10	4.19	mg/kg	B162117	1601121
1635047-09	Mn(F5)	Soil/Sediment	dry	77.9		0.183	0.366	mg/kg	B162118	1601121
WCTSD001A-40-50										
1635047-10	%TS	Soil/Sediment	NA	98.62		0.06	0.21	%	B162109	N/A
1635047-10	As(F1)	Soil/Sediment	dry	≤ 0.241	U	0.241	0.604	mg/kg	B162114	1601121
1635047-10	As(F2)	Soil/Sediment	dry	1.50	J	1.15	2.41	mg/kg	B162115	1601121
1635047-10	As(F3)	Soil/Sediment	dry	0.474	J	0.091	0.604	mg/kg	B162116	1601121
1635047-10	As(F4)	Soil/Sediment	dry	0.335	J	0.181	0.604	mg/kg	B162117	1601121
1635047-10	As(F5)	Soil/Sediment	dry	0.513		0.031	0.201	mg/kg	B162118	1601121
1635047-10	Fe(F1)	Soil/Sediment	dry	≤ 27.2	U	27.2	54.3	mg/kg	B162114	1601121
1635047-10	Fe(F2)	Soil/Sediment	dry	1080		15.1	30.2	mg/kg	B162115	1601121
1635047-10	Fe(F3)	Soil/Sediment	dry	292		25.7	51.3	mg/kg	B162116	1601121
1635047-10	Fe(F4)	Soil/Sediment	dry	8030		7.39	14.8	mg/kg	B162117	1601121
1635047-10	Fe(F5)	Soil/Sediment	dry	8520		6.54	13.1	mg/kg	B162118	1601121
1635047-10	Mn(F1)	Soil/Sediment	dry	13.3		0.407	0.815	mg/kg	B162114	1601121
1635047-10	Mn(F2)	Soil/Sediment	dry	28.5		0.377	0.754	mg/kg	B162115	1601121
1635047-10	Mn(F3)	Soil/Sediment	dry	2.21		0.453	0.905	mg/kg	B162116	1601121
1635047-10	Mn(F4)	Soil/Sediment	dry	49.0		1.96	3.92	mg/kg	B162117	1601121
1635047-10	Mn(F5)	Soil/Sediment	dry	83.4		0.171	0.342	mg/kg	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
WCTSD001B-0-10										
1635047-11	%TS	Soil/Sediment	NA	99.02		0.08	0.26	%	B162113	N/A
1635047-11	As(F1)	Soil/Sediment	dry	1.10		0.240	0.601	mg/kg	B162114	1601121
1635047-11	As(F2)	Soil/Sediment	dry	8.99		1.14	2.40	mg/kg	B162115	1601121
1635047-11	As(F3)	Soil/Sediment	dry	2.04		0.090	0.601	mg/kg	B162116	1601121
1635047-11	As(F4)	Soil/Sediment	dry	0.972		0.180	0.601	mg/kg	B162117	1601121
1635047-11	As(F5)	Soil/Sediment	dry	2.38		0.031	0.200	mg/kg	B162118	1601121
1635047-11	Fe(F1)	Soil/Sediment	dry	≤ 27.0	U	27.0	54.1	mg/kg	B162114	1601121
1635047-11	Fe(F2)	Soil/Sediment	dry	991		15.0	30.1	mg/kg	B162115	1601121
1635047-11	Fe(F3)	Soil/Sediment	dry	189		25.5	51.1	mg/kg	B162116	1601121
1635047-11	Fe(F4)	Soil/Sediment	dry	11000		7.36	14.7	mg/kg	B162117	1601121
1635047-11	Fe(F5)	Soil/Sediment	dry	11400		6.51	13.0	mg/kg	B162118	1601121
1635047-11	Mn(F1)	Soil/Sediment	dry	9.90		0.406	0.811	mg/kg	B162114	1601121
1635047-11	Mn(F2)	Soil/Sediment	dry	26.9		0.376	0.751	mg/kg	B162115	1601121
1635047-11	Mn(F3)	Soil/Sediment	dry	0.586	J	0.451	0.902	mg/kg	B162116	1601121
1635047-11	Mn(F4)	Soil/Sediment	dry	35.5		1.95	3.91	mg/kg	B162117	1601121
1635047-11	Mn(F5)	Soil/Sediment	dry	91.9		0.170	0.341	mg/kg	B162118	1601121
WCTSD001B-40-50										
1635047-12	%TS	Soil/Sediment	NA	74.26		0.08	0.26	%	B162113	N/A
1635047-12	As(F1)	Soil/Sediment	dry	≤ 0.323	U	0.323	0.808	mg/kg	B162114	1601121
1635047-12	As(F2)	Soil/Sediment	dry	2.25	J	1.53	3.23	mg/kg	B162115	1601121
1635047-12	As(F3)	Soil/Sediment	dry	0.992		0.121	0.808	mg/kg	B162116	1601121
1635047-12	As(F4)	Soil/Sediment	dry	0.687	J	0.242	0.808	mg/kg	B162117	1601121
1635047-12	As(F5)	Soil/Sediment	dry	4.07		0.042	0.269	mg/kg	B162118	1601121
1635047-12	Fe(F1)	Soil/Sediment	dry	≤ 36.4	U	36.4	72.7	mg/kg	B162114	1601121
1635047-12	Fe(F2)	Soil/Sediment	dry	1140		20.2	40.4	mg/kg	B162115	1601121
1635047-12	Fe(F3)	Soil/Sediment	dry	875		34.3	68.7	mg/kg	B162116	1601121
1635047-12	Fe(F4)	Soil/Sediment	dry	5920		9.90	19.8	mg/kg	B162117	1601121
1635047-12	Fe(F5)	Soil/Sediment	dry	19100		8.75	17.5	mg/kg	B162118	1601121
1635047-12	Mn(F1)	Soil/Sediment	dry	42.8		0.545	1.09	mg/kg	B162114	1601121
1635047-12	Mn(F2)	Soil/Sediment	dry	14.0		0.505	1.01	mg/kg	B162115	1601121
1635047-12	Mn(F3)	Soil/Sediment	dry	3.70		0.606	1.21	mg/kg	B162116	1601121
1635047-12	Mn(F4)	Soil/Sediment	dry	36.2		2.63	5.25	mg/kg	B162117	1601121
1635047-12	Mn(F5)	Soil/Sediment	dry	119		0.229	0.458	mg/kg	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS007-9-10										
1635047-01	As(F1)	Soil/Sediment	dry	2.17	J	1.60	4.00	µg/L	B162114	1601121
1635047-01	As(F2)	Soil/Sediment	dry	12.9	J	7.60	16.0	µg/L	B162115	1601121
1635047-01	As(F3)	Soil/Sediment	dry	3.49	J	0.600	4.00	µg/L	B162116	1601121
1635047-01	As(F4)	Soil/Sediment	dry	1.82	J	1.20	4.00	µg/L	B162117	1601121
1635047-01	As(F5)	Soil/Sediment	dry	12.3		0.620	4.00	µg/L	B162118	1601121
1635047-01	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-01	Fe(F2)	Soil/Sediment	dry	5380		100	200	µg/L	B162115	1601121
1635047-01	Fe(F3)	Soil/Sediment	dry	533		170	340	µg/L	B162116	1601121
1635047-01	Fe(F4)	Soil/Sediment	dry	24100		49.0	98.0	µg/L	B162117	1601121
1635047-01	Fe(F5)	Soil/Sediment	dry	139000		130	260	µg/L	B162118	1601121
1635047-01	Mn(F1)	Soil/Sediment	dry	8.06		2.70	5.40	µg/L	B162114	1601121
1635047-01	Mn(F2)	Soil/Sediment	dry	23.4		2.50	5.00	µg/L	B162115	1601121
1635047-01	Mn(F3)	Soil/Sediment	dry	≤ 3.00	U	3.00	6.00	µg/L	B162116	1601121
1635047-01	Mn(F4)	Soil/Sediment	dry	99.0		13.0	26.0	µg/L	B162117	1601121
1635047-01	Mn(F5)	Soil/Sediment	dry	1180		3.40	6.80	µg/L	B162118	1601121
MWS009-11-12										
1635047-02	As(F1)	Soil/Sediment	dry	≤ 1.60	U	1.60	4.00	µg/L	B162114	1601121
1635047-02	As(F2)	Soil/Sediment	dry	7.84	J	7.60	16.0	µg/L	B162115	1601121
1635047-02	As(F3)	Soil/Sediment	dry	1.75	J	0.600	4.00	µg/L	B162116	1601121
1635047-02	As(F4)	Soil/Sediment	dry	1.49	J	1.20	4.00	µg/L	B162117	1601121
1635047-02	As(F5)	Soil/Sediment	dry	7.56		0.620	4.00	µg/L	B162118	1601121
1635047-02	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-02	Fe(F2)	Soil/Sediment	dry	5780		100	200	µg/L	B162115	1601121
1635047-02	Fe(F3)	Soil/Sediment	dry	1150		170	340	µg/L	B162116	1601121
1635047-02	Fe(F4)	Soil/Sediment	dry	32900		49.0	98.0	µg/L	B162117	1601121
1635047-02	Fe(F5)	Soil/Sediment	dry	136000		130	260	µg/L	B162118	1601121
1635047-02	Mn(F1)	Soil/Sediment	dry	42.7		2.70	5.40	µg/L	B162114	1601121
1635047-02	Mn(F2)	Soil/Sediment	dry	54.4		2.50	5.00	µg/L	B162115	1601121
1635047-02	Mn(F3)	Soil/Sediment	dry	≤ 3.00	U	3.00	6.00	µg/L	B162116	1601121
1635047-02	Mn(F4)	Soil/Sediment	dry	138		13.0	26.0	µg/L	B162117	1601121
1635047-02	Mn(F5)	Soil/Sediment	dry	1170		3.40	6.80	µg/L	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS010-12-13										
1635047-03	As(F1)	Soil/Sediment	dry	89.3	M	1.60	4.00	µg/L	B162114	1601121
1635047-03	As(F2)	Soil/Sediment	dry	461	M	7.60	16.0	µg/L	B162115	1601121
1635047-03	As(F3)	Soil/Sediment	dry	640		0.600	4.00	µg/L	B162116	1601121
1635047-03	As(F4)	Soil/Sediment	dry	48.5	M	1.20	4.00	µg/L	B162117	1601121
1635047-03	As(F5)	Soil/Sediment	dry	648	M	0.620	4.00	µg/L	B162118	1601121
1635047-03	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-03	Fe(F2)	Soil/Sediment	dry	6940		100	200	µg/L	B162115	1601121
1635047-03	Fe(F3)	Soil/Sediment	dry	2430		170	340	µg/L	B162116	1601121
1635047-03	Fe(F4)	Soil/Sediment	dry	40000		49.0	98.0	µg/L	B162117	1601121
1635047-03	Fe(F5)	Soil/Sediment	dry	207000	M	130	260	µg/L	B162118	1601121
1635047-03	Mn(F1)	Soil/Sediment	dry	118	M	2.70	5.40	µg/L	B162114	1601121
1635047-03	Mn(F2)	Soil/Sediment	dry	87.5		2.50	5.00	µg/L	B162115	1601121
1635047-03	Mn(F3)	Soil/Sediment	dry	11.8		3.00	6.00	µg/L	B162116	1601121
1635047-03	Mn(F4)	Soil/Sediment	dry	169		13.0	26.0	µg/L	B162117	1601121
1635047-03	Mn(F5)	Soil/Sediment	dry	1490		3.40	6.80	µg/L	B162118	1601121
MWS012-11.5-12.5										
1635047-04	As(F1)	Soil/Sediment	dry	≤ 1.60	U	1.60	4.00	µg/L	B162114	1601121
1635047-04	As(F2)	Soil/Sediment	dry	8.38	J	7.60	16.0	µg/L	B162115	1601121
1635047-04	As(F3)	Soil/Sediment	dry	0.802	J	0.600	4.00	µg/L	B162116	1601121
1635047-04	As(F4)	Soil/Sediment	dry	24.1		1.20	4.00	µg/L	B162117	1601121
1635047-04	As(F5)	Soil/Sediment	dry	5.28		0.620	4.00	µg/L	B162118	1601121
1635047-04	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-04	Fe(F2)	Soil/Sediment	dry	6230		100	200	µg/L	B162115	1601121
1635047-04	Fe(F3)	Soil/Sediment	dry	698		170	340	µg/L	B162116	1601121
1635047-04	Fe(F4)	Soil/Sediment	dry	31900		49.0	98.0	µg/L	B162117	1601121
1635047-04	Fe(F5)	Soil/Sediment	dry	196000		130	260	µg/L	B162118	1601121
1635047-04	Mn(F1)	Soil/Sediment	dry	101		2.70	5.40	µg/L	B162114	1601121
1635047-04	Mn(F2)	Soil/Sediment	dry	260		2.50	5.00	µg/L	B162115	1601121
1635047-04	Mn(F3)	Soil/Sediment	dry	6.24		3.00	6.00	µg/L	B162116	1601121
1635047-04	Mn(F4)	Soil/Sediment	dry	182		13.0	26.0	µg/L	B162117	1601121
1635047-04	Mn(F5)	Soil/Sediment	dry	1480		3.40	6.80	µg/L	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS013-12.5-13.5										
1635047-05	As(F1)	Soil/Sediment	dry	2.41	J	1.60	4.00	µg/L	B162114	1601121
1635047-05	As(F2)	Soil/Sediment	dry	31.3		7.60	16.0	µg/L	B162115	1601121
1635047-05	As(F3)	Soil/Sediment	dry	16.1		0.600	4.00	µg/L	B162116	1601121
1635047-05	As(F4)	Soil/Sediment	dry	6.50		1.20	4.00	µg/L	B162117	1601121
1635047-05	As(F5)	Soil/Sediment	dry	126		0.620	4.00	µg/L	B162118	1601121
1635047-05	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-05	Fe(F2)	Soil/Sediment	dry	6180		100	200	µg/L	B162115	1601121
1635047-05	Fe(F3)	Soil/Sediment	dry	2430		170	340	µg/L	B162116	1601121
1635047-05	Fe(F4)	Soil/Sediment	dry	57100		49.0	98.0	µg/L	B162117	1601121
1635047-05	Fe(F5)	Soil/Sediment	dry	205000		130	260	µg/L	B162118	1601121
1635047-05	Mn(F1)	Soil/Sediment	dry	347		2.70	5.40	µg/L	B162114	1601121
1635047-05	Mn(F2)	Soil/Sediment	dry	386		2.50	5.00	µg/L	B162115	1601121
1635047-05	Mn(F3)	Soil/Sediment	dry	32.7		3.00	6.00	µg/L	B162116	1601121
1635047-05	Mn(F4)	Soil/Sediment	dry	654		13.0	26.0	µg/L	B162117	1601121
1635047-05	Mn(F5)	Soil/Sediment	dry	2410		3.40	6.80	µg/L	B162118	1601121
TBS003-14-15										
1635047-06	As(F1)	Soil/Sediment	dry	≤ 1.60	U	1.60	4.00	µg/L	B162114	1601121
1635047-06	As(F2)	Soil/Sediment	dry	21.1		7.60	16.0	µg/L	B162115	1601121
1635047-06	As(F3)	Soil/Sediment	dry	7.40		0.600	4.00	µg/L	B162116	1601121
1635047-06	As(F4)	Soil/Sediment	dry	4.09		1.20	4.00	µg/L	B162117	1601121
1635047-06	As(F5)	Soil/Sediment	dry	18.8		0.620	4.00	µg/L	B162118	1601121
1635047-06	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-06	Fe(F2)	Soil/Sediment	dry	6210		100	200	µg/L	B162115	1601121
1635047-06	Fe(F3)	Soil/Sediment	dry	7690		170	340	µg/L	B162116	1601121
1635047-06	Fe(F4)	Soil/Sediment	dry	68700		49.0	98.0	µg/L	B162117	1601121
1635047-06	Fe(F5)	Soil/Sediment	dry	220000		130	260	µg/L	B162118	1601121
1635047-06	Mn(F1)	Soil/Sediment	dry	298		2.70	5.40	µg/L	B162114	1601121
1635047-06	Mn(F2)	Soil/Sediment	dry	109		2.50	5.00	µg/L	B162115	1601121
1635047-06	Mn(F3)	Soil/Sediment	dry	9.45		3.00	6.00	µg/L	B162116	1601121
1635047-06	Mn(F4)	Soil/Sediment	dry	168		13.0	26.0	µg/L	B162117	1601121
1635047-06	Mn(F5)	Soil/Sediment	dry	1630		3.40	6.80	µg/L	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
TBS005-17-18										
1635047-07	As(F1)	Soil/Sediment	dry	1.89	J	1.60	4.00	µg/L	B162114	1601121
1635047-07	As(F2)	Soil/Sediment	dry	10.5	J	7.60	16.0	µg/L	B162115	1601121
1635047-07	As(F3)	Soil/Sediment	dry	2.19	J	0.600	4.00	µg/L	B162116	1601121
1635047-07	As(F4)	Soil/Sediment	dry	2.47	J	1.20	4.00	µg/L	B162117	1601121
1635047-07	As(F5)	Soil/Sediment	dry	6.41		0.620	4.00	µg/L	B162118	1601121
1635047-07	Fe(F1)	Soil/Sediment	dry	15600		180	360	µg/L	B162114	1601121
1635047-07	Fe(F2)	Soil/Sediment	dry	6700		100	200	µg/L	B162115	1601121
1635047-07	Fe(F3)	Soil/Sediment	dry	1100		170	340	µg/L	B162116	1601121
1635047-07	Fe(F4)	Soil/Sediment	dry	41900		49.0	98.0	µg/L	B162117	1601121
1635047-07	Fe(F5)	Soil/Sediment	dry	144000		130	260	µg/L	B162118	1601121
1635047-07	Mn(F1)	Soil/Sediment	dry	153		2.70	5.40	µg/L	B162114	1601121
1635047-07	Mn(F2)	Soil/Sediment	dry	76.0		2.50	5.00	µg/L	B162115	1601121
1635047-07	Mn(F3)	Soil/Sediment	dry	4.67	J	3.00	6.00	µg/L	B162116	1601121
1635047-07	Mn(F4)	Soil/Sediment	dry	171		13.0	26.0	µg/L	B162117	1601121
1635047-07	Mn(F5)	Soil/Sediment	dry	1230		3.40	6.80	µg/L	B162118	1601121
TBS007-16.5-17.5										
1635047-08	As(F1)	Soil/Sediment	dry	≤ 1.60	U	1.60	4.00	µg/L	B162114	1601121
1635047-08	As(F2)	Soil/Sediment	dry	8.78	J	7.60	16.0	µg/L	B162115	1601121
1635047-08	As(F3)	Soil/Sediment	dry	1.64	J	0.600	4.00	µg/L	B162116	1601121
1635047-08	As(F4)	Soil/Sediment	dry	1.39	J	1.20	4.00	µg/L	B162117	1601121
1635047-08	As(F5)	Soil/Sediment	dry	12.8		0.620	4.00	µg/L	B162118	1601121
1635047-08	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-08	Fe(F2)	Soil/Sediment	dry	6230		100	200	µg/L	B162115	1601121
1635047-08	Fe(F3)	Soil/Sediment	dry	564		170	340	µg/L	B162116	1601121
1635047-08	Fe(F4)	Soil/Sediment	dry	36100		49.0	98.0	µg/L	B162117	1601121
1635047-08	Fe(F5)	Soil/Sediment	dry	158000		130	260	µg/L	B162118	1601121
1635047-08	Mn(F1)	Soil/Sediment	dry	20.1		2.70	5.40	µg/L	B162114	1601121
1635047-08	Mn(F2)	Soil/Sediment	dry	89.9		2.50	5.00	µg/L	B162115	1601121
1635047-08	Mn(F3)	Soil/Sediment	dry	≤ 3.00	U	3.00	6.00	µg/L	B162116	1601121
1635047-08	Mn(F4)	Soil/Sediment	dry	135		13.0	26.0	µg/L	B162117	1601121
1635047-08	Mn(F5)	Soil/Sediment	dry	1270		3.40	6.80	µg/L	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
WCTSD001A-0-10										
1635047-09	As(F1)	Soil/Sediment	dry	2.34	J	1.60	4.00	µg/L	B162114	1601121
1635047-09	As(F2)	Soil/Sediment	dry	18.5		7.60	16.0	µg/L	B162115	1601121
1635047-09	As(F3)	Soil/Sediment	dry	4.27		0.600	4.00	µg/L	B162116	1601121
1635047-09	As(F4)	Soil/Sediment	dry	3.68	J	1.20	4.00	µg/L	B162117	1601121
1635047-09	As(F5)	Soil/Sediment	dry	9.84		0.620	4.00	µg/L	B162118	1601121
1635047-09	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-09	Fe(F2)	Soil/Sediment	dry	6260		100	200	µg/L	B162115	1601121
1635047-09	Fe(F3)	Soil/Sediment	dry	2170		170	340	µg/L	B162116	1601121
1635047-09	Fe(F4)	Soil/Sediment	dry	42500		49.0	98.0	µg/L	B162117	1601121
1635047-09	Fe(F5)	Soil/Sediment	dry	162000		130	260	µg/L	B162118	1601121
1635047-09	Mn(F1)	Soil/Sediment	dry	26.9		2.70	5.40	µg/L	B162114	1601121
1635047-09	Mn(F2)	Soil/Sediment	dry	88.6		2.50	5.00	µg/L	B162115	1601121
1635047-09	Mn(F3)	Soil/Sediment	dry	8.60		3.00	6.00	µg/L	B162116	1601121
1635047-09	Mn(F4)	Soil/Sediment	dry	198		13.0	26.0	µg/L	B162117	1601121
1635047-09	Mn(F5)	Soil/Sediment	dry	1450		3.40	6.80	µg/L	B162118	1601121
WCTSD001A-40-50										
1635047-10	As(F1)	Soil/Sediment	dry	≤ 1.60	U	1.60	4.00	µg/L	B162114	1601121
1635047-10	As(F2)	Soil/Sediment	dry	9.95	J	7.60	16.0	µg/L	B162115	1601121
1635047-10	As(F3)	Soil/Sediment	dry	3.14	J	0.600	4.00	µg/L	B162116	1601121
1635047-10	As(F4)	Soil/Sediment	dry	2.22	J	1.20	4.00	µg/L	B162117	1601121
1635047-10	As(F5)	Soil/Sediment	dry	10.2		0.620	4.00	µg/L	B162118	1601121
1635047-10	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-10	Fe(F2)	Soil/Sediment	dry	7150		100	200	µg/L	B162115	1601121
1635047-10	Fe(F3)	Soil/Sediment	dry	1940		170	340	µg/L	B162116	1601121
1635047-10	Fe(F4)	Soil/Sediment	dry	53200		49.0	98.0	µg/L	B162117	1601121
1635047-10	Fe(F5)	Soil/Sediment	dry	169000		130	260	µg/L	B162118	1601121
1635047-10	Mn(F1)	Soil/Sediment	dry	88.3		2.70	5.40	µg/L	B162114	1601121
1635047-10	Mn(F2)	Soil/Sediment	dry	189		2.50	5.00	µg/L	B162115	1601121
1635047-10	Mn(F3)	Soil/Sediment	dry	14.7		3.00	6.00	µg/L	B162116	1601121
1635047-10	Mn(F4)	Soil/Sediment	dry	325		13.0	26.0	µg/L	B162117	1601121
1635047-10	Mn(F5)	Soil/Sediment	dry	1660		3.40	6.80	µg/L	B162118	1601121

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
WCTSD001B-0-10										
1635047-11	As(F1)	Soil/Sediment	dry	7.33		1.60	4.00	µg/L	B162114	1601121
1635047-11	As(F2)	Soil/Sediment	dry	59.8		7.60	16.0	µg/L	B162115	1601121
1635047-11	As(F3)	Soil/Sediment	dry	13.6		0.600	4.00	µg/L	B162116	1601121
1635047-11	As(F4)	Soil/Sediment	dry	6.47		1.20	4.00	µg/L	B162117	1601121
1635047-11	As(F5)	Soil/Sediment	dry	47.6		0.620	4.00	µg/L	B162118	1601121
1635047-11	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-11	Fe(F2)	Soil/Sediment	dry	6590		100	200	µg/L	B162115	1601121
1635047-11	Fe(F3)	Soil/Sediment	dry	1260		170	340	µg/L	B162116	1601121
1635047-11	Fe(F4)	Soil/Sediment	dry	73100		49.0	98.0	µg/L	B162117	1601121
1635047-11	Fe(F5)	Soil/Sediment	dry	227000		130	260	µg/L	B162118	1601121
1635047-11	Mn(F1)	Soil/Sediment	dry	65.9		2.70	5.40	µg/L	B162114	1601121
1635047-11	Mn(F2)	Soil/Sediment	dry	179		2.50	5.00	µg/L	B162115	1601121
1635047-11	Mn(F3)	Soil/Sediment	dry	3.90	J	3.00	6.00	µg/L	B162116	1601121
1635047-11	Mn(F4)	Soil/Sediment	dry	236		13.0	26.0	µg/L	B162117	1601121
1635047-11	Mn(F5)	Soil/Sediment	dry	1830		3.40	6.80	µg/L	B162118	1601121
WCTSD001B-40-50										
1635047-12	As(F1)	Soil/Sediment	dry	≤ 1.60	U	1.60	4.00	µg/L	B162114	1601121
1635047-12	As(F2)	Soil/Sediment	dry	11.1	J	7.60	16.0	µg/L	B162115	1601121
1635047-12	As(F3)	Soil/Sediment	dry	4.91		0.600	4.00	µg/L	B162116	1601121
1635047-12	As(F4)	Soil/Sediment	dry	3.40	J	1.20	4.00	µg/L	B162117	1601121
1635047-12	As(F5)	Soil/Sediment	dry	60.5		0.620	4.00	µg/L	B162118	1601121
1635047-12	Fe(F1)	Soil/Sediment	dry	≤ 180	U	180	360	µg/L	B162114	1601121
1635047-12	Fe(F2)	Soil/Sediment	dry	5650		100	200	µg/L	B162115	1601121
1635047-12	Fe(F3)	Soil/Sediment	dry	4330		170	340	µg/L	B162116	1601121
1635047-12	Fe(F4)	Soil/Sediment	dry	29300		49.0	98.0	µg/L	B162117	1601121
1635047-12	Fe(F5)	Soil/Sediment	dry	283000		130	260	µg/L	B162118	1601121
1635047-12	Mn(F1)	Soil/Sediment	dry	212		2.70	5.40	µg/L	B162114	1601121
1635047-12	Mn(F2)	Soil/Sediment	dry	69.5		2.50	5.00	µg/L	B162115	1601121
1635047-12	Mn(F3)	Soil/Sediment	dry	18.3		3.00	6.00	µg/L	B162116	1601121
1635047-12	Mn(F4)	Soil/Sediment	dry	179		13.0	26.0	µg/L	B162117	1601121
1635047-12	Mn(F5)	Soil/Sediment	dry	1770		3.40	6.80	µg/L	B162118	1601121

Accuracy & Precision Summary

Batch: B162109
Lab Matrix: Soil/Sediment
Method: SM 2540G

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B162109-DUP1	**Duplicate, (1635047-01)**						
	%TS	97.27		97.27	%		0% 15

Accuracy & Precision Summary

Batch: B162113
Lab Matrix: Soil/Sediment
Method: SM 2540G

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B162113-DUP1	**Duplicate, (1635047-02)**								
	%TS	90.28		91.02	%			0.8%	15

Accuracy & Precision Summary

Batch: B162114
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B162114-DUP1	**Duplicate, (1635047-03)**								
	As(F1)	15.18		ND	mg/kg			N/C	30
	Fe(F1)	ND		ND	mg/kg			N/C	30
	Mn(F1)	19.99		37.50	mg/kg			*61%*	30
B162114-MS1	**Matrix Spike, (1635047-12)**								
	As(F1)	ND	201.8	206.2	mg/kg	102%	75-125		
	Fe(F1)	ND	2018	2225	mg/kg	110%	75-125		
	Mn(F1)	42.76	201.8	264.5	mg/kg	110%	75-125		
B162114-MSD1	**Matrix Spike Duplicate, (1635047-12)**								
	As(F1)	ND	201.8	213.6	mg/kg	106%	75-125	4%	20
	Fe(F1)	ND	2018	2244	mg/kg	111%	75-125	0.8%	20
	Mn(F1)	42.76	201.8	261.1	mg/kg	108%	75-125	2%	20

Accuracy & Precision Summary

Batch: B162115
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B162115-DUP1	**Duplicate, (1635047-03)**								
	As(F2)	78.31		1.743	mg/kg			*191%*	30
	Fe(F2)	1181		948.4	mg/kg			22%	30
	Mn(F2)	14.88		11.69	mg/kg			24%	30
B162115-MS1	**Matrix Spike, (1635047-12)**								
	As(F2)	2.251	202.0	225.5	mg/kg	111%	75-125		
	Fe(F2)	1141	2020	3433	mg/kg	113%	75-125		
	Mn(F2)	14.04	202.0	242.5	mg/kg	113%	75-125		
B162115-MSD1	**Matrix Spike Duplicate, (1635047-12)**								
	As(F2)	2.251	202.0	228.8	mg/kg	112%	75-125	1%	20
	Fe(F2)	1141	2020	3483	mg/kg	116%	75-125	2%	20
	Mn(F2)	14.04	202.0	242.9	mg/kg	113%	75-125	0.2%	20

Accuracy & Precision Summary

Batch: B162116
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B162116-MS1	**Matrix Spike, (1635047-12)**								
	As(F3)	0.992	202.0	213.6	mg/kg	105%	75-125		
	Fe(F3)	874.8	2020	3102	mg/kg	110%	75-125		
	Mn(F3)	3.702	202.0	223.0	mg/kg	109%	75-125		
B162116-MSD1	**Matrix Spike Duplicate, (1635047-12)**								
	As(F3)	0.992	202.0	218.1	mg/kg	108%	75-125	2%	20
	Fe(F3)	874.8	2020	3136	mg/kg	112%	75-125	1%	20
	Mn(F3)	3.702	202.0	220.5	mg/kg	107%	75-125	1%	20

Accuracy & Precision Summary

Batch: B162117
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC	REC Limits	RPD	RPD Limits
B162117-DUP1	**Duplicate, (1635047-03)**								
	As(F4)	8.240		0.600	mg/kg			*173%*	30
	Fe(F4)	6807		5055	mg/kg			30%	30
	Mn(F4)	28.81		30.60	mg/kg			6%	30
B162117-MS1	**Matrix Spike, (1635047-12)**								
	As(F4)	0.687	202.0	204.9	mg/kg	101%	75-125		
	Fe(F4)	5922	2020	8248	mg/kg	115%	75-125		
	Mn(F4)	36.16	202.0	254.5	mg/kg	108%	75-125		
B162117-MSD1	**Matrix Spike Duplicate, (1635047-12)**								
	As(F4)	0.687	202.0	208.1	mg/kg	103%	75-125	2%	20
	Fe(F4)	5922	2020	8064	mg/kg	106%	75-125	8%	20
	Mn(F4)	36.16	202.0	253.2	mg/kg	107%	75-125	0.6%	20

Accuracy & Precision Summary

Batch: B162118
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B162118-DUP1	**Duplicate, (1635047-03)**								
	As(F5)	36.73		4.282	mg/kg			*158%*	30
	Fe(F5)	11760		16940	mg/kg			*36%*	30
	Mn(F5)	84.28		99.89	mg/kg			17%	30
B162118-MS1	**Matrix Spike, (1635047-12)**								
	As(F5)	4.071	67.32	73.70	mg/kg	103%	75-125		
	Fe(F5)	19060	673.2	19890	mg/kg	NR	75-125		
	Mn(F5)	119.2	67.32	189.8	mg/kg	105%	75-125		
B162118-MSD1	**Matrix Spike Duplicate, (1635047-12)**								
	As(F5)	4.071	67.32	74.50	mg/kg	105%	75-125	1%	20
	Fe(F5)	19060	673.2	19850	mg/kg	NR	75-125	N/C	20
	Mn(F5)	119.2	67.32	190.4	mg/kg	106%	75-125	0.8%	20

Method Blanks & Reporting Limits

Batch: B162109
Matrix: Soil/Sediment
Method: SM 2540G
Analyte: %TS

Sample	Result	Units
B162109-BLK1	-0.02	%
B162109-BLK2	-0.06	%

Average: -0.04
Limit: 0.21

MDL: 0.06
MRL: 0.21

Method Blanks & Reporting Limits

Batch: B162113
Matrix: Soil/Sediment
Method: SM 2540G
Analyte: %TS

Sample	Result	Units
B162113-BLK1	-0.05	%
B162113-BLK2	-0.02	%

Average: -0.04
Limit: 0.26

MDL: 0.08
MRL: 0.26

Method Blanks & Reporting Limits

Batch: B162114
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F1)

Sample	Result	Units
B162114-BLK1	0.165	mg/kg wet
B162114-BLK2	0.124	mg/kg wet
B162114-BLK3	0.068	mg/kg wet
B162114-BLK4	0.112	mg/kg wet

Average: 0.117 **Standard Deviation:** 0.040 **MDL:** 0.240
Limit: 0.600 **Limit:** 0.240 **MRL:** 0.600

Analyte: Fe(F1)

Sample	Result	Units
B162114-BLK1	2.57	mg/kg wet
B162114-BLK2	9.15	mg/kg wet
B162114-BLK3	5.20	mg/kg wet
B162114-BLK4	16.8	mg/kg wet

Average: 8.425 **Standard Deviation:** 6.192 **MDL:** 27.0
Limit: 54.000 **Limit:** 27.000 **MRL:** 54.0

Analyte: Mn(F1)

Sample	Result	Units
B162114-BLK1	0.263	mg/kg wet
B162114-BLK2	0.299	mg/kg wet
B162114-BLK3	0.298	mg/kg wet
B162114-BLK4	0.345	mg/kg wet

Average: 0.301 **Standard Deviation:** 0.034 **MDL:** 0.405
Limit: 0.810 **Limit:** 0.405 **MRL:** 0.810

Method Blanks & Reporting Limits

Batch: B162115
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F2)

Sample	Result	Units
B162115-BLK1	0.940	mg/kg wet
B162115-BLK2	0.666	mg/kg wet
B162115-BLK3	0.728	mg/kg wet
B162115-BLK4	0.801	mg/kg wet

Average: 0.784 **Standard Deviation:** 0.118 **MDL:** 1.14
Limit: 2.400 **Limit:** 1.140 **MRL:** 2.40

Analyte: Fe(F2)

Sample	Result	Units
B162115-BLK1	9.61	mg/kg wet
B162115-BLK2	12.2	mg/kg wet
B162115-BLK3	8.28	mg/kg wet
B162115-BLK4	8.26	mg/kg wet

Average: 9.578 **Standard Deviation:** 1.834 **MDL:** 15.0
Limit: 30.000 **Limit:** 15.000 **MRL:** 30.0

Analyte: Mn(F2)

Sample	Result	Units
B162115-BLK1	0.155	mg/kg wet
B162115-BLK2	0.282	mg/kg wet
B162115-BLK3	0.228	mg/kg wet
B162115-BLK4	0.177	mg/kg wet

Average: 0.211 **Standard Deviation:** 0.057 **MDL:** 0.375
Limit: 0.750 **Limit:** 0.375 **MRL:** 0.750

Method Blanks & Reporting Limits

Batch: B162116
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F3)

Sample	Result	Units
B162116-BLK1	0.046	mg/kg wet
B162116-BLK2	0.034	mg/kg wet
B162116-BLK3	0.063	mg/kg wet
B162116-BLK4	0.036	mg/kg wet

Average: 0.045 **Standard Deviation:** 0.013 **MDL:** 0.090
Limit: 0.600 **Limit:** 0.090 **MRL:** 0.600

Analyte: Fe(F3)

Sample	Result	Units
B162116-BLK1	12.9	mg/kg wet
B162116-BLK2	2.87	mg/kg wet
B162116-BLK3	1.22	mg/kg wet
B162116-BLK4	11.8	mg/kg wet

Average: 7.185 **Standard Deviation:** 5.986 **MDL:** 25.5
Limit: 51.000 **Limit:** 25.500 **MRL:** 51.0

Analyte: Mn(F3)

Sample	Result	Units
B162116-BLK1	0.323	mg/kg wet
B162116-BLK2	0.218	mg/kg wet
B162116-BLK3	0.235	mg/kg wet
B162116-BLK4	0.322	mg/kg wet

Average: 0.274 **Standard Deviation:** 0.056 **MDL:** 0.450
Limit: 0.900 **Limit:** 0.450 **MRL:** 0.900

Method Blanks & Reporting Limits

Batch: B162117
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F4)

Sample	Result	Units
B162117-BLK1	0.061	mg/kg wet
B162117-BLK2	0.020	mg/kg wet
B162117-BLK3	0.108	mg/kg wet
B162117-BLK4	0.081	mg/kg wet

Average: 0.068 **Standard Deviation:** 0.037 **MDL:** 0.180
Limit: 0.600 **Limit:** 0.180 **MRL:** 0.600

Analyte: Fe(F4)

Sample	Result	Units
B162117-BLK1	7.13	mg/kg wet
B162117-BLK2	6.96	mg/kg wet
B162117-BLK3	16.6	mg/kg wet
B162117-BLK4	6.93	mg/kg wet

Average: 9.401 **Standard Deviation:** 4.787 **MDL:** 7.35
Limit: 14.700 **Limit:** 7.350 **MRL:** 14.7

Analyte: Mn(F4)

Sample	Result	Units
B162117-BLK1	1.65	mg/kg wet
B162117-BLK2	1.35	mg/kg wet
B162117-BLK3	1.54	mg/kg wet
B162117-BLK4	1.56	mg/kg wet

Average: 1.523 **Standard Deviation:** 0.125 **MDL:** 1.95
Limit: 3.900 **Limit:** 1.950 **MRL:** 3.90

Method Blanks & Reporting Limits

Batch: B162118
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F5)

Sample	Result	Units
B162118-BLK1	0.018	mg/kg wet
B162118-BLK2	0.016	mg/kg wet
B162118-BLK3	0.011	mg/kg wet
B162118-BLK4	0.023	mg/kg wet

Average: 0.017	**Standard Deviation:** 0.005	**MDL:** 0.031
Limit: 0.200	**Limit:** 0.031	**MRL:** 0.200

Analyte: Fe(F5)

Sample	Result	Units
B162118-BLK1	1.11	mg/kg wet
B162118-BLK2	1.17	mg/kg wet
B162118-BLK3	4.23	mg/kg wet
B162118-BLK4	1.97	mg/kg wet

Average: 2.119	**Standard Deviation:** 1.461	**MDL:** 6.50
Limit: 13.000	**Limit:** 6.500	**MRL:** 13.0

Analyte: Mn(F5)

Sample	Result	Units
B162118-BLK1	0.089	mg/kg wet
B162118-BLK2	0.077	mg/kg wet
B162118-BLK3	0.131	mg/kg wet
B162118-BLK4	0.104	mg/kg wet

Average: 0.100	**Standard Deviation:** 0.023	**MDL:** 0.170
Limit: 0.340	**Limit:** 0.170	**MRL:** 0.340

Method Blanks & Reporting Limits

Batch: B162114
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F1)

Sample	Result	Units
B162114-BLK1	1.10	µg/L
B162114-BLK2	0.824	µg/L
B162114-BLK3	0.452	µg/L
B162114-BLK4	0.747	µg/L

Average: 0.781 **Standard Deviation:** 0.267 **MDL:** 1.60
Limit: 4.000 **Limit:** 1.600 **MRL:** 4.00

Analyte: Fe(F1)

Sample	Result	Units
B162114-BLK1	17.1	µg/L
B162114-BLK2	61.0	µg/L
B162114-BLK3	34.7	µg/L
B162114-BLK4	112	µg/L

Average: 56.148 **Standard Deviation:** 41.254 **MDL:** 180
Limit: 360.000 **Limit:** 180.000 **MRL:** 360

Analyte: Mn(F1)

Sample	Result	Units
B162114-BLK1	1.76	µg/L
B162114-BLK2	1.99	µg/L
B162114-BLK3	1.99	µg/L
B162114-BLK4	2.30	µg/L

Average: 2.009 **Standard Deviation:** 0.223 **MDL:** 2.70
Limit: 5.400 **Limit:** 2.700 **MRL:** 5.40

Method Blanks & Reporting Limits

Batch: B162115
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F2)

Sample	Result	Units
B162115-BLK1	6.27	µg/L
B162115-BLK2	4.44	µg/L
B162115-BLK3	4.86	µg/L
B162115-BLK4	5.34	µg/L

Average: 5.225	**Standard Deviation:** 0.785	**MDL:** 7.60
Limit: 16.000	**Limit:** 7.600	**MRL:** 16.0

Analyte: Fe(F2)

Sample	Result	Units
B162115-BLK1	64.1	µg/L
B162115-BLK2	81.1	µg/L
B162115-BLK3	55.2	µg/L
B162115-BLK4	55.1	µg/L

Average: 63.853	**Standard Deviation:** 12.234	**MDL:** 100
Limit: 200.000	**Limit:** 100.000	**MRL:** 200

Analyte: Mn(F2)

Sample	Result	Units
B162115-BLK1	1.03	µg/L
B162115-BLK2	1.88	µg/L
B162115-BLK3	1.52	µg/L
B162115-BLK4	1.18	µg/L

Average: 1.404	**Standard Deviation:** 0.378	**MDL:** 2.50
Limit: 5.000	**Limit:** 2.500	**MRL:** 5.00

Method Blanks & Reporting Limits

Batch: B162116
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F3)

Sample	Result	Units
B162116-BLK1	0.307	µg/L
B162116-BLK2	0.225	µg/L
B162116-BLK3	0.419	µg/L
B162116-BLK4	0.240	µg/L

Average: 0.298 **Standard Deviation:** 0.088 **MDL:** 0.600
Limit: 4.000 **Limit:** 0.600 **MRL:** 4.00

Analyte: Fe(F3)

Sample	Result	Units
B162116-BLK1	85.9	µg/L
B162116-BLK2	19.2	µg/L
B162116-BLK3	8.16	µg/L
B162116-BLK4	78.3	µg/L

Average: 47.894 **Standard Deviation:** 39.901 **MDL:** 170
Limit: 340.000 **Limit:** 170.000 **MRL:** 340

Analyte: Mn(F3)

Sample	Result	Units
B162116-BLK1	2.16	µg/L
B162116-BLK2	1.45	µg/L
B162116-BLK3	1.57	µg/L
B162116-BLK4	2.15	µg/L

Average: 1.832 **Standard Deviation:** 0.373 **MDL:** 3.00
Limit: 6.000 **Limit:** 3.000 **MRL:** 6.00

Method Blanks & Reporting Limits

Batch: B162117
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F4)

Sample	Result	Units
B162117-BLK1	0.406	µg/L
B162117-BLK2	0.136	µg/L
B162117-BLK3	0.722	µg/L
B162117-BLK4	0.543	µg/L

Average: 0.452 **Standard Deviation:** 0.247 **MDL:** 1.20
Limit: 4.000 **Limit:** 1.200 **MRL:** 4.00

Analyte: Fe(F4)

Sample	Result	Units
B162117-BLK1	47.5	µg/L
B162117-BLK2	46.4	µg/L
B162117-BLK3	111	µg/L
B162117-BLK4	46.2	µg/L

Average: 62.688 **Standard Deviation:** 31.947 **MDL:** 49.0
Limit: 98.000 **Limit:** 49.000 **MRL:** 98.0

Analyte: Mn(F4)

Sample	Result	Units
B162117-BLK1	11.0	µg/L
B162117-BLK2	9.00	µg/L
B162117-BLK3	10.2	µg/L
B162117-BLK4	10.4	µg/L

Average: 10.155 **Standard Deviation:** 0.833 **MDL:** 13.0
Limit: 26.000 **Limit:** 13.000 **MRL:** 26.0

Method Blanks & Reporting Limits

Batch: B162118
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(F5)

Sample	Result	Units
B162118-BLK1	0.368	µg/L
B162118-BLK2	0.319	µg/L
B162118-BLK3	0.229	µg/L
B162118-BLK4	0.451	µg/L

Average: 0.342 **Standard Deviation:** 0.093 **MDL:** 0.620
Limit: 4.000 **Limit:** 0.620 **MRL:** 4.00

Analyte: Fe(F5)

Sample	Result	Units
B162118-BLK1	22.2	µg/L
B162118-BLK2	23.3	µg/L
B162118-BLK3	84.6	µg/L
B162118-BLK4	39.3	µg/L

Average: 42.383 **Standard Deviation:** 29.225 **MDL:** 130
Limit: 260.000 **Limit:** 130.000 **MRL:** 260

Analyte: Mn(F5)

Sample	Result	Units
B162118-BLK1	1.79	µg/L
B162118-BLK2	1.54	µg/L
B162118-BLK3	2.63	µg/L
B162118-BLK4	2.07	µg/L

Average: 2.009 **Standard Deviation:** 0.466 **MDL:** 3.40
Limit: 6.800 **Limit:** 3.400 **MRL:** 6.80

Sample Containers

Lab ID: 1635047-01
Sample: MWS007-9-10
Comments: originally 1620033-06

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/11/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635047-02
Sample: MWS009-11-12
Comments: originally 1620033-07

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/11/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 2

Lab ID: 1635047-03
Sample: MWS010-12-13
Comments: originally 1620033-05

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/10/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler1

Lab ID: 1635047-04
Sample: MWS012-11.5-12.5
Comments: originally 1620033-08

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/12/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635047-05
Sample: MWS013-12.5-13.5
Comments: originally 1620033-04

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/10/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler1

Sample Containers

Lab ID: 1635047-06
Sample: TBS003-14-15
Comments: originally 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635047-07
Sample: TBS005-17-18
Comments: originally 1620033-18
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635047-08
Sample: TBS007-16.5-17.5
Comments: originally 1620033-20
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 5

Lab ID: 1635047-09
Sample: WCTSD001A-0-10
Comments: originally 1620033-34
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635047-10
Sample: WCTSD001A-40-50
Comments: originally 1620033-35
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Sample Containers

Lab ID: 1635047-11
Sample: WCTSD001B-0-10
Comments: originally 1620033-36

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635047-12
Sample: WCTSD001B-40-50
Comments: originally 1620033-37

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Shipping Containers

Cooler 2

Received: August 26, 2016 10:42
Tracking No: Courier via Courier
Coolant Type: Blue Ice
Temperature: 5.8 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 3

Received: August 26, 2016 10:42
Tracking No: Courier via Courier
Coolant Type: Blue Ice
Temperature: 4.0 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 4

Received: August 26, 2016 10:42
Tracking No: Courier via Courier
Coolant Type: Blue Ice
Temperature: 4.1 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 5

Received: August 26, 2016 10:42
Tracking No: Courier via Courier
Coolant Type: Blue Ice
Temperature: 2.1 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 7

Received: August 26, 2016 10:42
Tracking No: Courier via Courier
Coolant Type: Blue Ice
Temperature: 6.5 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR4

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler1

Received: August 26, 2016 10:42
Tracking No: Courier via Courier
Coolant Type: Blue Ice
Temperature: 5.1 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR4

Custody seals present? No
Custody seals intact? No
COC present? Yes

GSI Water Solutions, Inc.
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s): GSI

Client Contact

Project Name: Parcel 15 - POT

Project # or PO #: 603.002.010

Project Manager: Erin Hughes/Cindy Ryals

Phone #:971-200-8528 and 971-200-8531

Report to email: echughes@gsiws.com, cryals@gsiws.com

Analysis Turnaround Time: ☒ 21 days (STD) ☐ 14 days * ☐ 7 days * ☐ 5 days * ☐ 3 day * ☐ 2 days * ☐ 1 day *

For Lab Use Only:

SDG:___

Custody Seals intact? ☐ Yes ☐ No

Hand delivered? ☐ Yes ☐ No

Cooler Temp :____°C

Therm ID No.:____Therm Exp.____

Laboratory: Brooks Applied Labs / TestAmerica

Lab PM: *Brooks- Ben Wozniak- 206-753-6158*; *TestAmerica - Christabel Escarez- 253.248.4975*

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
MWS005R-10.5-11.5	5/9/16	1445	G	S	1	X	X	X	X				X	X	X	X				
MWS008-11.5-12.5	↓	1650	G	S	1	X	X	X	X				X	X						
MWS011-13-14	5/10/16	925	G	S	1	X	X	X	X				X	X						
MWS013-12.5-13.5	↓	1135	G	S	1	X	X	X	X	X	X	X	X	X			X	X		
MWS010-12-13	↓	1505	G	S	1	X	X	X	X	X	X	X	X	X			X	X		

Possible Hazard Identification:

Are samples hazardous? ☐ Yes ☒ No

If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic

If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal **(A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)**

☐ Return to Client ☐ Disposal by Lab ☒ Archive for 1 yr + contact GSI

Received by: Mark McDonald Date/Time: 5/11/16 10:00

Relinquished by: Peter Pellegrini – GSI Date/Time: 5-11-16 : 1000

Received by: Date/Time: 5/11/16 14:30

Relinquished by: Date/Time:

Received in Laboratory by: Date/Time:

Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other Tracking #:

Special Instructions/QC Requirements

*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquotes for analysis at Brooks and Test America.**
**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**
***** Sample cores have been packaged anoxically and will be held under frozen archival at Test America for potential future analysis.**
Please contact Cindy Ryals at 971-200-8531 with any questions.

See SAP tables A-3 + A-5

GSI Water Solutions, Inc.
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s): GSI

Client Contact
Project Name: Parcel 15 - POT
Project # or PO #: 603.002.010
Project Manager: Erin Hughes/Cindy Ryals
Phone #:971-200-8528 and 971-200-8531
Report to email: echughes@gsiws.com, cryals@gsiws.com

For Lab Use Only:
SDG:___
Custody Seals intact? ☐ Yes ☐ No
Hand delivered? ☐ Yes ☐ No
Cooler Temp :____°C
Therm ID No.:____Therm Exp.____

Analysis Turnaround Time: ☐ 21 days (STD)
☐ 14 days * ☐ 7 days * ☐ 5 days * See
☐ 3 day * ☐ 2 days * ☐ 1 day * contract

Laboratory: Brooks Applied Labs | TestAmerica
Analysis Requested

Lab PM
Brooks- Ben Wozniak- 206-753-6158
TestAmerica - Christabel Escarez- 253.248.4975

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
MWS007-9-10	5/11/16	940	G	S	1	X	X	X	X	X	X	X	X	X			X	X		
MWS009-11-12	↓	1435	|	|	|	X	X	X	X	X	X	X	X	X			X	X		
MWS012-11.5-12.5	5/12/16	1000	|	|	|	X	X	X	X	X	X	X	X	X			X	X		
TBS006-13-14	|	1325	|	|	|	X	X	X	X				X	X						no liner present - only soil
TBS004-12-13	↓	1640	↓	↓	↓	X	X	X	X				X	X						
TBS008-13-14	5/13/16	915	G	S	1	X	X	X	X				X	X						
TBS009-7.4-8.4	↓	1215	↓	↓	↓	X	X	X	X				X	X	X			X		
TBS009-8.8-9.8	5/13/16	1220	G	S	1	X	X	X	X				X	X	X			X		
TBS009-12-13	↓	1225	↓	↓	↓	X	X	X	X				X	X	X			X		

Possible Hazard Identification:
Are samples hazardous? ☐ Yes ☒ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic
If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal (A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)
☐ Return to Client ☐ Disposal by Lab ☒ Archive for 1 yr + contact GSI

Received by: Mark McDonald Date/Time: 5/13/16 1525
Relinquished by: Renee Fowler, GSI Date/Time: 5/13/16 1525
Received by: Date/Time:
Relinquished by: Date/Time:
Received in Laboratory by: Jen Waller Date/Time: 5/13/16 17:05
Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other Tracking #:

Special Instructions/QC Requirements
*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquotes for analysis at Brooks and Test America.**
**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**
***** Sample cores have been packaged anoxically and will be held under frozen archival at Test America for potential future analysis.**
Please contact Cindy Ryals at 971-200-8531 with any questions.

See SAP Tables ~~[illegible]~~ RF
A-3 + A-4

GSI Water Solutions, Inc.

55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s): GSI

Client Contact

Project Name: Parcel 15 - POT

Project # or PO #: 603.002.010

Project Manager: Erin Hughes/Cindy Ryals

Phone #:971-200-8528 and 971-200-8531

Report to email: echughes@gsiws.com, cryals@gsiws.com

For Lab Use Only:

SDG:___

Custody Seals intact? ☐ Yes ☐ No

Hand delivered? ☐ Yes ☐ No

Cooler Temp :____°C

Therm ID No.:____Therm Exp.____

Analysis Turnaround Time: ☐ 21 days (STD)

☐ 14 days * ☐ 7 days * ☐ 5 days * See contract

☐ 3 day * ☐ 2 days * ☐ 1 day *

Laboratory: Brooks Applied Labs | TestAmerica

Lab PM: Brooks- Ben Wozniak- 206-753-6158 | TestAmerica - Christabel Escarez- 253.248.4975

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
TBS001-~~10.5-11.5~~ RF 11-12	5/16/16	1115	G	S	1	X	X	X	X				X	X						
TBS002-12.5-13.5	↓	1400	↓	↓	↓	X	X	X	X				X	X						
TBS003-14-15	5/17/16	925				X	X	X	X	X	X	X	X	X			X	X		
~~TBS003-1~~ ECH	~~5/17/16~~	~~1000~~																		
TBS005-17-18	5/17/16	1155	G	S	1	X	X	X	X	X	X	X	X	X			X	X		
TPS002-0.5-1.5	↓	1410	↓	↓	↓	X	X	X	X	X	X	X	X	X	X	X	~~X~~	~~X~~		RF no sulfide + grain size
TBS007-16.5-17.5		1520				X	X	X	X	X	X	X	X	X			X	X		
TPS001-0.5-1.5		1720				X	X	X	X	X	X	X	X	X	X	X				
TPS001F-1.5-2.5		1730				X	X	X	X	X	X	X	X	X	X	X				
TPS002-10.5-12.5	5/17/16	1530	G	S	1	X	X	X	X				X	X	X					

Possible Hazard Identification:

Are samples hazardous? ☐ Yes ☒ No

If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic

If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal **(A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)**

☐ Return to Client ☐ Disposal by Lab ☒ Archive for 1 yr + contact GSI

Relinquished by: Erin Hughes Date/Time: 5/18/16 8:15

Received by: Chris Bygsch Date/Time: 5/18/16 8:15am

Relinquished by: Chris Date/Time: 5/18/16 10:45

Received by: Date/Time: 5/18/16 10:45

Relinquished by: Date/Time:

Received in Laboratory by: Date/Time:

Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other Tracking #:

Special Instructions/QC Requirements

*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquotes for analysis at Brooks and Test America.**

**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**

***** Sample cores have been packaged anoxically and will be held under frozen archival at Test America for potential future analysis.**

Please contact Cindy Ryals at 971-200-8531 with any questions.

GSI Water Solutions, Inc.
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

page 1 of 2

Chain of Custody Record

Field Sampler(s): GSI

Client Contact	
Project Name: Parcel 15 - POT	
Project # or PO #: 603.002.010	
Project Manager: Erin Hughes/Cindy Ryals	
Phone #:971-200-8528 and 971-200-8531	
Report to email: echughes@gsiws.com, cryals@gsiws.com	

For Lab Use Only:
SDG:___
Custody Seals intact? ☐ Yes ☐ No
Hand delivered? ☐ Yes ☐ No
Cooler Temp :____°C
Therm ID No.:____Therm Exp.____

Analysis Turnaround Time:
☐ 21 days (STD)
☐ 14 days * ☐ 7 days * ☐ 5 days *
☐ 3 day * ☐ 2 days * ☐ 1 day *
See contract

Laboratory: [✓ Brooks Applied Labs] TestAmerica

Lab PM
Brooks- Ben Wozniak- 206-753-6158
TestAmerica - Christabel Escarez- 253.248.4975

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
~~TB~~ ~~FB~~ TPS001TB-12_13	5/18/16	920		soil	1	X	X	X	X				X	X	X					
WCTSD004B-0_10	5/18/16	10:15		sed	1	X	X	X	X				X	X	X		X			
WCTSD003A-0_10	5/18/16	11:00		sed	1	X	X	X	X				X	X			X			
WCTSD003A-40_50	5/18/16	11:05		sed	1	X	X	X	X				X	X			X			
WCTSD003B-0_10	5/18/16	1110		sed	1	X	X	X	X				X	X			X			
WCTSD003B-40_50	5/18/16	1130		sed	1	X	X	X	X				X	X			X			
WCTSD002A-0_10	↓	1200		↓	↓	X	X	X	X				X	X			X			
WCTSD002A-36_46		1210				X	X	X	X				X	X			X			
WCTSD002B-0_10		1220				X	X	X	X				X	X			X			
WCTSD002B-40_50		1230				X	X	X	X				X	X			X			
WCTSD001A-0_10		1240				X	X	X	X				X	X			X			
WCTSD001A-40_50		1245				X	X	X	X				X	X			X			
WCTSD001B-0_10		1250				X	X	X	X				X	X			X			

Possible Hazard Identification:
Are samples hazardous? ☐ Yes ☒ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic
If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal **(A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)**
☐ Return to Client ☐ Disposal by Lab ☒ Archive for 1 yr + contact GSI

Received by:	Date/Time: 5/20/16 8:15am	Relinquished by: GSI	Date/Time: 5/20/16 815
Received by:	Date/Time:	Relinquished by:	Date/Time: 5/20/16 956
Received in Laboratory by:	Date/Time: 5/20/16 9:30	Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other	Tracking #:

Special Instructions/QC Requirements
*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquotes for analysis at Brooks and Test America.**
**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**
***** Sample cores have been packaged anoxically and will be held under frozen archival at Test America for potential future analysis.**
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GSI Water Solutions, Inc.
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

page 2 of 2

Chain of Custody Record

Field Sampler(s): GSI

Client Contact	**For Lab Use Only:**
Project Name: Parcel 15 - POT	SDG:___
Project # or PO #: 603.002.010	Custody Seals intact? ☐ Yes ☐ No
Project Manager: Erin Hughes/Cindy Ryals	Hand delivered? ☐ Yes ☐ No
Phone #:971-200-8528 and 971-200-8531	Cooler Temp :____°C
Report to email: echughes@gsiws.com, cryals@gsiws.com	Therm ID No.:____Therm Exp.____
Analysis Turnaround Time: ☐ 21 days (STD) ☐ 14 days * ☐ 7 days * ☐ 5 days * ☐ 3 day * ☐ 2 days * ☐ 1 day * See contract	

Laboratory: Brooks Applied Labs | TestAmerica

Lab PM:
Brooks- Ben Wozniak- 206-753-6158
TestAmerica - Christabel Escarez- 253.248.4975

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
WCTSD001B-40-50	5/18/16	1255	G	sed	1	X	X	X	X				X	X			X			
WCTSD004A-40-50	↓	1340	↓	↓	↓	X	X	X	X				X	X	X		X			
WCTSD004B-40-50	↓	1345	↓	↓	↓	X	X	X	X				X	X	X		X			
WCTSD004A-0-10	↓	1350	↓	↓	↓	X	X	X	X				X	X	X		X			

Possible Hazard Identification:
Are samples hazardous? ☐ Yes ☒ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic
If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal **(A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)**
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Received by:	Date/Time: 5/20/16 8:15am	Relinquished by: GSI	Date/Time: 5/20/16 815
Received by:	Date/Time:	Relinquished by:	Date/Time: 5/20/16 9:56am
Received in Laboratory by:	Date/Time: 5/20/16 9:30	Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other	Tracking #:

Special Instructions/QC Requirements
*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquotes for analysis at Brooks and Test America.**
**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**
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Please contact Cindy Ryals at 971-200-8531 with any questions.

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Tel: (253)922-2310

TestAmerica Job ID: 580-62377-1
Client Project/Site: Parcel 15, Event I

For:
GSI Water Solutions, Inc
55 SW Yamhill Street
Suite 300
Portland, Oregon 97204

Attn: Cindy Ryals

Authorized for release by:
9/26/2016 3:43:00 PM

Christabel Escarez, Project Manager I
(253)922-2310
christabel.escarez@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Client: GSI Water Solutions, Inc
Project/Site: Parcel 15, Event I

TestAmerica Job ID: 580-62377-1

Job ID: 580-62377-1

Laboratory: TestAmerica Seattle

Narrative

Job Narrative
580-62377-1

Receipt
The samples were received on 9/9/2016 5:05 PM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 9.9º C.

Receipt Exceptions
The following samples were received at the laboratory outside the required temperature criteria: MWS007-9-10 F1 (580-62377-1), MWS009-11-12 F1 (580-62377-2), MWS010-]12□-13 F1 (580-62377-3), MWS012-11.5-12.5 F1 (580-62377-4), MWS013-12.5-13.5 F1 (580-62377-5), TBS003□-14□-15 F1 (580-62377-6), TBS005-17-18 F1 (580-62377-7), TBS007-16.5-17.5 F1 (580-62377-8), WCTSD001A□-0□-1 F1 (580-62377-9), WCTSD001A-40-50 F1 (580-62377-10), WCTSD001B-0-10 F1 (580-62377-11), WCTSD001B□-40□-50 F1 (580-62377-12) and Method Blank - F1 (580-62377-13).

A Chain-of-Custody (COC) was not received with these samples: MWS007-9-10 F1 (580-62377-1), MWS009-11-12 F1 (580-62377-2), MWS010-]12□-13 F1 (580-62377-3), MWS012-11.5-12.5 F1 (580-62377-4), MWS013-12.5-13.5 F1 (580-62377-5), TBS003□-14□-15 F1 (58 62377-6), TBS005-17-18 F1 (580-62377-7), TBS007-16.5-17.5 F1 (580-62377-8), WCTSD001A□-0□-10 F1 (580-62377-9), WCTSD001A-40 -50 F1 (580-62377-10), WCTSD001B-0-10 F1 (580-62377-11), WCTSD001B□-40□-50 F1 (580-62377-12) and Method Blank - F1 (580-62377-13). The client was contacted and a COC was provided on 9/9/16.

The Chain-of-Custody (COC) was incomplete as received. No sample times were listed on the COC. Sample times were taken from container labels.

General Chemistry
Method(s) 300.0: Due to the high level of chloride a 1000X dilution was utilized for the following samples to prevent damage to the instrument: MWS007-9-10 F1 (580-62377-1), MWS009-11-12 F1 (580-62377-2), MWS010-]12□-13 F1 (580-62377-3), MWS012-11.5-12.5 F1 (580-62377-4), MWS013-12.5-13.5 F1 (580-62377-5), TBS003□-14□-15 F1 (580-62377-6), TBS005-17-18 F1 (580-62377-7), TBS007-16.5-17.5 F1 (580-62377-8), WCTSD001A□-0□-10 F1 (580-62377-9), WCTSD001A-40-50 F1 (580-62377-10), WCTSD001B-0-10 F1 (580-62377-11), WCTSD001B□-40□-50 F1 (580-62377-12) and Method Blank - F1 (580-62377-13). As such, any low concentration of sulfate may have been dliuted out of the samples.

Method(s) 9034: Insufficient sample volume for Sulfide was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 280-342086 and analytical batch 280-342149.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client Sample ID: MWS007-9-10 F1
Lab Sample ID: 580-62377-1

Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 14:14	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample Results

Client Sample ID: MWS009-11-12 F1

Lab Sample ID: 580-62377-2

Date Collected: 09/08/16 14:55

Matrix: Water

Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 14:33	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample Results

Client Sample ID: MWS010-]12-13 F1

Lab Sample ID: 580-62377-3

Date Collected: 09/08/16 14:55

Matrix: Water

Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 14:51	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample ID: MWS012-11.5-12.5 F1

Lab Sample ID: 580-62377-4

Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 15:46	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample Results

Client Sample ID: MWS013-12.5-13.5 F1
Lab Sample ID: 580-62377-5
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 16:05	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample ID: TBS003-14-15 F1
Lab Sample ID: 580-62377-6
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 16:23	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample ID: TBS005-17-18 F1
Lab Sample ID: 580-62377-7
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 16:41	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample ID: TBS007-16.5-17.5 F1

Lab Sample ID: 580-62377-8

Date Collected: 09/08/16 14:55

Matrix: Water

Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 17:00	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

1 2 3 4 5 6 7 8 9 10 11

Client Sample ID: WCTSD001A□-0-10 F1

Lab Sample ID: 580-62377-9

Date Collected: 09/08/16 14:55

Matrix: Water

Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 17:18	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample ID: WCTSD001A-40-50 F1
Lab Sample ID: 580-62377-10
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 17:37	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample ID: WCTSD001B-0-10 F1
Lab Sample ID: 580-62377-11
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 17:55	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample Results

Client: GSI Water Solutions, Inc
TestAmerica Job ID: 580-62377-1
Project/Site: Parcel 15, Event I

Client Sample ID: WCTSD001B□-40-50 F1
Lab Sample ID: 580-62377-12
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 18:13	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

Client Sample ID: Method Blank – F1 **Lab Sample ID: 580-62377-13**
Date Collected: 09/08/16 14:55 **Matrix: Water**
Date Received: 09/09/16 14:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1200	260	mg/L			09/14/16 18:32	1000
Sulfide	ND		20	4.0	mg/L		09/14/16 11:12	09/14/16 15:36	1

QC Sample Results

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 580-227554/3
Matrix: Water
Analysis Batch: 227554

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1.2	0.26	mg/L			09/14/16 11:10	1

Lab Sample ID: LCS 580-227554/4
Matrix: Water
Analysis Batch: 227554

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfate	50.0	51.5		mg/L		103	90 - 110

Lab Sample ID: LCSD 580-227554/5
Matrix: Water
Analysis Batch: 227554

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Sulfate	50.0	51.7		mg/L		103	90 - 110	0	15

Method: 9034 - Sulfide, Acid Soluble and Insoluble (Titrimetric)

Lab Sample ID: MB 280-342086/1-A
Matrix: Water
Analysis Batch: 342149

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 342086

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		4.0	0.79	mg/L		09/14/16 11:12	09/14/16 15:36	1

Lab Sample ID: LCS 280-342086/2-A
Matrix: Water
Analysis Batch: 342149

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 342086

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfide	19.9	11.2		mg/L		56	50 - 106

Lab Sample ID: LCSD 280-342086/3-A
Matrix: Water
Analysis Batch: 342149

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 342086

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Sulfide	19.9	10.2		mg/L		51	50 - 106	9	20

Lab Chronicle

Client: GSI Water Solutions, Inc
TestAmerica Job ID: 580-62377-1
Project/Site: Parcel 15, Event I

Client Sample ID: MWS007-9-10 F1
Lab Sample ID: 580-62377-1
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 14:14	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: MWS009-11-12 F1
Lab Sample ID: 580-62377-2
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 14:33	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: MWS010-]12-13 F1
Lab Sample ID: 580-62377-3
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 14:51	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: MWS012-11.5-12.5 F1
Lab Sample ID: 580-62377-4
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 15:46	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: MWS013-12.5-13.5 F1
Lab Sample ID: 580-62377-5
Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 16:05	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: TBS003-14-15 F1

Lab Sample ID: 580-62377-6

Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 16:23	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: TBS005-17-18 F1

Lab Sample ID: 580-62377-7

Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 16:41	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: TBS007-16.5-17.5 F1

Lab Sample ID: 580-62377-8

Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 17:00	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: WCTSD001A□-0-10 F1

Lab Sample ID: 580-62377-9

Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 17:18	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: WCTSD001A-40-50 F1

Lab Sample ID: 580-62377-10

Date Collected: 09/08/16 14:55
Matrix: Water
Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 17:37	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Lab Chronicle

Client Sample ID: WCTSD001B-0-10 F1

Lab Sample ID: 580-62377-11

Date Collected: 09/08/16 14:55

Matrix: Water

Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 17:55	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: WCTSD001B□-40-50 F1

Lab Sample ID: 580-62377-12

Date Collected: 09/08/16 14:55

Matrix: Water

Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 18:13	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Client Sample ID: Method Blank – F1

Lab Sample ID: 580-62377-13

Date Collected: 09/08/16 14:55

Matrix: Water

Date Received: 09/09/16 14:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		1000	227554	09/14/16 18:32	RSB	TAL SEA
Total/NA	Prep	9030B			342086	09/14/16 11:12	NJF	TAL DEN
Total/NA	Analysis	9034		1	342149	09/14/16 15:36	NJF	TAL DEN

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TAL SEA = TestAmerica Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Certification Summary

Client: GSI Water Solutions, Inc
Project/Site: Parcel 15, Event I

Laboratory: TestAmerica Seattle

The certifications listed below are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Washington	State Program	10	C553	02-17-17

Laboratory: TestAmerica Denver

The certifications listed below are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Washington	State Program	10	C583	08-03-17

Sample Summary

Client: GSI Water Solutions, Inc
Project/Site: Parcel 15, Event I

TestAmerica Job ID: 580-62377-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
580-62377-1	MWS007-9-10 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-2	MWS009-11-12 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-3	MWS010-]12-13 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-4	MWS012-11.5-12.5 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-5	MWS013-12.5-13.5 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-6	TBS003-14-15 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-7	TBS005-17-18 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-8	TBS007-16.5-17.5 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-9	WCTSD001A□-0-10 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-10	WCTSD001A-40-50 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-11	WCTSD001B-0-10 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-12	WCTSD001B□-40-50 F1	Water	09/08/16 14:55	09/09/16 14:00
580-62377-13	Method Blank – F1	Water	09/08/16 14:55	09/09/16 14:00

BROOKS APPLIED LABS

Chain-of-Custody Form

For BRL use only

Received by:

Date:

Work Order ID:

Time:

Project ID:

Client: GSI Water Solutions

Contact: Cindy Ryals

Client Project ID: Parcel 15, Event 1

Test America PM: Christabel Escarez

PO Number:

Phone: 971-200-8531

Email: cryals@gsiws.com

Mailing Address:

Requested TAT (business days)

☐ 20 (standard)
☐ 15*
☐ 10*
☐ 5*
☐ Other ___

**Surcharges may apply to expedited TATs*

		Collection		Client Sample Info				Analyses Required								Comments
	Sample ID	Date	Time	Matrix Type	Number of Containers	Field Filtered? *(Yes/No)*	Other *(specify)*	Sulfide	Sulfate	Other *(specify)*	Other *(specify)*	Other *(specify)*	Other *(specify)*	Other *(specify)*	Other *(specify)*	*Specify Here*
1	MWS007-9-10 F1	9/8/16		1M MgCl2	2	Y		X	X							
2	MWS009-11-12 F1	9/8/16		1M MgCl2	2	Y		X	X							
3	MWS010-12-13 F1	9/8/16		1M MgCl2	2	Y		X	X							
4	MWS012-11.5-12.5 F1	9/8/16		1M MgCl2	2	Y		X	X							
5	MWS013-12.5-13.5 F1	9/8/16		1M MgCl2	2	Y		X	X							
6	TBS003-14-15 F1	9/8/16		1M MgCl2	2	Y		X	X							
7	TBS005-17-18 F1	9/8/16		1M MgCl2	2	Y		X	X							
8	TBS007-16.5-17.5 F1	9/8/16		1M MgCl2	2	Y		X	X							
9	WCTSD001A-0-10 F1	9/8/16		1M MgCl2	2	Y		X	X							
10	WCTSD001A-40-50 F1	9/8/16		1M MgCl2	2	Y		X	X							

Relinquished By:	Date: 9/9/16	Time: 14:00	Relinquished By:	Date:	Time:
Received By:	Date: 9/9/16	Time: 1400	Total Number of Packages:		

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BROOKS APPLIED LABS

Chain-of-Custody Form

For BRL use only

Received by: 　Date:

Work Order ID: 　Time:

Project ID:

Client: GSI Water Solutions

Contact: Cindy Ryals

Client Project ID: Parcel 15, Event 1

Test America PM: Christabel Escarez

PO Number:

Phone: 971-200-8531

Email: cryals@gsiws.com

Mailing Address:

Requested TAT (business days)

- ☐ 20 (standard)
- ☐ 15*
- ☐ 10*
- ☐ 5*
- ☐ Other ____

*Surcharges may apply to expedited TATs

		Collection		Client Sample Info				Analyses Required								Comments
	Sample ID	Date	Time	Matrix Type	Number of Containers	Field Filtered? (Yes/No)	Other (specify)	Sulfide	Sulfate	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Specify Here
1	WCTSD001B-0-10 F1	9/8/16		1M MgCl2	2	Y		X	X							
2	WCTSD001B-40-50 F1	9/8/16		1M MgCl2	2	Y		X	X							
3	Method Blank – F1	9/8/16		1M MgCl2	2	Y		X	X							
4																
5																
6																
7																
8																
9																
10																

Relinquished By:	Date: 9/9/16	Time: 14:00	Relinquished By:	Date:	Time:
Received By:	Date: 9/9/16	Time: 1400	Total Number of Packages:		

Page_2_of_2___

TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Phone (253) 922-2310 Fax (253) 922-5047

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Escarez, Christabel C	Carrier Tracking No(s):	COC No: 580-40669.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: christabel.escarez@testamericainc.com		Page: Page 1 of 2
Company: TestAmerica Laboratories, Inc.		**Analysis Requested**		Job #: 580-62377-1
Address: 4955 Yarrow Street,	**Due Date Requested:** 9/25/2016			
City: Arvada	**TAT Requested (days):**			
State, Zip: CO, 80002				
Phone: 303-736-0100(Tel) 303-431-7171(Fax)	PO #:			
Email:	WO #:			
Project Name: Parcel 15, Event I	Project #: 58009703			
Site:	SSOW#:			

Preservation Codes:
- A - HCL
- B - NaOH
- C - Zn Acetate
- D - Nitric Acid
- E - NaHSO4
- F - MeOH
- G - Amchlor
- H - Ascorbic Acid
- I - Ice
- J - DI Water
- K - EDTA
- L - EDA
- M - Hexane
- N - None
- O - AsNaO2
- P - Na2O4S
- Q - Na2SO3
- R - Na2S2O3
- S - H2SO4
- T - TSP Dodecahydrate
- U - Acetone
- V - MCAA
- W - pH 4-5
- Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	**Sample Date**	**Sample Time**	**Sample Type** (C=comp, G=grab)	**Matrix** (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	**Field Filtered Sample (Yes or No)**	**Perform MS/MSD (Yes or No)**	9034/9030B Total sulfides (from seq. extracts)	**Total Number of containers**	**Special Instructions/Note:**
				Preservation Code:					
MWS007-9-10 F1 (580-62377-1)	9/8/16	14:55 Pacific		Water			X	1	
MWS009-11-12 F1 (580-62377-2)	9/8/16	14:55 Pacific		Water			X	1	
MWS010-]12-13 F1 (580-62377-3)	9/8/16	14:55 Pacific		Water			X	1	
MWS012-11.5-12.5 F1 (580-62377-4)	9/8/16	14:55 Pacific		Water			X	1	
MWS013-12.5-13.5 F1 (580-62377-5)	9/8/16	14:55 Pacific		Water			X	1	
TBS003-14-15 F1 (580-62377-6)	9/8/16	14:55 Pacific		Water			X	1	
TBS005-17-18 F1 (580-62377-7)	9/8/16	14:55 Pacific		Water			X	1	
TBS007-16.5-17.5 F1 (580-62377-8)	9/8/16	14:55 Pacific		Water			X	1	
WCTSD001A-0-10 F1 (580-62377-9)	9/8/16	14:55 Pacific		Water			X	1	
WCTSD001A-40-50 F1 (580-62377-10)	9/8/16	14:55 Pacific		Water			X	1	
WCTSD001B-0-10 F1 (580-62377-11)	9/8/16	14:55 Pacific		Water			X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ________ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)
Primary Deliverable Rank: 2

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by: Tom Blank	Date/Time: 9/9/16	Company: TA-Sea	Received by:	Date/Time: 9/13/16 0935	Company: TAD
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

3.1 +0 0 TC+ [illegible]

TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Phone (253) 922-2310 Fax (253) 922-5047

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)

Sampler:

Lab PM: Escarez, Christabel C

Carrier Tracking No(s):

COC No: 580-40669.2

Client Contact: Shipping/Receiving

Phone:

E-Mail: christabel.escarez@testamericainc.com

Page: Page 2 of 2

Company: TestAmerica Laboratories, Inc.

Job #: 580-62377-1

Address: 4955 Yarrow Street,

Due Date Requested: 9/25/2016

City: Arvada

TAT Requested (days):

State, Zip: CO, 80002

Phone: 303-736-0100(Tel) 303-431-7171(Fax)

PO #:

Email:

WO #:

Project Name: Parcel 15, Event I

Project #: 58009703

Site:

SSOW#:

Analysis Requested

Preservation Codes:

A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA

M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9034/9030B Total sulfides (from seq. extracts)	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
WCTSD001B-40-50 F1 (580-62377-12)	9/8/16	14:55 Pacific		Water			X	1	
Method Blank – F1 (580-62377-13)	9/8/16	14:55 Pacific		Water			X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Primary Deliverable Rank: 2

Special Instructions/QC Requirements:

Empty Kit Relinquished by:

Date:

Time:

Method of Shipment:

Relinquished by: Tom	Date/Time: 9/9/16	Company:	Received by:	Date/Time: 9/13/16 0935	Company: TAD
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: Δ Yes Δ No

Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks:

1 2 3 4 5 6 7 8 9 10 11

Login Sample Receipt Checklist

Client: GSI Water Solutions, Inc

Job Number: 580-62377-1

Login Number: 62377

List Source: TestAmerica Seattle

List Number: 1

Creator: Escarez, Christabel C

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	False	Refer to Job Narrative for details.
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	True	

Login Sample Receipt Checklist

Client: GSI Water Solutions, Inc

Job Number: 580-62377-1

Login Number: 62377

List Number: 2

Creator: White, Denise E

List Source: TestAmerica Denver

List Creation: 09/13/16 11:53 AM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	Received project as a subcontract.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Tel: (253)922-2310

TestAmerica Job ID: 580-62510-1
Client Project/Site: Parcel 15, Event 1

For:
GSI Water Solutions, Inc
55 SW Yamhill Street
Suite 300
Portland, Oregon 97204

Attn: Cindy Ryals

Authorized for release by:
9/27/2016 11:42:00 AM

Christabel Escarez, Project Manager I
(253)922-2310
christabel.escarez@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at:
www.testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Job ID: 580-62510-1

Laboratory: TestAmerica Seattle

Narrative

Job Narrative
580-62510-1

Receipt
The samples were received on 9/14/2016 12:40 PM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 8.2º C.

Receipt Exceptions
The following samples were received at the laboratory without a sample collection time documented on the chain of custody: MWS007-9-10 F2 (580-62510-1), MWS009-11-12 F2 (580-62510-2), MWS010-12-13 F2 (580-62510-3), MWS012-11.5-12.5 F2 (580-62510-4), MWS013-12.5-13.5 F2 (580-62510-5), TBS003-14-15 F2 (580-62510-6), TBS005-17-18 F2 (580-62510-7), TBS007-16.5-17.5 F2 (580-62510-8), WCTSD001A-0-10 F2 (580-62510-9), WCTSD001A-40-50 F2 (580-62510-10), WCTSD001B-0-10 F2 (580-62510-11), WCTSD001B-40-50 F2 (580-62510-12) and Method Blank - F2 (580-62510-13). The sample times were taken from container labels.

The following samples were received at the laboratory outside the required temperature criteria: MWS007-9-10 F2 (580-62510-1), MWS009-11-12 F2 (580-62510-2), MWS010-12-13 F2 (580-62510-3), MWS012-11.5-12.5 F2 (580-62510-4), MWS013-12.5-13.5 F2 (580-62510-5), TBS003-14-15 F2 (580-62510-6), TBS005-17-18 F2 (580-62510-7), TBS007-16.5-17.5 F2 (580-62510-8), WCTSD001A-0-10 F2 (580-62510-9), WCTSD001A-40-50 F2 (580-62510-10), WCTSD001B-0-10 F2 (580-62510-11), WCTSD001B-40-50 F2 (580-62510-12) and Method Blank - F2 (580-62510-13).

The reference method requires samples to have a pH of 12 or higher. The following samples were received with a pH of less than 12: MWS007-9-10 F2 (580-62510-1), MWS009-11-12 F2 (580-62510-2), MWS010-12-13 F2 (580-62510-3), MWS012-11.5-12.5 F2 (580-62510-4), MWS013-12.5-13.5 F2 (580-62510-5), TBS003-14-15 F2 (580-62510-6), TBS005-17-18 F2 (580-62510-7), TBS007-16.5-17.5 F2 (580-62510-8), WCTSD001A-0-10 F2 (580-62510-9), WCTSD001A-40-50 F2 (580-62510-10), WCTSD001B-0-10 F2 (580-62510-11), WCTSD001B-40-50 F2 (580-62510-12) and Method Blank - F2 (580-62510-13). 2mL of NaOH (lot#0000021972) and ~83µL of Zinc Acetate (lot#G05146) was added by the laboratory on 9-15-16. The following samples are impacted.

General Chemistry
Method(s) 300.0: The following samples were diluted due to the high level of Phosphate and to prevent damage to the column set: MWS007-9-10 F2 (580-62510-1), MWS009-11-12 F2 (580-62510-2), MWS010-12-13 F2 (580-62510-3), MWS012-11.5-12.5 F2 (580-62510-4), MWS013-12.5-13.5 F2 (580-62510-5), TBS003-14-15 F2 (580-62510-6), TBS005-17-18 F2 (580-62510-7), TBS007-16.5-17.5 F2 (580-62510-8) and WCTSD001A-0-10 F2 (580-62510-9)

Method(s) 300.0: The following samples were diluted to prevent damage to the column set due to high analyte levels: WCTSD001A-40-50 F2 (580-62510-10), WCTSD001B-0-10 F2 (580-62510-11), WCTSD001B-40-50 F2 (580-62510-12) and Method Blank - F2 (580-62510-13).

Method(s) 9034: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with Sulfidepreparation batch 280-342761 and analytical batch 280-342791.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Definitions/Glossary

Qualifiers

General Chemistry

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client Sample ID: MWS007-9-10 F2

Lab Sample ID: 580-62510-1

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 18:09	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample Results

Client Sample ID: MWS009-11-12 F2

Lab Sample ID: 580-62510-2

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 18:27	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample ID: MWS010-12-13 F2
Lab Sample ID: 580-62510-3
Date Collected: 09/13/16 16:30
Matrix: Water
Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 18:46	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample ID: MWS012-11.5-12.5 F2
Lab Sample ID: 580-62510-4
Date Collected: 09/13/16 16:30
Matrix: Water
Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 19:04	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample Results

Client Sample ID: MWS013-12.5-13.5 F2

Lab Sample ID: 580-62510-5

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 19:23	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample Results

Client Sample ID: TBS003-14-15 F2

Lab Sample ID: 580-62510-6

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 19:41	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample ID: TBS005-17-18 F2

Lab Sample ID: 580-62510-7

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 19:59	500
Sulfide	**5.6**	**J**	20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample Results

Client Sample ID: TBS007-16.5-17.5 F2

Lab Sample ID: 580-62510-8

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 20:18	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample ID: WCTSD001A-0-10 F2
Date Collected: 09/13/16 16:30
Date Received: 09/14/16 12:40

Lab Sample ID: 580-62510-9
Matrix: Water

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/23/16 20:36	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample ID: WCTSD001A-40-50 F2
Lab Sample ID: 580-62510-10
Date Collected: 09/13/16 16:30
Matrix: Water
Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/26/16 15:32	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample Results

Client Sample ID: WCTSD001B-0-10 F2
Lab Sample ID: 580-62510-11
Date Collected: 09/13/16 16:30
Matrix: Water
Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/26/16 15:50	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample ID: WCTSD001B-40-50 F2
Lab Sample ID: 580-62510-12
Date Collected: 09/13/16 16:30
Matrix: Water
Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/26/16 16:09	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Client Sample ID: Method Blank - F2

Lab Sample ID: 580-62510-13

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		600	130	mg/L			09/26/16 16:27	500
Sulfide	ND		20	4.0	mg/L		09/19/16 14:05	09/19/16 17:01	1

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 580-228320/3
Matrix: Water
Analysis Batch: 228320

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1.2	0.26	mg/L			09/23/16 13:15	1

Lab Sample ID: LCS 580-228320/4
Matrix: Water
Analysis Batch: 228320

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfate	50.0	53.8		mg/L		108	90 - 110

Lab Sample ID: LCSD 580-228320/5
Matrix: Water
Analysis Batch: 228320

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Sulfate	50.0	53.1		mg/L		106	90 - 110	1	15

Lab Sample ID: MB 580-228374/3
Matrix: Water
Analysis Batch: 228374

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1.2	0.26	mg/L			09/26/16 12:57	1

Lab Sample ID: LCS 580-228374/4
Matrix: Water
Analysis Batch: 228374

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfate	50.0	52.6		mg/L		105	90 - 110

Method: 9034 - Sulfide, Acid Soluble and Insoluble (Titrimetric)

Lab Sample ID: MB 280-342761/3-A
Matrix: Water
Analysis Batch: 342791

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 342761

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		4.0	0.79	mg/L		09/19/16 14:05	09/19/16 17:01	1

Lab Sample ID: LCS 280-342761/1-A
Matrix: Water
Analysis Batch: 342791

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 342761

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfide	19.5	14.4		mg/L		74	50 - 106

Method: 9034 - Sulfide, Acid Soluble and Insoluble (Titrimetric) (Continued)

Lab Sample ID: LCSD 280-342761/2-A
Matrix: Water
Analysis Batch: 342791

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 342761

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Sulfide			19.5	12.8		mg/L		66	50 - 106	12	20

Lab Chronicle

Client Sample ID: MWS007-9-10 F2

Lab Sample ID: 580-62510-1

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 18:09	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: MWS009-11-12 F2

Lab Sample ID: 580-62510-2

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 18:27	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: MWS010-12-13 F2

Lab Sample ID: 580-62510-3

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 18:46	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: MWS012-11.5-12.5 F2

Lab Sample ID: 580-62510-4

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 19:04	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: MWS013-12.5-13.5 F2

Lab Sample ID: 580-62510-5

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 19:23	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: TBS003-14-15 F2 **Lab Sample ID: 580-62510-6**

Date Collected: 09/13/16 16:30 **Matrix: Water**

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 19:41	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: TBS005-17-18 F2 **Lab Sample ID: 580-62510-7**

Date Collected: 09/13/16 16:30 **Matrix: Water**

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 19:59	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: TBS007-16.5-17.5 F2 **Lab Sample ID: 580-62510-8**

Date Collected: 09/13/16 16:30 **Matrix: Water**

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 20:18	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: WCTSD001A-0-10 F2 **Lab Sample ID: 580-62510-9**

Date Collected: 09/13/16 16:30 **Matrix: Water**

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228320	09/23/16 20:36	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: WCTSD001A-40-50 F2 **Lab Sample ID: 580-62510-10**

Date Collected: 09/13/16 16:30 **Matrix: Water**

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228374	09/26/16 15:32	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Lab Chronicle

Client Sample ID: WCTSD001B-0-10 F2

Lab Sample ID: 580-62510-11

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228374	09/26/16 15:50	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: WCTSD001B-40-50 F2

Lab Sample ID: 580-62510-12

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228374	09/26/16 16:09	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Client Sample ID: Method Blank - F2

Lab Sample ID: 580-62510-13

Date Collected: 09/13/16 16:30

Matrix: Water

Date Received: 09/14/16 12:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		500	228374	09/26/16 16:27	RSB	TAL SEA
Total/NA	Prep	9030B			342761	09/19/16 14:05	NJF	TAL DEN
Total/NA	Analysis	9034		1	342791	09/19/16 17:01	NJF	TAL DEN

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TAL SEA = TestAmerica Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Certification Summary

Laboratory: TestAmerica Seattle

The certifications listed below are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Washington	State Program	10	C553	02-17-17

Laboratory: TestAmerica Denver

The certifications listed below are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Washington	State Program	10	C583	08-03-17

Sample Summary

Client: GSI Water Solutions, Inc
Project/Site: Parcel 15, Event 1

TestAmerica Job ID: 580-62510-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
580-62510-1	MWS007-9-10 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-2	MWS009-11-12 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-3	MWS010-12-13 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-4	MWS012-11.5-12.5 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-5	MWS013-12.5-13.5 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-6	TBS003-14-15 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-7	TBS005-17-18 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-8	TBS007-16.5-17.5 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-9	WCTSD001A-0-10 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-10	WCTSD001A-40-50 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-11	WCTSD001B-0-10 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-12	WCTSD001B-40-50 F2	Water	09/13/16 16:30	09/14/16 12:40
580-62510-13	Method Blank - F2	Water	09/13/16 16:30	09/14/16 12:40

TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Phone (253) 922-2310 Fax (253) 922-5047

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Escarez, Christabel C	Carrier Tracking No(s):	COC No: 580-40828.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: christabel.escarez@testamericainc.com		Page: Page 1 of 2
Company: TestAmerica Laboratories, Inc.		**Analysis Requested**		Job #: 580-62510-1
Address: 4955 Yarrow Street,	**Due Date Requested:** 9/30/2016			**Preservation Codes:**
City: Arvada	**TAT Requested (days):**			
State, Zip: CO, 80002				
Phone: 303-736-0100(Tel) 303-431-7171(Fax)	PO #:			
Email:	WO #:			
Project Name: Parcel 15, Event 1	Project #: 58009703			
Site:	SSOW#:			Other:

Preservation Codes:
A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9034/9030B Total sulfides (from seq. extracts)	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
MWS007-9-10 F2 (580-62510-1)	9/13/16	16:30 Pacific		Water			X	1	
MWS009-11-12 F2 (580-62510-2)	9/13/16	16:30 Pacific		Water			X	1	
MWS010-12-13 F2 (580-62510-3)	9/13/16	16:30 Pacific		Water			X	1	
MWS012-11.5-12.5 F2 (580-62510-4)	9/13/16	16:30 Pacific		Water			X	1	
MWS013-12.5-13.5 F2 (580-62510-5)	9/13/16	16:30 Pacific		Water			X	1	
TBS003-14-15 F2 (580-62510-6)	9/13/16	16:30 Pacific		Water			X	1	
TBS005-17-18 F2 (580-62510-7)	9/13/16	16:30 Pacific		Water			X	1	
TBS007-16.5-17.5 F2 (580-62510-8)	9/13/16	16:30 Pacific		Water			X	1	
WCTSD001A-0-10 F2 (580-62510-9)	9/13/16	16:30 Pacific		Water			X	1	
WCTSD001A-40-50 F2 (580-62510-10)	9/13/16	16:30 Pacific		Water			X	1	
WCTSD001B-0-10 F2 (580-62510-11)	9/13/16	16:30 Pacific		Water			X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ________ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)
Primary Deliverable Rank: 2
Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:		Method of Shipment:	
Relinquished by: B. Hall	Date/Time: 9.16.16 1530	Company: SEA TA	Received by:	Date/Time: 0845 17Sep16	Company: TAD
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks: 0.4 IRS 0.0 17Sep16

TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Phone (253) 922-2310 Fax (253) 922-5047

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Escarez, Christabel C	Carrier Tracking No(s):	COC No: 580-40828.2
Client Contact: Shipping/Receiving	Phone:	E-Mail: christabel.escarez@testamericainc.com		Page: Page 2 of 2
Company: TestAmerica Laboratories, Inc.				Job #: 580-62510-1
Address: 4955 Yarrow Street,	Due Date Requested: 9/30/2016			
City: Arvada	TAT Requested (days):			
State, Zip: CO, 80002				
Phone: 303-736-0100(Tel) 303-431-7171(Fax)	PO #:			
Email:	WO #:			
Project Name: Parcel 15, Event 1	Project #: 58009703			
Site:	SSOW#:			

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9034/9030B Total sulfides (from seq. extracts)	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
WCTSD001B-40-50 F2 (580-62510-12)	9/13/16	16:30 Pacific		Water			X	1	
Method Blank - F2 (580-62510-13)	9/13/16	16:30 Pacific		Water			X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)
Primary Deliverable Rank: 2
Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by: B. Hall	Date/Time: 9/16/16 1530	Company: SEA TA	Received by:	Date/Time: 0845 17Sep16	Company: TA
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks:

Login Sample Receipt Checklist

Client: GSI Water Solutions, Inc

Job Number: 580-62510-1

Login Number: 62510

List Source: TestAmerica Seattle

List Number: 1

Creator: Escarez, Christabel C

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	True	

Login Sample Receipt Checklist

Client: GSI Water Solutions, Inc

Job Number: 580-62510-1

Login Number: 62510
List Number: 2
Creator: Muniz, Ashley T

List Source: TestAmerica Denver
List Creation: 09/17/16 04:23 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	Received project as a subcontract.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Tel: (253)922-2310

TestAmerica Job ID: 580-62614-1
Client Project/Site: Parcel 15, Event 1

For:
GSI Water Solutions, Inc
55 SW Yamhill Street
Suite 300
Portland, Oregon 97204

Attn: Cindy Ryals

Authorized for release by:
9/30/2016 1:58:37 PM

Christabel Escarez, Project Manager I
(253)922-2310
christabel.escarez@testamericainc.com

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Table of Contents

Job ID: 580-62614-1

Laboratory: TestAmerica Seattle

Narrative

Job Narrative
580-62614-1

Receipt
The samples were received on 9/20/2016 12:07 PM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 12.0º C, which is outside the required temperature range of 0-6 º C. SAmples have been logged in and will be analyzed unless otherwise instructed by the client.

General Chemistry
Method(s) 300.0: Samples MWS007-9-10 F3 (580-62614-1), MWS009-11-12 F3 (580-62614-2), MWS010-12-13 F3 (580-62614-3), MWS012-11.5-12.5 F3 (580-62614-4), MWS013-12.5-13.5 F3 (580-62614-5), TBS003-14-15 F3 (580-62614-6), TBS005-17-18 F3 (580-62614-7), TBS007-16.5-17.5 F3 (580-62614-8), WCTSD001A-0-10 F3 (580-62614-9), WCTSD001A-40-50 F3 (580-62614-10), WCTSD001B-0-10 F3 (580-62614-11), WCTSD001B-40-50 F3 (580-62614-12) and Method Blank - F3 (580-62614-13) were diluted to prevent damage to the column set due to high noted high analyte levels.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Definitions/Glossary

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client Sample Results

Client Sample ID: MWS007-9-10 F3

Lab Sample ID: 580-62614-1

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 16:45	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample ID: MWS009-11-12 F3

Lab Sample ID: 580-62614-2

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 17:04	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample ID: MWS010-12-13 F3

Lab Sample ID: 580-62614-3

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 17:59	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:13	09/26/16 15:28	1

Client Sample ID: MWS012-11.5-12.5 F3
Lab Sample ID: 580-62614-4
Date Collected: 09/19/16 00:00
Matrix: Water
Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 18:17	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample ID: MWS013-12.5-13.5 F3
Lab Sample ID: 580-62614-5

Date Collected: 09/19/16 00:00
Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 18:36	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample Results

Client Sample ID: TBS003-14-15 F3

Lab Sample ID: 580-62614-6

Date Collected: 09/19/16 00:00
Date Received: 09/20/16 12:07
Matrix: Water

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 18:54	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample Results

Client Sample ID: TBS005-17-18 F3

Lab Sample ID: 580-62614-7

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 19:13	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample Results

Client Sample ID: TBS007-16.5-17.5 F3
Lab Sample ID: 580-62614-8
Date Collected: 09/19/16 00:00
Matrix: Water
Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 19:31	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample Results

Client: GSI Water Solutions, Inc
Project/Site: Parcel 15, Event 1

TestAmerica Job ID: 580-62614-1

Client Sample ID: WCTSD001A-0-10 F3

Lab Sample ID: 580-62614-9

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 19:49	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample Results

Client: GSI Water Solutions, Inc

TestAmerica Job ID: 580-62614-1

Project/Site: Parcel 15, Event 1

Client Sample ID: WCTSD001A-40-50 F3

Lab Sample ID: 580-62614-10

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 20:08	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample Results

Client Sample ID: WCTSD001B-0-10 F3
Lab Sample ID: 580-62614-11

Date Collected: 09/19/16 00:00
Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 20:26	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:09	09/26/16 15:28	1

Client Sample Results

Client Sample ID: WCTSD001B-40-50 F3

Lab Sample ID: 580-62614-12

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 20:45	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:13	09/26/16 15:28	1

Client Sample Results

Client Sample ID: Method Blank - F3
Lab Sample ID: 580-62614-13
Date Collected: 09/19/16 00:00
Matrix: Water
Date Received: 09/20/16 12:07

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		120	26	mg/L			09/26/16 21:40	100
Sulfide	ND		20	4.0	mg/L		09/26/16 13:13	09/26/16 15:28	1

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 580-228374/3
Matrix: Water
Analysis Batch: 228374

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		1.2	0.26	mg/L			09/26/16 12:57	1

Lab Sample ID: LCS 580-228374/4
Matrix: Water
Analysis Batch: 228374

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Sulfate			50.0	52.6		mg/L		105	90 - 110		

Method: 9034 - Sulfide, Acid Soluble and Insoluble (Titrimetric)

Lab Sample ID: MB 280-343771/3-A
Matrix: Water
Analysis Batch: 343785

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 343771

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		4.0	0.79	mg/L		09/26/16 13:09	09/26/16 15:28	1

Lab Sample ID: LCS 280-343771/1-A
Matrix: Water
Analysis Batch: 343785

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 343771

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Sulfide			20.0	17.6		mg/L		88	50 - 106		

Lab Sample ID: LCSD 280-343771/2-A
Matrix: Water
Analysis Batch: 343785

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 343771

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Sulfide			20.0	15.2		mg/L		76	50 - 106	15	20

Lab Chronicle

Client Sample ID: MWS007-9-10 F3

Lab Sample ID: 580-62614-1

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 16:45	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: MWS009-11-12 F3

Lab Sample ID: 580-62614-2

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 17:04	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: MWS010-12-13 F3

Lab Sample ID: 580-62614-3

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 17:59	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:13	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: MWS012-11.5-12.5 F3

Lab Sample ID: 580-62614-4

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 18:17	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: MWS013-12.5-13.5 F3

Lab Sample ID: 580-62614-5

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 18:36	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Lab Chronicle

Client Sample ID: TBS003-14-15 F3

Lab Sample ID: 580-62614-6

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 18:54	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: TBS005-17-18 F3

Lab Sample ID: 580-62614-7

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 19:13	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: TBS007-16.5-17.5 F3

Lab Sample ID: 580-62614-8

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 19:31	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: WCTSD001A-0-10 F3

Lab Sample ID: 580-62614-9

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 19:49	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: WCTSD001A-40-50 F3

Lab Sample ID: 580-62614-10

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 20:08	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: WCTSD001B-0-10 F3

Lab Sample ID: 580-62614-11

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 20:26	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:09	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: WCTSD001B-40-50 F3

Lab Sample ID: 580-62614-12

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 20:45	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:13	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Client Sample ID: Method Blank - F3

Lab Sample ID: 580-62614-13

Date Collected: 09/19/16 00:00

Matrix: Water

Date Received: 09/20/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	300.0		100	228374	09/26/16 21:40	RSB	TAL SEA
Total/NA	Prep	9030B			343771	09/26/16 13:13	NJF	TAL DEN
Total/NA	Analysis	9034		1	343785	09/26/16 15:28	NJF	TAL DEN

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TAL SEA = TestAmerica Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Certification Summary

Client: GSI Water Solutions, Inc
Project/Site: Parcel 15, Event 1

TestAmerica Job ID: 580-62614-1

Laboratory: TestAmerica Seattle

The certifications listed below are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Washington	State Program	10	C553	02-17-17

Laboratory: TestAmerica Denver

Unless otherwise noted, all analytes for this laboratory were covered under each certification below.

Authority	Program	EPA Region	Certification ID	Expiration Date
Washington	State Program	10	C583	08-03-17

Analysis Method	Prep Method	Matrix	Analyte

Sample Summary

Client: GSI Water Solutions, Inc
Project/Site: Parcel 15, Event 1

TestAmerica Job ID: 580-62614-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
580-62614-1	MWS007-9-10 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-2	MWS009-11-12 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-3	MWS010-12-13 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-4	MWS012-11.5-12.5 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-5	MWS013-12.5-13.5 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-6	TBS003-14-15 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-7	TBS005-17-18 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-8	TBS007-16.5-17.5 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-9	WCTSD001A-0-10 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-10	WCTSD001A-40-50 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-11	WCTSD001B-0-10 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-12	WCTSD001B-40-50 F3	Water	09/19/16 00:00	09/20/16 12:07
580-62614-13	Method Blank - F3	Water	09/19/16 00:00	09/20/16 12:07

62614

BROOKS APPLIED LABS

Chain-of-Custody Form

For BRL use only

Received by: Date:

Work Order ID: Time:

Project ID:

Client: GSI Water Solutions

Contact: Cindy Ryals

Client Project ID: Parcel 15, Event 1

Test America PM: Christabel Escarez

PO Number:

Phone: 971-200-8531

Email: cryals@gsiws.com

Mailing Address:

Requested TAT (business days)

☐ 20 (standard)
☐ 15*
☐ 10*
☐ 5*
☐ Other ____

*Surcharges may apply to expedited TATs

		Collection		Client Sample Info				Analyses Required								Comments
	Sample ID	Date	Time	Matrix Type	Number of Containers	Field Filtered? (Yes/No)	Other (specify)	Sulfide	Sulfate	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Specify Here
1	MWS007-9-10 F3	9/19/16		0.1M NaOH	2	Y		X	X							
2	MWS009-11-12 F3	9/19/16		0.1M NaOH	2	Y		X	X							
3	MWS010-12-13 F3	9/19/16		0.1M NaOH	2	Y		X	X							
4	MWS012-11.5-12.5 F3	9/19/16		0.1M NaOH	2	Y		X	X							
5	MWS013-12.5-13.5 F3	9/19/16		0.1M NaOH	2	Y		X	X							
6	TBS003-14-15 F3	9/19/16		0.1M NaOH	2	Y		X	X							
7	TBS005-17-18 F3	9/19/16		0.1M NaOH	2	Y		X	X							
8	TBS007-16.5-17.5 F3	9/19/16		0.1M NaOH	2	Y		X	X							
9	WCTSD001A-0-10 F3	9/19/16		0.1M NaOH	2	Y		X	X							
10	WCTSD001A-40-50 F3	9/19/16		0.1M NaOH	2	Y		X	X							

TB ____ Cooler FR1 Cor 12. Unc 12.1 °c
Cooler Dsc Lg Red/white @Lab 1415
Wet/[✓ Packs] Packing other
w/cs

Relinquished By:	Date: 9/20/16	Time: 12:07	Relinquished By:	Date:	Time:
Received By:	Date: 9/20/16	Time: 1207	Total Number of Packages:		

Page_1_of_2__

580-62614 Chain of Custody

BROOKS APPLIED LABS

Chain-of-Custody Form

For BRL use only

Received by: Date:

Work Order ID: Time:

Project ID:

Client: GSI Water Solutions

Contact: Cindy Ryals

Client Project ID: Parcel 15, Event 1

Test America PM: Christabel Escarez

PO Number:

Phone: 971-200-8531

Email: cryals@gsiws.com

Mailing Address:

Requested TAT (business days)

☐ 20 (standard)
☐ 15*
☐ 10*
☐ 5*
☐ Other ____

*Surcharges may apply to expedited TATs

		Collection		Client Sample Info				Analyses Required								Comments
	Sample ID	Date	Time	Matrix Type	Number of Containers	Field Filtered? (Yes/No)	Other (specify)	Sulfide	Sulfate	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Other (specify)	Specify Here
1	WCTSD001B-0-10 F3	9/19/16		0.1M NaOH	2	Y		X	X							
2	WCTSD001B-40-50 F3	9/19/16		0.1M NaOH	2	Y		X	X							
3	Method Blank – F3	9/19/16		0.1M NaOH	2	Y		X	X							
4																
5																
6																
7																
8																
9																
10																

Relinquished By:	Date: 9/20/16	Time: 12:07	Relinquished By:	Date:	Time:
Received By:	Date: 9/20/16	Time: 1207	Total Number of Packages:		

Page_2_of_2___

1 2 3 4 5 6 7 8 9 10 11

TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Phone (253) 922-2310 Fax (253) 922-5047

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Escarez, Christabel C	Carrier Tracking No(s):	COC No: 580-40914.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: christabel.escarez@testamericainc.com		Page: Page 1 of 2
Company: TestAmerica Laboratories, Inc.		**Analysis Requested**		Job #: 580-62614-1
Address: 4955 Yarrow Street,	**Due Date Requested:** 10/6/2016			**Preservation Codes:**
City: Arvada	**TAT Requested (days):**			
State, Zip: CO, 80002				
Phone: 303-736-0100(Tel) 303-431-7171(Fax)	PO #:			
Email:	WO #:			
Project Name: Parcel 15, Event 1	Project #: 58009703			
Site:	SSOW#:			**Other:**

Preservation Codes:
A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9034/9030B Total sulfides (from seq. extracts)	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
MWS007-9-10 F3 (580-62614-1)	9/19/16	Pacific		Water			X	1	
MWS009-11-12 F3 (580-62614-2)	9/19/16	Pacific		Water			X	1	
MWS010-12-13 F3 (580-62614-3)	9/19/16	Pacific		Water			X	1	
MWS012-11.5-12.5 F3 (580-62614-4)	9/19/16	Pacific		Water			X	1	
MWS013-12.5-13.5 F3 (580-62614-5)	9/19/16	Pacific		Water			X	1	
TBS003-14-15 F3 (580-62614-6)	9/19/16	Pacific		Water			X	1	
TBS005-17-18 F3 (580-62614-7)	9/19/16	Pacific		Water			X	1	
TBS007-16.5-17.5 F3 (580-62614-8)	9/19/16	Pacific		Water			X	1	
WCTSD001A-0-10 F3 (580-62614-9)	9/19/16	Pacific		Water			X	1	
WCTSD001A-40-50 F3 (580-62614-10)	9/19/16	Pacific		Water			X	1	
WCTSD001B-0-10 F3 (580-62614-11)	9/19/16	Pacific		Water			X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)
Primary Deliverable Rank: 2
Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:		Time:	Method of Shipment:	
Relinquished by: B Hall	Date/Time: 9.21.16 1425	Company SEA TA	Received by:	Date/Time: 0900 22Sep16	Company TAD
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks: 1.7 IRS 0.0 22Sep16 Transfer AW		

TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Phone (253) 922-2310 Fax (253) 922-5047

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Escarez, Christabel C	Carrier Tracking No(s):	COC No: 580-40914.2
Client Contact: Shipping/Receiving	Phone:	E-Mail: christabel.escarez@testamericainc.com		Page: Page 2 of 2
Company: TestAmerica Laboratories, Inc.		**Analysis Requested**		Job #: 580-62614-1
Address: 4955 Yarrow Street,	**Due Date Requested:** 10/6/2016			**Preservation Codes:**
City: Arvada	**TAT Requested (days):**			
State, Zip: CO, 80002				
Phone: 303-736-0100(Tel) 303-431-7171(Fax)	PO #:			
Email:	WO #:			
Project Name: Parcel 15, Event 1	Project #: 58009703			
Site:	SSOW#:			**Other:**

Preservation Codes:
A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9034/9030B Total sulfides (from seq. extracts)	Total Number of containers	Special Instructions/Note:
				Preservation Code:					
WCTSD001B-40-50 F3 (580-62614-12)	9/19/16	Pacific		Water			X	1	
Method Blank - F3 (580-62614-13)	9/19/16	Pacific		Water			X	1	

Possible Hazard Identification
Unconfirmed

Deliverable Requested: I, II, III, IV, Other (specify)
Primary Deliverable Rank: 2

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ______ Months*

Special Instructions/QC Requirements:

Empty Kit Relinquished by:		Date:	Time:	Method of Shipment:	
Relinquished by: B. Hall	Date/Time: 9.21.16 1425	Company: SEATTA	Received by:	Date/Time: 0900 22Sep16	Company: TA
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks:

Login Sample Receipt Checklist

Client: GSI Water Solutions, Inc

Job Number: 580-62614-1

Login Number: 62614

List Source: TestAmerica Seattle

List Number: 1

Creator: Presley, Kim A

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: GSI Water Solutions, Inc

Job Number: 580-62614-1

Login Number: 62614
List Number: 2
Creator: Muniz, Ashley T

List Source: TestAmerica Denver
List Creation: 09/22/16 01:58 PM

Question	**Answer**	**Comment**
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	Received project as a subcontract.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

BROOKS APPLIED LABS
18804 North Creek Parkway, Ste 100, Bothell, WA 98011 • USA • T: 206 632 6206 F: 206 632 6017 • info@brooksapplied.com

October 25, 2016

GSI Water Solutions, Inc.
ATTN: Erin Carroll Hughes
55 SW Yamhill St. Suite 300
Portland OR 97204
echughes@gsiws.com

RE: Project GSI-PR1601a Waters Client Project: Parcel 15 – POT (603.002.012)

Dear Ms. Carroll Hughes,

On August 16, 2016, Brooks Applied Labs (BAL) received six (6) groundwater samples for use in Batch Adsorption Testing (BAT). The samples were logged-in for the BAT testing and then stored according to BAL SOPs.

In accordance with the email from the client on September 16th, one of the bottles of groundwater submitted for BAT testing was selected for testing for arsenic and iron as described herein. All sample preparation (with the exception of the rotary tumbling) was performed in a glovebox maintained under anoxic conditions.

The original, field-filtered sample was photographed (see Figure 1) and then an aliquot was split off for analysis. This aliquot was identified as *MW007-EZ-BAT Unfiltered* in the attached results table.

A separate aliquot of the original sample was filtered (0.1µm) and photographed (see Figure 2). This fraction was then spiked with 1mg/L of arsenite, photographed again (see Figure 3), and then an aliquot was split off for analysis; the aliquot split for analysis was identified as *MW007-EZ-BAT Spiked* in the attached results table.

The remaining sample aliquot that had been spiked with 1mg/L of arsenite was placed on a rotary tumbler (kept outside the glove box) for the selected equilibration time 48 hours. After tumbling, the sample was photographed again (see Figure 4). An aliquot of the final sample was filtered (0.1µm) for analysis and identified as *MW007-EZ-BAT 0.1µm Spiked 48 hr* in the attached results table. The remaining unfiltered aliquot was identified as *MW007-EZ-BAT Spiked 48 hr* and submitted for analysis.

Each of the four sample splits designated for As and Fe quantitation were acidified to a pH < 2 with nitric acid. Aliquots of each preserved sample were then digested on a hotblock apparatus with aliquots of with nitric and hydrochloric acids. The resulting digests were analyzed for As and Fe via inductively coupled plasma triple quadrupole mass spectrometry (ICP-QQQ-MS). The ICP-QQQ-MS determinative method uses advanced interference removal techniques to ensure accuracy of the sample results. For more information, please visit the *Interference Reduction Technology* section on our website, brooksapplied.com.

Due to the nature of the requested procedure, no quality control was performed during the BAT testing itself. However, quality control (including a matrix duplicate and matrix spike / matrix spike duplicate set) was prepared during the hotblock digestion.

All results were *not* method blank corrected, as described in the calculations section of the relevant BAL SOPs, and were evaluated using reporting limits adjusted to account for sample aliquot size. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

Instances where the matrix spike/matrix spike duplicate (MS/MSD) sets were spiked at a concentration less than 25% of the native sample result, the recoveries were not reported (**NR**) and the MSD RPD is not calculated (**N/C**), as they are not valid indicators of data quality.

All data was reported without qualification, aside from concentration qualifiers, and all other associated quality control results met the acceptance criteria.

BAL, an accredited laboratory, certifies that the reported results of all analyses for which BAL is NELAP accredited meet all NELAP requirements. For more information, please see the *Report Information* page in your report. Please feel free to contact me if you have any questions regarding this report.

Sincerely,

Ben Wozniak

Ben Wozniak
Project Manager
ben@brooksapplied.com

Figure 1 - MW007-EZ-BAT Unfiltered (Original Groundwater)

Figure 2 – 0.1µm Filtered Groundwater (Before Spiking)

Figure 3 – MW007-EZ-BAT Spiked (0.1µm Filtered Groundwater after spiking)

Figure 4 – MW007-EZ-BAT 0.1µm Spiked 48 hr (After Tumbling)

Report Information

Laboratory Accreditation

BAL is accredited by the *National Environmental Laboratory Accreditation Program* (NELAP) through the State of Florida Department of Health, Bureau of Laboratories (E87982) and is certified to perform many environmental analyses. BAL is also certified by many other states to perform environmental analyses. For a current list of our accreditations/certifications, please visit our website at <http://www.brooksapplied.com/resources/certificates-permits/>. Results reported relate only to the samples listed in the report.

Field Quality Control Samples

Please be notified that certain EPA methods require the collection of field quality control samples of an appropriate type and frequency; failure to do so is considered a deviation from some methods and for compliance purposes should only be done with the approval of regulatory authorities. Please see the specific EPA methods for details regarding required field quality control samples.

Common Abbreviations

BAL	Brooks Applied Labs	**MS**	matrix spike
BLK	method blank	**MSD**	matrix spike duplicate
BS	laboratory fortified blank	**ND**	non-detect
CAL	calibration standard	**NR**	non-reportable
CCB	continuing calibration blank	**N/C**	not calculated
CCV	continuing calibration verification	**PS**	post preparation spike
COC	chain of custody record	**REC**	percent recovery
D	dissolved fraction	**RPD**	relative percent difference
DUP	duplicate	**SCV**	secondary calibration verification
IBL	instrument blank	**SOP**	standard operating procedure
ICV	initial calibration verification	**SRM**	standard reference material
MDL	method detection limit	**T**	total fraction
MRL	method reporting limit	**TR**	total recoverable fraction

Definition of Data Qualifiers

(Effective 9/23/09)

J	Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
E	An estimated value due to the presence of interferences. A full explanation is presented in the narrative.
H	Holding time and/or preservation requirements not met. Result is estimated.
J-1	Estimated value. A full explanation is presented in the narrative.
J-M	Duplicate precision (RPD) for associated QC sample was not within acceptance criteria. Result is estimated.
J-N	Spike recovery for associated QC sample was not within acceptance criteria. Result is estimated.
M	Duplicate precision (RPD) was not within acceptance criteria. Result is estimated.
N	Spike recovery was not within acceptance criteria. Result is estimated.
R	Rejected, unusable value. A full explanation is presented in the narrative.
U	Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
X	Result is not BLK-corrected and is within 10x the absolute value of the highest detectable BLK in the batch. Result is estimated.

These qualifiers are based on those previously utilized by Brooks Applied Labs, those found in the EPA SOW ILM03.0, Exhibit B, Section III, pg. B-18, and the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review; USEPA; January 2010. These supersede all previous qualifiers ever employed by BAL.

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
MW007-EZ	1635052-01	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT-1	1635052-02	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT-2	1635052-03	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT-3	1635052-04	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT-4	1635052-05	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT-5	1635052-06	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT-6	1635052-07	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT Unfiltered	1635052-08	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT Spiked	1635052-09	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT 0.1µm Spiked 48 hr	1635052-10	Water	Sample	08/16/2016	08/26/2016
MW007-EZ-BAT Spiked 48 hr	1635052-11	Water	Sample	08/16/2016	08/26/2016

Batch Summary

Analyte	Lab Matrix	Method	Prepared	Analyzed	Batch	Sequence
As	Water	EPA 1638 Mod	10/17/2016	10/20/2016	B162590	1601190
Fe	Water	EPA 1638 Mod	10/17/2016	10/20/2016	B162590	1601190

Sample Results

Sample	Analyte	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
1635052-08	***MW007-EZ-BAT Unfiltered* collected on 08/16/2016**								
	As	D	20.9		0.290	1.01	µg/L	B162590	1601190
	Fe	D	100000		9.85	19.7	µg/L	B162590	1601190
1635052-09	***MW007-EZ-BAT Spiked* collected on 08/16/2016**								
	As	D	1120		0.290	1.01	µg/L	B162590	1601190
	Fe	D	54400		9.85	19.7	µg/L	B162590	1601190
1635052-10	***MW007-EZ-BAT 0.1µm Spiked 48 hr* collected on 08/16/2016**								
	As	D	124		0.290	1.01	µg/L	B162590	1601190
	Fe	D	110		9.85	19.7	µg/L	B162590	1601190
1635052-11	***MW007-EZ-BAT Spiked 48 hr* collected on 08/16/2016**								
	As	D	1090		0.290	1.01	µg/L	B162590	1601190
	Fe	D	53900		9.85	19.7	µg/L	B162590	1601190

Accuracy & Precision Summary

Batch: B162590
Lab Matrix: Water
Method: EPA 1638 Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B162590-BS1	**Laboratory Fortified Blank, (1643007)**								
	As		200.0	187.3	µg/L	94%	75-125		
	Fe		2000	1900	µg/L	95%	75-125		
B162590-SRM1	**Certified Reference Material, (NC00149, TMDA 70.2 Reference Standard - Bottle6)**								
	As		42.20	43.70	µg/L	104%	75-125		
	Fe		376.0	353.9	µg/L	94%	75-125		
B162590-DUP1	**Duplicate, (1635052-08)**								
	As	20.88		23.32	µg/L			11%	20
	Fe	99960		112100	µg/L			11%	20
B162590-MS1	**Matrix Spike, (1635052-08)**								
	As	20.88	202.0	230.2	µg/L	104%	75-125		
	Fe	99960	2020	109300	µg/L	NR	75-125		
B162590-MSD1	**Matrix Spike Duplicate, (1635052-08)**								
	As	20.88	202.0	214.5	µg/L	96%	75-125	7%	20
	Fe	99960	2020	100900	µg/L	NR	75-125	N/C	20

Method Blanks & Reporting Limits

Batch: B162590
Matrix: Water
Method: EPA 1638 Mod
Analyte: As

Sample	Result	Units
B162590-BLK1	0.006	µg/L
B162590-BLK2	0.003	µg/L
B162590-BLK3	0.006	µg/L
B162590-BLK4	0.004	µg/L

Average: 0.005 **Standard Deviation:** 0.002 **MDL:** 0.023
Limit: 0.080 **Limit:** 0.023 **MRL:** 0.080

Analyte: Fe

Sample	Result	Units
B162590-BLK1	0.481	µg/L
B162590-BLK2	0.170	µg/L
B162590-BLK3	0.422	µg/L
B162590-BLK4	0.389	µg/L

Average: 0.365 **Standard Deviation:** 0.136 **MDL:** 0.780
Limit: 1.560 **Limit:** 0.780 **MRL:** 1.56

Sample Containers

Lab ID: 1635052-01
Sample: MW007-EZ
Comments: Logged into another work order

Report Matrix: Water
Sample Type: Sample

Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)		<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Lab ID: 1635052-02
Sample: MW007-EZ-BAT-1
Comments: 1L (B) bottles are for BAT only, Do not open these bottles at any time!

Report Matrix: Water
Sample Type: Sample

Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Lab ID: 1635052-03
Sample: MW007-EZ-BAT-2
Comments: 1L (B) bottles are for BAT only, Do not open these bottles at any time!

Report Matrix: Water
Sample Type: Sample

Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Lab ID: 1635052-04
Sample: MW007-EZ-BAT-3
Comments: 1L (B) bottles are for BAT only, Do not open these bottles at any time!

Report Matrix: Water
Sample Type: Sample

Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Sample Containers

Lab ID: 1635052-05
Sample: MW007-EZ-BAT-4
Report Matrix: Water
Sample Type: Sample
Collected: 08/16/2016
Received: 08/26/2016
Comments: 1L (B) bottles are for BAT only, Do not open these bottles at any time!

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Lab ID: 1635052-06
Sample: MW007-EZ-BAT-5
Report Matrix: Water
Sample Type: Sample
Collected: 08/16/2016
Received: 08/26/2016
Comments: 1L (B) bottles are for BAT only, Do not open these bottles at any time!

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Lab ID: 1635052-07
Sample: MW007-EZ-BAT-6
Report Matrix: Water
Sample Type: Sample
Collected: 08/16/2016
Received: 08/26/2016
Comments: 1L (B) bottles are for BAT only, Do not open these bottles at any time!

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Lab ID: 1635052-08
Sample: MW007-EZ-BAT Unfiltered
Report Matrix: Water
Sample Type: Sample
Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Sample Containers

Lab ID: 1635052-09
Sample: MW007-EZ-BAT Spiked
Report Matrix: Water
Sample Type: Sample
Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Lab ID: 1635052-10
Sample: MW007-EZ-BAT 0.1µm Spiked 48 hr
Report Matrix: Water
Sample Type: Sample
Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Lab ID: 1635052-11
Sample: MW007-EZ-BAT Spiked 48 hr
Report Matrix: Water
Sample Type: Sample
Collected: 08/16/2016
Received: 08/26/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL	16-0142	1% HNO3 (BAL)	1630022	<2	Cooler
B	EXTRA_VOL	1L	15-0259	none			Cooler

Comments: BAT

Shipping Containers

Cooler

Received: August 26, 2016 13:59
Tracking No: n/a via Customer Drop-Off
Coolant Type: Blue Ice
Temperature: 7.4 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR6

Custody seals present? No
Custody seals intact? No
COC present? Yes

To Brooks

55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s):

Client Contact	**For Lab Use Only:**
Project Name: Parcel 15 - POT	SDG:___
Project # or PO #: 603.002.012	Custody Seals intact?
Project Manager: Erin Hughes/Cindy Ryals	Hand delivered?
Phone #:971-200-8528 and 971-200-8531	Cooler Temp :____°C
Report to email: echughes@gsiws.com, cryals@gsiws.com	Therm ID No.:____Therm Exp.____
Analysis Turnaround Time: Standard 21 day TAT on Most Analyses Rush 5 day on Dissolved Metals in Porewater	

Laboratory

Lab PM

Brooks- Ben Wozniak- 206-753-6158

TestAmerica - Christabel Escarez- 253.248.4975

							TestAmerica												Brooks			
							Analysis Requested															
Sample Identification	**Sample Date**	**Sample Time**	**Field Conductivity (uS/cm)**	**Sample Type (C=Comp, G=Grab)**	**Matrix**	**Total # of Cont.**	SM5310B: Total Organic Carbon	SM5310B: Dissolved Organic Carbon (field filtered)	SM4500 S 2D: Sulfide (dissolved; field filtered)	SM2540D: Total Suspended Solids (TSS)	6010C: Major Cations (Ca, Mg, K, Na; dissolved; field filtered)*	300.0: Major Anions (Br, Cl, F, SO4; dissolved; field filtered)**	300.0: Nitrate and Nitrite (dissolved; field filtered)	SM2320B: Alkalinity (field filtered)***	365.1: Major Anions (Orthophosphate; dissolved; field	6020A: Arsenic (total)	6020A: Arsenic, Iron, and Manganese (dissolved; field filtered)	8260D SIM: Pentachlorophenol	1638M: Arsenic (total)	1638M: Arsenic, Iron, and Manganese (dissolved; field filtered)***	Arsenic Speciation - As (III)/As(V) (dissolved; field filtered)	**Sample Specific Notes**
MW007-EZ	8/16	1405	2822	G	W	12	X	X	X	X	X	X	X		X				X	X	X	
MW007-EZ-BAT-1	8/16	1440	2822	G	W	2																
MW007-EZ-BAT-2	''	↓	↓	↓	↓	2																Brooks
MW007-EZ-BAT-3	↓	↓	↓	↓	↓	2																Batch
MW007-EZ-BAT-4	↓	↓	↓	↓	↓	2																Samples
MW007-EZ-BAT-5	↓	↓	↓	↓	↓	2																
MW007-EZ-BAT-6	↓	↓	↓	↓	↓	2																

Possible Hazard Identification:

Are samples hazardous? ☑ No

If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic

Sample Disposal (A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)

☐ Return to Client ☑ Disposal by Lab ☐ Archive frozen for 1 year

Relinquished by:	Date/Time: 8/16/18 1545	Received by: B. Hill SEA TA	Date/Time: 8.16.16 1600
Relinquished by:	Date/Time: 8/17/16 1231	Received by:	Date/Time: 8/17/16 1231
Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☐ Other	Tracking #:	Received in Laboratory by:	Date/Time:

Special Instructions/QC Requirements

*Major Cations include calcium, magnesium, potassium, and sodium.

**Major anions include sulfate, chloride, bromide, fluoride, and ortho-phosphate.

***Alkalinity includes total, carbonate as CaCO3, bicarbonate as CaCO3, and hydroxide as CaCO3.

Please contact Cindy Ryals at 971-200-8531 with any questions.

Customer Dropoff

NO CS COC✓

Blue ice 7.4°C IR #6

1L HDPE 15-0259 TM

250mL HDPE 16-0142 TM

6mL VaCL 16-0183 As Sp EDTA PP

BROOKS APPLIED LABS
18804 North Creek Parkway, Ste 100, Bothell, WA 98011 • USA • T: 206 632 6206 F: 206 632 6017 • info@brooksapplied.com

March 3, 2017

GSI Water Solutions, Inc.
ATTN: Erin Carroll Hughes
55 SW Yamhill St. Suite 300
Portland OR 97204
echughes@gsiws.com

RE: Project GSI-PR1601b Client Project: Parcel 15 – POT (603.002.010)

Ms. Carroll Hughes,

On May 11th through May 20th, 2016, Brooks Applied Labs (BAL) received forty (40) soil/sediment samples. The temperature of samples received on May 20th, in Cooler 6, was 7.5 °C and exceeded the recommended temperature range of 0 – 4 °C ± 2 °C. The temperature of all other shipments were within the recommended limits. All samples were received and stored according to BAL SOPs and EPA methodology.

Shortly after receipt, all submitted core samples were unpacked in a glove box maintained under anoxic conditions, split into appropriate sample containers, and then stored according to BAL SOPs. All sample fractions designated for batch adsorption testing (BAT) were frozen pending the client's decision on which samples to analyze. On August 10, 2016 the client notified BAL that twelve (12) samples required the BAT. After initial testing on three samples using site groundwater (data presented in BAL Report 1635049A), the client requested that all 12 samples instead be prepared with a synthetic groundwater, as described herein.

Batch Adsorption Testing (BAT)

Prior to the BAT, each soil was dried in a glove box maintained under anoxic conditions and then sieved using a 2mm mesh size. An aliquot of each sieved sample was then taken for dry weight determination; in accordance with the BAT protocol, the resultant dry weights were used to calculate the appropriate sample masses required for the testing. All subsequent testing was performed on the original sieved sample portions.

In accordance with the client's request, a synthetic groundwater solution consisting of deoxygenated 0.025M NaCl (pH near 7) was spiked to contain approximately 1 mg/L of arsenite. An aliquot of this original spiked synthetic groundwater was split into a separate container, acidified to a pH < 2 with nitric acid, and then reserved for analysis for determination of the initial As concentration; this aliquot was identified as *Spiked 0.025M NaCl* in the attached result tables.

Aliquots of the remaining spiked synthetic groundwater were added to an appropriate mass of each sample to achieve the requested soil:solution ratios of 1:4, 1:10, 1:50, and 1:200. Aliquots of the spiked synthetic groundwater were also added to empty sample containers and extracted alongside the client samples to monitor for potential losses during the extraction procedure; these fractions have been identified as method blanks B170298-BLK1, B170298-BLK2, and B170298-BLK3 in the attached result tables. B170298-BLK1 was extracted for 168 hours, -BLK2 for 48 hours, and -BLK3 for 96 hours.

In accordance with the client's request, all samples were extracted using an equilibration time of 168 hours. However, aliquots of three samples were also extracted at a 1:50 soil:solution ratio for both 48 hours and 96 hours; the additional equilibration times for these three samples were identified in the attached report by appending either *48hrs* or *96hrs* to the client sample ID.

All prepared samples were then placed on a rotary tumbler (kept inside the glove box) for the selected equilibration times of 48, 96, and 168 hours. After the designated equilibration time had elapsed an aliquot of each resulting extract was filtered (0.45µm), acidified to a pH < 2 with nitric acid, and then reserved for dissolved As analysis. The remaining extract for each sample was evaluated for pH and temperature (the temperatures of all extracts were within 20 ± 2˚C).

A matrix duplicate (MD) was performed for each designated soil:solution ratio during the BAT. The matrix duplicate B170298-DUP1 was extracted for 168 hours, whereas B170298-DUP2 was extracted for 48 hours. Due to the nature of the BAT, no matrix spikes could be performed during the extraction procedure. Instead, analytical duplicates and analytical spikes (the latter identified as *Post Spike* in the *Accuracy & Precision* Summary pages) were prepared at the time of analysis to demonstrate the precision and accuracy of the analyses.

pH Measurement

The pH of all extracts was measured via a modified SM2540B using a calibrated pH electrode. The measured pH value of each fraction is presented in Table 1 of this report.

The client requested that the synthetic groundwater be prepared at a pH of approximately 7. While the pH of the initial synthetic groundwater was near 7 (6.90 for the *Spiked 0.025M NaCl* sample), the pH of the remaining method blanks and samples varied greatly. Initial experiments with the spiked synthetic groundwater revealed that its pH was not stable over time. The client was informed about this issue but requested that the BAT proceed. While the cause of the pH instability is unknown at this time, BAL recommends use of a buffered synthetic groundwater solution for any future experiments.

Total Metals Quantitation of the BAT Extracts

An aliquot of each extract was directly analyzed for As using inductively coupled plasma triple quadrupole mass spectrometry (ICP-QQQ-MS). The ICP-QQQ-MS uses advanced interference removal techniques to ensure accuracy of the sample results. For more information, please visit the Interference Reduction Technology section on our website.

Arsenic contamination above the method reporting limit (MRL) of 0.040 µg/L was observed in most of the continuing calibration blanks (CCBs) bracketing Batch B170298. The As concentrations of all samples and quality control in this batch were greater than ten times the contamination observed in the CCBs. The elevated CCBs therefore had no significant impact on the obtained sample results, so no corrective action or qualification of the data was required.

All data was reported without qualification and all other associated quality control sample results met the acceptance criteria.

The results were *not* method blank corrected, as described in the calculations section of the relevant BAL SOPs, and were evaluated using reporting limits adjusted to account for sample aliquot size. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

Instances where the matrix spike/matrix spike duplicate (MS/MSD) sets were spiked at a concentration less than 25% of the native sample result or recovered below the MDL, the recoveries were not reported (**NR**).

BAL, an accredited laboratory, certifies that the reported results of all analyses for which BAL is NELAP accredited meet all NELAP requirements. For more information please see the *Report Information* page in your report. Please feel free to contact me if you have any questions regarding this report.

Sincerely,

Ben Wozniak

Ben Wozniak
Project Manager
ben@brooksapplied.com

Table 1: Extract pH

Sample ID	pH
Spiked 0.025M NaCl	6.90
B170298-BLK1	8.85
B170298-BLK2	8.39
B170298-BLK3	9.89
MWS007-9-10 1:10	4.21
MWS007-9-10 1:200	4.70
MWS007-9-10 1:4	4.01
MWS007-9-10 1:50	4.43
MWS007-9-10 1:50	4.33
MWS007-9-10 1:50	4.34
MWS007-9-10 1:50 48hrs	4.46
MWS007-9-10 1:50 96hrs	4.48
MWS009-11-12 1:10	4.66
MWS009-11-12 1:200	5.17
MWS009-11-12 1:4	4.54
MWS009-11-12 1:50	4.85
MWS010-12-13 1:10	3.12
MWS010-12-13 1:200	3.84
MWS010-12-13 1:4	3.00
MWS010-12-13 1:50	3.44
MWS012-11.5-12.5 1:10	5.78
MWS012-11.5-12.5 1:200	5.42
MWS012-11.5-12.5 1:4	5.54
MWS012-11.5-12.5 1:50	5.88
MWS013-12.5-13.5 1:10	6.12
MWS013-12.5-13.5 1:200	6.23
MWS013-12.5-13.5 1:4	5.92
MWS013-12.5-13.5 1:50	6.14
TBS003-14-15 1:10	3.80
TBS003-14-15 1:200	4.12
TBS003-14-15 1:4	3.66
TBS003-14-15 1:50	3.97
TBS003-14-15 1:50 48 hrs.	3.93
TBS003-14-15 1:50 96 hrs.	4.01
TBS005-17-18 1:10	5.09
TBS005-17-18 1:200	5.47
TBS005-17-18 1:4	5.03
TBS005-17-18 1:50	5.21
TBS007-16.5-17.5 1:10	5.80
TBS007-16.5-17.5 1:200	5.66
TBS007-16.5-17.5 1:4	5.63
TBS007-16.5-17.5 1:50	5.76
WCTSD001A-0-10 1:10	6.44
WCTSD001A-0-10 1:200	6.42
WCTSD001A-0-10 1:4	6.14
WCTSD001A-0-10 1:50	6.37
WCTSD001A-40-50 1:10	6.55
WCTSD001A-40-50 1:200	6.81
WCTSD001A-40-50 1:4	6.44
WCTSD001A-40-50 1:50	6.68
WCTSD001A-40-50 1:50 48 hrs.	5.38
WCTSD001A-40-50 1:50 96 hrs.	5.60
WCTSD001B-0-10 1:10	7.26
WCTSD001B-0-10 1:200	7.46
WCTSD001B-0-10 1:4	6.97
WCTSD001B-0-10 1:50	7.50
WCTSD001B-40-50 1:10	3.21
WCTSD001B-40-50 1:200	3.85
WCTSD001B-40-50 1:4	3.07
WCTSD001B-40-50 1:50	3.50

Report Information

Laboratory Accreditation

BAL is accredited by the *National Environmental Laboratory Accreditation Program* (NELAP) through the State of Florida Department of Health, Bureau of Laboratories (E87982) and is certified to perform many environmental analyses. BAL is also certified by many other states to perform environmental analyses. For a current list of our accreditations/certifications, please visit our website at <http://www.brooksapplied.com/resources/certificates-permits/>. Results reported relate only to the samples listed in the report.

Field Quality Control Samples

Please be notified that certain EPA methods require the collection of field quality control samples of an appropriate type and frequency; failure to do so is considered a deviation from some methods and for compliance purposes should only be done with the approval of regulatory authorities. Please see the specific EPA methods for details regarding required field quality control samples.

Common Abbreviations

BAL	Brooks Applied Labs	**MS**	matrix spike
BLK	method blank	**MSD**	matrix spike duplicate
BS	laboratory fortified blank	**ND**	non-detect
CAL	calibration standard	**NR**	non-reportable
CCB	continuing calibration blank	**N/C**	not calculated
CCV	continuing calibration verification	**PS**	post preparation spike
COC	chain of custody record	**REC**	percent recovery
D	dissolved fraction	**RPD**	relative percent difference
DUP	duplicate	**SCV**	secondary calibration verification
IBL	instrument blank	**SOP**	standard operating procedure
ICV	initial calibration verification	**SRM**	standard reference material
MDL	method detection limit	**AR**	as received
MRL	method reporting limit	**TR**	total recoverable fraction

Definition of Data Qualifiers

(Effective 9/23/09)

J	Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
E	An estimated value due to the presence of interferences. A full explanation is presented in the narrative.
H	Holding time and/or preservation requirements not met. Result is estimated.
J-1	Estimated value. A full explanation is presented in the narrative.
J-M	Duplicate precision (RPD) for associated QC sample was not within acceptance criteria. Result is estimated.
J-N	Spike recovery for associated QC sample was not within acceptance criteria. Result is estimated.
M	Duplicate precision (RPD) was not within acceptance criteria. Result is estimated.
N	Spike recovery was not within acceptance criteria. Result is estimated.
R	Rejected, unusable value. A full explanation is presented in the narrative.
U	Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
X	Result is not BLK-corrected and is within 10x the absolute value of the highest detectable BLK in the batch. Result is estimated.

These qualifiers are based on those previously utilized by Brooks Applied Labs, those found in the EPA SOW ILM03.0, Exhibit B, Section III, pg. B-18, and the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review; USEPA; January 2010. These supersede all previous qualifiers ever employed by BAL.

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
MWS007-9-10 1:50 48hrs	1635049-01	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS007-9-10 1:50 96hrs	1635049-02	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS007-9-10 1:50 168hrs	1635049-03	Soil/Sediment	Sample	08/25/2016	05/13/2016
MWS007-9-10 1:4	1635049-04	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS007-9-10 1:10	1635049-05	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS007-9-10 1:50	1635049-06	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS007-9-10 1:200	1635049-07	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS009-11-12 1:4	1635049-08	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS009-11-12 1:10	1635049-09	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS009-11-12 1:50	1635049-10	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS009-11-12 1:200	1635049-11	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS010-12-13 1:4	1635049-12	Soil/Sediment	Sample	05/10/2016	05/11/2016
MWS010-12-13 1:10	1635049-13	Soil/Sediment	Sample	05/10/2016	05/11/2016
MWS010-12-13 1:50	1635049-14	Soil/Sediment	Sample	05/10/2016	05/11/2016
MWS010-12-13 1:200	1635049-15	Soil/Sediment	Sample	05/10/2016	05/11/2016
MWS012-11.5-12.5 1:4	1635049-16	Soil/Sediment	Sample	05/12/2016	05/13/2016
MWS012-11.5-12.5 1:10	1635049-17	Soil/Sediment	Sample	05/12/2016	05/13/2016
MWS012-11.5-12.5 1:50	1635049-18	Soil/Sediment	Sample	05/12/2016	05/13/2016
MWS012-11.5-12.5 1:200	1635049-19	Soil/Sediment	Sample	05/12/2016	05/13/2016
MWS013-12.5-13.5 1:4	1635049-20	Soil/Sediment	Sample	05/10/2016	05/11/2016
MWS013-12.5-13.5 1:10	1635049-21	Soil/Sediment	Sample	05/10/2016	05/11/2016
MWS013-12.5-13.5 1:50	1635049-22	Soil/Sediment	Sample	05/10/2016	05/11/2016
MWS013-12.5-13.5 1:200	1635049-23	Soil/Sediment	Sample	05/10/2016	05/11/2016
TBS003-14-15 1:50 48 hrs.	1635049-24	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS003-14-15 1:50 96 hrs.	1635049-25	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS003-14-15 1:50 168 hrs.	1635049-26	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS003-14-15 1:4	1635049-27	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS003-14-15 1:10	1635049-28	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS003-14-15 1:50	1635049-29	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS003-14-15 1:200	1635049-30	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS005-17-18 1:4	1635049-31	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS005-17-18 1:10	1635049-32	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS005-17-18 1:50	1635049-33	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS005-17-18 1:200	1635049-34	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS007-16.5-17.5 1:4	1635049-35	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS007-16.5-17.5 1:10	1635049-36	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS007-16.5-17.5 1:50	1635049-37	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS007-16.5-17.5 1:200	1635049-38	Soil/Sediment	Sample	05/17/2016	05/18/2016
WCTSD001A-0-10 1:4	1635049-39	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-0-10 1:10	1635049-40	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-0-10 1:50	1635049-41	Soil/Sediment	Sample	05/18/2016	05/20/2016

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
WCTSD001A-0-10 1:200	1635049-42	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:50 48 hrs.	1635049-43	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:50 96 hrs.	1635049-44	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:50 168 hrs.	1635049-45	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:4	1635049-46	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:10	1635049-47	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:50	1635049-48	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:200	1635049-49	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001B-0-10 1:4	1635049-50	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001B-0-10 1:10	1635049-51	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001B-0-10 1:50	1635049-52	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001B-0-10 1:200	1635049-53	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001B-40-50 1:4	1635049-54	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001B-40-50 1:10	1635049-55	Soil/Sediment	Sample	08/18/2016	05/20/2016
WCTSD001B-40-50 1:50	1635049-56	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001B-40-50 1:200	1635049-57	Soil/Sediment	Sample	05/18/2016	05/20/2016
Spiked Groundwater (Step 1)	1635049-58	Soil/Sediment	Sample	08/25/2016	08/26/2016
Spiked Groundwater (Step 2)	1635049-59	Soil/Sediment	Sample	08/25/2016	08/26/2016
MWS007-9-10 1:50 48hrs	1635049-60	Soil/Sediment	Sample	05/11/2016	05/13/2016
MWS007-9-10 1:50 96hrs	1635049-61	Soil/Sediment	Sample	05/11/2016	05/13/2016
TBS003-14-15 1:50 48 hrs.	1635049-62	Soil/Sediment	Sample	05/17/2016	05/18/2016
TBS003-14-15 1:50 96 hrs.	1635049-63	Soil/Sediment	Sample	05/17/2016	05/18/2016
WCTSD001A-40-50 1:50 48 hrs.	1635049-64	Soil/Sediment	Sample	05/18/2016	05/20/2016
WCTSD001A-40-50 1:50 96 hrs.	1635049-65	Soil/Sediment	Sample	05/18/2016	05/20/2016
Spiked 0.025M NaCl	1635049-66	Soil/Sediment	Sample	08/25/2016	08/26/2016

Batch Summary

Analyte	Lab Matrix	Method	Prepared	Analyzed	Batch	Sequence
%TS	Soil/Sediment	SM 2540G	08/26/2016	09/07/2016	B162109	N/A
%TS	Soil/Sediment	SM 2540G	09/28/2016	10/04/2016	B162113	N/A
As(BAT)	Soil/Sediment	EPA 6020B Mod	02/14/2017	02/28/2017	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS007-9-10 1:10										
1635049-05	%TS	Soil/Sediment	NA	97.27		0.06	0.21	%	B162109	N/A
1635049-05	As(BAT)	Soil/Sediment	dry	3.15		0.004	0.010	mg/kg	B170298	1700249
MWS007-9-10 1:200										
1635049-07	%TS	Soil/Sediment	NA	97.27		0.06	0.21	%	B162109	N/A
1635049-07	As(BAT)	Soil/Sediment	dry	157		0.084	0.193	mg/kg	B170298	1700249
MWS007-9-10 1:4										
1635049-04	%TS	Soil/Sediment	NA	97.27		0.06	0.21	%	B162109	N/A
1635049-04	As(BAT)	Soil/Sediment	dry	0.521		0.002	0.004	mg/kg	B170298	1700249
MWS007-9-10 1:50										
1635049-06	%TS	Soil/Sediment	NA	97.27		0.06	0.21	%	B162109	N/A
1635049-06	As(BAT)	Soil/Sediment	dry	33.7		0.022	0.049	mg/kg	B170298	1700249
MWS007-9-10 1:50 48hrs										
1635049-60	%TS	Soil/Sediment	NA	97.27		0.06	0.21	%	B162109	N/A
1635049-60	As(BAT)	Soil/Sediment	dry	36.7		0.021	0.048	mg/kg	B170298	1700249
MWS007-9-10 1:50 96hrs										
1635049-61	%TS	Soil/Sediment	NA	97.27		0.06	0.21	%	B162109	N/A
1635049-61	As(BAT)	Soil/Sediment	dry	37.0		0.022	0.049	mg/kg	B170298	1700249
MWS009-11-12 1:10										
1635049-09	%TS	Soil/Sediment	NA	90.28		0.08	0.26	%	B162113	N/A
1635049-09	As(BAT)	Soil/Sediment	dry	4.51		0.004	0.010	mg/kg	B170298	1700249
MWS009-11-12 1:200										
1635049-11	%TS	Soil/Sediment	NA	90.28		0.08	0.26	%	B162113	N/A
1635049-11	As(BAT)	Soil/Sediment	dry	166		0.087	0.199	mg/kg	B170298	1700249
MWS009-11-12 1:4										
1635049-08	%TS	Soil/Sediment	NA	90.28		0.08	0.26	%	B162113	N/A
1635049-08	As(BAT)	Soil/Sediment	dry	1.01		0.002	0.004	mg/kg	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS009-11-12 1:50										
1635049-10	%TS	Soil/Sediment	NA	90.28		0.08	0.26	%	B162113	N/A
1635049-10	As(BAT)	Soil/Sediment	dry	37.1		0.022	0.050	mg/kg	B170298	1700249
MWS010-12-13 1:10										
1635049-13	%TS	Soil/Sediment	NA	86.43		0.08	0.26	%	B162113	N/A
1635049-13	As(BAT)	Soil/Sediment	dry	8.03		0.004	0.010	mg/kg	B170298	1700249
MWS010-12-13 1:200										
1635049-15	%TS	Soil/Sediment	NA	86.43		0.08	0.26	%	B162113	N/A
1635049-15	As(BAT)	Soil/Sediment	dry	146		0.086	0.197	mg/kg	B170298	1700249
MWS010-12-13 1:4										
1635049-12	%TS	Soil/Sediment	NA	86.43		0.08	0.26	%	B162113	N/A
1635049-12	As(BAT)	Soil/Sediment	dry	3.93		0.002	0.004	mg/kg	B170298	1700249
MWS010-12-13 1:50										
1635049-14	%TS	Soil/Sediment	NA	86.43		0.08	0.26	%	B162113	N/A
1635049-14	As(BAT)	Soil/Sediment	dry	36.2		0.022	0.050	mg/kg	B170298	1700249
MWS012-11.5-12.5 1:10										
1635049-17	%TS	Soil/Sediment	NA	89.59		0.08	0.26	%	B162113	N/A
1635049-17	As(BAT)	Soil/Sediment	dry	2.79		0.004	0.010	mg/kg	B170298	1700249
MWS012-11.5-12.5 1:200										
1635049-19	%TS	Soil/Sediment	NA	89.59		0.08	0.26	%	B162113	N/A
1635049-19	As(BAT)	Soil/Sediment	dry	149		0.083	0.190	mg/kg	B170298	1700249
MWS012-11.5-12.5 1:4										
1635049-16	%TS	Soil/Sediment	NA	89.59		0.08	0.26	%	B162113	N/A
1635049-16	As(BAT)	Soil/Sediment	dry	0.468		0.002	0.004	mg/kg	B170298	1700249
MWS012-11.5-12.5 1:50										
1635049-18	%TS	Soil/Sediment	NA	89.59		0.08	0.26	%	B162113	N/A
1635049-18	As(BAT)	Soil/Sediment	dry	31.4		0.021	0.049	mg/kg	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS013-12.5-13.5 1:10										
1635049-21	%TS	Soil/Sediment	NA	86.51		0.08	0.26	%	B162113	N/A
1635049-21	As(BAT)	Soil/Sediment	dry	0.567		0.004	0.010	mg/kg	B170298	1700249
MWS013-12.5-13.5 1:200										
1635049-23	%TS	Soil/Sediment	NA	86.51		0.08	0.26	%	B162113	N/A
1635049-23	As(BAT)	Soil/Sediment	dry	127		0.088	0.201	mg/kg	B170298	1700249
MWS013-12.5-13.5 1:4										
1635049-20	%TS	Soil/Sediment	NA	86.51		0.08	0.26	%	B162113	N/A
1635049-20	As(BAT)	Soil/Sediment	dry	0.144		0.002	0.004	mg/kg	B170298	1700249
MWS013-12.5-13.5 1:50										
1635049-22	%TS	Soil/Sediment	NA	86.51		0.08	0.26	%	B162113	N/A
1635049-22	As(BAT)	Soil/Sediment	dry	10.7		0.022	0.050	mg/kg	B170298	1700249
Spiked 0.025M NaCl										
1635049-66	As(BAT)	Soil/Sediment	AR	35.1		0.018	0.040	mg/kg wet	B170298	1700249
TBS003-14-15 1:10										
1635049-28	%TS	Soil/Sediment	NA	80.79		0.06	0.21	%	B162109	N/A
1635049-28	As(BAT)	Soil/Sediment	dry	0.799		0.004	0.010	mg/kg	B170298	1700249
TBS003-14-15 1:200										
1635049-30	%TS	Soil/Sediment	NA	80.79		0.06	0.21	%	B162109	N/A
1635049-30	As(BAT)	Soil/Sediment	dry	80.3		0.076	0.175	mg/kg	B170298	1700249
TBS003-14-15 1:4										
1635049-27	%TS	Soil/Sediment	NA	80.79		0.06	0.21	%	B162109	N/A
1635049-27	As(BAT)	Soil/Sediment	dry	0.151		0.002	0.004	mg/kg	B170298	1700249
TBS003-14-15 1:50										
1635049-29	%TS	Soil/Sediment	NA	80.79		0.06	0.21	%	B162109	N/A
1635049-29	As(BAT)	Soil/Sediment	dry	13.3		0.021	0.049	mg/kg	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
TBS003-14-15 1:50 48 hrs.										
1635049-62	%TS	Soil/Sediment	NA	80.79		0.06	0.21	%	B162109	N/A
1635049-62	As(BAT)	Soil/Sediment	dry	20.6		0.021	0.049	mg/kg	B170298	1700249
TBS003-14-15 1:50 96 hrs.										
1635049-63	%TS	Soil/Sediment	NA	80.79		0.06	0.21	%	B162109	N/A
1635049-63	As(BAT)	Soil/Sediment	dry	17.6		0.022	0.050	mg/kg	B170298	1700249
TBS005-17-18 1:10										
1635049-32	%TS	Soil/Sediment	NA	90.73		0.08	0.26	%	B162113	N/A
1635049-32	As(BAT)	Soil/Sediment	dry	0.363		0.004	0.010	mg/kg	B170298	1700249
TBS005-17-18 1:200										
1635049-34	%TS	Soil/Sediment	NA	90.73		0.08	0.26	%	B162113	N/A
1635049-34	As(BAT)	Soil/Sediment	dry	149		0.081	0.185	mg/kg	B170298	1700249
TBS005-17-18 1:4										
1635049-31	%TS	Soil/Sediment	NA	90.73		0.08	0.26	%	B162113	N/A
1635049-31	As(BAT)	Soil/Sediment	dry	0.208		0.002	0.004	mg/kg	B170298	1700249
TBS005-17-18 1:50										
1635049-33	%TS	Soil/Sediment	NA	90.73		0.08	0.26	%	B162113	N/A
1635049-33	As(BAT)	Soil/Sediment	dry	16.6		0.021	0.049	mg/kg	B170298	1700249
TBS007-16.5-17.5 1:10										
1635049-36	%TS	Soil/Sediment	NA	96.02		0.08	0.26	%	B162113	N/A
1635049-36	As(BAT)	Soil/Sediment	dry	3.33		0.004	0.010	mg/kg	B170298	1700249
TBS007-16.5-17.5 1:200										
1635049-38	%TS	Soil/Sediment	NA	96.02		0.08	0.26	%	B162113	N/A
1635049-38	As(BAT)	Soil/Sediment	dry	139		0.077	0.176	mg/kg	B170298	1700249
TBS007-16.5-17.5 1:4										
1635049-35	%TS	Soil/Sediment	NA	96.02		0.08	0.26	%	B162113	N/A
1635049-35	As(BAT)	Soil/Sediment	dry	0.600		0.002	0.004	mg/kg	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
TBS007-16.5-17.5 1:50										
1635049-37	%TS	Soil/Sediment	NA	96.02		0.08	0.26	%	B162113	N/A
1635049-37	As(BAT)	Soil/Sediment	dry	33.0		0.021	0.048	mg/kg	B170298	1700249
WCTSD001A-0-10 1:10										
1635049-40	%TS	Soil/Sediment	NA	92.89		0.08	0.26	%	B162113	N/A
1635049-40	As(BAT)	Soil/Sediment	dry	1.75		0.004	0.010	mg/kg	B170298	1700249
WCTSD001A-0-10 1:200										
1635049-42	%TS	Soil/Sediment	NA	92.89		0.08	0.26	%	B162113	N/A
1635049-42	As(BAT)	Soil/Sediment	dry	146		0.082	0.188	mg/kg	B170298	1700249
WCTSD001A-0-10 1:4										
1635049-39	%TS	Soil/Sediment	NA	96.89		0.08	0.26	%	B162113	N/A
1635049-39	As(BAT)	Soil/Sediment	dry	0.372		0.002	0.004	mg/kg	B170298	1700249
WCTSD001A-0-10 1:50										
1635049-41	%TS	Soil/Sediment	NA	92.89		0.08	0.26	%	B162113	N/A
1635049-41	As(BAT)	Soil/Sediment	dry	27.8		0.022	0.049	mg/kg	B170298	1700249
WCTSD001A-40-50 1:10										
1635049-47	%TS	Soil/Sediment	NA	98.62		0.06	0.21	%	B162109	N/A
1635049-47	As(BAT)	Soil/Sediment	dry	0.867		0.004	0.010	mg/kg	B170298	1700249
WCTSD001A-40-50 1:200										
1635049-49	%TS	Soil/Sediment	NA	98.62		0.06	0.21	%	B162109	N/A
1635049-49	As(BAT)	Soil/Sediment	dry	107		0.078	0.179	mg/kg	B170298	1700249
WCTSD001A-40-50 1:4										
1635049-46	%TS	Soil/Sediment	NA	98.62		0.06	0.21	%	B162109	N/A
1635049-46	As(BAT)	Soil/Sediment	dry	0.142		0.002	0.004	mg/kg	B170298	1700249
WCTSD001A-40-50 1:50										
1635049-48	%TS	Soil/Sediment	NA	98.62		0.06	0.21	%	B162109	N/A
1635049-48	As(BAT)	Soil/Sediment	dry	15.8		0.021	0.049	mg/kg	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
WCTSD001A-40-50 1:50 48 hrs.										
1635049-64	%TS	Soil/Sediment	NA	98.62		0.06	0.21	%	B162109	N/A
1635049-64	As(BAT)	Soil/Sediment	dry	19.3		0.022	0.049	mg/kg	B170298	1700249
WCTSD001A-40-50 1:50 96 hrs.										
1635049-65	%TS	Soil/Sediment	NA	98.62		0.06	0.21	%	B162109	N/A
1635049-65	As(BAT)	Soil/Sediment	dry	17.6		0.022	0.050	mg/kg	B170298	1700249
WCTSD001B-0-10 1:10										
1635049-51	%TS	Soil/Sediment	NA	99.02		0.08	0.26	%	B162113	N/A
1635049-51	As(BAT)	Soil/Sediment	dry	0.940		0.004	0.010	mg/kg	B170298	1700249
WCTSD001B-0-10 1:200										
1635049-53	%TS	Soil/Sediment	NA	99.02		0.08	0.26	%	B162113	N/A
1635049-53	As(BAT)	Soil/Sediment	dry	70.4		0.078	0.179	mg/kg	B170298	1700249
WCTSD001B-0-10 1:4										
1635049-50	%TS	Soil/Sediment	NA	99.02		0.08	0.26	%	B162113	N/A
1635049-50	As(BAT)	Soil/Sediment	dry	0.446		0.002	0.004	mg/kg	B170298	1700249
WCTSD001B-0-10 1:50										
1635049-52	%TS	Soil/Sediment	NA	99.02		0.08	0.26	%	B162113	N/A
1635049-52	As(BAT)	Soil/Sediment	dry	11.0		0.022	0.049	mg/kg	B170298	1700249
WCTSD001B-40-50 1:10										
1635049-55	%TS	Soil/Sediment	NA	74.26		0.08	0.26	%	B162113	N/A
1635049-55	As(BAT)	Soil/Sediment	dry	2.95		0.004	0.010	mg/kg	B170298	1700249
WCTSD001B-40-50 1:200										
1635049-57	%TS	Soil/Sediment	NA	74.26		0.08	0.26	%	B162113	N/A
1635049-57	As(BAT)	Soil/Sediment	dry	161		0.087	0.198	mg/kg	B170298	1700249
WCTSD001B-40-50 1:4										
1635049-54	%TS	Soil/Sediment	NA	74.26		0.08	0.26	%	B162113	N/A
1635049-54	As(BAT)	Soil/Sediment	dry	0.569		0.002	0.004	mg/kg	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
WCTSD001B-40-50 1:50										
1635049-56	%TS	Soil/Sediment	NA	74.26		0.08	0.26	%	B162113	N/A
1635049-56	As(BAT)	Soil/Sediment	dry	32.0		0.022	0.051	mg/kg	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS007-9-10 1:10										
1635049-05	As(BAT)	Soil/Sediment	D	316		0.450	1.00	µg/L	B170298	1700249
MWS007-9-10 1:200										
1635049-07	As(BAT)	Soil/Sediment	D	813		0.450	1.00	µg/L	B170298	1700249
MWS007-9-10 1:4										
1635049-04	As(BAT)	Soil/Sediment	D	130		0.450	1.00	µg/L	B170298	1700249
MWS007-9-10 1:50										
1635049-06	As(BAT)	Soil/Sediment	D	684		0.450	1.00	µg/L	B170298	1700249
MWS007-9-10 1:50 48hrs										
1635049-60	As(BAT)	Soil/Sediment	D	762		0.450	1.00	µg/L	B170298	1700249
MWS007-9-10 1:50 96hrs										
1635049-61	As(BAT)	Soil/Sediment	D	749		0.450	1.00	µg/L	B170298	1700249
MWS009-11-12 1:10										
1635049-09	As(BAT)	Soil/Sediment	D	452		0.450	1.00	µg/L	B170298	1700249
MWS009-11-12 1:200										
1635049-11	As(BAT)	Soil/Sediment	D	837		0.450	1.00	µg/L	B170298	1700249
MWS009-11-12 1:4										
1635049-08	As(BAT)	Soil/Sediment	D	253		0.450	1.00	µg/L	B170298	1700249
MWS009-11-12 1:50										
1635049-10	As(BAT)	Soil/Sediment	D	745		0.450	1.00	µg/L	B170298	1700249
MWS010-12-13 1:10										
1635049-13	As(BAT)	Soil/Sediment	D	802		0.450	1.00	µg/L	B170298	1700249
MWS010-12-13 1:200										
1635049-15	As(BAT)	Soil/Sediment	D	740		0.450	1.00	µg/L	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MWS010-12-13 1:4										
1635049-12	As(BAT)	Soil/Sediment	D	983		0.450	1.00	µg/L	B170298	1700249
MWS010-12-13 1:50										
1635049-14	As(BAT)	Soil/Sediment	D	730		0.450	1.00	µg/L	B170298	1700249
MWS012-11.5-12.5 1:10										
1635049-17	As(BAT)	Soil/Sediment	D	277		0.450	1.00	µg/L	B170298	1700249
MWS012-11.5-12.5 1:200										
1635049-19	As(BAT)	Soil/Sediment	D	788		0.450	1.00	µg/L	B170298	1700249
MWS012-11.5-12.5 1:4										
1635049-16	As(BAT)	Soil/Sediment	D	117		0.450	1.00	µg/L	B170298	1700249
MWS012-11.5-12.5 1:50										
1635049-18	As(BAT)	Soil/Sediment	D	644		0.450	1.00	µg/L	B170298	1700249
MWS013-12.5-13.5 1:10										
1635049-21	As(BAT)	Soil/Sediment	D	56.9		0.450	1.00	µg/L	B170298	1700249
MWS013-12.5-13.5 1:200										
1635049-23	As(BAT)	Soil/Sediment	D	632		0.450	1.00	µg/L	B170298	1700249
MWS013-12.5-13.5 1:4										
1635049-20	As(BAT)	Soil/Sediment	D	36.0		0.450	1.00	µg/L	B170298	1700249
MWS013-12.5-13.5 1:50										
1635049-22	As(BAT)	Soil/Sediment	D	215		0.450	1.00	µg/L	B170298	1700249
Spiked 0.025M NaCl										
1635049-66	As(BAT)	Soil/Sediment	D	877		0.450	1.00	µg/L	B170298	1700249
TBS003-14-15 1:10										
1635049-28	As(BAT)	Soil/Sediment	D	80.4		0.450	1.00	µg/L	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
TBS003-14-15 1:200										
1635049-30	As(BAT)	Soil/Sediment	D	460		0.450	1.00	µg/L	B170298	1700249
TBS003-14-15 1:4										
1635049-27	As(BAT)	Soil/Sediment	D	37.8		0.450	1.00	µg/L	B170298	1700249
TBS003-14-15 1:50										
1635049-29	As(BAT)	Soil/Sediment	D	270		0.450	1.00	µg/L	B170298	1700249
TBS003-14-15 1:50 48 hrs.										
1635049-62	As(BAT)	Soil/Sediment	D	421		0.450	1.00	µg/L	B170298	1700249
TBS003-14-15 1:50 96 hrs.										
1635049-63	As(BAT)	Soil/Sediment	D	352		0.450	1.00	µg/L	B170298	1700249
TBS005-17-18 1:10										
1635049-32	As(BAT)	Soil/Sediment	D	36.5		0.450	1.00	µg/L	B170298	1700249
TBS005-17-18 1:200										
1635049-34	As(BAT)	Soil/Sediment	D	805		0.450	1.00	µg/L	B170298	1700249
TBS005-17-18 1:4										
1635049-31	As(BAT)	Soil/Sediment	D	52.2		0.450	1.00	µg/L	B170298	1700249
TBS005-17-18 1:50										
1635049-33	As(BAT)	Soil/Sediment	D	338		0.450	1.00	µg/L	B170298	1700249
TBS007-16.5-17.5 1:10										
1635049-36	As(BAT)	Soil/Sediment	D	331		0.450	1.00	µg/L	B170298	1700249
TBS007-16.5-17.5 1:200										
1635049-38	As(BAT)	Soil/Sediment	D	789		0.450	1.00	µg/L	B170298	1700249
TBS007-16.5-17.5 1:4										
1635049-35	As(BAT)	Soil/Sediment	D	150		0.450	1.00	µg/L	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
TBS007-16.5-17.5 1:50										
1635049-37	As(BAT)	Soil/Sediment	D	683		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-0-10 1:10										
1635049-40	As(BAT)	Soil/Sediment	D	176		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-0-10 1:200										
1635049-42	As(BAT)	Soil/Sediment	D	774		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-0-10 1:4										
1635049-39	As(BAT)	Soil/Sediment	D	93.2		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-0-10 1:50										
1635049-41	As(BAT)	Soil/Sediment	D	566		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-40-50 1:10										
1635049-47	As(BAT)	Soil/Sediment	D	87.6		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-40-50 1:200										
1635049-49	As(BAT)	Soil/Sediment	D	599		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-40-50 1:4										
1635049-46	As(BAT)	Soil/Sediment	D	35.6		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-40-50 1:50										
1635049-48	As(BAT)	Soil/Sediment	D	323		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-40-50 1:50 48 hrs.										
1635049-64	As(BAT)	Soil/Sediment	D	391		0.450	1.00	µg/L	B170298	1700249
WCTSD001A-40-50 1:50 96 hrs.										
1635049-65	As(BAT)	Soil/Sediment	D	354		0.450	1.00	µg/L	B170298	1700249
WCTSD001B-0-10 1:10										
1635049-51	As(BAT)	Soil/Sediment	D	93.9		0.450	1.00	µg/L	B170298	1700249

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
WCTSD001B-0-10 1:200										
1635049-53	As(BAT)	Soil/Sediment	D	394		0.450	1.00	µg/L	B170298	1700249
WCTSD001B-0-10 1:4										
1635049-50	As(BAT)	Soil/Sediment	D	111		0.450	1.00	µg/L	B170298	1700249
WCTSD001B-0-10 1:50										
1635049-52	As(BAT)	Soil/Sediment	D	222		0.450	1.00	µg/L	B170298	1700249
WCTSD001B-40-50 1:10										
1635049-55	As(BAT)	Soil/Sediment	D	295		0.450	1.00	µg/L	B170298	1700249
WCTSD001B-40-50 1:200										
1635049-57	As(BAT)	Soil/Sediment	D	812		0.450	1.00	µg/L	B170298	1700249
WCTSD001B-40-50 1:4										
1635049-54	As(BAT)	Soil/Sediment	D	142		0.450	1.00	µg/L	B170298	1700249
WCTSD001B-40-50 1:50										
1635049-56	As(BAT)	Soil/Sediment	D	632		0.450	1.00	µg/L	B170298	1700249

Accuracy & Precision Summary

Batch: B162109
Lab Matrix: Soil/Sediment
Method: SM 2540G

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B162109-DUP1	**Duplicate, (1635047-01)**						
	%TS	97.27		97.27	%		0% 15

Accuracy & Precision Summary

Batch: B162113
Lab Matrix: Soil/Sediment
Method: SM 2540G

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B162113-DUP1	**Duplicate, (1635047-02)**								
	%TS	90.28		91.02	%			0.8%	15

Accuracy & Precision Summary

Batch: B170298
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B170298-DUP3	**Duplicate, Analytical Duplicate (1635049-04)**						
	As(BAT)	0.521		0.523	mg/kg		0.5% 30
B170298-MS3	**Matrix Spike, Post Spike (1635049-04)**						
	As(BAT)	0.521	1.000	1.432	mg/kg	91% 70-130	
B170298-MSD3	**Matrix Spike Duplicate, Post Spike (1635049-04)**						
	As(BAT)	0.521	1.000	1.465	mg/kg	94% 70-130	3% 30
B170298-DUP1	**Duplicate, (1635049-06)**						
	As(BAT)	33.72		33.89	mg/kg		0.5% 30
B170298-DUP4	**Duplicate, Analytical Duplicate (1635049-14)**						
	As(BAT)	36.25		35.81	mg/kg		1% 30
B170298-MS4	**Matrix Spike, Post Spike (1635049-14)**						
	As(BAT)	36.25	12.41	48.62	mg/kg	100% 70-130	
B170298-MSD4	**Matrix Spike Duplicate, Post Spike (1635049-14)**						
	As(BAT)	36.25	12.41	48.80	mg/kg	101% 70-130	1% 30
B170298-DUP5	**Duplicate, Analytical Duplicate (1635049-23)**						
	As(BAT)	127.1		128.7	mg/kg		1% 30
B170298-MS5	**Matrix Spike, Post Spike (1635049-23)**						
	As(BAT)	127.1	50.32	181.2	mg/kg	107% 70-130	
B170298-MSD5	**Matrix Spike Duplicate, Post Spike (1635049-23)**						
	As(BAT)	127.1	50.32	182.4	mg/kg	110% 70-130	2% 30
B170298-MS6	**Matrix Spike, Post Spike (1635049-41)**						
	As(BAT)	27.85	12.30	38.97	mg/kg	90% 70-130	
B170298-MSD6	**Matrix Spike Duplicate, Post Spike (1635049-41)**						
	As(BAT)	27.85	12.30	38.92	mg/kg	90% 70-130	0.5% 30

Accuracy & Precision Summary

Batch: B170298
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B170298-MS1	**Matrix Spike, Post Spike (1635049-57)**						
	As(BAT)	160.8	49.51	210.9	mg/kg	101% 70-130	
B170298-MSD1	**Matrix Spike Duplicate, Post Spike (1635049-57)**						
	As(BAT)	160.8	49.51	212.6	mg/kg	105% 70-130	3% 30
B170298-DUP2	**Duplicate, (1635049-60)**						
	As(BAT)	36.69		38.16	mg/kg		4% 30
B170298-MS2	**Matrix Spike, Post Spike (1635049-64)**						
	As(BAT)	19.32	12.35	31.96	mg/kg	102% 70-130	
B170298-MSD2	**Matrix Spike Duplicate, Post Spike (1635049-64)**						
	As(BAT)	19.32	12.35	32.66	mg/kg	108% 70-130	5% 30

Accuracy & Precision Summary

Batch: B170298
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B170298-DUP3	**Duplicate, Analytical Duplicate (1635049-04)**								
	As(BAT)	130.2		130.8	µg/L			0.5%	20
B170298-MS3	**Matrix Spike, Post Spike (1635049-04)**								
	As(BAT)	130.2	250.0	358.0	µg/L	91%	75-125		
B170298-MSD3	**Matrix Spike Duplicate, Post Spike (1635049-04)**								
	As(BAT)	130.2	250.0	366.1	µg/L	94%	75-125	2%	20
B170298-DUP1	**Duplicate, (1635049-06)**								
	As(BAT)	684.3		703.0	µg/L			3%	20
B170298-DUP4	**Duplicate, Analytical Duplicate (1635049-14)**								
	As(BAT)	730.2		721.3	µg/L			1%	20
B170298-MS4	**Matrix Spike, Post Spike (1635049-14)**								
	As(BAT)	730.2	250.0	979.4	µg/L	100%	75-125		
B170298-MSD4	**Matrix Spike Duplicate, Post Spike (1635049-14)**								
	As(BAT)	730.2	250.0	983.0	µg/L	101%	75-125	0.4%	20
B170298-DUP5	**Duplicate, Analytical Duplicate (1635049-23)**								
	As(BAT)	631.6		639.3	µg/L			1%	20
B170298-MS5	**Matrix Spike, Post Spike (1635049-23)**								
	As(BAT)	631.6	250.0	900.3	µg/L	107%	75-125		
B170298-MSD5	**Matrix Spike Duplicate, Post Spike (1635049-23)**								
	As(BAT)	631.6	250.0	906.0	µg/L	110%	75-125	0.6%	20
B170298-MS6	**Matrix Spike, Post Spike (1635049-41)**								
	As(BAT)	565.9	250.0	792.0	µg/L	90%	75-125		
B170298-MSD6	**Matrix Spike Duplicate, Post Spike (1635049-41)**								
	As(BAT)	565.9	250.0	791.0	µg/L	90%	75-125	0.1%	20

Accuracy & Precision Summary

Batch: B170298
Lab Matrix: Soil/Sediment
Method: EPA 6020B Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B170298-MS1	**Matrix Spike, Post Spike (1635049-57)**						
	As(BAT)	811.9	250.0	1065	µg/L	101% 75-125	
B170298-MSD1	**Matrix Spike Duplicate, Post Spike (1635049-57)**						
	As(BAT)	811.9	250.0	1073	µg/L	105% 75-125	0.8% 20
B170298-DUP2	**Duplicate, (1635049-60)**						
	As(BAT)	761.6		767.5	µg/L		0.8% 20
B170298-MS2	**Matrix Spike, Post Spike (1635049-64)**						
	As(BAT)	391.1	250.0	646.9	µg/L	102% 75-125	
B170298-MSD2	**Matrix Spike Duplicate, Post Spike (1635049-64)**						
	As(BAT)	391.1	250.0	661.2	µg/L	108% 75-125	2% 20

Method Blanks & Reporting Limits

Batch: B162109
Matrix: Soil/Sediment
Method: SM 2540G
Analyte: %TS

Sample	Result	Units
B162109-BLK1	-0.02	%
B162109-BLK2	-0.06	%

Average: -0.04
Limit: 0.21

MDL: 0.06
MRL: 0.21

Method Blanks & Reporting Limits

Batch: B162113
Matrix: Soil/Sediment
Method: SM 2540G
Analyte: %TS

Sample	Result	Units
B162113-BLK1	-0.05	%
B162113-BLK2	-0.02	%

Average: -0.04
Limit: 0.26

MDL: 0.08
MRL: 0.26

Method Blanks & Reporting Limits

Batch: B170298
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(BAT)

Sample	Result	Units
B170298-BLK1	35.9	mg/kg wet
B170298-BLK2	35.4	mg/kg wet
B170298-BLK3	35.2	mg/kg wet

MDL: 0.018
MRL: 0.040

Method Blanks & Reporting Limits

Batch: B170298
Matrix: Soil/Sediment
Method: EPA 6020B Mod
Analyte: As(BAT)

Sample	Result	Units
B170298-BLK1	897	µg/L
B170298-BLK2	884	µg/L
B170298-BLK3	880	µg/L

MDL: 0.450
MRL: 1.00

Sample Containers

Lab ID: 1635049-01
Sample: MWS007-9-10 1:50 48hrs
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-02
Sample: MWS007-9-10 1:50 96hrs
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-03
Sample: MWS007-9-10 1:50 168hrs
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 08/25/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-04
Sample: MWS007-9-10 1:4
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-05
Sample: MWS007-9-10 1:10
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Sample Containers

Lab ID: 1635049-06
Sample: MWS007-9-10 1:50
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-07
Sample: MWS007-9-10 1:200
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-08
Sample: MWS009-11-12 1:4
Comments: originally sample 1620033-07
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 2

Lab ID: 1635049-09
Sample: MWS009-11-12 1:10
Comments: originally sample 1620033-07
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 2

Lab ID: 1635049-10
Sample: MWS009-11-12 1:50
Comments: originally sample 1620033-07
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 2

Sample Containers

Lab ID: 1635049-11
Sample: MWS009-11-12 1:200
Comments: originally sample 1620033-07

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 2

Lab ID: 1635049-12
Sample: MWS010-12-13 1:4
Comments: originally sample 1620033-05

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Lab ID: 1635049-13
Sample: MWS010-12-13 1:10
Comments: originally sample 1620033-05

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Lab ID: 1635049-14
Sample: MWS010-12-13 1:50
Comments: originally sample 1620033-05

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Lab ID: 1635049-15
Sample: MWS010-12-13 1:200
Comments: originally sample 1620033-05

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Sample Containers

Lab ID: 1635049-16
Sample: MWS012-11.5-12.5 1:4
Comments: originally sample 1620033-08
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/12/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-17
Sample: MWS012-11.5-12.5 1:10
Comments: originally sample 1620033-08
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/12/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-18
Sample: MWS012-11.5-12.5 1:50
Comments: originally sample 1620033-08
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/12/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-19
Sample: MWS012-11.5-12.5 1:200
Comments: originally sample 1620033-08
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/12/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-20
Sample: MWS013-12.5-13.5 1:4
Comments: originally sample 1620033-04
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Sample Containers

Lab ID: 1635049-21
Sample: MWS013-12.5-13.5 1:10
Comments: originally sample 1620033-04
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Lab ID: 1635049-22
Sample: MWS013-12.5-13.5 1:50
Comments: originally sample 1620033-04
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Lab ID: 1635049-23
Sample: MWS013-12.5-13.5 1:200
Comments: originally sample 1620033-04
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/10/2016
Received: 05/11/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 1

Lab ID: 1635049-24
Sample: TBS003-14-15 1:50 48 hrs.
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-25
Sample: TBS003-14-15 1:50 96 hrs.
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Sample Containers

Lab ID: 1635049-26
Sample: TBS003-14-15 1:50 168 hrs.
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-27
Sample: TBS003-14-15 1:4
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-28
Sample: TBS003-14-15 1:10
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-29
Sample: TBS003-14-15 1:50
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-30
Sample: TBS003-14-15 1:200
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Sample Containers

Lab ID: 1635049-31
Sample: TBS005-17-18 1:4
Comments: originally sample 1620033-18
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-32
Sample: TBS005-17-18 1:10
Comments: originally sample 1620033-18
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-33
Sample: TBS005-17-18 1:50
Comments: originally sample 1620033-18
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-34
Sample: TBS005-17-18 1:200
Comments: originally sample 1620033-18
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-35
Sample: TBS007-16.5-17.5 1:4
Comments: originally sample 1620033-20
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 5

Sample Containers

Lab ID: 1635049-36
Sample: TBS007-16.5-17.5 1:10
Comments: originally sample 1620033-20

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 5

Lab ID: 1635049-37
Sample: TBS007-16.5-17.5 1:50
Comments: originally sample 1620033-20

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 5

Lab ID: 1635049-38
Sample: TBS007-16.5-17.5 1:200
Comments: originally sample 1620033-20

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 5

Lab ID: 1635049-39
Sample: WCTSD001A-0-10 1:4
Comments: originally sample 1620033-34

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-40
Sample: WCTSD001A-0-10 1:10
Comments: originally sample 1620033-34

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Sample Containers

Lab ID: 1635049-41
Sample: WCTSD001A-0-10 1:50
Comments: originally sample 1620033-34

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-42
Sample: WCTSD001A-0-10 1:200
Comments: originally sample 1620033-34

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-43
Sample: WCTSD001A-40-50 1:50 48 hrs.
Comments: originally sample 1620033-35

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-44
Sample: WCTSD001A-40-50 1:50 96 hrs.
Comments: originally sample 1620033-35

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-45
Sample: WCTSD001A-40-50 1:50 168 hrs.
Comments: originally sample 1620033-35

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Sample Containers

Lab ID: 1635049-46
Sample: WCTSD001A-40-50 1:4
Comments: originally sample 1620033-35

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE		4oz	none	n/a		Cooler 7

Lab ID: 1635049-47
Sample: WCTSD001A-40-50 1:10
Comments: originally sample 1620033-35

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-48
Sample: WCTSD001A-40-50 1:50
Comments: originally sample 1620033-35

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-49
Sample: WCTSD001A-40-50 1:200
Comments: originally sample 1620033-35

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-50
Sample: WCTSD001B-0-10 1:4
Comments: originally sample 1620033-36

Report Matrix: Soil/Sediment
Sample Type: Sample

Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Sample Containers

Lab ID: 1635049-51
Sample: WCTSD001B-0-10 1:10
Comments: originally sample 1620033-36
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-52
Sample: WCTSD001B-0-10 1:50
Comments: originally sample 1620033-36
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-53
Sample: WCTSD001B-0-10 1:200
Comments: originally sample 1620033-36
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-54
Sample: WCTSD001B-40-50 1:4
Comments: originally sample 1620033-37
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-55
Sample: WCTSD001B-40-50 1:10
Comments: originally sample 1620033-37
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 08/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Sample Containers

Lab ID: 1635049-56
Sample: WCTSD001B-40-50 1:50
Comments: originally sample 1620033-37
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-57
Sample: WCTSD001B-40-50 1:200
Comments: originally sample 1620033-37
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-58
Sample: Spiked Groundwater (Step 1)
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 08/25/2016
Received: 08/26/2016

Lab ID: 1635049-59
Sample: Spiked Groundwater (Step 2)
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 08/25/2016
Received: 08/26/2016

Lab ID: 1635049-60
Sample: MWS007-9-10 1:50 48hrs
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Lab ID: 1635049-61
Sample: MWS007-9-10 1:50 96hrs
Comments: originally sample 1620033-06
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/11/2016
Received: 05/13/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 3

Sample Containers

Lab ID: 1635049-62
Sample: TBS003-14-15 1:50 48 hrs.
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-63
Sample: TBS003-14-15 1:50 96 hrs.
Comments: originally sample 1620033-17
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/17/2016
Received: 05/18/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 4

Lab ID: 1635049-64
Sample: WCTSD001A-40-50 1:50 48 hrs.
Comments: originally sample 1620033-35
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-65
Sample: WCTSD001A-40-50 1:50 96 hrs.
Comments: originally sample 1620033-35
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 05/18/2016
Received: 05/20/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Jar HDPE	4oz		none	n/a		Cooler 7

Lab ID: 1635049-66
Sample: Spiked 0.025M NaCl
Report Matrix: Soil/Sediment
Sample Type: Sample
Collected: 08/25/2016
Received: 08/26/2016

Shipping Containers

Cooler 1

Received: May 11, 2016 14:30
Tracking No: Courier via FedEx
Coolant Type: Blue Ice
Temperature: 5.1 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR4

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 2

Received: May 13, 2016 17:05
Tracking No: Courier via FedEx
Coolant Type: Blue Ice
Temperature: 5.8 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 3

Received: May 13, 2016 17:05
Tracking No: Courier via FedEx
Coolant Type: Blue Ice
Temperature: 4.0 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 4

Received: May 18, 2016 10:45
Tracking No: Courier via FedEx
Coolant Type: Blue Ice
Temperature: 4.1 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 5

Received: May 18, 2016 10:45
Tracking No: Courier via FedEx
Coolant Type: Blue Ice
Temperature: 2.1 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR2

Custody seals present? No
Custody seals intact? No
COC present? Yes

Cooler 7

Received: May 20, 2016 9:30
Tracking No: Courier via FedEx
Coolant Type: Blue Ice
Temperature: 6.5 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR4

Custody seals present? No
Custody seals intact? No
COC present? Yes

GSI Water Solutions, Inc.
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s): GSI

Client Contact

Project Name: Parcel 15 - POT
Project # or PO #: 603.002.010
Project Manager: Erin Hughes/Cindy Ryals
Phone #:971-200-8528 and 971-200-8531
Report to email: echughes@gsiws.com, cryals@gsiws.com

For Lab Use Only:
SDG:___
Custody Seals intact? ☐ Yes ☐ No
Hand delivered? ☐ Yes ☐ No
Cooler Temp :____°C
Therm ID No.:____Therm Exp.____

Analysis Turnaround Time: ☒ 21 days (STD)
☐ 14 days * ☐ 7 days * ☐ 5 days *
☐ 3 day * ☐ 2 days * ☐ 1 day *

Lab PM
Brooks- Ben Wozniak- 206-753-6158
TestAmerica - Christabel Escarez- 253.248.4975

						Laboratory: Brooks Applied Labs — Analysis Requested								TestAmerica							
Sample Identification	**Sample Date**	**Sample Time**	**Sample Type (C=Comp, G=Grab)**	**Matrix**	**Total # of Cont.**	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	**Sample Specific Notes:**
MWS005R-10.5-11.5	5/9/16	1445	G	S	1	X	X	X	X				X	X	X	X				
MWS008-11.5-12.5	↓	1650	G	S	1	X	X	X	X				X	X						
MWS011-13-14	5/10/16	925	G	S	1	X	X	X	X				X	X						
MWS013-12.5-13.5	↓	1135	G	S	1	X	X	X	X	X	X	X	X	X			X	X		
MWS010-12-13	↓	1505	G	S	1	X	X	X	X	X	X	X	X	X			X	X		

Possible Hazard Identification:
Are samples hazardous? ☐ Yes ☒ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic
If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal **(A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)**
☐ Return to Client ☐ Disposal by Lab ☑ Archive for 1 yr + contact GSI

Received by: Mark McDonald Date/Time: 5/11/16 10:00
Received by: Date/Time: 5/11/16 14:30
Received in Laboratory by: Date/Time:

Relinquished by: Peter Pellegrini - GSI Date/Time: 5-11-16 : 1000
Relinquished by: Date/Time:
Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other Tracking #:

Special Instructions/QC Requirements
*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquots for analysis at Brooks and Test America.**
**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**
***** Sample cores have been packaged anoxically and will be held under frozen archival at Test America for potential future analysis.**
Please contact Cindy Ryals at 971-200-8531 with any questions.

See SAP tables A-3 + A-5

GSI Water Solutions, Inc.
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s): GSI

Client Contact

Project Name: Parcel 15 - POT

Project # or PO #: 603.002.010

Project Manager: Erin Hughes/Cindy Ryals

Phone #:971-200-8528 and 971-200-8531

Report to email: echughes@gsiws.com, cryals@gsiws.com

Analysis Turnaround Time:
☐ 21 days (STD)
☐ 14 days *
☐ 7 days *
☐ 5 days * See contract
☐ 3 day *
☐ 2 days *
☐ 1 day *

For Lab Use Only:
SDG:___
Custody Seals intact? ☐ Yes ☐ No
Hand delivered? ☐ Yes ☐ No
Cooler Temp :____°C
Therm ID No.:____Therm Exp.____

Lab PM
Brooks- Ben Wozniak- 206-753-6158
TestAmerica - Christabel Escarez- 253.248.4975

						Laboratory														
						Brooks Applied Labs								TestAmerica						
						Analysis Requested														
Sample Identification	**Sample Date**	**Sample Time**	**Sample Type (C=Comp, G=Grab)**	**Matrix**	**Total # of Cont.**	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
MWS007-9-10	5/11/16	940	G	S	1	X	X	X	X	X	X	X	X	X			X	X		
MWS009-11-12	↓	1435	|	|	|	X	X	X	X	X	X	X	X	X			X	X		
MWS012-11.5-12.5	5/12/16	1000	|	|	|	X	X	X	X	X	X	X	X	X			X	X		
TBS006-13-14	|	1325	|	|	|	X	X	X	X				X	X			no liner present - only soil			
TBS004-12-13	↓	1640	↓	↓	↓	X	X	X	X				X	X						
TBS008-13-14	5/13/16	915	G	S	1	X	X	X	X				X	X						
TBS009-7.4-8.4	↓	1215	↓	↓	↓	X	X	X	X				X	X	X			X		
TBS009-8.8-9.8	5/13/16	1220	G	S	1	X	X	X	X				X	X	X			X		
TBS009-12-13	↓	1225	↓	↓	↓	X	X	X	X				X	X	X			X		

Possible Hazard Identification:
Are samples hazardous? ☐ Yes ☒ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic
If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal (A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)
☐ Return to Client ☐ Disposal by Lab ☒ Archive for 1 yr + contact GSI

Received by: Mark McDonald Date/Time: 5/13/16 1525
Relinquished by: Renee Fowler, GSI Date/Time: 5/13/16 1525
Received by: Date/Time:
Relinquished by: Date/Time:
Received in Laboratory by: Jen Waller Date/Time: 5/13/16 17:05
Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other Tracking #:

Special Instructions/QC Requirements
*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquotes for analysis at Brooks and Test America.**
**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**
***** Sample cores have been packaged anoxically and will be held under frozen archival at Test America for potential future analysis.**
Please contact Cindy Ryals at 971-200-8531 with any questions.

See SAP Tables ~~B-4 + B-5~~ RF A-3 + A-4

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Project Name: Parcel 15 - POT	SDG:___
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Project Manager: Erin Hughes/Cindy Ryals	Hand delivered? ☐ Yes ☐ No
Phone #:971-200-8528 and 971-200-8531	Cooler Temp :____°C
Report to email: echughes@gsiws.com, cryals@gsiws.com	Therm ID No.:____Therm Exp.____

Analysis Turnaround Time:
☐ 21 days (STD)
☐ 14 days * ☐ 7 days * ☐ 5 days *
☐ 3 day * ☐ 2 days * ☐ 1 day *
See contract

Laboratory: [✓ Brooks Applied Labs] | TestAmerica

Lab PM

Brooks- Ben Wozniak- 206-753-6158

TestAmerica - Christabel Escarez- 253.248.4975

Analysis Requested (Brooks Applied Labs: Anoxic Homogenization* through Archive (frozen)**; TestAmerica: Total Organic Carbon through Archive Only (Frozen)***)

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
TBS001-[illegible] RF 11-12	5/16/16	1115	G	S	1	X	X	X	X				X	X						
TBS002-12.5-13.5	↓	1400	↓	↓	↓	X	X	X	X				X	X						
TBS003-14-15	5/17/16	925				X	X	X	X	X	X	X	X	X			X	X		
~~TBS003-1~~ ECH	~~5/17/16~~	~~1000~~																		
TBS005-17-18	5/17/16	1155	G	S	2	X	X	X	X	X	X	X	X	X			X	X		
TPS002-0.5-1.5	↓	1410	↓	↓		X	X	X	X	X	X	X	X	X	X	X	~~X~~	~~X~~	no sulfide + grain size RF	
TBS007-16.5-17.5		1520			↓	X	X	X	X	X	X	X	X	X			X	X		
TPS001-0.5-1.5		1720				X	X	X	X	X	X	X	X	X	X	X				
TPS001F-1.5-2.5		1730				X	X	X	X	X	X	X	X	X	X	X				
TPS002-10.5-12.5	5/17/16	1530	G	S	1	X	X	X	X				X	X	X					

Possible Hazard Identification:
Are samples hazardous? ☐ Yes ☒ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic
If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal **(A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)**
☐ Return to Client ☐ Disposal by Lab ☒ Archive for 1 yr + contact GSI

Received by: Chris Bugsch	Date/Time: 5/18/16 8:15am	Relinquished by: Erin Hughes	Date/Time: 5/18/16 8:15
Received by:	Date/Time: 5/18/16 10:45	Relinquished by: Chris	Date/Time: 5/18/16 10:45
Received in Laboratory by:	Date/Time:	Relinquished by:	Date/Time:
		Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other	Tracking #:

Special Instructions/QC Requirements
*** Brooks analytical to homogenize sediment anoxically in a glove box and provide aliquotes for analysis at Brooks and Test America.**
**** Brooks to archive approximately 8 oz of extra homogenized soil/sediment frozen for potential future analysis.**
***** Sample cores have been packaged anoxically and will be held under frozen archival at Test America for potential future analysis.**
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55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

page 1 of 2

Chain of Custody Record

Field Sampler(s): GSI

Client Contact	**For Lab Use Only:**
Project Name: Parcel 15 - POT	SDG:___
Project # or PO #: 603.002.010	Custody Seals intact? ☐ Yes ☐ No
Project Manager: Erin Hughes/Cindy Ryals	Hand delivered? ☐ Yes ☐ No
Phone #:971-200-8528 and 971-200-8531	Cooler Temp :____°C
Report to email: echughes@gsiws.com, cryals@gsiws.com	Therm ID No.:____Therm Exp.____

Analysis Turnaround Time: ☐ 21 days (STD) ☐ 14 days * ☐ 7 days * ☐ 5 days * ☐ 3 day * ☐ 2 days * ☐ 1 day * See contract

Laboratory: [✓ Brooks Applied Labs] TestAmerica

Lab PM: Brooks- Ben Wozniak- 206-753-6158; TestAmerica - Christabel Escarez- 253.248.4975

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
~~TB~~ ~~FB~~ TPS001TB-12_13	5/18/16	920		soil	1	X	X	X	X				X	X	X					
WCTSD004B-0_10	5/18/16	10:15		sed	1	X	X	X	X				X	X	X		X			
WCTSD003A-0_10	5/18/16	11:00		sed	1	X	X	X	X				X	X			X			
WCTSD003A-40_50	5/18/16	11:05		sed	1	X	X	X	X				X	X			X			
WCTSD003B-0_10	5/18/16	1110		sed	1	X	X	X	X				X	X			X			
WCTSD003B-40_50	5/18/16	1130		sed	1	X	X	X	X				X	X			X			
WCTSD002A-0_10	↓	1200		↓	↓	X	X	X	X				X	X			X			
WCTSD002A-36_46		1210				X	X	X	X				X	X			X			
WCTSD002B-0_10		1220				X	X	X	X				X	X			X			
WCTSD002B-40_50		1230				X	X	X	X				X	X			X			
WCTSD001A-0_10		1240				X	X	X	X				X	X			X			
WCTSD001A-40_50		1245				X	X	X	X				X	X			X			
WCTSD001B-0_10		1250				X	X	X	X				X	X			X			

Possible Hazard Identification:

Are samples hazardous? ☐ Yes ☒ No

If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic

If YES or NO is not checked above, samples will be assumed hazardous and hazardous disposal fees will be applied.

Sample Disposal **(A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)**

☐ Return to Client ☐ Disposal by Lab ☒ Archive for 1 yr + contact GSI

Received by:	Date/Time: 5/20/16 8:15am	Relinquished by: Renee Foster GSI	Date/Time: 5/20/16 815
Received by:	Date/Time:	Relinquished by:	Date/Time: 5/20/16 956
Received in Laboratory by:	Date/Time: 5/20/16 9:30	Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other	Tracking #:

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page 2 of 2

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See contract

Laboratory: Brooks Applied Labs | TestAmerica

Lab PM

Brooks- Ben Wozniak- 206-753-6158

TestAmerica - Christabel Escarez- 253.248.4975

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	Anoxic Homogenization*	Arsenic	Iron	Total Solids	Arsenic Speciation - As (III)/As(V)	Sequential Extraction	Batch Adsorption	Archive (frozen)**	Total Organic Carbon	Pentachlorophenol and pH	Dixon/Furans	Sulfide	Grain Size	Archive Only (Frozen)***	Sample Specific Notes:
WCTSD001B-40_50	5/18/16	1255	G	Sed	1	X	X	X	X				X	X			X			
WCTSD004A-40_50	↓	1340	↓	↓	↓	X	X	X	X				X	X	X		X			
WCTSD004B-40_50	↓	1345	↓	↓	↓	X	X	X	X				X	X	X		X			
WCTSD004A-0_10	↓	1350	↓	↓	↓	X	X	X	X				X	X	X		X			

Possible Hazard Identification:
Are samples hazardous? ☐ Yes ☒ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic
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Received by:	Date/Time: 5/20/16 8:15am	Relinquished by: GSI	Date/Time: 5/20/16 815
Received by:	Date/Time:	Relinquished by:	Date/Time: 5/20/16 9:56am
Received in Laboratory by:	Date/Time: 5/20/16 9:30	Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☑ Other	Tracking #:

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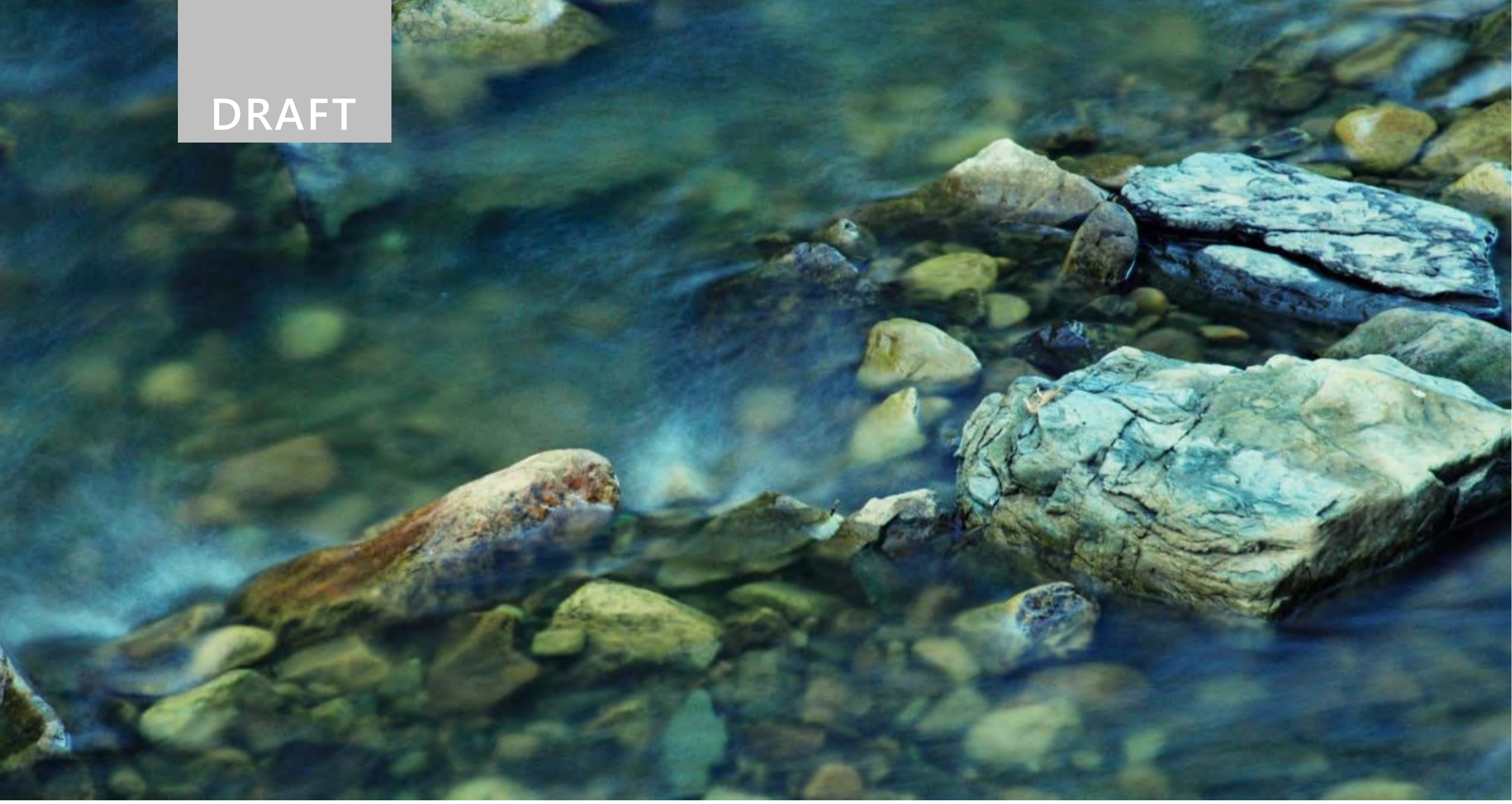
Please contact Cindy Ryals at 971-200-8531 with any questions.

Appendix I: Iron-Arsenic Precipitate Characterization Study

DRAFT



June 2017
Parcel 15 (Portac) Remedial Investigation

Iron-Arsenic Precipitate Characterization Study
Parcel 15 (Portac) Remedial Investigation

Prepared for the Port of Tacoma and Portac, Inc.

DRAFT

June 2017
Parcel 15 (Portac) Remedial Investigation

Iron-Arsenic Precipitate Characterization Study Parcel 15 (Portac) Remedial Investigation

Prepared for
Port of Tacoma
and Portac, Inc.

Prepared by
Anchor QEA, LLC
6720 SW Macadam Avenue, Suite 125
Portland, Oregon 97219

Project Number: 150996-01.01

DRAFT

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TABLES

FIGURES

ATTACHMENTS

ABBREVIATIONS

µg/L	micrograms per liter
µS/cm	microSiemens per centimeter
As	arsenic
DO	dissolved oxygen
EDX	energy dispersive X-ray
EGL	Anchor QEA Environmental Geochemistry Laboratory
Fe	iron
Fe/As	the atomic ratio of iron to arsenic
FS	Feasibility Study
FTIR	fourier-transform infrared spectroscopy
HRSEM	high resolution scanning electron microscopy
mg/L	milligrams per liter
mV	millivolt
O	oxygen
ORP	oxidation-reduction potential
Port	Port of Tacoma
Portac	Parcel 15
RI	Remedial Investigation
SAED	selected area electron diffraction
SC	specific conductance
SEM	scanning electron microscopy
STEM	scanning transmission electron microscope
TEM	transmission electron microscopy
XRD	X-ray diffraction
WDX	wavelength dispersive X-ray

1 Background

This report presents the results of the arsenic precipitation study performed by Anchor QEA, LLC, with support from GSI Water Solutions, Inc., and S.S. Papadopulos & Associates, Inc., for the Remedial Investigation (RI) at the Parcel 15 (Portac) site. That RI is being prepared on behalf of the Port of Tacoma (Port) and Portac, Inc., as required under the Model Toxics Control Act Agreed Order No. DE-11237 executed by the Washington State Department of Ecology, the Port, and Portac.

This work was initiated after spontaneous precipitation of arsenic and iron was observed during laboratory batch adsorption testing. That precipitation was observed in the absence of soils in filtered groundwater samples maintained under anaerobic conditions. Based on the potential importance of this precipitate formation to an understanding of arsenic fate and transport potential, follow-up studies were implemented to better define the identity of the precipitate and the conditions under which the precipitates may form.

The methods for the supplemental testing are described in Section 2. Results are presented and discussed in Section 3. Implications of the arsenic-iron precipitation have been incorporated into the site RI and will inform the pending development of the Feasibility Study (FS).

2 Procedures and Methods

2.1 Groundwater Collection

Representative site groundwater for the laboratory study was collected from monitoring well MW-07 using low-flow sampling procedures with a peristaltic pump and oxygen-impermeable tubing. The well was purged until field parameters (dissolved oxygen [DO], oxidation-reduction potential [ORP], and pH) stabilized in the flow-cell as measured by a multi-parameter meter. Sampling was performed inside a glove bag under a nitrogen atmosphere (Figure 1). Samples were field filtered through a 0.45-micron filter and were placed in 1-gallon glass jars with Teflon-lined lids. The sample bottles were packaged in Mylar barrier bags along with oxygen-absorbent packets, sealed, and transported on ice to the Anchor QEA Environmental Geochemistry Laboratory (EGL).

2.2 Precipitate Formation

Once the samples were received at the EGL, the anaerobic test bottles were transferred to the glove box prior to removal from the Mylar barrier bags. Aerobic test bottles were placed on the bench-top under ambient atmosphere. Photographs were taken of each sample bottle (Figure 2). A slight color change was noted between field and laboratory appearance (per observation by Anchor QEA staff); however, no precipitates were noted. The pH, ORP, specific conductance [SC], and DO were determined for each sample.

Arsenic spiking was performed for one each of the aerobic and anaerobic tests using a stock solution of either disodium hydrogen arsenate ($Na_2HAs^{V}O_4$) or sodium arsenite ($NaAs^{III}O_2$) to a target concentration of 100 milligrams per liter (mg/L) arsenic, reflecting maximum observed concentrations at the site. One anaerobic test was left as an unspiked control. The five test solutions generated (Table 1) were stirred continuously throughout the testing period.

Table 1
Induced Precipitation Test Configuration

Incubation	Arsenic Spike	Test Code
Anaerobic	Arsenate	NA
	Arsenite	NI
	Control (not spiked)	NC
Aerobic	Arsenate	OA
	Arsenite	OI

Note:
Anaerobic incubations were performed under a nitrogen atmosphere and in sealed containers. Aerobic incubations were performed in open containers in contact with ambient air.

Immediately after the arsenic stock solution was spiked, the test solutions were photographed; the post-spike pH, ORP, SC, and DO were recorded; and a sample was collected from each test solution. The samples were 0.1-micron filtered and submitted to Brooks Applied Labs for analysis of dissolved arsenic, iron, and manganese.

The test solutions were incubated at ambient temperature with continuous stirring. The samples were inspected visually and photographed after 24 hours of stirring and exhibited minimal change in color and no obvious precipitates. The samples were inspected visually and photographed at 48 hours, and minimal precipitates were noted. Test solution photographs for pre-spike, post-spike, 24-hour, and 48-hour inspections are shown in Figure 2. After 6 days of reaction, notable color change and precipitates were observed in the sample bottles, and the final sample collection was performed. Each sample bottle was photographed (Figure 3); the pH, ORP, SC, and DO were recorded; and samples were collected for Brooks Applied Labs with 0.1-micron filtration for dissolved arsenic, iron, and manganese analysis.

2.3 Precipitate Recovery

Following 6 days of incubation, the test solutions were filtered through 0.45-micron filters to recover precipitates (Figure 4). Following the 0.45-micron filtration, the test solutions were filtered through a 0.1-micron filter, with minimal additional solids retained. Anaerobic tests were filtered under a nitrogen atmosphere. The precipitate material from each test solution was dried under a nitrogen atmosphere.

2.4 X-Ray Diffraction

X-ray diffraction (XRD) was performed to determine bulk mineralogy of crystalline phases of the precipitates at Portland State University using a Phillips X'Pert XRD with a copper k-alpha X-ray source. The precipitate samples were transferred under nitrogen to XRD sample holders with Mylar XRD-specific oxygen barrier films. Sample handling was minimized, and the samples were not ground to fine powder, except the aerobic-arsenate solution precipitate, which was manually ground in air in a mortar and pestle and lightly packed into a top-pack XRD specimen holder. Given the limited sample mass, the sample holders were not packed to specimen eucentric height.

2.5 Fourier-Transform Infrared Spectroscopy

Fourier-transform infrared spectroscopy (FTIR) was used to determine chemical bonds and functional groups present in the precipitates. FTIR analysis was performed on a Nicolet™ FT-IR Spectrometer. The samples were transported to Portland State University under a nitrogen atmosphere in Mylar barrier bags. Samples were transferred to the instrument under ambient atmosphere.

2.6 Scanning Electron Microscopy

High-resolution scanning electron microscopy (HRSEM) allows characterization of sample surface details and elemental composition. HRSEM was performed at Portland State University using a Zeiss Sigma variable pressure field emission gun HRSEM. Precipitate samples were mounted on scanning electron microscopy (SEM) sample holders and transported to Portland State University under a nitrogen atmosphere. The samples were coated with a very thin layer of carbon (a few angstroms) prior to SEM analysis to prevent build-up of electrons on the sample surface (charging). In SEM, a high voltage beam of electrons is directed at the sample surface, causing ejection of electrons and X-ray energy from the sample surface. The following three detectors were utilized: 1) the secondary electron detector, which allows visualization of the sample surface; 2) the back-scatter electron detector, which allows visualization of variability in average atomic mass of the material; and 3) the wavelength dispersive X-ray (WDX) detector, which is used to identify the elements present and determine relative elemental composition.

2.7 Transmission Electron Microscopy

Transmission electron microscopy (TEM) allows characterization of materials at the atomic scale. TEM was performed at Portland State University on an FEI Tecnai F-20 TEM/STEM (scanning transmission electron microscope). The precipitates were suspended in ethanol and sonicated to disrupt clumps. A drop of the suspension was placed on a TEM grid and allowed to dry. All sample preparation was performed under nitrogen, and the TEM grids were transported in sealed barrier bags to the instrument. Each sample was removed from the nitrogen atmosphere immediately prior to being placed in the TEM, at which point vacuum was immediately applied. The capabilities of this TEM include high-resolution imaging, element identification with the energy dispersive X-ray (EDX) detector, and nano-diffraction for mineral structure characterization. In TEM, an electron beam passes through a very thin sample of material. Bright Field images are generated by a sensor that detects weakening of the transmitted beam, and areas that are thicker, have higher atomic mass atoms, or are highly crystalline will appear darker in a Bright Field image. Selected area electron diffraction (SAED) patterns are generated by scattering in the electron beam by repeated patterns (crystal structure) in the sample.

3 Results

3.1 Groundwater Chemistry

Representative site groundwater was collected from MW-07 as described in Section 2.1. Groundwater in this well has had elevated alkalinity (approximately 1,000 mg/L as $CaCO_3$) and iron (approximately 100 mg/L) concentrations in recent sampling events (RI/FS Events 1 through 3). Arsenic concentrations have been approximately 20 mg/L in RI/FS Events 1 through 3. The groundwater chemistry from the three sampling events is included in Table 2. Groundwater chemistry has been variable, with notably lower concentrations of arsenic, iron, alkalinity, and dissolved ions in the Event 3 sample.

Table 2
Summary of Groundwater Chemistry Data for MW-07

Parameter[1]	Units	May/June 2016	August/ September 2016	November/ December 2016
Specific conductance	µS/cm	2,342	2,822	479
Dissolved oxygen	mg/L	0.36	0.37	0.15
pH		6.65	6.88	5.86
Oxidation-reduction potential	mV	-83.8	-144.8	57.3
Arsenic (total)	µg/L	20.8	25.7	15.6
Arsenic	µg/L	21.5	27.5	13.2
Arsenate	µg/L	--	30.5	9.71
Arsenite	µg/L	--	0.924 J	3.75
Iron	mg/L	118	123	59.1
Manganese	mg/L	7.18	7.98	2.77
Dissolved organic carbon	mg/L	66	80	23
Total organic carbon	mg/L	64	79	12
Total suspended solids	mg/L	--	87	55
Calcium	mg/L	160	150	53
Magnesium	mg/L	110	100	30
Potassium	mg/L	37	38	24
Sodium	mg/L	200	260	37
Sulfate	mg/L	0.71 J	1.2	95 J
Chloride	mg/L	240	260	26
Fluoride	mg/L	1.2	0.97	0.73

Parameter[1]	Units	May/June 2016	August/ September 2016	November/ December 2016
Ortho-phosphate	mg/L	0.12	0.14	0.1 U
Alkalinity (total)	mg/L as $CaCO_3$	940	1,100	310

Notes:

1. Parameter results are for dissolved concentrations except where otherwise noted.
   Sulfide was below the detection limit in all three sampling events (not shown).
   Nitrate was less than the reporting limit, and nitrite was less than the detection limit in all three sampling events (not shown).

--: not reported
µg/L: micrograms per liter
µS/cm: microSiemens per centimeter
J: estimated value
mg/L: milligrams per liter
mV: millivolts
U: non-detect reported at the method detection limit

3.2 Precipitation Tests Water Chemistry

Groundwater collected at MW-7 was used in the precipitate test solutions. The initial (prior to arsenic spiking) and final (at the Day 6 sampling event) geochemical parameters in each test solution are summarized in Table 3. Geochemical parameters for the aerobic tests were measured under ambient air. The aerobic tests exhibited an increase in pH and ORP.

Table 3
Geochemical Parameters Measured During Precipitation Tests

Test	Sample	pH	ORP (mV)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)
Anaerobic Arsenite (NI)	Initial (Pre-Spike)	6.09	-53.6	1.6	535
	Final (Day 6)	6.40	-29.1	1.5	521
Anaerobic Arsenate (NA)	Initial (Pre-Spike)	5.93	-27.9	1.7	473
	Final (Day 6)	6.32	15.4	1.5	545
Aerobic Arsenite (OI)	Initial (Pre-Spike)	5.86	-4.2	5.2	579
	Final (Day 6)	8.23	113	4.9	580
Aerobic Arsenate (OA)	Initial (Pre-Spike)	5.90	-21.5	4.5	628
	Final (Day 6)	8.28	100	7.5	609
Anaerobic Control (NC)	Initial	5.77	-1.3	2.0	425
	Final (Day 6)	6.04	-6.3	1.6	368

Notes:
µS/cm: microSiemens per centimeter
mg/L: milligrams per liter
mV: millivolt
ORP: oxidation-reduction potential

Total and dissolved arsenic, iron, and manganese were measured prior to the precipitation tests, in the post-spike groundwater samples, and after the precipitate solids were recovered following 6 days of incubation (Table 4). Dissolved iron concentrations showed a substantial decrease (20 to 30 mg/L) in all of the arsenic-spiked solutions at the end of the reaction period. The laboratory analytical report is included in Attachment A.

Table 4
Arsenic, Iron, and Manganese Concentrations During the Precipitation Experiments

Test	Sample	Total Arsenic (μg/L)	Dissolved Arsenic (μg/L)	Total Iron (μg/L)	Dissolved Iron (μg/L)	Total Manganese (μg/L)	Dissolved Manganese (μg/L)
Anaerobic Arsenite (NI)	Initial (Post-Spike)	86,500	86,700	30,600	30,000	1,920	1,840
	Final	--	78,200	--	8,140	--	1,730
Anaerobic Arsenate (NA)	Initial (Post-Spike)	92,200	94,300	25,700	24,700	1,570	1,490
	Final	--	71,400	--	1,580	--	892
Aerobic Arsenite (OI)	Initial (Post-Spike)	99,300	103,000	35,000	32,300	2,150	2,100
	Final	--	75,800	--	41	--	545
Aerobic Arsenate (OA)	Initial (Post-Spike)	92,300	79,400	40,500	24,100	2,460	2,060
	Final	--	54,500	--	24	--	174
Anaerobic Control (NC)	Initial	1.82	2.16	21,200	20,400	1,350	1,260
	Final	--	3.89	--	14,300	--	1,280

Notes:
--: not measured
μg/L: micrograms per liter

3.3 X-ray Diffraction

The precipitate that formed in the aerobic arsenate-spiked solution had an XRD spectra consistent with ferrihydrite, a hydrated iron oxyhydroxide. Three of the precipitates—those formed in the anaerobic arsenite and arsenate-spiked solutions, as well as in the aerobic arsenite-spiked solution—were X-ray amorphous in the bulk powder samples, indicating they are dominated by non-crystalline or poorly crystalline phases. The XRD results are included in Attachment B.

3.4 Fourier-Transform Infrared Spectroscopy

The bonds identified by FTIR include arsenic-oxygen bonds, carbon oxygen bonds, and hydroxyl or water groups for precipitates from both the arsenate and arsenite-spiked solutions (Figure 5). The precipitates from the arsenite-spiked solutions also had a peak consistent with arsenic-oxygen-iron groups. The complete FTIR results are included in Attachment C.

3.5 High-Resolution Scanning Electron Microscopy

The precipitates formed a homogeneous layer on the filters, and at low magnification, they appear as a thin layer that cracked upon drying. At high magnification, very fine-scale (nanometer) individual particulates are visible in each sample (e.g., Figure 6). Each sample had a homogeneous composition, and the samples were composed predominantly of oxygen, iron, and arsenic (Figure 7). Carbon content is not reported because each sample was mounted on a carbon matrix and coated in carbon to minimize charging. The complete HRSEM results are included in Attachment D.

3.6 Transmission Electron Microscopy

TEM was performed on the precipitates formed in both the arsenite and arsenate-spiked anaerobic test solutions. The predominant material observed in the arsenate precipitate was poorly crystalline platelets (Figure 8) primarily composed of arsenic, iron, and oxygen. The arsenite precipitates had a greater degree of crystallinity than the precipitates formed in the arsenate-spiked samples. The carbon content could not be determined because the sample holder contains carbon. SAED d-spacings for the iron-arsenic precipitates are given in Table 5. The complete TEM results are included in Attachment E.

Table 5
Observed d-Spacings in Precipitates

Sample	Spot	Comments	Observed d-Spacings[1] (angstroms)				
		Approximate d-Spacing	**1.2**	**1.4**	**2.5**	**3.3**	**5.7**
Anaerobic Arsenite (NI)	NI-E[2]	Bright Field image shows typical iron-arsenic precipitates, with a greater degree of internal structure than other examples of the As-Fe particles—SAED image shows sharp rings	*	*	*	*	*
	NI-H	Typically observed iron-arsenic precipitates, with little internal structure in the platelets in the Bright Field image and very diffuse rings in the SAED image		*	*		
Anaerobic Arsenate (NA)	NA-A	Typical iron-arsenic precipitates, little internal structure in the Bright Field image, diffuse rings in the SAED image		*	*	*	
	NA-K	Typical iron-arsenic precipitates, also contains spar-like crystalline material; SAED sharp rings		*		*	
	NA-L	Typical iron-arsenic precipitates, little internal structure, SAED has diffuse rings		*	*		

Notes:

1. Excludes d-spacings observed for the TEM grid at approximately 1.95 and 3.4 angstroms.
2. The dots observed for spot NI-E indicate a greater degree of crystallinity than the diffuse rings observed for the other spots.

*: d-spacing observed

The d-spacing for the most crystalline example of the anaerobic arsenite precipitates (NI-E) is potentially consistent with green rust (Legrand et al. 2004). The platelets observed in the anaerobic arsenate precipitate are potentially consistent with ferrihydrite (Géhin et al. 2002; Legrand et al. 2004; Usman et al. 2012).

3.7 Micro-Elemental Analysis

Precipitate composition was determined on both SEM and TEM samples and is shown in Table 6. The SEM analysis would represent a greater mass of the precipitates analyzed, while TEM analysis would represent specific particulates. The precipitates generally had an atomic ratio of 2:1 iron to arsenic, though this ratio varied. Calcium was typically at a greater concentration in the precipitates formed in solutions with the arsenate spike. Cobalt was identified in the anaerobic arsenite spike precipitates but only in the TEM samples, and the source of this detection is unknown. Carbon content is not included in this table, while carbon is analyzed by both instruments the inclusion of carbon in the filter matrix for the SEM samples, the carbon coating for the SEM samples, and in the TEM grid prevent accurate determination of carbon content.

Table 6
Summary of Micro-Elemental Spot Analyses of Precipitates

Sample	Method	Spot	Element Concentration (Atom Percent)										Iron/Arsenic Ratio
			Arsenic	Iron	Oxygen	Silicon	Calcium	Manganese	Magnesium	Aluminum	Potassium	Cobalt	
Anaerobic Arsenite (NI)	SEM	Spectrum 7	11.0	26.5	60.2	1.6	0.7	ND	ND	ND	ND	ND	2.4
	SEM	Spectrum 8	11.0	23.8	62.9	1.5	0.7	ND	ND	ND	ND	ND	2.2
	SEM	Spectrum 9	10.9	22.1	65.0	1.4	0.6	ND	ND	ND	ND	ND	2.0
	TEM	NI-H	9.0	42.7	25.6	4.6	0.41	ND	ND	1.3	0.41	16.0	4.8
	TEM	NI-E	9.9	17.0	56.9	13.1	0.81	ND	ND	ND	ND	2.2	1.7
Anaerobic Arsenate (NA)	SEM	Spectrum 4	15.2	23.6	56.7	0.4	3.1	0.7	ND	ND	0.3	ND	1.6
	SEM	Spectrum 5	15.0	19.1	62.0	0.4	2.5	0.6	ND	ND	0.3	ND	1.3
	SEM	Spectrum 6	14.9	21.7	59.1	0.5	2.8	0.7	ND	ND	0.3	ND	1.5
	TEM	NA-L	12.4	13.1	69.9	1.2	2.7	0.4	ND	ND	0.30	ND	1.1
Aerobic Arsenite (OI)	SEM	Spectrum 1	10.3	20.7	64.1	2.1	2.0	0.9	ND	ND	ND	ND	2.0
	SEM	Spectrum 2	10.7	23.4	60.4	2.3	2.1	1.1	ND	ND	ND	ND	2.2
	SEM	Spectrum 3	10.0	20.0	65.1	2.0	1.8	1.0	ND	ND	ND	ND	2.0
Aerobic Arsenate (OA)	SEM	Spectrum 10	9.4	16.2	59.5	0.7	4.2	1.0	1.7	7.1	0.2	ND	1.7
	SEM	Spectrum 11	6.8	30.1	52.9	0.4	5.1	1.6	1.1	1.9	0.2	ND	4.4
	SEM	Spectrum 12	9.3	21.7	58.2	0.6	5.2	1.2	1.4	2.1	0.2	ND	2.3

Notes:
The elemental analysis for TEM Point NA-K is not included in this table because the material analyzed in that point was morphologically inconsistent with the iron-arsenic particles.
Elemental analyses are normalized to the sum percent of detected elements (excluding carbon).
ND: non-detect
SEM: scanning electron microscopy
TEM: transmission electron microscopy

4 Summary and Discussion

Results demonstrated that iron-arsenic precipitates were formed under both aerobic and anaerobic test conditions. Testing performed on the resulting precipitates showed that the precipitates formed from arsenite-spiked anaerobic groundwater were most consistent with green rusts. The precipitates formed from the arsenate-spiked groundwater were most consistent with ferrihydrite. Significant observations included the following:

- Micro-elemental analysis showed that the precipitates generally had an atomic ratio of 2:1 iron to arsenic, though this ratio varied slightly.
- Differences in the precipitates were noted as follows:
  - Three of the precipitates—those formed in the anaerobic arsenite and arsenate-spiked solutions, as well as in the aerobic arsenite-spiked solution—showed XRD patterns for non-crystalline or poorly crystalline phases.
  - The bonds identified by FTIR for all the precipitates included arsenic oxygen bonds, carbon oxygen bonds, and hydroxyl (water groups). However, the precipitates from the arsenite-spiked solutions also had a peak consistent with arsenic-oxygen-iron groups.
  - The precipitate that formed in the aerobic arsenate-spiked solution had an XRD spectra consistent with ferrihydrite, a hydrated iron oxyhydroxide. The poorly crystalline platelets observed under the TEM in the anaerobic arsenate precipitate were also potentially consistent with ferrihydrite (Géhin et al. 2002; Legrand et al. 2004; Usman et al. 2012).
  - Under the TEM, the arsenite precipitates had a greater degree of crystallinity than the precipitates formed in the arsenate-spiked samples. The d-spacing for the most crystalline example of the anaerobic arsenite precipitates (NI-E) is potentially consistent with green rust (Legrand et al. 2004).

5 References

Géhin, A., C. Ruby, M. Abdelmoula, O. Benali, J. Ghanbaja, P. Refait, and J.-M.R. Génin, 2002. Synthesis of Fe (II-III) hydroxysulphate green rust by coprecipitation. *Solid State Sciences* 4:61-66.

Legrand, L., L. Mazerolles, and A. Chaussé, 2004. The oxidation of carbonate green rust into ferric phases: solid-state reaction or transformation via solution. *Geochimica et Cosmochimica Acta* 68:3497-3507.

Usman, M., K. Hanna, M. Abdelmoula, A. Zegeye, P. Faure, and C. Ruby, 2012. Formation of green rust via mineralogical transformation of ferric oxides (ferrihydrite, goethite and hematite). *Applied Clay Science* 64:38-43.

Figures

Figure 1
Sample Collection

Figure 2

Test Solutions 1) Prior to Spiking; 2) Immediately Post-Spike; 3) at 24 hours; and 4) at 48 hours

Figure 3
Test Solutions after 6 Days of Reaction

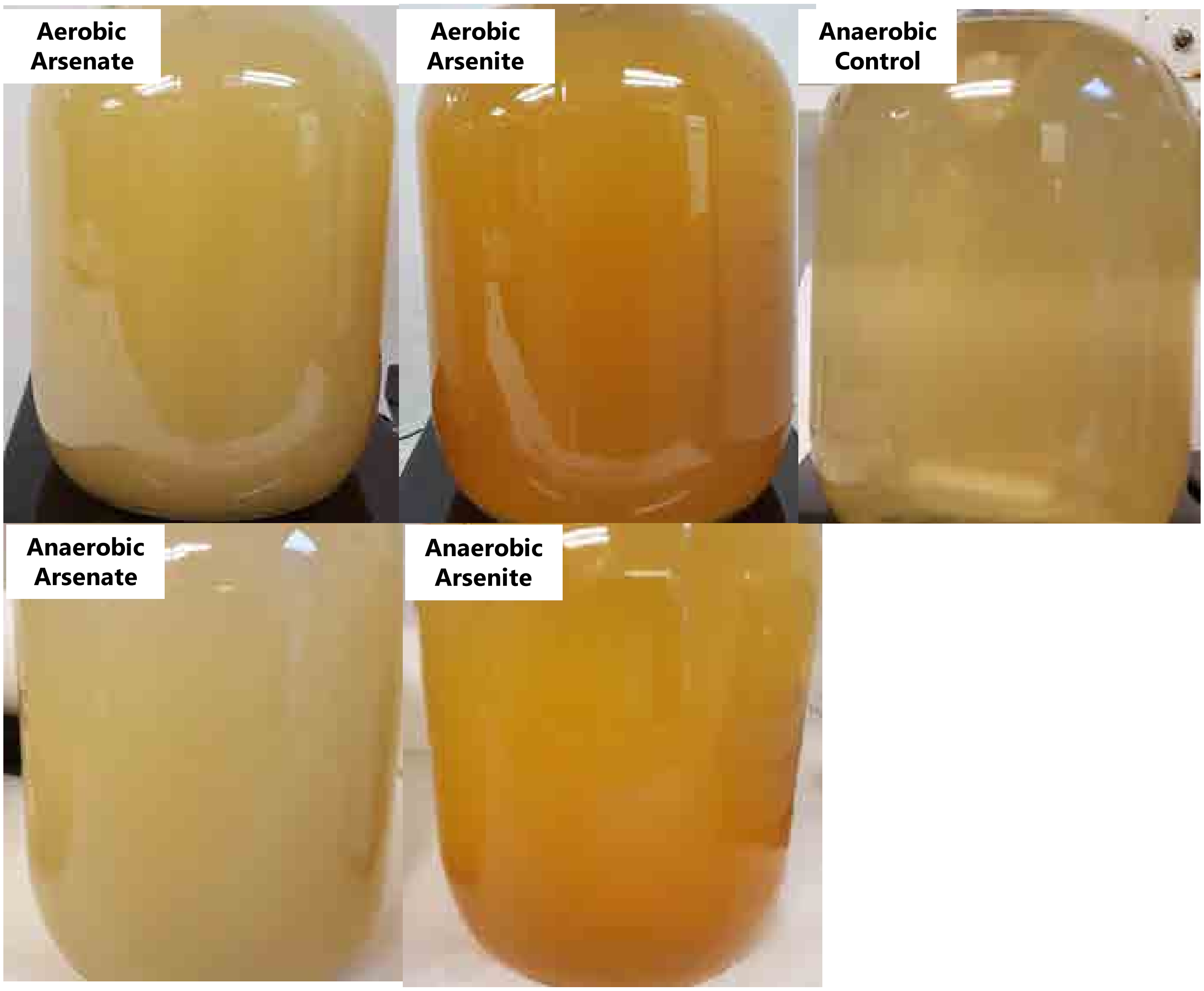
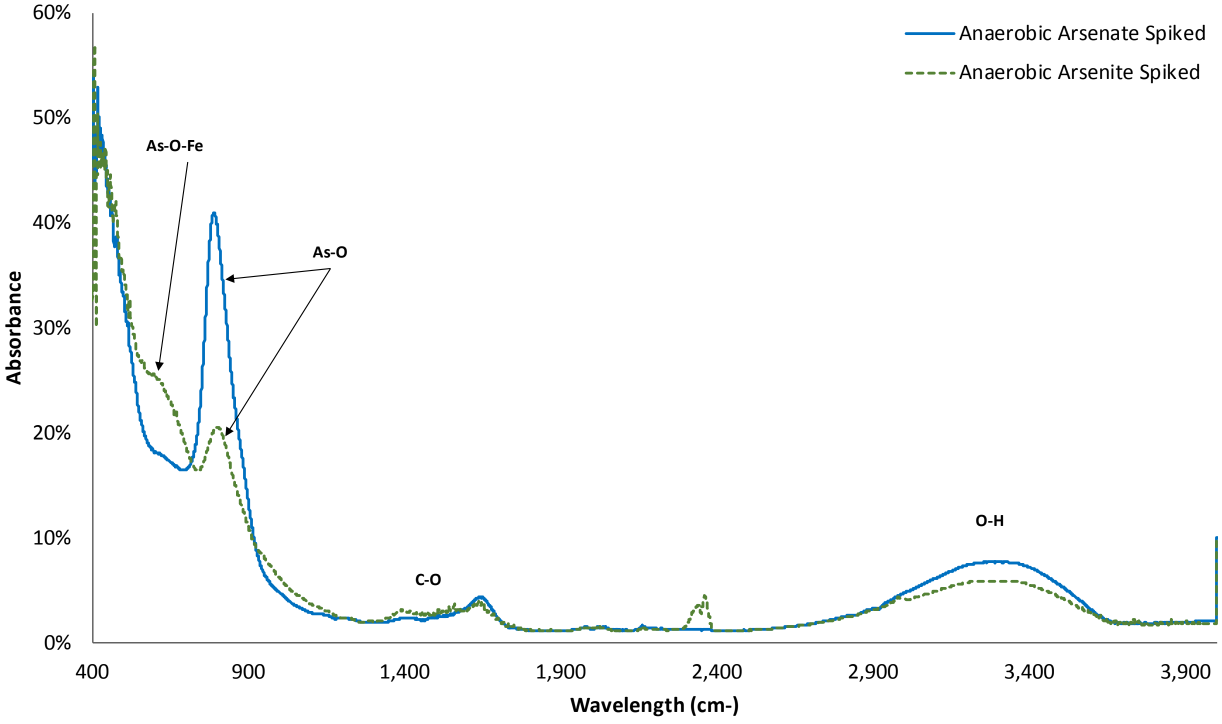


Figure 4
Filtration of the OI Test Solution

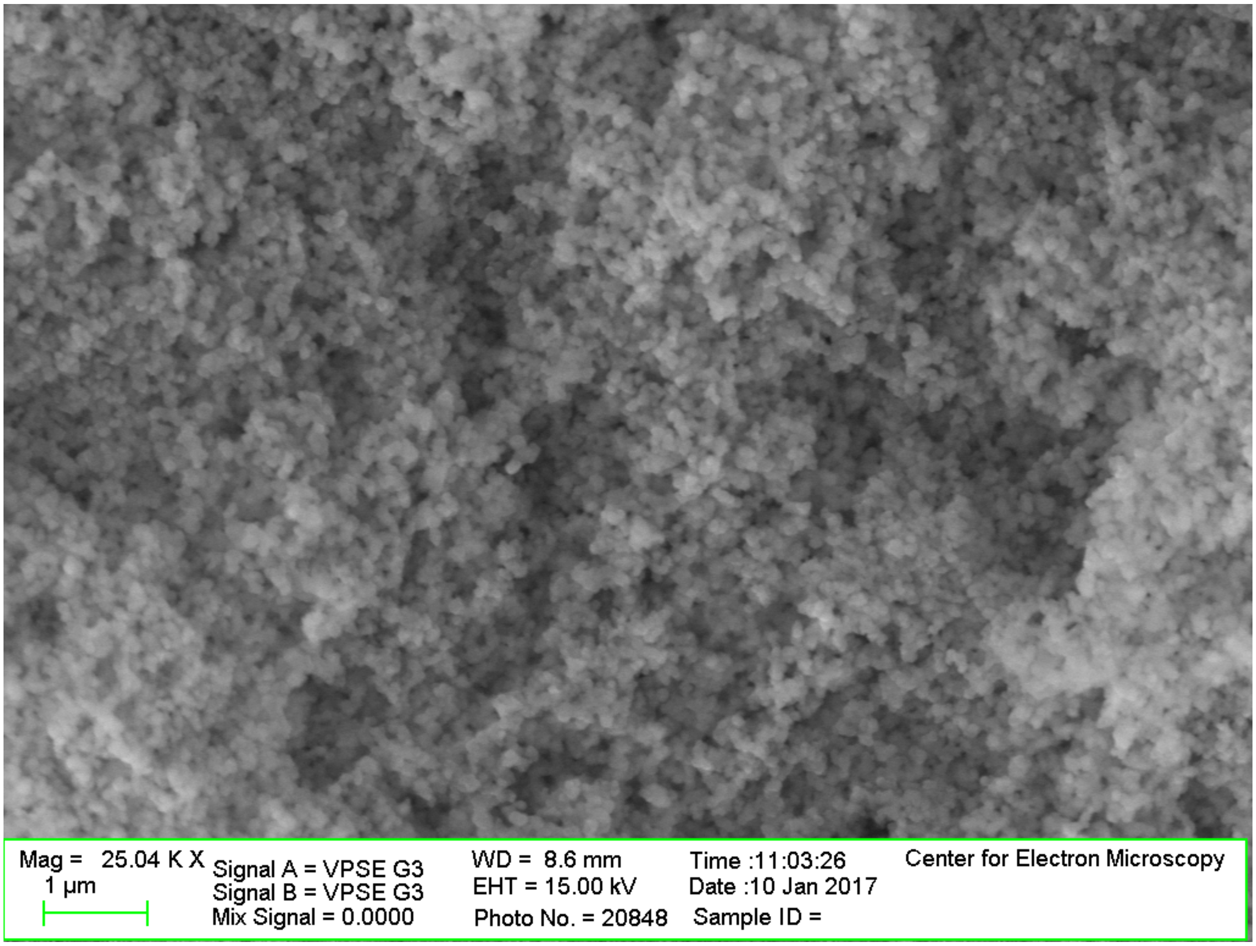
After Filtration **Before Filtration**

Figure 5
Functional Groups Identified by Fourier-Transform Infrared Spectroscopy



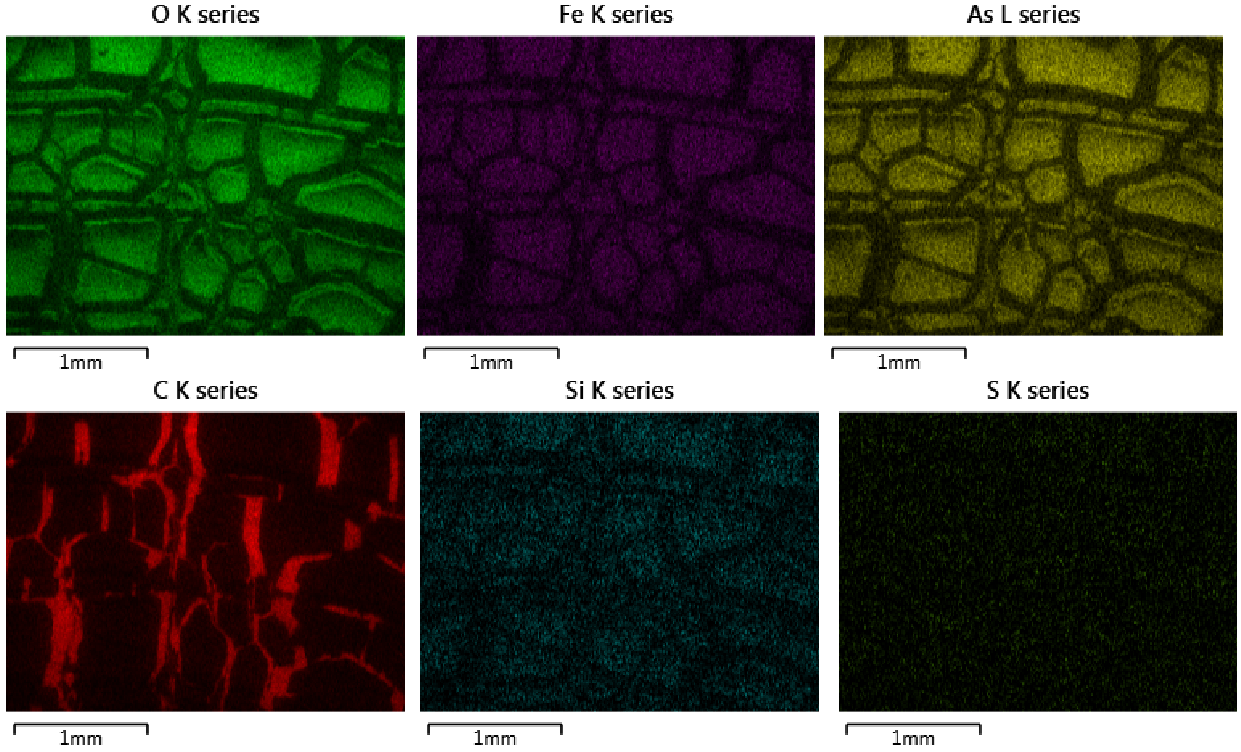
Note:
Functional groups identified by FTIR include arsenic-oxygen-iron bonds (As-O-Fe) only in the precipitates from the arsenite-spiked samples, arsenic-oxygen bonds (As-O) in all precipitates, carbonate functional groups (C-O) in all precipitates, and formula water or hydroxyl groups (O-H) in all precipitates.

Figure 6
HRSEM Image of Precipitate Morphology: Anaerobic Arsenate Solution



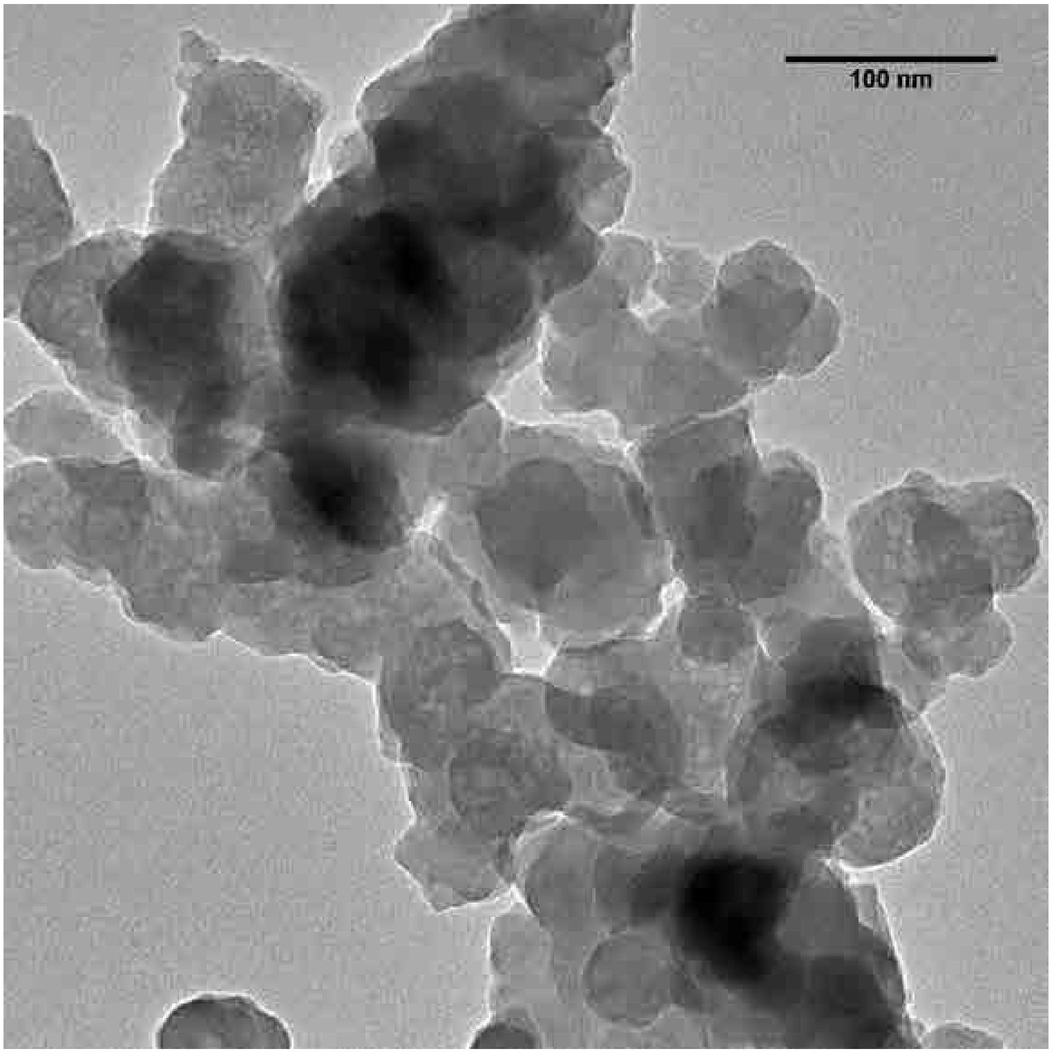
Note:
At high magnification, the precipitates appear to consist of nanometer scale rounded particles of uniform size and shape.

Figure 7
HRSEM Element Mapping of Precipitate from the Anaerobic Arsenite Solution



Note:
In this set of element maps for the precipitate formed in the anaerobic arsenite-spiked solution, the composition is dominated by oxygen, iron, and arsenic. Some silicon (silica) is present in the precipitate as well, while the carbon signal is much greater in areas where the precipitate is thin on the filter material. Sulfur was included for its importance in arsenic geochemistry; however, it was not detected.

Figure 8
Transmission Electron Microscopy Image of Anaerobic Arsenate Precipitate



Notes:
The precipitates from both the anaerobic arsenite and anaerobic arsenate-spiked solutions were predominantly amorphous to weakly crystalline and composed of a mixture of iron, arsenic, oxygen, and possibly carbon.
nm: nanometer

Attachment A

Brooks Applied Labs Data Report

BROOKS APPLIED LABS
18804 North Creek Parkway, Ste 100, Bothell, WA 98011 • USA • T: 206 632 6206 F: 206 632 6017 • info@brooksapplied.com

January 13, 2017

GSI Water Solutions, Inc.
ATTN: Erin Carroll Hughes
55 SW Yamhill St. Suite 300
Portland OR 97204
cryals@gsiws.com

RE: Project GSI-PR1601a Waters Client Project: Parcel 15 – POT (603.002.012)

Ms. Carroll Hughes,

On December 14, 2016 and December 21, 2016, Brooks Applied Labs (BAL) received ten (10) aqueous samples. The samples were logged-in for the analyses of dissolved arsenic (As), dissolved iron (Fe), dissolved manganese (Mn), total recoverable As, total recoverable Fe, and total recoverable Mn, as per the chain-of-custody (COC) forms. All samples requiring filtration were field-filtered by the client prior to reception at BAL. All samples were received and stored according to BAL SOPs and EPA methodology.

Dissolved Metals Quantitation by ICP-QQQ-MS

All aqueous samples for dissolved metals were directly analyzed for As, Fe, and Mn by inductively coupled plasma triple quadrupole mass spectrometry (ICP-QQQ-MS). The ICP-QQQ-MS determinative method uses advanced interference removal techniques to ensure accuracy of the sample results. For more information, please visit the *Interference Reduction Technology* section on our website, brooksapplied.com.

Total Recoverable Metals Quantitation by ICP-QQQ-MS

All aqueous samples for total recoverable metals were digested on a hotblock apparatus with aliquots of with nitric and hydrochloric acids. The resulting digests were analyzed for As, Fe, and Mn via ICP-QQQ-MS.

Batch B163255

The method blank identified as B163255-BLK3 contained As above the method reporting limit (MRL) of 0.200 µg/L, at a concentration of 2.06 µg/L. The As concentrations of all samples reported in this batch were greater than ten times the contamination observed in the method blanks. Since the elevated blanks did not significantly impact any of the results reported from this batch, no corrective action or qualification of the data was required.

Instances where the matrix spike/matrix spike duplicate (MS/MSD) sets were spiked at a concentration less than 25% of the native sample result, the recoveries were not reported (**NR**) and the MSD RPD is not calculated (**N/C**), as they are not valid indicators of data quality.

All results were *not* method blank corrected, as described in the calculations section of the relevant BAL SOPs, and were evaluated using reporting limits adjusted to account for sample aliquot size. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

All data was reported without qualification, aside from concentration qualifiers. With the exceptions noted above, all associated quality control results met the acceptance criteria.

BAL, an accredited laboratory, certifies that the reported results of all analyses for which BAL is NELAP accredited meet all NELAP requirements. For more information, please see the *Report Information* page in your report. Please feel free to contact us if you have any questions regarding this report.

Sincerely,

Ben Woznick

Ben Wozniak
Project Manager
ben@brooksapplied.com

Report Information

Laboratory Accreditation

BAL is accredited by the *National Environmental Laboratory Accreditation Program* (NELAP) through the State of Florida Department of Health, Bureau of Laboratories (E87982) and is certified to perform many environmental analyses. BAL is also certified by many other states to perform environmental analyses. For a current list of our accreditations /certifications, please visit our website at <http://www.brooksapplied.com/resources/certificates-permits/>. Results reported relate only to the samples listed in the report.

Field Quality Control Samples

Please be notified that certain EPA methods require the collection of field quality control samples of an appropriate type and frequency; failure to do so is considered a deviation from some methods and for compliance purposes should only be done with the approval of regulatory authorities. Please see the specific EPA methods for details regarding required field quality control samples.

Common Abbreviations

BAL	Brooks Applied Labs	**MS**	matrix spike
BLK	method blank	**MSD**	matrix spike duplicate
BS	laboratory fortified blank	**ND**	non-detect
CAL	calibration standard	**NR**	non-reportable
CCB	continuing calibration blank	**N/C**	not calculated
CCV	continuing calibration verification	**PS**	post preparation spike
COC	chain of custody record	**REC**	percent recovery
D	dissolved fraction	**RPD**	relative percent difference
DUP	duplicate	**SCV**	secondary calibration verification
IBL	instrument blank	**SOP**	standard operating procedure
ICV	initial calibration verification	**SRM**	standard reference material
MDL	method detection limit	**T**	total fraction
MRL	method reporting limit	**TR**	total recoverable fraction

Definition of Data Qualifiers

(Effective 9/23/09)

J	Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
E	An estimated value due to the presence of interferences. A full explanation is presented in the narrative.
H	Holding time and/or preservation requirements not met. Result is estimated.
J-1	Estimated value. A full explanation is presented in the narrative.
J-M	Duplicate precision (RPD) for associated QC sample was not within acceptance criteria. Result is estimated.
J-N	Spike recovery for associated QC sample was not within acceptance criteria. Result is estimated.
M	Duplicate precision (RPD) was not within acceptance criteria. Result is estimated.
N	Spike recovery was not within acceptance criteria. Result is estimated.
R	Rejected, unusable value. A full explanation is presented in the narrative.
U	Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
X	Result is not BLK-corrected and is within 10x the absolute value of the highest detectable BLK in the batch. Result is estimated.

These qualifiers are based on those previously utilized by Brooks Applied Labs, those found in the EPA SOW ILM03.0, Exhibit B, Section III, pg. B-18, and the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review; USEPA; January 2010. These supersede all previous qualifiers ever employed by BAL.

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
MW007-IAS-5-OA	1651030-01	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-5-OA	1651030-02	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-4-OI	1651030-03	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-4-OI	1651030-04	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-1-NC	1651030-05	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-1-NC	1651030-06	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-3-NI	1651030-07	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-3-NI	1651030-08	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-2-NA	1651030-09	Water	Sample	12/13/2016	12/14/2016
MW007-IAS-2-NA	1651030-10	Water	Sample	12/13/2016	12/14/2016

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
MW007-1AS-5-0A-6d	1652013-01	Water	Sample	12/19/2016	12/21/2016
MW007-1AS-4-0I-6d	1652013-02	Water	Sample	12/19/2016	12/21/2016
MW007-1AS-3-NI-6d	1652013-03	Water	Sample	12/19/2016	12/21/2016
MW007-1AS-2-NA-6d	1652013-04	Water	Sample	12/19/2016	12/21/2016
MW007-1AS-1-NC-6d	1652013-05	Water	Sample	12/19/2016	12/21/2016

Batch Summary

Analyte	Lab Matrix	Method	Prepared	Analyzed	Batch	Sequence
As	Water	EPA 1638 Mod	01/03/2017	01/04/2017	B163254	1700008
As	Water	EPA 1638 Mod	12/27/2016	01/04/2017	B163255	1700010
As	Water	EPA 1638 Mod	01/03/2017	01/05/2017	B163254	1700016
As	Water	EPA 1638 Mod	01/10/2017	01/11/2017	B170062	1700037
Fe	Water	EPA 1638 Mod	01/03/2017	01/04/2017	B163254	1700008
Fe	Water	EPA 1638 Mod	12/27/2016	01/04/2017	B163255	1700010
Mn	Water	EPA 1638 Mod	01/03/2017	01/04/2017	B163254	1700008
Mn	Water	EPA 1638 Mod	12/27/2016	01/04/2017	B163255	1700010

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MW007-1AS-1-NC-6d										
1652013-05	As	Water	D	3.89		0.177	1.01	µg/L	B163254	1700016
1652013-05	Fe	Water	D	14300		7.07	21.5	µg/L	B163254	1700008
1652013-05	Mn	Water	D	1280		0.530	1.59	µg/L	B163254	1700008
MW007-1AS-2-NA-6d										
1652013-04	As	Water	D	71400		7.07	40.4	µg/L	B163254	1700008
1652013-04	Fe	Water	D	1580		7.07	21.5	µg/L	B163254	1700008
1652013-04	Mn	Water	D	892		0.530	1.59	µg/L	B163254	1700008
MW007-1AS-3-NI-6d										
1652013-03	As	Water	D	78200		7.07	40.4	µg/L	B163254	1700008
1652013-03	Fe	Water	D	8140		7.07	21.5	µg/L	B163254	1700008
1652013-03	Mn	Water	D	1730		0.530	1.59	µg/L	B163254	1700008
MW007-1AS-4-0I-6d										
1652013-02	As	Water	D	75800		7.07	40.4	µg/L	B163254	1700008
1652013-02	Fe	Water	D	40.7		7.07	21.5	µg/L	B163254	1700008
1652013-02	Mn	Water	D	545		0.530	1.59	µg/L	B163254	1700008
MW007-1AS-5-0A-6d										
1652013-01	As	Water	D	54500		7.07	40.4	µg/L	B163254	1700008
1652013-01	Fe	Water	D	24.3		7.07	21.5	µg/L	B163254	1700008
1652013-01	Mn	Water	D	174		0.530	1.59	µg/L	B163254	1700008
MW007-IAS-1-NC										
1651030-05	As	Water	TR	1.82		0.290	1.01	µg/L	B170062	1700037
1651030-06	As	Water	D	2.16		0.177	1.01	µg/L	B163254	1700016
1651030-05	Fe	Water	TR	21200		20.7	42.9	µg/L	B163255	1700010
1651030-06	Fe	Water	D	20400		7.07	21.5	µg/L	B163254	1700008
1651030-05	Mn	Water	TR	1350		0.530	1.59	µg/L	B163255	1700010
1651030-06	Mn	Water	D	1260		0.530	1.59	µg/L	B163254	1700008

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
MW007-IAS-2-NA										
1651030-09	As	Water	TR	92200		11.6	101	µg/L	B163255	1700010
1651030-10	As	Water	D	94300		7.07	40.4	µg/L	B163254	1700008
1651030-09	Fe	Water	TR	25700		20.7	42.9	µg/L	B163255	1700010
1651030-10	Fe	Water	D	24700		283	859	µg/L	B163254	1700008
1651030-09	Mn	Water	TR	1570		0.530	1.59	µg/L	B163255	1700010
1651030-10	Mn	Water	D	1490		21.2	63.6	µg/L	B163254	1700008
MW007-IAS-3-NI										
1651030-07	As	Water	TR	86500		11.6	101	µg/L	B163255	1700010
1651030-08	As	Water	D	86700		7.07	40.4	µg/L	B163254	1700008
1651030-07	Fe	Water	TR	30600		20.7	42.9	µg/L	B163255	1700010
1651030-08	Fe	Water	D	30000		7.07	21.5	µg/L	B163254	1700008
1651030-07	Mn	Water	TR	1920		0.530	1.59	µg/L	B163255	1700010
1651030-08	Mn	Water	D	1840		0.530	1.59	µg/L	B163254	1700008
MW007-IAS-4-OI										
1651030-03	As	Water	TR	99300		11.6	101	µg/L	B163255	1700010
1651030-04	As	Water	D	103000		7.07	40.4	µg/L	B163254	1700008
1651030-03	Fe	Water	TR	35000		20.7	42.9	µg/L	B163255	1700010
1651030-04	Fe	Water	D	32300		7.07	21.5	µg/L	B163254	1700008
1651030-03	Mn	Water	TR	2150		0.530	1.59	µg/L	B163255	1700010
1651030-04	Mn	Water	D	2100		0.530	1.59	µg/L	B163254	1700008
MW007-IAS-5-OA										
1651030-01	As	Water	TR	92300		11.6	101	µg/L	B163255	1700010
1651030-02	As	Water	D	79400		7.07	40.4	µg/L	B163254	1700008
1651030-01	Fe	Water	TR	40500		20.7	42.9	µg/L	B163255	1700010
1651030-02	Fe	Water	D	24100		7.07	21.5	µg/L	B163254	1700008
1651030-01	Mn	Water	TR	2460		0.530	1.59	µg/L	B163255	1700010
1651030-02	Mn	Water	D	2060		0.530	1.59	µg/L	B163254	1700008

Accuracy & Precision Summary

Batch: B163254
Lab Matrix: Water
Method: EPA 1638 Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B163254-SRM1	**Certified Reference Material, (NC00370, T191 as SRM)**								
	As		4.080	4.363	µg/L	107%	75-125		
	Fe		83.00	93.26	µg/L	112%	75-125		
	Mn		27.00	29.20	µg/L	108%	75-125		
B163254-SRM2	**Certified Reference Material, (1649067, NIST 1643f (batch SRM))**								
	As		57.42	62.02	µg/L	108%	75-125		
	Fe		93.44	106.0	µg/L	113%	75-125		
	Mn		37.14	40.32	µg/L	109%	75-125		
B163254-DUP2	**Duplicate, (1652013-05)**								
	Fe	14270		13870	µg/L			3%	20
	Mn	1276		1245	µg/L			2%	20
B163254-DUP3	**Duplicate, (1652013-05)**								
	As	3.887		4.267	µg/L			9%	20
B163254-MS2	**Matrix Spike, (1652013-05)**								
	Fe	14270	2525	16310	µg/L	NR	75-125		
	Mn	1276	252.5	1471	µg/L	NR	75-125		
B163254-MS3	**Matrix Spike, (1652013-05)**								
	As	3.887	252.5	243.1	µg/L	95%	75-125		
B163254-MSD2	**Matrix Spike Duplicate, (1652013-05)**								
	Fe	14270	2525	16150	µg/L	NR	75-125	N/C	20
	Mn	1276	252.5	1458	µg/L	NR	75-125	N/C	20
B163254-MSD3	**Matrix Spike Duplicate, (1652013-05)**								
	As	3.887	252.5	248.7	µg/L	97%	75-125	2%	20

Accuracy & Precision Summary

Batch: B163255
Lab Matrix: Water
Method: EPA 1638 Mod

Sample	Analyte	Native	Spike	Result	Units	REC	Limits	RPD	Limits
B163255-BS1	**Laboratory Fortified Blank, (1634047)**								
	As		200.0	186.8	µg/L	93%	75-125		
	Fe		2000	1941	µg/L	97%	75-125		
	Mn		200.0	192.2	µg/L	96%	75-125		
B163255-SRM1	**Certified Reference Material, (1647034, TMDA 70.2 Reference Standard - Bottle2)**								
	As		42.30	40.50	µg/L	96%	75-125		
	Fe		377.0	387.1	µg/L	103%	75-125		
	Mn		312.0	316.2	µg/L	101%	75-125		
B163255-DUP2	**Duplicate, (1651030-07)**								
	As	86520		97700	µg/L			12%	20
B163255-DUP3	**Duplicate, (1651030-07)**								
	Fe	30590		29850	µg/L			2%	20
	Mn	1917		1880	µg/L			2%	20
B163255-MS2	**Matrix Spike, (1651030-07)**								
	As	86520	505.1	86710	µg/L	NR	75-125		
B163255-MS3	**Matrix Spike, (1651030-07)**								
	Fe	30590	5051	35060	µg/L	NR	75-125		
	Mn	1917	505.1	2407	µg/L	97%	75-125		
B163255-MSD2	**Matrix Spike Duplicate, (1651030-07)**								
	As	86520	505.1	90710	µg/L	NR	75-125	N/C	20
B163255-MSD3	**Matrix Spike Duplicate, (1651030-07)**								
	Fe	30590	5051	35550	µg/L	NR	75-125	N/C	20
	Mn	1917	505.1	2403	µg/L	96%	75-125	0.2%	20

Accuracy & Precision Summary

Batch: B170062
Lab Matrix: Water
Method: EPA 1638 Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B170062-BS1	**Laboratory Fortified Blank, (1634047)**						
	As		500.0	471.3	µg/L	94% 75-125	
B170062-BS2	**Laboratory Fortified Blank, (1634047)**						
	As		200.0	185.1	µg/L	93% 75-125	
B170062-SRM1	**Certified Reference Material, (1647034, TMDA 70.2 Reference Standard - Bottle2)**						
	As		42.30	39.16	µg/L	93% 75-125	
B170062-SRM2	**Certified Reference Material, (1647034, TMDA 70.2 Reference Standard - Bottle2)**						
	As		42.30	39.44	µg/L	93% 75-125	
B170062-DUP2	**Duplicate, (1651030-05)**						
	As	1.818		1.708	µg/L		6% 20
B170062-MS2	**Matrix Spike, (1651030-05)**						
	As	1.818	202.0	188.5	µg/L	92% 75-125	
B170062-MSD2	**Matrix Spike Duplicate, (1651030-05)**						
	As	1.818	202.0	197.5	µg/L	97% 75-125	5% 20

Method Blanks & Reporting Limits

Batch: B163254
Matrix: Water
Method: EPA 1638 Mod
Analyte: As

Sample	Result	Units
B163254-BLK1	-0.002	µg/L
B163254-BLK2	0.001	µg/L
B163254-BLK3	0.002	µg/L
B163254-BLK4	0.001	µg/L

Average: 0.001 **Standard Deviation:** 0.002 **MDL:** 0.007
Limit: 0.040 **Limit:** 0.007 **MRL:** 0.040

Analyte: Fe

Sample	Result	Units
B163254-BLK1	0.37	µg/L
B163254-BLK2	0.32	µg/L
B163254-BLK3	0.33	µg/L
B163254-BLK4	0.74	µg/L

Average: 0.44 **Standard Deviation:** 0.20 **MDL:** 0.28
Limit: 0.85 **Limit:** 0.28 **MRL:** 0.85

Analyte: Mn

Sample	Result	Units
B163254-BLK1	0.004	µg/L
B163254-BLK2	-0.001	µg/L
B163254-BLK3	0.004	µg/L
B163254-BLK4	-0.002	µg/L

Average: 0.001 **Standard Deviation:** 0.003 **MDL:** 0.021
Limit: 0.063 **Limit:** 0.021 **MRL:** 0.063

Method Blanks & Reporting Limits

Batch: B163255
Matrix: Water
Method: EPA 1638 Mod
Analyte: As

Sample	Result	Units
B163255-BLK1	-0.047	µg/L
B163255-BLK2	-0.052	µg/L
B163255-BLK3	2.06	µg/L
B163255-BLK4	-0.036	µg/L

Average: *0.480* **Standard Deviation:** *1.051* **MDL:** 0.023
Limit: 0.200 **Limit:** 0.023 **MRL:** 0.200

Analyte: Fe

Sample	Result	Units
B163255-BLK1	0.793	µg/L
B163255-BLK2	0.760	µg/L
B163255-BLK3	1.17	µg/L
B163255-BLK4	0.513	µg/L

Average: 0.810 **Standard Deviation:** 0.272 **MDL:** 1.64
Limit: 3.400 **Limit:** 1.640 **MRL:** 3.40

Analyte: Mn

Sample	Result	Units
B163255-BLK1	0.001	µg/L
B163255-BLK2	0.0008	µg/L
B163255-BLK3	0.077	µg/L
B163255-BLK4	0.008	µg/L

Average: 0.022 **Standard Deviation:** 0.037 **MDL:** 0.042
Limit: 0.126 **Limit:** 0.042 **MRL:** 0.126

Method Blanks & Reporting Limits

Batch: B170062
Matrix: Water
Method: EPA 1638 Mod
Analyte: As

Sample	Result	Units
B170062-BLK1	0.006	µg/L
B170062-BLK2	0.002	µg/L
B170062-BLK3	0.004	µg/L
B170062-BLK4	0.002	µg/L

Average: 0.004	**Standard Deviation:** 0.002	**MDL:** 0.023
Limit: 0.080	**Limit:** 0.023	**MRL:** 0.080

Sample Containers

Lab ID: 1651030-01
Sample: MW007-IAS-5-OA
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-02
Sample: MW007-IAS-5-OA
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-03
Sample: MW007-IAS-4-OI
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-04
Sample: MW007-IAS-4-OI
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-05
Sample: MW007-IAS-1-NC
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-06
Sample: MW007-IAS-1-NC
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Sample Containers

Lab ID: 1651030-07
Sample: MW007-IAS-3-NI
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-08
Sample: MW007-IAS-3-NI
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-09
Sample: MW007-IAS-2-NA
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Lab ID: 1651030-10
Sample: MW007-IAS-2-NA
Report Matrix: Water
Sample Type: Sample
Collected: 12/13/2016
Received: 12/14/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0193	1% HNO3 (BAL)	1644020	<2	Cooler

Sample Containers

Lab ID: 1652013-01
Sample: MW007-1AS-5-0A-6d
Report Matrix: Water
Sample Type: Sample
Collected: 12/19/2016
Received: 12/21/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250mL FLPE	14-0171	1% HNO3 (BAL)	<2	65103	Cooler 2

Comments: Arrived in FLPE bottle

Sample Containers

Lab ID: 1652013-02 **Report Matrix:** Water **Collected:** 12/19/2016
Sample: MW007-1AS-4-0I-6d **Sample Type:** Sample **Received:** 12/21/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0273	1% HNO3 (BAL)	<2	65103	Cooler 2

Comments: Arrived in FLPE bottle

Lab ID: 1652013-03 **Report Matrix:** Water **Collected:** 12/19/2016
Sample: MW007-1AS-3-NI-6d **Sample Type:** Sample **Received:** 12/21/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0273	1% HNO3 (BAL)	<2	65103	Cooler 2

Comments: Arrived in FLPE bottle

Lab ID: 1652013-04 **Report Matrix:** Water **Collected:** 12/19/2016
Sample: MW007-1AS-2-NA-6d **Sample Type:** Sample **Received:** 12/21/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0273	1% HNO3 (BAL)	<2	65103	Cooler 2

Comments: Arrived in FLPE bottle

Lab ID: 1652013-05 **Report Matrix:** Water **Collected:** 12/19/2016
Sample: MW007-1AS-1-NC-6d **Sample Type:** Sample **Received:** 12/21/2016

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	16-0273	1% HNO3 (BAL)	<2	65103	Cooler 2

Comments: Arrived in FLPE bottle

Shipping Containers

Cooler

Received: December 14, 2016 11:40
Tracking No: 777942729227 via FedEx
Coolant Type: Blue Ice
Temperature: 3.9 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR#8

Custody seals present? Yes
Custody seals intact? Yes
COC present? Yes

Shipping Containers

Cooler 2

Received: December 21, 2016 11:35
Tracking No: 778005150245 via FedEx
Coolant Type: Ice
Temperature: 5.9 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR#7

Custody seals present? Yes
Custody seals intact? No
COC present? Yes

GSI Water Solutions, Inc.
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s):

Client Contact	**For Lab Use Only:**
Project Name: Parcel 15 - POT	SDG:___
Project # or PO #: 603.002.014	Custody Seals intact?
Project Manager: Erin Hughes	Hand delivered?
Phone #:971-200-8529	Cooler Temp :____°C
Report to email: ehughes@gsiws.com	Therm ID No.:____Therm Exp.____

Analysis Turnaround Time:
Standard 21 day TAT on Most Analyses
Rush 5 day on Dissolved Metals in Porewater

Laboratory: TestAmerica | Brooks

Lab PM

Brooks
Ben Wozniak
206-753-6156

TestAmerica
Rob Greer
253-922-5047

Analysis Requested ✓

Sample Identification	Sample Date	Sample Time	Field Conductivity (uS/cm)	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	SM5310B: Total Organic Carbon	SM5310B: Dissolved Organic Carbon (field filtered)	SM4500 S 2D: Sulfide (dissolved; field filtered)	SM2540D: Total Suspended Solids (TSS)	6010C: Major Cations (Ca, Mg, K, Na; dissolved; field filtered)*	300.0: Major Anions (Br, Cl, F, SO4; dissolved; field filtered)**	300.0: Nitrate and Nitrite (dissolved; field filtered)	SM2320B: Alkalinity (field filtered)***	385.1: Major Anions (Orthophosphate; dissolved; field filtered)	6020A: Arsenic (total)	6020A: Arsenic, Iron, and Manganese (dissolved; field filtered)	8260D SIM: Pentachlorophenol	1638M: Arsenic (total), Iron, Manganese (total)	1638M: Arsenic, Iron, and Manganese (dissolved; field filtered)***	Arsenic Speciation - As (III)/As(V) (dissolved; field filtered)	Sample Specific Notes
MW007-IAS-5-OA	12/13/16	1100	388		GW	2											~~✓~~ cxl		✓	✓		
MW007-IAS-4-OI	12/13/16	1130	"		GW	2											~~✓~~ cxl		✓	✓		
MW007-IAS-1-NC	12/13/16	1145	"		GW	2											~~✓~~ cxl		✓	✓		
MW007-IAS-3-NI	12/13/16	1200	"		GW	2											~~✓~~ cxl		✓	✓		
MW007-IAS-2-NA	12/13/16	1215	"		GW	2											~~✓~~ cxl		✓	✓		

Possible Hazard Identification:
Are samples hazardous? ☑ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic

Sample Disposal (A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)
☐ Return to Client ☑ Disposal by Lab ☐ Archive frozen for 1 year

Relinquished by: Date/Time: 12/13/16
Received by: Date/Time: 12/13/16 1440
Relinquished by: Date/Time:
Received by: Date/Time:
Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☐ Other Tracking #:
Received in Laboratory by: Date/Time:

Special Instructions/QC Requirements
*Major Cations include calcium, magnesium, potassium, and sodium.
**Major anions include sulfate, chloride, bromide, fluoride, and ortho-phosphate.
***Alkalinity includes total, carbonate as CaCO3, bicarbonate as CaCO3, and hydroxide as CaCO3.
Please contact Cindy Ryals at 971-200-8531 with any questions.

ORIGIN ID:MRIA (503) 972-5014
JEN MOTT
ANCHOR QEA
421 SW SIXTH AVENUE
SUITE 750
PORTLAND, OR 97204
UNITED STATES US

SHIP DATE: 13DEC16
ACTWGT: 15.00 LB
CAD: 109495568/INET3790

BILL SENDER

TO SAMPLE RECEIVING
BROOKS APPLIED
18804 NORTH CREEK PARKWAY
SUITE 100
BOTHELL WA 98011
(206) 632-6206 REF: PORTAC
INV:
PO: JESSICA GOIN DEPT: PORTAC SAMPLES

544J1/D42F/14EH

FedEx. Express

E

WED - 14 DEC 3:00P
STANDARD OVERNIGHT

TRK# 0201 7779 4272 9227

98011
WA-US SEA

85 PAEA

Cooler CS✓ COC✓
Blu ice 3.9°C IR #8
125mL 16-0-93 TM

After printing this label:
1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

Warning: Use only the printed original label for shipping. Using a photocopy of this label for shipping purposes is fraudulent and could result in additional billing charges, along with the cancellation of your FedEx account number.
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GSI
55 SW Yamhill St, Suite 300
Portland, Oregon 97204
503.239.8700

Chain of Custody Record

Field Sampler(s):

Client Contact

Project Name: Parcel 15 - POT

Project # or PO #: 603.002.014

Project Manager: Erin Hughes

Phone #: 971-200-8528

Report to email: echughes@gsiws.com

Analysis Turnaround Time:
Standard 21 day TAT on Most Analyses
Rush 5 day on Dissolved Metals in Porewater

For Lab Use Only:
SDG:___
Custody Seals intact?
Hand delivered?
Cooler Temp ____°C
Therm ID No.:____ Therm Exp.____

Laboratory: TestAmerica (columns SM5310B through 8280D SIM); Brooks (columns 1638M and Arsenic Speciation)

Lab PM
Brooks
Ben Wozniak
206-753-6158

TestAmerica
Rob Greer
253-922-5047

Analysis Requested

Sample Identification	Sample Date	Sample Time	Field Conductivity (uS/cm)	Sample Type (C=Comp, G=Grab)	Matrix	Total # of Cont.	SM5310B: Total Organic Carbon	SM5310B: Dissolved Organic Carbon (field filtered)	SM4500 S 2D: Sulfide (dissolved; field filtered)	SM2540D: Total Suspended Solids (TSS)	6010C: Major Cations (Ca, Mg, K, Na; dissolved; field filtered)*	300.0: Major Anions (Br, Cl, F, SO4; dissolved; field filtered)**	300.0: Nitrate and Nitrite (dissolved; field filtered)	SM2320B: Alkalinity (field filtered)***	365.1: Major Anions (Orthophosphate; dissolved; field filtered)	6020A: Arsenic (total)	6020A: Arsenic, Iron, and Manganese (dissolved; field filtered)	8280D SIM: Pentachlorophenol	1638M: Arsenic (total)	1638M: Arsenic, Iron, and Manganese (dissolved; field filtered)***	Arsenic Speciation - As (III)/As(V) (dissolved; field filtered)	Sample Specific Notes
MW007-IAS-5-OA-6d	12/19	1350	669		GW	1														X		Rush*
MW007-IAS-4-OI-6d	12/19	1350	605		GW	1														X		*
MW007-IAS-3-NI-6d	12/19	~~1420~~ 1500	[illegible] 580		GW	1														X		*
MW007-IAS-2-NA-6d	12/19	1440	[illegible]		GW	1														X		*
MW007-IAS-1-NC-6d	12/19	1420	368		GW	1														X		*

Possible Hazard Identification:
Are samples hazardous? ☑ No
If yes, select hazard(s): ☐ Listed ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Toxic

Sample Disposal (A fee may be added if samples are retained longer than 30 day per client request, samples are returned to client, or classified as hazardous.)
☐ Return to Client ☑ Disposal by Lab ☐ Archive frozen for 1 year

Relinquished by:	Date/Time: 12/20 1100	Received by:	Date/Time: 12/21/16 11:30
Relinquished by:	Date/Time:	Received by:	Date/Time:
Shipped Via: ☐ UPS ☐ Fed-Ex ☐ USPS ☐ Other	Tracking #:	Received in Laboratory by:	Date/Time:

Special Instructions/QC Requirements
*Major Cations include calcium, magnesium, potassium, and sodium.
**Major anions include sulfate, chloride, bromide, fluoride, and ortho-phosphate.
***Alkalinity includes total, carbonate as CaCO3, bicarbonate as CaCO3, and hydroxide as CaCO3.
Please contact Cindy Ryals at 971-200-8531 with any questions.

*All samples field filtered 0.1µ
* Rush analysis requested
* Please batch w/ samples recieved on 12/20

ORIGIN ID:MRIA (503) 972-5014
JEN MOTT
ANCHOR QEA
421 SW SIXTH AVENUE
SUITE 750
PORTLAND, OR 97204
UNITED STATES US

SHIP DATE: 20DEC16
ACTWGT: 15.00 LB
CAD: 109495568/INET3790

BILL SENDER

TO SAMPLE RECEIVING
BROOKS APPLIED
18804 NORTH CREEK PARKWAY
SUITE 100
BOTHELL WA 98011
(206) 632-6206 REF: PORTAC - LAB
INV:
PO: JESSICA GOIN DEPT: PORTAC SAMPLES

544J1/D42F/14E8

FedEx Express

E

WED - 21 DEC 3:00P
STANDARD OVERNIGHT

TRK# 0201 7780 0515 0245

85 PAEA

98011
WA-US SEA

Cooler CS Not intact COC
Ice 5.9°C IR#7
125mL HDPE 16-0293 TM
250mL FLPE 14-0171 TM

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Attachment B

X-Ray Diffraction Report

DRAFT

June 2017
Parcel 15 (Portac) Remedial Investigation

X-Ray Diffraction Report

Project Number: 150996-01.01
S:\Projects\Portac\As Precip Report\Attachments\Attachment A_Portac_XRD Report_2017-06-27_redlines.docx

Summary of X-Ray Diffraction Analysis Results

Summary Conclusion

Samples OI, NI, and NA are X-ray-amorphous material and cannot be matched to a known chemical phase. A small number of distinct peaks at a low angle (large d-spacing) are due to the use of Mylar film to protect the samples from oxidation. Sample OA is most likely ferric arsenate, which has an X-ray spectrum similar to ferrihydrite.

Method

Powder samples OI, NI, and NA prepared by Anchor QEA, LLC, were transferred under controlled atmosphere conditions to special atmosphere-barrier X-ray diffraction (XRD) specimen holders sealed with Mylar XRD-specific oxygen barrier films. Sample handling was minimized—samples were not ground to fine powder nor were they packed to specimen-eucentric height.

Powder sample OA was manually ground in air in a mortar and pestle and lightly packed into a top-pack XRD specimen holder.

All XRD scans were acquired from 5 ° to 75 ° (2θ) at 0.02 ° per second. The X-ray source was a copper tube operated at 40 kilovolts and 30nA.

Results

XRD scans are provided below. Samples OI, NI, and NA gave nearly identical results, with the only peaks reflecting the Mylar cover. The peak positions of sample NI are shifted approximately 0.4 º (2θ) relative to samples OI and NA. This could be due to structural changes or to the differences in diffraction geometry resulting from the lack of specimen packing. The fact that all four peaks in this spectrum are shifted the same angle relative to the other specimens, with no change in relative peak heights, suggests that the difference is due to diffraction geometry.

Sample OA produced a low-intensity, noisy spectrum with very broad peaks centered at 2.9 ångströms and 1.5 ångströms. This approximately matches a reported spectrum for ferric arsenate. The reference pattern is given below, and the source paper is attached.

Attachment C

Fourier-Transform Infrared Spectroscopy Report

DRAFT

June 2017
Parcel 15 (Portac) Remedial Investigation

ANCHOR QEA

Fourier-Transform Infrared Spectroscopy Report

Project Number: 150996-01.01
S:\Projects\Portac\As Precip Report\Attachments\Attachment B_Portac_FTIR_Report_2017-06-27_redlines.docx

Background

This report describes fourier-transform infrared spectroscopy (FTIR) performed on solids collected from the arsenic precipitation study.

Instrument

Analysis was performed on a Nicolet™ iS™ 10 FTIR Spectrometer with a Smart iTX Attenuated Total Reflectance diamond crystal (Figure 1).

Figure 1
Fourier-Transform Infrared Spectroscopy

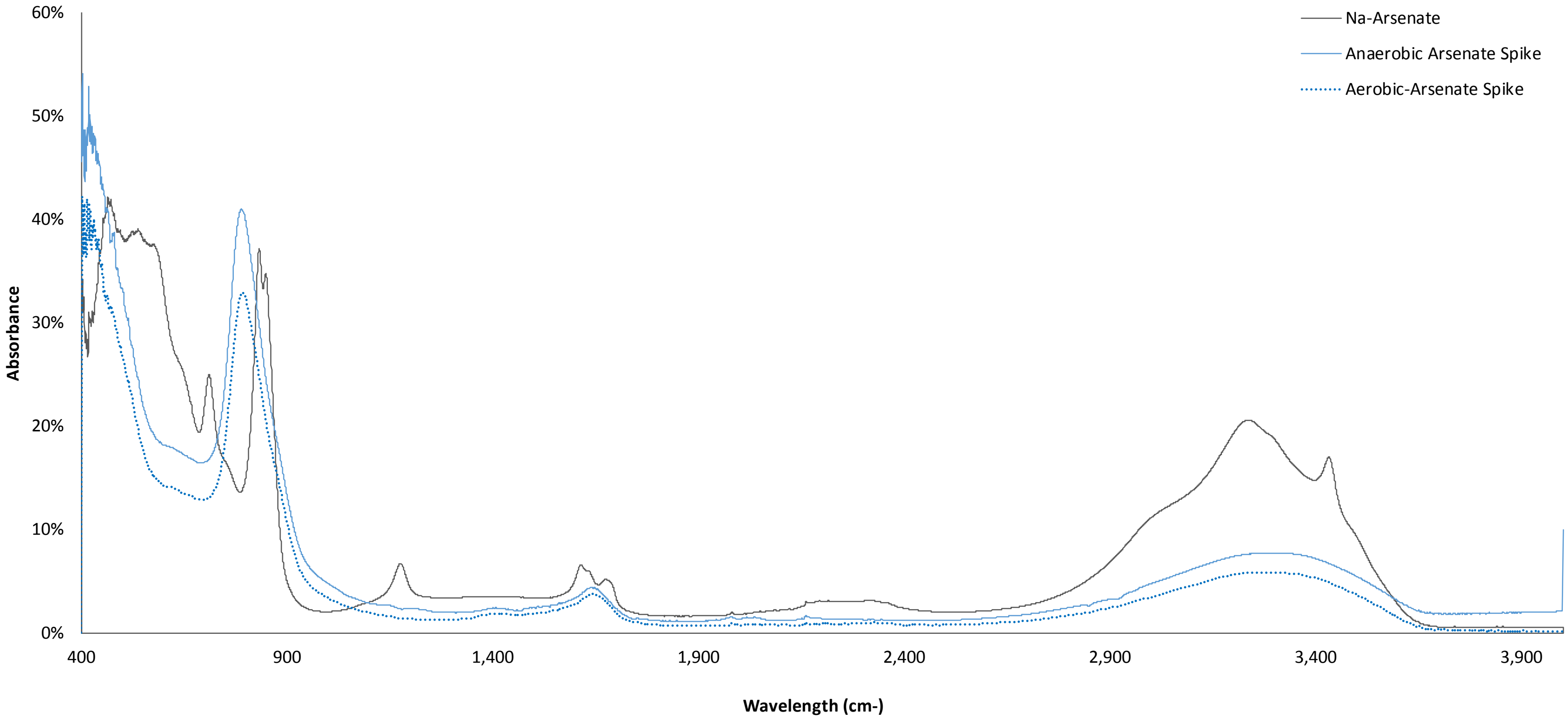
The sample is placed in a small pile over the diamond crystal (in the center of the silver disc) and pressed into place using the pressure device (shown off to the side).

Results

The spectra for the precipitates from the arsenate-spiked samples, and the sodium arsenate used to spike the samples, is provided in Figure 2. The FTIR spectra of precipitates formed in the arsenite-spiked solutions, and the sodium arsenite used to spike the solutions, is provided in Figures 3a and 3b. Note that the FTIR spectra for the anaerobic and aerobic tests are very similar in both the arsenate and arsenite tests. Functional groups identified in all precipitates include arsenic-oxygen bonds, carbon-oxygen bonds (carbonate), and water or hydroxyl functional groups (Figure 4). Additionally, precipitates formed in the arsenite-spiked solutions had arsenic-oxygen-iron functional groups. FTIR of the precipitates is compared to published FTIR spectra for minerals of interest in Figures 5, 6, and 7.

Figure 2

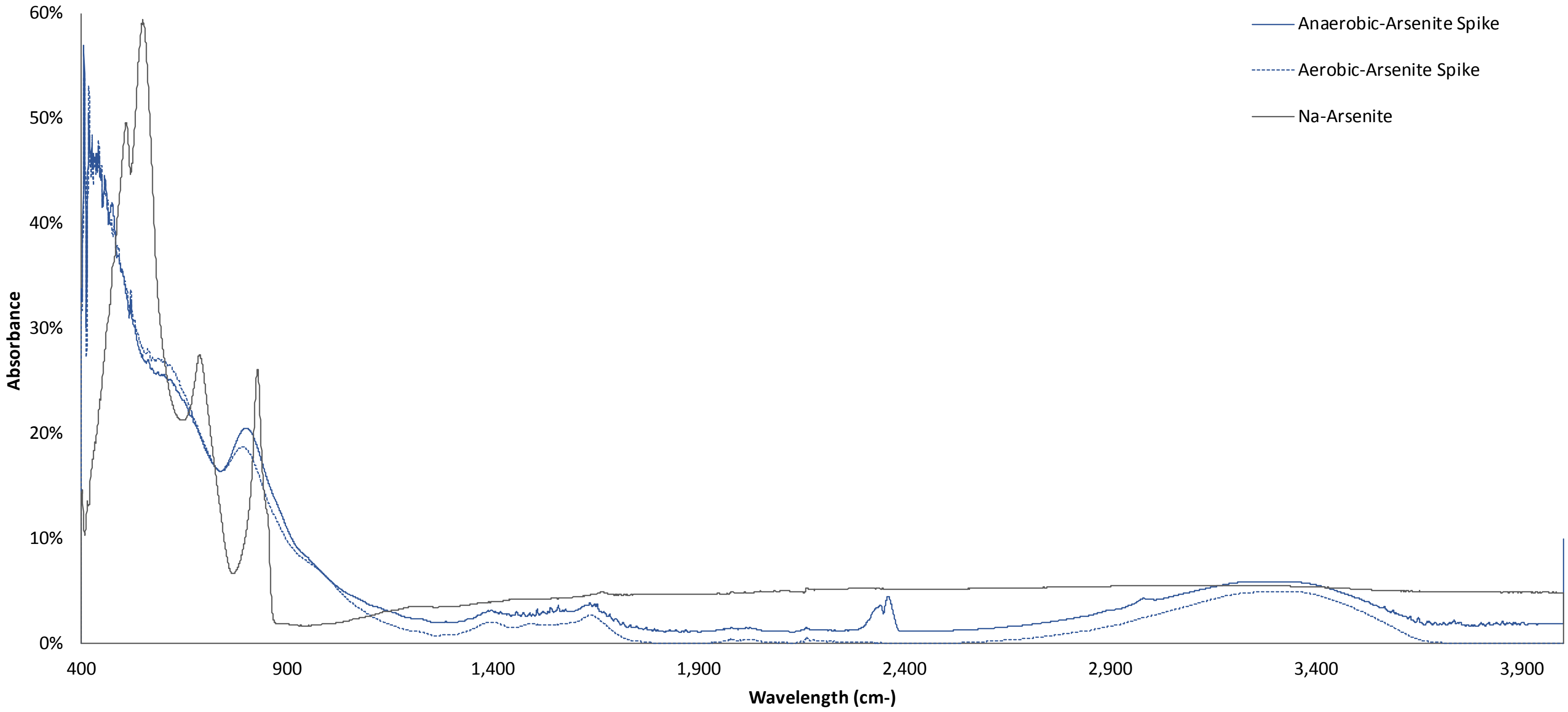
FTIR Spectra of Precipitates Formed in Sodium Arsenate-Spiked Solutions and of Sodium Arsenate



The precipitates formed under both anaerobic and aerobic conditions following a sodium arsenate spike have similar FTIR spectra. The percent absorbance is recorded at each wavelength 1 per centimeter (cm^-) of infrared light transmitted through the sample, and the absorbance is characteristic of specific functional groups present in the sample.

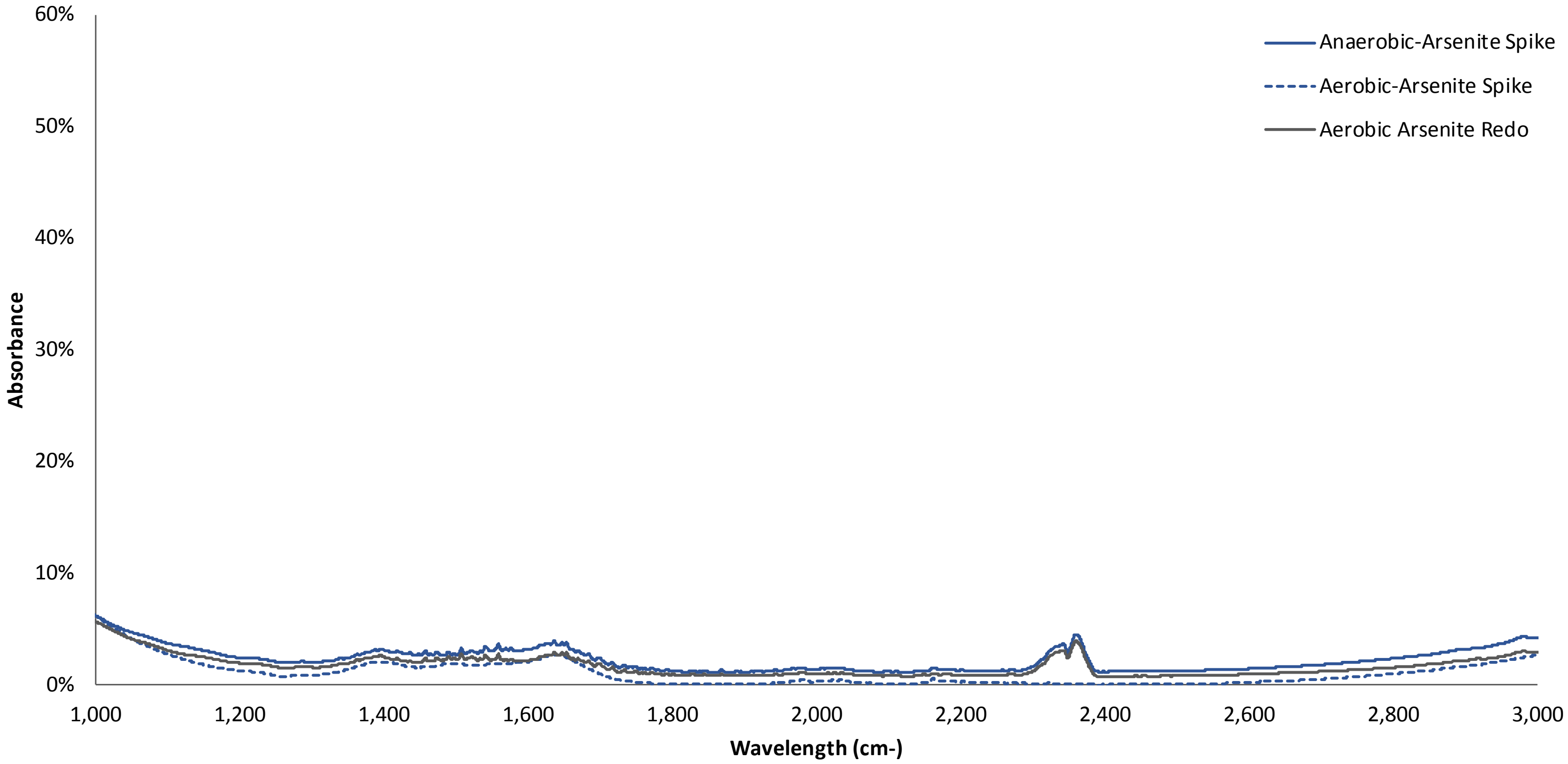
Figure 3a

FTIR Spectra of Precipitates Formed in Sodium Arsenite-Spiked Solutions and of Sodium Arsenite



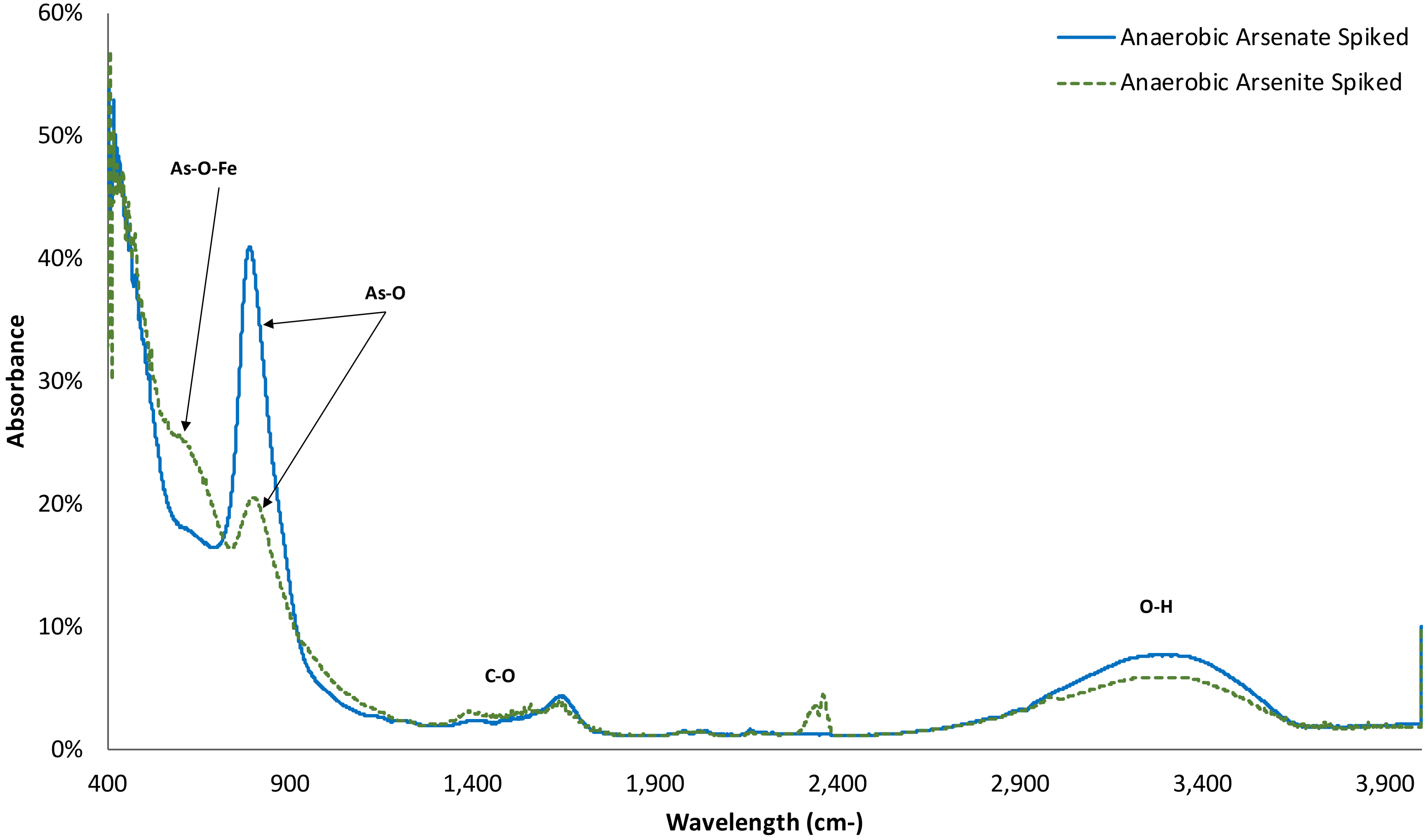
The precipitates formed under both anaerobic and aerobic conditions following a sodium arsenite spike have very similar FTIR spectra. The presence of the apparent peak at approximately 2,350 cm^- is an artefact of exposure of this sample to oxidation and was not present when the sample was run immediately after removal from the nitrogen atmosphere (Figure 3b). The spectra is also very similar to the spectra for the precipitates formed by arsenate-spiked solutions, with the exception of the peak at approximately 600 cm^-.

Figure 3b
Appearance of Peak at 2,350 cm⁻ with Exposure to Atmosphere



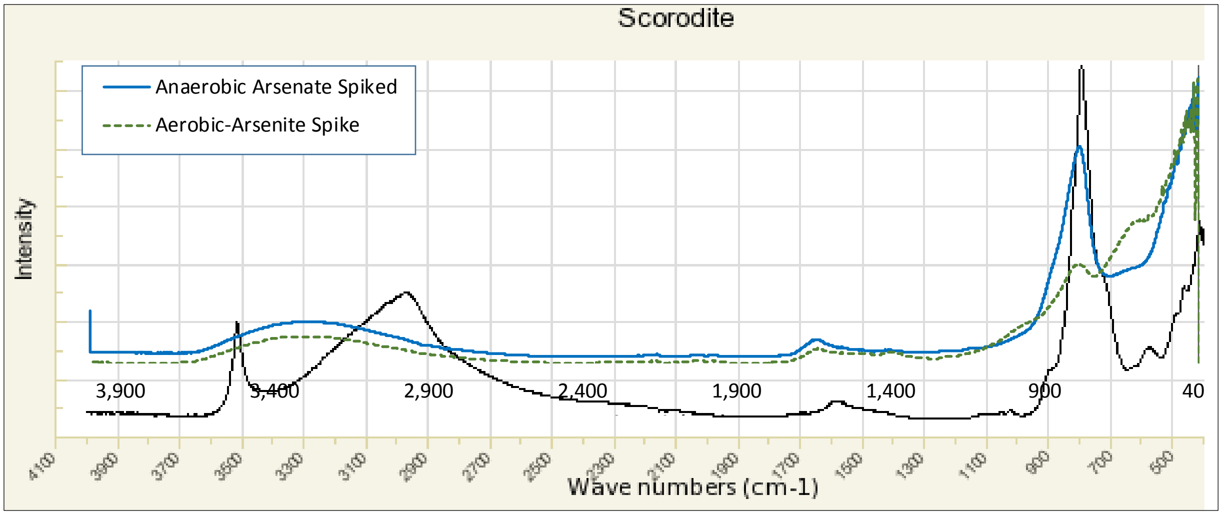
Due to a technical issue with the instrument, the precipitates had to be re-analyzed following exposure to atmosphere. Comparing the FTIR spectra of the precipitates from the aerobic arsenite spike and the reanalysis of the same sample following exposure to atmosphere, note the appearance of a peak at approximately 2,350 cm^{-}. This comparison is shown to support excluding that same peak from analysis of the FTIR data for the precipitates from the anaerobic arsenite-spiked samples, as there was insufficient sample to reanalyze these without the exposure to atmosphere.

Figure 4
Identification of Functional Groups



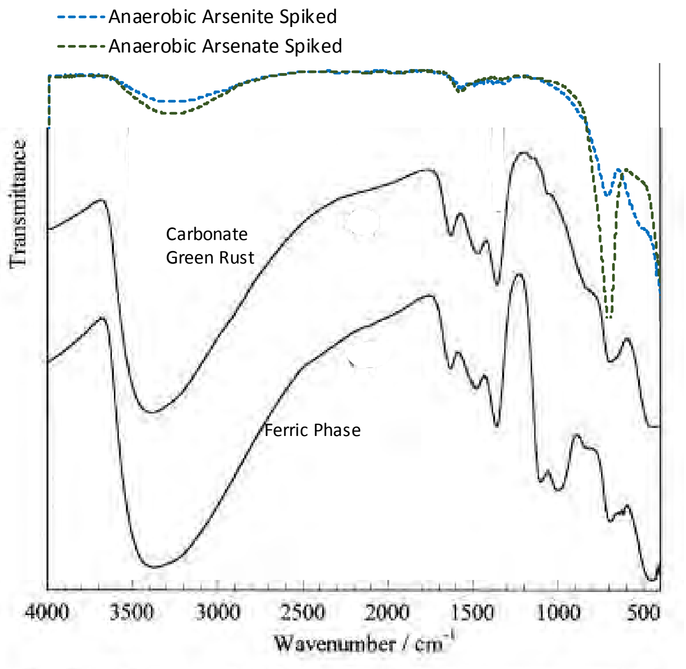
Functional groups identified by FTIR include arsenic-oxygen-iron bonds (As-O-Fe) only in the precipitates from the arsenite-spiked samples, arsenic-oxygen bonds (As-O) in all precipitates, carbonate functional groups (C-O) in all precipitates, and formula water or hydroxyl groups (O-H) in all precipitates. Note again that the peak at 2350 cm^{-} is due to exposure of the sample to atmosphere. Identification of functional groups based on Legrand et al. 2004, Jia et al. 2007, Gomez et al. 2010, Brechbühl et al. 2012, and Tofan-Lazar 2012.

Figure 5
Comparison of Precipitate FTIR Spectra to Scorodite ($FeAsO_4$-$2H_2O$)



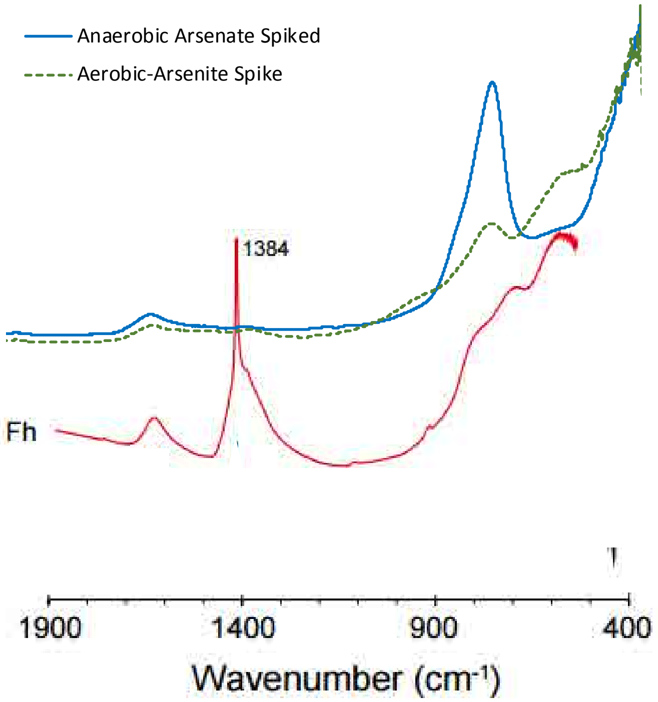
Scorodite FTIR Spectra from the RRUFF database entry R050465 http://rruff.info/Scorodite/R050465. As anticipated, the scorodite spectra shows peaks for the O-H bond and the As-O bond and a small peak that could corrrespond to the As-O-Fe bond.

Figure 6
Comparison of Precipitate and Carbonate Green Rust $Fe(II)_4Fe(III)_2(OH)_{12}$ – CO_3, H_2O FTIR Spectra



The FTIR spectra for a carbonate green rust and ferric oxyhydroxycarbonate (ferric phase) from Legrand et al. 2004.

Figure 7
Comparison of Precipitate FTIR Spectra to Ferrihydrite



The FTIR spectra for ferrihydrite (Fe10O14[OH]2) from Eusterhues et al. 2014

References

Brechbühl, Y., I. Christl, E.J. Elzinga, and R. Kretzschmar, 2012. Competitive sorption of carbonate and arsenic to hematite: Combined ATR-FTIR and batch experiments. *Journal of Colloid and Interface Science*. 377(1):313−321.

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Gomez, M.A., H. Assaaoudi, L. Becze, J.N. Cutler, and G.P. Demopoulos, 2010. Vibrational spectroscopy study of hydrothermally produced scorodite ($FeAsO_4\ 2H_2O$), ferric arsenate sub-hydrate (FAsH; $FeAsO_4 \cdot 0.75H_2O$) and basic ferric arsenate sulfate (BFAS; $Fe\ [(AsO_4)_{1-x}\ (SO_4)_x\ (OH)_x] \cdot wH_2O$). *Journal of Raman Spectroscopy*. 41(2):212−221.

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Tofan-Lazar Miss, J., 2012. *ATR-FTIR Studies on the Kinetics of Dimethylarsinic Acid (DMA) Surface Complexation with Iron-(Oxyhydr)oxides* [Master of Science]. Waterloo, Ontario: Chemistry Department, Wilfrid Laurier University.

Yongfeng, J., L. Xu, X. Wang, and G.P. Demopoulos, 2007. Infrared spectroscopic and X-ray diffraction characterization of the nature of adsorbed arsenate on ferrihydrite. *Geochimica et Cosmochimica Acta*. 71(7):1643−1654.

Attachment D

High-Resolution Electron Microscopy Report

DRAFT

June 2017
Parcel 15 (Portac) Remedial Investigation

ANCHOR
QEA

High-Resolution Electron Microscopy Report

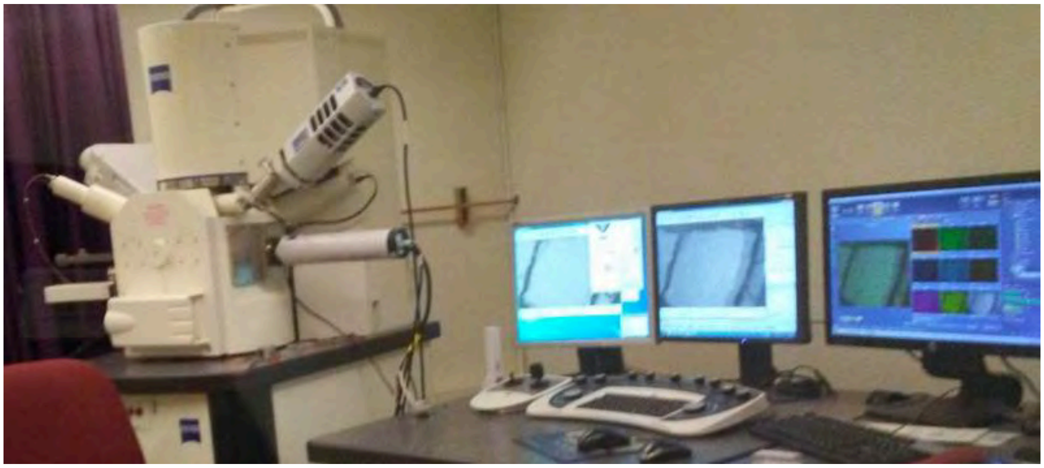
Background

This report describes high-resolution electron microscopy (HRSEM) performed on solids collected from the arsenic precipitation study.

Instrument

HRSEM was performed on a Zeiss Sigma variable pressure field emission gun scanning electron microscope equipped with an Oxford Energy Dispersive X-ray/Wavelength Dispersive X-ray (WDX) detector. The instrument is located in the Portland State Center for Electron Microscopy and Nanofabrication. Three detectors were utilized during HRSEM: 1) the secondary electron detector, which allows visualization of the sample surface; 2) the back-scatter electron detector, which allows visualization of variability in average atomic mass of the material; and 3) the WDX detector, which is used to identify the elements present and determine relative elemental composition.

Figure 1
High-Resolution Electron Microscope



The sample is within the chamber on the left-side of the view. The read-outs from left to right are the back-scatter image, the secondary electron image, and the WDX element maps.

Each detector has different capabilities and limitations:

- Secondary electron – Secondary electron images can be collected using high- or low-excitation voltage. Secondary electrons are ejected from the surface of the sample due to interaction with electron beam, and the strength of the signal reflects the sample topography and surface details. Very high-resolution images can be achieved with secondary electrons, especially when low-excitation voltages are used.

- Back-scatter electron – Back-scatter electrons are electrons from the excitation beam that interact with atoms in the sample to "'loop'" back towards the detectors. Large atoms (such as heavy metals) are more likely than small atoms to cause these interactions; therefore, the strength of the back-scatter electron signal is proportional to the atomic mass of the material. Back-scatter electrons are generated to a greater depth in the sample than secondary electrons, and therefore some surface detail may be lost as compared to a secondary electron image.
- X-ray – In addition to the electrons that are ejected from the sample due to the excitation beam (secondary electrons), some electrons jump to a higher energy orbital without being ejected. These electrons will then fall back to their resting orbital with a concurrent release of X-ray energy. The wavelength of the X-ray released is proportional to the distance between the excited and resting orbital, which is in turn diagnostic for the element involved. X-rays have an even greater interaction volume (are generated deeper within the sample) than back-scatter electrons; therefore, high-magnification element maps are not realistic.

Samples

Four samples were analyzed by HRSEM. Precipitates were mounted on the scanning electron microscope sample holder using carbon tape, and a very thin layer (approximately 10 angstroms) of carbon was deposited on the sample surface to prevent charge buildup in the sample.

Table 1
HRSEM Samples

Test Solution/Conditions	Sample ID	HRSEM Image Code
Arsenite Spike/Anaerobic	MW-007IAS-3_NI	NI
Arsenate Spike/Anaerobic	MW-007IAS-2_NA	NA
Arsenite Spike/Aerobic	MW-007IAS-4_OI	OI
Arsenate Spike/Aerobic	MW-007IAS-5_OA	OA

Notes:
Numerical order appended to the HRSEM images reflects collection order. Element maps are numbered to match the first image at the location mapped.
HRSEM: high-resolution electron microscopy

Results

Visual Observations

The samples were very homogeneous, with no obvious changes in mass between or within the pieces of dried material. At high magnification, each sample is shown to consist of small, rounded granules approximately 100 nanometers in diameter.

Compositional Analysis

Multiple element maps and point composition analyses were performed for each sample. There was little variability in composition within each sample, and overall composition was dominated by oxygen, iron, and arsenic. Carbon is very likely present in the samples; however, carbon cannot be quantified as the material is mounted on carbon-containing material and coated in carbon. Calcium was present in each sample, and the aerobic arsenate sample appeared to have relatively elevated calcium levels. Aluminum was also reported in the aerobic arsenate precipitates; however, this is the only sample that was mounted directly onto the aluminum stub, and this is almost certainly an artifact.

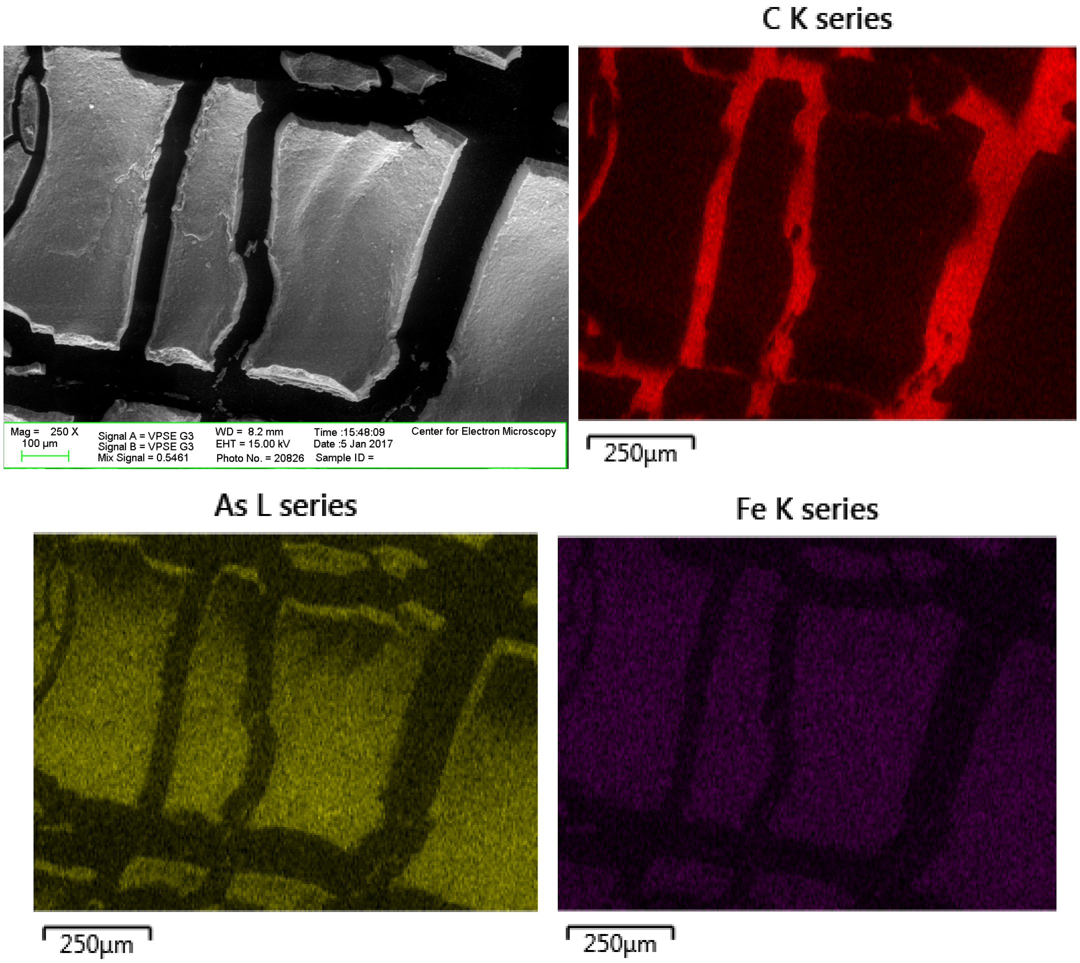
The average composition based on three point analyses for each sample are provided in Table 2. An example element map is shown in Figure 2. The element maps collected for each sample are attached to this report.

Table 2
Point Analysis Summary

Sample		Arsenic (%)	Iron (%)	Oxygen (%)	Calcium (%)	Silicon (%)	Manganese (%)	Magnesium (%)
Anaerobic Arsenite	Average	11.0	24.1	62.7	0.7	1.5	0.0	0.0
	St. Dev.	0.1	2.2	2.4	0.1	0.1	0.0	0.0
Anaerobic Arsenate	Average	15.1	21.5	59.3	2.8	0.4	0.7	0.0
	St. Dev.	0.1	2.3	2.6	0.3	0.0	0.1	0.0
Aerobic Arsenite	Average	10.3	21.4	63.2	2.0	2.1	1.0	0.0
	St. Dev.	0.3	1.8	2.5	0.2	0.1	0.1	0.0
Aerobic Arsenate	Average	8.8	23.4	59.1	5.0	0.6	1.3	1.4
	St. Dev.	1.7	6.7	5.1	0.4	0.1	0.3	0.3

Notes:
Percent on a molar basis with the exclusion of carbon and aluminum.
Potassium was also detected at a trace levels in the aerobic precipitates (0.3 percent).
St. Dev: standard deviation

Figure 2
Element Map Example



A secondary electron image is shown at the top left, with element maps for carbon, arsenic and iron following. Note that the signal for carbon is strongest between the pieces of precipitate material, where the filter material is not covered, while arsenic and iron have no signal in those areas. Element maps where also generated at this area for oxygen, silicon, and calcium[1]—the elements present in each sample are identified by the instrument, so lack of an element map in the reports indicates absence of that element. Element maps are generated for moderate magnification images, as the interaction volume limits the resolution of this type of analysis.

---

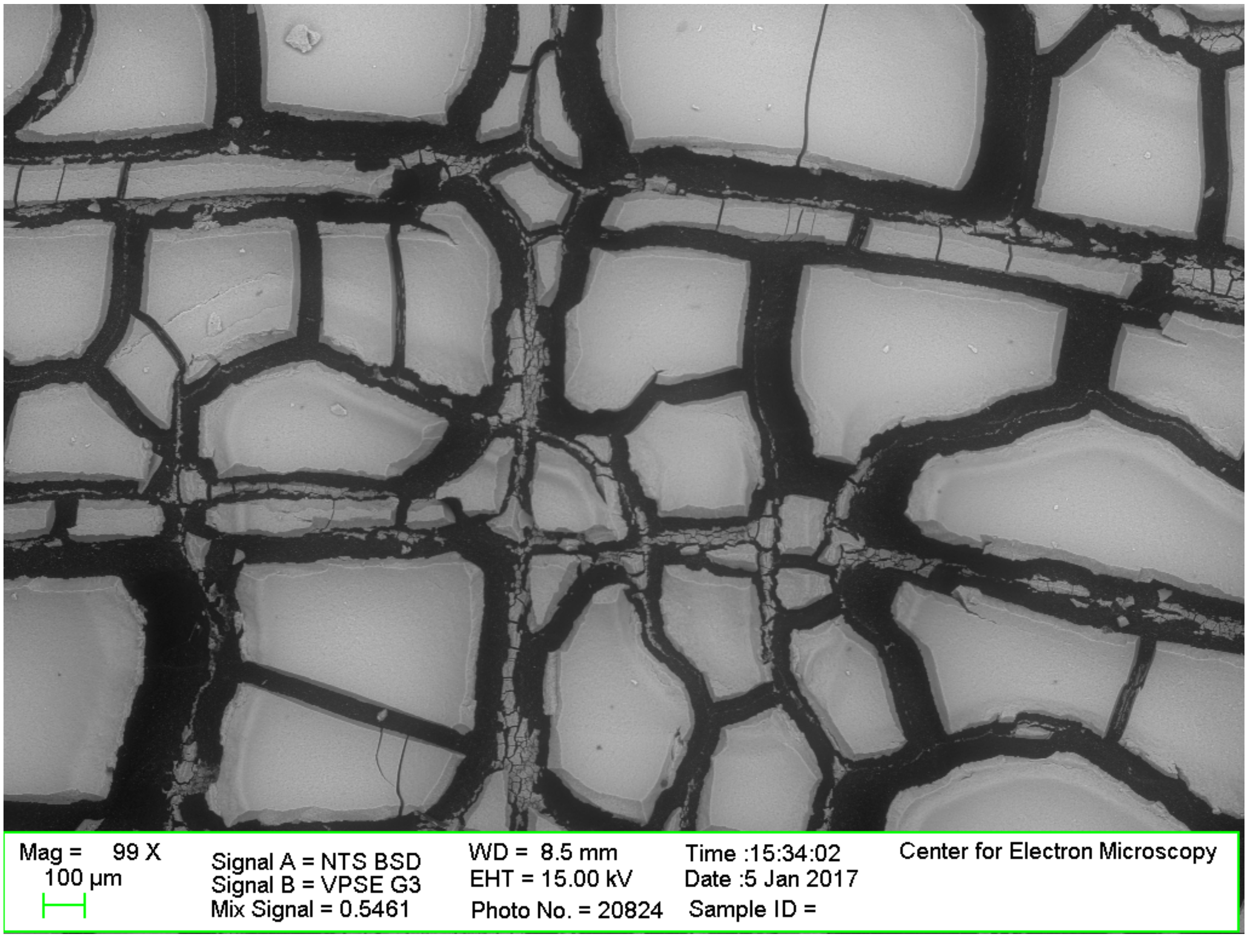
[1] K series and L series refer to which electron shell generated the X-ray; the series with the best separation from other elements is used to determine composition.

Summary

The precipitates are predominantly composed of oxygen, arsenic, iron, and likely carbon. The precipitate morphology is very similar between samples, consisting of very small (approximately 100 nanometers) granules.

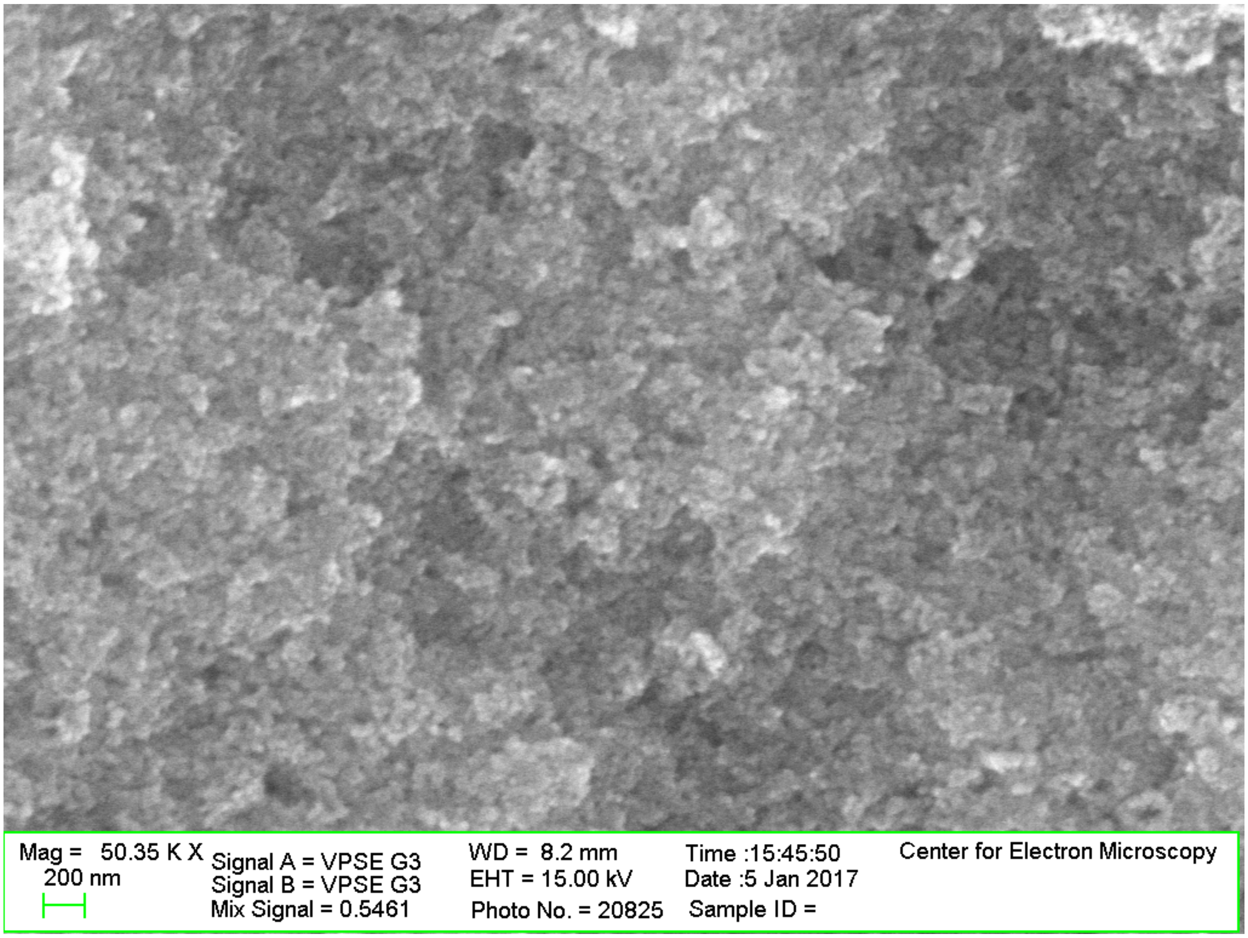
Secondary Electron and Back-Scatter Electron Images

Image NI-01



Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image NI-02



Notes:
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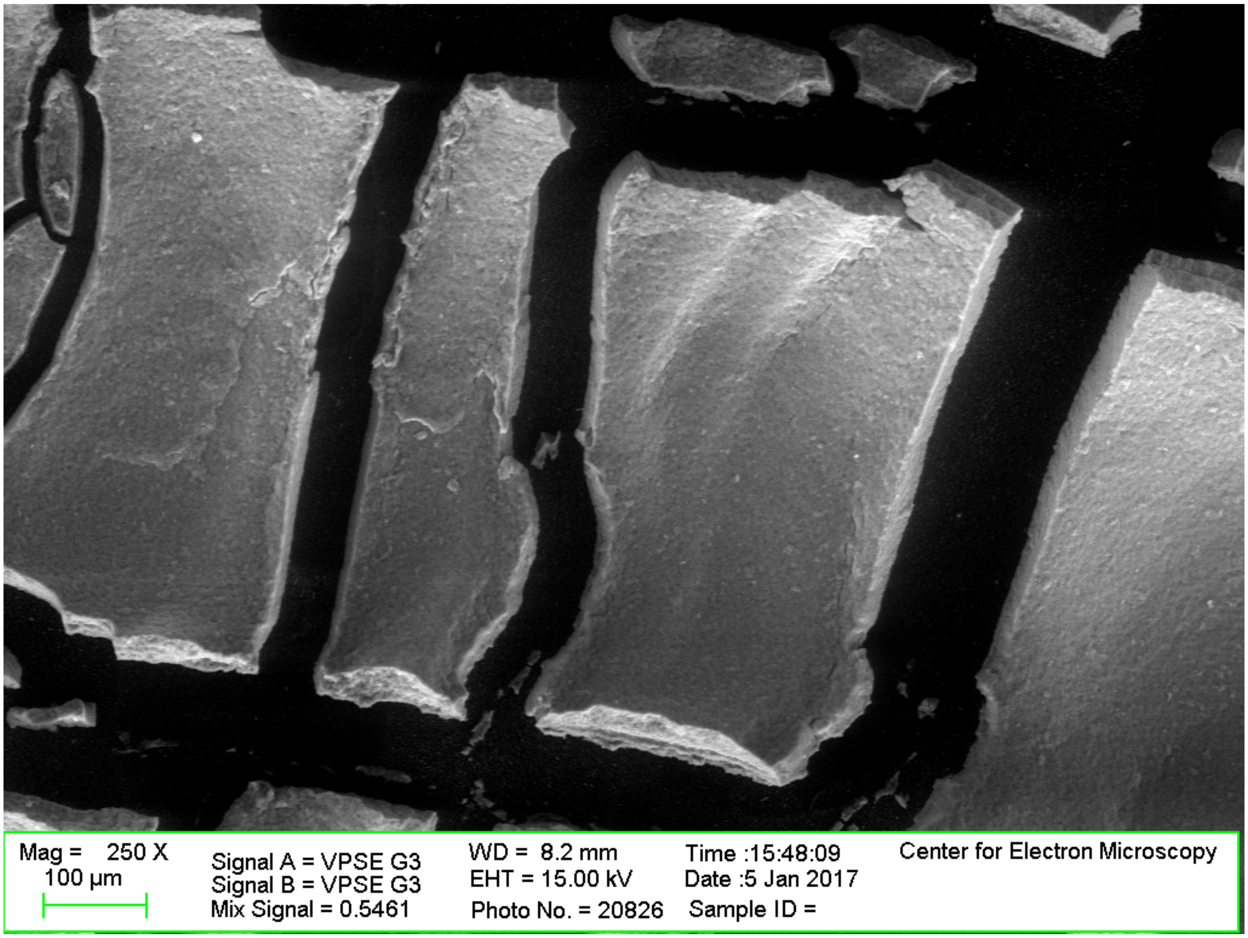
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image NI-03



Notes:
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Mag: magnification
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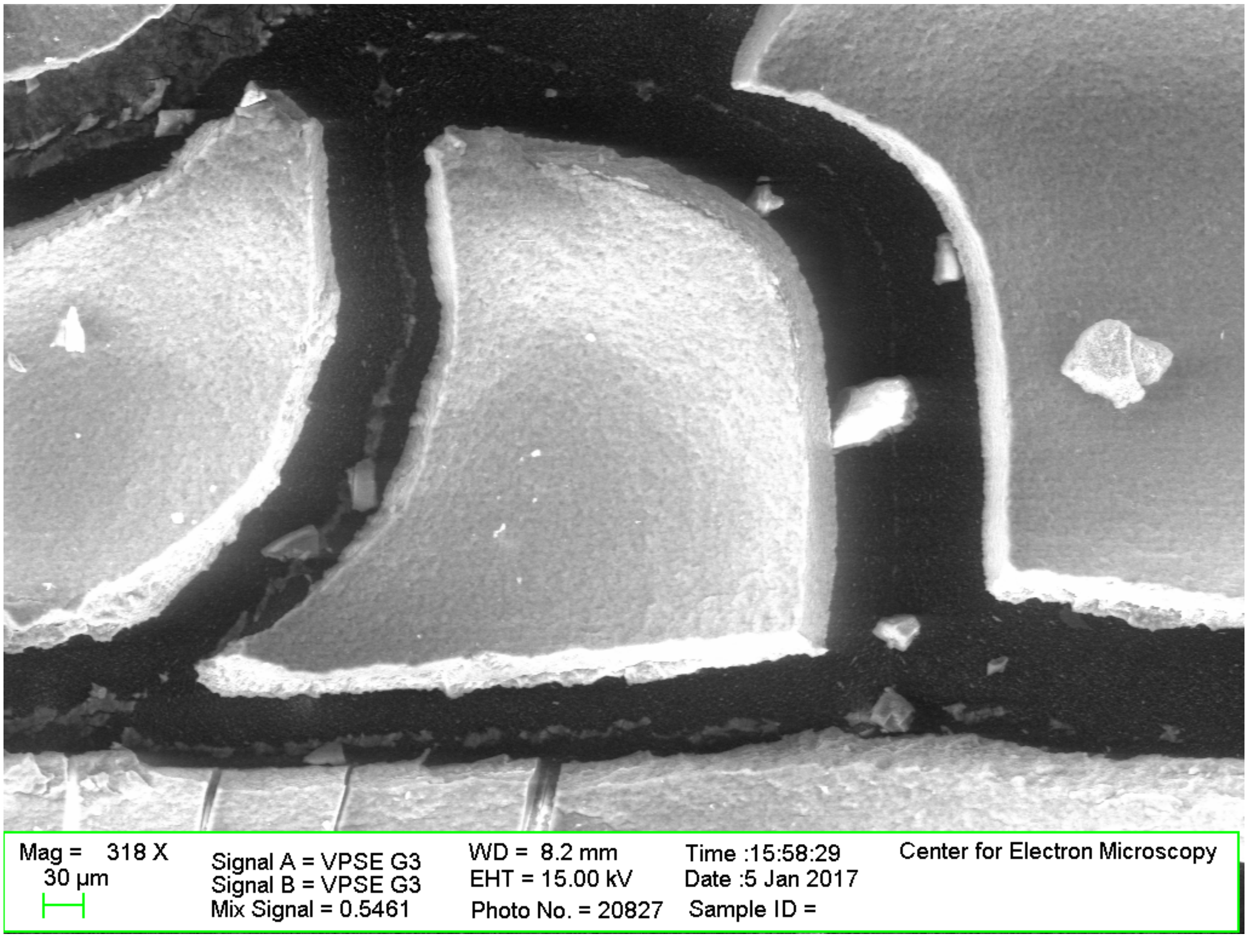
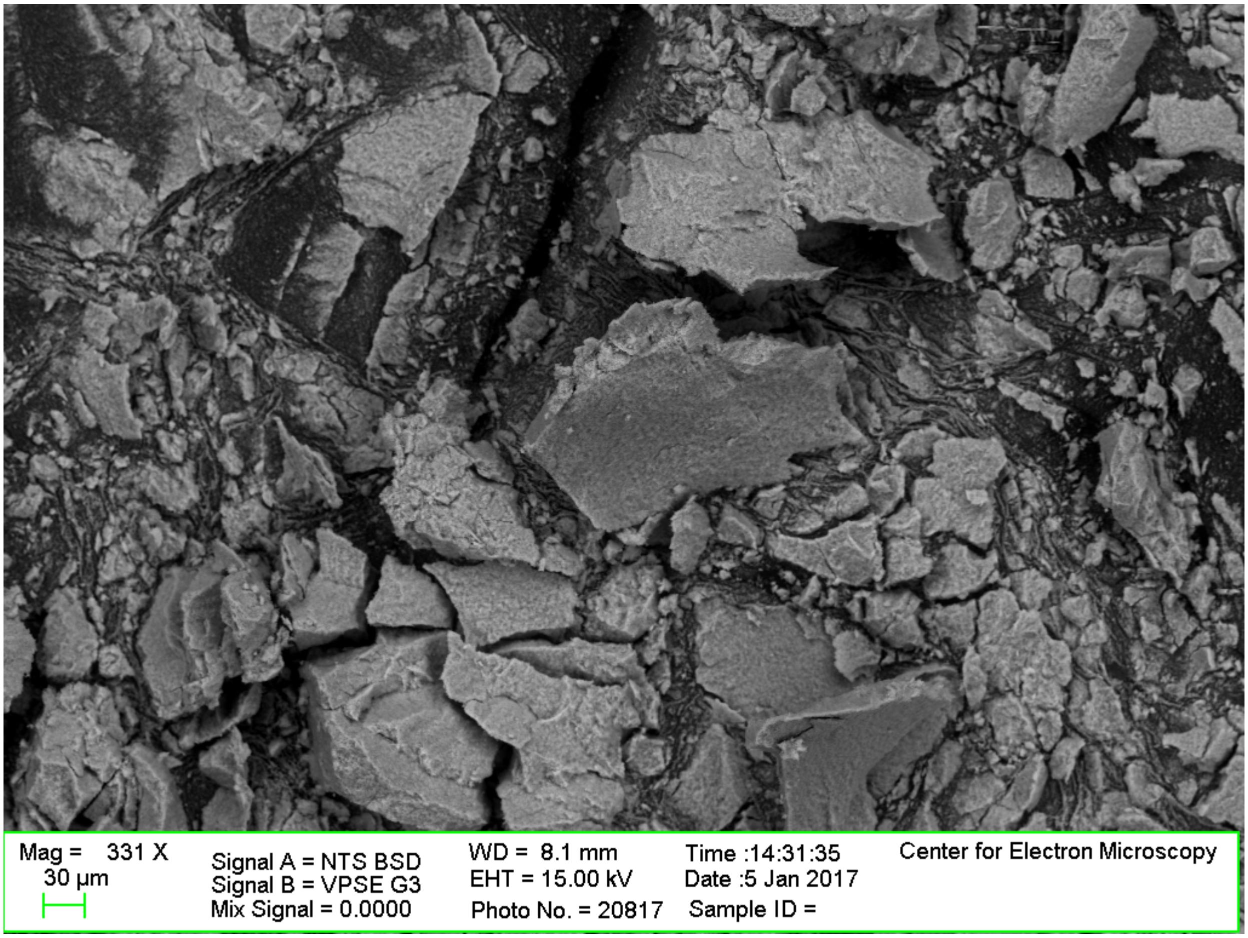
VPSE G3: secondary electron detector
WD: working distance

Image NI-04



Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OA-01



Notes:
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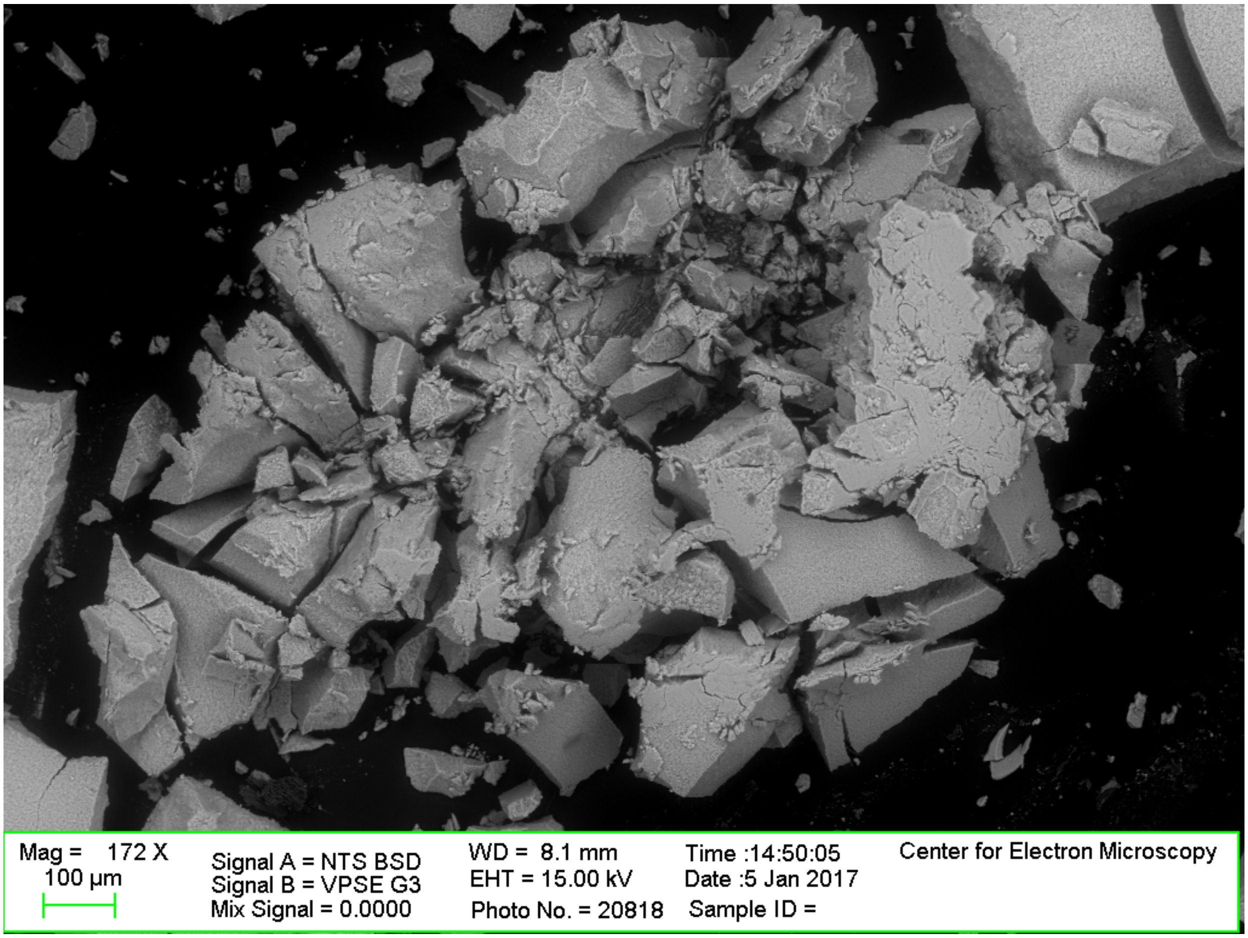
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OA-02



Notes:
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Mag: magnification
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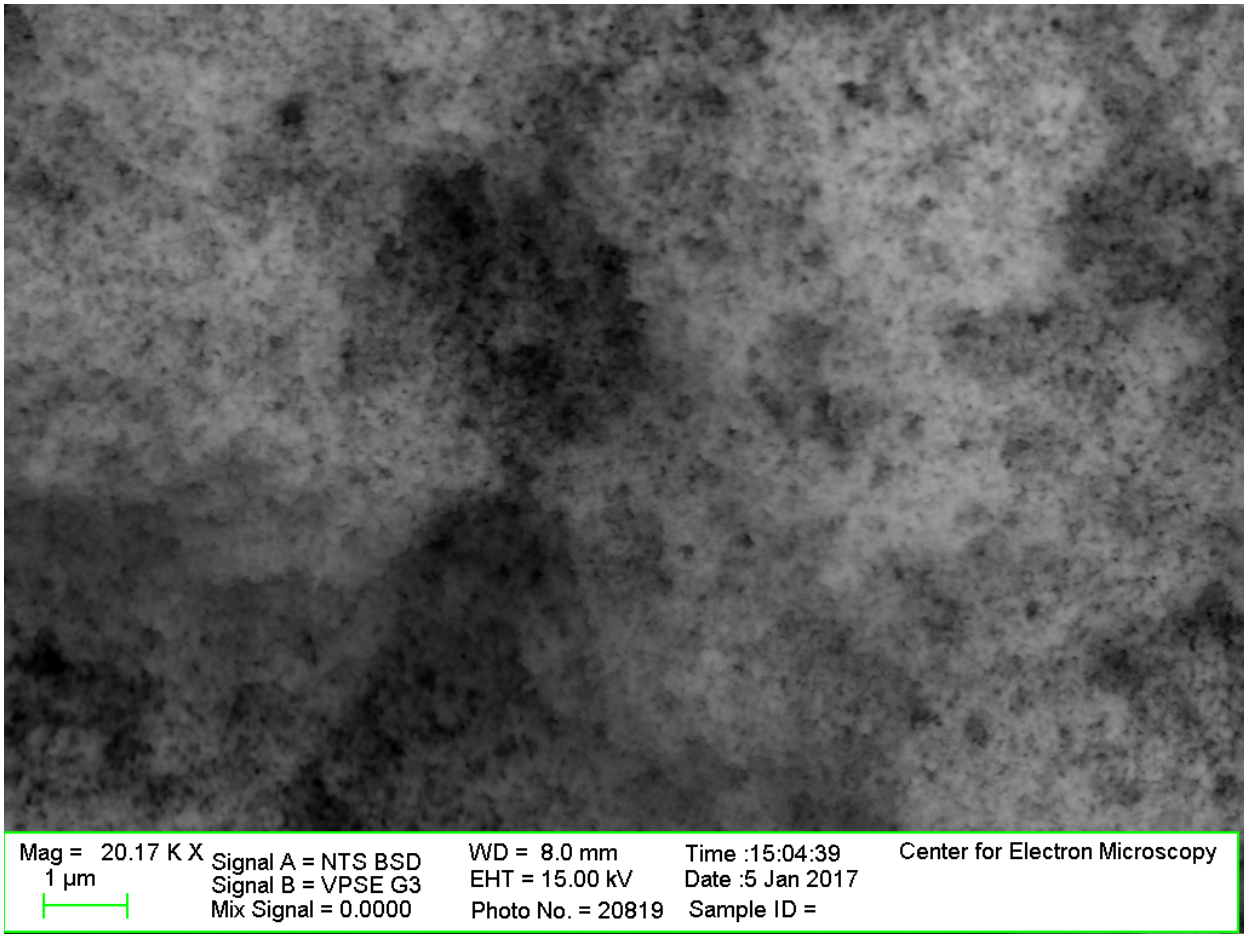
VPSE G3: secondary electron detector
WD: working distance

Image OA-03



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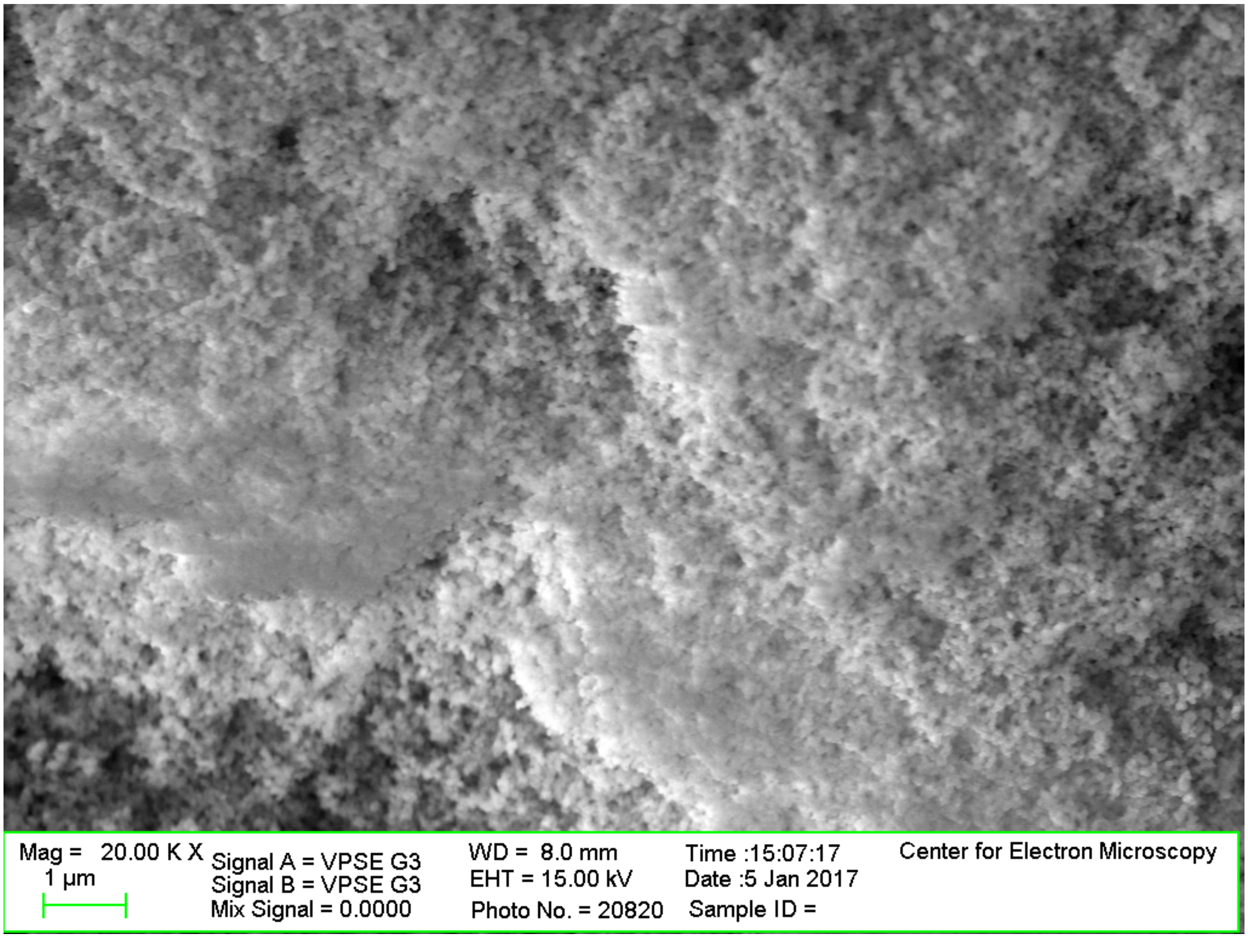
VPSE G3: secondary electron detector
WD: working distance

Image OA-04



Notes:
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Mag: magnification
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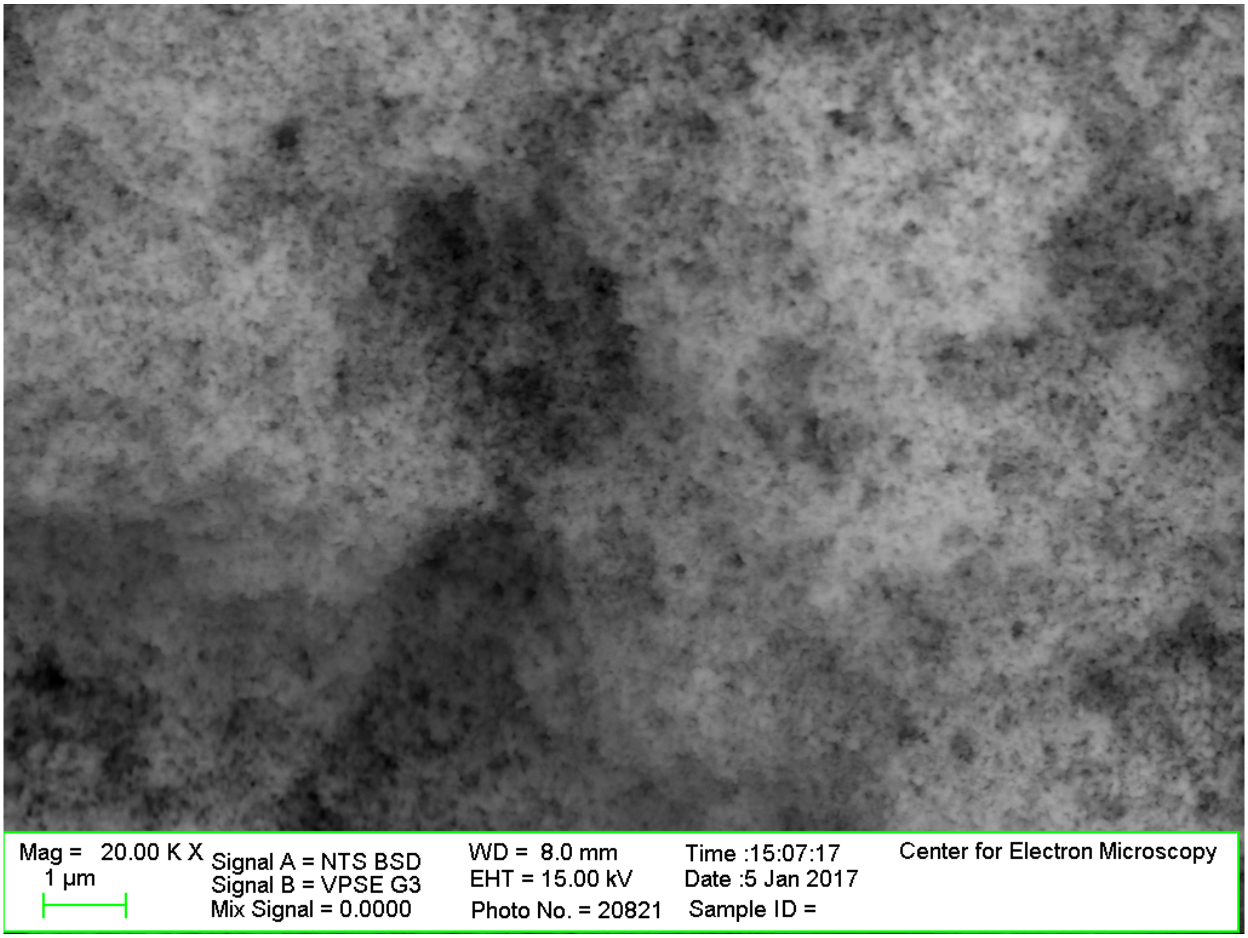
VPSE G3: secondary electron detector
WD: working distance

Image OA-05



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Mag: magnification
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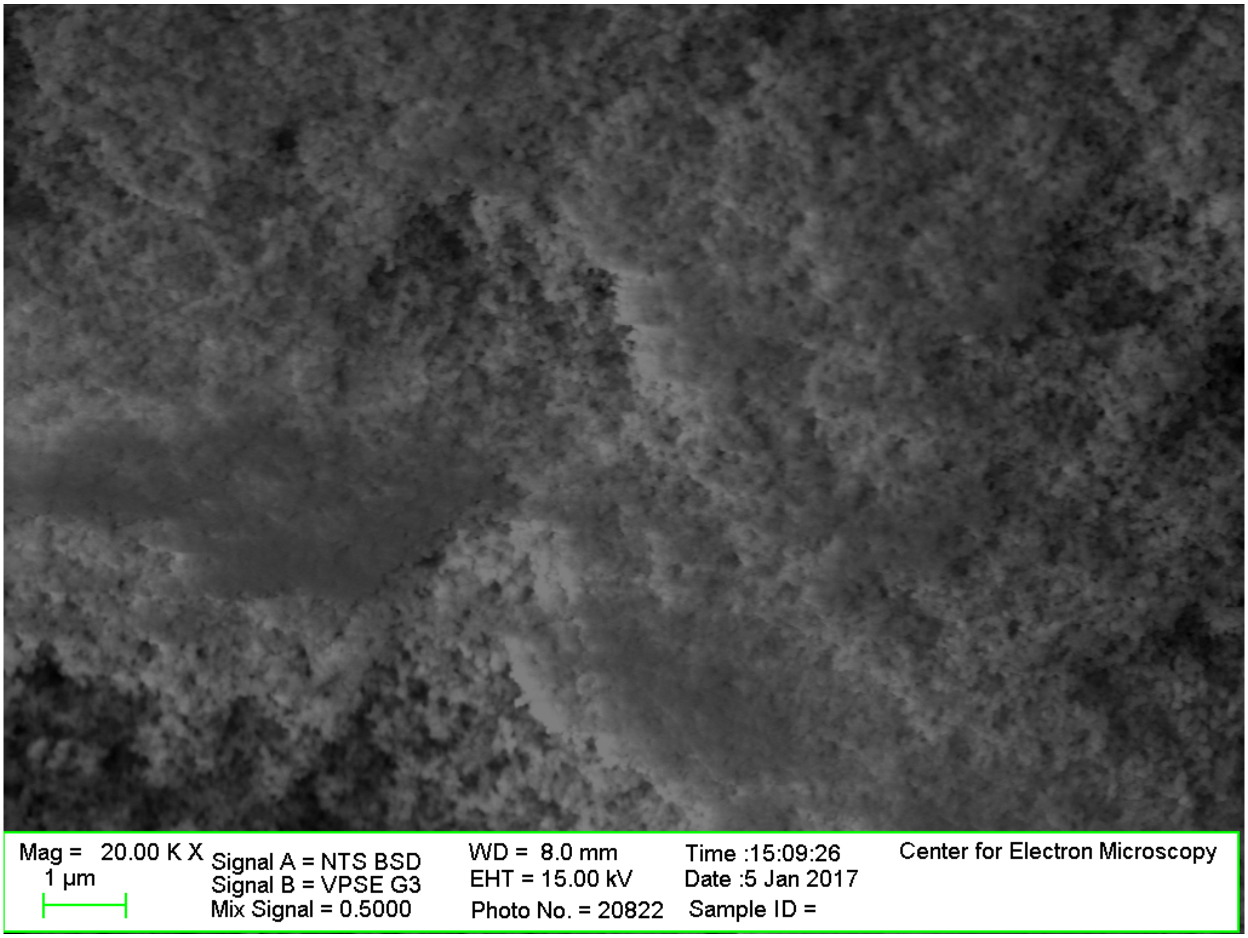
VPSE G3: secondary electron detector
WD: working distance

Image OA-06



Notes:
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Mag: magnification
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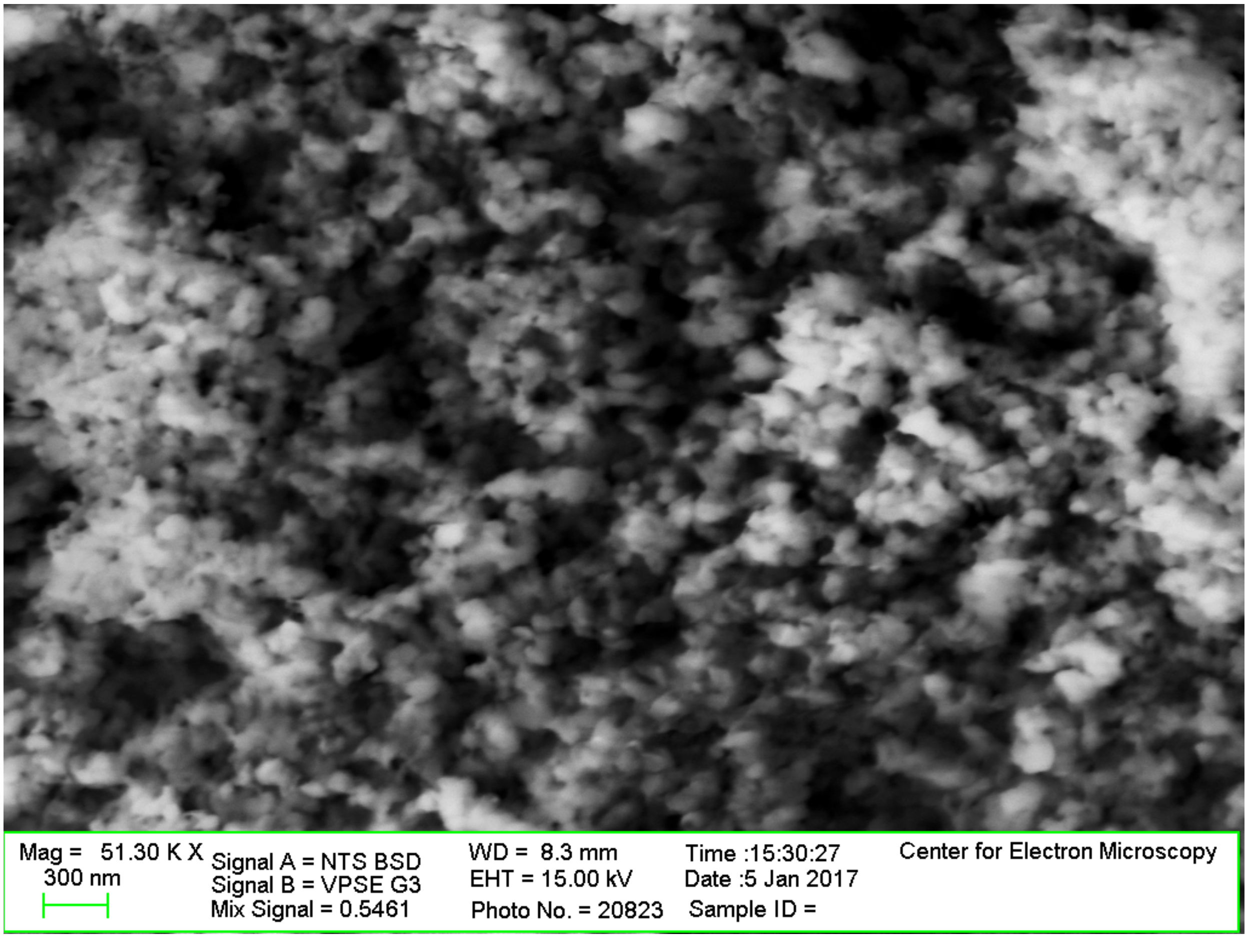
VPSE G3: secondary electron detector
WD: working distance

Image OA-07



Notes:
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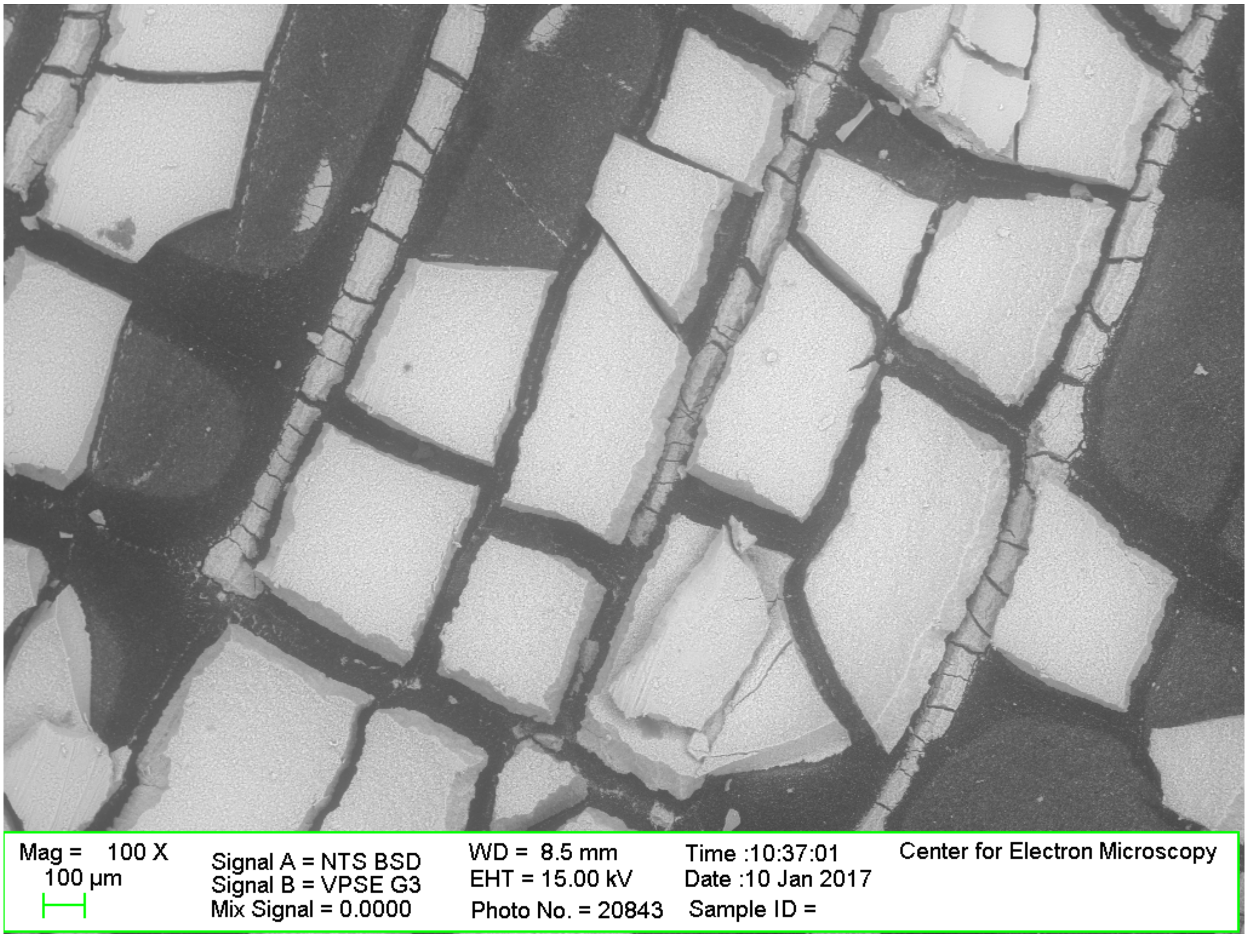
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image NA-02



Notes:
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Mag: magnification
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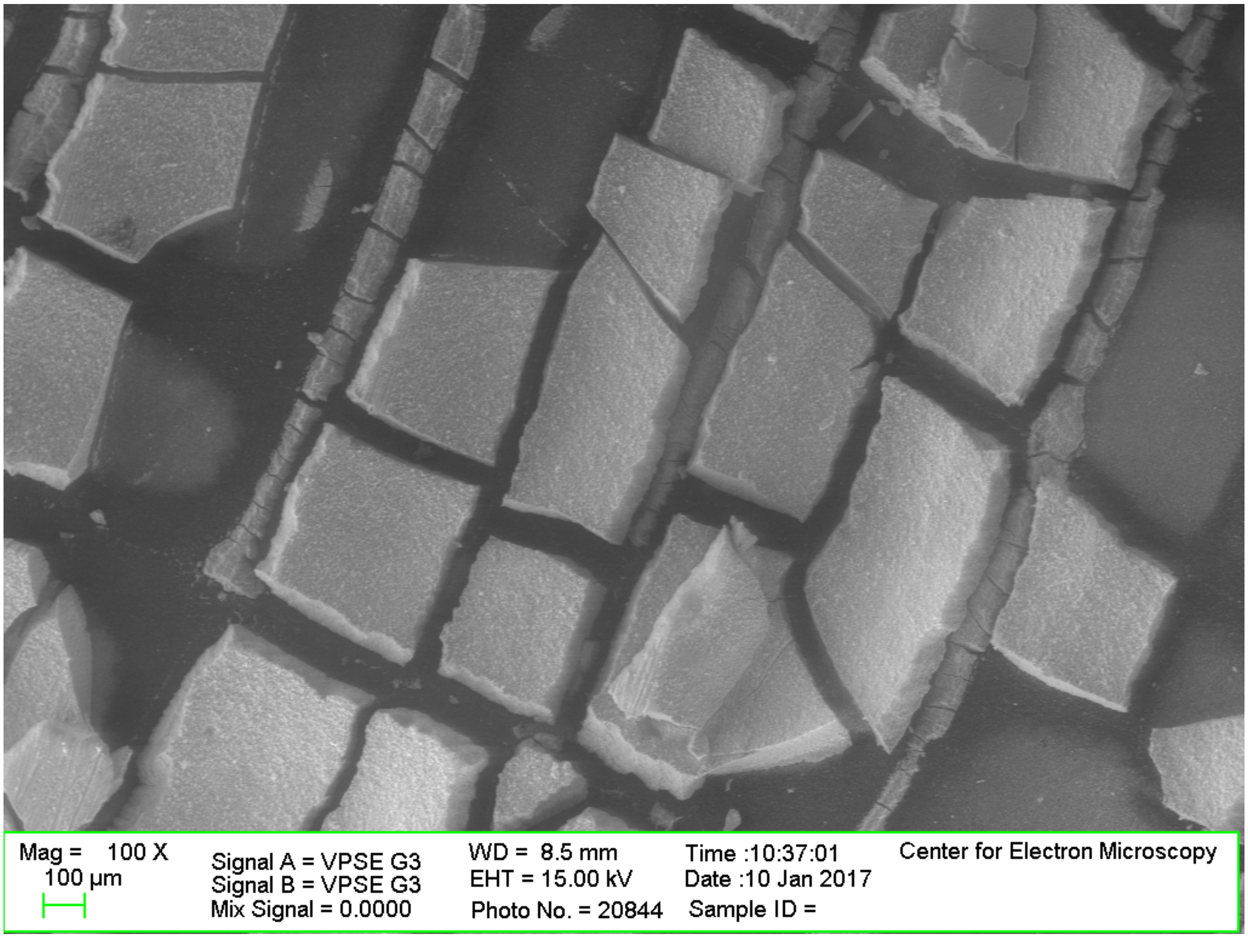
VPSE G3: secondary electron detector
WD: working distance

Image NA-03



Notes:
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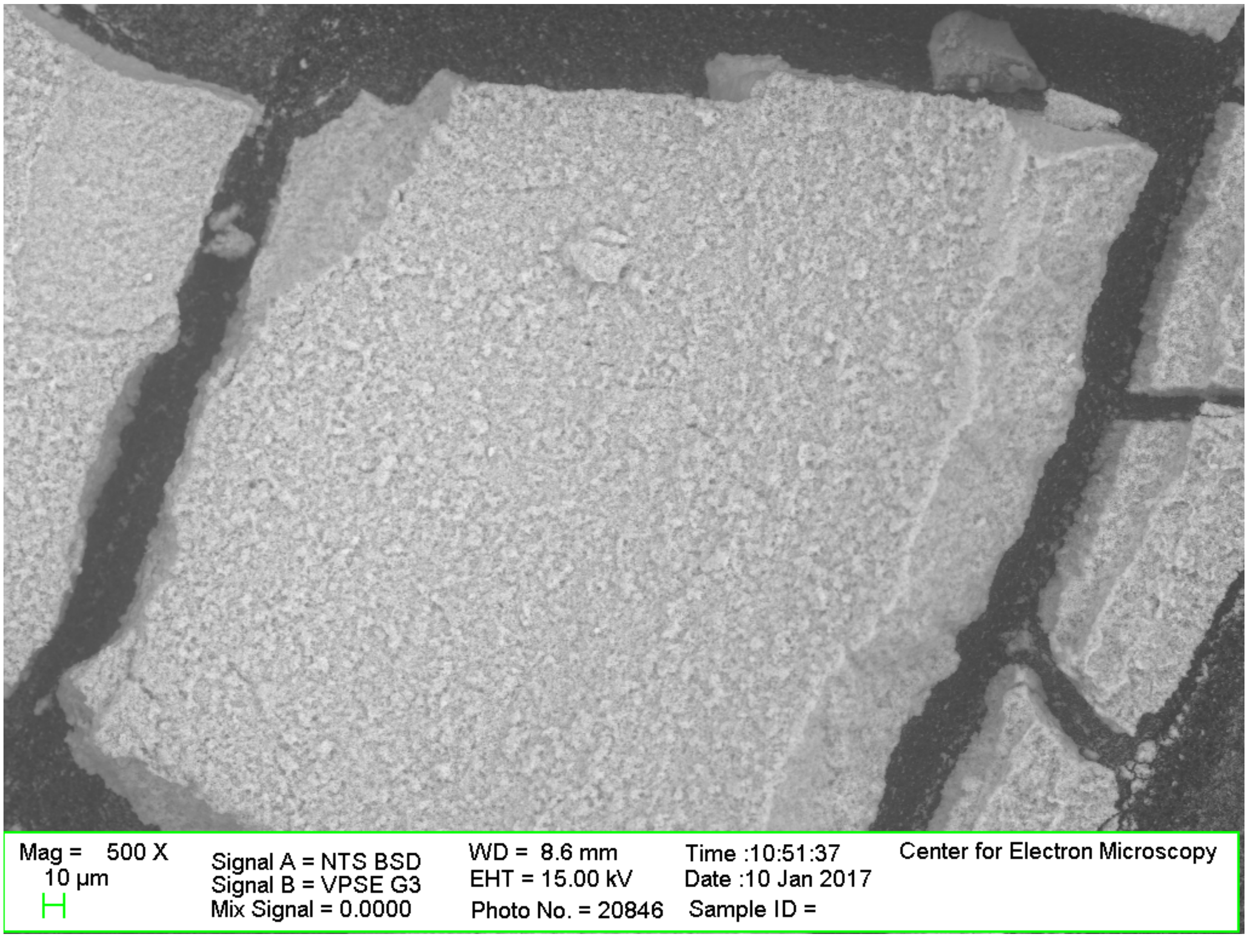
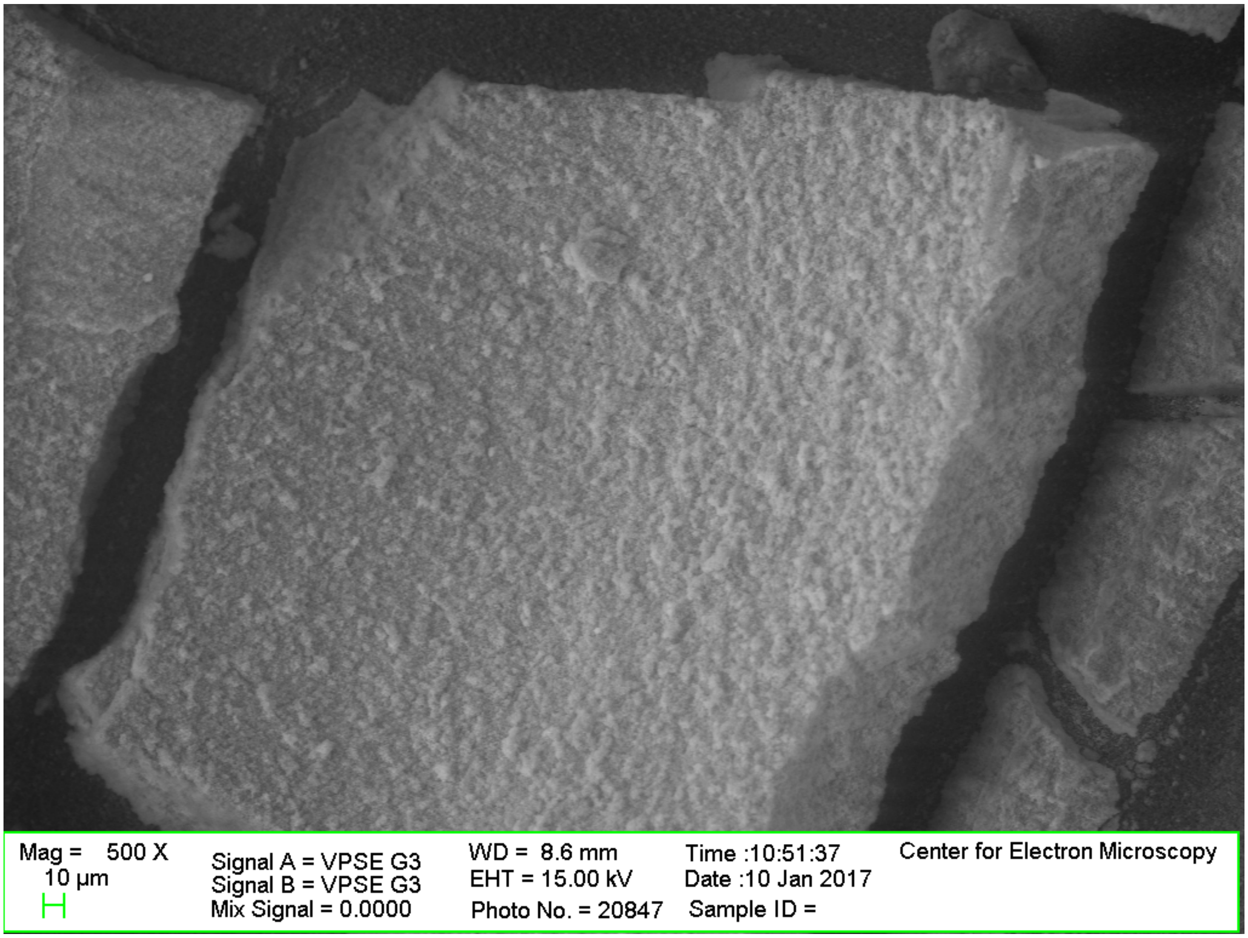
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image NA-04



Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image NA-05



Notes:
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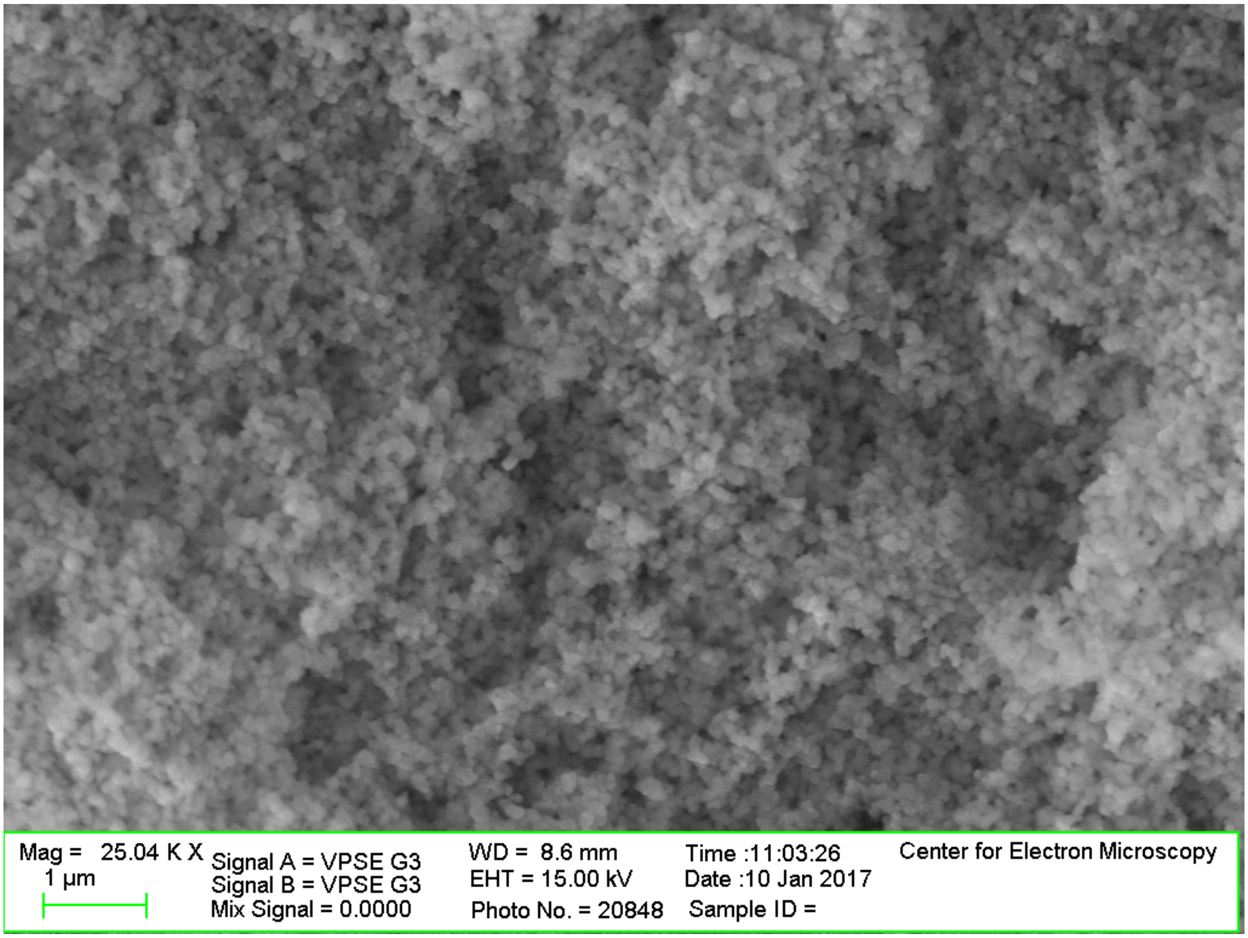
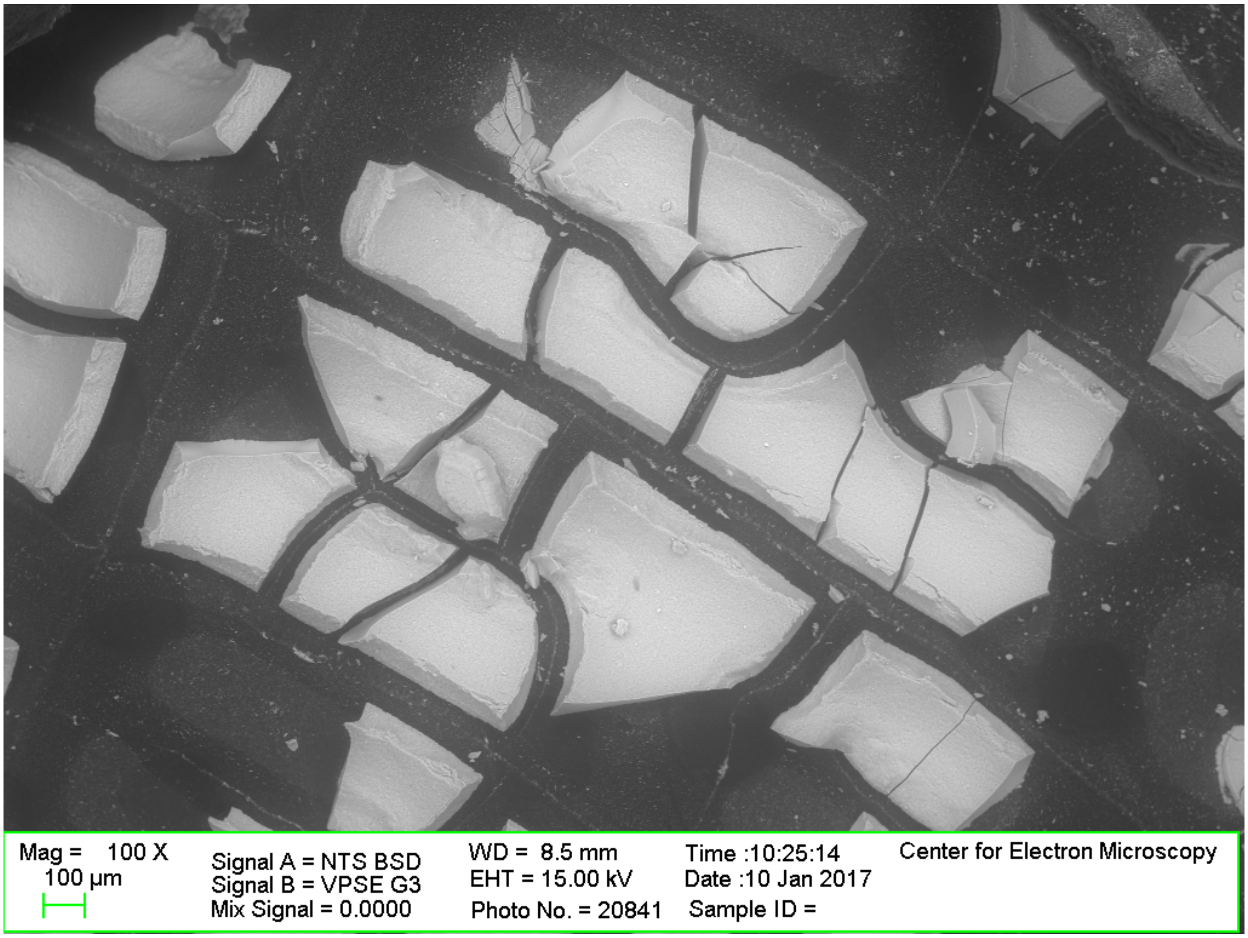
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image NA-06



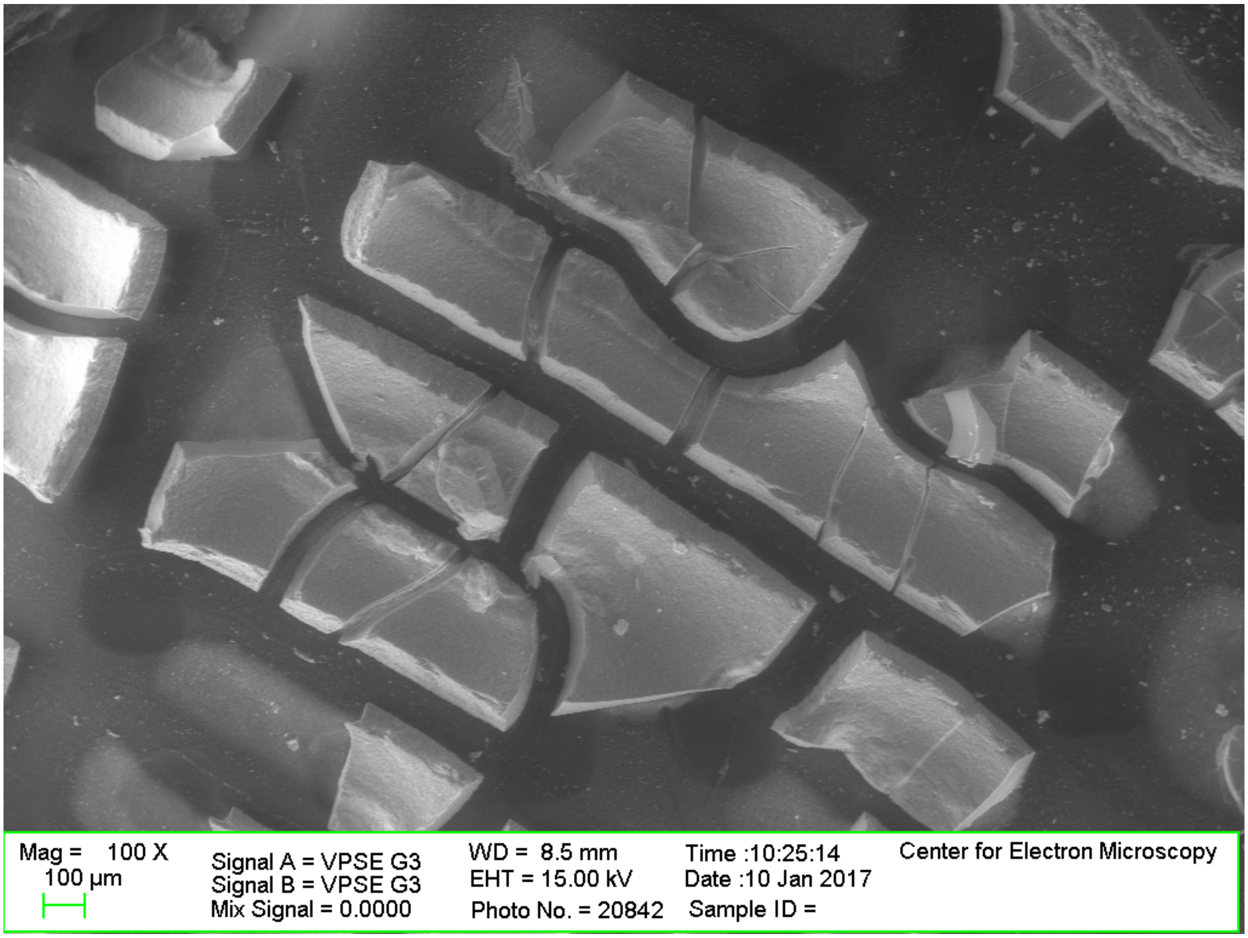
Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OI-00



Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

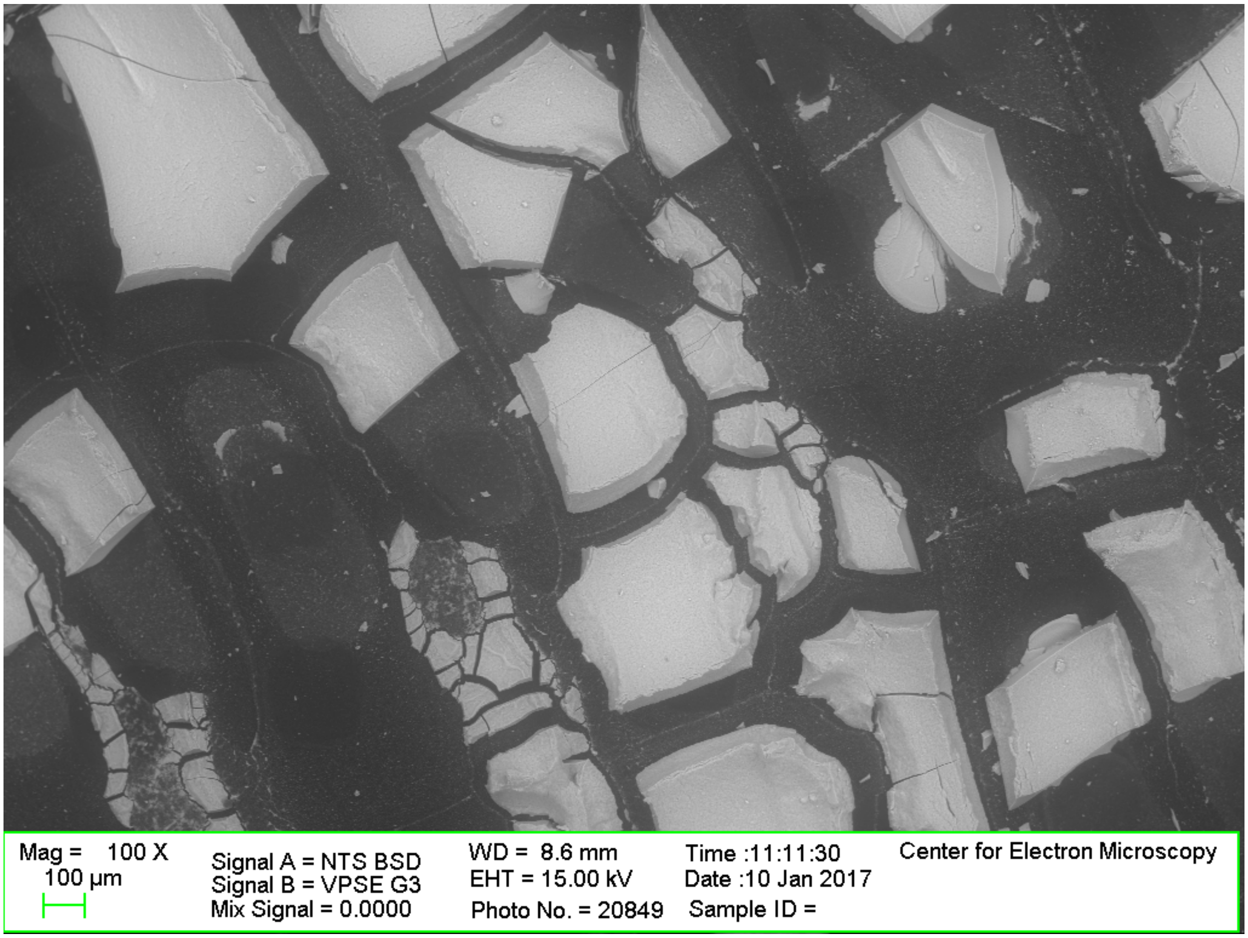
Image OI-01



Mag = 100 X
100 µm
Signal A = VPSE G3
Signal B = VPSE G3
Mix Signal = 0.0000
WD = 8.5 mm
EHT = 15.00 kV
Photo No. = 20842
Time :10:25:14
Date :10 Jan 2017
Sample ID =
Center for Electron Microscopy

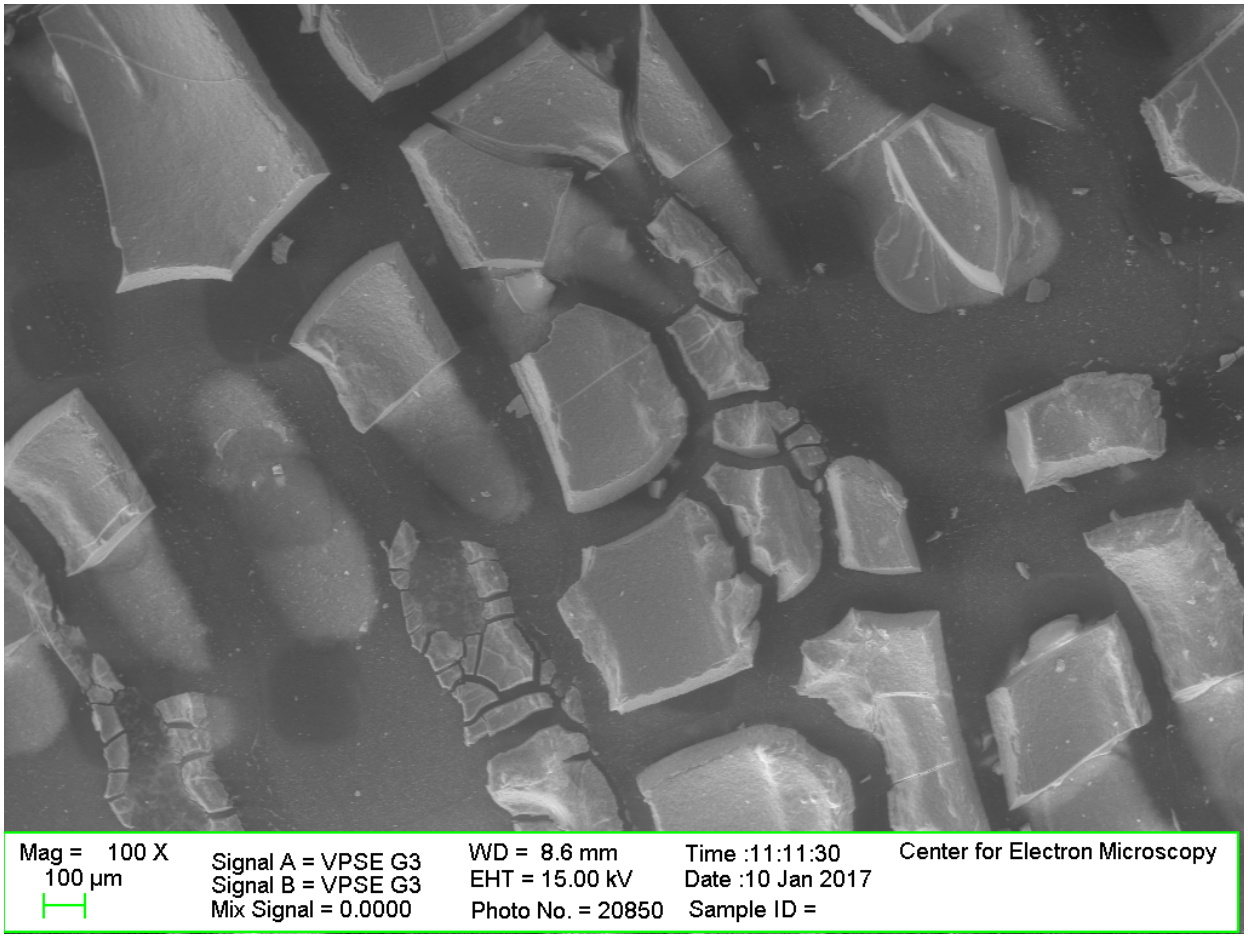
Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OI-02



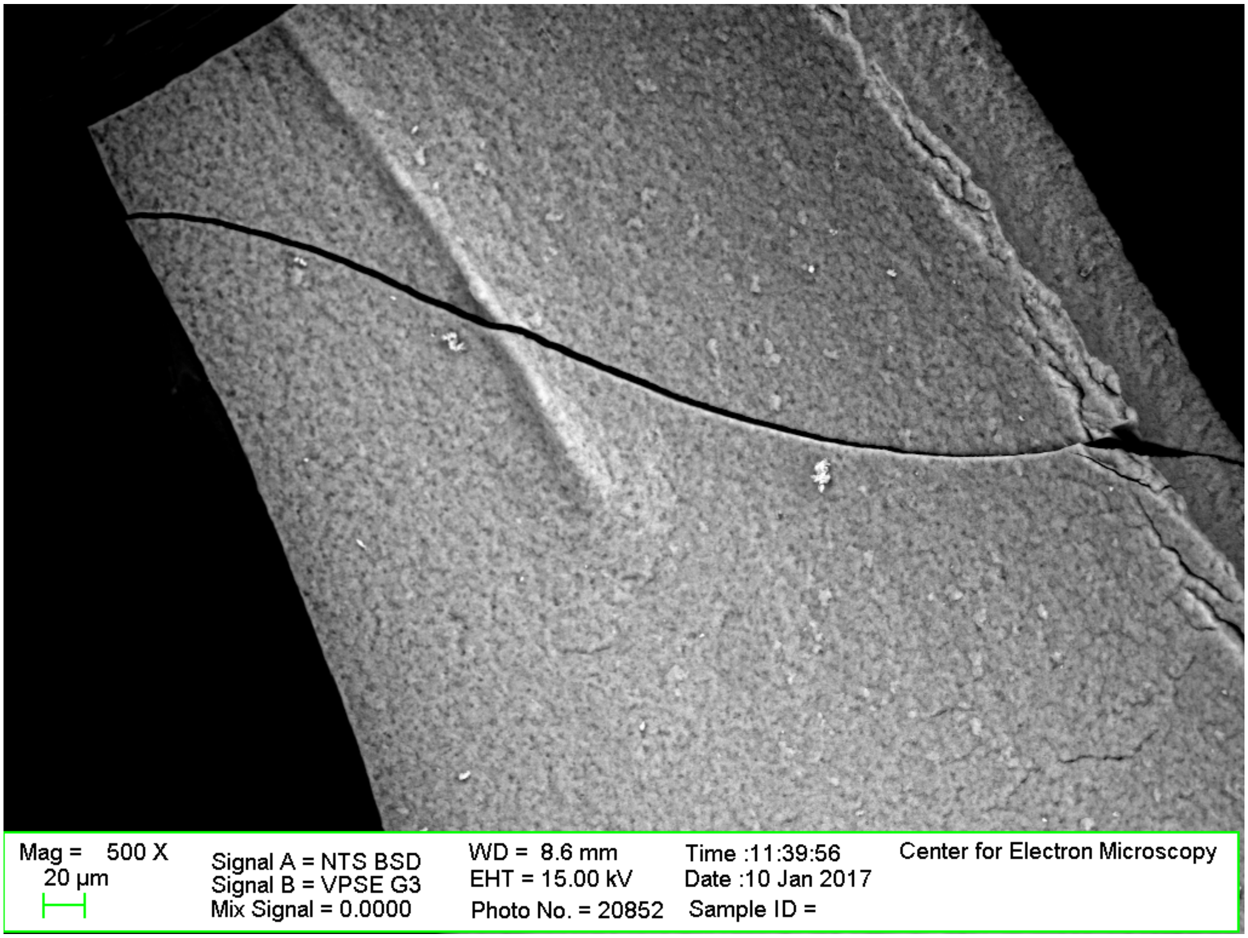
Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OI-03



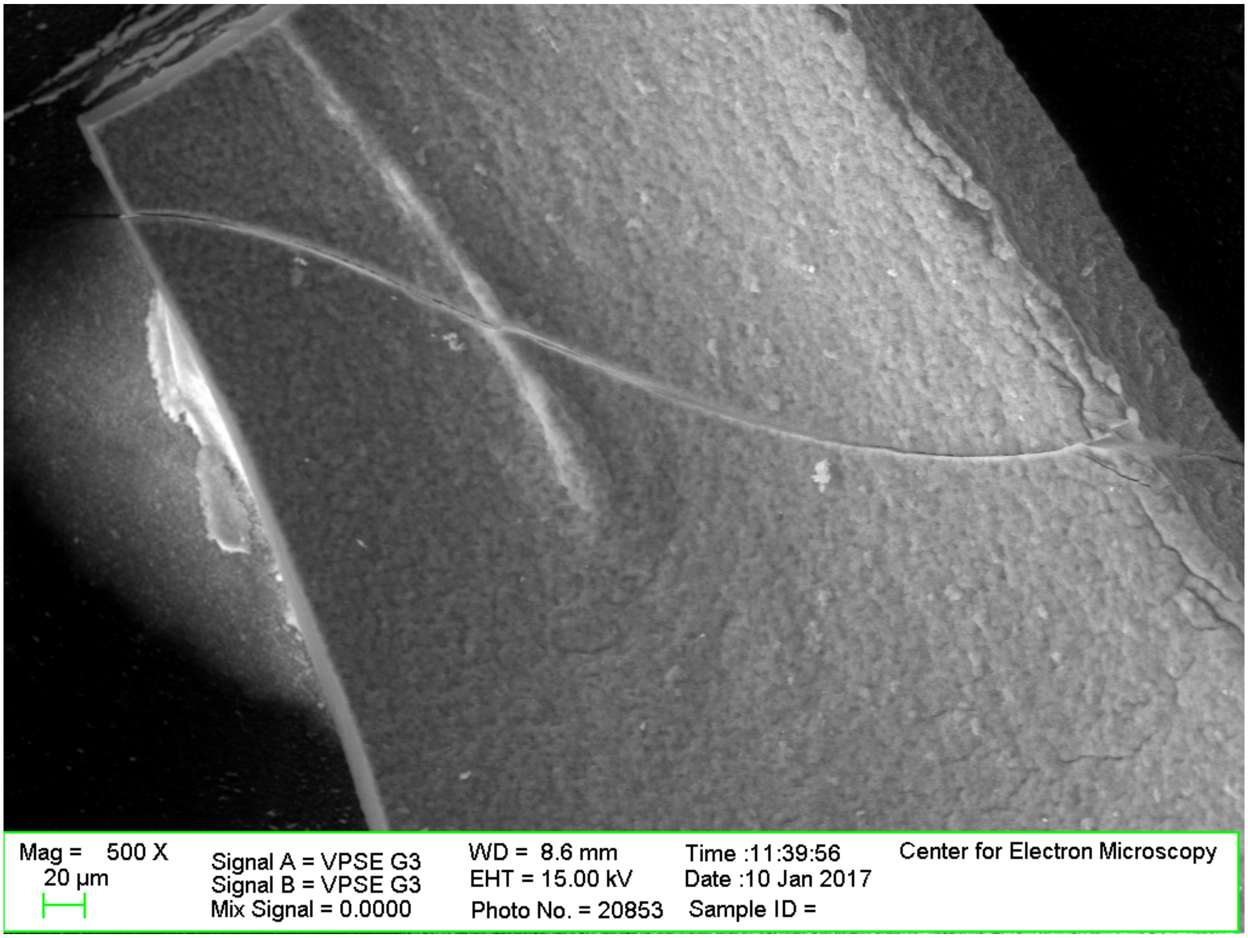
Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OI-04



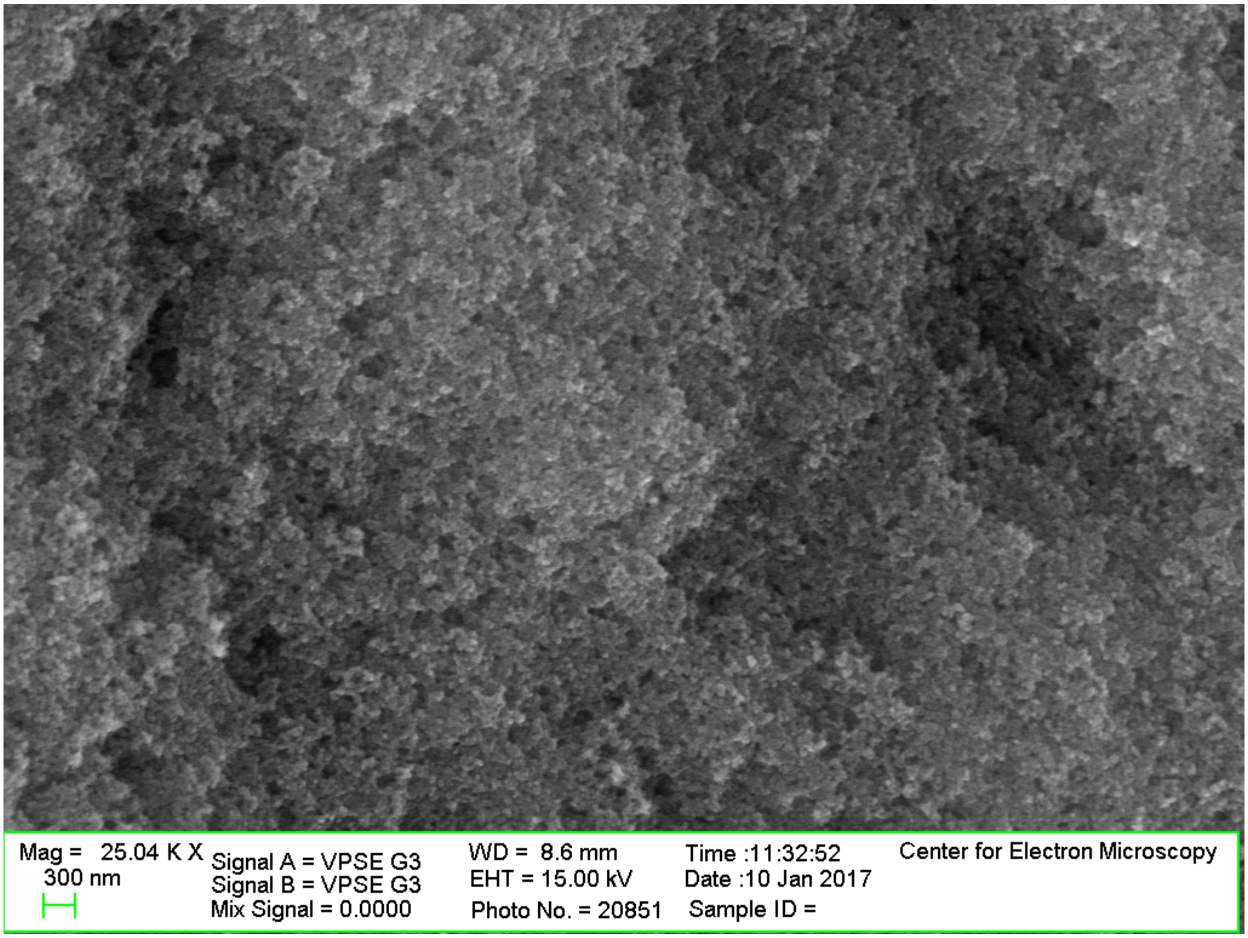
Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OI-05



Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Image OI-06



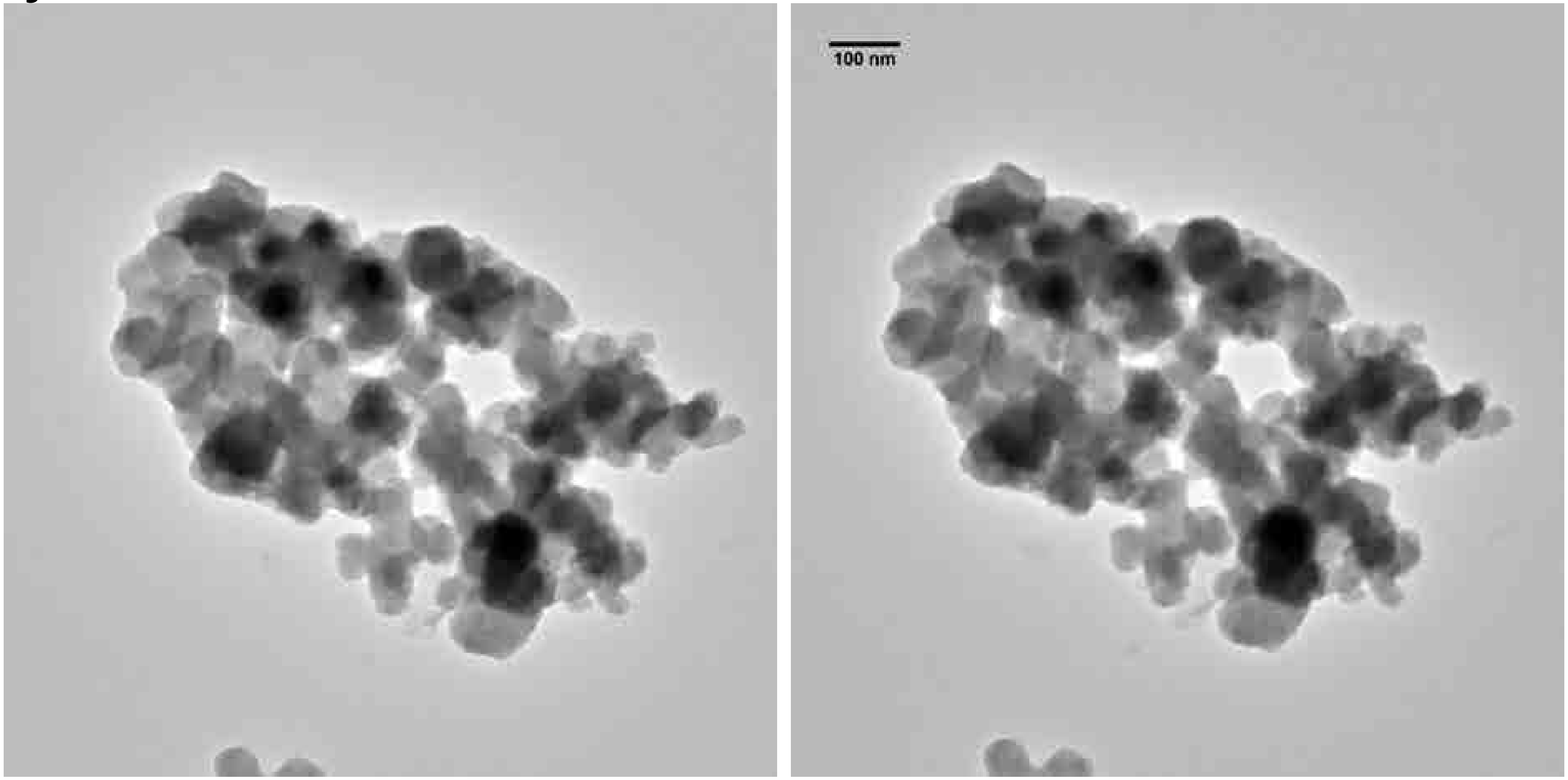
Notes:
µm: micrometers
EHT: accelerating voltage in kilovolts
Mag: magnification
NTS BSD: back-scatter electron detector
VPSE G3: secondary electron detector
WD: working distance

Attachment E

Transmission Electron Microscopy Report

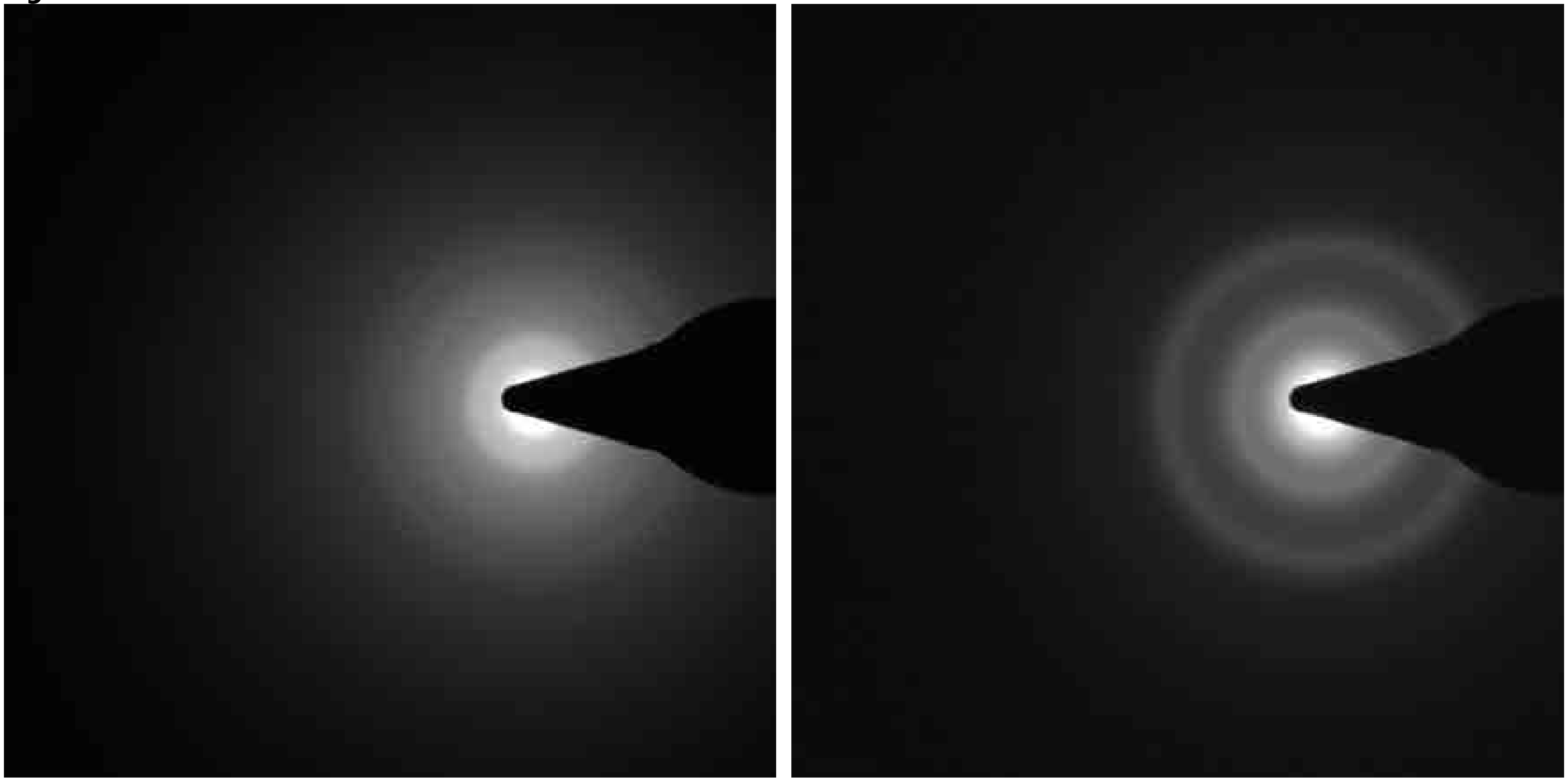
Specimen NA

Figure 1



Stereopair of area NA-A, a small agglomerate of Fe-As containing nanoparticles

Figure 2

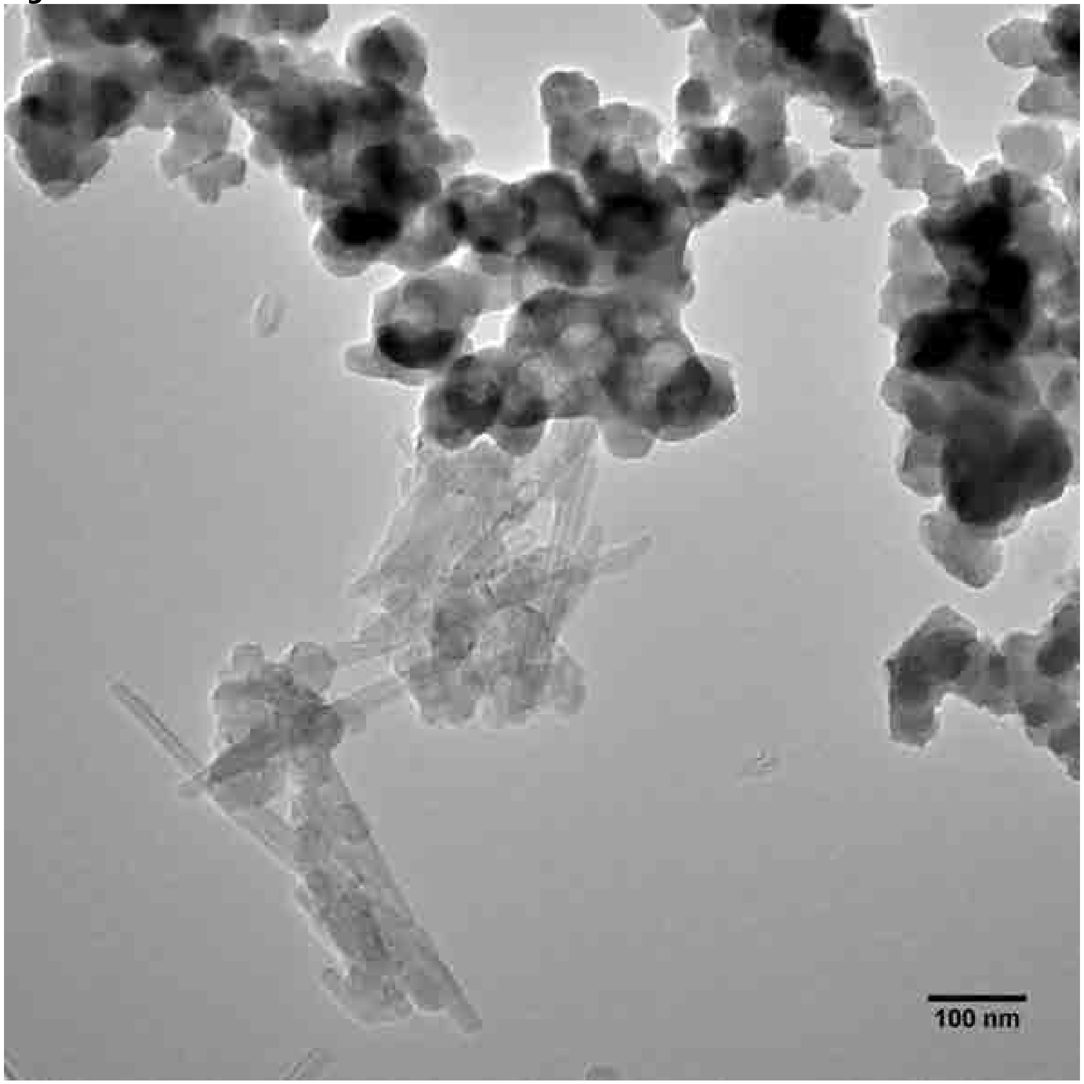


Diffraction from (A) area NA-A; (B) carbon support film

Table 1. d-spacings (in Å) from diffraction patterns above.

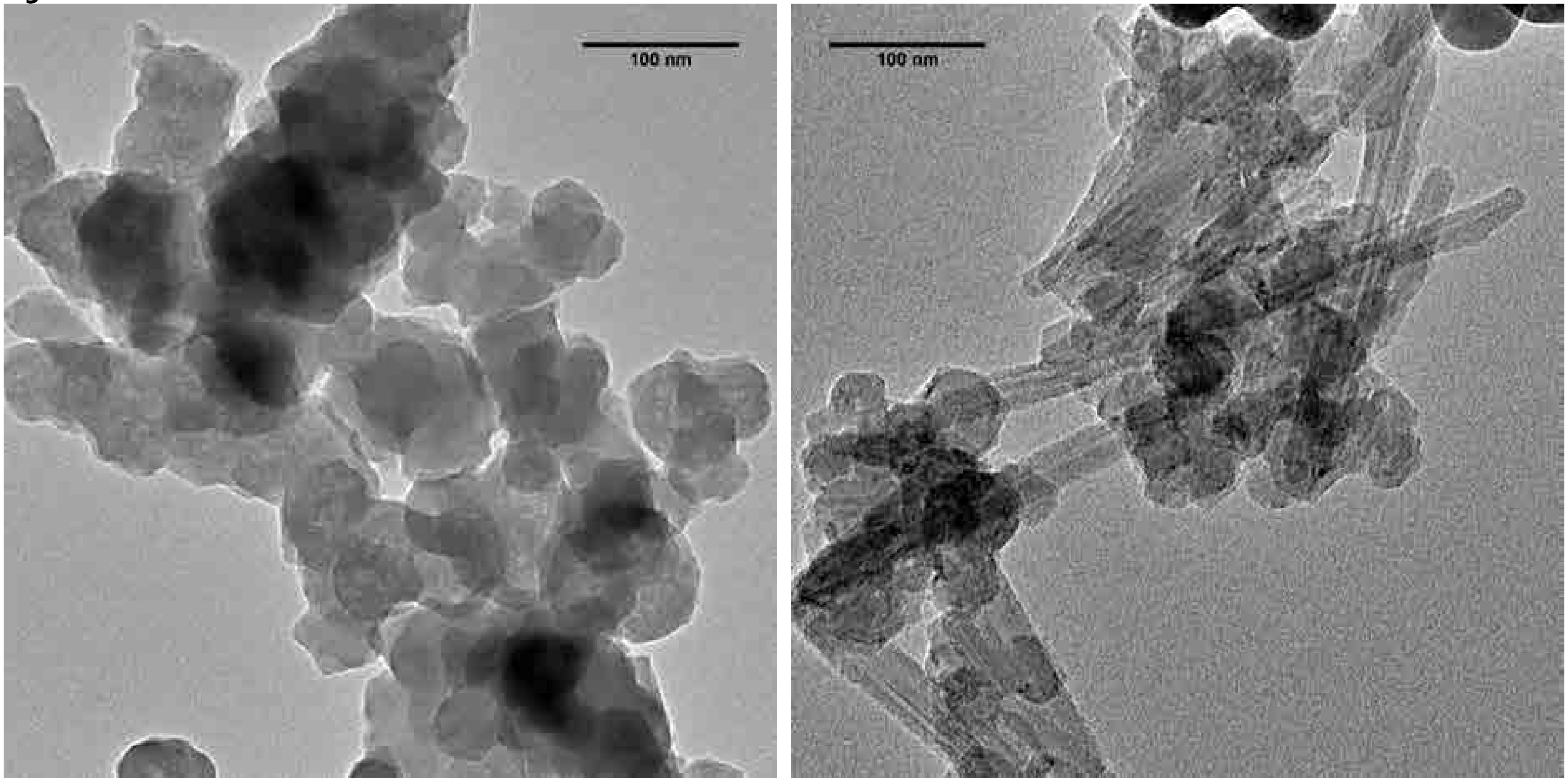
NA-A	carbon film
1.34	
1.95	1.94
2.60	
3.28	
3.56	3.54

Figure 3



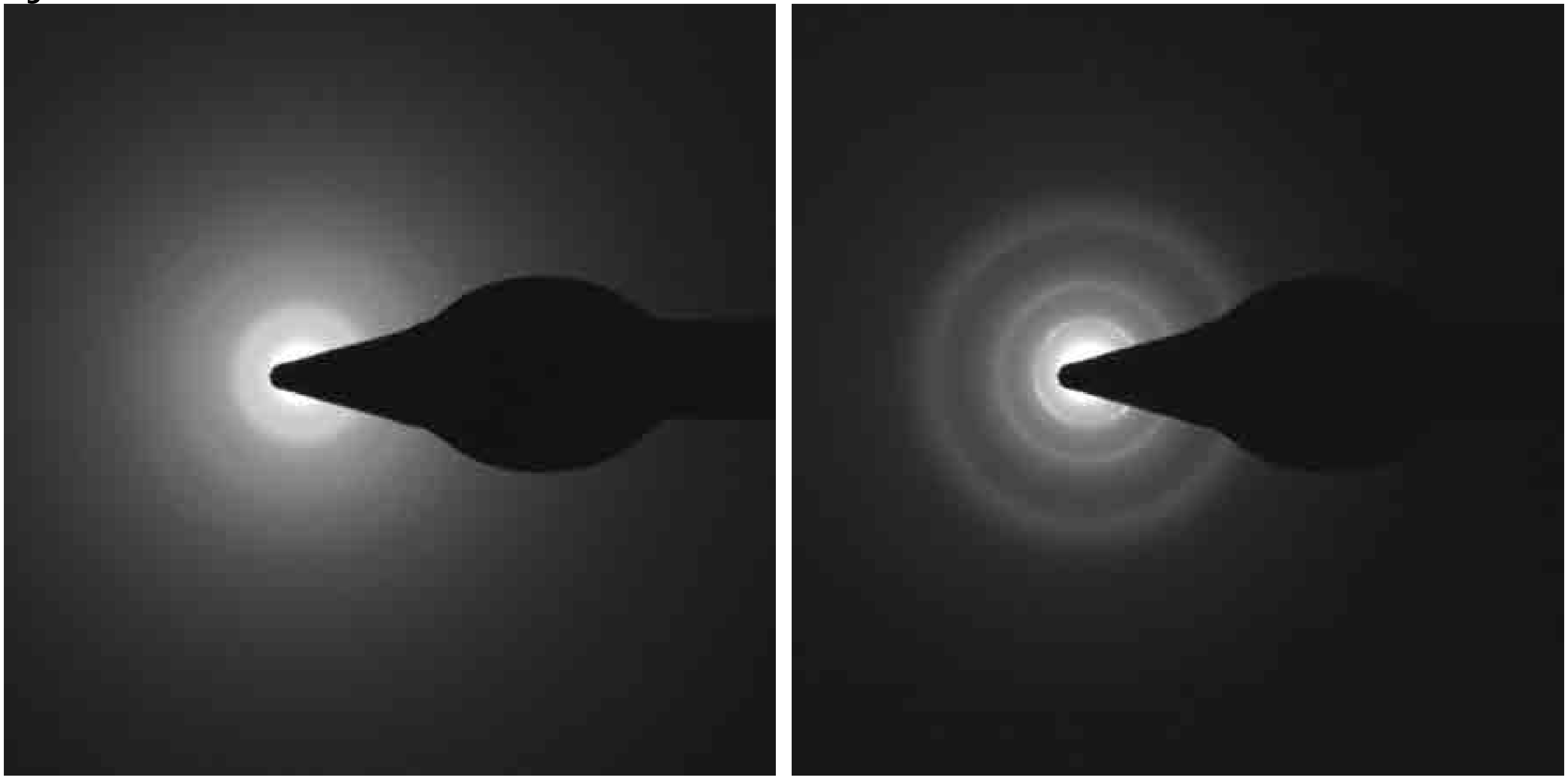
The two types of particles found in sample NA – aggregates of Fe-As containing nanospheroids and silica rods. Other, more blocky silica particles were also found. Most of the specimen was comprised of Fe-As nanospheroids.

Figure 4



Higher detail of the two types of particulates found: (A) NA-L and (B) NA-K.

Figure 5

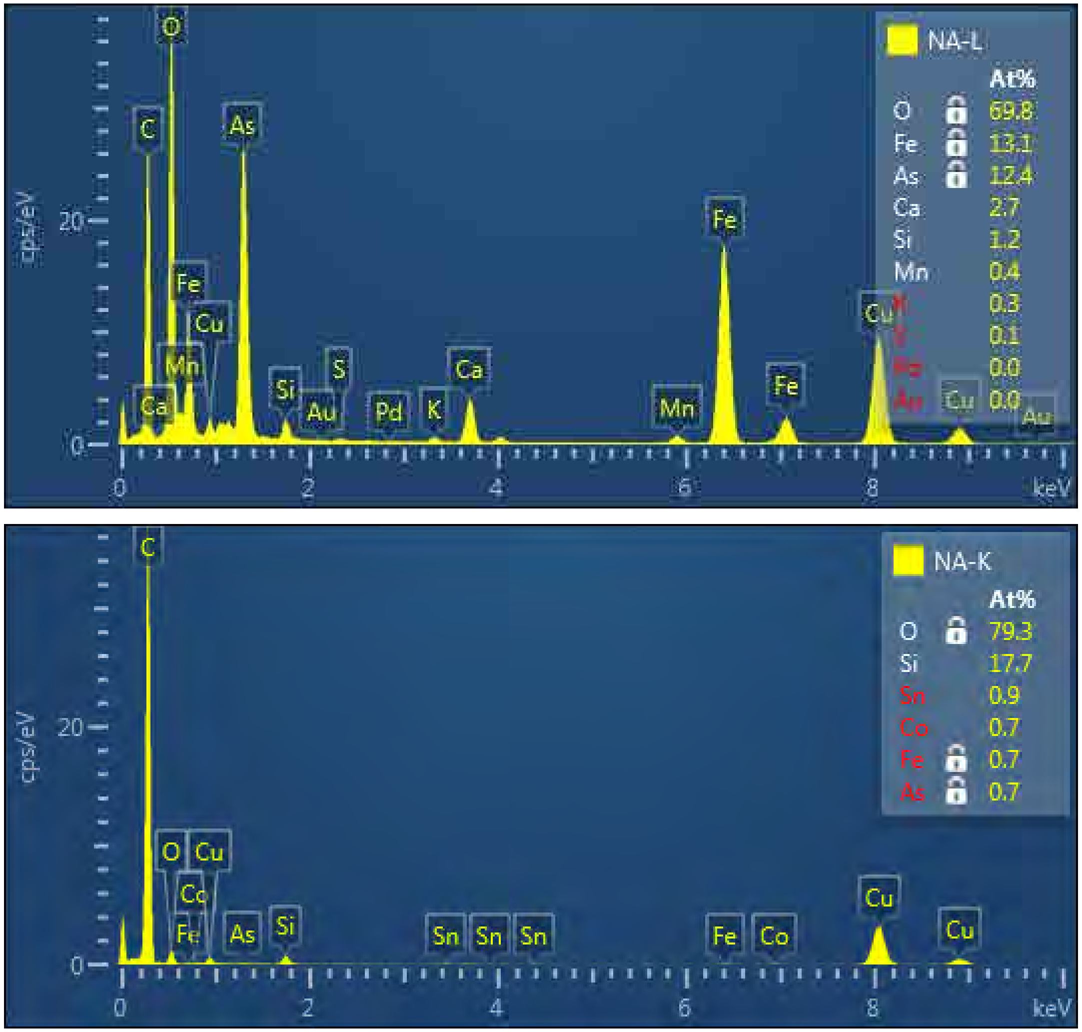


SAED patterns from areas NA-L and NA-K.

Table 2. d-spacings (in Å) from particles NA-L and NA-K. Spacings associated with the carbon support film are not reported here.

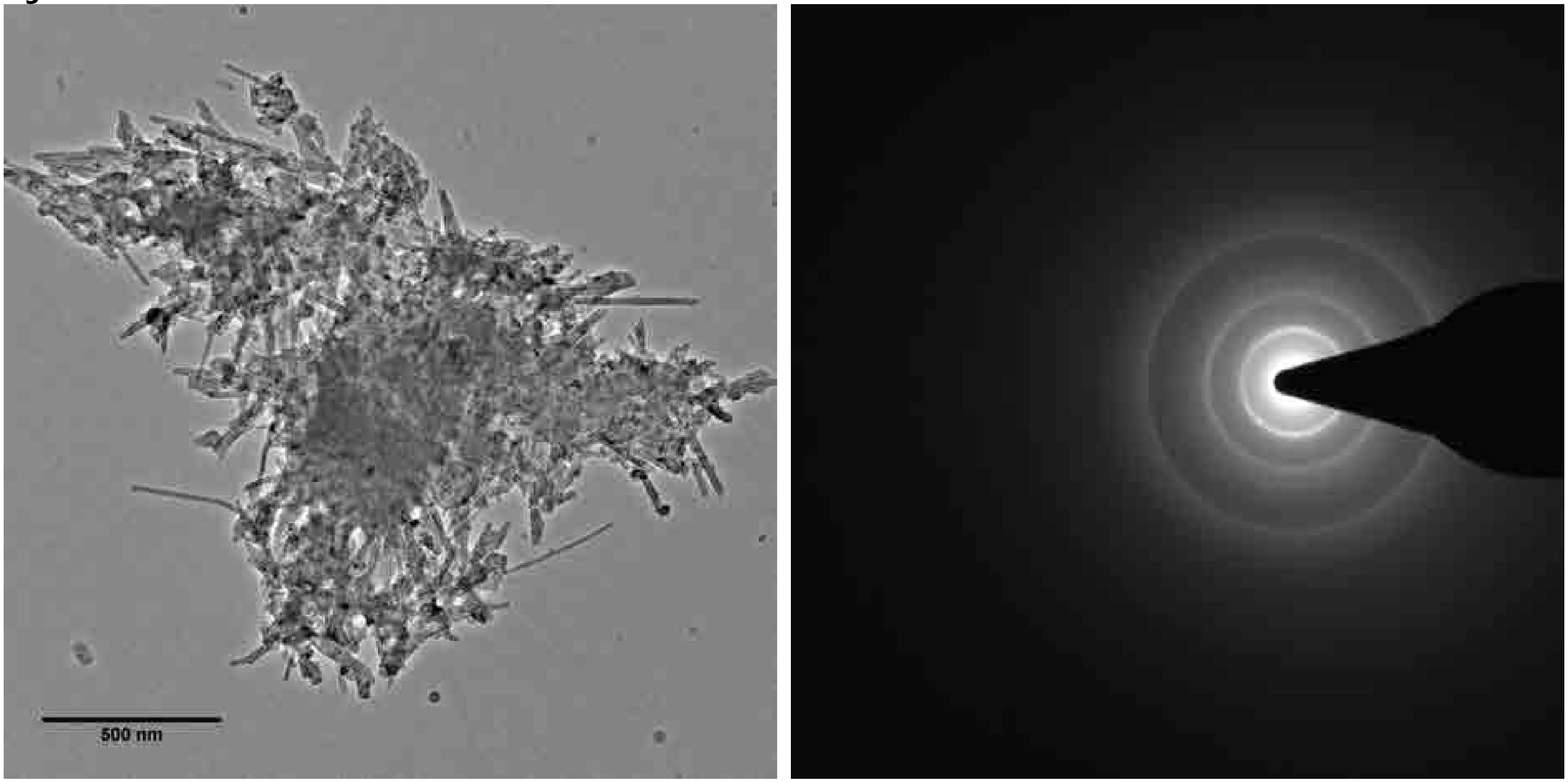
NA-L	NA-K
1.378151261	1.178992
2.605042017	1.957983
	3.315126

Figure 6



EDS spectrum and corrected analysis of NA-L and NA-K. Since the specimen was mounted on a carbon film on Cu mesh, and because significant C was not detected in SEM analyses, Cu and C have been removed from the quantitative analysis. Elements listed in red have concentrations lower than 2σ (90% confidence interval) significance.

Figure 7

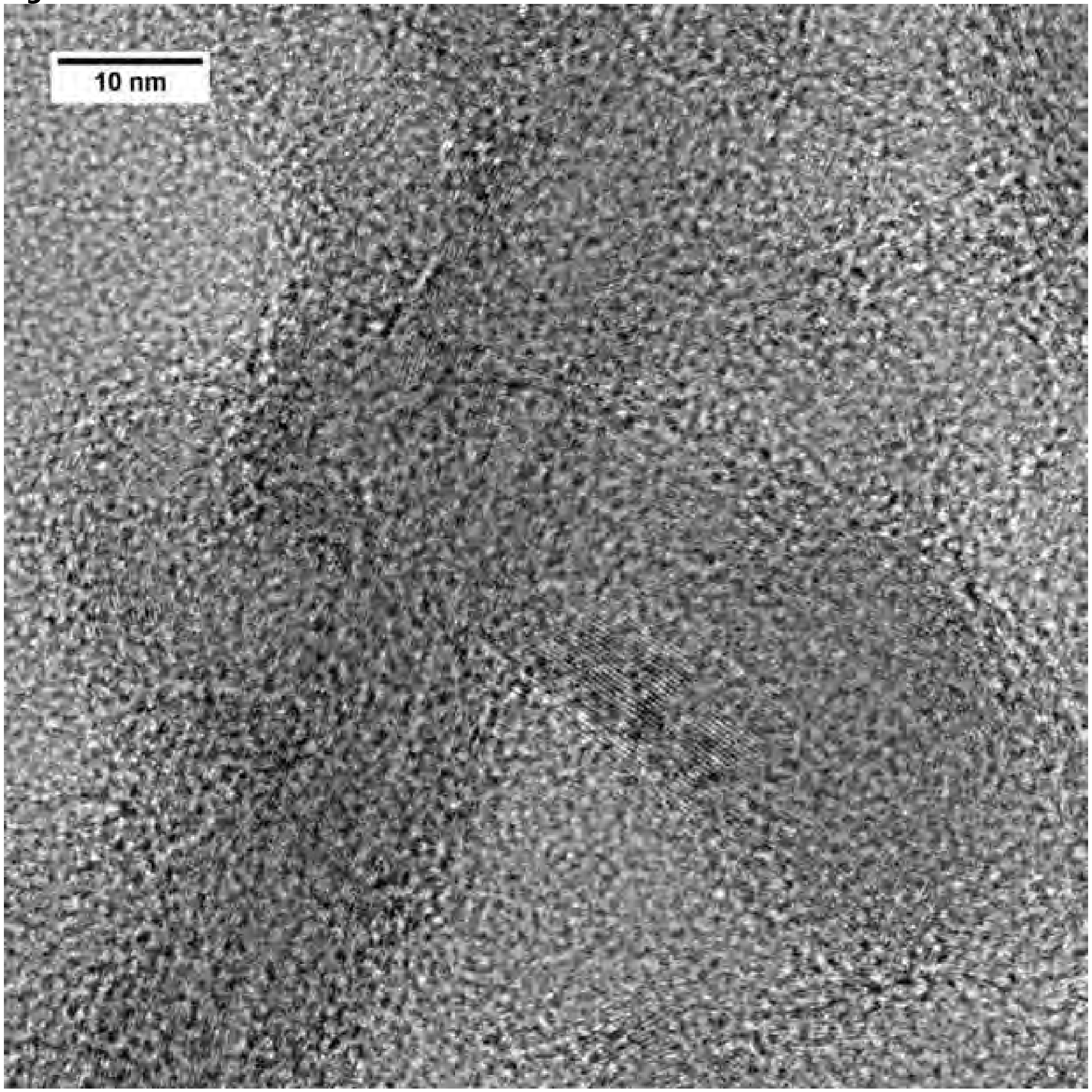


BF image and SAED pattern of particle NA-G, an agglomerate of blocky material with nanorods or nanotubes. No EDS information is available for this particle. This type of particle was rare.

Table 3. d-spacing of particle NA-G

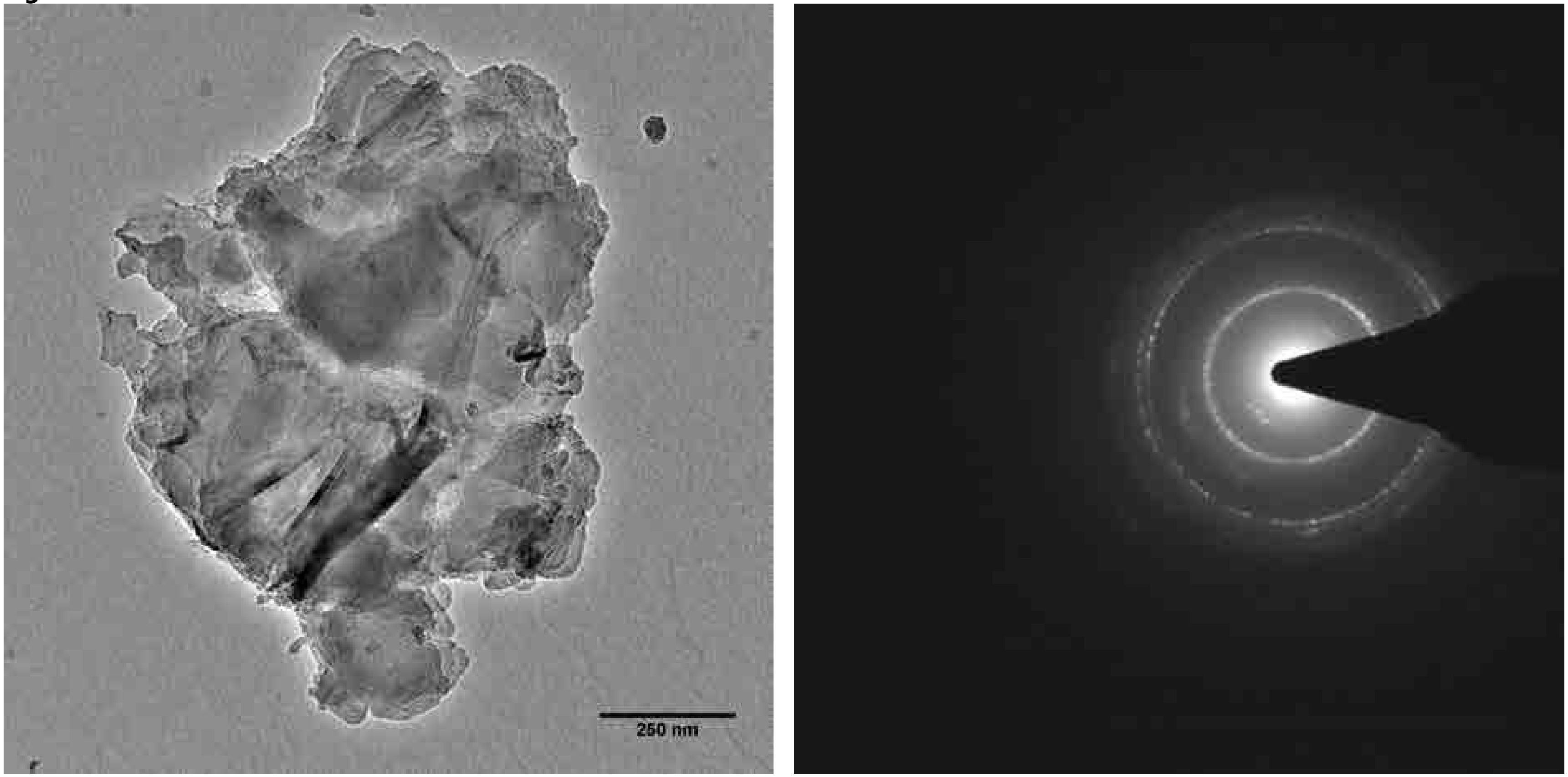
1.176470588
1.927310924
2.364285714
3.294117647
3.823529412
5.047058824
5.736554622
6.594537815

Figure 8



HR-TEM image of the interior of particle NA-G, showing lattice fringes. The silica rods appear in this image to be nanotubes, as shown by a region in the middle of each rod that has no clear lattice fringes.

Figure 9

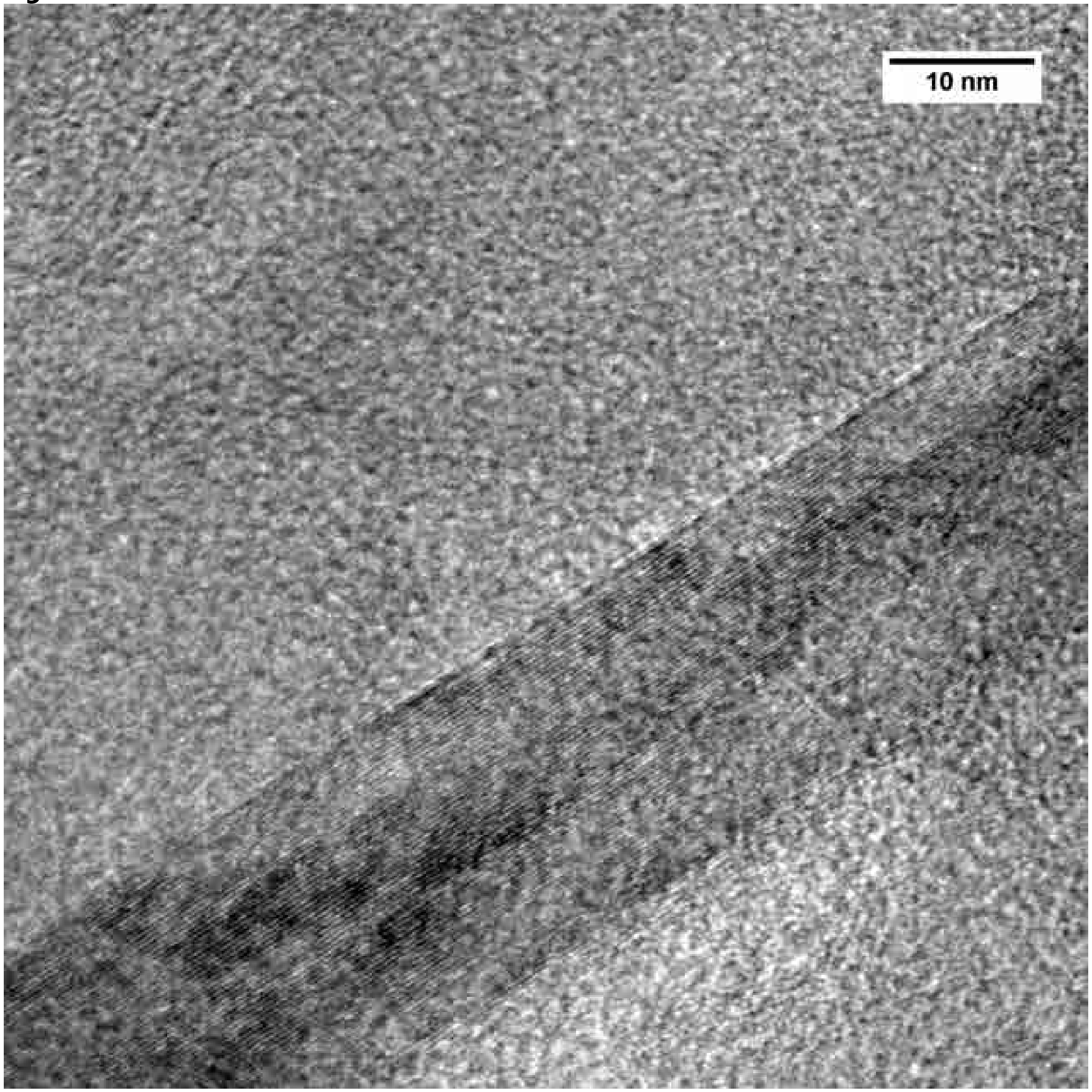


BF image and SAED pattern from particle NA-H. These blocky, well-ordered particles were rare.

Table 4. d-spacings from particle NA-H. Note that these are very similar to NA-H.

1.181933
1.973529
2.505042
3.291176
3.486975
3.839076
5.068908
5.842857

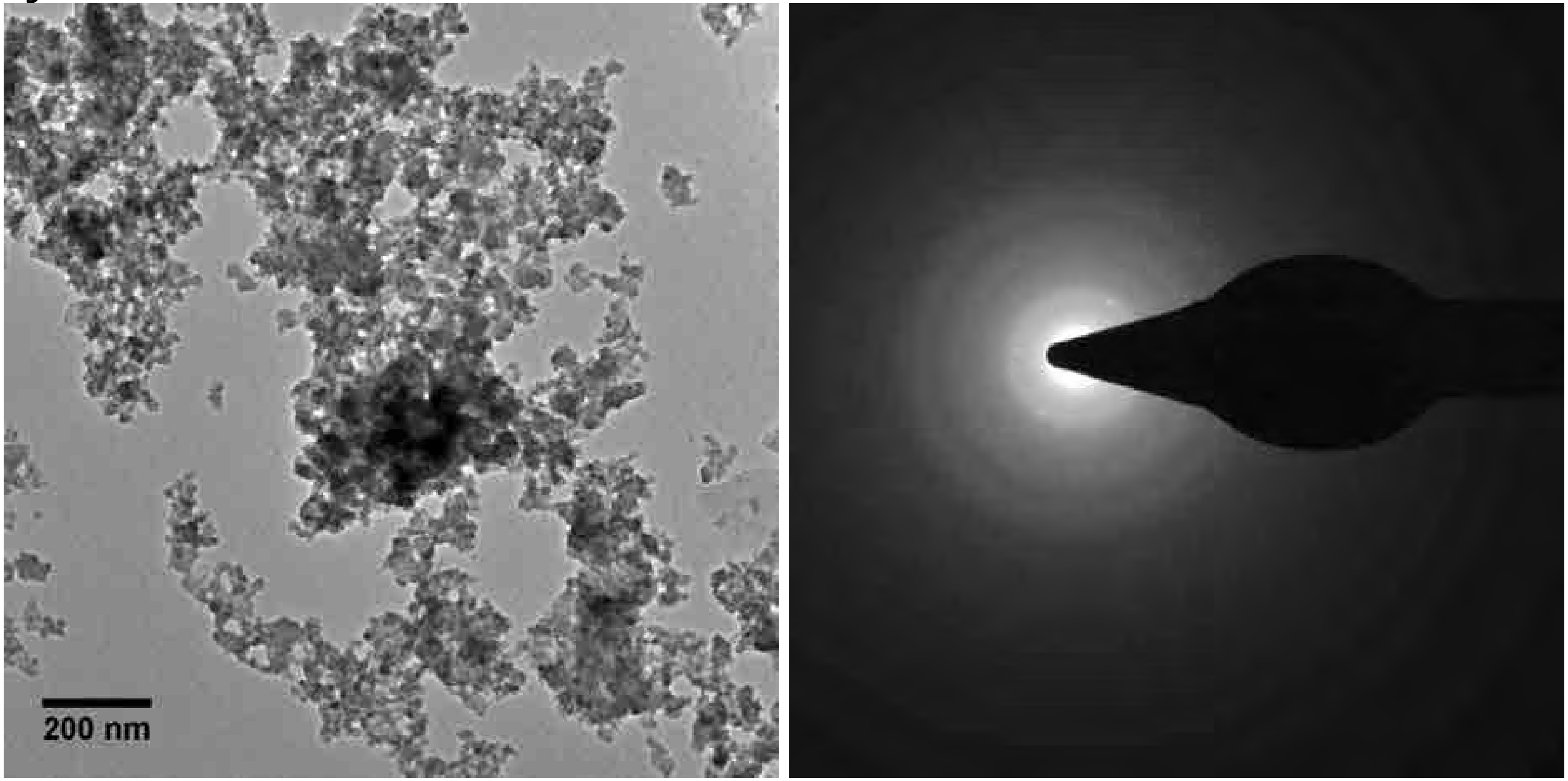
Figure 10



HR-TEM image of a portion of NA-H, showing lattice fringes.

Specimen NI

Figure 1

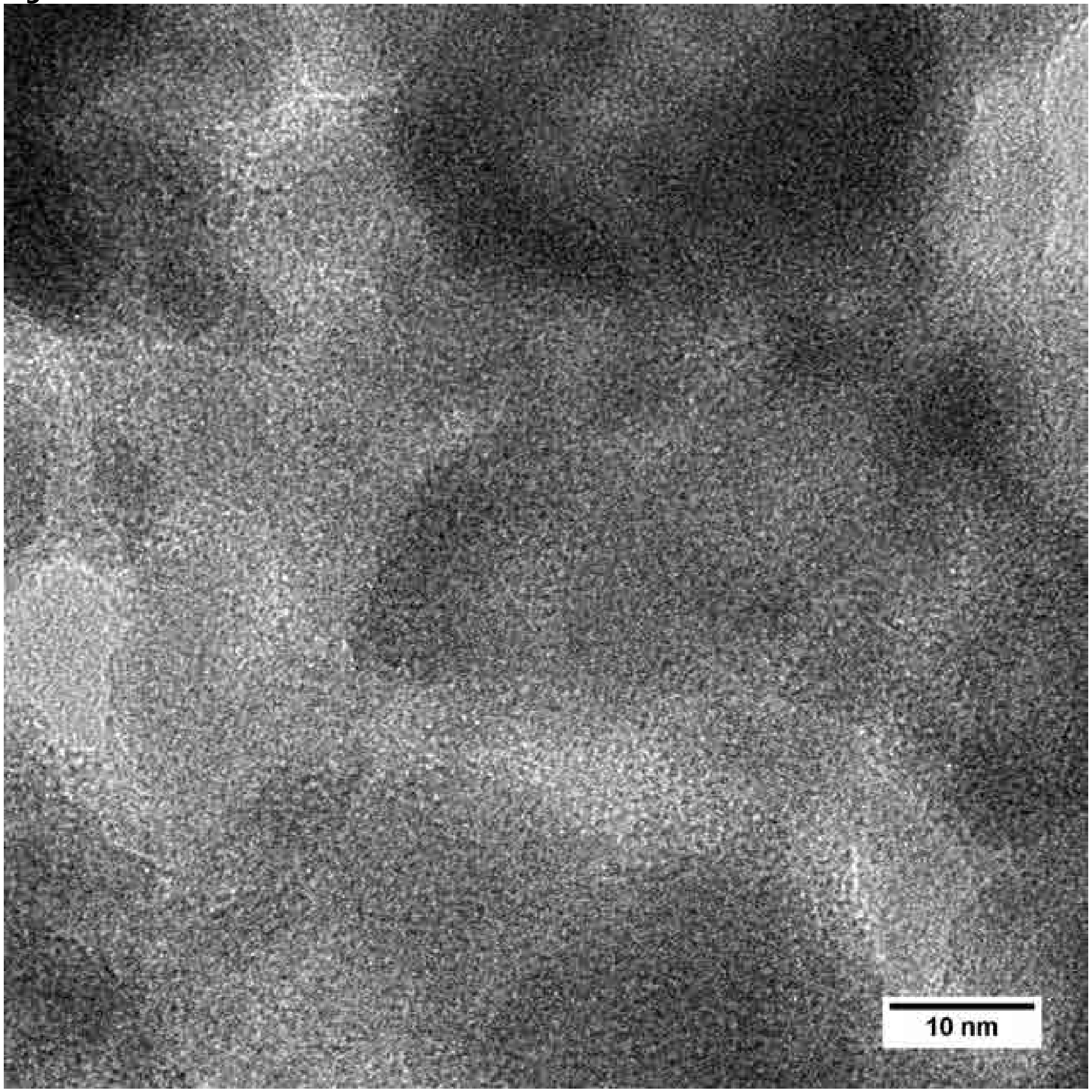


Bright field image and diffraction pattern from area NI-H, an Fe-As containing agglomerate. This type of agglomerate was the most common type of particle found in specimen NI.

Table 1. d-spacings (in Å) from particle NI-H. Spacings associated with the carbon support film are not reported here.

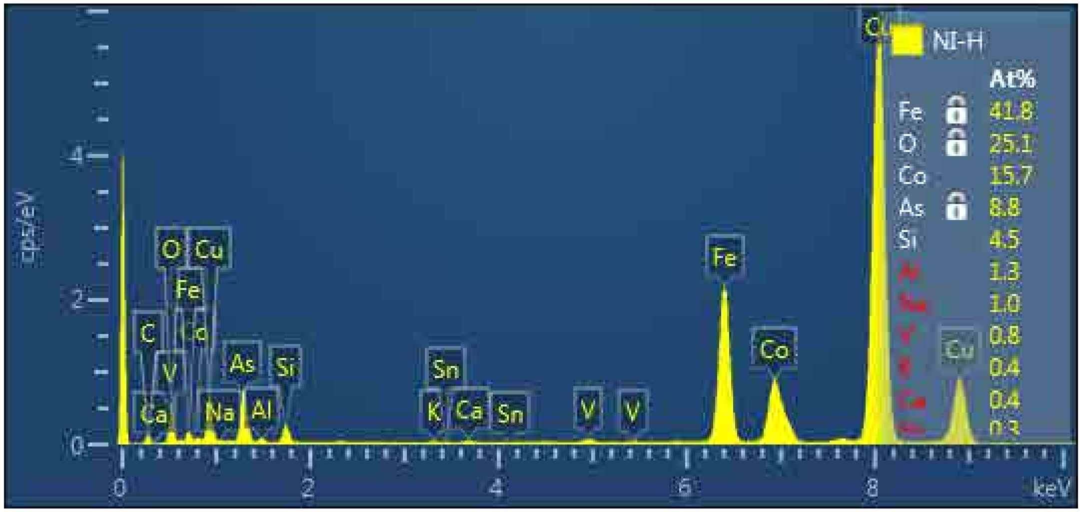
NI-H
1.453782
2.638655

Figure 2



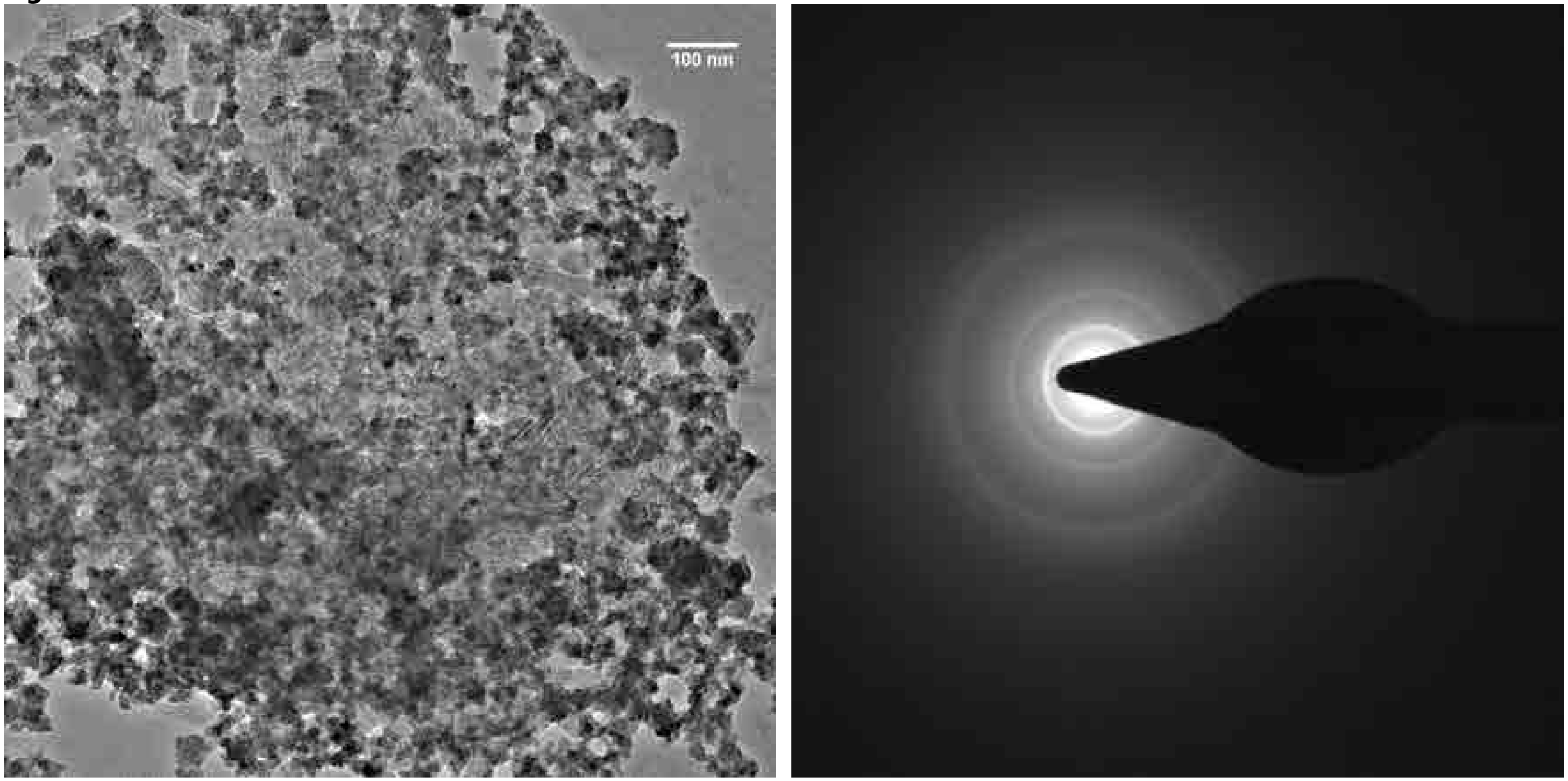
High resolution micrograph of the above agglomerate. Note the lack of visible lattice fringes in this amorphous agglomerate.

Figure 3



EDS spectrum and analysis from NI-H.

Figure 4

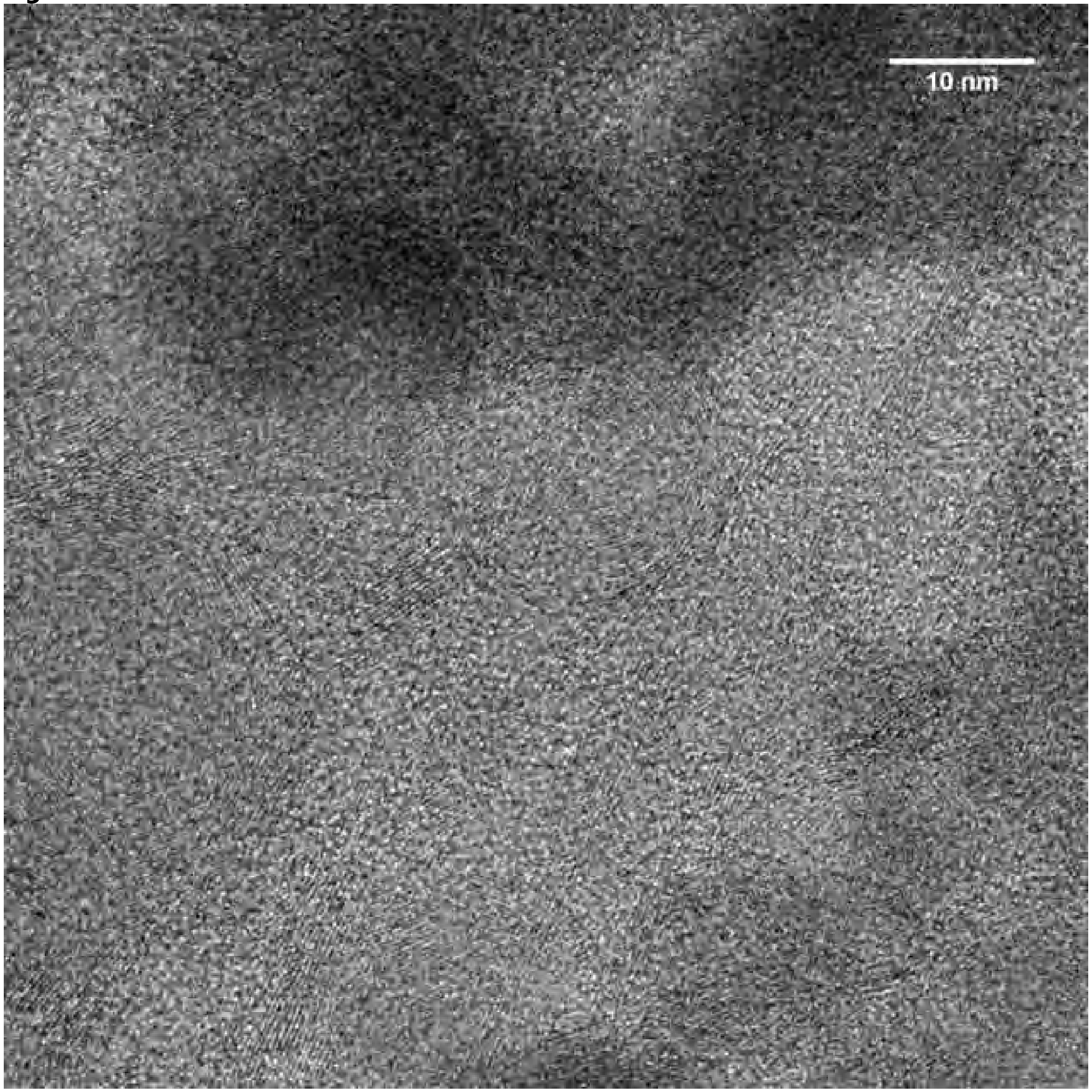


Bright field image and diffraction pattern from NI-E, an Fe-As containing nanoparticle agglomerate. Note much sharper diffraction rings compared to those found in the NA specimen.

Table 2. d-spacings (in Å) from particle NI-E. Spacings associated with the carbon support film are not reported here.

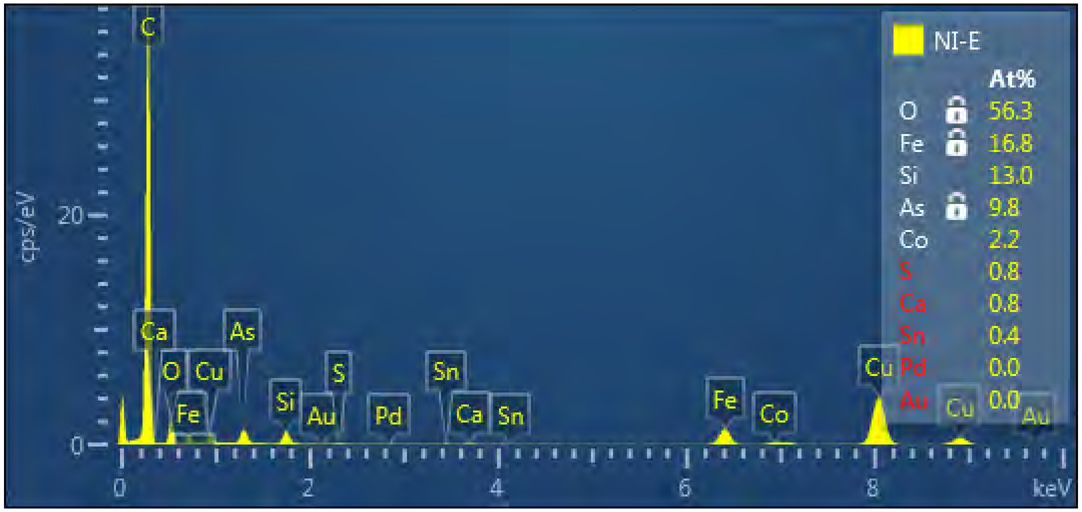
NI-E
1.172268908
1.361344538
2.382352941
3.316386555
5.722689076

Figure 5



High resolution image from particle NI-E. Lattice fringes are apparent throughout this region and are consistent with well-defined diffraction rings.

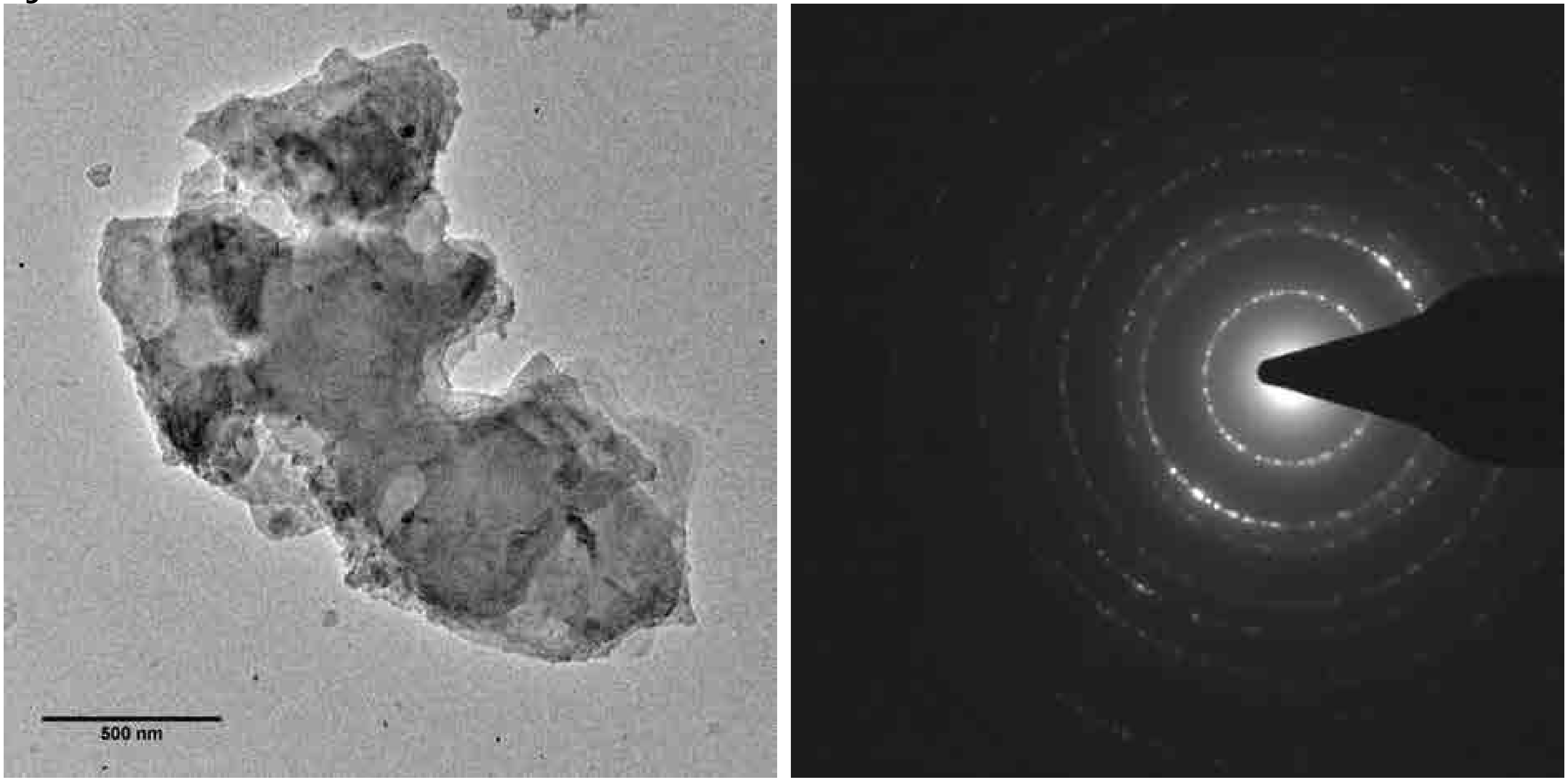
Figure 6



		At%
O	🔒	56.3
Fe	🔒	16.8
Si		13.0
As	🔒	9.8
Co		2.2
S		0.8
Ca		0.8
Sn		0.4
Pd		0.0
Au		0.0

EDS spectrum and analysis from particle NI-E. Note the relatively high Si concentration.

Figure 7



BF image and SAED pattern from particle NI-A. This type of particle was rare. No EDS information is available for this particle.

Table 3. d-spacings for particle NI-A

1.906723
3.331933
3.819328
5.04958
5.752941
6.64916
6.892017
7.689496
8.759244
9.910084