ANALYTICAL SUMMARY REPORT

September 27, 2012

MT DEQ-Site Response
PO Box 200901
Helena, MT 59620-0901

Workorder No.: H12090089 Quote ID: H711 - UBMC Metal Soil Sampling

Project Name: Mike Horse Flood Plan

Energy Laboratories Inc Helena MT received the following 8 samples for MT DEQ-Site Response on 9/6/2012 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H12090089-001	TP-FP-05- (6.0-7.0)	07/24/12 14:07	09/06/12	Soil	Metals by ICP/ICPMS, Total Digestion, Total Metals Soil Preparation
H12090089-002	TP-FP-06 (7-8.0)	07/24/12 15:50	09/06/12	Soil	Same As Above
H12090089-003	TP-FP-08 (2.4-2.9)	07/25/12 16:07	09/06/12	Soil	Same As Above
H12090089-004	TP-FP-09 (3.2-3.3)	07/25/12 17:15	09/06/12	Soil	Same As Above
H12090089-005	TP-FP-10A (2.1-2.6)	07/26/12 10:50	09/06/12	Soil	Same As Above
H12090089-006	TP-FP-13 (2.4-2.7)	07/30/12 11:35	09/06/12	Soil	Same As Above
H12090089-007	TP-FP-15 (0-0.2)	07/30/12 16:45	09/06/12	Soil	Same As Above
H12090089-008	TP-FP-15A (8.5-9.0)	07/31/12 10:50	09/06/12	Soil	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: Mike Horse Flood Plan
Workorder: H12090089

Report Date: 09/27/12
Date Received: 09/06/12

		Analysis		Al-T	As-T	Cd-T	Cu-T	Fe-T	Mn-T	Pb-T	Zn-T
		Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Up**	**Low**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
H12090089-001	TP-FP-05- (6.0-7.0)	0	0	8310	138	34.5	860	46900	4570	6750	5630
H12090089-002	TP-FP-06 (7-8.0)	0	0	9100	117	26.9	505	48400	2540	5330	4500
H12090089-003	TP-FP-08 (2.4-2.9)	0	0	11100	215	35.6	1600	110000	701	2220	6870
H12090089-004	TP-FP-09 (3.2-3.3)	0	0	10100	283	120	2170	106000	1590	2940	5610
H12090089-005	TP-FP-10A (2.1-2.6)	0	0	13000	39	2.9	179	28200	1850	205	504
H12090089-006	TP-FP-13 (2.4-2.7)	0	0	12100	88	1.9	169	55000	1060	287	403
H12090089-007	TP-FP-15 (0-0.2)	0	0	9360	157	4.8	254	60200	3370	1160	835
H12090089-008	TP-FP-15A (8.5-9.0)	0	0	14400	39	1.3	114	29000	2560	184	357

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Report Date: 09/27/12
Project: Mike Horse Flood Plan
Work Order: H12090089

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP2-HE_120912B	
Sample ID: ICV	8	Initial Calibration Verification Standard							09/12/12 09:08	
Aluminum		4.09	mg/L	0.10	102	90	110			
Arsenic		0.813	mg/L	0.0092	102	90	110			
Cadmium		0.389	mg/L	0.0010	97	90	110			
Copper		0.826	mg/L	0.010	103	90	110			
Iron		4.07	mg/L	0.030	102	90	110			
Lead		0.804	mg/L	0.013	100	90	110			
Manganese		4.09	mg/L	0.010	102	90	110			
Zinc		0.807	mg/L	0.010	101	90	110			
Sample ID: ICSA	8	Interference Check Sample A							09/12/12 09:23	
Aluminum		523	mg/L	0.10	105	80	120			
Arsenic		-0.00519	mg/L	0.0092		0	0			
Cadmium		0.00244	mg/L	0.0010		0	0			
Copper		0.00111	mg/L	0.010		0	0			
Iron		186	mg/L	0.030	93	80	120			
Lead		0.0356	mg/L	0.013		0	0			
Manganese		0.000800	mg/L	0.010		0	0			
Zinc		0.00693	mg/L	0.010		0	0			
Sample ID: ICSAB	8	Interference Check Sample AB							09/12/12 09:27	
Aluminum		527	mg/L	0.10	105	80	120			
Arsenic		1.06	mg/L	0.0092	106	80	120			
Cadmium		0.884	mg/L	0.0010	88	80	120			
Copper		0.515	mg/L	0.010	103	80	120			
Iron		189	mg/L	0.030	95	80	120			
Lead		0.948	mg/L	0.013	95	80	120			
Manganese		0.487	mg/L	0.010	97	80	120			
Zinc		0.987	mg/L	0.010	99	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 09/27/12

Project: Mike Horse Flood Plan **Work Order:** H12090089

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP2-HE_120913B	
Sample ID: ICV	8	Initial Calibration Verification Standard							09/13/12 12:51	
Aluminum		4.09	mg/L	0.10	102	90	110			
Arsenic		0.768	mg/L	0.0092	96	90	110			
Cadmium		0.378	mg/L	0.0010	94	90	110			
Copper		0.801	mg/L	0.010	100	90	110			
Iron		4.00	mg/L	0.030	100	90	110			
Lead		0.780	mg/L	0.013	98	90	110			
Manganese		3.97	mg/L	0.010	99	90	110			
Zinc		0.783	mg/L	0.010	98	90	110			
Sample ID: ICSA	8	Interference Check Sample A							09/13/12 13:06	
Aluminum		525	mg/L	0.10	105	80	120			
Arsenic		-0.0117	mg/L	0.0092		0	0			
Cadmium		0.00191	mg/L	0.0010		0	0			
Copper		-0.00148	mg/L	0.010		0	0			
Iron		187	mg/L	0.030	94	80	120			
Lead		0.0349	mg/L	0.013		0	0			
Manganese		-0.000740	mg/L	0.010		0	0			
Zinc		0.00827	mg/L	0.010		0	0			
Sample ID: ICSAB	8	Interference Check Sample AB							09/13/12 13:10	
Aluminum		532	mg/L	0.10	106	80	120			
Arsenic		1.05	mg/L	0.0092	105	80	120			
Cadmium		0.919	mg/L	0.0010	92	80	120			
Copper		0.509	mg/L	0.010	102	80	120			
Iron		188	mg/L	0.030	94	80	120			
Lead		0.974	mg/L	0.013	97	80	120			
Manganese		0.475	mg/L	0.010	95	80	120			
Zinc		1.01	mg/L	0.010	101	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 09/27/12

Project: Mike Horse Flood Plan **Work Order:** H12090089

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 17912
Sample ID: MB-17912	8	Method Blank				Run: ICP2-HE_120912B				09/12/12 20:40
Aluminum		0.5	mg/kg	0.3						
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		2	mg/kg	0.7						
Lead		ND	mg/kg	1						
Manganese		0.05	mg/kg	0.04						
Zinc		0.3	mg/kg	0.1						
Sample ID: LFB-17912	8	Laboratory Fortified Blank				Run: ICP2-HE_120912B				09/12/12 20:51
Aluminum		261	mg/kg	5.0	104	80	120			
Arsenic		53.1	mg/kg	1.0	106	80	120			
Cadmium		24.8	mg/kg	1.0	99	80	120			
Copper		52.2	mg/kg	1.0	104	80	120			
Iron		263	mg/kg	5.0	105	80	120			
Lead		51.7	mg/kg	1.0	103	80	120			
Manganese		265	mg/kg	1.0	106	80	120			
Zinc		51.7	mg/kg	1.0	103	80	120			
Sample ID: LCS-17912	8	Laboratory Control Sample				Run: ICP2-HE_120912B				09/12/12 20:55
Aluminum		12000	mg/kg	5.0	83	50.7	131.3			
Arsenic		291	mg/kg	1.5	86	72.3	106.4			
Cadmium		119	mg/kg	1.0	88	73	105.1			
Copper		257	mg/kg	1.0	94	77.5	109.6			
Iron		19700	mg/kg	5.0	87	39.6	138.3			
Lead		183	mg/kg	3.0	100	75.9	108.6			
Manganese		374	mg/kg	1.0	103	80.8	115.7			
Zinc		192	mg/kg	1.0	92	74.2	109.9			
Sample ID: H12090089-008AMS	8	Sample Matrix Spike				Run: ICP2-HE_120912B				09/12/12 22:09
Aluminum		19500	mg/kg	5.0		75	125			A
Arsenic		73.3	mg/kg	1.5	69	75	125			S
Cadmium		21.5	mg/kg	1.0	82	75	125			
Copper		146	mg/kg	1.0	65	75	125			S
Iron		25900	mg/kg	5.0		75	125			A
Lead		202	mg/kg	3.1	36	75	125			S
Manganese		2320	mg/kg	1.0		75	125			A
Zinc		364	mg/kg	1.0		75	125			A
Sample ID: H12090089-008AMSD	8	Sample Matrix Spike Duplicate				Run: ICP2-HE_120912B				09/12/12 22:13
Aluminum		20000	mg/kg	5.0		75	125	2.3	20	A
Arsenic		79.8	mg/kg	1.5	82	75	125	8.5	20	
Cadmium		21.3	mg/kg	1.0	81	75	125	1.0	20	
Copper		165	mg/kg	1.0	103	75	125	12	20	
Iron		29600	mg/kg	5.0		75	125	13	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 09/27/12

Project: Mike Horse Flood Plan **Work Order:** H12090089

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 17912
Sample ID: H12090089-008AMSD	8	Sample Matrix Spike Duplicate				Run: ICP2-HE_120912B			09/12/12 22:13	
Lead		234	mg/kg	3.1	102	75	125	15	20	
Manganese		2430	mg/kg	1.0		75	125	4.8	20	A
Zinc		432	mg/kg	1.0		75	125	17	20	A
Method: SW6010B										Batch: 17912
Sample ID: MB-17912	8	Method Blank				Run: ICP2-HE_120913B			09/13/12 13:48	
Aluminum		ND	mg/kg	0.8						
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		0.9	mg/kg	0.7						
Lead		1	mg/kg	1						
Manganese		0.05	mg/kg	0.04						
Zinc		0.2	mg/kg	0.1						

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Workorder Receipt Checklist

MT DEQ-Site Response H12090089

Login completed by:	Wanda Johnson	Date Received:	9/6/2012
Reviewed by:	BL2000\jhager	Received by:	TLL
Reviewed Date:	9/10/2012	Carrier name:	Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☐	No ☑	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	12.8°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☑	Not Applicable ☐

Contact and Corrective Action Comments:

No collection time on sample bags for sample 001-TP-FP-05 (6.0-7.0) &002- TP-FP-06 (7-8.0). Sample ID on COC for sample 008-TP-FP-15A (8.5-9.0), bag states TP-FP-15A (5.5-5.7). Logged in with ID from COC. Contacted client on which ID should be used. Wj 9/6/12
Niki Griffis called and stated they did not want pH and conductivity analyzed, only analyze for metals. Wj 9/6/12

ENERGY

Chain of Custody and Analytical Request Record

PLEASE PRINT (Provide as much information as possible.)

Company Name: Pioneer Technical Services

Report Mail Address: 1215 Apple's Way Belgrade ~~MT~~ 59714

Invoice Address:

Project Name, PWS, Permit, Etc.: Mike Horse Floodplain

Contact Name: Niki Griffis Phone/Fax: 406-388-8578

Invoice Contact & Phone:

Sample Origin State: MT

Email: ngriffis@pioneertechnical.com

Purchase Order:

EPA/State Compliance: Yes ☐ No ☐

Sampler: (Please Print)

Quote/Bottle Order:

Shipped by: Hand

Cooler ID(s): Y

Receipt Temp: 12.8°C

On Ice: (Y) N

Custody Seal: On Bottle Y (N); On Cooler (Y) N

Intact (Y) N

Signature Match Y (N)

Special Report/Formats:
* See attached for list of metals

☐ DW
☐ POTW/WWTP
☐ State: _____
☒ Other: _____
Regular Spectrum Format Same as Zortman

☒ EDD/EDT (Electronic Data) Format: _____
☐ LEVEL IV
☐ NELAC

ANALYSIS REQUESTED

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids Vegetation Bioassay Other
DW - Drinking Water

RUSH: Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Total 350 Digestion	Saturated pH	Electrical Conductivity	SEE ATTACHED	Standard Turnaround (TAT)
1	TP-FP-05(6.0-7.0)	07/24/12	1407		X	X	X		X
2	TP-FP-06(7-8.0)	07/24/12	1550		X	X	X		X
3	TP-FP-08(2.4-2.9)	07/25/12	1607		X	X	X		X
4	TP-FP-09 (3.2-3.3)	07/25/12	1715		X	X	X		X
5	TP-FP-10A (2.1-2.6)	07/26/12	1050		X	X	X		X
6	TP-FP-13(2.4-2.7)	07/30/12	1135		X	X	X		X
7	TP-FP-15(0-0.2)	07/30/12	1645		X	X	X		X
8	TP-FP-15A(8.5-9.0)	07/31/12	1050		X	X	X		X
9									
10									

LABORATORY USE ONLY #1209008

Custody Record MUST be Signed

Relinquished by (print): Lance Sorensen Date/Time: 9/6/12 12:00 Signature: [signature]

Relinquished by (print): Date/Time: Signature:

Received by (print): Date/Time: Signature:

Received by (print): Date/Time: Signature:

Received by Laboratory: Tracy Carash Date/Time: 9/6/12 12:00 Signature: [signature]

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Parameter**	Method[1]	PQL[2]
General**		
Saturated Paste pH (s.u.) and Electrical Conductivity (mmhos/cm)	ASAM10-3	--
TAL Metals**		
Total Aluminum	SW-846 – 6020 / 6010B	1
Total Arsenic (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Cadmium (mg/kg)	SW-846 – 6020 / 6010B	0.15
Total Copper (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Iron	SW-846 – 6020 / 6010B	5
Total Lead (mg/kg)	SW-846 – 6020 / 6010B	0.2
Total Manganese (mg/kg)	SW-846 – 6020 / 6010B	10
Total Zinc (mg/kg)	SW-846 – 6020 / 6010B	2

Account Number: H12433
Invoice Number: 320960411
Invoice Date: 9/28/2012
Purchase Order: SPB05-894PB
Invoice Total: $1,080.00
Amount Received: $0.00
Amount Due: $1,080.00

Remit To: Energy Laboratories Inc
Accounts Receivable
PO Box 30975
Billings, MT 59107-0975

H124333209604110001080000321080916

Detach and Return Stub with Payment

INVOICE

BILL TO: Spectrum Engineering
Attn: Bill Maehle
1413 4th Ave N
Billings, MT 59101

Invoice Date: *September 28, 2012*

Invoice No: 320960411

Purchase Order SPB05-894PB
Account Number H12433

TERMS: NET 30 DAYS
Interest charged after 30 days 1.5% per month.
VISA/MasterCard payments accepted.

From: ENERGY LABORATORIES

3161 East Lyndale Avenue • Helena, MT 59601
(406) 442-0711

Project Name: Mike Horse Flood Plan

Item	Remarks	Matrix	Test Price	Mult	Price	Qty	Test Total
WorkOrder H12090089							
Metals by ICP/ICPMS, Total		Solid	$155.00	1	$155.00	8	$1,240.00
Digestion, Total Metals		Soil	$25.00	1	$25.00	8	$200.00

Comments:

Subtotal:	**$1,440.00**
25% Discount:	-360.00
Order Amount:	**1,080.00**
INVOICE TOTAL:	**$1,080.00**
Amount Received:	$0.00
AMOUNT DUE:	**$1,080.00**

ANALYTICAL SUMMARY REPORT

October 17, 2012

MT DEQ-Site Response
PO Box 200901
Helena, MT 59620-0901

Workorder No.: H12090382 Quote ID: H711 - UBMC Metal Soil Sampling

Project Name: MIke Horse Floodplain

Energy Laboratories Inc Helena MT received the following 10 samples for MT DEQ-Site Response on 9/24/2012 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H12090382-001	TP-FP-16 (11.5-12)	07/31/12 12:40	09/24/12	Soil	Metals by ICP/ICPMS, Total Digestion, Total Metals
H12090382-002	TP-FP-18 (0.6-0.8)	07/31/12 15:33	09/24/12	Soil	Same As Above
H12090382-003	TP-FP-19 (1.8-2.4)	07/31/12 17:26	09/24/12	Soil	Same As Above
H12090382-004	TP-FP-20 (8-8.5)	08/01/12 14:40	09/24/12	Soil	Same As Above
H12090382-005	TP-FP-21 (10-10.5)	08/01/12 12:49	09/24/12	Soil	Same As Above
H12090382-006	TP-FP-25 (0.4-0.9)	08/02/12 9:35	09/24/12	Soil	Same As Above
H12090382-007	TP-FP-26 (4-4.5)	08/02/12 11:43	09/24/12	Soil	Same As Above
H12090382-008	TP-FP-27 (6.5-7)	08/02/12 13:50	09/24/12	Soil	Same As Above
H12090382-009	TP-FP-28 (9-9.5)	08/06/12 12:30	09/24/12	Soil	Same As Above
H12090382-010	TP-FP-30 (10-10.5)	08/07/12 9:30	09/24/12	Soil	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-001
Client Sample ID TP-FP-16 (11.5-12)

Report Date: 10/17/12
Collection Date: 07/31/12 12:40
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	8800	mg/kg		5		SW6010B	10/02/12 07:57 / sld
Arsenic	47	mg/kg		1		SW6010B	10/02/12 07:57 / sld
Cadmium	9	mg/kg		1		SW6010B	10/02/12 07:57 / sld
Copper	164	mg/kg		1		SW6010B	10/02/12 07:57 / sld
Iron	25000	mg/kg		5		SW6010B	10/02/12 07:57 / sld
Lead	381	mg/kg	D	3		SW6010B	10/10/12 14:23 / sld
Manganese	3710	mg/kg		1		SW6010B	10/02/12 07:57 / sld
Zinc	1010	mg/kg		1		SW6010B	10/10/12 14:23 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-002
Client Sample ID TP-FP-18 (0.6-0.8)

Report Date: 10/17/12
Collection Date: 07/31/12 15:33
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	9010	mg/kg		5		SW6010B	10/02/12 08:01 / sld
Arsenic	174	mg/kg	D	2		SW6010B	10/02/12 08:01 / sld
Cadmium	11	mg/kg		1		SW6010B	10/04/12 13:35 / sld
Copper	1060	mg/kg		1		SW6010B	10/02/12 08:01 / sld
Iron	54800	mg/kg		5		SW6010B	10/02/12 08:01 / sld
Lead	6470	mg/kg	D	3		SW6010B	10/10/12 14:27 / sld
Manganese	5090	mg/kg		1		SW6010B	10/04/12 13:35 / sld
Zinc	2690	mg/kg		1		SW6010B	10/04/12 13:35 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-003
Client Sample ID TP-FP-19 (1.8-2.4)

Report Date: 10/17/12
Collection Date: 07/31/12 17:26
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	9910	mg/kg		5		SW6010B	10/02/12 08:05 / sld
Arsenic	24	mg/kg		1		SW6010B	10/03/12 01:18 / sld
Cadmium	7	mg/kg		1		SW6010B	10/02/12 08:05 / sld
Copper	125	mg/kg		1		SW6010B	10/02/12 08:05 / sld
Iron	23800	mg/kg		5		SW6010B	10/02/12 08:05 / sld
Lead	76	mg/kg	D	3		SW6010B	10/10/12 14:30 / sld
Manganese	1460	mg/kg		1		SW6010B	10/02/12 08:05 / sld
Zinc	849	mg/kg		1		SW6010B	10/02/12 08:05 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-004
Client Sample ID TP-FP-20 (8-8.5)

Report Date: 10/17/12
Collection Date: 08/01/12 14:40
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	8220	mg/kg		5		SW6010B	10/02/12 08:16 / sld
Arsenic	59	mg/kg		1		SW6010B	10/02/12 08:16 / sld
Cadmium	11	mg/kg		1		SW6010B	10/02/12 08:16 / sld
Copper	344	mg/kg		1		SW6010B	10/02/12 08:16 / sld
Iron	28100	mg/kg		5		SW6010B	10/02/12 08:16 / sld
Lead	2030	mg/kg	D	3		SW6010B	10/10/12 14:34 / sld
Manganese	3260	mg/kg		1		SW6010B	10/02/12 08:16 / sld
Zinc	1340	mg/kg		1		SW6010B	10/02/12 08:16 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-005
Client Sample ID TP-FP-21 (10-10.5)

Report Date: 10/17/12
Collection Date: 08/01/12 12:49
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	11600	mg/kg		5		SW6010B	10/02/12 08:19 / sld
Arsenic	22	mg/kg		1		SW6010B	10/02/12 08:19 / sld
Cadmium	6	mg/kg		1		SW6010B	10/02/12 08:19 / sld
Copper	139	mg/kg		1		SW6010B	10/02/12 08:19 / sld
Iron	21000	mg/kg		5		SW6010B	10/02/12 08:19 / sld
Lead	568	mg/kg	D	3		SW6010B	10/10/12 14:38 / sld
Manganese	833	mg/kg		1		SW6010B	10/02/12 08:19 / sld
Zinc	1200	mg/kg		1		SW6010B	10/02/12 08:19 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-006
Client Sample ID TP-FP-25 (0.4-0.9)

Report Date: 10/17/12
Collection Date: 08/02/12 09:35
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	3880	mg/kg		5		SW6010B	10/02/12 08:23 / sld
Arsenic	268	mg/kg		1		SW6010B	10/02/12 08:23 / sld
Cadmium	2	mg/kg		1		SW6010B	10/02/12 08:23 / sld
Copper	377	mg/kg		1		SW6010B	10/02/12 08:23 / sld
Iron	116000	mg/kg	D	6		SW6010B	10/03/12 01:21 / sld
Lead	1730	mg/kg	D	6		SW6010B	10/10/12 14:41 / sld
Manganese	421	mg/kg		1		SW6010B	10/02/12 08:23 / sld
Zinc	860	mg/kg		1		SW6010B	10/04/12 14:23 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-007
Client Sample ID TP-FP-26 (4-4.5)

Report Date: 10/17/12
Collection Date: 08/02/12 11:43
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	5780	mg/kg		5		SW6010B	10/02/12 08:27 / sld
Arsenic	223	mg/kg		1		SW6010B	10/02/12 08:27 / sld
Cadmium	56	mg/kg		1		SW6010B	10/04/12 14:27 / sld
Copper	786	mg/kg		1		SW6010B	10/02/12 08:27 / sld
Iron	76200	mg/kg		5		SW6010B	10/03/12 01:25 / sld
Lead	5520	mg/kg	D	6		SW6010B	10/10/12 14:52 / sld
Manganese	9980	mg/kg		1		SW6010B	10/02/12 08:27 / sld
Zinc	6190	mg/kg		1		SW6010B	10/04/12 14:27 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-008
Client Sample ID TP-FP-27 (6.5-7)

Report Date: 10/17/12
Collection Date: 08/02/12 13:50
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	13100	mg/kg		5		SW6010B	10/02/12 08:31 / sld
Arsenic	17	mg/kg		1		SW6010B	10/03/12 01:29 / sld
Cadmium	3	mg/kg		1		SW6010B	10/02/12 08:31 / sld
Copper	89	mg/kg		1		SW6010B	10/02/12 08:31 / sld
Iron	19800	mg/kg		5		SW6010B	10/02/12 08:31 / sld
Lead	182	mg/kg	D	3		SW6010B	10/10/12 14:56 / sld
Manganese	1240	mg/kg		1		SW6010B	10/02/12 08:31 / sld
Zinc	561	mg/kg		1		SW6010B	10/02/12 08:31 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-009
Client Sample ID TP-FP-28 (9-9.5)

Report Date: 10/17/12
Collection Date: 08/06/12 12:30
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	11200	mg/kg		5		SW6010B	10/02/12 08:34 / sld
Arsenic	19	mg/kg	D	2		SW6010B	10/03/12 01:33 / sld
Cadmium	ND	mg/kg		1		SW6010B	10/02/12 08:34 / sld
Copper	35	mg/kg		1		SW6010B	10/02/12 08:34 / sld
Iron	19200	mg/kg		5		SW6010B	10/02/12 08:34 / sld
Lead	63	mg/kg	D	3		SW6010B	10/10/12 15:00 / sld
Manganese	411	mg/kg		1		SW6010B	10/02/12 08:34 / sld
Zinc	174	mg/kg		1		SW6010B	10/02/12 08:34 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Lab ID: H12090382-010
Client Sample ID TP-FP-30 (10-10.5)

Report Date: 10/17/12
Collection Date: 08/07/12 09:30
DateReceived: 09/24/12
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
3050 EXTRACTABLE METALS							
Aluminum	12600	mg/kg		5		SW6010B	10/02/12 08:38 / sld
Arsenic	11	mg/kg		1		SW6010B	10/04/12 14:38 / sld
Cadmium	2	mg/kg		1		SW6010B	10/02/12 08:38 / sld
Copper	85	mg/kg		1		SW6010B	10/02/12 08:38 / sld
Iron	23100	mg/kg		5		SW6010B	10/02/12 08:38 / sld
Lead	275	mg/kg	D	3		SW6010B	10/10/12 15:03 / sld
Manganese	3890	mg/kg		1		SW6010B	10/02/12 08:38 / sld
Zinc	345	mg/kg		1		SW6010B	10/02/12 08:38 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/17/12

Project: MIke Horse Floodplain **Work Order:** H12090382

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Analytical Run: ICP2-HE_121001B		
Sample ID: ICV	7	Initial Calibration Verification Standard								10/01/12 10:00
Aluminum		3.96	mg/L	0.10	99	90	110			
Arsenic		0.789	mg/L	0.0092	99	90	110			
Cadmium		0.383	mg/L	0.0010	96	90	110			
Copper		0.796	mg/L	0.010	100	90	110			
Iron		3.95	mg/L	0.030	99	90	110			
Manganese		3.96	mg/L	0.010	99	90	110			
Zinc		0.791	mg/L	0.010	99	90	110			
Sample ID: ICV	7	Initial Calibration Verification Standard								10/01/12 10:11
Aluminum		3.94	mg/L	0.10	99	90	110			
Arsenic		0.792	mg/L	0.0092	99	90	110			
Cadmium		0.386	mg/L	0.0010	96	90	110			
Copper		0.795	mg/L	0.010	99	90	110			
Iron		3.94	mg/L	0.030	99	90	110			
Manganese		3.94	mg/L	0.010	98	90	110			
Zinc		0.799	mg/L	0.010	100	90	110			
Sample ID: ICSA	7	Interference Check Sample A								10/01/12 10:26
Aluminum		524	mg/L	0.10	105	80	120			
Arsenic		-0.0244	mg/L	0.0092		0	0			
Cadmium		0.000490	mg/L	0.0010		0	0			
Copper		0.00143	mg/L	0.010		0	0			
Iron		187	mg/L	0.030	93	80	120			
Manganese		9.00E-05	mg/L	0.010		0	0			
Zinc		0.00633	mg/L	0.010		0	0			
Sample ID: ICSAB	7	Interference Check Sample AB								10/01/12 10:30
Aluminum		511	mg/L	0.10	102	80	120			
Arsenic		1.05	mg/L	0.0092	105	80	120			
Cadmium		0.909	mg/L	0.0010	91	80	120			
Copper		0.505	mg/L	0.010	101	80	120			
Iron		187	mg/L	0.030	93	80	120			
Manganese		0.473	mg/L	0.010	95	80	120			
Zinc		1.00	mg/L	0.010	100	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/17/12

Project: MIke Horse Floodplain **Work Order:** H12090382

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Analytical Run: ICP2-HE_121002A		
Sample ID: ICV	2	Initial Calibration Verification Standard								10/02/12 13:33
Arsenic		0.804	mg/L	0.0092	101	90	110			
Iron		4.00	mg/L	0.030	100	90	110			
Sample ID: ICSA	2	Interference Check Sample A								10/02/12 13:48
Arsenic		-0.0229	mg/L	0.0092		0	0			
Iron		190	mg/L	0.030	95	80	120			
Sample ID: ICSAB	2	Interference Check Sample AB								10/02/12 13:52
Arsenic		1.04	mg/L	0.0092	104	80	120			
Iron		191	mg/L	0.030	95	80	120			
Method: E200.7								Analytical Run: ICP2-HE_121004B		
Sample ID: ICV	4	Initial Calibration Verification Standard								10/04/12 10:01
Arsenic		0.793	mg/L	0.0092	99	90	110			
Cadmium		0.383	mg/L	0.0010	96	90	110			
Manganese		3.99	mg/L	0.010	100	90	110			
Zinc		0.791	mg/L	0.010	99	90	110			
Sample ID: ICSA	4	Interference Check Sample A								10/04/12 10:16
Arsenic		0.00754	mg/L	0.0092		0	0			
Cadmium		0.00198	mg/L	0.0010		0	0			
Manganese		0.00237	mg/L	0.010		0	0			
Zinc		0.00687	mg/L	0.010		0	0			
Sample ID: ICSAB	4	Interference Check Sample AB								10/04/12 10:20
Arsenic		1.02	mg/L	0.0092	102	80	120			
Cadmium		0.894	mg/L	0.0010	89	80	120			
Manganese		0.470	mg/L	0.010	94	80	120			
Zinc		0.986	mg/L	0.010	99	80	120			
Method: E200.7								Analytical Run: ICP2-HE_121010A		
Sample ID: ICV	2	Initial Calibration Verification Standard								10/10/12 11:43
Lead		0.757	mg/L	0.013	95	90	110			
Zinc		0.790	mg/L	0.010	99	90	110			
Sample ID: ICSA	2	Interference Check Sample A								10/10/12 11:58
Lead		0.0410	mg/L	0.013		0	0			
Zinc		0.00777	mg/L	0.010		0	0			
Sample ID: ICSAB	2	Interference Check Sample AB								10/10/12 12:02
Lead		0.940	mg/L	0.013	94	80	120			
Zinc		1.01	mg/L	0.010	101	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/17/12

Project: MIke Horse Floodplain **Work Order:** H12090382

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18134
Sample ID: MB-18134	7	Method Blank				Run: ICP2-HE_121001B				10/02/12 07:46
Aluminum		0.9	mg/kg	0.3						
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		2	mg/kg	0.7						
Manganese		0.07	mg/kg	0.04						
Zinc		0.2	mg/kg	0.1						
Sample ID: LFB-18134	7	Laboratory Fortified Blank				Run: ICP2-HE_121001B				10/02/12 07:50
Aluminum		244	mg/kg	5.0	97	80	120			
Arsenic		46.5	mg/kg	1.0	93	80	120			
Cadmium		22.1	mg/kg	1.0	88	80	120			
Copper		48.9	mg/kg	1.0	98	80	120			
Iron		239	mg/kg	5.0	95	80	120			
Manganese		237	mg/kg	1.0	95	80	120			
Zinc		46.7	mg/kg	1.0	93	80	120			
Sample ID: LCS-18134	7	Laboratory Control Sample				Run: ICP2-HE_121001B				10/02/12 07:54
Aluminum		11400	mg/kg	5.0	78	50.7	131.3			
Arsenic		275	mg/kg	1.5	81	72.3	106.4			
Cadmium		115	mg/kg	1.0	85	73	105.1			
Copper		241	mg/kg	1.0	87	77.5	109.6			
Iron		18400	mg/kg	5.0	81	39.6	138.3			
Manganese		369	mg/kg	1.0	101	80.8	115.7			
Zinc		185	mg/kg	1.0	88	74.2	109.9			
Sample ID: H12090382-010AMS	7	Sample Matrix Spike				Run: ICP2-HE_121001B				10/02/12 08:49
Aluminum		16300	mg/kg	5.0		75	125			A
Arsenic		63.9	mg/kg	1.5	99	75	125			
Cadmium		23.0	mg/kg	1.0	85	75	125			
Copper		115	mg/kg	1.0	61	75	125			S
Iron		21500	mg/kg	5.0		75	125			A
Manganese		4010	mg/kg	1.0		75	125			A
Zinc		390	mg/kg	1.0		75	125			A
Sample ID: H12090382-010AMSD	7	Sample Matrix Spike Duplicate				Run: ICP2-HE_121001B				10/02/12 09:00
Aluminum		16800	mg/kg	5.0		75	125	3.0	20	A
Arsenic		63.0	mg/kg	1.5	98	75	125	1.6	20	
Cadmium		23.2	mg/kg	1.0	86	75	125	1.3	20	
Copper		122	mg/kg	1.0	74	75	125	5.3	20	S
Iron		22800	mg/kg	5.0		75	125	5.9	20	A
Manganese		4710	mg/kg	1.0		75	125	16	20	A
Zinc		390	mg/kg	1.0		75	125	0.1	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/17/12

Project: MIke Horse Floodplain **Work Order:** H12090382

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18134
Sample ID: MB-18134	7	Method Blank				Run: ICP2-HE_121002A				10/03/12 01:14
Aluminum		0.9	mg/kg	0.3						
Arsenic		0.7	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		2	mg/kg	0.7						
Manganese		ND	mg/kg	0.04						
Zinc		0.2	mg/kg	0.1						
Sample ID: H12090382-010AMS	7	Sample Matrix Spike				Run: ICP2-HE_121002A				10/03/12 01:40
Aluminum		16500	mg/kg	5.0		75	125			A
Arsenic		61.4	mg/kg	1.5	102	75	125			
Cadmium		22.6	mg/kg	1.0	83	75	125			
Copper		115	mg/kg	1.0	59	75	125			S
Iron		21000	mg/kg	5.0		75	125			A
Manganese		3940	mg/kg	1.0		75	125			A
Zinc		388	mg/kg	1.0		75	125			A
Sample ID: H12090382-010AMSD	7	Sample Matrix Spike Duplicate				Run: ICP2-HE_121002A				10/03/12 01:44
Aluminum		17100	mg/kg	5.0		75	125	3.4	20	A
Arsenic		60.6	mg/kg	1.5	100	75	125	1.4	20	
Cadmium		22.9	mg/kg	1.0	85	75	125	1.5	20	
Copper		122	mg/kg	1.0	74	75	125	5.9	20	S
Iron		22500	mg/kg	5.0		75	125	6.5	20	A
Manganese		4690	mg/kg	1.0		75	125	17	20	A
Zinc		385	mg/kg	1.0		75	125	0.9	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/17/12

Project: MIke Horse Floodplain **Work Order:** H12090382

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18222
Sample ID: MB-18222	4	Method Blank				Run: ICP2-HE_121004B				10/04/12 13:20
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Manganese		0.04	mg/kg	0.04						
Zinc		0.1	mg/kg	0.1						
Sample ID: LFB-18222	4	Laboratory Fortified Blank				Run: ICP2-HE_121004B				10/04/12 13:24
Arsenic		48.7	mg/kg	1.0	97	80	120			
Cadmium		23.3	mg/kg	1.0	93	80	120			
Manganese		246	mg/kg	1.0	98	80	120			
Zinc		48.6	mg/kg	1.0	97	80	120			
Sample ID: LCS-18222	4	Laboratory Control Sample				Run: ICP2-HE_121004B				10/04/12 13:28
Arsenic		294	mg/kg	1.5	86	72.3	106.4			
Cadmium		126	mg/kg	1.0	92	73	105.1			
Manganese		374	mg/kg	1.0	101	80.8	115.7			
Zinc		201	mg/kg	1.0	95	74.2	109.9			
Sample ID: H12090382-010AMS	4	Sample Matrix Spike				Run: ICP2-HE_121004B				10/04/12 14:49
Arsenic		67.6	mg/kg	1.5	114	75	125			
Cadmium		23.0	mg/kg	1.0	84	75	125			
Manganese		4460	mg/kg	1.0		75	125			A
Zinc		387	mg/kg	1.0		75	125			A
Sample ID: H12090382-010AMSD	4	Sample Matrix Spike Duplicate				Run: ICP2-HE_121004B				10/04/12 14:53
Arsenic		57.9	mg/kg	1.5	94	75	125	16	20	
Cadmium		23.0	mg/kg	1.0	84	75	125	0.0	20	
Manganese		5070	mg/kg	1.0		75	125	13	20	A
Zinc		376	mg/kg	1.0		75	125	2.9	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/17/12

Project: MIke Horse Floodplain **Work Order:** H12090382

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18296
Sample ID: MB-18296	2	Method Blank				Run: ICP2-HE_121010A				10/10/12 14:12
Lead		ND	mg/kg	1						
Zinc		0.3	mg/kg	0.1						
Sample ID: LFB-18296	2	Laboratory Fortified Blank				Run: ICP2-HE_121010A				10/10/12 14:16
Lead		47.6	mg/kg	1.0	95	80	120			
Zinc		49.4	mg/kg	1.0	98	80	120			
Sample ID: LCS-18296	2	Laboratory Control Sample				Run: ICP2-HE_121010A				10/10/12 14:19
Lead		171	mg/kg	3.1	92	75.9	108.6			
Zinc		192	mg/kg	1.0	91	74.2	109.9			
Sample ID: H12090382-010AMS	2	Sample Matrix Spike				Run: ICP2-HE_121010A				10/10/12 15:14
Lead		194	mg/kg	3.0		75	125			A
Zinc		379	mg/kg	1.0		75	125			A
Sample ID: H12090382-010AMSD	2	Sample Matrix Spike Duplicate				Run: ICP2-HE_121010A				10/10/12 15:18
Lead		144	mg/kg	3.1		75	125	30	20	AR
Zinc		371	mg/kg	1.0		75	125	2.1	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

R - RPD exceeds advisory limit.

Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Workorder Receipt Checklist

MT DEQ-Site Response H12090382

Login completed by:	Tracy L. Lorash	Date Received:	9/24/2012
Reviewed by:	BL2000\sdull	Received by:	TLL
Reviewed Date:	9/26/2012	Carrier name:	Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	10.6°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Contact and Corrective Action Comments:

None

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT (Provide as much information as possible.)

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
Pioneer Technical Services	Mike Horse Floodplain	State: MT	Yes ☐ No ☐
Report Mail Address:	**Contact Name:** / **Phone/Fax:**	**Email:**	**Sampler: (Please Print)**
1215 Apple's Way Belgrade 59714	Niki Griffis 388-8578	ngriffis@pioneer-technical.com	
Invoice Address:	**Invoice Contact & Phone:**	**Purchase Order:**	**Quote/Bottle Order:**

Special Report/Formats:

☐ DW
☐ POTW/WWTP
☐ State: _____
☒ Other: _____
☒ EDD/EDT (Electronic Data) Format: _____
☐ LEVEL IV
☐ NELAC

Regular Spectrum Format same as Zortman

ANALYSIS REQUESTED

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids Vegetation Bioassay Other DW - Drinking Water

SEE ATTACHED

Standard Turnaround (TAT)

R U S H

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments: Same Metals as Previous for Mike Horse Floodplain

Shipped by: Hand del.
Cooler ID(s): Y
Receipt Temp 10.6 °C
On Ice: (Y) N
Custody Seal On Bottle (Y) N
On Cooler (Y) N
Intact (Y) N
Signature Match (Y) N

LABORATORY USE ONLY H12090382

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Total 350 Digestion
1	TP-FP-16(11.5-12)	07/31/12	1240		X
2	TP FP-18(0.6-0.8)	07/31/12	1533		X
3	TP-FP-19(1.8-2.4)	07/31/12	1726		X
4	TP-FP-20(8-8.5)	08/01/12	1440		X
5	TP-FP-21(10-10.5)	08/01/12	1249		X
6	TP-FP-25(0.4-0.9)	08/02/12	0935		X
7	TP FP-26(4-4.5)	08/02/12	1143		X
8	TP-FP-27(6.5-7)	08/02/12	1350		X
9	TP-FP-28(9-9.5)	08/06/12	1230		X
10	TP-FP-30(10-10.5)	08/07/12	0930		X

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
PATRICK REDMOND	9/24/12 1:06P				
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory: Tracy Lorch	Date/Time: 9/24/12 13:06	Signature:

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Parameter**	Method[1]	PQL[2]
General**		
Saturated Paste pH (s.u.) and Electrical Conductivity (mmhos/cm)	ASAM10-3	--
TAL Metals**		
Total Aluminum	SW-846 – 6020 / 6010B	1
Total Arsenic (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Cadmium (mg/kg)	SW-846 – 6020 / 6010B	0.15
Total Copper (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Iron	SW-846 – 6020 / 6010B	5
Total Lead (mg/kg)	SW-846 – 6020 / 6010B	0.2
Total Manganese (mg/kg)	SW-846 – 6020 / 6010B	10
Total Zinc (mg/kg)	SW-846 – 6020 / 6010B	2

Account Number: H12433
Invoice Number: 321060277
Invoice Date: 10/17/2012
Purchase Order: SPB05-894PB
Invoice Total: $787.50
Amount Received: $0.00
Amount Due: $787.50

Remit To: Energy Laboratories Inc
Accounts Receivable
PO Box 30975
Billings, MT 59107-0975

H124333210602770000787500321151532

Detach and Return Stub with Payment

INVOICE

BILL TO: MT DEQ-Site Response
Attn:
PO Box 200901
Helena, MT 59620-0901

Invoice Date: *October 17, 2012*

Invoice No: 321060277

Purchase Order SPB05-894PB
Account Number H12433

TERMS: NET 30 DAYS
Interest charged after 30 days 1.5% per month.
VISA/MasterCard payments accepted.

From: ENERGY LABORATORIES

3161 East Lyndale Avenue • Helena, MT 59601
(406) 442-0711

Project Name: MIke Horse Floodplain

Item	Remarks	Matrix	Test Price	Mult	Price	Qty	Test Total
WorkOrder H12090382							
Metals by ICP/ICPMS, Total		Solid	$80.00	1	$80.00	10	$800.00
Digestion, Total Metals		Soil	$25.00	1	$25.00	10	$250.00

Comments:

Subtotal:	**$1,050.00**
25% Discount:	-262.50
Order Amount:	**787.50**
INVOICE TOTAL:	**$787.50**
Amount Received:	$0.00
AMOUNT DUE:	**$787.50**

ANALYTICAL SUMMARY REPORT

October 22, 2012

MT DEQ-Site Response
PO Box 200901
Helena, MT 59620-0901

Workorder No.: H12100091 Quote ID: H711 - UBMC Metal Soil Sampling

Project Name: Mike Horse Floodplain

Energy Laboratories Inc Helena MT received the following 16 samples for MT DEQ-Site Response on 10/3/2012 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H12100091-001	TP-FP-32 (0-0.4)	08/07/12 14:00	10/03/12	Soil	Metals by ICP/ICPMS, Total Digestion, Total Metals
H12100091-002	TP-FP-33 (8-8.5)	08/07/12 13:15	10/03/12	Soil	Same As Above
H12100091-003	TP-FP-35 (0.5-0.7)	08/08/12 9:55	10/03/12	Soil	Same As Above
H12100091-004	TP-FP-36 (3.5-4)	08/13/12 13:56	10/03/12	Soil	Same As Above
H12100091-005	TP-FP-37 (11.5-12)	08/14/12 10:24	10/03/12	Soil	Same As Above
H12100091-006	TP-FP-38A (1-1.5)	08/14/12 11:26	10/03/12	Soil	Same As Above
H12100091-007	TP-FP-40 (1.5-2)	08/08/12 12:38	10/03/12	Soil	Same As Above
H12100091-008	TP-FP-41 (2-2.5)	08/08/12 14:45	10/03/12	Soil	Same As Above
H12100091-009	TP-FP-42 (6.6-7)	08/08/12 16:57	10/03/12	Soil	Same As Above
H12100091-010	TP-FP-44 (0-0.7)	08/09/12 10:39	10/03/12	Soil	Same As Above
H12100091-011	TP-FP-45 (0.5-1)	08/09/12 12:50	10/03/12	Soil	Same As Above
H12100091-012	TP-FP-45A (0.8-1.2)	08/13/12 10:05	10/03/12	Soil	Same As Above
H12100091-013	TP-FP-46 (8.5-9)	08/16/12 11:31	10/03/12	Soil	Same As Above
H12100091-014	TP-FP-48 (1.5-2)	08/15/12 15:37	10/03/12	Soil	Same As Above
H12100091-015	TP-FP-49A (2.8-3.2)	08/14/12 17:04	10/03/12	Soil	Same As Above
H12100091-016	TP-FP-50 (9-10)	08/15/12 10:27	10/03/12	Soil	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: Mike Horse Floodplain
Workorder: H12100091

Report Date: 10/22/12
Date Received: 10/03/12

		Analysis		Al-T	As-T	Cd-T	Cu-T	Fe-T	Mn-T	Pb-T	Zn-T
		Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Up**	**Low**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
H12100091-001	TP-FP-32 (0-0.4)	0	0	3140	230	8.3	563	89200	4140	1200	1130
H12100091-002	TP-FP-33 (8-8.5)	0	0	11600	22	5.0	125	23100	1100	338	1020
H12100091-003	TP-FP-35 (0.5-0.7)	0	0	15700	24	1.2	74	23400	1320	169	297
H12100091-004	TP-FP-36 (3.5-4)	0	0	14400	24	12.8	136	27900	1350	126	1460
H12100091-005	TP-FP-37 (11.5-12)	0	0	12900	14	5.0	114	23100	1300	142	1040
H12100091-006	TP-FP-38A (1-1.5)	0	0	7080	133	37.3	1620	50000	6740	12600	6560
H12100091-007	TP-FP-40 (1.5-2)	0	0	13800	16	1.0	83	29300	513	152	242
H12100091-008	TP-FP-41 (2-2.5)	0	0	11400	23	0.6	148	39400	1240	584	183
H12100091-009	TP-FP-42 (6.6-7)	0	0	13700	18	5.3	232	28500	1340	104	1010
H12100091-010	TP-FP-44 (0-0.7)	0	0	4060	429	38.7	3150	80500	6470	36100	8690
H12100091-011	TP-FP-45 (0.5-1)	0	0	4260	342	78.6	3450	78800	7980	31700	13200
H12100091-012	TP-FP-45A (0.8-1.2)	0	0	18500	22	7.0	238	34400	2030	437	1100
H12100091-013	TP-FP-46 (8.5-9)	0	0	10700	24	5.8	177	29200	1830	381	1190
H12100091-014	TP-FP-48 (1.5-2)	0	0	7060	147	19.9	495	66000	4780	1120	3160
H12100091-015	TP-FP-49A (2.8-3.2)	0	0	10200	58	1.8	281	40800	3200	2490	412
H12100091-016	TP-FP-50 (9-10)	0	0	19600	16	1.4	151	35800	241	145	396

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/22/12

Project: Mike Horse Floodplain **Work Order:** H12100091

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Analytical Run: ICP2-HE_121008B	
Sample ID: ICV	Initial Calibration Verification Standard								10/08/12 13:26
Aluminum	3.99	mg/L	0.10	100	90	110			
Arsenic	0.799	mg/L	0.0092	100	90	110			
Cadmium	0.383	mg/L	0.0010	96	90	110			
Copper	0.792	mg/L	0.010	99	90	110			
Iron	4.00	mg/L	0.030	100	90	110			
Lead	0.748	mg/L	0.013	93	90	110			
Manganese	4.00	mg/L	0.010	100	90	110			
Zinc	0.783	mg/L	0.010	98	90	110			
Sample ID: ICSA	Interference Check Sample A								10/08/12 13:42
Aluminum	520	mg/L	0.10	104	80	120			
Arsenic	0.0114	mg/L	0.0092		0	0			
Cadmium	0.00126	mg/L	0.0010		0	0			
Copper	0.00175	mg/L	0.010		0	0			
Iron	185	mg/L	0.030	92	80	120			
Lead	0.0462	mg/L	0.013		0	0			
Manganese	-0.00292	mg/L	0.010		0	0			
Zinc	0.00819	mg/L	0.010		0	0			
Sample ID: ICSAB	Interference Check Sample AB								10/08/12 13:46
Aluminum	523	mg/L	0.10	105	80	120			
Arsenic	1.06	mg/L	0.0092	106	80	120			
Cadmium	0.894	mg/L	0.0010	89	80	120			
Copper	0.499	mg/L	0.010	100	80	120			
Iron	185	mg/L	0.030	93	80	120			
Lead	0.941	mg/L	0.013	94	80	120			
Manganese	0.476	mg/L	0.010	95	80	120			
Zinc	0.979	mg/L	0.010	98	80	120			
Method: E200.7								Analytical Run: ICP2-HE_121009D	
Sample ID: ICV	Initial Calibration Verification Standard								10/09/12 15:31
Iron	3.96	mg/L	0.030	99	90	110			
Lead	0.788	mg/L	0.013	98	90	110			
Sample ID: ICSA	Interference Check Sample A								10/09/12 15:46
Iron	189	mg/L	0.030	94	80	120			
Lead	0.0436	mg/L	0.013		0	0			
Sample ID: ICSAB	Interference Check Sample AB								10/09/12 15:50
Iron	187	mg/L	0.030	94	80	120			
Lead	0.960	mg/L	0.013	96	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 10/22/12

Project: Mike Horse Floodplain **Work Order:** H12100091

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Batch: 18262
Sample ID: MB-18262	Method Blank				Run: ICP2-HE_121008B				10/08/12 19:46
Aluminum	ND	mg/kg	0.8						
Arsenic	ND	mg/kg	0.4						
Cadmium	ND	mg/kg	0.01						
Copper	ND	mg/kg	0.2						
Iron	2	mg/kg	0.7						
Lead	2	mg/kg	1						
Manganese	0.05	mg/kg	0.04						
Zinc	0.2	mg/kg	0.1						
Sample ID: LFB-18262	Laboratory Fortified Blank				Run: ICP2-HE_121008B				10/08/12 19:50
Aluminum	248	mg/kg	5.0	99	80	120			
Arsenic	49.5	mg/kg	1.0	99	80	120			
Cadmium	24.3	mg/kg	1.0	97	80	120			
Copper	49.4	mg/kg	1.0	99	80	120			
Iron	258	mg/kg	5.0	102	80	120			
Lead	51.5	mg/kg	1.0	99	80	120			
Manganese	248	mg/kg	1.0	99	80	120			
Zinc	50.1	mg/kg	1.0	100	80	120			
Sample ID: LCS-18262	Laboratory Control Sample				Run: ICP2-HE_121008B				10/08/12 20:01
Aluminum	12600	mg/kg	5.0	87	50.7	131.3			
Arsenic	282	mg/kg	1.5	83	72.3	106.4			
Cadmium	122	mg/kg	1.0	90	73	105.1			
Copper	248	mg/kg	1.0	89	77.5	109.6			
Iron	20200	mg/kg	5.0	89	39.6	138.3			
Lead	189	mg/kg	3.1	101	75.9	108.6			
Manganese	369	mg/kg	1.0	101	80.8	115.7			
Zinc	197	mg/kg	1.0	93	74.2	109.9			
Sample ID: H12100091-016AMS	Sample Matrix Spike				Run: ICP2-HE_121008B				10/08/12 21:17
Aluminum	25000	mg/kg	5.0		75	125			A
Arsenic	58.2	mg/kg	1.5	87	75	125			
Cadmium	23.0	mg/kg	1.0	88	75	125			
Copper	200	mg/kg	1.0	100	75	125			
Iron	37400	mg/kg	5.0		75	125			A
Lead	209	mg/kg	3.0	131	75	125			S
Manganese	437	mg/kg	1.0	80	75	125			
Zinc	441	mg/kg	1.0		75	125			A
Sample ID: H12100091-016AMSD	Sample Matrix Spike Duplicate				Run: ICP2-HE_121008B				10/08/12 21:55
Aluminum	24100	mg/kg	5.0		75	125	3.4	20	A
Arsenic	59.3	mg/kg	1.5	89	75	125	1.8	20	
Cadmium	21.5	mg/kg	1.0	82	75	125	7.1	20	
Copper	193	mg/kg	1.0	86	75	125	3.5	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: Mike Horse Floodplain

Report Date: 10/22/12
Work Order: H12100091

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Batch: 18262
Sample ID: H12100091-016AMSD	Sample Matrix Spike Duplicate				Run: ICP2-HE_121008B				10/08/12 21:55
Iron	33200	mg/kg	5.0		75	125	12	20	A
Lead	176	mg/kg	3.0	63	75	125	17	20	S
Manganese	518	mg/kg	1.0	113	75	125	17	20	
Zinc	414	mg/kg	1.0		75	125	6.2	20	A
Method: SW6010B									Batch: 18262
Sample ID: MB-18262	Method Blank				Run: ICP2-HE_121009D				10/10/12 01:42
Aluminum	0.4	mg/kg	0.3						
Arsenic	ND	mg/kg	0.4						
Cadmium	ND	mg/kg	0.01						
Copper	ND	mg/kg	0.2						
Iron	2	mg/kg	0.7						
Lead	ND	mg/kg	1						
Manganese	0.07	mg/kg	0.04						
Zinc	0.2	mg/kg	0.1						

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.

Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Workorder Receipt Checklist

MT DEQ-Site Response H12100091

Login completed by:	Tracy L. Lorash	Date Received:	10/3/2012
Reviewed by:	BL2000\sdull	Received by:	TLL
Reviewed Date:	10/11/2012	Carrier name:	Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	14.2°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Contact and Corrective Action Comments:

None

ENERGY LAB

Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT (Provide as much information as possible.)

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
Pioneer Technical Services	Mike Horse Floodplain	State: MT	Yes ☐ No ☐
Report Mail Address:	**Contact Name:** / **Phone/Fax:**	**Email:**	**Sampler: (Please Print)**
1215 Apple's Way, Belgrade 59714	Niki Griffis 388-8578	ngriffis@pioneer-technical.com	
Invoice Address:	**Invoice Contact & Phone:**	**Purchase Order:**	**Quote/Bottle Order:**

Special Report/Formats:

☐ DW
☐ POTW/WWTP
☐ State: _____
☒ Other: _____
Regular Spectrum format

☒ EDD/EDT (Electronic Data) Format: _____
☐ LEVEL IV
☐ NELAC

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids Vegetation Bioassay Other DW - Drinking Water

ANALYSIS REQUESTED

SEE ATTACHED

Standard Turnaround (TAT)

RUSH

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: Hand
Cooler ID(s): Y
Receipt Temp 14.2°C
On Ice: (Y) N
Custody Seal: On Bottle Y (N); On Cooler Y N
Intact Y N
Signature Match Y N

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Total 350 Digestion											
1	TP-FP-32(0-0.4)	08072012	1400		X											
2	TP-FP-33(8-8.5)	08072012	1315		X											
3	TP-FP-35(0.5-0.7)	08082012	955		X											
4	TP-FP-36(3.5-4)	08132012	1356		X											
5	TP-FP-37(11.5-12)	08142012	1024		X											
6	TP-FP-38A(1-1.5)	08142012	1126		X											
7	TP-FP-40(1.5-2)	08082012	1238		X											
8	TP-FP-41(2-2.5)	08082012	1445		X											
9	TP-FP-42(6.6-7)	08082012	1657		X											
10	TP-FP-44(0-0.7)	08092012	1039													

LABORATORY USE ONLY H12100098

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
LAUREE SORENSEN	10-3-12-8:12	[signature]			
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory: Tracy Lynch	Date/Time: 10/3/12 8:12	Signature: [signature]

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

ENERGY LAB

Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT (Provide as much information as possible.)

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
Pioneer Technical Services	Mike Horse Flood Plain	State: MT	Yes ☐ No ☐
Report Mail Address:	**Contact Name:** / **Phone/Fax:**	**Email:**	**Sampler: (Please Print)**
1215 Apple's Way, Belgrade 59714	Niki Griffis 388-8578	ngriffis@pioneer-technical.com	
Invoice Address:	**Invoice Contact & Phone:**	**Purchase Order:**	**Quote/Bottle Order:**

Special Report/Formats:

- ☐ DW
- ☐ POTW/WWTP
- ☐ State: _____
- ☒ Other: _____
- ☒ EDD/EDT (Electronic Data) Format: _____
- ☐ LEVEL IV
- ☐ NELAC

Regular Spectrum Format

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids
Vegetation Bioassay Other
DW - Drinking Water

ANALYSIS REQUESTED

SEE ATTACHED

Standard Turnaround (TAT)

RUSH

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: Hand

Cooler ID(s): Y

Receipt Temp: 14.2 °C

On Ice: Y N

Custody Seal: On Bottle Y N; On Cooler Y N

Intact Y N

Signature Match Y N

LABORATORY USE ONLY: H210009

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Total 350 Digestion
1	TP-FP-45 (0.5-1)	08092012	1250		X
2	TP-FP-45A (0.8-1.2)	08132012	1005		X
3	TP-FP-46 (8.5-9)	08162012	1131		X
4	TP-FP-48 (1.5-2)	08152012	1537		X
5	TP-FP-49A (2.8-3.2)	08142012	1704		X
6	TP-FP-50 (9-10)	08152012	1027		X
7					
8					
9					
10					

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Lance Sorensen	10/3/12 - 8:12				
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory: Tracy Lovel	Date/Time: 10/3/12 8:12	Signature:

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Account Number: H12433
Invoice Number: 321060391
Invoice Date: 10/24/2012
Purchase Order: SPB05-894PB
Invoice Total: $1,176.00
Amount Received: $0.00
Amount Due: $1,176.00

Remit To: Energy Laboratories Inc
Accounts Receivable
PO Box 30975
Billings, MT 59107-0975

H124333210603910001176000321190496

Detach and Return Stub with Payment

INVOICE

BILL TO: MT DEQ-Site Response
Attn: Shellie Haaland
PO Box 200901
Helena, MT 59620-0901

Invoice Date: *October 24, 2012*

Invoice No: 321060391

Purchase Order SPB05-894PB
Account Number H12433

TERMS: NET 30 DAYS
Interest charged after 30 days 1.5% per month.
VISA/MasterCard payments accepted.

From: ENERGY LABORATORIES

3161 East Lyndale Avenue • Helena, MT 59601
(406) 442-0711

Project Name: Mike Horse Floodplain

Item	Remarks	Matrix	Test Price	Mult	Price	Qty	Test Total
WorkOrder H12100091							
Metals by ICP/ICPMS, Total		Solid	$80.00	1	$80.00	16	$1,280.00
Digestion, Total Metals		Soil	$25.00	1	$25.00	16	$400.00

Comments:

Subtotal:	**$1,680.00**
30% Discount:	-504.00
Order Amount:	**1,176.00**
INVOICE TOTAL:	**$1,176.00**
Amount Received:	$0.00
AMOUNT DUE:	**$1,176.00**

ANALYTICAL SUMMARY REPORT

November 08, 2012

MT DEQ-Site Response
PO Box 200901
Helena, MT 59620-0901

Workorder No.: H12100208 Quote ID: H711 - UBMC Metal Soil Sampling

Project Name: MIke Horse Floodplain

Energy Laboratories Inc Helena MT received the following 14 samples for MT DEQ-Site Response on 10/10/2012 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H12100208-001	TP-FP-50A (8.5-9)	08/15/12 15:00	10/10/12	Soil	Metals by ICP/ICPMS, Total Digestion, Total Metals
H12100208-002	TP-MS-05 (1.8-2)	08/29/12 9:48	10/10/12	Soil	Same As Above
H12100208-003	TP-MS-19 (1-2)	09/13/12 15:55	10/10/12	Soil	Same As Above
H12100208-004	TP-MS-25 (0.5-1)	09/11/12 11:55	10/10/12	Soil	Same As Above
H12100208-005	TP-MS-09 (6-7)	09/20/12 17:00	10/10/12	Soil	Same As Above
H12100208-006	TP-MS-04 (1-2)	09/21/12 13:10	10/10/12	Soil	Same As Above
H12100208-007	TP-MS-27 (2-2.5)	09/10/12 16:00	10/10/12	Soil	Same As Above
H12100208-008	TP-MS-03 (1-2)	09/24/12 10:38	10/10/12	Soil	Same As Above
H12100208-009	TP-MS-10B (1-2)	09/20/12 9:23	10/10/12	Soil	Same As Above
H12100208-010	TP-MS-15 (3-3.7)	09/19/12 9:50	10/10/12	Soil	Same As Above
H12100208-011	TP-MS-11B (2-3)	09/20/12 13:56	10/10/12	Soil	Same As Above
H12100208-012	TP-MS-24 (5.3-5.75)	09/11/12 16:45	10/10/12	Soil	Same As Above
H12100208-013	TP-MS-23 (0-1.0)	09/12/12 15:30	10/10/12	Soil	Same As Above
H12100208-014	TP-MS-11C (2-3.0) DUP1	09/20/12 12:25	10/10/12	Soil	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Workorder: H12100208

Report Date: 11/08/12
Date Received: 10/10/12

		Analysis		Al-T	As-T	Cd-T	Cu-T	Fe-T	Mn-T	Pb-T	Zn-T
		Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Up**	**Low**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
H12100208-001	TP-FP-50A (8.5-9)	0	0	21000	12	< 0.2	167	44200	380	52	35
H12100208-002	TP-MS-05 (1.8-2)	0	0	12400	19	0.6	155	27200	212	85	191
H12100208-003	TP-MS-19 (1-2)	0	0	17600	15	< 0.2	98	106000	107	94	103
H12100208-004	TP-MS-25 (0.5-1)	0	0	18500	76	24.0	1500	39000	5480	4160	3900
H12100208-005	TP-MS-09 (6-7)	0	0	22700	6	1.1	214	16500	129	161	261
H12100208-006	TP-MS-04 (1-2)	0	0	16800	69	8.2	327	32900	1890	1230	1300
H12100208-007	TP-MS-27 (2-2.5)	0	0	21500	19	1.2	253	24800	226	134	345
H12100208-008	TP-MS-03 (1-2)	0	0	4340	214	12.2	458	87500	9240	1120	2100
H12100208-009	TP-MS-10B (1-2)	0	0	8080	179	33.4	690	65600	11100	2310	4840
H12100208-010	TP-MS-15 (3-3.7)	0	0	17200	18	0.7	108	22700	133	145	192
H12100208-011	TP-MS-11B (2-3)	0	0	21700	21	3.4	229	19600	238	288	687
H12100208-012	TP-MS-24 (5.3-5.75)	0	0	17100	9	1.1	367	25400	125	278	507
H12100208-013	TP-MS-23 (0-1.0)	0	0	18500	33	2.5	186	68100	1230	177	550
H12100208-014	TP-MS-11C (2-3.0) DUP1	0	0	17200	15	6.3	208	20700	441	305	1060

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100208

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Analytical Run: ICP2-HE_121024B		
Sample ID: ICV	5	Initial Calibration Verification Standard							10/24/12 13:57	
Arsenic		0.859	mg/L	0.0092	107	90	110			
Cadmium		0.422	mg/L	0.0010	105	90	110			
Iron		4.09	mg/L	0.030	102	90	110			
Lead		0.857	mg/L	0.013	107	90	110			
Zinc		0.866	mg/L	0.010	108	90	110			
Sample ID: ICSA	5	Interference Check Sample A							10/24/12 14:12	
Arsenic		-0.0221	mg/L	0.0092		0	0			
Cadmium		0.00136	mg/L	0.0010		0	0			
Iron		187	mg/L	0.030	94	80	120			
Lead		0.0414	mg/L	0.013		0	0			
Zinc		0.0148	mg/L	0.010		0	0			
Sample ID: ICSAB	5	Interference Check Sample AB							10/24/12 14:16	
Arsenic		1.15	mg/L	0.0092	115	80	120			
Cadmium		0.972	mg/L	0.0010	97	80	120			
Iron		188	mg/L	0.030	94	80	120			
Lead		1.02	mg/L	0.013	102	80	120			
Zinc		1.05	mg/L	0.010	105	80	120			
Sample ID: ICV	5	Initial Calibration Verification Standard							10/24/12 16:34	
Arsenic		0.882	mg/L	0.0092	110	90	110			
Cadmium		0.408	mg/L	0.0010	102	90	110			
Iron		4.18	mg/L	0.030	104	90	110			
Lead		0.844	mg/L	0.013	106	90	110			
Zinc		0.856	mg/L	0.010	107	90	110			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100208

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP2-HE_121025C	
Sample ID: ICV	8	Initial Calibration Verification Standard							10/25/12 13:06	
Aluminum		4.04	mg/L	0.10	101	90	110			
Arsenic		0.805	mg/L	0.0092	101	90	110			
Cadmium		0.383	mg/L	0.0010	96	90	110			
Copper		0.807	mg/L	0.010	101	90	110			
Iron		3.94	mg/L	0.030	98	90	110			
Lead		0.784	mg/L	0.013	98	90	110			
Manganese		3.98	mg/L	0.010	99	90	110			
Zinc		0.802	mg/L	0.010	100	90	110			
Sample ID: ICSA	8	Interference Check Sample A							10/25/12 13:21	
Aluminum		510	mg/L	0.10	102	80	120			
Arsenic		-0.00353	mg/L	0.0092		0	0			
Cadmium		0.00325	mg/L	0.0010		0	0			
Copper		-0.00118	mg/L	0.010		0	0			
Iron		186	mg/L	0.030	93	80	120			
Lead		0.0277	mg/L	0.013		0	0			
Manganese		0.00489	mg/L	0.010		0	0			
Zinc		0.0137	mg/L	0.010		0	0			
Sample ID: ICSAB	8	Interference Check Sample AB							10/25/12 13:25	
Aluminum		507	mg/L	0.10	101	80	120			
Arsenic		1.08	mg/L	0.0092	108	80	120			
Cadmium		0.899	mg/L	0.0010	90	80	120			
Copper		0.499	mg/L	0.010	100	80	120			
Iron		185	mg/L	0.030	92	80	120			
Lead		0.924	mg/L	0.013	92	80	120			
Manganese		0.480	mg/L	0.010	96	80	120			
Zinc		0.981	mg/L	0.010	98	80	120			
Method: E200.7									Analytical Run: ICP2-HE_121029B	
Sample ID: ICV	2	Initial Calibration Verification Standard							10/29/12 11:22	
Arsenic		0.813	mg/L	0.0092	102	90	110			
Iron		3.99	mg/L	0.030	100	90	110			
Sample ID: ICSA	2	Interference Check Sample A							10/29/12 11:37	
Arsenic		-0.0140	mg/L	0.0092		0	0			
Iron		184	mg/L	0.030	92	80	120			
Sample ID: ICSAB	2	Interference Check Sample AB							10/29/12 11:41	
Arsenic		1.09	mg/L	0.0092	109	80	120			
Iron		184	mg/L	0.030	92	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Report Date: 11/08/12
Project: MIke Horse Floodplain
Work Order: H12100208

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP2-HE_121030B	
Sample ID: ICV	2	Initial Calibration Verification Standard							10/30/12 15:57	
Arsenic		0.819	mg/L	0.0092	102	90	110			
Iron		3.97	mg/L	0.030	99	90	110			
Sample ID: ICSA	2	Interference Check Sample A							10/30/12 16:12	
Arsenic		0.00846	mg/L	0.0092		0	0			
Iron		184	mg/L	0.030	92	80	120			
Sample ID: ICSAB	2	Interference Check Sample AB							10/30/12 16:16	
Arsenic		1.09	mg/L	0.0092	109	80	120			
Iron		184	mg/L	0.030	92	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100208

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18381
Sample ID: MB-18381	5	Method Blank				Run: ICP2-HE_121024B				10/24/12 19:58
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Iron		4	mg/kg	0.7						
Lead		ND	mg/kg	1						
Zinc		0.2	mg/kg	0.1						
Sample ID: LFB-18381	5	Laboratory Fortified Blank				Run: ICP2-HE_121024B				10/24/12 20:02
Arsenic		46.4	mg/kg	1.0	93	80	120			
Cadmium		22.2	mg/kg	1.0	89	80	120			
Iron		235	mg/kg	5.0	92	80	120			
Lead		46.6	mg/kg	1.0	93	80	120			
Zinc		46.7	mg/kg	1.0	93	80	120			
Sample ID: LCS-18381	5	Laboratory Control Sample				Run: ICP2-HE_121024B				10/24/12 20:06
Arsenic		249	mg/kg	1.5	73	72.3	106.4			
Cadmium		105	mg/kg	1.0	77	73	105.1			
Iron		17500	mg/kg	5.0	77	39.6	138.3			
Lead		163	mg/kg	3.1	88	75.9	108.6			
Zinc		169	mg/kg	1.0	80	74.2	109.9			
Sample ID: H12100241-004AMS	5	Sample Matrix Spike				Run: ICP2-HE_121024B				10/24/12 22:04
Arsenic		52.4	mg/kg	1.5	94	75	125			
Cadmium		21.7	mg/kg	1.0	88	75	125			
Iron		11000	mg/kg	5.0		75	125			A
Lead		60.3	mg/kg	3.1	97	75	125			
Zinc		76.4	mg/kg	1.0	90	75	125			
Sample ID: H12100241-004AMSD	5	Sample Matrix Spike Duplicate				Run: ICP2-HE_121024B				10/24/12 22:08
Arsenic		50.3	mg/kg	1.5	89	75	125	4.1	20	
Cadmium		22.4	mg/kg	1.0	90	75	125	3.1	20	
Iron		11000	mg/kg	5.0		75	125	0.3	20	A
Lead		57.1	mg/kg	3.1	91	75	125	5.4	20	
Zinc		79.3	mg/kg	1.0	96	75	125	3.7	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100208

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18381
Sample ID: MB-18381	8	Method Blank				Run: ICP2-HE_121025C				10/26/12 10:05
Aluminum		0.6	mg/kg	0.3						
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		4	mg/kg	0.7						
Lead		ND	mg/kg	1						
Manganese		ND	mg/kg	0.04						
Zinc		0.3	mg/kg	0.1						
Sample ID: LFB-18381	8	Laboratory Fortified Blank				Run: ICP2-HE_121025C				10/26/12 10:09
Aluminum		244	mg/kg	5.0	97	80	120			
Arsenic		47.8	mg/kg	1.0	96	80	120			
Cadmium		24.2	mg/kg	1.0	97	80	120			
Copper		49.0	mg/kg	1.0	98	80	120			
Iron		245	mg/kg	5.0	96	80	120			
Lead		50.1	mg/kg	1.0	100	80	120			
Manganese		247	mg/kg	1.0	99	80	120			
Zinc		50.2	mg/kg	1.0	100	80	120			
Sample ID: LCS-18381	8	Laboratory Control Sample				Run: ICP2-HE_121025C				10/26/12 10:20
Aluminum		12300	mg/kg	5.0	84	50.7	131.3			
Arsenic		270	mg/kg	1.5	79	72.3	106.4			
Cadmium		118	mg/kg	1.0	87	73	105.1			
Copper		234	mg/kg	1.0	84	77.5	109.6			
Iron		18600	mg/kg	5.0	82	39.6	138.3			
Lead		181	mg/kg	3.1	98	75.9	108.6			
Manganese		351	mg/kg	1.0	96	80.8	115.7			
Zinc		187	mg/kg	1.0	89	74.2	109.9			
Sample ID: H12100241-004AMS	8	Sample Matrix Spike				Run: ICP2-HE_121025C				10/26/12 12:19
Aluminum		13500	mg/kg	5.0		75	125			A
Arsenic		55.9	mg/kg	1.5	102	75	125			
Cadmium		23.0	mg/kg	1.0	93	75	125			
Copper		54.0	mg/kg	1.0	92	75	125			
Iron		10900	mg/kg	5.0		75	125			A
Lead		59.8	mg/kg	3.1	100	75	125			
Manganese		387	mg/kg	1.0	94	75	125			
Zinc		80.5	mg/kg	1.0	98	75	125			
Sample ID: H12100241-004AMSD	8	Sample Matrix Spike Duplicate				Run: ICP2-HE_121025C				10/26/12 12:23
Aluminum		14200	mg/kg	5.0		75	125	5.2	20	A
Arsenic		55.7	mg/kg	1.5	101	75	125	0.4	20	
Cadmium		23.7	mg/kg	1.0	96	75	125	3.0	20	
Copper		56.8	mg/kg	1.0	97	75	125	5.1	20	
Iron		11200	mg/kg	5.0		75	125	2.8	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100208

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18381
Sample ID: H12100241-004AMSD	8	Sample Matrix Spike Duplicate				Run: ICP2-HE_121025C			10/26/12 12:23	
Lead		59.9	mg/kg	3.1	101	75	125	0.2	20	
Manganese		408	mg/kg	1.0	102	75	125	5.3	20	
Zinc		83.3	mg/kg	1.0	104	75	125	3.4	20	
Method: SW6010B										Batch: 18381
Sample ID: MB-18381	8	Method Blank				Run: ICP2-HE_121029B			10/29/12 16:11	
Aluminum		ND	mg/kg	0.8						
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		4	mg/kg	0.7						
Lead		ND	mg/kg	1						
Manganese		0.04	mg/kg	0.04						
Zinc		0.2	mg/kg	0.1						
Method: SW6010B										Batch: 18381
Sample ID: MB-18381	8	Method Blank				Run: ICP2-HE_121030B			10/30/12 16:31	
Aluminum		ND	mg/kg	0.3						
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		4	mg/kg	0.7						
Lead		ND	mg/kg	1						
Manganese		0.08	mg/kg	0.04						
Zinc		0.3	mg/kg	0.1						

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100208

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020								Analytical Run: ICPMS204-B_121031A		
Sample ID: ICV STD	2	Initial Calibration Verification Standard								10/31/12 12:08
Arsenic		0.0461	mg/L	0.0010	92	90	110			
Cadmium		0.0254	mg/L	0.0010	102	90	110			
Sample ID: ICV STD	2	Initial Calibration Verification Standard								11/01/12 02:51
Arsenic		0.0455	mg/L	0.0010	91	90	110			
Cadmium		0.0253	mg/L	0.0010	101	90	110			
Sample ID: ICV STD	2	Initial Calibration Verification Standard								11/02/12 12:00
Arsenic		0.0495	mg/L	0.0010	99	90	110			
Cadmium		0.0249	mg/L	0.0010	100	90	110			
Sample ID: ICV STD	2	Initial Calibration Verification Standard								11/03/12 01:48
Arsenic		0.0495	mg/L	0.0010	99	90	110			
Cadmium		0.0257	mg/L	0.0010	103	90	110			
Method: SW6020										Batch: 18381
Sample ID: MB-18381	2	Method Blank				Run: ICPMS204-B_121031A				10/31/12 16:49
Arsenic		0.04	mg/kg	0.006						
Cadmium		0.04	mg/kg	0.003						
Sample ID: LCS-18381	2	Laboratory Control Sample				Run: ICPMS204-B_121031A				10/31/12 16:58
Arsenic		300	mg/kg	1.0	88	72.3	106.4			
Cadmium		110	mg/kg	1.0	81	73	105.1			
Sample ID: LFB-18381	2	Laboratory Fortified Blank				Run: ICPMS204-B_121031A				10/31/12 17:03
Arsenic		52.2	mg/kg	1.0	104	80	120			
Cadmium		26.3	mg/kg	1.0	105	80	120			
Sample ID: H12100241-004AMS	2	Sample Matrix Spike				Run: ICPMS204-B_121031A				10/31/12 18:02
Arsenic		55.6	mg/kg	1.0	105	75	125			
Cadmium		23.8	mg/kg	1.0	95	75	125			
Sample ID: H12100241-004AMSD	2	Sample Matrix Spike Duplicate				Run: ICPMS204-B_121031A				10/31/12 18:07
Arsenic		55.5	mg/kg	1.0	104	75	125	0.3	20	
Cadmium		23.8	mg/kg	1.0	95	75	125	0.2	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Workorder Receipt Checklist

MT DEQ-Site Response H12100208

Login completed by:	Tracy L. Lorash	Date Received:	10/10/2012
Reviewed by:	BL2000\sdull	Received by:	TLL
Reviewed Date:	10/18/2012	Carrier name:	Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	-0.9°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Contact and Corrective Action Comments:

None

ENERGY

Chain of Custody and Analytical Request Record

Page _____ of _____

PLEASE PRINT (Provide as much information as possible.)

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
Pioneer Technical Services	Mike Horse Flood Plain	State: MT	Yes ☐ No ☐
Report Mail Address:	**Contact Name:** / **Phone/Fax:**	**Email:**	**Sampler: (Please Print)**
1215 Apple's Way, Belgrade MT 59714	Niki Griffis 388-8578	ngriffis@pioneer-technical.com	
Invoice Address:	**Invoice Contact & Phone:**	**Purchase Order:**	**Quote/Bottle Order:**

Special Report/Formats:

- ☐ DW
- ☐ POTW/WWTP
- ☐ State: _____
- ☒ Other: Regular
- ☒ EDD/EDT (Electronic Data) Format: _____
- ☐ LEVEL IV
- ☐ NELAC

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids Vegetation Bioassay Other DW - Drinking Water

ANALYSIS REQUESTED

SEE ATTACHED

Standard Turnaround (TAT)

RUSH

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: Hand

Cooler ID(s): Y

Receipt Temp: -0.9 °C

On Ice: Y N

Custody Seal: On Bottle Y N; On Cooler Y N

Intact Y N

Signature Match Y N

LABORATORY USE ONLY: H12100208

SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	TOTAL-350 Digestion
1 TP-FP-50A (2.5-9)	08-15-12	1500		X
2 TP-MS-05 (1.8-2)	08-29-12	0948		X
3 TP-MS-19 (1-2)	09-13-12	1555		X
4 TP-MS-25 (0.5-1)	09-11-12	1155		X
5 TP-MS-09 (6-7)	09-20-12	1700		X
6 TP-MS-04 (1-2)	09-21-12	1310		X
7 TP-MS-27 (2-2.5)	09-10-12	1600		X
8 TP-MS-03 (1-2)	09-24-12	1038		X
9 TP-MS-10B (1-2)	09-20-12	923		X
10 TP-MS-15 (3-3.7)	09-19-12	950		X

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Jeff Riedel	10-10-12 / 9:55AM				
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory: Tracy Urual	Date/Time: 10/10/12 9:55	Signature: Tracy Urual

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

ENERGY

Chain of Custody and Analytical Request Record

Page _____ of _____

PLEASE PRINT (Provide as much information as possible.)

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
Pioneer Technical Services	Mike Horse Flood Plain	State: MT	Yes ☐ No ☐
Report Mail Address:	**Contact Name:** Phone/Fax:	Email:	Sampler: (Please Print)
1215 Apple's Way, Belgrade, MT 59714	Niki Griffis 388-8578	ngriffis@pioneer-technical.com	
Invoice Address:	**Invoice Contact & Phone:**	Purchase Order:	Quote/Bottle Order:

Special Report/Formats:

☐ DW
☐ POTW/WWTP
☐ State: _____
☒ Other: _____
Regular

☒ EDD/EDT (Electronic Data) Format: _____
☐ LEVEL IV
☐ NELAC

ANALYSIS REQUESTED

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids Vegetation Bioassay Other DW - Drinking Water

Standard Turnaround (TAT)

RUSH

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: Hand
Cooler ID(s): 4
Receipt Temp: -0.9 °C
On Ice: (Y) N
Custody Seal: On Bottle Y (N); On Cooler (Y) N
Intact: (Y) N
Signature Match: Y (N)

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Total 350 Digestion	SEE ATTACHED	Standard Turnaround (TAT)	RUSH	Comments
1	TP-MS-11B(2-3)	09202012	1356		X				
2	TP-MS-24(5.3-5.75)	09112012	1645		X				
3	TP-MS-23(0-1.0)	09122012	1530		X				
4	TP-MS-11C(2-3.0) DUP1	09202012	1225		X				
5									
6									
7									
8									
9									
10									

LABORATORY USE ONLY #12100208

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Jeff Riedel	10-10-12 / 9:55am				
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory: Tracy Grad	Date/Time: 10/10/12 9:55	Signature:

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Remit To: Energy Laboratories Inc
Accounts Receivable
PO Box 30975
Billings, MT 59107-0975

H12433321160120000102900032127552 5

Account Number:	**H12433**
Invoice Number:	**321160120**
Invoice Date:	**11/10/2012**
Purchase Order:	**SPB05-894PB**
Invoice Total:	**$1,029.00**
Amount Received:	**$0.00**
Amount Due:	**$1,029.00**

Detach and Return Stub with Payment

INVOICE

BILL TO: **MT DEQ-Site Response**
Attn: Shellie Haaland
PO Box 200901
Helena, MT 59620-0901

Invoice Date: *November 10, 2012*

Invoice No: 321160120

Purchase Order SPB05-894PB

Account Number H12433

TERMS: NET 30 DAYS
Interest charged after 30 days 1.5% per month.
VISA/MasterCard payments accepted.

From: ENERGY LABORATORIES

3161 East Lyndale Avenue • Helena, MT 59601
(406) 442-0711

Project Name: MIke Horse Floodplain

Item	Remarks	Matrix	Test Price	Mult	Price	Qty	Test Total
WorkOrder H12100208							
Metals by ICP/ICPMS, Total		Solid	$80.00	1	$80.00	14	$1,120.00
Digestion, Total Metals		Soil	$25.00	1	$25.00	14	$350.00

Comments:

Subtotal:	**$1,470.00**
30% Discount:	-441.00
Order Amount:	**1,029.00**
INVOICE TOTAL:	**$1,029.00**
Amount Received:	$0.00
AMOUNT DUE:	**$1,029.00**

ANALYTICAL SUMMARY REPORT

November 08, 2012

MT DEQ-Site Response
PO Box 200901
Helena, MT 59620-0901

Workorder No.: H12100328 Quote ID: H711 - UBMC Metal Soil Sampling

Project Name: MIke Horse Floodplain

Energy Laboratories Inc Helena MT received the following 9 samples for MT DEQ-Site Response on 10/18/2012 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H12100328-001	TP-MS-16 (0.1-0.2)	09/13/12 10:18	10/18/12	Soil	Metals by ICP/ICPMS, Total Digestion, Total Metals
H12100328-002	TP-MS-07 (2.75-3.5)	09/24/12 14:40	10/18/12	Soil	Same As Above
H12100328-003	TP-FP-53 (9.5-10.0)	08/27/12 16:10	10/18/12	Soil	Same As Above
H12100328-004	TP-MS-04A (1-2.0)	09/21/12 14:19	10/18/12	Soil	Same As Above
H12100328-005	TP-FP-55 (.6-1)	08/28/12 10:15	10/18/12	Soil	Same As Above
H12100328-006	TP-FP-57 (0.5-1.0)	09/25/12 9:12	10/18/12	Soil	Same As Above
H12100328-007	TP-FP-58 (6-6.5)	08/28/12 15:37	10/18/12	Soil	Same As Above
H12100328-008	TP-FP-59 (12-12.5)	08/28/12 14:20	10/18/12	Soil	Same As Above
H12100328-009	TP-TS-02 (1.5-2)	08/06/12 15:18	10/18/12	Soil	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response
Project: MIke Horse Floodplain
Workorder: H12100328

Report Date: 11/08/12
Date Received: 10/18/12

		Analysis		Al-T	As-T	Cd-T	Cu-T	Fe-T	Mn-T	Pb-T	Zn-T
		Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Up**	**Low**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
H12100328-001	TP-MS-16 (0.1-0.2)	0	0	8570	149	1.3	373	48900	252	773	312
H12100328-002	TP-MS-07 (2.75-3.5)	0	0	33600	15	0.2	167	14200	119	115	104
H12100328-003	TP-FP-53 (9.5-10.0)	0	0	11900	15	1.1	414	43300	235	178	263
H12100328-004	TP-MS-04A (1-2.0)	0	0	7650	108	7.3	352	60000	1230	833	1670
H12100328-005	TP-FP-55 (.6-1)	0	0	8810	165	2.2	533	63300	1060	7380	523
H12100328-006	TP-FP-57 (0.5-1.0)	0	0	16700	18	1.2	131	23700	516	120	338
H12100328-007	TP-FP-58 (6-6.5)	0	0	13300	17	1.3	210	36600	752	99	387
H12100328-008	TP-FP-59 (12-12.5)	0	0	13500	15	1.0	418	44500	375	75	363
H12100328-009	TP-TS-02 (1.5-2)	0	0	11300	22	0.7	86	19900	634	176	175

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100328

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Analytical Run: ICP2-HE_121029B		
Sample ID: ICV	5	Initial Calibration Verification Standard							10/29/12 11:22	
Aluminum		4.00	mg/L	0.10	100	90	110			
Copper		0.799	mg/L	0.010	100	90	110			
Iron		3.99	mg/L	0.030	100	90	110			
Lead		0.786	mg/L	0.013	98	90	110			
Zinc		0.825	mg/L	0.010	103	90	110			
Sample ID: ICSA	5	Interference Check Sample A							10/29/12 11:37	
Aluminum		508	mg/L	0.10	102	80	120			
Copper		0.00151	mg/L	0.010		0	0			
Iron		184	mg/L	0.030	92	80	120			
Lead		0.0279	mg/L	0.013		0	0			
Zinc		0.0112	mg/L	0.010		0	0			
Sample ID: ICSAB	5	Interference Check Sample AB							10/29/12 11:41	
Aluminum		508	mg/L	0.10	102	80	120			
Copper		0.498	mg/L	0.010	100	80	120			
Iron		184	mg/L	0.030	92	80	120			
Lead		0.977	mg/L	0.013	98	80	120			
Zinc		1.02	mg/L	0.010	102	80	120			
Method: E200.7								Analytical Run: ICP2-HE_121030B		
Sample ID: ICV	6	Initial Calibration Verification Standard							10/30/12 15:57	
Arsenic		0.819	mg/L	0.0092	102	90	110			
Cadmium		0.401	mg/L	0.0010	100	90	110			
Iron		3.97	mg/L	0.030	99	90	110			
Lead		0.811	mg/L	0.013	101	90	110			
Manganese		4.05	mg/L	0.010	101	90	110			
Zinc		0.825	mg/L	0.010	103	90	110			
Sample ID: ICSA	6	Interference Check Sample A							10/30/12 16:12	
Arsenic		0.00846	mg/L	0.0092		0	0			
Cadmium		0.000580	mg/L	0.0010		0	0			
Iron		184	mg/L	0.030	92	80	120			
Lead		0.0659	mg/L	0.013		0	0			
Manganese		-0.00178	mg/L	0.010		0	0			
Zinc		0.0133	mg/L	0.010		0	0			
Sample ID: ICSAB	6	Interference Check Sample AB							10/30/12 16:16	
Arsenic		1.09	mg/L	0.0092	109	80	120			
Cadmium		0.919	mg/L	0.0010	92	80	120			
Iron		184	mg/L	0.030	92	80	120			
Lead		0.991	mg/L	0.013	99	80	120			
Manganese		0.481	mg/L	0.010	96	80	120			
Zinc		0.997	mg/L	0.010	100	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100328

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18461
Sample ID: MB-18461	5	Method Blank				Run: ICP2-HE_121029B				10/29/12 18:03
Aluminum		0.5	mg/kg	0.3						
Copper		ND	mg/kg	0.2						
Iron		2	mg/kg	0.7						
Lead		ND	mg/kg	1						
Zinc		0.2	mg/kg	0.1						
Sample ID: LFB-18461	5	Laboratory Fortified Blank				Run: ICP2-HE_121029B				10/29/12 18:07
Aluminum		242	mg/kg	5.0	96	80	120			
Copper		48.1	mg/kg	1.0	96	80	120			
Iron		243	mg/kg	5.0	96	80	120			
Lead		45.4	mg/kg	1.0	91	80	120			
Zinc		46.5	mg/kg	1.0	93	80	120			
Sample ID: LCS-18461	5	Laboratory Control Sample				Run: ICP2-HE_121029B				10/29/12 18:11
Aluminum		11600	mg/kg	5.0	80	50.7	131.3			
Copper		233	mg/kg	1.0	84	77.5	109.6			
Iron		17800	mg/kg	5.0	78	39.6	138.3			
Lead		165	mg/kg	3.1	89	75.9	108.6			
Zinc		175	mg/kg	1.0	83	74.2	109.9			
Sample ID: H12100328-009AMS	3	Sample Matrix Spike				Run: ICP2-HE_121029B				10/29/12 19:17
Aluminum		16600	mg/kg	5.0		75	125			A
Copper		126	mg/kg	1.0	83	75	125			
Iron		20800	mg/kg	5.0		75	125			A
Sample ID: H12100328-009AMSD	3	Sample Matrix Spike Duplicate				Run: ICP2-HE_121029B				10/29/12 19:54
Aluminum		17500	mg/kg	5.0		75	125	5.0	20	A
Copper		144	mg/kg	1.0	120	75	125	13	20	
Iron		23400	mg/kg	5.0		75	125	12	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100328

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18461
Sample ID: MB-18461	8	Method Blank				Run: ICP2-HE_121030B				10/30/12 18:13
Aluminum		0.4	mg/kg	0.3						
Arsenic		ND	mg/kg	0.4						
Cadmium		ND	mg/kg	0.01						
Copper		ND	mg/kg	0.2						
Iron		2	mg/kg	0.7						
Lead		ND	mg/kg	1						
Manganese		ND	mg/kg	0.04						
Zinc		0.3	mg/kg	0.1						
Sample ID: LFB-18461	8	Laboratory Fortified Blank				Run: ICP2-HE_121030B				10/30/12 18:24
Aluminum		239	mg/kg	5.0	96	80	120			
Arsenic		48.1	mg/kg	1.0	96	80	120			
Cadmium		23.3	mg/kg	1.0	93	80	120			
Copper		47.4	mg/kg	1.0	95	80	120			
Iron		239	mg/kg	5.0	95	80	120			
Lead		48.3	mg/kg	1.0	97	80	120			
Manganese		244	mg/kg	1.0	97	80	120			
Zinc		48.3	mg/kg	1.0	96	80	120			
Sample ID: LCS-18461	8	Laboratory Control Sample				Run: ICP2-HE_121030B				10/30/12 18:27
Aluminum		11900	mg/kg	5.0	82	50.7	131.3			
Arsenic		276	mg/kg	1.5	81	72.3	106.4			
Cadmium		118	mg/kg	1.0	87	73	105.1			
Copper		236	mg/kg	1.0	85	77.5	109.6			
Iron		18000	mg/kg	5.0	79	39.6	138.3			
Lead		169	mg/kg	3.1	91	75.9	108.6			
Manganese		368	mg/kg	1.0	101	80.8	115.7			
Zinc		187	mg/kg	1.0	89	74.2	109.9			
Sample ID: H12100328-009AMS	8	Sample Matrix Spike				Run: ICP2-HE_121030B				10/30/12 19:34
Aluminum		17000	mg/kg	5.0		75	125			A
Arsenic		70.7	mg/kg	1.5	100	75	125			
Cadmium		21.8	mg/kg	1.0	89	75	125			
Copper		128	mg/kg	1.0	78	75	125			
Iron		21100	mg/kg	5.0		75	125			A
Lead		251	mg/kg	3.0	155	75	125			S
Manganese		812	mg/kg	1.0	73	75	125			S
Zinc		220	mg/kg	1.0	92	75	125			
Sample ID: H12100328-009AMSD	8	Sample Matrix Spike Duplicate				Run: ICP2-HE_121030B				10/30/12 19:37
Aluminum		16500	mg/kg	5.0		75	125	3.4	20	A
Arsenic		68.9	mg/kg	1.5	96	75	125	2.7	20	
Cadmium		22.2	mg/kg	1.0	90	75	125	1.8	20	
Copper		134	mg/kg	1.0	91	75	125	4.8	20	
Iron		21800	mg/kg	5.0		75	125	3.3	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100328

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 18461
Sample ID: H12100328-009AMSD	8	Sample Matrix Spike Duplicate				Run: ICP2-HE_121030B			10/30/12 19:37	
Lead		216	mg/kg	3.0	83	75	125	15	20	
Manganese		990	mg/kg	1.0	147	75	125	20	20	S
Zinc		270	mg/kg	1.0	195	75	125	20	20	SR

Qualifiers:

RL - Analyte reporting limit.

R - RPD exceeds advisory limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Site Response **Report Date:** 11/08/12

Project: MIke Horse Floodplain **Work Order:** H12100328

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020								Analytical Run: ICPMS204-B_121031A		
Sample ID: ICV STD		Initial Calibration Verification Standard								10/31/12 12:08
Cadmium		0.0254	mg/L	0.0010	102	90	110			
Sample ID: ICV STD		Initial Calibration Verification Standard								11/01/12 02:51
Cadmium		0.0253	mg/L	0.0010	101	90	110			
Sample ID: ICV STD		Initial Calibration Verification Standard								11/02/12 12:00
Cadmium		0.0249	mg/L	0.0010	100	90	110			
Sample ID: ICV STD		Initial Calibration Verification Standard								11/03/12 01:48
Cadmium		0.0257	mg/L	0.0010	103	90	110			
Method: SW6020										Batch: 18461
Sample ID: MB-18461		Method Blank				Run: ICPMS204-B_121031A				10/31/12 19:30
Cadmium		0.02	mg/kg	0.001						
Sample ID: LCS-18461		Laboratory Control Sample				Run: ICPMS204-B_121031A				10/31/12 19:35
Cadmium		116	mg/kg	1.0	86	73	105.1			
Sample ID: LFB-18461		Laboratory Fortified Blank				Run: ICPMS204-B_121031A				10/31/12 19:39
Cadmium		26.6	mg/kg	1.0	106	80	120			
Sample ID: H12100328-009AMS		Sample Matrix Spike				Run: ICPMS204-B_121031A				10/31/12 20:44
Cadmium		23.8	mg/kg	1.0	95	75	125			
Sample ID: H12100328-009AMSD		Sample Matrix Spike Duplicate				Run: ICPMS204-B_121031A				10/31/12 20:48
Cadmium		24.1	mg/kg	1.0	97	75	125	1.3	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Workorder Receipt Checklist

MT DEQ-Site Response H12100328

Login completed by:	Tracy L. Lorash	Date Received:	10/18/2012
Reviewed by:	BL2000\jweidemoyer	Received by:	elm
Reviewed Date:	10/24/2012	Carrier name:	Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	8.1°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Contact and Corrective Action Comments:

None

Chain of Custody and Analytical Request Record

Page _____ of _____

PLEASE PRINT (Provide as much information as possible.)

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
Pioneer Technical Services	Mike Horse Flood Plain	State: MT	Yes ☐ No ☐
Report Mail Address:	**Contact Name:** Phone/Fax:	**Email:**	**Sampler: (Please Print)**
1215 Apple's Way, Belgrade, MT 59714	Niki Griffis 388-8578	ngriffis@pioneer-technical.com	
Invoice Address:	**Invoice Contact & Phone:**	**Purchase Order:**	**Quote/Bottle Order:**

Special Report/Formats:

☐ DW
☐ POTW/WWTP
☐ State: _____
☒ Other: _____
Regular

☒ EDD/EDT (Electronic Data) Format: _____
☐ LEVEL IV
☐ NELAC

ANALYSIS REQUESTED

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids
Vegetation Bioassay Other
DW - Drinking Water

SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Total 350 Digestion									SEE ATTACHED
1 TP-MS-16 (0.1-0.2)	09132012	1018		X									
2 TP-MS-07 (2.75-3.5)	09242012	1440		X									
3 TP-FP-53 (9.5-10.0)	08272012	1610		X									
4 TP-MS-04A (1-2.0)	09212012	1419		X									
5 TP-FP-55 (.6-1)	08282012	1015		X									
6 TP-FP-57 (0.5-1.0)	09252012	912		X									
7 TP-FP-58 (6-6.5)	08282012	1537		X									
8 TP-FP-59 (12-12.5)	08282012	1420		X									
9 TP-TS-02 (1.5-2)	08062012	1518		X									
10													

Standard Turnaround (TAT)

RUSH

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

LABORATORY USE ONLY

Shipped by: Hand
Cooler ID(s): 1
Receipt Temp: 8.1 °C
On Ice: (Y) N
Custody Seal: On Bottle Y N; On Cooler Y N
Intact: (Y) N
Signature Match: (Y) N
~~H120~~
H12100328

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Lance Sorensen	10/18/12 9:03	[signature]			
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory: Esther Merritt	10/18/12 9:03	[signature]

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Remit To: Energy Laboratories Inc
Accounts Receivable
PO Box 30975
Billings, MT 59107-0975

H124333211601210000661500321238776

Account Number:	**H12433**
Invoice Number:	**321160121**
Invoice Date:	**11/10/2012**
Purchase Order:	**SPB05-894PB**
Invoice Total:	**$661.50**
Amount Received:	**$0.00**
Amount Due:	**$661.50**

Detach and Return Stub with Payment

BILL TO: **MT DEQ-Site Response**
Attn: Shellie Haaland
PO Box 200901
Helena, MT 59620-0901

INVOICE

Invoice Date: *November 10, 2012*

Invoice No: 321160121

Purchase Order SPB05-894PB

Account Number H12433

TERMS: NET 30 DAYS
Interest charged after 30 days 1.5% per month.
VISA/MasterCard payments accepted.

From: ENERGY LABORATORIES

3161 East Lyndale Avenue • Helena, MT 59601
(406) 442-0711

Project Name: MIke Horse Floodplain

Item	Remarks	Matrix	Test Price	Mult	Price	Qty	Test Total
WorkOrder H12100328							
Metals by ICP/ICPMS, Total		Solid	$80.00	1	$80.00	9	$720.00
Digestion, Total Metals		Soil	$25.00	1	$25.00	9	$225.00

Comments:

Subtotal:	**$945.00**
30% Discount:	-283.50
Order Amount:	**661.50**
INVOICE TOTAL:	**$661.50**
Amount Received:	$0.00
AMOUNT DUE:	**$661.50**

DATA VALIDATION REPORT FOR LABORATORY WORK ORDER H12090089
FLOODPLAIN INVESTIGATION,
UPPER BLACKFOOT MINING COMPLEX, MONTANA

Sample collection and analysis were consistent with the *Final Quality Assurance Project Plan* (QAPP) *for the Upper Blackfoot Mining Complex Design Investigations*, approved July 13, 2012. Tables D-2 and D-3 (in this Appendix) provide a listing of the samples discussed in this data validation report, laboratory information including, lab identification number, date sampled, the sample matrix, the analytical method, reporting units, the laboratory and data validation qualifiers associated with each sample, the reason for the qualifier, and the type and number of laboratory QA/QC samples. Table D-4 presents the laboratory data with the appropriate laboratory and data qualifiers.

Soil samples were collected by Pioneer Technical Services from July 24 through July 31, 2012 and analyzed using a Thermo Scientific Niton XL3T portable XRF unit. Eight confirmation samples were selected and hand delivered to Energy Laboratories, Inc. (Energy) in Helena, Montana on September 6, 2012. The temperature of the samples upon receipt by the laboratory was recorded at 12.8ºC which is above the accepted temperature range of 4ºC (±2ºC) in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and Table 6 of the *Final Upper Blackfoot Mining Complex Sampling and Analysis Plan*. The samples were analyzed for aluminum, arsenic, cadmium, copper, iron, manganese, lead and zinc using ICP/MS. These elements are present in the sample matrix, a river gravel, as aluminum silicates, sulfides, oxides, and hydroxides, none of which are volatile within normal temperature ranges. Some oxidation may occur but this would not affect the total metal content. Based on professional judgment no qualification is necessary because of the temperature exceedance.

The Chain of Custody records from field to laboratory were complete and custody was maintained as evidenced by field and laboratory personnel signatures, dates, and times of receipt. It appears from the analytical report that all analytes were extracted and analyzed within the appropriate holding times.

Analytical results with laboratory and data qualifiers are presented in Table D-4 in this appendix, the analytical reports are included in Appendix 1. Table D-2 in Appendix 1 presents the field sample number, the associated lab sample number, the analysis performed, the analytical method, the reporting units, any laboratory data qualifiers associated with the analysis, the assigned data validation qualifiers and reason for qualification. A description of the data qualifiers used in the table is included as Table D-1. Data validation was completed on March 18, 2013 by J. Flammang of Pioneer Technical Services.

Table D-3 in Appendix1 presents a summary of the Laboratory Quality Control/Quality Assurance samples that the laboratory ran for each sample batch and analysis. Included on the table is the analysis, the type and quantity of QA/QC samples and a description of the result if it was out of the laboratory control limits Results for continuing calibration verification samples were not reported, but are assumed to be acceptable as the laboratory did not report any calibration results that were outside of QC limits. As shown on Table D-3 the number of laboratory QA/QC samples met the requirements defined in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and the QAPP.

Several of the laboratory QA/QC results that were outside of the laboratory control limits resulted in data qualifications as follows:

- Based on the laboratory matrix spike (MS) results (73% recovery), all manganese concentrations reported above the method detection limit (MDL) have been qualified as estimated low (J-). The matrix spike duplicate (MSD) recovery was 147%. Based on guidance in the EPA National

Functional Guidelines for Inorganic Data Review "if the spiked sample analysis was performed on the same sample that was chosen for the duplicate sample analysis, spike calculations shall be performed using the results of the sample designated as the "original sample"". Samples have already been qualified as estimated low (J-) based on the MS sample.

- Based on a MS recovery outside of the laboratory control limits (155% recovery), all lead concentrations reported above the MDL have been qualified as estimated high (J+).
- Based on a spike result of the MSD sample outside of the laboratory control limits (195%), all zinc concentrations reported above the MDL have been qualified as estimated high (J+).

Field sample, TP-TS-02 (1.5-2), laboratory sample identification number H12100328-009 was used to prepare the MS and MSD. All samples were described as river gravel so this sample matrix was appropriate to use for the MS/MSD.

The reporting limit (RL) for lead as indicated on the Laboratory QA/QC summary report was 1 mg/kg, higher than the Practical Quantitation Limit (PQL) of 0.2 mg/kg listed in Table 5, Mine Waste Analytical Requirements in the QAPP. All lead results were greater than 10 times the laboratory RL of 1, the higher RL will have no effect on the use of the data.

No field blanks were collected as none were required in the SAP or QAPP. Field duplicates were collected and analyzed using the XRF. No field duplicates were submitted to the laboratory.

Analytical methods and reporting limits (except as discussed above) as defined in the SAP and QAPP were met by the laboratory and are adequate to define mine waste materials in the Blackfoot River floodplain to aid in developing remediation options.

No additional samples were flagged due to the data validation and the results are accepted with the qualifications indicated. No data was rejected.

DATA VALIDATION REPORT FOR LABORATORY WORK ORDER H12090382
FLOODPLAIN INVESTIGATION,
UPPER BLACKFOOT MINING COMPLEX, MONTANA

Sample collection and analysis were consistent with the *Final Quality Assurance Project Plan* (QAPP) *for the Upper Blackfoot Mining Complex Design Investigations*, approved July 13, 2012. Tables D-5 and D-6 (in this appendix) provide a listing of the samples discussed in this data validation report, laboratory information including, lab identification number, date sampled, the sample matrix, the analytical method, reporting units, the laboratory and data validation qualifiers associated with each sample, the reason for the qualifier, and the type and number of laboratory QA/QC samples. Table D-7 presents the laboratory data with the appropriate laboratory and data qualifiers.

Soil samples were collected by Pioneer Technical Services from July 31 through August 7, 2012 and analyzed using a Thermo Scientific Niton XL3T portable XRF unit. Ten confirmation samples were selected and hand delivered to Energy Laboratories, Inc. (Energy) in Helena, Montana on September 24, 2012. The temperature of the samples upon receipt by the laboratory was recorded at 10.6ºC which is above the accepted temperature range of 4ºC (±2ºC) in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and Table 6 of the *Final Upper Blackfoot Mining Complex Sampling and Analysis Plan*. The samples were analyzed for aluminum, arsenic, cadmium, copper, iron, manganese, lead and zinc using ICP/MS. These elements are present in the sample matrix, a river gravel, as aluminum silicates, sulfides, oxides, and hydroxides, none of which are volatile within normal temperature ranges. Some oxidation may occur but this would not affect the total metal content. Based on professional judgment no qualification is necessary because of the temperature exceedance alone.

The Chain of Custody records from field to laboratory were complete and custody was maintained as evidenced by field and laboratory personnel signatures, dates, and times of receipt. It appears from the analytical report that all analytes were extracted and analyzed within the appropriate holding times.

Analytical results with laboratory and data qualifiers are presented in Table D-7 in this Appendix. The laboratory analytical reports are included in Appendix 1. Table D-5 in Appendix 1 presents the field sample number, the associated lab sample number, the analysis performed, the analytical method, the reporting units, any laboratory data qualifiers associated with the analysis, the assigned data validation qualifiers and reason for qualification. A description of the data qualifiers used in the table is included as Table D-1. Data validation was completed on March 18, 2013 by J. Flammang of Pioneer Technical Services.

Table D-6 in Appendix1 presents a summary of the Laboratory Quality Control/Quality Assurance samples that the laboratory ran for each sample batch and analysis. Included on the table is the analysis, the type and quantity of QA/QC samples and a description of the result if it was out of the laboratory control limits Results for continuing calibration verification samples were not reported, but are assumed to be acceptable as the laboratory did not report any calibration results that were outside of QC limits. As shown on Table D-6 the number of laboratory QA/QC samples met the requirements defined in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and the QAPP.

The laboratory QA/QC results that were outside of the laboratory control limits resulted in data qualifications as follows:

- Based on two laboratory matrix spike (MS) results (61% and 59 recovery) and two matrix spike duplicate sample results (74% and 74% recovery) which were outside of laboratory control limits, all copper concentrations reported above the method detection limit (MDL) have been qualified as estimated low (J-).

Field sample, TP-FP-30 (10-10.5), laboratory sample identification number H12090382-010, was used to prepare the MS and MSD. All samples were described as river gravel so this sample matrix was appropriate for use as the MS/MSD.

The laboratory had flagged all of the reported lead results, two reported arsenic results (TP-FP-18 (0.6-0.8) and TP-FP-28(9-9.5)), and one iron result (TP-FP-25 (0.4-0.9) with a D, indicating the reporting limit was increased due to the sample matrix. The reporting limit (RL) for lead as indicated on the Laboratory QA/QC summary report was 2 mg/kg, higher than the Practical Quantitation Limit (PQL) of 0.2 mg/kg listed in Table 5, Mine Waste Analytical Requirements in the QAPP. All lead results were greater than the laboratory RL of 2. The reporting limit (RL) for arsenic as indicated on the Laboratory QA/QC summary report was 2 mg/kg, higher than the PQL of 0.5 mg/kg listed in the QAPP. Both arsenic results were greater than the laboratory RL of 2. The reporting limit (RL) for iron as indicated on the Laboratory QA/QC summary report was 6 mg/kg, higher than the PQL of 5 mg/kg listed in the QAPP. The reported iron result was well above the RL. All reported data was well above the raised RL and have no effect on the use of the data.

No field blanks were collected as none were required in the SAP or QAPP. Field duplicates were collected and analyzed using the XRF. No field duplicates were submitted to the laboratory.

Analytical methods and reporting limits (except as discussed above) as defined in the SAP and QAPP were met by the laboratory and are adequate to define mine waste materials in the Blackfoot River floodplain to aid in developing remediation options.

No additional samples were flagged due to the data validation and the results are accepted with the qualifications indicated. No data was rejected.

DATA VALIDATION REPORT FOR LABORATORY WORK ORDER H12100091
FLOODPLAIN INVESTIGATION,
UPPER BLACKFOOT MINING COMPLEX, MONTANA

Sample collection and analysis were consistent with the *Final Quality Assurance Project Plan* (QAPP) *for the Upper Blackfoot Mining Complex Design Investigations*, approved July 13, 2012. Tables D-8 and D-9(in this appendix) provide a listing of the samples discussed in this data validation report, laboratory information including, lab identification number, date sampled, the sample matrix, the analytical method, reporting units, the laboratory and data validation qualifiers associated with each sample, the reason for the qualifier, and the type and number of laboratory QA/QC samples. Table D-10 presents the laboratory data with the appropriate laboratory and data qualifiers.

Soil samples were collected by Pioneer Technical Services from August 7 through August 15, 2012 and analyzed using a Thermo Scientific Niton XL3T portable XRF unit. Sixteen confirmation samples were selected and hand delivered to Energy Laboratories, Inc. (Energy) in Helena, Montana on October 3, 2012. The temperature of the samples upon receipt by the laboratory was recorded at 14.2ºC which is above the accepted temperature range of 4ºC (±2ºC) in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and Table 6 of the *Final Upper Blackfoot Mining Complex Sampling and Analysis Plan*. The samples were analyzed for aluminum, arsenic, cadmium, copper, iron, manganese, lead and zinc using ICP/MS. These elements are present in the sample matrix, a river gravel, as aluminum silicates, sulfides, oxides, and hydroxides, none of which are volatile within normal temperature ranges. Some oxidation may occur but this would not affect the total metal content. Based on professional judgment no qualification is necessary because of the temperature exceedance alone.

The Chain of Custody records from field to laboratory were complete and custody was maintained as evidenced by field and laboratory personnel signatures, dates, and times of receipt. It appears from the analytical report that all analytes were extracted and analyzed within the appropriate holding times.

Analytical results with laboratory and data qualifiers are presented in Table D-10 in this Appendix. The laboratory analytical reports are included in Appendix 1. Table D-8 in Appendix 1 presents the field sample number, the associated lab sample number, the analysis performed, the analytical method, the reporting units, any laboratory data qualifiers associated with the analysis, the assigned data validation qualifiers and reason for qualification. A description of the data qualifiers used in the table is included as Table D-1. Data validation was completed on March 18, 2013 by J. Flammang of Pioneer Technical Services.

Table D-9 in Appendix1 presents a summary of the Laboratory Quality Control/Quality Assurance samples that the laboratory ran for each sample batch and analysis. Included on the table is the analysis, the type and quantity of QA/QC samples and a description of the result if it was out of the laboratory control limits Results for continuing calibration verification samples were not reported, but are assumed to be acceptable as the laboratory did not report any calibration results that were outside of QC limits. As shown on Table D-9 the number of laboratory QA/QC samples met the requirements defined in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and the QAPP.

The laboratory QA/QC results that were outside of the laboratory control limits resulted in data qualifications as follows:

- Based on laboratory matrix spike (MS) results (131% recovery) which was outside of laboratory control limits, all lead concentrations reported above the method detection limit (MDL) have been qualified as estimated high (J+). The matrix spike duplicate (MSD) had a recovery of 63% which was outside of the lower laboratory control limits. Based on the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) qualification should be made based on the "original" MS sample rather than an average of the two (duplicate and original) sample results.

Field sample, TP-FP-50 (9-10), laboratory sample identification number H12100091-016, was used to prepare the MS and MSD. All samples were described as river gravel so this sample matrix was appropriate for use as the MS/MSD.

The reporting limit (RL) for lead as indicated on the Laboratory QA/QC summary report was 1 mg/kg, higher than the Practical Quantitation Limit (PQL) of 0.2 mg/kg listed in Table 5, Mine Waste Analytical Requirements in the QAPP. All lead results were much greater than the laboratory RL of 1, the higher RL will have no effect on the use of the data.

No field blanks were collected as none were required in the SAP or QAPP. Field duplicates were collected and analyzed using the XRF. No field duplicates were submitted to the laboratory.

Analytical methods and reporting limits (except as discussed above) as defined in the SAP and QAPP were met by the laboratory and are adequate to define mine waste materials in the Blackfoot River floodplain to aid in developing remediation options.

No additional samples were flagged due to the data validation and the results are accepted with the qualifications indicated. No data was rejected.

DATA VALIDATION REPORT FOR LABORATORY WORK ORDER H12100208
FLOODPLAIN INVESTIGATION,
UPPER BLACKFOOT MINING COMPLEX, MONTANA

Sample collection and analysis were consistent with the *Final Quality Assurance Project Plan* (QAPP) *for the Upper Blackfoot Mining Complex Design Investigations*, approved July 13, 2012. Tables D-11and D-12 (in this appendix) provide a listing of the samples discussed in this data validation report, laboratory information including, lab identification number, date sampled, the sample matrix, the analytical method, reporting units, the laboratory and data validation qualifiers associated with each sample, the reason for the qualifier, and the type and number of laboratory QA/QC samples. Table D-13 presents the laboratory data with the appropriate laboratory and data qualifiers.

Soil samples were collected by Pioneer Technical Services from August 15 through September 20, 2012 and analyzed using a Thermo Scientific Niton XL3T portable XRF unit. Fourteen confirmation samples were selected and hand delivered to Energy Laboratories, Inc. (Energy) in Helena, Montana on October 10, 2012. The temperature of the samples upon receipt by the laboratory was recorded at -0.9ºC which is just below the accepted temperature range of 4ºC (±2ºC) in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and Table 6 of the *Final Upper Blackfoot Mining Complex Sampling and Analysis Plan*. The samples were analyzed for aluminum, arsenic, cadmium, copper, iron, manganese, lead and zinc using ICP/MS. These elements are present in the sample matrix, a river gravel, as aluminum silicates, sulfides, oxides, and hydroxides, none of which are volatile within normal temperature ranges. Some oxidation may occur but this would not affect the total metal content. Based on professional judgment no qualification is necessary because of the temperature exceedance alone.

The Chain of Custody records from field to laboratory were complete and custody was maintained as evidenced by field and laboratory personnel signatures, dates, and times of receipt. It appears from the analytical report that all analytes were extracted and analyzed within the appropriate holding times.

Analytical results with laboratory and data qualifiers are presented in Table D-13 in this Appendix. The laboratory analytical reports are included in Appendix 1. Table D-11 in Appendix 1 presents the field sample number, the associated lab sample number, the analysis performed, the analytical method, the reporting units, any laboratory data qualifiers associated with the analysis, the assigned data validation qualifiers and reason for qualification. A description of the data qualifiers used in the table is included as Table D-1. Data validation was completed on March 18, 2013 by J. Flammang of Pioneer Technical Services.

Table D-12 in Appendix1 presents a summary of the Laboratory Quality Control/Quality Assurance samples that the laboratory ran for each sample batch and analysis. Included on the table is the analysis, the type and quantity of QA/QC samples and a description of the result if it was out of the laboratory control limits Results for continuing calibration verification samples were not reported, but are assumed to be acceptable as the laboratory did not report any calibration results that were outside of QC limits. As shown on Table D-12 the number of laboratory QA/QC samples met the requirements defined in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and the QAPP.

Sample H12100241-004 was identified by the laboratory as used to prepare the MS and MSD. This sample was not one of the samples submitted with this work order. The similarity of this sample matrix to the samples submitted cannot be evaluated with the information available.

The reporting limit (RL) for lead as indicated on the Laboratory QA/QC summary report was between 1 and 3.1 mg/kg, which is higher than the Practical Quantitation Limit (PQL) of 0.2 mg/kg listed in Table 5, Mine Waste Analytical Requirements in the QAPP. All lead results were more than 10 times greater than the highest laboratory RL of 3.1, the higher RL will have no effect on the use of the data.

No field blanks were collected as none were required in the SAP or QAPP. Field duplicates were collected and analyzed using the XRF. No field duplicates were submitted to the laboratory.

Analytical methods and reporting limits (except as discussed above) as defined in the SAP and QAPP were met by the laboratory and are adequate to define mine waste materials in the Blackfoot River floodplain to aid in developing remediation options.

No samples were qualified due to the data validation. No data was rejected.

DATA VALIDATION REPORT FOR LABORATORY WORK ORDER H12100328
FLOODPLAIN INVESTIGATION,
UPPER BLACKFOOT MINING COMPLEX, MONTANA

Sample collection and analysis were consistent with the *Final Quality Assurance Project Plan* (QAPP) *for the Upper Blackfoot Mining Complex Design Investigations*, approved July 13, 2012. Tables D-1, D-14, and D-15(in this appendix) provide a listing of the samples discussed in this data validation report, laboratory information including, lab identification number, date sampled, the sample matrix, the analytical method, reporting units, the laboratory and data validation qualifiers associated with each sample, the reason for the qualifier, and the type and number of laboratory QA/QC samples. Table D-16 presents the laboratory data with the appropriate laboratory and data qualifiers.

Soil samples were collected by Pioneer Technical Services from August 6 through September 25, 2012 and analyzed using a Thermo Scientific Niton XL3T portable XRF unit. Nine confirmation samples were selected and hand delivered to Energy Laboratories, Inc. (Energy) in Helena, Montana on October 18, 2012. The temperature of the samples upon receipt by the laboratory was recorded at 8.1ºC which is above the accepted temperature range of 4ºC (±2ºC) in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and Table 6 of the *Final Upper Blackfoot Mining Complex Sampling and Analysis Plan*. The samples were analyzed for aluminum, arsenic, cadmium, copper, iron, manganese, lead and zinc using ICP/MS. These elements are present in the sample matrix, a river gravel, as aluminum silicates, sulfides, oxides, and hydroxides, none of which are volatile within normal temperature ranges. Some oxidation may occur but this would not affect the total metal content. Based on professional judgment no qualification is necessary because of the temperature exceedance.

The Chain of Custody records from field to laboratory were complete and custody was maintained as evidenced by field and laboratory personnel signatures, dates, and times of receipt. It appears from the analytical report that all analytes were extracted and analyzed within the appropriate holding times.

Analytical results with laboratory and data qualifiers are presented in Table D-16 in this Appendix. The laboratory analytical reports are included in Appendix 1. Table D-14 in Appendix 1 presents the field sample number, the associated lab sample number, the analysis performed, the analytical method, the reporting units, any laboratory data qualifiers associated with the analysis, the assigned data validation qualifiers and reason for qualification. A description of the data qualifiers used in the table is included as Table D-1. Data validation was completed on March 18, 2013 by J. Flammang of Pioneer Technical Services.

Table D-15 in Appendix1 presents a summary of the Laboratory Quality Control/Quality Assurance samples that the laboratory ran for each sample batch and analysis. Included on the table is the analysis, the type and quantity of QA/QC samples and a description of the result if it was out of the laboratory control limits Results for continuing calibration verification samples were not reported, but are assumed to be acceptable as the laboratory did not report any calibration results that were outside of QC limits. As shown on Table D-15 the number of laboratory QA/QC samples met the requirements defined in the *EPA National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) and the QAPP.

Several of the laboratory QA/QC results that were outside of the laboratory control limits resulted in data qualifications as follows:

- Based on the laboratory matrix spike (MS) results (73% recovery), which were outside of laboratory control limits, all manganese concentrations reported above the method detection limit

(MDL) have been qualified as estimated low (J-). The matrix spike duplicate (MSD) recovery was 147%. Based on guidance in the EPA National Functional Guidelines for Inorganic Data Review "if the spiked sample analysis was performed on the same sample that was chosen for the duplicate sample analysis, spike calculations shall be performed using the results of the sample designated as the "original sample"". Samples have already been qualified as estimated low (J-) based on the MS sample.

- Based on a MS recovery outside of the laboratory control limits (155% recovery), all lead concentrations reported above the MDL have been qualified as estimated high (J+).
- Based on a spike result of the MSD sample outside of the laboratory control limits (195%), all zinc concentrations reported above the MDL have been qualified as estimated high (J+).

Field sample, TP-TS-02 (1.5-2), laboratory sample identification number H12100328-009 was used to prepare the MS and MSD. All samples were described as river gravel so this sample matrix was appropriate to use for the MS/MSD.

The reporting limit (RL) for lead as indicated on the Laboratory QA/QC summary report was 1 mg/kg, higher than the Practical Quantitation Limit (PQL) of 0.2 mg/kg listed in Table 5, Mine Waste Analytical Requirements in the QAPP. All lead results were greater than 10 times the laboratory RL of 1, the higher RL will have no effect on the use of the data.

No field blanks were collected as none were required in the SAP or QAPP. Field duplicates were collected and analyzed using the XRF. No field duplicates were submitted to the laboratory.

Analytical methods and reporting limits (except as discussed above) as defined in the SAP and QAPP were met by the laboratory and are adequate to define mine waste materials in the Blackfoot River floodplain to aid in developing remediation options.

No additional samples were flagged due to the data validation and the results are accepted with the qualifications indicated. No data was rejected.

REFERENCES

EPA, 2010. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, OSWER 9240.1-51, USEPA-540-R-10-011, January 2010.

TABLE-1	
List of Data Qualifiers	
Upper Blackfoot Mining Complex Floodplain Investigation	
Code	**Definition**
U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
RL	Analyte Reporting Limit
ND	Not detected at the reporting limit
D	RL increased due to sample matrix.

TABLE-2
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12090089
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	TotalAluminum (Al)	SW6010B	mg/kg		
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	Total Arsenic (As)	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	Total Cadmium (Cd)	SW6010B	mg/kg		
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	Total Copper (Cu)	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	Total Iron (Fe)	SW6010B	mg/kg		
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	Total Manganese (Mn)	SW6010B	mg/kg		
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	Total Lead (Pb)	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-05(6.0-7.0)	H12090089-001	7/24/2012	Solid	Total Zinc (Zn)	SW6010B	mg/kg		
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	As	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	Pb	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-06(7-8.0)	H12090089-002	7/24/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	As	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	Pb	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-08(2.4-2.9)	H12090089-003	7/25/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	As	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	Pb	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-09(3.2-3.3)	H12090089-004	7/25/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	As	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	Pb	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-10A(2.1-2.6)	H12090089-005	7/26/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	As	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	Pb	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-13(2.4-2.7)	H12090089-006	7/30/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	As	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	Pb	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-15(0-0.2)	H12090089-007	7/30/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	As	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	Pb	SW6010B	mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low (J-)
Energy	H12090089	TP-FP-15A(8.5-9.0)	H12090089-008	7/31/2012	Solid	Zn	SW6010B	mg/kg		

mg/kg - milligram per kilogram
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - Relative Percent Difference
MDL - Method Detection Limit as provided by the laboratory

TABLE-3
Summary of Laboratory QA/QC Sample Results by Analyte for Laboratory Work Order H12090089
Upper Blackfoot Mining Complex Floodplain Investigation

Work Order Number	Date Analyzed	Analysis	Analytical Method	Units	Type of QA/QC	# of QA/QC Samples	Laboratory Result	Data Validation Qualifiers/Reason
H12090089	9/12/2012	Total Aluminum (Al)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Aluminum (Al)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Aluminum (Al)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Aluminum (Al)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Aluminum (Al)	SW6010B	mg/kg	MB	1	Detected at 0.5, RL - 0.3, PQL - 1	No qualification required, all results greater than 10X the Blank results
H12090089	9/12/2012	Total Aluminum (Al)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Aluminum (Al)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Aluminum (Al)	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Aluminum (Al)	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Aluminum (Al)	SW6010B	mg/kg	RPD	1		
H12090089	9/13/2012	TotalAluminum (Al)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Arsenic (As)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Arsenic (As)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Arsenic (As)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Arsenic (As)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Arsenic (As)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Arsenic (As)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Arsenic (As)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Arsenic (As)	SW6010B	mg/kg	MS	1	Spike recovery was outside of advisory limit, 69%	Qualify affected results that are ≥MDL as estimated low (J-) and affected non-
H12090089	9/12/2012	Total Arsenic (As)	SW6010B	mg/kg	MSD	1		
H12090089	9/12/2012	Total Arsenic (As)	SW6010B	mg/kg	RPD	1		
H12090089	9/13/2012	Total Arsenic (As)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Cadmium (Cd)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Cadmium (Cd)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Cadmium (Cd)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Cadmium (Cd)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Cadmium (Cd)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Cadmium (Cd)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Cadmium (Cd)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Cadmium (Cd)	SW6010B	mg/kg	MS	1		
H12090089	9/12/2012	Total Cadmium (Cd)	SW6010B	mg/kg	MSD	1		
H12090089	9/12/2012	Total Cadmium (Cd)	SW6010B	mg/kg	RPD	1		
H12090089	9/13/2012	Total Cadmium (Cd)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Copper (Cu)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Copper (Cu)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Copper (Cu)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Copper (Cu)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Copper (Cu)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Copper (Cu)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Copper (Cu)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Copper (Cu)	SW6010B	mg/kg	MS	1	Spike recovery was outside of advisory limit, 65%	Qualify affected results that are ≥MDL as estimated low (J-) and affected non-
H12090089	9/12/2012	Total Copper (Cu)	SW6010B	mg/kg	MSD	1		
H12090089	9/12/2012	Total Copper (Cu)	SW6010B	mg/kg	RPD	1		
H12090089	9/13/2012	Total Copper (Cu)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Iron (Fe)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Iron (Fe)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Iron (Fe)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Iron (Fe)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Iron (Fe)	SW6010B	mg/kg	MB	1	Reported at 2, RL-0.7, PQL - 5	No qualification required, all results greater than 10X the Blank results
H12090089	9/12/2012	Total Iron (Fe)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Iron (Fe)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Iron (Fe)	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Iron (Fe)	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Iron (Fe)	SW6010B	mg/kg	RPD	1		

H12090089	9/13/2012	Total Iron (Fe)	SW6010B	mg/kg	MB	1	Reported at 0.9, RL-0.7, PQL-5	No qualification required, all results greater than 10X the Blank results
H12090089	9/12/2012	Total Manganese (Mn)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Manganese (Mn)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Manganese (Mn)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Manganese (Mn)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Manganese (Mn)	SW6010B	mg/kg	MB	1	Reported at 0.05, RL - 0.04,PQL-10	No qualification required, all results greater than 10X the Blank results
H12090089	9/12/2012	Total Manganese (Mn)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Manganese (Mn)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Manganese (Mn)	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Manganese (Mn)	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Manganese (Mn)	SW6010B	mg/kg	RPD	1		
H12090089	9/13/2012	Total Manganese (Mn)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Lead (Pb)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Lead (Pb)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Lead (Pb)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Lead (Pb)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Lead (Pb)	SW6010B	mg/kg	MB	1		
H12090089	9/12/2012	Total Lead (Pb)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Lead (Pb)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Lead (Pb)	SW6010B	mg/kg	MS	1	Spike recovery was outside of advisory limit, 36%	as estimated low (J-) and affected non-detects as estimated (UJ)
H12090089	9/12/2012	Total Lead (Pb)	SW6010B	mg/kg	MSD	1		
H12090089	9/12/2012	Total Lead (Pb)	SW6010B	mg/kg	RPD	1		
H12090089	9/13/2012	Total Lead (Pb)	SW6010B	mg/kg	MB	1	Reported at 1, RL-1, PQL - 0.2	No qualification required, all results greater than 10X the Blank results
H12090089	9/12/2012	Total Zinc (Zn)	E200.7	mg/L	ICV	1		
H12090089	9/12/2012	Total Zinc (Zn)	E200.7	mg/L	ICS	2		
H12090089	9/13/2012	Total Zinc (Zn)	E200.7	mg/L	ICV	1		
H12090089	9/13/2012	Total Zinc (Zn)	E200.7	mg/L	ICS	2		
H12090089	9/12/2012	Total Zinc (Zn)	SW6010B	mg/kg	MB	1	Reported at 0.3, RL - 0.1, PQL - 2	No qualification required, all results greater than 10X the Blank results
H12090089	9/12/2012	Total Zinc (Zn)	SW6010B	mg/kg	LFB	1		
H12090089	9/12/2012	Total Zinc (Zn)	SW6010B	mg/kg	LCS	1		
H12090089	9/12/2012	Total Zinc (Zn)	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Zinc (Zn)	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090089	9/12/2012	Total Zinc (Zn)	SW6010B	mg/kg	RPD	1		
H12090089	9/13/2012	Total Zinc (Zn)	SW6010B	mg/kg	MB	1	Reported at 0.2, RL- 0.1, PQL - 2	No qualification required, all results greater than 10X the Blank results

mg/L - milligrams per Liter
mg/kg - killigrams per killigram
ICV - Initial Calibration Verification Sample
ICS - Interference Check Samples
MB - Method Blank
LFB - Laboratory Fortified Blank
LCS - Laboratory Control Sample
MS - Matrix Spike Sample
MSD - Matrix Spike Duplicate Sample
RPD -Relative Percent Difference
RL - Reporting Limit
PQL - Practical Quantitaion Limit as Indicated in the QAPP
MDL - Method Detection Limit as provided by the laboratory

TABLE-4
Analytical Data For Laboratory Analytical Work Order H12090089 With Validation Qualifiers
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory Sample Identification	Field Sample Number	Aluminum (mg/kg)	LQ	DVQ	Arsenic (mg/kg)	LQ	DVQ	Cadmium (mg/kg)	LQ	DVQ	Copper (mg/kg)	LQ	DVQ	Iron (mg/kg)	LQ	DVQ	Manganese (mg/kg)	LQ	DVQ	Lead (mg/kg)	LQ	DVQ	Zinc (mg/kg)	LQ	DVQ
H1209089-001	TP-FP-05(6.0-7.0)	8310			138		J-	34.5			860		J-	46900			4570			6750		J-	5630		
H12090089-002	TP-FP-06(7-8.0)	9100			117		J-	26.9			505		J-	48400			2540			5330		J-	4500		
H12090089-003	TP-FP-08(2.4-2.9)	11100			215		J-	35.6			1600		J-	110000			701			2220		J-	6870		
H12090089-004	TP-FP-09(3.2-3.3)	10100			283		J-	120			2170		J-	106000			1590			2940		J-	5610		
H12090089-005	TP-FP-10A(2.1-2.6)	13000			39		J-	2.9			179		J-	28200			1850			205		J-	504		
H12090089-006	TP-FP-13(2.4-2.7)	12100			88		J-	1.9			169		J-	55000			1060			287		J-	403		
H12090089-007	TP-FP-15(0-0.2)	9360			157		J-	4.8			254		J-	60200			3370			1160		J-	835		
H12090089-008	TP-FP-15A(8.5-9.0)	14400			39		J-	1.3			114		J-	29000			2560			184		J-	357		

mg/kg - milligram per kilogram
LQ - Laboratory Designated Data Qualifier
DVQ - Data Validation Applied Data Qualifier
J- - The result is an estimated quantity, but the result may be biased low.

TABLE-5
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12090382
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	TotalAluminum (Al)	SW6010B	mg/kg		
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	Total Arsenic (As)	SW6010B	mg/kg		
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	Total Cadmium (Cd)	SW6010B	mg/kg		
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	Total Copper (Cu)	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	Total Iron (Fe)	SW6010B	mg/kg		
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	Total Manganese (Mn)	SW6010B	mg/kg		
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	Total Lead (Pb)	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-16(11.5-12)	H12090382-001	7/31/2012	Solid	Total Zinc (Zn)	SW6010B	mg/kg		
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	As	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-18(0.6-0.8)	H12090382-002	7/31/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	As	SW6010B	mg/kg		
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-19(1.8-2.4)	H12090382-003	7/31/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	As	SW6010B	mg/kg		
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-20(8-8.5)	H12090382-004	8/1/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	As	SW6010B	mg/kg		
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-21(10-10.5)	H12090382-005	8/1/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	As	SW6010B	mg/kg		
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	Cd	SW6010B	mg/kg		

TABLE-5
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12090382
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	Fe	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-25(0.4-0.9)	H12090382-006	8/2/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	As	SW6010B	mg/kg		
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-26(4-4.5)	H12090382-007	8/2/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	As	SW6010B	mg/kg		
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-27(6.5-7)	H12090382-008	8/2/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	As	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	Cd	SW6010B	mg/kg	ND	
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-28(9-9.5)	H12090382-009	8/6/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	As	SW6010B	mg/kg		
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	Cu	SW6010B	mg/kg		J-, Based on MS/MSD results, qualify results that are ≥ MDL as estimated low(J-)
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	Pb	SW6010B	mg/kg	D	
Energy	H12090382	TP-FP-30(10-10.5)	H12090382-010	8/7/2012	Solid	Zn	SW6010B	mg/kg		

mg/kg - milligram per kilogram
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - Relative Percent Difference
MDL - Method Detection Limit as provided by the laboratory
D - RL increased due to sample matrix
ND - Not detected at the reporting limit

TABLE-6
Summary of Laboratory QA/QC Sample Results by Analyte for Laboratory Work Order H12090382
Upper Blackfoot Mining Complex Floodplain Investigation

Work Order Number	Date Analyzed	Analysis	Analytical Method	Units	Type of QA/QC	# of QA/QC Samples	Laboratory Result*	Qualification Needed?
H12090382	10/1/2012	Aluminum	E200.7	mg/L	ICV	2		
H12090382	10/1/2012	Aluminum	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Aluminum	SW6010B	mg/kg	MB	1	Detected at 0.9, RL is 0.3, PQL is 1	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/2/2012	Aluminum	SW6010B	mg/kg	LFB	1		
H12090382	10/2/2012	Aluminum	SW6010B	mg/kg	LCS	1		
H12090382	10/2/2012	Aluminum	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Aluminum	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Aluminum	SW6010B	mg/kg	RPD	1		
H12090382	10/3/2012	Aluminum	SW6010B	mg/kg	MB	1	Detected at 0.9, RL is 0.3, PQL is 1	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/3/2012	Aluminum	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Aluminum	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Aluminum	SW6010B	mg/kg	RPD	1		
H12090382	10/1/2012	Arsenic	E200.7	mg/L	ICV	2		
H12090382	10/1/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Arsenic	E200.7	mg/L	ICV	2		
H12090382	10/2/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/4/2012	Arsenic	E200.7	mg/L	ICV	2		
H12090382	10/4/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12090382	10/2/2012	Arsenic	SW6010B	mg/kg	LFB	1		

H12090382	10/2/2012	Arsenic	SW6010B	mg/kg	LCS	1		
H12090382	10/2/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12090382	10/2/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12090382	10/2/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12090382	10/3/2012	Arsenic	SW6010B	mg/kg	MB	1	Detected at 0.7, RL is 0.4, PQL is 0.5	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/3/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12090382	10/3/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12090382	10/3/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12090382	10/4/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12090382	10/4/2012	Arsenic	SW6010B	mg/kg	LFB	1		
H12090382	10/4/2012	Arsenic	SW6010B	mg/kg	LCS	1		
H12090382	10/4/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12090382	10/4/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12090382	10/4/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12090382	10/1/2012	Cadmium	E200.7	mg/L	ICV	2		
H12090382	10/1/2012	Cadmium	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/4/2012	Cadmium	E200.7	mg/L	ICV	2		
H12090382	10/4/2012	Cadmium	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12090382	10/2/2012	Cadmium	SW6010B	mg/kg	LFB	1		
H12090382	10/2/2012	Cadmium	SW6010B	mg/kg	LCS	1		
H12090382	10/2/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12090382	10/2/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12090382	10/2/2012	Cadmium	SW6010B	mg/kg	RPD	1		
H12090382	10/3/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12090382	10/3/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12090382	10/3/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12090382	10/3/2012	Cadmium	SW6010B	mg/kg	RPD	1		
H12090382	10/1/2012	Copper	E200.7	mg/L	ICV	2		
H12090382	10/1/2012	Copper	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Copper	SW6010B	mg/kg	MB	1		
H12090382	10/2/2012	Copper	SW6010B	mg/kg	LFB	1		
H12090382	10/2/2012	Copper	SW6010B	mg/kg	LCS	1		
H12090382	10/2/2012	Copper	SW6010B	mg/kg	MS	1	Spike recovery outside of advisory limits, 61%	Affected results that are ≥ MDL qualified as estimated low (J-)
H12090382	10/2/2012	Copper	SW6010B	mg/kg	MSD	1	Spike recovery outside of advisory limits, 74%	Affected results that are ≥ MDL qualified as estimated low (J-)
H12090382	10/2/2012	Copper	SW6010B	mg/kg	RPD	1		
H12090382	10/3/2012	Copper	SW6010B	mg/kg	MB	1		
H12090382	10/3/2012	Copper	SW6010B	mg/kg	MS	1	Spike recovery outside of advisory limits, 59%	Affected results that are ≥ MDL qualified as estimated low (J-)
H12090382	10/3/2012	Copper	SW6010B	mg/kg	MSD	1	Spike recovery outside of advisory limits, 74%	Affected results that are ≥ MDL qualified as estimated low (J-)

H12090382	10/3/2012	Copper	SW6010B	mg/kg	RPD	1		
H12090382	10/1/2012	Iron	E200.7	mg/L	ICV	2		
H12090382	10/1/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Iron	E200.7	mg/L	ICV	2		
H12090382	10/2/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 2, RL is 0.7, PQL is 5	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/2/2012	Iron	SW6010B	mg/kg	LFB	1		
H12090382	10/2/2012	Iron	SW6010B	mg/kg	LCS	1		
H12090382	10/2/2012	Iron	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Iron	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Iron	SW6010B	mg/kg	RPD	1		
H12090382	10/3/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 2, RL is 0.7, PQL is 5	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/3/2012	Iron	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Iron	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Iron	SW6010B	mg/kg	RPD	1		
H12090382	10/10/2012	Lead	E200.7	mg/L	ICV	2		
H12090382	10/10/2012	Lead	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/10/2012	Lead	SW6010B	mg/kg	MB	1		
H12090382	10/10/2012	Lead	SW6010B	mg/kg	LFB	1		
H12090382	10/10/2012	Lead	SW6010B	mg/kg	LCS	1		
H12090382	10/10/2012	Lead	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/10/2012	Lead	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias

H12090382	10/10/2012	Lead	SW6010B	mg/kg	RPD	1	RPD was 30% ,outside of laboratory control limits	The QAPP indicates that the upper control limit for duplicate soil sample RPD is 35%, no qualification is necessary.
H12090382	10/1/2012	Manganese	E200.7	mg/L	ICV	2		
H12090382	10/1/2012	Manganese	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/4/2012	Manganese	E200.7	mg/L	ICV	2		
H12090382	10/4/2012	Manganese	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Manganese	SW6010B	mg/kg	MB	1	Detected at 0.07, RL is 0.04, PQL is 10	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/2/2012	Manganese	SW6010B	mg/kg	LFB	1		
H12090382	10/2/2012	Manganese	SW6010B	mg/kg	LCS	1		
H12090382	10/2/2012	Manganese	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Manganese	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Manganese	SW6010B	mg/kg	RPD	1		
H12090382	10/3/2012	Manganese	SW6010B	mg/kg	MB	1		
H12090382	10/3/2012	Manganese	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Manganese	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Manganese	SW6010B	mg/kg	RPD	1		
H12090382	10/4/2012	Manganese	SW6010B	mg/kg	MB	1	Detected at 0.04, Rl is 0.04, PQL is 10	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/4/2012	Manganese	SW6010B	mg/kg	LFB	1		
H12090382	10/4/2012	Manganese	SW6010B	mg/kg	LCS	1		
H12090382	10/4/2012	Manganese	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/4/2012	Manganese	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias

H12090382	10/4/2012	Manganese	SW6010B	mg/kg	RPD	1		
H12090382	10/1/2012	Zinc	E200.7	mg/L	ICV	2		
H12090382	10/1/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/4/2012	Zinc	E200.7	mg/L	ICV	2		
H12090382	10/4/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/10/2012	Zinc	E200.7	mg/L	ICV	2		
H12090382	10/10/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12090382	10/2/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.2, RL is 0.1, PQL is2	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/2/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12090382	10/2/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12090382	10/2/2012	Zinc	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Zinc	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/2/2012	Zinc	SW6010B	mg/kg	RPD	1		
H12090382	10/3/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.2, RL is 0.1, PQL is2	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/3/2012	Zinc	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Zinc	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/3/2012	Zinc	SW6010B	mg/kg	RPD	1		
H12090382	10/4/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.1, RL is 0.1, PQL is2	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/4/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12090382	10/4/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12090382	10/4/2012	Zinc	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias

H12090382	10/4/2012	Zinc	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/4/2012	Zinc	SW6010B	mg/kg	RPD	1		
H12090382	10/10/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.3, RL is 0.1, PQL is2	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12090382	10/10/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12090382	10/10/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12090382	10/10/2012	Zinc	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/10/2012	Zinc	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12090382	10/10/2012	Zinc	SW6010B	mg/kg	RPD	1		

mg/L - milligrams per Liter
mg/kg - killigrams per killigram
ICV - Initial Calibration Verification Sample
ICS - Interference Check Samples
MB - Method Blank
LFB - Laboratory Fortified Blank
LCS - Laboratory Control Sample
MS - Matrix Spike Sample
MSD - Matrix Spike Duplicate Sample
RPD -Relative Percent Difference
RL - Reporting Limit
PQL - Practical Quantitaion Limit as Indicated in the QAPP
MDL - Method Detection Limit as provided by the laboratory

TABLE-7
Analytical Data For Laboratory Analytical Work Order H12090382 with Validation Qualifiers
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory Sample Identification	Field Sample Number	Aluminum (mg/kg)	LQ	DVQ	Arsenic (mg/kg)	LQ	DVQ	Cadmium (mg/kg)	LQ	DVQ	Copper (mg/kg)	LQ	DVQ	Iron (mg/kg)	LQ	DVQ	Lead (mg/kg)	LQ	DVQ	Manganese (mg/kg)	LQ	DVQ	Zinc (mg/kg)	LQ	DVQ
H12090382-001	TP-FP-16(11.5-12)	8000			47			9			164		J-	25000			381	D		3710			1010		
H12090382-002	TP-FP-18(0.6-0.8)	9010			174	D		11			1060		J-	54800			6470	D		5090			2690		
H12090382-003	TP-FP-19(1.8-2.4)	9910			24			7			125		J-	23800			76	D		1460			849		
H12090382-004	TP-FP-20(8-8.5)	8220			59			11			344		J-	28100			2030	D		3260			1340		
H12090382-005	TP-FP-21(10-10.5)	11600			22			6			139		J-	21000			568	D		833			1200		
H12090382-006	TP-FP-25(0.4-0.9)	3880			268			2			377		J-	116000	D		1730	D		421			860		
H12090382-007	TP-FP-26(4-4.5)	5780			223			56			786		J-	76200			5520	D		9980			6190		
H12090382-008	TP-FP-27(6.5-7)	13100			17			3			89		J-	19800			182	D		1240			561		
H12090382-009	TP-FP-28(9-9.5)	11200			19	D		ND			35		J-	19200			63	D		411			174		
H12090382-010	TP-FP-30(10-10.5)	12600			11			2			85		J-	23100			275	D		3890			345		

D - RL increased due to sample matrix
ND - Not detected at the reporting limit
mg/kg - milligram per kilogram
LQ - Laboratory Designated Data Qualifier
DVQ - Data Validation Applied Data Qualifier
J -The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+ - The result is an estimated quantity, but the result may be biased high.
J- - The result is an estimated quantity, but the result may be biased low.

TABLE-8
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H1210091
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	TotalAluminum (Al)	SW6010B	mg/kg		
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	Total Arsenic (As)	SW6010B	mg/kg		
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	Total Cadmium (Cd)	SW6010B	mg/kg		
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	Total Copper (Cu)	SW6010B	mg/kg		
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	Total Iron (Fe)	SW6010B	mg/kg		
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	Total Manganese (Mn)	SW6010B	mg/kg		
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	Total Lead (Pb)	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-32(0-0.4)	H12100091-001	8/7/2012	Solid	Total Zinc (Zn)	SW6010B	mg/kg		
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-33(8-8.5)	H12100091-002	8/7/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-35(0.5-0.7)	H12100091-003	8/8/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)

Energy	H12100091	TP-FP-36(3.5-4)	H12100091-004	8/13/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-37(11.5-12)	H12100091-005	8/14/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-38A(1-1.5)	H12100091-006	8/14/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-40(1.5-2)	H12100091-007	8/8/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-41(2-2.5)	H12100091-008	8/8/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	Mn	SW6010B	mg/kg		

Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-42(6.6-7)	H12100091-009	8/8/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-44(0-0.7)	H12100091-010	8/9/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-45(0.5-1)	H12100091-011	8/9/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-45A(0.8-1.2)	H12100091-012	8/13/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-46(8.5-9)	H12100091-013	8/16/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	Cu	SW6010B	mg/kg		

Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-48(1.5-2)	H12100091-014	8/15/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-49A(2.8-3.2)	H12100091-015	8/14/2012	Solid	Zn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	As	SW6010B	mg/kg		
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	Cd	SW6010B	mg/kg		
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	Cu	SW6010B	mg/kg		
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	Fe	SW6010B	mg/kg		
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	Mn	SW6010B	mg/kg		
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	Pb	SW6010B	mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100091	TP-FP-50(9-10)	H12100091-016	8/15/2012	Solid	Zn	SW6010B	mg/kg		

TABLE-9
Summary of Laboratory QA/QC Sample Results by Analyte for Laboratory Work Order H1210091
Upper Blackfoot Mining Complex Floodplain Investigation

Work Order Number	Date Analyzed	Analysis	Analytical Method	Units	Type of QA/QC	# of QA/QC Samples	Laboratory Result	Data Validation Qualifiers/Reason
H12100091	10/8/2012	Aluminum	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Aluminum	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Aluminum	SW6010B	mg/kg	MB	1		
H12100091	10/8/2012	Aluminum	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Aluminum	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Aluminum	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100091	10/8/2012	Aluminum	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100091	10/8/2012	Aluminum	SW6010B	mg/kg	RPD	1		
H12100091	10/10/2012	Aluminum	SW6010B	mg/kg	MB	1	Detected at 0.4, RL is 0.3, PQL = 1	No qualification required, all results greater than 10X the Blank results
H12100091	10/8/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12100091	10/8/2012	Arsenic	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Arsenic	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12100091	10/8/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12100091	10/8/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12100091	10/10/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12100091	10/8/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Cadmium	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12100091	10/8/2012	Cadmium	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Cadmium	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12100091	10/8/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12100091	10/8/2012	Cadmium	SW6010B	mg/kg	RPD	1		
H12100091	10/10/2012	Cadmium	SW6010B	mg/kg	MB	1		

H12100091	10/8/2012	Copper	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Copper	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Copper	SW6010B	mg/kg	MB	1		
H12100091	10/8/2012	Copper	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Copper	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Copper	SW6010B	mg/kg	MS	1		
H12100091	10/8/2012	Copper	SW6010B	mg/kg	MSD	1		
H12100091	10/8/2012	Copper	SW6010B	mg/kg	RPD	1		
H12100091	10/10/2012	Copper	SW6010B	mg/kg	MB	1		
H12100091	10/8/2012	Iron	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/9/2012	Iron	E200.7	mg/L	ICV	1		
H12100091	10/9/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 2, RL is 0.7, PQL is 5	No qualification required, all results greater than 10X the Blank results
H12100091	10/8/2012	Iron	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Iron	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Iron	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100091	10/8/2012	Iron	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100091	10/8/2012	Iron	SW6010B	mg/kg	RPD	1		
H12100091	10/10/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 2, RL is 0.7, PQL is 5	No qualification required, all results greater than 10X the Blank results
H12100091	10/8/2012	Lead	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Lead	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Lead	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Lead	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Lead	SW6010B	mg/kg	MB	1	Detected at 2, RL is 1, PQL is 0.2	No qualification required, all results greater than 10X the Blank results
H12100091	10/8/2012	Lead	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Lead	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Lead	SW6010B	mg/kg	MS	1	Spike recovery was outside of advisory limit, 131%	All results for PB above MDL, so affected results that are ≥MDL are qualified as estimated high (J+).
H12100091	10/8/2012	Lead	SW6010B	mg/kg	MSD	1	Spike recovery was outside of advisory limit, 63%	All samples originally flagged as J+, based on original sample.
H12100091	10/8/2012	Lead	SW6010B	mg/kg	RPD	1		

H12100091	10/10/2012	Lead	SW6010B	mg/kg	MB	1		
H12100091	10/8/2012	Manganese	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Manganese	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Manganese	SW6010B	mg/kg	MB	1	Detected at 0.05, RL is 0.04, PQL is 10	No qualification required, all results greater than 10X the Blank results
H12100091	10/8/2012	Manganese	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Manganese	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Manganese	SW6010B	mg/kg	MS	1		
H12100091	10/8/2012	Manganese	SW6010B	mg/kg	MSD	1		
H12100091	10/8/2012	Manganese	SW6010B	mg/kg	RPD	1		
H12100091	10/10/2012	Manganese	SW6010B	mg/kg	MB	1	Detected at 0.07, RL is 0.04, PQL is 10	No qualification required, all results greater than 10X the Blank results
H12100091	10/8/2012	Zinc	E200.7	mg/L	ICV	1		
H12100091	10/8/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12100091	10/8/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.2, RL is 0.1, PQL is 2	No qualification required, all results greater than 10X the Blank results
H12100091	10/8/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12100091	10/8/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12100091	10/8/2012	Zinc	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100091	10/8/2012	Zinc	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100091	10/8/2012	Zinc	SW6010B	mg/kg	RPD	1		
H12100091	10/10/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.2, RL is 0.1, PQL is 2	No qualification required, all results greater than 10X the Blank results

TABLE-10
Analytical Data For Laboratory Analytical Work Order H12100091 With Validation Qualifiers
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory Sample Identification	Field Sample Number	Aluminum (mg/kg)	LQ	DVQ	Arsenic (mg/kg)	LQ	DVQ	Cadmium (mg/kg)	LQ	DVQ	Copper (mg/kg)	LQ	DVQ	Iron (mg/kg)	LQ	DVQ	Manganese (mg/kg)	LQ	DVQ	Lead (mg/kg)	LQ	DVQ	Zinc (mg/kg)	LQ	DVQ
H12100091-001	TP-FP-32(0-0.4)	3140			230			8.3			563			89200			4140			1200		J+	1130		
H12100091-002	TP-FP-33(8-8.5)	11600			22			5			125			23100			1100			338		J+	1020		
H12100091-003	TP-FP-35(0.5-0.7)	15700			24			1.2			74			23400			1320			169		J+	297		
H12100091-004	TP-FP-36(3.5-4)	14400			24			12.8			136			27900			1350			126		J+	1460		
H12100091-005	TP-FP-37(11.5-12)	12900			14			5			114			23100			1300			142		J+	1040		
H12100091-006	TP-FP-38A(1-1.5)	7080			133			37.3			1620			50000			6740			12600		J+	6560		
H12100091-007	TP-FP-40(1.5-2)	13800			16			1			83			29300			513			152		J+	242		
H12100091-008	TP-FP-41(2-2.5)	11400			23			0.6			148			39400			1240			584		J+	183		
H12100091-009	TP-FP-42(6.6-7)	13700			18			5.3			232			28500			1340			104		J+	1010		
H12100091-010	TP-FP-44(0-0.7)	4060			429			38.7			3150			80500			6470			36100		J+	8690		
H12100091-011	TP-FP-45(0.5-1)	4260			342			78.6			3450			78800			7980			31700		J+	13200		
H12100091-012	TP-FP-45A(0.8-1.2)	18500			22			7			238			34400			2030			437		J+	1100		
H12100091-013	TP-FP-46(8.5-9)	10700			24			5.8			177			29200			1830			381		J+	1190		
H12100091-014	TP-FP-48(1.5-2)	7060			147			19.9			495			66000			4780			1120		J+	3160		
H12100091-015	TP-FP-49A(2.8-3.2)	10200			58			1.8			281			40800			3200			2490		J+	412		
H12100091-016	TP-FP-50(9-10)	19600			16			1.4			151			35800			241			145		J+	396		

mg/kg - milligram per kilogram
LQ - Laboratory Designated Data Qualifier
DVQ - Data Validation Applied Data Qualifier
J+ - The result is an estimated quantity, but the result may be biased high.

TABLE-11
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12100208
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	TotalAluminum (Al)	SW6010B	mg/kg		
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	Total Arsenic (As)	SW6010B	mg/kg		
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	Total Cadmium (Cd)	SW6010B	mg/kg		
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	Total Copper (Cu)	SW6010B	mg/kg		
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	Total Iron (Fe)	SW6010B	mg/kg		
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	Total Manganese (Mn)	SW6010B	mg/kg		
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	Total Lead (Pb)	SW6010B	mg/kg		
Energy	H12100208	TP-FP-50A(8.5-9)	H12100208-001	8/15/2012	Soil	Total Zinc (Zn)	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-05(1.8-2)	H12100208-002	8/29/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-19(1-2)	H12100208-003	9/13/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-25(0.5-1)	H12100208-004	9/11/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-09(6-7)	H12100208-005	9/20/2012	Soil	Zn	SW6010B	mg/kg		

Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-04(1-2)	H12100208-006	9/21/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-27(2-2.5)	H12100208-007	9/10/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-03(1.2)	H12100208-008	9/24/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-10B(1-2)	H12100208-009	9/20/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-15(3-3.7)	H12100208-010	9/19/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	Pb	SW6010B	mg/kg		

Energy	H12100208	TP-MS-11B(2-3)	H12100208-011	9/20/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-24(5.3-5.75)	H12100208-012	9/11/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-23(0-1.0)	H12100208-013	9/12/2012	Soil	Zn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	Al	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	As	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	Cd	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	Cu	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	Fe	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	Mn	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	Pb	SW6010B	mg/kg		
Energy	H12100208	TP-MS-11C(2-3.0) Dup1	H12100208-014	9/20/2012	Soil	Zn	SW6010B	mg/kg		

mg/kg - milligram per kilogram
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - Relative Percent Difference
MDL - Method Detection Limit as provided by the laboratory

TABLE-12
Summary of Laboratory QA/QC Sample Results by Analyte for Laboratory Work Order H12100208
Upper Blackfoot Mining Complex Floodplain Investigation

Work Order Number	Date Analyzed	Analysis	Analytical Method	Units	Type of QA/QC	# of QA/QC Samples	Laboratory Result	Qualification Needed?
H12100208	10/25/2012	Aluminum	E200.7	mg/L	ICV	1		
H12100208	10/25/2012	Aluminum	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/26/2012	Aluminum	SW6010B	mg/kg	MB	1	Detected at 0.6, RL is 0.3, PQL is 1	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/26/2012	Aluminum	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Aluminum	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Aluminum	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100208	10/26/2012	Aluminum	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100208	10/26/2012	Aluminum	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Aluminum	SW6010B	mg/kg	MB	1		
H12100208	10/30/2012	Aluminum	SW6010B	mg/kg	MB	1		
H12100208	10/24/2012	Arsenic	E200.7	mg/L	ICV	2		
H12100208	10/24/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/25/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100208	10/25/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/29/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100208	10/29/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/30/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100208	10/30/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/31/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100208	11/1/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100208	11/2/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100208	11/3/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100208	10/24/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12100208	10/24/2012	Arsenic	SW6010B	mg/kg	LFB	1		
H12100208	10/24/2012	Arsenic	SW6010B	mg/kg	LCS	1		
H12100208	10/24/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12100208	10/24/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12100208	10/24/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12100208	10/26/2012	Arsenic	SW6010B	mg/kg	MB	1		

H12100208	10/26/2012	Arsenic	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Arsenic	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12100208	10/26/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12100208	10/26/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12100208	10/30/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12100208	10/31/2012	Arsenic	SW6010B	mg/kg	MB	1	Detected at 0.04, RL is 0.006, PQL is 0.5	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/31/2012	Arsenic	SW6010B	mg/kg	LFB	1		
H12100208	10/31/2012	Arsenic	SW6010B	mg/kg	LCS	1		
H12100208	10/31/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12100208	10/31/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12100208	10/31/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12100208	10/24/2012	Cadmium	E200.7	mg/L	ICV	2		
H12100208	10/24/2012	Cadmium	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/25/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100208	10/25/2012	Cadmium	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/31/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100208	11/1/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100208	11/2/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100208	11/3/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100208	10/24/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12100208	10/24/2012	Cadmium	SW6010B	mg/kg	LFB	1		
H12100208	10/24/2012	Cadmium	SW6010B	mg/kg	LCS	1		
H12100208	10/24/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12100208	10/24/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12100208	10/24/2012	Cadmium	SW6010B	mg/kg	RPD	1		
H12100208	10/26/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12100208	10/26/2012	Cadmium	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Cadmium	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12100208	10/26/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12100208	10/26/2012	Cadmium	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12100208	10/30/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12100208	10/31/2012	Cadmium	SW6010B	mg/kg	MB	1	Detected at 0.04, RL is 0.003, PQL is 0.15	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/31/2012	Cadmium	SW6010B	mg/kg	LFB	1		
H12100208	10/31/2012	Cadmium	SW6010B	mg/kg	LCS	1		
H12100208	10/31/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12100208	10/31/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12100208	10/31/2012	Cadmium	SW6010B	mg/kg	RPD	1		

H12100208	10/25/2012	Copper	E200.7	mg/L	ICV	1		
H12100208	10/25/2012	Copper	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/26/2012	Copper	SW6010B	mg/kg	MB	1		
H12100208	10/26/2012	Copper	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Copper	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Copper	SW6010B	mg/kg	MS	1		
H12100208	10/26/2012	Copper	SW6010B	mg/kg	MSD	1		
H12100208	10/26/2012	Copper	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Copper	SW6010B	mg/kg	MB	1		
H12100208	10/30/2012	Copper	SW6010B	mg/kg	MB	1		
H12100208	10/24/2012	Iron	E200.7	mg/L	ICV	2		
H12100208	10/24/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/25/2012	Iron	E200.7	mg/L	ICV	1		
H12100208	10/25/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/29/2012	Iron	E200.7	mg/L	ICV	1		
H12100208	10/29/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/30/2012	Iron	E200.7	mg/L	ICV	1		
H12100208	10/30/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/24/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 4, RL is 0.4, PQL is 5	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/24/2012	Iron	SW6010B	mg/kg	LFB	1		
H12100208	10/24/2012	Iron	SW6010B	mg/kg	LCS	1		
H12100208	10/24/2012	Iron	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100208	10/24/2012	Iron	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100208	10/24/2012	Iron	SW6010B	mg/kg	RPD	1		
H12100208	10/26/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 4, RL is 0.7, PQL is 5	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/26/2012	Iron	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Iron	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Iron	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100208	10/26/2012	Iron	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100208	10/26/2012	Iron	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 4, RL is 0.7, PQL is 5	No Qualification necessary, all results greater than 10X the blank result

H12100208	10/30/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 4, RL is 0.7, PQL is 5	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/24/2012	Lead	E200.7	mg/L	ICV	2		
H12100208		Lead	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/25/2012	Lead	E200.7	mg/L	ICV	1		
H12100208		Lead	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/24/2012	Lead	SW6010B	mg/kg	MB	1		
H12100208	10/24/2012	Lead	SW6010B	mg/kg	LFB	1		
H12100208	10/24/2012	Lead	SW6010B	mg/kg	LCS	1		
H12100208	10/24/2012	Lead	SW6010B	mg/kg	MS	1		
H12100208	10/24/2012	Lead	SW6010B	mg/kg	MSD	1		
H12100208	10/24/2012	Lead	SW6010B	mg/kg	RPD	1		
H12100208	10/26/2012	Lead	SW6010B	mg/kg	MB	1		
H12100208	10/26/2012	Lead	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Lead	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Lead	SW6010B	mg/kg	MS	1		
H12100208	10/26/2012	Lead	SW6010B	mg/kg	MSD	1		
H12100208	10/26/2012	Lead	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Lead	SW6010B	mg/kg	MB	1		
H12100208	10/30/2012	Lead	SW6010B	mg/kg	MB	1		
H12100208	10/25/2012	Manganese	E200.7	mg/L	ICV	1		
H12100208	10/25/2012	Manganese	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/26/2012	Manganese	SW6010B	mg/kg	MB	1		
H12100208	10/26/2012	Manganese	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Manganese	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Manganese	SW6010B	mg/kg	MS	1		
H12100208	10/26/2012	Manganese	SW6010B	mg/kg	MSD	1		
H12100208	10/26/2012	Manganese	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Manganese	SW6010B	mg/kg	MB	1	Detected at 0.04, RL is 0.04, PQL is 10	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/30/2012	Manganese	SW6010B	mg/kg	MB	1	Detected at 0.08, RL is 0.04, PQL is 10	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/24/2012	Zinc	E200.7	mg/L	ICV	2		
H12100208	10/24/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/25/2012	Zinc	E200.7	mg/L	ICV	1		
H12100208	10/25/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12100208	10/24/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.2, RL is 0.1, PQL is 2	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/24/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12100208	10/24/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12100208	10/24/2012	Zinc	SW6010B	mg/kg	MS	1		
H12100208	10/24/2012	Zinc	SW6010B	mg/kg	MSD	1		
H12100208	10/24/2012	Zinc	SW6010B	mg/kg	RPD	1		

H12100208	10/26/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.3, RL is 0.1, PQL is 2	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/26/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12100208	10/26/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12100208	10/26/2012	Zinc	SW6010B	mg/kg	MS	1		
H12100208	10/26/2012	Zinc	SW6010B	mg/kg	MSD	1		
H12100208	10/26/2012	Zinc	SW6010B	mg/kg	RPD	1		
H12100208	10/29/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.2, RL is 0.1, PQL is 2	No Qualification necessary, all results greater than 10X the blank result
H12100208	10/30/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.3, RL is 0.1, PQL is 2	No Qualification necessary, all results greater than 10X the blank result

mg/L - milligrams per Liter
mg/kg - killigrams per killigram
ICV - Initial Calibration Verification Sample
ICS - Interference Check Samples
MB - Method Blank
LFB - Laboratory Fortified Blank
LCS - Laboratory Control Sample
MS - Matrix Spike Sample
MSD - Matrix Spike Duplicate Sample
RPD -Relative Percent Difference
RL - Reporting Limit
PQL - Practical Quantitaion Limit as Indicated in the QAPP
MDL - Method Detection Limit as provided by the laboratory

TABLE-13
Analytical Data For Laboratory Work Order H12100208 With Validation Qualifiers
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory Sample Identification	Sample Number	Aluminum (mg/kg)	LQ	DVQ	Arsenic (mg/kg)	LQ	DVQ	Cadmium (mg/kg)	LQ	DVQ	Copper (mg/kg)	LQ	DVQ	Iron (mg/kg)	LQ	DVQ	Manganese (mg/kg)	LQ	DVQ	Lead (mg/kg)	LQ	DVQ	Zinc (mg/kg)	LQ	DVQ
H12100208-001	TP-FP-50A(8.5-9)	21000			12			<0.2			167			44200			380			52			35		
H12100208-002	TP-MS-05(1.8-2)	12400			19			0.6			155			27200			212			85			191		
H12100208-003	TP-MS-19(1-2)	17600			15			<0.2			98			106000			107			94			103		
H12100208-004	TP-MS-25(0.5-1)	18500			76			24			1500			39000			5480			4160			3900		
H12100208-005	TP-MS-09(6-7)	22700			6			1.1			214			16500			129			161			261		
H12100208-006	TP-MS-04(1-2)	16800			69			8.2			327			32900			1890			1230			1300		
H12100208-007	TP-MS-27(2-2.5)	21500			19			1.2			253			24800			226			134			345		
H12100208-008	TP-MS-03(1-2)	4340			214			12.2			458			87500			9240			1120			2100		
H12100208-009	TP-MS-10B(1-2)	8080			179			33.4			690			65600			11100			2310			4840		
H12100208-010	TP-MS-15(3-3.7)	17200			18			0.7			108			22700			133			145			192		
H12100208-011	TP-MS-11B(2-3)	21700			21			3.4			229			19600			238			288			687		
H12100208-012	TP-MS-24(5.3-5.75)	17100			9			1.1			367			25400			125			278			507		
H12100208-013	TP-MS-23(0-1.0)	18500			33			2.5			186			68100			1230			177			550		
H12100208-014	TP-MS-11C(2-3.0)DUP1	17200			15			6.3			208			20700			441			305			1060		

mg/kg - milligram per kilogram
LQ - Laboratory Designated Data Qualifier
DVQ - Data Validation Applied Data Qualifier

TABLE-14
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12100328
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	TotalAluminum (Al)	SW6010B	mg/kg		
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	Total Arsenic (As)		mg/kg		
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	Total Cadmium (Cd)		mg/kg		
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	Total Copper (Cu)		mg/kg		
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	Total Iron (Fe)		mg/kg		
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	Total Manganese (Mn)		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	Total Lead (Pb)		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-MS-16 (0.1-0.2)	H12100328-001	9/13/2012	Solid	Total Zinc (Zn)		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	As		mg/kg		
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	Cd		mg/kg		
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	Cu		mg/kg		
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	Fe		mg/kg		
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)

TABLE-14
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12100328
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-MS-07 (2.75-3.5)	H12100328-002	9/24/2012	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	As		mg/kg		
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	Cd		mg/kg		
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	Cu		mg/kg		
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	Fe		mg/kg		
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-FP-53 (9.5-10.0)	H12100328-003	8/27/2012	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	As		mg/kg		
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	Cd		mg/kg		
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	Cu		mg/kg		

TABLE-14
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12100328
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	Fe		mg/kg		
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-MS-04A (1-2.0)	H12100328-004	9/21/2012	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	As		mg/kg		
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	Cd		mg/kg		
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	Cu		mg/kg		
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	Fe		mg/kg		
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-FP-55 (.6-1)	H12100328-005	8/28/2012	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).

TABLE-14
Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12100328
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	As		mg/kg		
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	Cd		mg/kg		
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	Cu		mg/kg		
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	Fe		mg/kg		
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-FP-57 (0.5-1.0)	H12100328-006	9/25/2012	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	As		mg/kg		
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	Cd		mg/kg		
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	Cu		mg/kg		
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	Fe		mg/kg		
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-FP-58 (6-6.5)	H12100328-007	8/28/2023	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).

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Laboratory and Analytical Information By Sample Number for Laboratory Analytical Work Order H12100328
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory	Work Order Number	Field Sample Number	Laboratory Sample Number	Date Sampled	Matrix	Analysis	Analytical Method	Reporting Units	Laboratory Qualifiers	Data Validation Qualifiers/Reason
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	As		mg/kg		
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	Cd		mg/kg		
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	Cu		mg/kg		
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	Fe		mg/kg		
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-FP-59 (12-12.5)	H12100328-008	8/28/2012	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	Al	SW6010B	mg/kg		
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	As		mg/kg		
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	Cd		mg/kg		
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	Cu		mg/kg		
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	Fe		mg/kg		
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	Mn		mg/kg		J-, Based on MS results, qualify affected results that are ≥ MDL as estimated low(J-)
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	Pb		mg/kg		J+, Based on MS results, qualify affected results that are ≥ MDL as estimated high(J+)
Energy	H12100328	TP-TS-02 (1.5-2)	H12100328-009	8/6/2012	Solid	Zn		mg/kg		J+,Based on MS/MSD results, qualify affected results that are ≥ MDL as estimated high (J+).

mg/kg - milligram per kilogram
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - Relative Percent Difference
MDL - Method Detection Limit as provided by the laboratory

TABLE-15
Summary of Laboratory QA/QC Sample Results by Analyte for Laboratory Work Order H12100328
Upper Blackfoot Mining Complex Floodplain Investigation

Work Order Number	Date Analyzed	Analysis	Analytical Method	Units	Type of QA/QC	# of QA/QC Samples	Laboratory Result	Data Validation Qualifiers/Reason
H12100328	10/29/2012	Aluminum	E200.7	mg/L	ICV	1		
H12100328	10/29/2012	Aluminum	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/29/2012	Aluminum	SW6010B	mg/kg	MB	1	Detected at 0.5, RI is 0.3, PQL is 1	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12100328	10/29/2012	Aluminum	SW6010B	mg/kg	LFB	1		
H12100328	10/29/2012	Aluminum	SW6010B	mg/kg	LCS	1		
H12100328	10/29/2012	Aluminum	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100328	10/29/2012	Aluminum	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100328	10/29/2012	Aluminum	SW6010B	mg/kg	RPD	1		
H12100328	10/30/2012	Aluminum	SW6010B	mg/kg	MB	1	Detected at 0.4, RL is 0.3, PQL is 1	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12100328	10/30/2012	Aluminum	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Aluminum	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Aluminum	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100328	10/30/2012	Aluminum	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100328	10/30/2012	Aluminum	SW6010B	mg/kg	RPD	1		
H12100328	10/30/2012	Arsenic	E200.7	mg/L	ICV	1		
H12100328	10/30/2012	Arsenic	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/30/2012	Arsenic	SW6010B	mg/kg	MB	1		
H12100328	10/30/2012	Arsenic	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Arsenic	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Arsenic	SW6010B	mg/kg	MS	1		
H12100328	10/30/2012	Arsenic	SW6010B	mg/kg	MSD	1		
H12100328	10/30/2012	Arsenic	SW6010B	mg/kg	RPD	1		
H12100328	10/30/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100328	10/30/2012	Cadmium	E200.7	mg/L	ICS (Pair)	1		

H12100328	10/31/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100328	11/1/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100328	11/2/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100328	11/3/2012	Cadmium	E200.7	mg/L	ICV	1		
H12100328	10/30/2012	Cadmium	SW6010B	mg/kg	MB	1		
H12100328	10/30/2012	Cadmium	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Cadmium	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12100328	10/30/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12100328	10/30/2012	Cadmium	SW6010B	mg/kg	RPD	1		
H12100328	10/31/2012	Cadmium	SW6010B	mg/kg	MB	1	Detected at 0.02, RL is 0.001, PQL is 0.15	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12100328	10/31/2012	Cadmium	SW6010B	mg/kg	LFB	1		
H12100328	10/31/2012	Cadmium	SW6010B	mg/kg	LCS	1		
H12100328	10/31/2012	Cadmium	SW6010B	mg/kg	MS	1		
H12100328	10/31/2012	Cadmium	SW6010B	mg/kg	MSD	1		
H12100328	10/29/2012	Copper	SW6010B	mg/kg	RPD	1		
H12100328	10/29/2012	Copper	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/29/2012	Copper	SW6010B	mg/kg	MB	1		
H12100328	10/29/2012	Copper	SW6010B	mg/kg	LFB	1		
H12100328	10/29/2012	Copper	SW6010B	mg/kg	LCS	1		
H12100328	10/29/2012	Copper	SW6010B	mg/kg	MS	1		
H12100328	10/29/2012	Copper	SW6010B	mg/kg	MSD	1		
H12100328	10/29/2012	Copper	SW6010B	mg/kg	RPD	1		
H12100328	10/30/2012	Copper	SW6010B	mg/kg	MB	1		
H12100328	10/30/2012	Copper	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Copper	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Copper	SW6010B	mg/kg	MS	1		
H12100328	10/30/2012	Copper	SW6010B	mg/kg	MSD	1		
H12100328	10/30/2012	Copper	SW6010B	mg/kg	RPD	1		
H12100328	10/29/2012	Iron	E200.7	mg/L	ICV	1		
H12100328	10/29/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/30/2012	Iron	E200.7	mg/L	ICV	1		
H12100328	10/30/2012	Iron	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/29/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 2, RL is 0.7, PQL is 5	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12100328	10/29/2012	Iron	SW6010B	mg/kg	LFB	1		
H12100328	10/29/2012	Iron	SW6010B	mg/kg	LCS	1		
H12100328	10/29/2012	Iron	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias

H12100328	10/29/2012	Iron	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100328	10/29/2012	Iron	SW6010B	mg/kg	RPD	1		
H12100328	10/30/2012	Iron	SW6010B	mg/kg	MB	1	Detected at 2, RL is 0.7, PQL is 5	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12100328	10/30/2012	Iron	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Iron	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Iron	SW6010B	mg/kg	MS	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100328	10/30/2012	Iron	SW6010B	mg/kg	MSD	1	The analyte level was greater than 4 times the spike level, in accordance with the method, % recovery is not calculated.	The data shall be reported unflagged, even if the %R does not meet the acceptance criterias
H12100328	10/30/2012	Iron	SW6010B	mg/kg	RPD	1		
H12100328	10/29/2012	Lead	E200.7	mg/L	ICV	1		
H12100328	10/29/2012	Lead	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/30/2012	Lead	E200.7	mg/L	ICV	1		
H12100328	10/30/2012	Lead	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/29/2012	Lead	SW6010B	mg/kg	MB	1		
H12100328	10/29/2012	Lead	SW6010B	mg/kg	LFB	1		
H12100328	10/29/2012	Lead	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Lead	SW6010B	mg/kg	MB	1		
H12100328	10/30/2012	Lead	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Lead	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Lead	SW6010B	mg/kg	MS	1	Spike recovery outside of advisory limits, 155%	Affected results that are ≥MDL are qualified as estimated high (J+).
H12100328	10/30/2012	Lead	SW6010B	mg/kg	MSD	1		
H12100328	10/30/2012	Lead	SW6010B	mg/kg	RPD	1		
H12100328	10/30/2012	Manganese	E200.7	mg/L	ICV	1		
H12100328	10/30/2012	Manganese	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/30/2012	Manganese	SW6010B	mg/kg	MB	1		
H12100328	10/30/2012	Manganese	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Manganese	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Manganese	SW6010B	mg/kg	MS	1	Spike recovery outside of advisory limits, 73%	Affected results that are ≥ MDL qualified as estimated low (J-)

H12100328	10/30/2012	Manganese	SW6010B	mg/kg	MSD	1	Spike recovery outside of advisory limits, 147%	Affected results that are ≥MDL are qualified as estimated high (J+). However based on original sample all samples already flagged as estimated low.
H12100328	10/30/2012	Manganese	SW6010B	mg/kg	RPD	1	Actual RPD value is 19.75	The QAPP indicates that the upper control limit for soil samples is 35%, no qualification is necessary.
H12100328	10/29/2012	Zinc	E200.7	mg/L	ICV	1		
H12100328	10/29/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/30/2012	Zinc	E200.7	mg/L	ICV	1		
H12100328	10/30/2012	Zinc	E200.7	mg/L	ICS (Pair)	1		
H12100328	10/29/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.2, RL is 0.1, PQL is 2	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12100328	10/29/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12100328	10/29/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Zinc	SW6010B	mg/kg	MB	1	Detected at 0.3, RL is 0.1, PQL is 2	All results are greater than or equal to 10X the blank result so no qualification necessary.
H12100328	10/30/2012	Zinc	SW6010B	mg/kg	LFB	1		
H12100328	10/30/2012	Zinc	SW6010B	mg/kg	LCS	1		
H12100328	10/30/2012	Zinc	SW6010B	mg/kg	MS	1		
H12100328	10/30/2012	Zinc	SW6010B	mg/kg	MSD	1	Spike recovery outside of advisory limits, 195%	Affected results that are ≥MDL are qualified as estimated high (J+).
H12100328	10/30/2012	Zinc	SW6010B	mg/kg	RPD	1	RPD was 20.4% outside of laboratory control limits	The QAPP indicates that the upper control limit for duplicate soil sample RPD is 35%, no qualification is necessary.
H12100328	10/30/2012	Zinc	SW6010B	mg/kg	MB	1		

mg/L - milligrams per Liter
mg/kg - killigrams per killigram
ICV - Initial Calibration Verification Sample
ICS - Interference Check Samples
MB - Method Blank
LFB - Laboratory Fortified Blank
LCS - Laboratory Control Sample
MS - Matrix Spike Sample
MSD - Matrix Spike Duplicate Sample
RPD -Relative Percent Difference
RL - Reporting Limit
PQL - Practical Quantitaion Limit as Indicated in the QAPP
MDL - Method Detection Limit as provided by the laboratory

TABLE-16
Analytical Data with Validation Qualifiers
Upper Blackfoot Mining Complex Floodplain Investigation

Laboratory Sample Identification	Field Sample Number	Aluminum (mg/kg)	LQ	DVQ	Arsenic (mg/kg)	LQ	DVQ	Cadmium (mg/kg)	LQ	DVQ	Copper (mg/kg)	LQ	DVQ	Iron (mg/kg)	LQ	DVQ	Manganese (mg/kg)	LQ	DVQ	Lead (mg/kg)	LQ	DVQ	Zinc (mg/kg)	LQ	DVQ
H12100328-001	TP-MS-16(0.1-0.2)	8570			149			1.3			373			48900			252		J-	773		J+	312		J+
H12100328-002	TP-MS-07(2.75-3.5)	33600			15			0.2			167			14200			119		J-	115		J+	104		J+
H12100328-003	TP-FP-53(9.5-10.0)	11900			15			1.1			414			43300			235		J-	178		J+	263		J+
H12100328-004	TP-MS-04A(1-2.0)	7650			108			7.3			352			60000			1230		J-	833		J+	1670		J+
H12100328-005	TP-FP-55(.6-1)	8810			165			2.2			533			63300			1060		J-	7380		J+	523		J+
H12100328-006	TP-FP-57(0.5-1.0)	16700			18			1.2			131			23700			516		J-	120		J+	338		J+
H12100328-007	TP-FP-58(6-6.5)	13300			17			1.3			210			36600			752		J-	99		J+	387		J+
H12100328-008	TP-FP-59(12-12.5)	13500			15			1			418			44500			375		J-	75		J+	363		J+
H12100328-009	TP-TS-02(1.5-2)	11300			22			0.7			86			19900			634		J-	176		J+	175		J+

mg/kg - milligram per kilogram
LQ - Laboratory Designated Data Qualifier
DVQ - Data Validation Applied Data Qualifier
J -The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+ - The result is an estimated quantity, but the result may be biased high.
J- - The result is an estimated quantity, but the result may be biased low.

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
4	TP-FP 27 (2-2.4)	43530	533.65	14.02	1.49	< LOD	3.92	649814	2432.26	13.41	1.54	< LOD	6.19	205.9	15.9	< LOD	51.9	< LOD	64.98	48.81	5.52	32768.8	103.24	< LOD
5	TP-FP 27 (3.8-4.2)	52133	563.79	10.03	1.36	< LOD	4.39	636188	2331.93	16.26	1.72	< LOD	6.59	397.8	16.13	< LOD	58.14	< LOD	70.15	17.17	5.44	37801.6	116.92	< LOD
6	TP-FP 27 (5-5.5)	57870	595.01	59.23	4.41	< LOD	5.74	640904	2265.93	11.54	2.43	< LOD	7.2	240.3	14.79	< LOD	71.16	< LOD	69.5	570.48	10.51	57245.3	156.21	< LOD
7	TP-FP 27 (6.5-7)	53523	556.56	33.93	3.05	< LOD	4.84	646192	2181.89	16.95	2.04	< LOD	6.69	175.5	14.71	< LOD	61.56	< LOD	68.4	233.04	7.54	43717.6	127.25	< LOD
8	TP-FP 27 (9.5-10)	35988	419.58	34.11	3.5	< LOD	4.95	715580	1827.78	14.19	2.15	< LOD	6.67	356.7	14.5	< LOD	60.06	< LOD	68.8	147.2	6.79	41359.4	123.24	< LOD
9	TP-FP 27 (13-19)	33279	444.19	16.63	1.61	< LOD	4.25	699518	2160.61	16.29	1.69	< LOD	6.4	285.8	15.69	< LOD	57.8	< LOD	69.04	169.77	6.77	39861.2	117.91	< LOD
10	TP-FP 28 (1-1.5)	36401	425.13	32.35	2.35	< LOD	4.52	688176	1832.84	12.73	1.75	< LOD	6.38	282.7	14.36	< LOD	60.54	< LOD	65.33	122.8	6.29	46177.3	126.95	< LOD
11	TP-FP 28 (1.5-2)	24270	623.09	201.74	9.94	< LOD	9.51	583900	4630.88	9.71	4.44	< LOD	8.42	371	21.97	< LOD	106.55	< LOD	64.12	532.37	11.6	132069	315.44	< LOD
12	TP-FP 28 (3-3.5)	50971	569.22	19.43	2.16	< LOD	4.64	626913	2391.67	12.3	1.8	< LOD	6.67	172.1	15.43	< LOD	59.83	< LOD	71.16	83.29	6.19	40497.4	122.75	< LOD
13	TP-FP 28 (4.6-5)	52716	554.84	14.51	1.57	< LOD	4.65	629030	2189.84	23.47	1.88	< LOD	6.83	226.7	14.84	< LOD	68.07	< LOD	71.93	98.88	6.45	54646.8	148.01	< LOD
14	TP-FP 28 (5.5-7)	56238	556.11	30.49	2.91	< LOD	4.78	646814	2067.53	12.81	1.95	< LOD	6.57	172	14.45	< LOD	59.04	< LOD	68.44	181.22	6.99	40778.8	120.69	< LOD
15	TP-FP 28 (8-8.5)	51858	564.36	50.68	3.01	< LOD	4.82	628874	2296.09	16.07	1.98	< LOD	6.65	193	15.07	< LOD	65.53	< LOD	67.94	131.76	6.57	51457.8	139.75	< LOD
16	TP-FP 28 (9-9.5)	52575	537.32	22.84	1.83	< LOD	4.51	640054	2072.22	12.97	1.69	< LOD	6.47	206.1	14.77	< LOD	59.63	< LOD	69.93	33.45	5.49	42654.9	122.65	< LOD
17	TP-FP 28 REP(4.6-5)	51697	544.71	11.92	1.5	< LOD	4.2	634728	2138.56	20.07	1.75	< LOD	6.53	230.6	14.82	< LOD	64.46	< LOD	67.58	86.4	6.06	52337.1	138.81	< LOD
18	TP-FP 30 (0.5-0.8)	46662	903.85	213.93	8.04	< LOD	8.61	507194	5142.81	11.55	3.64	21.07	7.52	282.1	24.91	< LOD	100.32	< LOD	71.35	757.8	13.39	100528	256.21	< LOD
19	TP-FP 30 (1.6-2)	48117	685.64	158.37	6.78	< LOD	7.29	593525	3334.2	9.6	3.18	< LOD	8.37	344.4	18.93	< LOD	84.71	< LOD	67.93	586.22	11.1	84284.4	207.87	< LOD
20	TP-FP 30 (2.3-3.3)	26839	411.77	58.99	2.25	< LOD	5	714090	2278.58	14.34	1.84	< LOD	7.29	670.8	15.5	< LOD	82.82	< LOD	61.52	90.59	6.61	90346.9	213.28	< LOD
21	TP-FP 30 (3-3.5)	54021	540.59	18.21	1.65	< LOD	4.27	658586	2070.55	17.86	1.66	< LOD	6.33	283.5	14.7	< LOD	56.5	< LOD	66.95	97.2	6.02	39467.6	115.15	< LOD
22	TP-FP 30 (3.5-4)	57299	568.95	26.56	2.23	< LOD	4.5	649920	2115.16	17.02	1.84	< LOD	6.52	224.8	14.78	< LOD	58.15	< LOD	67.91	122	6.41	40813.3	119.36	< LOD
23	TP-FP 30 (4.8-5)	45522	520.13	24.82	1.91	< LOD	5.48	666204	2112.53	16.28	1.81	< LOD	6.99	269.5	14.72	< LOD	65.06	< LOD	67.12	237.36	7.8	44947.7	130.73	< LOD
24	TP-FP 30 (7.5-8)	55882	619.51	53.31	3.35	< LOD	5.27	612760	2479.8	15.65	2.09	< LOD	7.08	290.8	16.06	< LOD	71.15	< LOD	67.44	355.96	8.89	57236.2	154.74	< LOD
25	TP-FP 30 (10-10.5)	56357	591.89	15.14	2.03	< LOD	4.5	602526	2246.86	18.69	1.82	< LOD	6.66	151.4	15.22	< LOD	59.56	< LOD	69.36	94.63	6.3	39305.8	119.46	< LOD
26	TP-FP 30A (0.5-0.8) DUP	49396	914.22	180.4	7.73	< LOD	8.57	517295	5029.8	8.06	3.53	14.63	5.23	232.3	24.46	< LOD	98.06	< LOD	69.81	1188.1	15.95	95036.1	245	< LOD
27	TP-FP 30A (0.8-1)	34858	825.78	258.09	9.07	< LOD	9.66	496691	5693.4	9.2	4.02	< LOD	9.71	408.6	24.84	< LOD	116.58	< LOD	68.6	1018.5	15.85	143373	354.33	< LOD
28	TP-FP 31 (0.1-0.4)	35656	623.31	236.02	9.6	< LOD	9.47	584648	3693.24	< LOD	8.51	< LOD	8.46	449.7	19.27	< LOD	105.34	< LOD	63.83	554.47	11.74	128668	311.53	< LOD
29	TP-FP-01A(0-3)	57432	563.73	12.58	1.43	< LOD	4.39	617545	2036.13	14.21	1.6	< LOD	6.46	189.8	14.81	< LOD	57.56	< LOD	69.87	46.66	5.61	37812	115.05	< LOD
30	TP-FP-01B(0-2)			177.81	18.4	< LOD	21.73	911751	667.44	< LOD	16.76	< LOD	19.56			< LOD	195.8	< LOD	163.66	257.08	20.88	75025.8	464.64	
31	TP-FP-01B(0-2)	33960	506.27	203.11	7.2	< LOD	7.34	655864	2700.08	16.62	3.32	< LOD	7.27	329.9	16.97	< LOD	78.55	< LOD	64.03	230	7.92	77037.8	190.23	< LOD
32	TP-FP-02(3-8.5)	53103	538.43	26.37	2.06	< LOD	4.38	635600	2057.66	14.65	1.74	< LOD	6.53	218.4	14.71	< LOD	62.65	< LOD	67.82	77.75	5.97	46167.3	129.36	< LOD
33	TP-FP-02(8.5-9.5)	55305	734.64	241.45	8.43	< LOD	8.17	549977	3352.1	16.68	3.82	< LOD	7.74	365.8	19.3	< LOD	88.57	< LOD	66.68	436.47	10.05	93779.2	226.23	< LOD
34	TPFP03(2.5-3)	65183	1063.57	19.64	4.08	< LOD	5.85	578678	1498.9	< LOD	11.21	< LOD	9.31	< LOD	29.04	< LOD	96.43	< LOD	112.73	66.27	11.06	41269.5	257.42	7461.64
35	TP-FP-03(2.5-3.0)			18.94	2.71	< LOD	3.38									< LOD	75.33			64.18	6.16	31668.1	121.35	
36	TP-FP-03(4-4.5)			490.62	17.4	< LOD	7.13									< LOD	172.19			239.37	10.72	121750	285.06	
37	TP-FP-03(4-4.5)	32624	962.56	408.2	23.55	< LOD	12	620021	1516.82	< LOD	16.56	< LOD	11.31	62.58	22.67	< LOD	150.61	< LOD	103.11	241.74	16.73	110406	568.13	6600.18
38	TP-FP-03(6-7)			25.89	3.27	< LOD	3.39									< LOD	77.6			67.52	6.31	33193.1	125.26	
39	TP-FP-03(6-7)	63975	1048.11	22.65	4.91	< LOD	5.68	586980	1468.46	< LOD	11.26	< LOD	9.16	< LOD	30.3	< LOD	94.81	< LOD	110.87	69.76	11.08	42668.8	260.14	7977.56
40	TP-FP-03(7.6-8.6)	65032	1120.53	31.8	5.41	< LOD	6.01	580320	1444.7	< LOD	11.21	< LOD	9.51	< LOD	31.42	< LOD	98.37	< LOD	109.44	126.38	12.65	45012.7	269.48	6573.53
41	TP-FP-03(7.6-8.6)			< LOD	224.63	< LOD	323.62	950407	4566.79	< LOD	419.52	< LOD	255.18			< LOD	3127.9	< LOD	2481.9	< LOD	951.01	47210.6	6389.75	
42	TP-FP-03(9-9.5)	68794	1101.46	34.16	4.78	< LOD	6.31	603797	1429.96	< LOD	11.44	< LOD	9.43	< LOD	30.18	< LOD	98.47	< LOD	111.23	84.71	11.74	44681.3	270.68	9196.98
43	TP-FP-03(11.5-12.5)	62656	1058.51	32.52	6.17	< LOD	5.83	582545	1455.74	< LOD	11.24	< LOD	9.09	< LOD	30.63	< LOD	95.17	< LOD	111.04	73.28	11.13	43354.9	261.51	6390.95
44	TP-FP-04(1.5-2)	32075	1043.25	429.57	22.39	< LOD	11.8	595815	1648.74	< LOD	16.43	< LOD	11.98	84.48	23.83	< LOD	170.39	< LOD	101.03	558.82	23.14	138161	686.32	8306.67
45	TP-FP-04(3-4)			90.84	34.35	< LOD	17.24	903721	593.86	< LOD	24.9	< LOD	26.79			< LOD	173.45	< LOD	159.08	1525	46.19	66794.5	523.2	
46	TP-FP-04(3-4)	51562	1042.74	126.72	23.69	< LOD	11.53	627397	1453.28	< LOD	16.74	< LOD	11.92	< LOD	32.46	< LOD	121.52	< LOD	135	1438.8	31.16	67563.5	372.33	7407.87
47	TP-FP-04(5.5-6.5)	53074	1127.35	89.66	27.43	< LOD	13.32	584220	1604.99	< LOD	18.42	< LOD	18.66	< LOD	34.26	< LOD	131.21	< LOD	105.16	637.48	22.63	77143.9	416.45	7194.14
48	TP-FP-04(7-8)	50864	1001.7	131.23	17.15	< LOD	9.24	627329	1431.5	< LOD	13.94	< LOD	10.12	< LOD	30.38	< LOD	115.9	< LOD	103.1	397.55	17.85	64525.7	351.61	10350.6
49	TP-FP-04(9-10)	54908	1068.44	51.7	23.06	< LOD	11.55	603020	1563.03	< LOD	16.66	< LOD	12.16	< LOD	31.33	< LOD	122.33	< LOD	104.97	667.54	22.88	67906.1	376.75	9876.34

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
50	TP-FP-05(1-3)	41654	1275.21	310.46	16.79	< LOD	10.53	535264	1859.94	< LOD	15.12	< LOD	11.95	< LOD	39.76	< LOD	168.85	< LOD	165.24	412.39	21.16	126569	656.97	< LOD
51	TP-FP-05(1-3)DUP	29906	1179.7	480.18	22.89	< LOD	12.94	554378	1843.06	< LOD	17.18	< LOD	13.78	45.12	27.09	< LOD	186.84	< LOD	144.82	633.55	25.79	155030	796.61	< LOD
52	TP-FP-05(3.8-4.8)	55675	980.49	53.22	8.84	< LOD	6.47	624550	1358.59	< LOD	11.7	< LOD	9.48	< LOD	29.79	< LOD	100.79	< LOD	110.48	369.45	16.68	47499.9	280.1	5928.08
53	TP-FP-05(6-7)	57264	1168.58	219.47	36.14	< LOD	16.57	589414	1630.19	< LOD	21.82	< LOD	11.55	< LOD	35.72	< LOD	122	< LOD	108.58	1330.2	30.68	63580.1	369.65	10403.1
54	TP-FP-05(7.5-8.0)	60136	1016.66	37.39	10.66	< LOD	7.51	621877	1405.04	< LOD	12.41	< LOD	9.62	< LOD	28.99	< LOD	106.95	< LOD	105.4	236.89	14.72	53447.3	304.3	7488.51
55	TP-FP-05(8.5-9.5)	60631	1035.9	38.54	10.45	< LOD	6.71	595403	1399	< LOD	11.96	< LOD	9.4	< LOD	29.95	< LOD	98.56	< LOD	109.27	183.4	13.5	45425.3	271.14	7328.04
56	TP-FP-06(1.3-2)	45233	1353.21	302.93	20.35	< LOD	11.36	546113	1852.83	< LOD	16.02	< LOD	19.49	< LOD	41.2	< LOD	161.23	< LOD	146.37	823.68	26.9	112365	583.64	14464.9
57	TP-FP-06(4.5-5.5)	55111	1543.68	331.35	23.24	< LOD	12.23	485959	2105.2	< LOD	17.38	< LOD	20.15	< LOD	42.46	< LOD	171.88	< LOD	146.99	844.66	28.32	122907	652.97	10477.6
58	TP-FP-06(7-8)	77808	1412.81	75.32	23.96	< LOD	11.99	512031	1785	< LOD	17.05	< LOD	14.51	< LOD	35.63	< LOD	117.96	< LOD	110.22	782.01	23.68	61991.1	347.63	11676.1
59	TP-FP-06(8.5-9)	65096	1205.25	< LOD	31.53	< LOD	10.96	580312	1576.19	< LOD	16.22	< LOD	10.55	< LOD	33.65	< LOD	119.83	< LOD	107.37	486.95	19.66	64817.5	359.71	5629.14
60	TP-FP-07(0.5-1)	36499	1545.1	480.04	24.65	< LOD	13.53	491261	2186.28	< LOD	18.87	< LOD	13.74	208.3	30.49	< LOD	210.66	< LOD	168.95	833.27	30.67	192764	1009.13	< LOD
61	TP-FP-07(1-1.5)	59004	1851.08	394.7	25.68	< LOD	13.84	448382	2325.34	< LOD	17.97	< LOD	22.73	138	33.72	< LOD	180.4	< LOD	112.73	1043.7	31.67	133120	701.06	22156.3
62	TP-FP-07(2.5-3.0)	32023	727.09	27.99	3.77	< LOD	5.65	714293	1078.76	< LOD	11.33	< LOD	9.12	< LOD	31.7	< LOD	92.42	< LOD	112.32	65.56	11	39709.6	250.36	3802.1
63	TP-FP-07(5-5.5)	70971	1129.82	39.85	4.7	< LOD	5.86	599411	1417.6	< LOD	11.32	< LOD	9.29	< LOD	30.08	< LOD	97.81	< LOD	108.15	95.22	11.72	45984.3	269.73	10159.2
64	TP-FP-07(7-8)	79024	1726.55	324.71	21.59	< LOD	12.27	439576	2231.36	< LOD	16.71	< LOD	31.18	< LOD	41.59	< LOD	167.48	135.36	73.74	756.62	26.61	121522	621.29	16161.9
65	TP-FP-07(11-12)	62834	1378.79	172.44	15.8	< LOD	9.15	518033	1848.58	< LOD	14.35	< LOD	16.88	< LOD	37.56	< LOD	145.84	< LOD	163.73	355	18.77	96576.8	499.77	8835
66	TP-FP-07 Rep(0.5-1)	39775	1668.73	466.53	24.52	< LOD	13.54	481746	2258.22	< LOD	18.78	< LOD	14.68	222.8	30.98	< LOD	209.71	< LOD	168.8	863.57	30.99	192768	1037.41	< LOD
67	TP-FP-07 Rep(0.5-1)			404.21	64.5	< LOD	36.26	837762	1821.2	< LOD	46.88	< LOD	37.97			< LOD	524.68	< LOD	333.41	997.68	77.09	129138	1623.81	
68	TP-FP-08(1.3-2)	37543	1477.12	559.68	32.82	< LOD	16.31	479430	2239.53	< LOD	21.38	< LOD	15.81	259.6	31.25	< LOD	198.89	< LOD	172.05	667.49	27.59	168838	891.76	15675.8
69	TP-FP-08(2.4-2.9)	37533	1460.05	572.21	32.75	< LOD	16.5	484683	2212.46	< LOD	21.23	< LOD	18.89	270.2	31.19	< LOD	199.76	< LOD	124.77	682.54	27.88	168066	889.63	10756.4
70	TP-FP-08(3-3.8)	65992	1264.09	88.2	11.9	< LOD	9.55	556411	1721.86	< LOD	13.62	< LOD	17.32	< LOD	34.09	< LOD	129.58	< LOD	108.64	1054.5	27.74	74377.2	405.22	8082.04
71	TP-FP-08(4-4.5)	56549	1065.55	53.25	6.29	< LOD	7.72	646251	1351	< LOD	11.74	< LOD	13.39	< LOD	31.07	< LOD	104.26	< LOD	107.2	496.8	19.29	45044.7	273.38	6825.04
72	TP-FP-08(4.5-6.0)	55025	981.22	43.89	7.71	< LOD	6.25	633922	1364.47	< LOD	11.64	< LOD	9.59	< LOD	30.58	< LOD	104.35	< LOD	106.47	164.76	13.46	51723	301.16	4244.47
73	TP-FP-08(6-6.5)	31947	735.63	58.43	7.07	< LOD	8.89	726876	1056.04	< LOD	11.72	< LOD	9.54	< LOD	30.87	< LOD	104.43	< LOD	105.16	172.59	13.61	52479.4	298.82	< LOD
74	TP-FP-08(8-8.6)	39829	909.77	42.07	6.47	< LOD	6.45	680258	1213.39	< LOD	11.77	< LOD	10.04	< LOD	31.95	< LOD	124.26	< LOD	104.65	311.13	16.55	73944.2	387.32	< LOD
75	TP-FP-08b(2.4-2.9)			< LOD	943.34	< LOD	251.9	850396	13734.9	< LOD	420.71	< LOD	299.82			< LOD	3802.8	< LOD	3795.1	3169.4	1228.9	128916	13488.4	
76	TP-FP-08b(2.4-2.9)			< LOD	1218.12	< LOD	343.89	835636	16781.9	< LOD	554	< LOD	378.44			< LOD	4695.8	< LOD	1538.3	2116.1	1155.02	135692	15810.3	
77	TP-FP-08b(2.4-2.9)			< LOD	3337.09	< LOD	248.31	797526	35317.5	< LOD	1135.2	< LOD	812.65			< LOD	9756.1	< LOD	10569	< LOD	4425.78	184758	36118.2	
78	TP-FP-08b(2.4-2.9)	71377	1841.37	369.45	28.07	< LOD	14.31	511943	2072.93	< LOD	19.45	< LOD	17.35	60.03	28.35	< LOD	178.91	< LOD	105.57	2863.2	50.26	144535	735.96	< LOD
79	TP-FP-09(1.5-2.0)	30682	1404.95	654.27	28.01	< LOD	14.5	536522	1962.66	< LOD	18.48	< LOD	13.53	110.3	31.33	< LOD	186.73	< LOD	123.86	518.02	23.66	155316	822.33	< LOD
80	TP-FP-09(2.7-3.0)	30029	1512.61	546.02	30.44	< LOD	16.23	466894	2461.21	< LOD	21.18	< LOD	18.07	290.8	32.48	< LOD	233.92	< LOD	137.96	828.12	32.94	221507	1206.45	< LOD
81	TP-FP-09(3.2-3.3)	74285	1867.45	282.29	27.97	< LOD	14.14	432295	2336.48	< LOD	19.77	< LOD	117.29	< LOD	45.32	< LOD	227.04	< LOD	111.19	3139	53.3	126224	676.51	10610.9
82	TP-FP-09(4.5-5)	46430	1237.47	320.94	15.84	< LOD	9.31	570579	1697.94	< LOD	14.26	< LOD	11.32	< LOD	37.69	< LOD	155.15	< LOD	109.7	415.36	19.98	115410	576.28	10158.4
83	TP-FP-09(7.5-8)	69181	1331.98	143.62	11.19	< LOD	7.92	534925	1764.1	< LOD	13.18	< LOD	10.75	< LOD	34.63	< LOD	142.76	< LOD	122.4	396.85	18.95	94751.4	483.05	6047.09
84	TP-FP-10(2-2.4)	69514	1145.61	36.63	6.26	< LOD	5.98	581221	1486.22	< LOD	11.11	< LOD	9.08	< LOD	32.07	< LOD	94.49	< LOD	108.82	82.1	11.28	42625.2	258.52	7840.71
85	TP-FP-10(4-4.5)	61710	1048.47	48.98	6.37	< LOD	6.1	624524	1385.41	< LOD	11.54	< LOD	9.39	< LOD	29.71	< LOD	102.2	< LOD	107.71	104.64	12.03	50465.2	290.26	7320.26
86	TP-FP-10(5.5-6)	67379	1130.34	50.21	6.52	< LOD	6.15	608345	1420.1	< LOD	11.44	< LOD	9.51	< LOD	30.82	< LOD	101.2	< LOD	110.07	143.26	12.92	48988.8	285.15	6838.12
87	TP-FP-10(8-8.5)	71243	1285.79	106.74	13.26	< LOD	8.55	589652	1673.82	< LOD	14.67	< LOD	11.23	< LOD	31.8	< LOD	151.6	< LOD	142.39	76.48	13.46	111396	543.12	9729.59
88	TP-FP-10 Rep(5.5-6)	68781	1147.05	47.9	6.47	< LOD	6	604736	1448.35	< LOD	11.56	< LOD	9.44	< LOD	30.74	< LOD	101	< LOD	108.85	129.2	12.6	48938.4	284.19	7480.56
89	TP-FP-10A(.75-1.0)	31903	1026.09	661.12	29.09	< LOD	14.84	589211	1855.02	< LOD	19.58	< LOD	16.89	181.1	22.92	< LOD	204.08	< LOD	98.35	364.47	22.45	188823	957.34	8962.56
90	TP-FP-10A(1.1-1.3)	59956	1050.04	35.78	9.3	< LOD	6.54	600762	1424.47	< LOD	11.87	< LOD	9.28	< LOD	30.51	< LOD	104.96	< LOD	103.04	113.71	12.06	55519.2	305.6	6583.35
91	TP-FP-10A(2.1-2.6)	67152	1102.37	35.72	7.07	< LOD	6.09	612123	1415.65	< LOD	11.52	< LOD	9.28	< LOD	30.46	< LOD	100.57	< LOD	105.9	329.18	15.85	49334.1	284.18	5723.39
92	TP-FP-10A(3.5-4)	30856	719.92	36.3	5.29	< LOD	5.72	763386	943.42	< LOD	11.27	< LOD	9.5	< LOD	29.98	< LOD	98.71	< LOD	106.38	100.43	12.12	45544.2	274.25	4496.51
93	TP-FP-11(.1-.3)	32095	1042.14	559.07	25.21	< LOD	12.94	586760	1683.67	< LOD	17.25	< LOD	12.12	87.63	24.01	< LOD	173.23	< LOD	99.26	319.64	19.39	140678	701.15	8285.73
94	TP-FP-11(1-1.2)	43763	948.15	74.19	15.9	< LOD	8.47	649959	1335.1	< LOD	13.51	< LOD	10.22	< LOD	31.11	< LOD	130.57	< LOD	95.83	331.16	16.94	89032.6	439.59	7326.28
95	TP-FP-11(1.5-2.0)	56182	1013.7	38.26	4.92	< LOD	7.75	648379	1331.73	< LOD	11.33	< LOD	9.75	< LOD	29.16	< LOD	112.22	< LOD	101.77	325.36	16.35	62854.5	337.32	7160.75

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
96	TP-FP-11(2.7-3.0)	50264	951.1	46.85	10.68	< LOD	6.73	645957	1294.61	< LOD	12.2	< LOD	9.43	< LOD	29.65	< LOD	110.82	< LOD	93.91	439.94	17.55	64326.1	335.51	6347.65
97	TP-FP-11(3.7-4)	67868	1144.58	36.68	5.76	< LOD	6.18	612225	1469.69	< LOD	11.9	< LOD	9.76	< LOD	30.49	< LOD	104.51	< LOD	113.38	416.85	17.85	49347.8	292.27	9233.07
98	TP-FP-11(6.5-7)	73255	1154.82	25.31	4.48	< LOD	5.5	578674	1516.1	< LOD	11.11	< LOD	9.18	< LOD	29.98	< LOD	96.01	< LOD	109.46	64.37	10.98	43995.8	265.78	9618.64
99	TP-FP-11(8.5-9.0)	69737	1154.49	31.41	5.81	< LOD	6.68	573120	1527.98	< LOD	11.18	< LOD	9.34	< LOD	30.83	< LOD	100.54	< LOD	110.55	85.53	11.57	48147.4	282.82	8814.35
100	TP-FP-11A(6.5-7)	74921	1201.57	25.65	4.62	< LOD	9.07	566797	1582.03	< LOD	11.38	< LOD	9.45	< LOD	31.08	< LOD	101.74	< LOD	112.04	70.83	11.44	47109.6	283.76	9614.96
101	TP-FP-12(.9-1.3)	35256	1475.41	533.3	46.74	< LOD	22.11	489017	2455.97	< LOD	28.28	< LOD	19.13	205.1	29.96	< LOD	220.6	< LOD	107.48	826.38	32.13	194435	1108.79	15758.4
102	TP-FP-12(1.6-1.8)	41652	942.67	149.77	16.86	< LOD	9.22	641162	1375.24	< LOD	14.45	< LOD	10.46	< LOD	30.69	< LOD	136.92	< LOD	96.71	668.96	22.15	96159	469.72	6383.69
103	TP-FP-12(1.6-2.0)	32079	1338.71	659.61	43.4	< LOD	20.67	517429	2294.1	< LOD	26.26	< LOD	19.91	160.7	28.41	< LOD	219.85	122.24	70.16	567.81	27.72	199969	1105.72	10403.7
104	TP-FP-12(2-2.3)	55746	2284.2	774.98	39.58	< LOD	20.27	369160	3005.62	< LOD	25.19	< LOD	16.65	294.7	40.3	< LOD	245.51	< LOD	114.45	2551.7	57.12	208406	1202.15	17783.4
105	TP-FP-12(3-3.5)	48683	722.98	511.35	22.98	< LOD	18.74	588898	3680.24	< LOD	18.93	< LOD	10.1	642.3	21.96	< LOD	110.43	97.91	35.6	1775.3	20.6	114570	312.29	< LOD
106	TP-FP-12(3-3.3)	48492	957.55	127.56	27.86	< LOD	12.83	658144	1317.54	< LOD	17.72	< LOD	10.38	< LOD	31.31	< LOD	108.55	< LOD	105.45	735	22.23	55291.9	318.59	7012.49
107	TP-FP-12(6-6.5)	29911	742.72	139.37	19.44	< LOD	9.84	732318	1070.9	< LOD	15.69	< LOD	10.16	245.6	22.34	< LOD	110.42	< LOD	110.02	436.25	18.43	58035.2	328.21	3923.58
108	TP-FP-12(8-8.5)	53009	954.31	63.18	14.98	< LOD	8.4	626989	1378.93	< LOD	13.24	< LOD	9.68	49.91	21.34	< LOD	101	< LOD	107.05	163.72	13.42	46986.6	283	6390.69
109	TP-FP-12(9.5-10)	53604	987.66	41.3	14.66	< LOD	8.17	607707	1383.7	< LOD	12.93	< LOD	9.49	< LOD	49.62	< LOD	99.75	< LOD	109.38	221.43	14.2	45973.4	275.1	8877.03
110	TP-FP-13(1-1.3)	48835	1034.11	99.64	16.43	< LOD	8.81	602670	1470.57	< LOD	13.88	< LOD	10.24	122.6	23.25	< LOD	123.16	< LOD	104.25	794.36	23.4	72423	385.87	3927.51
111	TP-FP-13(1.5-1.8)	32808	975.44	288.38	24.69	< LOD	12.35	623003	1517.38	< LOD	17.37	< LOD	11.56	281.1	24.5	< LOD	154.86	< LOD	113.5	432.16	20.39	113312	573.63	7547.45
112	TP-FP-13(2.4-2.7)	18532	638.81	107.02	9.02	< LOD	7.05	758830	968.46	< LOD	12.34	< LOD	10.34	279.7	22.25	< LOD	135.19	< LOD	98.58	264.12	16.05	91609.3	453.06	4178.66
113	TP-FP-13(3.1-3.4)	46682	1568.54	66.83	43.46	< LOD	20.58	483746	2389.75	< LOD	27.42	< LOD	24.71	503.3	32.43	< LOD	215.6	112.96	70.37	2230.9	49.32	193317	1033.86	11357.5
114	TP-FP-13(3.5-3.7)	25538	740.63	83.06	13.85	< LOD	8.64	735381	1066.45	< LOD	13.53	< LOD	13.76	223.5	22.57	< LOD	119.18	< LOD	105.5	844.07	24.5	61967.7	348.1	3775.49
115	TP-FP-13(4-4.3)	53917	1103.78	116.67	12.83	< LOD	7.9	607518	1490.83	< LOD	12.7	< LOD	10.16	232.8	24.18	< LOD	124.65	< LOD	101.98	565.19	20.33	77278.5	398.99	7034.71
116	TP-FP-14(1-1.3)	56309	1055.69	64.82	12.07	< LOD	7.56	588513	1476.69	< LOD	12.62	< LOD	9.81	162.8	23.19	< LOD	114.9	< LOD	106.74	137.31	13.05	63030.8	344.35	5696.64
117	TP-FP-14(1.4-1.9)	51377	1029.37	155.92	32.59	< LOD	15.33	639320	1448.47	< LOD	20.17	< LOD	11.14	276.6	23.53	< LOD	133.78	< LOD	103.01	268.28	16.52	83948.7	444.39	5886.07
118	TP-FP-14(3.2-3.5)	31295	741.5	51.55	10.36	< LOD	7.02	732717	1033.23	< LOD	12.16	< LOD	9.65	403.4	23.53	< LOD	101.07	< LOD	111.16	454.85	18.04	48311.5	285.25	4767.73
119	TP-FP-14(4-4.6)	46492	906.51	92.91	26.33	< LOD	12.56	684279	1256.82	< LOD	17.1	< LOD	10.68	254.6	22.17	< LOD	104.88	< LOD	109.34	777.64	23.36	46794.6	291.49	4751.91
120	TP-FP-14(6-6.5)	28809	679.86	60.03	9.09	< LOD	6.55	739707	1006.92	< LOD	11.95	< LOD	9.56	< LOD	29.9	< LOD	104.21	< LOD	108.02	150.69	13.14	51528.9	297.22	< LOD
121	TP-FP-14(10-10.5)	41519	867.92	25.29	6.2	< LOD	6.07	655943	1259.33	< LOD	11.41	< LOD	9.37	< LOD	32.93	< LOD	120.06	< LOD	111.97	164.77	13.25	47606.8	281.71	5349.92
122	TP-FP-14 REP(4-4.6)REP	47924	921.79	107.43	25.92	< LOD	12.11	681018	1253.49	< LOD	17.01	< LOD	10.51	260	22.28	< LOD	103.59	< LOD	106.19	763.97	22.86	46864.2	287.87	5115.6
123	TP-FP-15(0-.2)	23387	732.19	162.08	14.6	< LOD	8.2	692711	1147.19	< LOD	12.64	< LOD	9.95	170.4	21.76	< LOD	126.3	< LOD	92.85	234.02	14.95	84076.1	416.09	< LOD
124	TP-FP-15(0-0.3)	63508	1090.07	38.07	4.98	< LOD	5.68	601422	1417.88	< LOD	11.11	< LOD	9.35	< LOD	31.83	< LOD	102.25	< LOD	111.27	94.99	11.86	48952.7	284.8	9608.06
125	TP-FP-15(0-0.4)	48709	1698.46	292.12	22.42	< LOD	22.53	466355	2240.26	< LOD	17.1	< LOD	20.84	156.9	34.04	193.41	120.46	< LOD	121.64	861.29	29.39	123043	668.71	19458.5
126	TP-FP-15(1.7-1.9)	49991	855.2	23.95	3.99	< LOD	5.27	648789	1253.88	< LOD	10.04	< LOD	8.69	< LOD	27.24	< LOD	87.63	< LOD	103.31	34.18	9.64	37307.7	232.7	5919.81
127	TP-FP-15(6.5-7)	62199	1073.27	35.7	5.35	< LOD	5.82	604346	1432.94	< LOD	11.28	< LOD	9.37	< LOD	32.8	< LOD	100.64	< LOD	109.49	129.64	12.57	47854.3	281.36	5480.13
128	TP-FP-15A(0.5-1)	27193	1684.92	211.01	24.67	< LOD	13.42	485372	2062.4	< LOD	18.2	< LOD	12.82	115.2	40.17	< LOD	256.38	< LOD	111.74	779.67	28.37	138726	765.82	< LOD
129	TP-FP-15A(2.7-3)	47397	1578.12	134.11	18.06	< LOD	10.55	486651	2009.39	< LOD	15.16	< LOD	12.76	< LOD	48.38	< LOD	196.68	< LOD	112.95	972.98	28.66	91878.1	504.95	21780.8
130	TP-FP-15A(3.1-3.6)			< LOD	301.63	< LOD	3128.66	< LOD	1.5	< LOD	1685.05	< LOD	2204.47			< LOD	911.68	< LOD	2134.3	< LOD	1841.26	8773.46	1751.65	
131	TP-FP-15A(3.1-3.6)	< LOD	33026.7	< LOD	183.18	< LOD	1368.07	< LOD	1.5	< LOD	1167.8	< LOD	1351.65	< LOD	2080.11	< LOD	579.98	< LOD	1742.4	< LOD	1131.98	8395.9	1095.5	< LOD
132	TP-FP-15A(3.1-3.6)	51388	1478.65	253.54	17.95	< LOD	10.9	525258	1964.05	< LOD	15.68	< LOD	20.61	< LOD	41.61	< LOD	177.7	< LOD	153.24	3837	57.89	118777	619.61	9530.14
133	TP-FP-15A(5-5.2)	50230	1020.43	52.64	7.62	< LOD	7	631094	1443.54	< LOD	12.85	< LOD	10.59	< LOD	30.67	< LOD	141.83	< LOD	99.83	228.41	15.79	101969	497.81	6138.73
134	TP-FP-15A(5-5.7)	62218	1036.09	49.7	7.04	< LOD	6.21	619058	1432.14	< LOD	11.84	< LOD	9.67	< LOD	29.36	< LOD	109.18	< LOD	107.5	176.89	13.7	55968.6	315.63	8940.91
135	TP-FP-15A(6-6.5)	64219	1119.51	52.72	7.06	< LOD	6.6	579832	1550.99	< LOD	11.91	< LOD	9.91	< LOD	31.41	< LOD	115.51	< LOD	110.73	253.28	15.52	60531.9	337.49	7702.42
136	TP-FP-15A(8.5-9.0)	60284	1119.27	43.41	6.35	< LOD	6.09	584904	1485.9	< LOD	11.33	< LOD	9.37	< LOD	32.84	< LOD	104.86	< LOD	110.7	201.7	13.92	51857.8	296.19	8751.31
137	TP-FP-15A DUP(0.5-1)	28648	1836.08	197.16	24.71	< LOD	13.16	476682	2085.53	< LOD	18	< LOD	12.63	66.12	41.69	< LOD	182.92	< LOD	123.71	886.5	29.47	129338	729.4	< LOD
138	TP-FP-16(1.1-1.5)	29531	1249.46	318.57	28.11	< LOD	14.5	572994	1750.71	< LOD	18.86	< LOD	12.41	55.78	29.07	< LOD	175.45	< LOD	169.91	596.64	24.41	137344	712.57	< LOD
139	TP-FP-16(3-3.4)	30024	1207.24	264.79	26.54	< LOD	13.38	593488	1656.29	< LOD	17.81	< LOD	12.98	79.94	28.71	< LOD	155.79	< LOD	106	530.01	22.04	111766	593.77	8522.19
140	TP-FP-16(3-3.4)DUP	27667	1222.39	259.43	26.89	< LOD	13.1	617507	1517.89	< LOD	17.73	< LOD	11.31	120.6	28.25	< LOD	148.17	< LOD	99.39	502.12	20.94	105521	555.18	< LOD
141	TP-FP-16(4.2-4.3)	42123	1409.38	417.68	49.74	< LOD	40.64	608910	7976.4	< LOD	41.73	< LOD	25.92	545.4	44.24	< LOD	205.72	< LOD	141.14	7862.5	92.41	87929.3	500.58	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
142	TP-FP-16(4.2-4.3)	51038	1481.38	521.86	68.01	< LOD	30.72	533194	2286.71	< LOD	38.69	< LOD	35.22	315.6	30.15	< LOD	174.81	142.68	78.74	7317.8	93.18	102185	615.59	15611.3
143	TP-FP-16(4.2-4.3)CHECK	49593	1440.99	399.17	64.14	< LOD	29.16	550647	2192.1	< LOD	36.46	< LOD	31.75	273.2	29.86	< LOD	168.1	< LOD	162.95	7053.1	88.62	99072.9	617.2	7922.82
144	TP-FP-16(4.8-5)	29568	1210.57	< LOD	38.42	< LOD	17.96	682767	6913.26	< LOD	15.97	< LOD	126.21	305.7	46.58	< LOD	131.21	< LOD	135.88	1600.8	33.68	45086.1	276.6	< LOD
145	TP-FP-16(5.5-6.3)	56426	1163.44	21.46	5.21	< LOD	10.01	628845	4479.66	14.41	3.86	< LOD	15.17	299.3	30.92	< LOD	122.36	< LOD	138.58	309.88	16.68	42341.8	251.21	< LOD
146	TP-FP-16(6.2-7.4)	75076	1425.16	151.57	17.94	< LOD	16.76	627640	4820.33	< LOD	16.25	< LOD	14.42	307.7	32.68	< LOD	132.73	< LOD	142.07	369.81	17.79	49897.7	282.53	< LOD
147	TP-FP-16(9-9.4)	23835	726.03	65.83	12.25	< LOD	13.25	770492	3542.08	13.32	6.1	< LOD	14.25	554.6	32.39	< LOD	134.23	< LOD	135.68	504.39	19.83	50809	285.74	< LOD
148	TP-FP-16(11.5-12)	58199	1241.87	53.84	8.65	< LOD	11.66	634356	4847.1	14.82	4.85	< LOD	14.32	357	31.51	< LOD	139.66	< LOD	136.58	323.07	17.28	54867.2	301.98	< LOD
149	TP-FP-17(1-1.5)	29509	1294.37	201.93	23.04	< LOD	21.22	589553	8799.58	< LOD	18.93	< LOD	17.23	396.3	43.03	< LOD	213.18	< LOD	129.34	446.17	22.08	129950	630.97	< LOD
150	TP-FP-17(2.6-3.0)	42240	1337.49	228.03	35.95	< LOD	30.34	609320	7331.25	< LOD	30.02	< LOD	18.14	495.2	41.93	< LOD	194.64	< LOD	138.04	1575.4	36.34	98046.7	521.47	< LOD
151	TP-FP-17(2.6-3.0)			< LOD	2648.55	< LOD	1272.99	873795	24282.7	< LOD	1117.51	< LOD	742.77			< LOD	7732.8	< LOD	9296.5	< LOD	2324.63	87288.1	15193.5	
152	TP-FP-17(2.6-3.0)	42776	1369.46	203.53	36.13	< LOD	30.29	607322	7539.95	< LOD	30.54	< LOD	18.21	480.5	42.36	< LOD	196.18	< LOD	141.75	1595	36.83	97943.9	525.14	< LOD
153	TP-FP-17(4.6-5)	59075	1190.42	38.14	6.67	< LOD	10.57	619616	4484.18	17.62	4.28	< LOD	13.92	466.3	31.84	< LOD	127.05	< LOD	138.96	134.56	13.83	45818.9	265.2	< LOD
154	TP-FP-17(5-6)	71774	1439.72	44.16	12.48	< LOD	13.23	596389	5173.49	13.79	6.19	< LOD	13.97	346.5	34.01	< LOD	133.16	< LOD	134.47	414.56	18.17	52153.7	284.71	< LOD
155	TP-FP-17(6.3-6.5)	63191	1261.3	36.69	5.98	< LOD	10.39	625002	4658.75	15.15	4.09	< LOD	14.01	474.4	31.8	< LOD	134.9	< LOD	139	184.64	14.72	52366.6	289.4	< LOD
156	TP-FP-17(9-9.5)	63888	1238.44	29.33	4.12	< LOD	9.17	621729	4497.41	13.43	3.56	< LOD	13.51	428	31.37	< LOD	123.4	< LOD	137.01	216.13	14.96	43522.3	255	< LOD
157	TP-FP-17(11.5-12)	63555	1245.9	15.55	4.54	< LOD	11.12	611696	4542.35	18.95	3.77	< LOD	13.44	466.7	32.12	< LOD	126.62	< LOD	136.23	144.75	13.59	47446.1	264.49	< LOD
158	TP-FP-17 (3-3.2)	40884	1005.6	92.05	24.73	< LOD	21.14	685776	4589.93	< LOD	20.24	< LOD	15.29	434	32.88	< LOD	120.11	< LOD	122.12	4421.5	52.67	38607.2	242.09	< LOD
159	TP-FP-18(0-0.3)	33913	1512.67	422.52	23.92	< LOD	22.74	495992	10334.8	< LOD	20.53	< LOD	20.37	886.1	47.44	< LOD	256.6	< LOD	132.88	764.92	29.33	183908	912.94	< LOD
160	TP-FP-18(12-12.5)	55284	1157.84	22.22	5.07	< LOD	9.53	618733	4480.03	16.07	3.84	< LOD	13.49	257.2	30.88	< LOD	124.95	< LOD	142.34	96.1	12.77	43513.2	256.08	< LOD
161	TP-FP-18-(0.6-0.8)	51638	1543.88	418.84	37.74	< LOD	31.71	551929	7956.13	< LOD	31.37	< LOD	20	673.8	43.09	< LOD	210.27	< LOD	131.87	1558.9	36.8	119945	596.21	< LOD
162	TP-FP-18-(2-2.3)	53826	1200.05	77.04	19.95	< LOD	18.7	624475	4900.31	< LOD	18.24	< LOD	19.29	574.2	35.02	< LOD	139.36	< LOD	133.59	1041.6	26.82	54440.2	302.03	< LOD
163	TP-FP-18-(4-4.5)	71708	1330.71	29.64	4.2	< LOD	9.54	617829	4616.54	19.05	3.75	< LOD	13.75	432.3	31.66	< LOD	129.07	< LOD	136.15	136.98	13.81	49262.4	274.1	< LOD
164	TP-FP-18A (4-4.5) DUP	69933	1338.65	36.56	5.09	< LOD	9.79	594760	4661.54	19.4	3.94	< LOD	13.88	518.6	32.9	< LOD	126.16	< LOD	135.72	164.38	14.19	47225.4	264.83	< LOD
165	TP-FP-18A (9-9.5)	65916	1268.88	31.76	5.76	< LOD	11.69	612333	4532.01	18.71	4.1	< LOD	13.78	608.7	32.74	< LOD	129.28	< LOD	134.87	170.29	14.43	49472.5	277.15	< LOD
166	TP-FP-18A DUP-rep(4-4.5)	71337	1362.64	40.47	5.22	< LOD	10.43	592926	4761.5	15.37	3.92	< LOD	13.89	519.6	32.81	< LOD	127.9	< LOD	138.95	179.7	14.64	47241.3	268.66	< LOD
167	TP-FP-19(.5-.9)	27798	1483.01	275.89	29.34	< LOD	26.31	536758	11044.5	< LOD	23.96	< LOD	20.53	465.4	49.5	< LOD	240.28	< LOD	135.85	904.53	31.07	145627	744.81	< LOD
168	TP-FP-19(1.8-2.4)	54275	1234.92	27.34	5.32	< LOD	9.71	630045	5146.01	13.22	3.82	< LOD	13.87	341.1	32.39	151.67	66.6	< LOD	139.14	280.1	16.3	45999.9	268.27	< LOD
169	TP-FP-19(1.8-2.4)CHECK	54441	616.81	23.84	2.63	< LOD	4.96	628948	2590.6	17.41	1.94	< LOD	6.89	331.1	15.99	198.44	33.16	< LOD	68.27	291.03	8.17	45980.3	133.07	< LOD
170	TP-FP-19(3.9-4.6)	70583	688.09	163.83	8.63	< LOD	8.08	643317	2456.18	< LOD	7.82	< LOD	7.22	188.1	15.99	< LOD	68.15	< LOD	70.22	453.67	9.57	53172	147.77	< LOD
171	TP-FP-19(4.9-5))	48754	520.22	37.37	3.03	< LOD	4.97	669347	2096.4	10.59	1.91	< LOD	6.78	264.5	14.62	< LOD	61.41	< LOD	63.56	346.3	8.42	44918.5	127.33	< LOD
172	TP-FP-19(5-5.5)	62599	627.43	40.83	3.77	< LOD	5.26	607099	2344.55	18.57	2.24	< LOD	6.76	221.3	15.33	< LOD	63.01	< LOD	66.66	424.61	9.01	46669.6	131.1	< LOD
173	TP-FP-19(8-8.5)	62216	660.96	34.31	2.92	< LOD	5.15	554940	2439.21	13.52	1.86	< LOD	6.78	183	16.15	91.96	34.58	< LOD	69.32	245.44	7.79	53844.3	145.11	< LOD
174	TP-FP-20(0.3-0.5)	41756	992.98	280.04	8.87	< LOD	9.84	455718	6536.2	< LOD	7.66	41.62	14.86	269	27.19	< LOD	123.43	< LOD	71.42	1327	18.42	144989	369.37	< LOD
175	TP-FP-20(2.1-2.4)	51545	740.77	178.2	15.97	< LOD	13.8	566815	3606.4	< LOD	13.32	< LOD	9.63	457.6	20.97	< LOD	94.5	< LOD	70.51	1688.1	18.7	85991.7	230.39	< LOD
176	TP-FP-20(9.5-10)	54375	605.43	98.18	8.64	< LOD	8.18	625843	2526.45	< LOD	7.93	< LOD	7.37	366.8	16.7	< LOD	72.4	< LOD	67.97	628.79	10.88	60088.2	160.87	< LOD
177	TP-FP-20(9.5-10)D	57688	666.29	128.41	10.56	< LOD	9.69	609299	2757.27	< LOD	8.8	< LOD	8.28	345.6	17.9	< LOD	78.18	< LOD	71.73	700.07	11.88	64509.4	175.7	< LOD
178	TP-FP-20 (3.1-3.6)	32077	494.12	139.61	13.28	< LOD	11.56	668751	2726.15	< LOD	10.99	< LOD	8.38	705.7	17.96	< LOD	92.82	< LOD	66.69	767.09	12.82	99151.2	242.79	< LOD
179	TP-FP-20 (6-6.5)	60774	616.99	35.56	4.12	< LOD	5.55	637255	2294.52	15.23	2.4	< LOD	6.92	234	15.46	< LOD	65.04	< LOD	69.88	343.02	8.59	48720.1	137.59	< LOD
180	TP-FP-20 (8-8.5)	52072	579.47	124.81	7.12	< LOD	7.19	640505	2377.42	< LOD	6.65	< LOD	7.27	419.8	16.81	< LOD	65.57	< LOD	68.78	546.3	10.35	46028.3	137.11	< LOD
181	TP-FP-20A (2.1-2.4)DUP	48610	868.1	194.67	13.26	< LOD	12.26	515661	4806.26	< LOD	11.03	18.25	6.52	309.9	23.62	< LOD	107.14	101.68	35.21	1127.5	16.08	114821	292.19	< LOD
182	TP-FP-21(1-1.3)	25512	712.93	312.3	11.52	< LOD	10.57	548174	5476.02	< LOD	10.1	< LOD	9.63	333.2	24.4	< LOD	113.01	82.75	34.1	565.55	12.43	140217	345.2	< LOD
183	TP-FP-21(3-3.2)	53490	609.63	137	8.11	< LOD	7.93	646299	2524.86	10.98	3.76	< LOD	7.51	397.3	16.94	< LOD	75.35	< LOD	68.14	922.78	12.91	65262.9	171.91	< LOD
184	TP-FP-21 (6.5-7)	57438	588.29	46.31	3.8	< LOD	5.3	618879	2239.39	14.16	2.23	< LOD	6.76	365.5	15.78	< LOD	63.19	< LOD	68.48	248.39	7.7	46957.5	132.29	< LOD
185	TP-FP-21 (10-10.5)	58035	604.6	15.85	3.73	< LOD	5.92	619369	2320.21	18.85	2.28	< LOD	6.68	410.7	16.41	< LOD	60.47	< LOD	69.33	218.78	7.38	43828.9	125.84	< LOD
186	TP-FP-21A(2.8-3)	37921	533.3	371.09	21.75	< LOD	17.6	650538	2684.74	< LOD	18.26	< LOD	9.37	403.7	18.09	< LOD	84.52	< LOD	65.92	3169.9	25.17	68868.7	196.65	< LOD
187	TP-FP-21A(3.4-3.7)	35751	719.35	654.93	29.23	< LOD	23.65	606441	4482.19	< LOD	25.05	< LOD	10.85	308.4	26	< LOD	105.1	85.43	37.12	2460.8	24.68	95951.1	277.39	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
188	TP-FP-21A(3.4-3.7)	34921	703.78	690.69	29.52	< LOD	24.17	604509	4394.27	< LOD	25.13	< LOD	11.01	350.8	25.97	< LOD	106.6	84.52	37.23	2474	24.89	96616.3	284.68	< LOD
189	TP-FP-21A(4.7-4.8)	57015	567.82	23.86	2.98	< LOD	5.13	630535	2125.24	12.54	2.03	< LOD	6.83	366.7	15.39	< LOD	61.5	< LOD	70.77	179.72	7.22	42566.5	126.78	< LOD
190	TP-FP-22 (0.1-0.3)	29822	648.21	270.1	10.03	< LOD	9.6	541753	4352.15	13.33	4.45	< LOD	8.98	635.4	21.44	< LOD	118.52	< LOD	63.8	521.5	12.26	154517	378.78	< LOD
191	TP-FP-22 (0.4-1.2)	41372	503.33	29.58	2.13	< LOD	4.28	635785	2251.22	15.06	1.7	< LOD	6.43	190.7	15.12	< LOD	59.85	< LOD	64.36	222.62	7.21	44219.6	125.32	< LOD
192	TP-FP-22 (0.7-1.2)	46050	873.08	163.7	6.93	< LOD	7.91	517174	4864.92	10.06	3.2	11.89	4.48	356.4	24.89	< LOD	96.76	< LOD	68.26	825.87	13.56	94989.1	241.72	< LOD
193	TP-FP-22 (2.0-2.3)	56576	567.11	9.8	1.28	< LOD	4.37	632786	2152.77	15.28	1.74	< LOD	6.64	349.5	15.57	< LOD	56.71	< LOD	72.51	23.07	5.53	34800.1	112.98	< LOD
194	TP-FP-22 (3.7-3.9)	51950	578.68	42.57	2.6	< LOD	4.9	627301	2444.33	18.35	1.95	< LOD	6.82	607.7	16.69	< LOD	65.79	< LOD	69.99	115.57	6.54	51256.4	142.23	< LOD
195	TP-FP-22 (5.5-6)	55407	548.24	19.78	1.69	< LOD	4.33	643492	2072.24	16.76	1.72	< LOD	6.38	204.3	14.41	< LOD	59.44	< LOD	68.81	56.41	5.66	43452.7	122.79	< LOD
196	TP-FP-22 (7.5-8)	55400	546.65	17.91	1.49	< LOD	4.24	638794	2089.32	16.27	1.7	< LOD	6.55	177.3	14.32	< LOD	59.74	< LOD	69.15	54.16	5.78	40606.9	121.07	< LOD
197	TP-FP-22 (9-9.5)	52934	540.65	16.46	1.61	< LOD	4.36	643590	2158.16	18.63	1.77	< LOD	6.55	234.1	14.64	< LOD	57.64	< LOD	70.9	59.13	5.86	37482.7	116.49	< LOD
198	TP-FP-22A DUP(0.7-1.2)	49562	895.98	168.19	7.13	< LOD	8.05	516110	4811.64	14.1	3.32	< LOD	8.98	218.2	24.14	< LOD	95.19	< LOD	69.98	765.01	13.2	92601	237.8	< LOD
199	TP-FP-25(4.3-4.5)	59182	616.26	25.53	2.78	< LOD	4.89	596281	2360.2	22.33	2.03	< LOD	6.67	259	15.77	< LOD	63.27	< LOD	68.17	209.34	7.32	47856.3	133.36	< LOD
200	TP-FP-25(6-6.2)	61309	617.52	30.78	3.29	< LOD	5.19	618950	2316.13	12.12	2.07	< LOD	6.82	249	15.33	< LOD	64.89	< LOD	67.58	342.2	8.49	49797.7	136.73	< LOD
201	TP-FP-25(7.5-8)	60651	608.24	22.82	2.81	< LOD	4.85	615464	2265.16	16.04	1.99	< LOD	6.59	291.4	15.71	< LOD	59.52	< LOD	69.53	158.98	6.84	42123.6	122.97	< LOD
202	TP-FP-25(7.5-8)	61268	617.79	29.64	2.85	< LOD	4.9	613794	2305.08	14.19	1.98	< LOD	6.7	256.9	15.66	< LOD	60.75	< LOD	69.94	155.96	6.91	42190.2	124.91	< LOD
203	TP-FP-25 (0.4-0.9)	30691	628.32	226.8	7.9	< LOD	8.66	549756	4101.9	10.98	3.56	< LOD	8.65	514.5	20.04	< LOD	114.75	< LOD	63.66	292.13	9.94	151339	363.11	< LOD
204	TP-FP-25 (1.1-1.2)	6998	273.84	66.7	3.5	< LOD	4.59	816010	2082.6	4.74	1.82	< LOD	6.35	629.2	16.16	< LOD	59.29	< LOD	52.69	943.72	11.61	48992.1	127.2	< LOD
205	TP-FP-25 (1.7-2.1)	50451	546.22	13.84	1.32	< LOD	4.11	640933	2261.34	14.22	1.6	< LOD	6.26	127.6	14.95	< LOD	52.26	< LOD	68.1	32.14	5.32	33154.6	104.46	< LOD
206	TP-FP-25 (10-10)	52894	553.07	21.91	2.59	< LOD	4.95	631557	2157.62	13.82	1.93	< LOD	6.81	195.7	14.82	< LOD	64.92	< LOD	68.65	129.61	6.74	48323.7	136.31	< LOD
207	TP-FP-25A(1.3-1.8)	26351	644.82	172.25	8.43	< LOD	8.91	615158	4229.65	10.41	3.82	< LOD	9.14	404.6	24.36	139.49	50.12	< LOD	69.79	773.17	13.46	100327	253.08	< LOD
208	TP-FP-25A(1.3-1.8)DUP	45614	903.79	202.58	8.63	< LOD	9.04	501730	5196.58	16.96	3.93	12.33	4.67	260.9	24.9	116.46	52.29	< LOD	71.04	684.11	13.11	106099	270.37	< LOD
209	TP-FP-26(4-4.5)	41620	641.29	261.61	12.09	< LOD	11.27	583831	3332.85	< LOD	10.71	38.29	13.67	446.7	18.87	< LOD	104.2	< LOD	66.06	1050.4	15.55	112793	284.08	< LOD
210	TP-FP-26(6-6.5)	47380	710.04	210.7	10.87	< LOD	10.12	574869	3628.41	< LOD	8.91	20.63	7.37	397.8	20.15	< LOD	94.89	< LOD	70.25	860.57	13.78	94585.4	239.96	< LOD
211	TP-FP-26(9-9.5)	39972	669.67	242.51	9.73	< LOD	9.73	572531	3864.01	< LOD	8.08	30.04	10.73	468.3	19.91	< LOD	103.27	< LOD	69.77	908.04	14.72	112419	286.28	< LOD
212	TP-FP-26 (0.7-1)	23702	688.58	311.34	10.26	< LOD	10.47	519434	5503.42	< LOD	8.18	16.01	5.72	467.6	22.44	< LOD	130.9	< LOD	64.86	584.8	13.47	186165	458	< LOD
213	TP-FP-26 (1.8-2)	28475	488.78	251.47	10.99	< LOD	10.44	652993	2651.87	< LOD	9	< LOD	9.66	666.7	17.41	< LOD	111.65	< LOD	63.64	763.87	13.78	149031	353.32	< LOD
214	TP-FP-27(4-5.2)	68368	683.64	22.1	2.23	< LOD	4.91	579695	2404.95	9.43	1.71	< LOD	7	742.3	17.6	< LOD	76.7	< LOD	65.74	832.56	11.92	70637.2	174.32	< LOD
215	TP-FP-27 (0-0.4)	48967	770.36	260.3	7.97	13.8	4.96	551509	3948.25	< LOD	7.09	28.34	10.12	370.9	20.73	< LOD	106.29	< LOD	69.96	922.55	14.81	115686	290.25	< LOD
216	TP-FP-27 (0.5-0.8)	50667	1052.32	266.55	9.59	< LOD	10.16	461751	6196.15	8.84	4.23	27.93	9.98	317.1	26.41	304.17	57.35	< LOD	71.33	1611.2	19.67	121489	311.7	14508.8
217	TP-FP-27 (0.9-1.2)	30716	738.2	218.97	10.69	< LOD	10.53	557676	5214.8	10.81	4.76	< LOD	9.36	355.4	23.86	< LOD	107.46	< LOD	66.37	697.67	13.01	126781	319.13	< LOD
218	TP-FP-27A(0.5-0.8) DUP	52452	1054.04	274.25	9.71	< LOD	10.04	474446	6164.93	10.08	4.29	37.17	13.27	807.6	27.79	296.69	58.39	< LOD	71.54	1961.2	21.56	126684	325.78	< LOD
219	TP-FP-31(1-1.8)	32589	411.24	16.5	1.6	< LOD	4.47	701170	1849.03	15.98	1.72	< LOD	6.64	294.4	14.61	< LOD	62.31	< LOD	69.17	104.23	6.35	44627.4	129.25	< LOD
220	TP-FP-31(2-2.75)	42939	507.74	23.09	1.77	< LOD	4.82	672275	2204.18	17.94	1.81	< LOD	6.93	238.1	14.9	< LOD	63.98	< LOD	71.34	286.32	8.18	43540.1	130.55	< LOD
221	TP-FP-31(4.5-5)	56296	556.7	19.69	1.69	< LOD	4.5	643927	2063.81	19	1.76	< LOD	6.58	257.8	14.7	< LOD	57.8	< LOD	69.25	121.58	6.51	38692.3	117.15	< LOD
222	TP-FP-31(6.5-7)	55848	566.41	25.2	1.77	< LOD	4.27	650236	2143.15	12.48	1.68	< LOD	6.58	259.9	15.03	< LOD	59.11	< LOD	69.28	173.07	6.95	40857.8	120.74	< LOD
223	TP-FP-31(7-7.5)	46336	479.32	14.21	1.55	< LOD	4.17	701964	1903.97	12.57	1.54	< LOD	6.06	251.7	14.4	< LOD	48.54	< LOD	64.9	76.57	5.63	28100.4	93.8	< LOD
224	TP-FP-31(9-9.5)	49862	564.71	68.12	3.55	< LOD	5.21	627258	2410.19	12.3	2.1	< LOD	6.98	279.3	15.19	< LOD	75.67	< LOD	65.2	185.8	7.32	69127.9	172.53	< LOD
225	TP-FP-31 REP(9-9.5)	50974	576.6	75.31	3.61	< LOD	5.38	622185	2450	12.15	2.12	< LOD	7.13	277.6	15.28	< LOD	76.83	< LOD	65.46	202.18	7.56	70134.9	176.48	< LOD
226	TP-FP-32(0-0.4)	19408	540.9	225.58	7.19	< LOD	7.92	616157	4103.37	< LOD	6.39	< LOD	8.58	486.2	20.51	< LOD	108.48	< LOD	63.33	670.14	12.91	133149	321.1	< LOD
227	TP-FP-32(1.3-1.4)	21702	636.79	218.43	7.28	< LOD	8.03	565574	4996.88	< LOD	6.52	< LOD	8.54	509.1	22.73	< LOD	111.86	< LOD	62.52	712.28	13.12	147909	347.61	< LOD
228	TP-FP-32(1.4-1.5)	36450	573.12	71.18	5.25	< LOD	5.67	659767	3145.65	5.32	2.51	< LOD	6.58	355.9	18.76	< LOD	64.93	< LOD	59.35	412.72	8.71	54943.2	143.26	< LOD
229	TP-FP-32(2.4-2.7)	43545	569.2	28.17	1.73	< LOD	4.52	641117	2735.64	13.15	1.7	< LOD	6.79	265.6	16.3	< LOD	69.97	< LOD	66.02	81.32	6.2	60153.5	157.23	< LOD
230	TP-FP-32(7-7.5)	59902	614.88	19.11	1.74	< LOD	4.66	622657	2327.72	15.38	1.76	< LOD	6.79	259.5	15.41	< LOD	65.51	< LOD	70.02	108.5	6.56	49637.3	138.75	< LOD
231	TP-FP-32(8.5-9)	59104	582.49	18	1.81	< LOD	4.45	601868	2121.21	15.28	1.69	< LOD	6.4	177.2	14.8	< LOD	58.01	< LOD	68.4	88.03	6.01	40085.4	117.11	< LOD
232	TP-FP-32(10.5-11)	64613	651.27	26.54	2.06	< LOD	4.8	593528	2386.82	14.73	1.8	< LOD	6.82	282.5	15.66	< LOD	66.23	< LOD	69.43	107.49	6.54	49658.3	138.84	< LOD
233	TP-FP-33(0-0.5)	50439	1054.73	329.96	11.21	< LOD	11.12	431857	6369.9	< LOD	9.6	29.3	10.47	379.2	26.39	< LOD	125.32	< LOD	70.81	1169.5	17.7	148502	378.16	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
234	TP-FP-33(2.3-2.6)	58469	630.49	20.06	2.23	< LOD	4.6	606565	2529.8	16.17	1.83	< LOD	6.61	138.2	15.42	< LOD	64.12	< LOD	67.61	57.61	5.84	49295.5	135.67	< LOD
235	TP-FP-33(3.5-4)	63388	628.55	44.14	4.21	< LOD	5.53	618577	2335.66	8.73	2.31	< LOD	6.78	288	15.19	< LOD	61.5	< LOD	66.94	597.08	10.13	44909.7	127.86	< LOD
236	TP-FP-33(5.9-6.2)	56610	578.63	40.76	3.27	< LOD	5.02	630535	2203.87	15.85	2.11	< LOD	6.85	246.2	14.97	< LOD	63.41	< LOD	67.57	518.54	9.74	46187	131.44	< LOD
237	TP-FP-33(8-8.5)	64432	677.95	87.06	4.48	< LOD	5.69	594087	2556.44	15.6	2.43	< LOD	6.91	317.6	16.65	< LOD	66.36	< LOD	69.45	449.44	9.36	50667.2	140.61	< LOD
238	TP-FP-34(0-0.6)	55473	561.83	29.91	2.36	< LOD	4.42	623914	2126.15	15.87	1.78	< LOD	6.3	273.1	15.09	< LOD	58.62	< LOD	64.99	168.9	6.63	42872.8	120.17	< LOD
239	TP-FP-34(1.2-1.7)	63629	645.28	21.25	2.04	< LOD	4.38	579342	2359.47	16.24	1.75	< LOD	6.49	166.3	15.58	< LOD	62.72	< LOD	67.11	122.19	6.39	48009.6	131.17	< LOD
240	TP-FP-34(3.5-4)	62015	605.9	20.75	2.14	< LOD	4.69	616454	2198.45	17.45	1.82	< LOD	6.58	271.3	15.04	< LOD	63.02	< LOD	66.71	174.5	6.95	46159.8	129.99	< LOD
241	TP-FP-34(6-6.3)	60100	602.41	15.73	2.83	< LOD	4.66	626044	2226.13	11.35	1.87	< LOD	6.43	752.4	17.09	< LOD	62.5	< LOD	63.23	259.66	7.49	49038.1	131.8	< LOD
242	TP-FP-34(7.5-8)	70807	741.73	26.28	4.85	< LOD	6.27	566190	2751.89	13.86	2.59	< LOD	7.42	438.9	16.62	< LOD	87.71	< LOD	65.61	471.48	10.12	92902.9	218.89	< LOD
243	TP-FP-34(8.5-9)	77104	738.1	10.01	3.73	< LOD	5.33	577367	2497.8	10.31	2.19	< LOD	6.94	363.5	16.13	< LOD	72.99	< LOD	65.61	325.33	8.48	63431.2	162.44	< LOD
244	TP-FP-34(10-10.5)	72752	673.57	32.34	3.35	< LOD	5.24	606677	2283.54	19.59	2.13	< LOD	6.74	410.8	15.52	< LOD	68.95	< LOD	64.31	937.01	12.11	59493.2	151.84	< LOD
245	TP-FP-34(12.5-13)	77329	717.11	21.67	2.8	< LOD	4.98	581850	2379.18	19.23	2.01	< LOD	6.8	309.9	15.78	< LOD	66.54	< LOD	67.84	1212.8	13.69	52184.6	141.69	< LOD
246	TP-FP-34 REP(10-10.5)REP	74117	683.52	19.4	3.45	< LOD	5.19	601735	2342	15.04	2.15	< LOD	6.88	357.1	15.15	< LOD	71.08	< LOD	65.58	906.36	12.13	61098.4	156.89	< LOD
247	TP-FP-35(0.5-0.7)	57734	571.02	20.75	1.93	< LOD	4.32	609377	2108.52	11.39	1.6	< LOD	6.23	226.1	14.97	< LOD	54.96	< LOD	65.46	72.41	5.72	36448	109.78	< LOD
248	TP-FP-35(2.3-2.8)	25741	356.17	13.58	1.58	< LOD	4.32	763949	1628.55	17.05	1.67	< LOD	6.28	888.5	17.02	< LOD	55.96	< LOD	66.82	79.98	5.81	37748.4	112.24	< LOD
249	TP-FP-35(4-4.3)	23836	789.91	361.64	8.75	< LOD	9.05	521540	6469.92	14.58	3.82	< LOD	8.82	327.7	26.63	< LOD	118.11	< LOD	67.14	860.22	14.62	152999	383.36	< LOD
250	TP-FP-35(6-6.4)	41093	535.31	100.65	5.93	< LOD	6.53	636225	2575.65	13.1	2.94	< LOD	7.4	376.5	16.27	< LOD	81	< LOD	65.71	185.94	7.65	78877.9	197.62	< LOD
251	TP-FP-35(8.5-9)	73086	687.4	29.66	2.4	< LOD	5.18	609766	2359.28	17.42	1.9	< LOD	6.85	403.2	15.56	< LOD	70.02	< LOD	66.65	359.94	8.65	60136.8	155.47	< LOD
252	TP-FP-35(9-9.8)	81229	768.22	23.24	2.72	< LOD	5.9	587513	2576.02	17.31	2.03	< LOD	7.14	751.3	17.35	< LOD	76.24	< LOD	68.38	563.53	10.43	68964.4	174.82	< LOD
253	TP-FP-35(12.5-13)	63524	642.33	39.67	3.39	< LOD	5.28	612445	2418.57	12.62	2.08	< LOD	6.88	682.6	16.7	< LOD	71.41	< LOD	66.5	224.4	7.59	62312.8	159.77	< LOD
254	TP-FP-35A(4-4.3)DUP	24936	870.73	372.01	9.11	< LOD	9.82	498899	7094.93	7.9	3.86	< LOD	9.27	391.6	29.29	< LOD	122.16	< LOD	69.36	583.19	13.01	154953	396.21	< LOD
255	TP-FP-35A(8.5-9)	55665	544.82	< LOD	3.61	< LOD	4.35	646874	2031.1	16.3	1.72	< LOD	6.39	611.8	15.79	< LOD	55.85	< LOD	65.76	89.08	6.06	37365.4	113.3	< LOD
256	TP-FP-36(1-1.5)	58005	641.25	107.49	6.78	< LOD	7.09	587384	2536.88	13.52	3.26	< LOD	7.51	396.9	16.84	< LOD	82.81	< LOD	65.64	343.53	9.07	82575.4	202.94	< LOD
257	TP-FP-36(3.5-4)	62704	609.8	32.91	2.35	< LOD	4.73	610528	2240.55	16.65	1.84	< LOD	6.79	280.4	14.87	< LOD	67.44	< LOD	67.05	191.36	7.27	54726.1	145.04	< LOD
258	TP-FP-36(6.5-7)	67674	666.25	21.75	2.98	< LOD	4.89	600350	2402.84	15.18	2.04	< LOD	6.92	436.2	16.22	< LOD	69.3	< LOD	66.48	176.16	7.28	55221.1	149.43	< LOD
259	TP-FP-36(9.5-10)	67441	651.13	15.38	1.97	< LOD	5.5	601088	2309.82	18.82	1.86	< LOD	6.83	564.6	16.41	< LOD	68.58	< LOD	68.28	95.67	6.41	54795.8	147.46	< LOD
260	TP-FP-36(10-10.5)	62809	599.95	15.67	2.1	< LOD	4.86	614105	2122.19	20.83	1.92	< LOD	6.96	526.3	15.75	< LOD	69.03	< LOD	69.06	141.36	7.02	53516.2	148.08	< LOD
261	TP-FP-37(0.5-1)	33906	524.44	216.3	8.99	< LOD	8.7	634528	2931.07	15.9	4.09	< LOD	8.17	544.8	17.28	< LOD	97.58	< LOD	65.31	342.77	9.73	111803	273.66	< LOD
262	TP-FP-37(2.5-3)	29184	606.24	163.15	8.08	< LOD	8.03	617554	3984.16	9.96	3.69	< LOD	7.85	483.9	21.49	< LOD	91.01	< LOD	66.3	353.45	9.5	99049.9	245.46	< LOD
263	TP-FP-37(4.5-5)	50231	568.13	113.2	9.27	< LOD	8.66	641019	2402.54	< LOD	8.42	< LOD	7.51	539.8	16.73	< LOD	76.02	< LOD	67.05	668.91	11.25	68249.9	176.79	< LOD
264	TP-FP-37(7.5-8)	66847	674.77	87.99	5.86	< LOD	6.58	603629	2468.32	11.95	2.93	< LOD	7.36	581.3	16.86	< LOD	76.83	< LOD	68.02	584.78	10.69	67730.1	174.64	< LOD
265	TP-FP-37(9.5-10)	71057	709.01	36.87	3.18	< LOD	5.4	587165	2509.39	15.18	2.1	< LOD	7.26	548.1	16.89	< LOD	76.28	< LOD	67.96	400.41	9.4	65777.8	170.43	< LOD
266	TP-FP-37(11.5-12)	71797	690.98	35.69	3.04	< LOD	5.2	587800	2397.97	18.34	2.08	< LOD	7	467.7	16.41	< LOD	67.84	< LOD	70.29	297.24	8.36	51695.1	143.63	< LOD
267	TP-FP-37 REP(7.5-8)REP	69501	701.36	92.96	5.82	< LOD	6.45	597915	2546.86	6.7	2.87	< LOD	7.28	554.9	16.88	< LOD	76.22	< LOD	67.09	578.39	10.59	67743.3	173.68	< LOD
268	TP-FP-38(2-2.5)	55429	580.94	17.47	1.98	< LOD	4.43	623928	2254.56	11.97	1.72	< LOD	6.52	1716	20.61	< LOD	60.13	< LOD	67.81	244.15	7.48	42765.2	123.21	< LOD
269	TP-FP-38(5-5.4)	65832	656.82	22	1.89	< LOD	4.69	592227	2413.36	16.11	1.79	< LOD	6.81	603.1	16.91	< LOD	67.84	< LOD	68	139.39	6.84	54919.5	145.99	< LOD
270	TP-FP-38(7.5-8)	67671	673.19	26.85	2.79	< LOD	5.66	594274	2417.19	16.16	2.02	< LOD	7.08	657.5	16.87	< LOD	72.69	< LOD	69.15	260.4	8.11	62199.9	162.02	< LOD
271	TP-FP-38(9.5-10)	64916	630.28	16.72	1.92	< LOD	4.59	614558	2285.36	19.09	1.8	< LOD	6.74	881	17.21	< LOD	66.71	< LOD	67.14	182.52	7.15	54830.2	144.81	< LOD
272	TP-FP-38(11.5-12)	48935	536.28	23.23	2.28	< LOD	4.94	656187	2137.22	15.23	1.87	< LOD	7.02	1843	20.49	< LOD	70.89	< LOD	68.63	198.12	7.57	56275.4	153.19	< LOD
273	TP-FP-38(14.5-15)	43920	477.94	10.74	1.58	< LOD	4.4	660904	1887.28	18.7	1.67	< LOD	6.41	1819	20.23	< LOD	55.57	< LOD	68.97	41.36	5.56	34896.1	109.93	< LOD
274	TP-FP-38A(0.5-1)	53516	719.17	168.03	16.94	< LOD	14.52	581077	3323.49	< LOD	14.24	22.82	8.15	719.7	21.48	< LOD	83.11	88.94	36.71	2222	20.89	66964.7	189.62	< LOD
275	TP-FP-38A(0.5-1)DUP	51455	689.54	< LOD	33.77	< LOD	14.24	592208	3186.07	< LOD	14.2	17.6	6.29	554.8	20.76	< LOD	80.75	< LOD	71.23	2310.9	21.18	62189.4	179.98	< LOD
276	TP-FP-38A(1-1.5)	53932	724.61	327.86	16.16	< LOD	13.61	607713	3245.91	< LOD	13.19	< LOD	8.53	667.8	22.4	< LOD	73.29	< LOD	73.17	1695.6	17.76	51588.1	157.66	< LOD
277	TP-FP-38A(2.5-3)	13683	568.6	1092.1	34.18	< LOD	27.43	624461	5021.83	< LOD	28.97	< LOD	11.89	529.9	25.94	< LOD	128.65	78.13	35.62	2338.7	26	146157	414.2	< LOD
278	TP-FP-38A(4.5-5)	60017	645.65	58.47	5.86	< LOD	6.57	608716	2511.07	17.36	2.96	< LOD	7.07	672.5	17.77	< LOD	70.42	< LOD	69.29	1147.5	13.51	57959.2	152.91	< LOD
279	TP-FP-38B(0.5-1)	25806	493.35	239.68	10.17	< LOD	9.61	628106	3096.34	< LOD	8.96	< LOD	8.49	658.5	18.16	< LOD	105.82	< LOD	62.63	301.51	9.66	131690	310.85	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
280	TP-FP-39(0.9-1.6)	56998	584.4	9.93	1.61	< LOD	4.38	595914	2172.68	18.06	1.75	< LOD	6.5	274.6	15.78	< LOD	59.68	< LOD	69.73	67.5	5.87	39443.9	118.15	< LOD
281	TP-FP-39(3.5-4.2)	59274	599.85	10.31	1.66	< LOD	4.41	586548	2200.89	16.2	1.68	< LOD	6.54	553.7	16.82	< LOD	59.87	< LOD	68.53	196.88	7.14	41084.3	121.68	< LOD
282	TP-FP-39(12.5-13)	56215	560.4	14.51	2.14	< LOD	4.57	616482	2116.57	15.75	1.77	< LOD	6.6	374.5	15.06	< LOD	64.34	< LOD	66.86	220.02	7.35	49276.5	135.3	< LOD
283	TP-FP-39A(6-6.5)	66548	733.24	16.13	2.42	< LOD	6.29	544532	2751.08	12.03	1.83	< LOD	7.56	778.1	18.71	< LOD	89.54	< LOD	67.8	897.23	13.05	89493.6	221.86	< LOD
284	TP-FP-39A(9.5-10)	62768	664.49	5.49	2.38	< LOD	4.98	561114	2450.36	11.69	1.76	< LOD	6.92	463.9	17.16	< LOD	71.3	< LOD	69.2	430.47	9.33	57365.1	153.91	< LOD
285	TP-FP-39A REP(9.5-10)	62408	660.6	< LOD	4.69	< LOD	4.83	560347	2457.97	12.66	1.76	< LOD	6.88	473.4	17.09	84.05	35.83	< LOD	68.81	408.11	9.08	57198.9	152.31	< LOD
286	TP-FP-39DUP(0.9-1.6)	58015	595.45	10.45	1.56	< LOD	4.23	589323	2201.71	15.06	1.67	< LOD	6.38	501.7	16.88	< LOD	55.69	< LOD	68.48	59.77	5.69	36514.1	111.37	< LOD
287	TP-FP-40(0-0.5)	57608	578.16	20.83	2.57	< LOD	4.52	599048	2126.28	11.5	1.78	< LOD	6.37	438.5	15.84	< LOD	59.88	< LOD	64.49	116.91	6.24	44245.8	124	< LOD
288	TP-FP-40(1.5-2)	56607	554.87	13.81	2.06	< LOD	4.5	633566	2099.9	13.15	1.75	< LOD	6.6	374.8	14.82	< LOD	64.45	< LOD	67.49	82.79	6.07	50295.7	136.59	< LOD
289	TP-FP-40(3.5-3.8)	57379	569.74	9.67	2.43	< LOD	4.86	624146	2096.74	16.03	1.84	< LOD	6.82	477.5	15.21	< LOD	71.77	< LOD	64.14	338.46	8.47	63315.1	159.73	< LOD
290	TP-FP-40(6-6.2)	66062	695.4	17.77	3.38	< LOD	6.57	564173	2568.19	10.26	2.03	< LOD	7.48	617.9	16.77	< LOD	90	< LOD	65.53	506.83	10.43	97568	229.38	< LOD
291	TP-FP-40(6.5-6.8)	63195	632.46	14.59	2.61	< LOD	4.91	578902	2298.3	12.97	1.8	< LOD	6.77	604.7	16.67	< LOD	70.31	< LOD	64.59	1852.6	16.56	59014.9	152.2	< LOD
292	TP-FP-40(8.5-9)	59236	617.71	7.14	3.06	< LOD	5.29	604081	2315.09	11.06	1.91	< LOD	7.09	649.5	16.5	< LOD	81.85	< LOD	64.23	250.78	8.03	82685.1	196.4	< LOD
293	TP-FP-40(13-13.5)	71002	758.37	21.55	3.76	< LOD	5.75	550953	2780.46	11.73	2.16	< LOD	7.61	644	17.35	< LOD	93.51	< LOD	66	312.89	9.07	105905	246.76	< LOD
294	TP-FP-40(14.5-15)	67190	620.54	16.79	2.51	< LOD	4.88	622457	2173.48	14.5	1.91	< LOD	6.82	442.8	15.19	< LOD	66.67	< LOD	68.82	787.98	11.42	51790.5	141.41	< LOD
295	TP-FP-40A(8.5-9)	60232	630.9	< LOD	5.84	< LOD	5.1	594359	2378.05	10.8	1.88	< LOD	7.14	600.1	16.32	< LOD	82.31	< LOD	63	256	8.09	84038.5	198.86	< LOD
296	TP-FP-41(0.3-0.7)	19988	395.99	179.65	6.8	< LOD	7.37	677492	2410.4	< LOD	6.18	< LOD	7.86	675.7	16.31	< LOD	98.04	< LOD	59.2	302.46	9.1	123175	281.43	< LOD
297	TP-FP-41(0.5-0.8)	50477	930.4	137.45	6.93	< LOD	7.83	506693	5022.35	12.32	3.26	27.84	9.94	498.7	25.49	< LOD	96.04	< LOD	69.44	679.4	12.57	94387.7	240.72	9228.62
298	TP-FP-41(2-2.5)	51818	583.98	66.72	5.04	< LOD	6.23	623404	2395.99	18.55	2.72	< LOD	7.53	638.2	16.36	< LOD	84.79	< LOD	67.19	283.72	8.66	85438.3	210.88	< LOD
299	TP-FP-41(4-4.5)	61532	577.13	27.32	3.63	< LOD	5.2	659830	2058.23	24.1	2.24	< LOD	6.73	924.3	16.22	< LOD	71.53	< LOD	61.97	529.33	9.69	65482.8	161.58	< LOD
300	TP-FP-41(5.5-6)	68501	645.04	32.7	3.87	< LOD	5.14	648188	2276.54	17.83	2.25	< LOD	7.02	621	15.32	< LOD	79.13	< LOD	62.13	659.38	10.84	79766.7	190.36	< LOD
301	TP-FP-41(8.5-9)	65213	610.96	31.04	2.8	< LOD	4.97	638668	2151.22	15.81	1.97	< LOD	6.92	594.2	15.29	< LOD	73.06	< LOD	65.58	401.25	9.04	64293.8	164.21	< LOD
302	TP-FP-41(10.5-11)	55556	553.78	11.53	2.12	< LOD	4.72	632948	2102.61	13.27	1.76	< LOD	6.76	514.5	15.14	< LOD	67.73	< LOD	66.91	204.88	7.33	54984.7	146.29	< LOD
303	TP-FP-42(0.5-1)	52084	830.77	133.43	8.99	< LOD	8.83	532154	4160.67	< LOD	8.09	16.56	5.92	440	22.5	< LOD	91.53	< LOD	67.82	735.15	12.64	91090.3	228.39	< LOD
304	TP-FP-42(2-2.6)	55996	576.79	27.71	2.43	< LOD	4.89	646870	2265.54	13.1	1.85	< LOD	6.8	787.5	16.86	< LOD	64.44	< LOD	69.23	177.69	7.14	48211.7	136.17	< LOD
305	TP-FP-42(4.2-4.8)	55799	574.26	24.12	1.91	< LOD	4.7	628633	2216.83	12.25	1.72	< LOD	6.78	419.9	15.49	< LOD	68.67	< LOD	66.49	92.49	6.3	55962.4	148.33	< LOD
306	TP-FP-42(4.8-5.2)	54361	520.5	9.1	1.92	< LOD	4.25	657596	1918.13	12.85	1.65	< LOD	6.31	321	14.39	< LOD	50.57	< LOD	66.77	143.02	6.42	29444.8	98.58	< LOD
307	TP-FP-42(6-6.1)	68821	661.87	20.31	1.95	< LOD	4.79	614949	2354.06	15.48	1.83	< LOD	6.86	401.2	15.65	< LOD	67.62	< LOD	69.33	363.48	8.67	54307.7	145.93	< LOD
308	TP-FP-42(6.6-7)	67826	651.25	17.76	1.97	< LOD	5.63	610142	2329.19	16.4	1.8	< LOD	6.82	429.8	15.58	< LOD	66.71	< LOD	67.27	407.37	8.98	52843.8	143.37	< LOD
309	TP-FP-42(10-10.5)	78829	745.17	28.54	2.4	< LOD	5.7	587816	2505.95	13.82	1.88	< LOD	7.16	537.1	16.29	< LOD	78	< LOD	67.31	779.06	11.76	73892.9	182.44	< LOD
310	TP-FP-42(12-12.5)	63843	617.39	19.75	2.02	< LOD	4.83	608080	2216.86	17.02	1.81	< LOD	6.85	394.6	15.23	< LOD	69.82	< LOD	67.33	245.34	7.73	57115.9	150.72	< LOD
311	TP-FP-42(15.6-16)	62762	623.77	14.36	2.84	< LOD	4.93	585996	2259.03	11.93	1.9	< LOD	6.8	403.7	15.7	< LOD	68.12	< LOD	66.93	232.48	7.61	53939.2	145.17	< LOD
312	TP-FP-42 REP(2-2.6)REP	55234	562.16	27.53	2.59	< LOD	4.86	646337	2166.37	13.15	1.92	< LOD	6.84	1014	17.26	< LOD	69	< LOD	68.05	208.78	7.46	55835.7	149.32	< LOD
313	TP-FP-42A(0.5-0.8)	32541	497.28	149.86	8.06	< LOD	7.89	648298	2742.55	< LOD	7.3	< LOD	7.41	661.6	17.78	< LOD	83.68	< LOD	61.81	290.37	8.49	87820	211.87	< LOD
314	TP-FP-43(1.2-1.4)	38712	510.99	159.44	7.33	< LOD	7.54	650378	2461.1	15	3.47	< LOD	7.93	524.3	16.4	< LOD	90.13	< LOD	67.73	443.11	10.25	97114.7	234.47	< LOD
315	TP-FP-43(4-4.3)	59328	645.43	56.05	4.16	< LOD	5.93	609357	2486.27	12.59	2.36	< LOD	7.48	543.3	16.18	< LOD	83.92	< LOD	67.26	471.51	10.15	83579.5	205.59	< LOD
316	TP-FP-43(6-6.5)	65167	627.66	30.82	2.78	< LOD	4.78	615400	2241.24	14.99	2.02	< LOD	7.13	461.7	15.55	< LOD	74.4	< LOD	67.9	352.05	8.9	62799.2	173.25	< LOD
317	TP-FP-43(9-9.5)	65155	629.82	26.66	2.38	< LOD	4.78	623295	2239.2	16.62	1.9	< LOD	6.89	468.4	15.72	< LOD	70.13	< LOD	66	306.51	8.3	59074.6	154.65	< LOD
318	TP-FP-43(11-11.5)	54941	539.1	17.8	1.87	< LOD	4.42	645372	2023.75	17.1	1.73	< LOD	6.46	600.8	15.45	< LOD	62.02	< LOD	66	136.53	6.48	47221.1	129.53	< LOD
319	TP-FP-44(0-0.7)	57687	894.1	< LOD	68.92	< LOD	28.3	497527	4428.86	< LOD	30.74	< LOD	12.13	434.4	24.18	< LOD	111.95	164.53	39.22	3636.9	31.88	96862.2	294.78	< LOD
320	TP-FP-44(0.7-1)	46425	512.45	53.17	5.2	< LOD	6.32	677348	2052.48	11.27	2.68	91.66	32.73	618.9	16.21	< LOD	60.92	< LOD	64.93	3038	21.77	41372.4	124.96	< LOD
321	TP-FP-44(2-2.5)	59591	602.21	21.91	2.06	< LOD	4.9	597575	2228.99	17.58	1.86	13.96	4.98	419.9	15.85	< LOD	67.76	< LOD	67.71	281.8	8.22	52559.6	143.67	< LOD
322	TP-FP-44(2.5-3)	51899	556.2	43.69	3.68	< LOD	5.12	619943	2215.06	13.17	2.16	< LOD	6.62	636.1	16.46	< LOD	64.5	< LOD	64.1	544.58	9.62	51853.5	138.14	< LOD
323	TP-FP-44(4-4.5)	63298	647.86	22.34	2.32	< LOD	4.89	579082	2401.51	12.13	1.84	< LOD	6.94	348.4	16.16	< LOD	69.59	< LOD	69.72	185.42	7.35	57612	151.09	< LOD
324	TP-FP-44(6-6.5)	50988	601.42	82.57	2.67	< LOD	6.36	624666	2530.67	8.6	1.84	< LOD	7.74	618.9	16.49	< LOD	91.41	< LOD	64.28	199.67	8.19	104218	243.1	< LOD
325	TP-FP-44(11.5-12)	37118	423.41	16.94	2.09	< LOD	4.6	718562	1779.48	11.88	1.75	< LOD	6.7	572.8	15.16	< LOD	64.64	< LOD	67.06	114.41	6.52	48868.9	136.61	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
326	TP-FP-44(13-13)	60938	602.89	26.32	2.98	< LOD	4.82	607028	2226.73	16.79	2	< LOD	6.64	347.2	15.38	< LOD	63.5	< LOD	66.63	184.92	7.06	48847.7	133.52	< LOD
327	TP-FP-44A(0-0.7)	48596	738.35	< LOD	62.91	< LOD	25.62	546966	3788.68	< LOD	27.5	< LOD	11.32	547.9	22.08	< LOD	109.52	< LOD	73.05	3048.2	27.88	104098	303.33	< LOD
328	TP-FP-44A(8-8.5)	19008	330.7	37.48	3.31	< LOD	5.21	808671	1670.74	15.77	2.14	< LOD	6.86	813.3	17.31	< LOD	69.09	< LOD	65.73	202.53	7.42	57097	149.72	< LOD
329	TP-FP-44A REP(8-8.5)REP	12708	282.03	37	3.22	< LOD	4.98	844553	1582.51	15.72	2.1	< LOD	6.77	850.8	17.45	< LOD	67.39	< LOD	65.64	196.98	7.32	54617.5	144.73	< LOD
330	TP-FP-45(0.5-1)	52934	908.34	447.58	34.66	< LOD	28.2	509628	4844.82	< LOD	30.33	31.23	11.15	507.8	26.82	< LOD	99.01	137.27	39.35	4763.1	35.85	74391.5	238.77	< LOD
331	TP-FP-45(1.2-1.6)	54554	735.2	158.81	10.6	< LOD	9.69	554072	3328.66	< LOD	9.07	10.32	4.22	266.7	20.65	< LOD	73.61	< LOD	68.53	1025.3	13.6	57733.2	160.7	< LOD
332	TP-FP-45(1.6-1.8)	79752	1176.79	< LOD	73.28	< LOD	30	436871	5151.79	< LOD	32.82	332.7	7.81	209.1	25.67	< LOD	95.86	150.72	40.7	5091.8	38.47	65299.6	223.62	9848.78
333	TP-FP-45(1.8-2)	61009	911.02	< LOD	78.4	< LOD	31.67	495255	4352.23	< LOD	35.06	26.49	9.46	374.9	24.03	< LOD	113.08	164.33	40.02	4491	36.8	94139.7	298.5	< LOD
334	TP-FP-45(2-2.3)	22616	337.8	24.91	2.37	< LOD	5.64	775841	1684.07	16	1.78	54.21	19.36	1174	17.18	< LOD	57.68	< LOD	60.53	794.22	11.09	42024.6	118.62	< LOD
335	TP-FP-45(3.5-4)	54805	555.99	40.89	3.79	< LOD	5.43	648792	2109.32	13.81	2.23	12.89	4.6	1091	17.53	< LOD	64.27	< LOD	67.94	804.23	11.61	48490.3	136.16	< LOD
336	TP-FP-45(7.5-8)	67663	635.58	37.03	4.64	< LOD	5.7	626048	2238.06	11.79	2.52	< LOD	7.08	1033	17.58	< LOD	62.84	< LOD	71.2	925.02	12.46	42400.4	128.52	< LOD
337	TP-FP-45(10.5-11)	69488	754.02	161.84	10.51	< LOD	9.45	587299	2911.6	< LOD	9.38	< LOD	8.48	913.7	19.79	< LOD	72.17	< LOD	69.84	2035.9	18.54	55414.4	156.31	5145.47
338	TP-FP-45(13.5-14)	62831	621.59	42.92	5.8	< LOD	6.5	633485	2313.02	11.14	2.9	< LOD	7.08	1229	18.39	< LOD	69.44	< LOD	66.2	906.2	12.25	57650.1	152.36	< LOD
339	TP-FP-45A(0.5-1)	48798	900.39	190.17	32.19	< LOD	25.86	512915	5125.57	< LOD	28.17	60.17	21.49	395.2	26.77	< LOD	105.36	< LOD	76.64	4074.8	33.27	86692.4	267.28	< LOD
340	TP-FP-45A(0.8-1.2)	59055	599.27	17.13	3.54	< LOD	5.26	631552	2222.98	15.82	2.17	< LOD	6.9	1053	18	< LOD	69.94	< LOD	65.29	359.02	8.72	54659	147.9	< LOD
341	TP-FP-45A(3-3.5)	66020	633.63	16.34	1.75	< LOD	4.67	619883	2267.41	16.44	1.79	< LOD	6.91	833.3	16.78	< LOD	68.86	< LOD	67.98	147.17	6.94	56025.2	150.59	< LOD
342	TP-FP-45A(5-6)	75217	691.62	32.07	4.7	< LOD	5.87	614205	2315.66	14.52	2.53	< LOD	6.92	870.9	17.26	< LOD	64.71	< LOD	64.84	1988.7	17.12	49273.6	136.38	< LOD
343	TP-FP-45A(5.5-6)	65731	635.68	25.83	2.6	< LOD	4.92	617804	2270.45	18.15	1.96	< LOD	6.9	884.1	17.15	< LOD	70.05	< LOD	67.23	497.78	9.72	57965.5	153.63	< LOD
344	TP-FP-45A(9-9.5)	72660	728.88	15.93	3.23	< LOD	5.44	556741	2563.85	13.86	2.12	< LOD	7.17	824.3	18.29	< LOD	73.61	< LOD	70.92	602.77	10.76	59669.8	160.2	< LOD
345	TP-FP-45A(11-11.5)	74674	715.12	23.93	2.7	< LOD	4.83	575911	2457.12	21.57	2.01	< LOD	6.64	769.8	17.75	< LOD	63.93	< LOD	68.34	233.93	7.46	48392.3	133.84	4824.73
346	TP-FP-45A(13.5-14)	63685	594.55	45.16	2.62	< LOD	4.59	629024	2113.81	18.37	1.9	< LOD	6.6	776.6	16.26	< LOD	65.59	< LOD	66.28	179.49	6.97	52268	139.35	< LOD
347	TP-FP-45A REP(13.5-14)REP	65162	605.4	29.17	2.55	< LOD	4.69	626861	2114.51	19.8	1.9	< LOD	6.45	761.2	16.62	< LOD	61.34	< LOD	66.7	186.53	6.88	46066.8	126.88	< LOD
348	TP-FP-46(1-1.5)	61436	571.12	12.21	1.98	< LOD	4.27	617552	1986.75	16.27	1.73	< LOD	6.44	830.5	16.29	< LOD	59.16	< LOD	65.05	213.53	7.11	42832.5	122.1	< LOD
349	TP-FP-46(3-3.5)	60709	583.25	13.97	1.9	< LOD	4.75	611118	2100.05	16.13	1.78	< LOD	6.77	848.1	16.67	< LOD	65.94	< LOD	68.48	161.64	6.97	51694.5	141.09	< LOD
350	TP-FP-46(6-6.5)	41100	461.7	17.68	1.95	< LOD	4.52	700009	1871.76	19.62	1.83	< LOD	6.65	2457	21.61	< LOD	65.28	< LOD	65.04	219.44	7.37	52874.9	141.1	< LOD
351	TP-FP-46(8.5-9)	63499	631.26	22.38	2.01	< LOD	5.18	607021	2320.47	12.83	1.8	< LOD	6.82	2543	22.85	< LOD	65.24	< LOD	68.77	209.85	7.48	49277.7	138.24	< LOD
352	TP-FP-46(11-11.5)	65374	637.27	16.34	2.31	< LOD	4.83	606310	2287.28	14.24	1.86	< LOD	6.95	2634	22.68	< LOD	67.11	< LOD	67.91	1470.9	15.07	50850.3	140.76	< LOD
353	TP-FP-47(0.1-0.3)	38844	607.21	207.4	8.94	< LOD	8.56	600509	3415.16	11.07	4.06	< LOD	8.26	2459	25.12	< LOD	97.49	< LOD	67.5	297.66	9.47	107821	268.17	< LOD
354	TP-FP-47(2-2.5)	61827	606	24.48	1.99	< LOD	4.74	621474	2231.78	13.33	1.78	< LOD	6.8	2891	23.48	< LOD	65.03	< LOD	67.91	156.47	6.98	49010.3	137.13	< LOD
355	TP-FP-47(3.5-4.0)	63938	641.94	15.37	1.95	< LOD	4.92	615617	2346.13	11.85	1.81	< LOD	7.82	2657	23.34	< LOD	71.1	< LOD	68.48	295.43	8.48	56532.1	154.52	< LOD
356	TP-FP-47(5.5-6)	61491	605.62	11.88	1.98	< LOD	4.52	591839	2174.79	12.28	1.7	< LOD	6.56	2507	22.64	< LOD	60.17	< LOD	64.02	260.25	7.65	44105.4	125.31	< LOD
357	TP-FP-47(6.5-7)	64753	636.08	6.33	2.51	< LOD	4.9	601381	2349.58	16.42	2.01	< LOD	7.19	2424	21.62	< LOD	78.67	< LOD	65.36	339.93	8.81	75716.1	185.79	< LOD
358	TP-FP-47A(0.1-0.3)DUP	31765	584.61	254.71	9.85	< LOD	9.65	587713	3696.76	11.12	4.38	< LOD	8.5	2713	26.2	< LOD	105.37	< LOD	67.07	493.89	11.26	127915	314.1	< LOD
359	TP-FP-48(0-0.4)	46516	756.33	177.09	7.45	< LOD	8.08	546693	4117.04	15.68	3.51	20.33	7.26	2637	28.34	< LOD	101.47	< LOD	67.43	883.03	14.11	108698	273.68	< LOD
360	TP-FP-48(1.5-2)	43801	714.21	186.57	6.77	< LOD	7.58	578566	3769.69	9.18	3.16	25.71	9.18	2500	28.18	< LOD	94.39	< LOD	68.17	740.49	12.71	98098.6	244.91	< LOD
361	TP-FP-48(2.5-3)	38484	488.22	85.13	6.62	< LOD	6.86	683153	2229.9	7.69	3.17	< LOD	7.18	3129	24.79	< LOD	71.22	< LOD	65.92	421.12	9.35	61874.4	162.28	< LOD
362	TP-FP-48(3-3.5)	44199	538.71	205.53	11.39	< LOD	10.05	652454	2419.44	< LOD	9.25	< LOD	7.94	3451	26.24	< LOD	78.62	< LOD	70.82	693.54	11.87	67460.2	181.74	< LOD
363	TP-FP-48(6-6.5)	61554	654.74	44.92	5.08	< LOD	5.89	606445	2527.69	13.04	2.68	< LOD	7.17	3497	26.63	< LOD	70.44	< LOD	68.99	863.24	12.22	56122.8	152.52	< LOD
364	TP-FP-48(8-8.5)	66441	693.67	43.81	4.02	< LOD	5.67	583308	2564.98	12.92	2.33	< LOD	7.27	3489	26.62	< LOD	74.46	< LOD	69.69	824.48	12.16	62202.5	164.77	< LOD
365	TP-FP-48(10-10.5)	62283	640.99	26.04	3.23	< LOD	5.19	601710	2397.63	13.71	2.09	< LOD	6.93	3486	25.82	< LOD	68.87	< LOD	68.7	431.12	9.22	56309.1	149.99	< LOD
366	TP-FP-48(13.5-14)	66819	695.12	42.93	3.13	< LOD	5.43	574807	2626.42	16.48	2.11	< LOD	7.39	3429	25.83	< LOD	83.01	< LOD	65.45	394.69	9.49	80328.5	197.05	< LOD
367	TP-FP-48 REP(13.5-14)REP	64119	646.8	19.52	3.19	< LOD	5.1	591375	2396.12	14.21	2.05	< LOD	6.81	3322	25.04	< LOD	70.94	< LOD	64.4	307.24	8.19	63144.6	158.68	< LOD
368	TP-FP-48A(1-1.5)	32670	581.16	200.79	8.07	< LOD	8.5	598770	3522.3	11.21	3.67	< LOD	8.2	2523	25.54	< LOD	99.73	< LOD	64.16	522.58	11.19	119106	286.94	< LOD
369	TP-FP-49(0.7-1.2)	41842	725.25	163.05	6.69	< LOD	8.01	564194	4074.09	9.1	3.16	16.98	6.06	3466	31.7	< LOD	93.09	< LOD	69.27	544.03	11.24	96243.5	240.31	< LOD
370	TP-FP-49(1.7-2.4)	30421	464.61	127.11	6.73	< LOD	7.24	670416	2555.22	8.36	3.17	< LOD	7.48	3569	26.04	< LOD	85.06	< LOD	63.41	278.89	8.49	93356.7	222.37	< LOD
371	TP-FP-49(3-3.4)	43361	522.85	181.58	9.08	< LOD	8.72	657424	2321.95	< LOD	8.16	< LOD	7.49	3532	25.89	< LOD	77.05	< LOD	65.19	460	9.77	71861	182.65	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
372	TP-FP-49(5-5.5)	51369	573.3	83.88	8.26	< LOD	7.96	629464	2324.04	< LOD	7.51	60.73	21.69	3271	25.87	< LOD	64.45	< LOD	66.21	755.05	11.57	45946.9	134.77	< LOD
373	TP-FP-49(6.5-7)	55175	593.64	38.29	4.24	< LOD	5.62	620023	2362.17	8.74	2.32	< LOD	6.99	3432	25.44	< LOD	70.52	< LOD	67.74	311.98	8.36	57970.8	153.72	< LOD
374	TP-FP-49(8.5-9)	59116	673.62	50.16	5.53	< LOD	6.55	598601	2684.26	13.01	2.83	< LOD	7.34	3664	28.24	< LOD	74.44	< LOD	68.38	389.83	9.47	60695.3	172.08	< LOD
375	TP-FP-49A(1.7-2.4)DUP	45569	751.53	122.89	6.63	< LOD	7.05	571076	3898.39	12.37	3.16	17.24	6.16	4009	34.25	< LOD	86.84	96.77	34.66	644.75	11.54	85932.3	213.73	< LOD
376	TP-FP-49A(2.8-3.2)	34208	468.55	107.06	8.32	< LOD	8.02	681762	2309.35	10.69	3.85	< LOD	7.42	3254	24.99	< LOD	80.14	< LOD	63.64	362.35	9.04	80874.6	197.19	< LOD
377	TP-FP-50(0.8-1.2)	24933	612.47	188.92	8.19	< LOD	8.24	593094	4355.74	< LOD	6.55	< LOD	8.17	4439	34.91	< LOD	101.57	< LOD	63.82	365.93	10.01	119458	292.68	< LOD
378	TP-FP-50(1.6-2.2)	51472	904.57	38.11	8.24	< LOD	8.53	521926	4697.18	< LOD	6.9	< LOD	8.78	3698	36.22	< LOD	91.87	< LOD	67.54	876.19	13.51	88607.1	226.14	17506.8
379	TP-FP-50(3.5-4)	52885	557.86	34.99	3.46	< LOD	4.87	639272	2168.44	12.69	2.06	< LOD	6.57	3330	24.92	< LOD	62.57	< LOD	64.3	767.1	10.91	47588	130.61	< LOD
380	TP-FP-50(5.5-6)	67184	708.43	7.2	3.59	< LOD	5.63	592620	2611.4	17.12	2.24	< LOD	7	3406	26.61	< LOD	71.02	< LOD	68.96	569.43	10.25	55472.1	149.3	< LOD
381	TP-FP-50(7.5-8)	56889	621.59	61.28	4.15	< LOD	5.46	614217	2481.96	16.22	2.32	< LOD	6.88	2554	23.24	< LOD	72.16	< LOD	65.59	356.7	8.64	64587	163.48	< LOD
382	TP-FP-50(9-10)	25778	384.07	12.23	2.2	< LOD	4.74	730434	1818.8	18.84	1.81	< LOD	6.84	2718	23.31	< LOD	68.66	< LOD	68.35	201.41	7.46	53677.8	146.86	< LOD
383	TP-FP-50(11.5-12)	20107	359.85	38.82	3.28	< LOD	5.35	755602	1874.32	16.47	2.11	< LOD	7.18	2452	22.51	< LOD	77.84	< LOD	66.58	269.1	8.31	69669	177.65	< LOD
384	TP-FP-50A(0.5-1)	13308	316.37	130.37	7.11	< LOD	7.36	773624	1872.93	9.92	3.33	< LOD	7.55	2195	21.84	< LOD	81.19	< LOD	64.14	614.28	11.05	78086.9	194.72	< LOD
385	TP-FP-50A(1-1.5)	14004	330.29	139.72	7.18	< LOD	7.42	761632	2072.72	< LOD	5.86	< LOD	7.19	2665	23.54	< LOD	75.94	< LOD	63.89	285.19	8.29	73915.6	183.17	< LOD
386	TP-FP-50A(1.6-2.2)	27194	596.68	100.01	7.65	< LOD	8.13	650607	3645.32	< LOD	7.04	< LOD	8.76	3007	31.94	< LOD	91.07	< LOD	67.37	814.65	13.19	86842.9	221.67	< LOD
387	TP-FP-50A(2.2-2.5)	63728	641.88	16.06	2.13	< LOD	4.7	596970	2313.79	13.8	1.75	< LOD	6.63	2348	22.86	< LOD	64.06	< LOD	67.56	237.57	7.54	48624.7	134.89	< LOD
388	TP-FP-50A(2.3-2.5)	60255	611.56	16.62	1.96	< LOD	4.49	605119	2252.12	11.74	1.65	< LOD	6.44	2422	22.75	< LOD	62.44	< LOD	65.61	218.07	7.17	47931.1	130.86	< LOD
389	TP-FP-50A(3.5-4)	62026	611.29	8.86	1.51	< LOD	4.44	617275	2215.55	17.01	1.71	< LOD	6.57	2488	22.73	< LOD	63.27	< LOD	67.33	151.28	6.71	48251.2	132.83	< LOD
390	TP-FP-50A(3.5-4)DUP	61578	623.21	13.27	1.67	< LOD	5.53	609420	2304.49	17.62	1.78	< LOD	6.85	2541	23	< LOD	69.02	< LOD	69.08	178.33	7.21	55286.9	149.31	< LOD
391	TP-FP-50A(5-5.5)	85513	877.73	19.18	1.95	< LOD	5.06	545302	2971.23	18.63	1.75	< LOD	7.32	2711	25.56	< LOD	87.25	< LOD	64.41	492.23	10.27	91894.8	223.22	< LOD
392	TP-FP-50A(8.5-9)	58283	633.53	13.66	1.55	< LOD	5.58	576687	2385.22	11.74	1.52	< LOD	7.14	2405	23.06	< LOD	81.67	< LOD	64.32	251.84	8.06	81554.5	198.85	< LOD
393	TP-FP-50A REP(2.3-2.5)REP	61255	619.48	11.4	1.93	< LOD	4.36	601828	2270.52	14.64	1.68	< LOD	6.4	2427	22.76	< LOD	62.31	< LOD	65.21	219.28	7.15	47971.4	130.12	< LOD
394	TP-FP-51(1.5-2)	67410	733.07	39.53	2.92	< LOD	5.35	541551	2712.03	22.17	2.03	< LOD	7.27	2692	25.13	< LOD	83.76	< LOD	66.07	438.95	9.71	82790.7	199.99	< LOD
395	TP-FP-51(3.5-4)	70247	742.63	24.36	2.23	< LOD	4.99	544197	2675.68	20.2	1.84	< LOD	7.05	2633	25.06	< LOD	75.81	< LOD	68.36	338.89	8.75	66170.9	169.9	< LOD
396	TP-FP-51(5.5-6)	72322	740.05	14.76	2.07	< LOD	4.78	536903	2591.33	20.68	1.8	< LOD	6.93	2640	24.85	119.62	37.78	< LOD	68.45	313.29	8.42	64794.7	164.93	< LOD
397	TP-FP-51(7.5-8)	83686	881.89	13.01	1.65	< LOD	5.14	530946	3028.49	16.07	1.68	< LOD	7.55	2755	26.14	< LOD	91.94	< LOD	64.23	463.74	10.2	101944	236.44	< LOD
398	TP-FP-51(10-10.5)	70809	735.97	16.96	2.07	< LOD	5.15	559522	2653.7	18.06	1.79	< LOD	7.35	2542	24.02	< LOD	85.27	< LOD	66.09	389.62	9.44	84846.3	205.39	< LOD
399	TP-FP-51(11-11.5)	74868	766.41	< LOD	4.58	< LOD	4.8	550724	2702.26	14.3	1.81	< LOD	7.11	2521	24.38	< LOD	80.88	< LOD	64.78	363.94	9	78396.7	189.41	< LOD
400	TP-FP-51(12-12.5)	69139	685.69	13.68	1.78	< LOD	4.73	571975	2434.16	15.87	1.67	< LOD	6.99	2368	22.37	< LOD	77.73	< LOD	64.76	255.02	7.95	72993.5	178.92	< LOD
401	TP-FP-51A(2.5-3)	33762	510.24	244.49	9.45	< LOD	8.84	629399	2700.11	10	4.21	< LOD	7.78	541	17.53	< LOD	88.57	< LOD	67.15	360.05	9.4	93691.4	230.91	< LOD
402	TP-FP-51A(4.5-5)	60974	608.72	23.16	2.09	< LOD	4.49	601450	2248.44	16.55	1.74	< LOD	6.69	397.4	15.56	< LOD	69.7	< LOD	64.11	185.64	7.08	59820.5	152.51	< LOD
403	TP-FP-51A(6-6.2)	66804	622.67	22.97	2.04	< LOD	4.61	628111	2161.95	18.87	1.83	< LOD	6.85	472.1	15.29	< LOD	70.42	< LOD	66.82	234.78	7.65	59252.6	154.68	< LOD
404	TP-FP-52(1-1.5)	54754	561.53	41.43	6.46	< LOD	6.46	620970	2148.34	8.59	3.05	< LOD	6.47	399.1	15.98	< LOD	56.06	< LOD	64.38	689	10.27	38262.6	113.5	< LOD
405	TP-FP-52(2.7-3)	67730	654.58	12.45	1.93	< LOD	4.51	598039	2315.96	16.2	1.76	< LOD	6.46	413.5	16.2	< LOD	56.19	< LOD	69.77	170.64	6.82	36268.5	111.97	< LOD
406	TP-FP-52(5-5.5)	46314	554.52	24.32	2.76	< LOD	5.58	636007	2357.71	8	1.98	< LOD	8.01	600.9	15.52	< LOD	101.3	< LOD	59.16	810.31	13.05	133789	300.02	< LOD
407	TP-FP-52(7.5-8)	46925	520.65	26.44	2.39	< LOD	5.22	652969	2139.03	9.3	1.85	< LOD	7.56	543	14.74	< LOD	88.04	< LOD	64.78	491.86	10.33	95735.8	226.73	< LOD
408	TP-FP-52(9.5-10)	51111	563.22	38.46	2.44	< LOD	5.24	654105	2288.31	13.59	1.9	< LOD	7.56	599.5	15.35	< LOD	90.5	< LOD	64.13	593.79	11.07	105039	242.95	< LOD
409	TP-FP-53(1.8-2.4)	49619	523.41	< LOD	18.92	< LOD	8.52	640352	2113.27	< LOD	8.07	< LOD	6.94	374.2	15.19	< LOD	65.3	< LOD	59.73	1288.8	13.83	52394	141.02	< LOD
410	TP-FP-53(3-3.6)	61471	649.16	31.85	2.21	< LOD	5.94	592837	2484.7	10.57	1.82	< LOD	8.09	496.3	16	< LOD	83.24	< LOD	68.06	877.76	12.65	82539.1	203.05	< LOD
411	TP-FP-53(5-5.5)	43934	492.19	29.29	2.25	< LOD	4.94	674559	2013.17	13.12	1.83	< LOD	7.23	515.9	14.64	< LOD	80.84	< LOD	64.09	331.97	8.79	83136.9	201.31	< LOD
412	TP-FP-53(7.5-8)	39275	494.67	32.49	3.08	< LOD	5.46	657445	2201.29	14.37	2.08	< LOD	7.6	593.5	15.33	< LOD	92.9	< LOD	60.58	428.5	9.86	115157	259.16	< LOD
413	TP-FP-53(9.5-10)	43819	533.37	28.73	2.85	< LOD	5.36	651946	2315.27	10.01	1.99	< LOD	7.53	613.8	15.94	< LOD	90.54	< LOD	61.92	810.56	12.44	107922	246.56	< LOD
414	TP-FP-53(12-12.5)	64801	695.31	50.09	4.05	< LOD	6.09	594319	2665.47	21.37	2.43	< LOD	7.8	533.1	16.6	< LOD	93.13	< LOD	65.24	1261.6	15.43	104371	246.65	< LOD
415	TP-FP-53 REP(12-12.5)REP	65448	688.21	43.49	3.85	< LOD	6.34	594533	2601.83	17.01	2.3	< LOD	7.52	557.1	16.45	< LOD	90.05	< LOD	62.18	1145.7	14.31	104624	239.62	< LOD
416	TP-FP-54(0.6-1)	25376	625.63	152.54	9.2	< LOD	9.04	598515	4486.62	< LOD	7.5	< LOD	8.05	376.7	22.67	< LOD	96.62	< LOD	65.62	365.87	9.85	106903	266.87	< LOD
417	TP-FP-54(0.6-1)DUP	26992	602.88	153.73	8.75	< LOD	8.56	606903	4096.77	< LOD	7.89	< LOD	7.86	613.9	22.45	< LOD	92.47	< LOD	64.12	284.95	8.94	103149	249.4	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
418	TP-FP-54(1.2-1.4)	39589	576.97	78.19	13.29	< LOD	11.76	602912	3043.09	< LOD	11.09	< LOD	8.09	396.9	18.23	< LOD	89.85	< LOD	63.33	683.26	11.92	92572	231.7	< LOD
419	TP-FP-54(1.8-2.4)	33672	524.29	376.81	13.92	< LOD	12.2	634750	2865.89	< LOD	11.31	< LOD	8.32	464.3	18.15	< LOD	91.46	< LOD	67.41	628.17	11.76	96023.5	243.8	< LOD
420	TP-FP-54(3.4-3.8)	63605	636.05	16.46	2.27	< LOD	4.67	600185	2331.18	13.25	1.76	10.22	3.62	338.1	15.89	< LOD	56.63	< LOD	66.25	956.1	11.85	38200.5	113.55	< LOD
421	TP-FP-54(5-5.5)	65855	657.3	57.84	4.2	< LOD	5.44	658282	2446.43	10.05	2.29	< LOD	6.97	546	15.9	< LOD	74.78	< LOD	63.57	888.44	12.13	72320.7	176.83	< LOD
422	TP-FP-54(7-7.5)	54883	585.94	29.08	2.71	< LOD	4.97	637318	2269.82	14.46	1.95	< LOD	6.89	459.9	16.01	< LOD	72.98	< LOD	66.49	754.48	11.29	66150.8	166.52	< LOD
423	TP-FP-54(9-9.5)	60796	587.23	45.1	3.35	< LOD	5.25	686223	2087.49	8.02	1.98	< LOD	6.88	489.2	14.9	< LOD	72.46	< LOD	62.79	2000.6	17.34	65667.9	164.13	< LOD
424	TP-FP-55(0.6-1)	38240	561.43	85.93	14.45	< LOD	12.22	617365	2936	< LOD	12.08	< LOD	8.2	517.3	18.8	< LOD	90.1	< LOD	63.93	690.17	11.97	95106.4	237.32	< LOD
425	TP-FP-55(2-2.3)	50616	516.22	27.67	3.51	< LOD	4.83	654717	2005.12	11.49	2.05	< LOD	6.6	398.9	14.8	< LOD	59.87	< LOD	62.49	2810.4	19.71	43914.6	125.03	< LOD
426	TP-FP-55(2.5-3)	56517	590.85	25.31	2.69	< LOD	4.97	625042	2237.17	14.35	1.95	< LOD	6.93	372.8	15.92	< LOD	68.96	< LOD	68.53	966.68	12.62	54549.8	148.12	< LOD
427	TP-FP-55(3.8-4.2)	57341	599.35	26.71	2.29	< LOD	4.96	617355	2260.64	17.65	1.91	< LOD	7.14	388.9	15.82	< LOD	75.14	< LOD	64.92	1125.7	13.72	66367.8	169.96	< LOD
428	TP-FP-55(5-5.5)	49306	621.41	80.16	5.08	< LOD	6.46	598576	2832.91	14.9	2.68	< LOD	7.57	414.9	16.74	< LOD	84.7	< LOD	68.43	918.6	13.04	84532.7	208.39	< LOD
429	TP-FP-56(0.3-0.7)	51168	511.62	15.69	2.24	< LOD	4.27	652463	1937.06	12.52	1.66	< LOD	6.12	315.7	14.5	< LOD	56.72	< LOD	61.76	210.4	6.8	41102	115.3	< LOD
430	TP-FP-56(2.6-3)	62561	636	14.99	2.28	< LOD	4.79	612712	2312.57	15.29	1.84	< LOD	6.92	364.1	15.62	< LOD	73.98	< LOD	67.55	153.6	6.99	65864.4	167.11	< LOD
431	TP-FP-56(4.5-4.9)	71574	783.58	29.34	2.87	< LOD	5.54	550842	2874.61	17.57	2.12	< LOD	7.71	470.7	17.25	< LOD	92.16	< LOD	71.16	206.82	8.29	95758.5	236.68	< LOD
432	TP-FP-56(6.5-7)	64020	651.47	23.27	2.35	< LOD	5.05	606368	2371.63	13.8	1.86	< LOD	7.13	383	15.86	< LOD	76.92	< LOD	67.88	200.58	7.65	67910.9	173.6	< LOD
433	TP-FP-57(0-0.5)	49580	515.49	26.53	2.01	< LOD	4.28	628944	1978.08	14.5	1.63	< LOD	6.33	354	15.09	< LOD	59.79	< LOD	61.73	183.94	6.79	44175.8	123.6	< LOD
434	TP-FP-57(0.5-1)	51104	525.2	19.25	2.2	< LOD	4.54	649494	2013.77	14.39	1.71	< LOD	6.36	397.3	15.25	< LOD	59.89	< LOD	62.94	210.08	7.07	43741.4	123.49	< LOD
435	TP-FP-57(1-1.5)	55146	550.3	10.43	2.14	< LOD	4.56	639655	2011.72	16.43	1.74	< LOD	6.45	318	15.08	< LOD	60.72	< LOD	65.24	289.42	7.8	43772	124.7	< LOD
436	TP-FP-57(1-1.5)DUP	54939	539.71	16.39	2.08	< LOD	4.32	641605	1980.23	16.08	1.71	< LOD	6.38	313.1	14.66	< LOD	59.28	< LOD	64.72	275.1	7.57	43282.5	122.5	< LOD
437	TP-FP-57 REP(1-1.5)REP	56702	562.51	10.64	2.08	< LOD	4.38	632427	2073.5	16.43	1.71	< LOD	6.29	331.8	15.19	< LOD	59.51	< LOD	63.09	287.65	7.61	44085.2	122.54	< LOD
438	TP-FP-58(.1-.3)	30911	513.87	220.97	8.13	< LOD	7.97	628673	2983.17	< LOD	7.27	< LOD	7.8	497.9	17.71	< LOD	93.89	< LOD	61.88	373.89	9.66	109309	254.96	< LOD
439	TP-FP-58(1.3-1.6)	51156	519.6	16.79	2.04	< LOD	4.39	645615	1955.35	11.69	1.67	< LOD	6.49	394.1	15.08	< LOD	62.85	< LOD	64.53	237.43	7.41	47680.8	131.49	< LOD
440	TP-FP-58(2.3-2.8)	53715	560.16	19.66	2.07	< LOD	4.74	634722	2159.23	16.4	1.82	< LOD	6.87	376.2	14.98	< LOD	73.44	< LOD	65.27	238.22	7.68	68029.5	169.03	< LOD
441	TP-FP-58(3.6-4)	56830	629.91	29.24	2.71	< LOD	4.96	615366	2456.41	18.19	1.99	< LOD	7.19	593.7	16.82	< LOD	82.29	< LOD	62.51	510.94	10.11	86044.2	204.15	< LOD
442	TP-FP-58(4.1-4.7)	65357	645.87	< LOD	3.96	< LOD	4.25	588013	2340.95	12.01	1.62	< LOD	6.17	271.6	15.7	< LOD	50.52	< LOD	66.53	206.19	6.84	30534.5	99.29	< LOD
443	TP-FP-58(6-6.5)	58834	646.79	28.03	2.27	< LOD	4.96	587503	2541.25	13.61	1.82	< LOD	7.11	573.1	16.78	< LOD	81.49	< LOD	63.87	496.03	9.86	84902.6	199.25	< LOD
444	TP-FP-58(8.5-9)	63615	628.82	22.6	2.08	< LOD	5.57	616259	2308.83	11.62	1.74	< LOD	6.88	434.6	15.44	< LOD	72.53	< LOD	66.08	1295.1	14.16	63794.5	161.88	< LOD
445	TP-FP-58(9.5-10)	64877	675.94	31.91	2.41	< LOD	5.08	596142	2525.28	14.2	1.85	< LOD	7.35	412.7	15.79	< LOD	83.96	< LOD	63.26	1789.5	17.23	86929.2	207.64	< LOD
446	TP-FP-58A(.1-.3)	39555	596.27	198.46	8.49	< LOD	8.13	586322	3122.58	10.95	3.85	< LOD	8.02	447.1	18.13	< LOD	97.25	< LOD	64.58	316.58	9.37	112003	269.35	< LOD
447	TP-FP-58B(4.1-4.7)	63873	646.67	< LOD	3.26	< LOD	4.17	590532	2383.73	14.28	1.63	< LOD	6.03	213.7	15.78	< LOD	49.92	< LOD	66.85	228.62	6.89	30923.5	98	< LOD
448	TP-FP-59(.2-.4)	39090	542.99	181.53	9.29	< LOD	8.71	605175	2640.86	< LOD	8.3	< LOD	8.13	526.6	17	< LOD	98.58	< LOD	62.41	347.15	9.72	115026	270.86	< LOD
449	TP-FP-59(1.5-1.8)	58273	575.32	10.12	1.92	< LOD	4.47	621275	2109.64	13.29	1.7	< LOD	6.46	288.8	15.1	< LOD	58.34	< LOD	67.9	239.25	7.37	39705.7	118.05	< LOD
450	TP-FP-59(1.8-2)	38045	522.45	50.73	2.52	< LOD	5.61	659072	2424.74	16.45	1.93	< LOD	7.56	504.2	16.15	< LOD	90.43	< LOD	63.02	298.38	8.8	105216	238.39	< LOD
451	TP-FP-59(2.5-3)	38854	507.5	50.1	2.63	< LOD	5.42	664511	2263.17	11.57	1.96	< LOD	7.68	528.7	15.84	< LOD	91.17	< LOD	63.74	189.98	7.98	104194	242.43	< LOD
452	TP-FP-59(3.5-4)	57561	568.26	15.85	2.11	< LOD	4.26	626683	2070.81	13.58	1.66	< LOD	6.2	467	15.79	< LOD	55.62	< LOD	65.86	287.07	7.51	38564	112.82	< LOD
453	TP-FP-59(6.5-7)	57169	614.83	21.19	2.2	< LOD	4.86	612197	2347.02	14.68	1.85	< LOD	7.08	824.9	17.7	< LOD	75.14	< LOD	67.36	296.39	8.43	66129.4	169.21	< LOD
454	TP-FP-59(8.5-9)	41323	514.27	27.45	2.28	< LOD	5.9	663501	2238.41	7.62	1.84	< LOD	7.94	550.2	15.24	< LOD	98.9	< LOD	64.04	583.52	11.45	122888	281.24	< LOD
455	TP-FP-59(12-12.5)	41803	490.37	15.81	2.31	< LOD	5	673727	2050.48	11.74	1.86	< LOD	7.46	515	14.75	< LOD	88.04	< LOD	61.15	886.84	12.75	102361	232.56	< LOD
456	TP-FP-60(.2-.5)	54342	547.77	30.29	2.09	< LOD	4.43	633024	2039.3	14.17	1.68	< LOD	6.4	595.5	16.17	< LOD	61.18	< LOD	64.58	144.93	6.5	46450.8	127.71	< LOD
457	TP-FP-60(2-2.2)	53310	545.41	13.36	1.82	< LOD	4.57	635630	2071.19	13.81	1.74	< LOD	6.83	345.4	15.05	< LOD	66.97	< LOD	67.47	122.1	6.64	51354.6	142.33	< LOD
458	TP-FP-60(3.6-4)	64502	642.73	22.37	2.8	< LOD	4.88	595712	2330.77	15.66	1.99	< LOD	6.87	483.5	16.15	< LOD	69.54	< LOD	69.33	190.02	7.29	57683.9	152.59	< LOD
459	TP-FP-60(5.8-6)	67471	664.67	12.51	1.98	< LOD	4.8	594741	2373.2	19.63	1.89	< LOD	6.95	355.9	15.65	< LOD	72.68	< LOD	68.9	420.04	9.24	62065.4	161.93	< LOD
460	TP-FP-60(8-8)	55405	647.53	23.35	2.22	< LOD	4.62	604748	2789.99	10.51	1.68	< LOD	6.55	388.1	16.4	< LOD	66.49	< LOD	65.66	312.25	7.99	54901.2	144.71	< LOD
461	TP-FP-60(8-8.5)	34753	443.68	26.48	2.1	< LOD	5.23	692052	1947.86	9.63	1.83	< LOD	7.78	666.5	14.55	< LOD	96.48	< LOD	59.55	366.64	9.62	124975	278.21	< LOD
462	TP-FP-60(9.5-10)	47861	529.07	20.41	2.21	< LOD	4.98	646273	2152.48	11.89	1.81	< LOD	7.22	498.2	15.21	< LOD	82.14	< LOD	63.44	498.19	10.05	82869	199.59	< LOD
463	TP-FP-60 REP(.2-.5)REP	54992	554.65	28.71	2.07	< LOD	4.24	632440	2104.46	14.58	1.66	< LOD	6.25	534	15.89	< LOD	60.05	< LOD	62.39	138.48	6.31	46327.1	124.91	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
464	TP-FP-6A(2-3)	70805	677.6	6.67	1.18	< LOD	4.37	570830	2338.17	18.27	1.65	< LOD	6.38	130.1	15.68	< LOD	57.27	< LOD	69.99	15.51	5.2	39153.4	115.72	< LOD
465	TP-FP-6A(5.5-6.5)	65250	645.24	12.68	1.48	< LOD	4.62	560903	2308.09	22.27	1.74	< LOD	6.47	116.2	15.46	< LOD	57.75	< LOD	70.77	43.93	5.58	38200.9	115.77	< LOD
466	TP-FP-6A(16-16.5)	66170	654.17	13.3	1.97	< LOD	4.41	574163	2325.33	16.29	1.75	< LOD	6.5	365.4	16.55	< LOD	57.69	< LOD	70.59	47.78	5.66	38707.9	116.91	< LOD
467	TP-FP-6B(2.5-3.5)	51057	522.64	7.94	1.26	< LOD	4.2	609003	1997.28	15.96	1.64	< LOD	6.54	141.6	14.57	< LOD	57.43	< LOD	71.32	< LOD	10.47	35062.4	111.56	< LOD
468	TP-FP-6B(12-13)	70448	683.68	16.22	1.59	< LOD	4.51	571924	2372.41	16.35	1.72	< LOD	6.58	269.8	16.25	< LOD	59.99	< LOD	71.16	63.17	5.92	41537.8	122.77	< LOD
469	TP-MS-01(0-0.5)	54950	741.16	144.56	8.89	< LOD	8.17	565012	3435.2	< LOD	7.17	< LOD	7.16	370.1	19.66	< LOD	76.31	< LOD	59.43	772.09	11.55	71045.5	176.27	< LOD
470	TP-MS-01(0.5-1)	53640	538.56	25.84	2.55	< LOD	4.39	631949	2070.52	13.13	1.7	< LOD	6.26	483	15.13	< LOD	59.29	< LOD	61.55	655.86	9.98	44950.1	123.69	< LOD
471	TP-MS-03(0-0.3)	39868	588.33	117.9	10.13	< LOD	9.94	598619	2885.58	< LOD	9.15	< LOD	8.81	816.8	18.98	< LOD	105.47	< LOD	60.77	1176.8	16.22	119737	291.45	< LOD
472	TP-MS-03(0.3-0.5)	51965	1018.67	147.94	6.34	< LOD	7.4	481789	5578.91	7.42	2.94	< LOD	8.6	288.4	26.89	< LOD	91.07	< LOD	69.47	435.07	10.38	88990.6	226.26	9688.46
473	TP-MS-03(0.5-1)	49203	1068	164.35	6.49	< LOD	7.66	454497	6289.62	6.64	2.98	< LOD	9.03	419.7	29.04	< LOD	99.8	< LOD	70.05	512.62	11.5	100454	258.77	11589.9
474	TP-MS-03(1-2)	55969	1132.61	164.65	6.59	< LOD	7.78	458224	6249.21	8.39	3.03	20.02	7.15	418.3	28.67	< LOD	98.09	< LOD	70.68	522.99	11.48	98888.7	255.73	< LOD
475	TP-MS-03(1-2)DUP	56130	1067.83	115.2	5.96	< LOD	7.96	463972	5713.01	9.87	2.84	16.26	5.81	335.5	27.19	< LOD	88.58	< LOD	71.37	444.77	10.35	83739.3	216.16	19636.5
476	TP-MS-03(2-2.75)	57982	668.23	39.69	3.37	< LOD	5.13	592413	2695.16	9.2	1.96	< LOD	6.61	456.1	17.91	< LOD	61.22	< LOD	66.38	270.25	7.73	43841.5	126.79	< LOD
477	TP-MS-03 REP(2-2.75)REP	58486	673.76	51.51	3.3	< LOD	5.06	590035	2732.8	13.21	1.95	< LOD	6.47	357.4	17.49	< LOD	59.82	< LOD	65.42	265.28	7.57	42072.4	122.05	< LOD
478	TP-MS-04(0-0.5)	39754	568.71	164.54	9.75	< LOD	9.14	620642	2798.91	< LOD	8.71	< LOD	8.26	567.3	18.11	< LOD	93.36	< LOD	61.99	1146.9	15.17	97219.2	239.71	< LOD
479	TP-MS-04(0.5-1)	37693	766.23	149.63	6.02	< LOD	7.02	557575	4551.62	11.24	2.83	< LOD	7.78	531.8	25.35	< LOD	88.22	< LOD	68.96	422.77	10.14	84153.4	215.16	< LOD
480	TP-MS-04(1-2)	46186	564.5	78.65	5.67	< LOD	6.01	632856	2566.81	9.47	2.73	< LOD	6.68	348.9	16.9	< LOD	64.78	< LOD	61.7	511.25	9.39	51109.1	145.63	< LOD
481	TP-MS-04(2-2.5)	45589	462.13	11	2.33	< LOD	4.48	681137	1808.73	13.85	1.73	< LOD	6.33	407.3	14.25	< LOD	55.94	< LOD	64.83	240.71	7.28	36974.2	112.15	< LOD
482	TP-MS-05(1.2-1.5)	69137	686.37	18.38	2.16	< LOD	4.58	574567	2413.36	16.88	1.76	< LOD	6.5	2373	23.37	108.07	31.17	< LOD	67.48	286.28	7.82	43223	124.62	< LOD
483	TP-MS-05(1.8-2)	53902	589.97	16.8	1.82	< LOD	4.58	622563	2352.41	14.51	1.7	< LOD	6.82	2368	22.58	< LOD	73.11	< LOD	65.2	282.33	8.04	66858.7	165.61	< LOD
484	TP-MS-05(3.3-3.5)	58907	618.21	14.88	1.98	< LOD	4.51	604745	2358.55	14.96	1.71	< LOD	6.68	2204	22.34	< LOD	69.93	< LOD	65.91	272.58	7.79	61506.2	154.43	< LOD
485	TP-MS-05(4-4.5)	68163	655.5	10.26	2.18	< LOD	4.27	594282	2264.64	15.64	1.71	< LOD	6.2	2289	22.59	< LOD	53.94	< LOD	67.25	359.72	8.05	35428.9	107.52	< LOD
486	TP-MS-05(6-6.5)	61207	619.2	14.53	2.23	< LOD	4.68	588324	2276.85	17.6	1.79	< LOD	6.57	2310	22.29	< LOD	63.99	< LOD	67.45	255.47	7.61	49625.5	135.02	< LOD
487	TP-MS-05(9-9.5)	59950	635.22	17.06	2.41	< LOD	4.9	595243	2435.4	14.02	1.8	< LOD	6.79	2401	23.11	< LOD	67.61	< LOD	68.65	415.64	9.03	53531.7	145.5	< LOD
488	TP-MS-05A(1.2-1.5)	65963	649.06	19.78	2.2	< LOD	5.38	589357	2316.75	15.2	1.72	< LOD	6.33	2292	22.51	< LOD	57.03	< LOD	66.52	299.98	7.74	38614.1	114.72	< LOD
489	TP-MS-06(0.5-1)	53018	565.2	16.08	1.88	< LOD	4.3	619993	2186.87	16.68	1.67	< LOD	6.31	2322	22.35	< LOD	58.63	< LOD	65.28	246.39	7.28	42682.4	120.29	< LOD
490	TP-MS-06(1-1.5)	61018	611.32	14.69	2.04	< LOD	4.38	605504	2233.7	14.73	1.69	< LOD	6.36	2288	22.22	< LOD	58.72	< LOD	66.44	237.27	7.28	42193.5	120.51	< LOD
491	TP-MS-06(1.6-2.3)	65502	708.63	38.35	2.39	< LOD	4.95	566399	2685.96	13.3	1.86	< LOD	7.38	2318	23.46	< LOD	86.88	< LOD	63.2	145.58	7.33	91967	216.38	< LOD
492	TP-MS-06(2.5-2.7)	62235	645.38	8.16	2.4	< LOD	4.8	609925	2401.09	18.68	1.85	< LOD	6.7	2341	22.78	< LOD	69.61	< LOD	66.45	153.71	6.84	60495.7	154.64	< LOD
493	TP-MS-06(4.5-5)	51768	573.91	13.08	2.88	< LOD	5.33	618875	2254.06	14.21	1.95	< LOD	7.13	2442	22.46	< LOD	80.54	< LOD	65.35	354.96	8.93	79148.5	192.73	< LOD
494	TP-MS-06 REP(0.5-1)REP	53355	559.7	18.08	1.89	< LOD	4.41	617203	2127.44	12.65	1.63	< LOD	6.33	2306	22.13	< LOD	58.95	< LOD	65.19	261.44	7.41	42817.2	120.79	< LOD
495	TP-MS-07(0-0.5)	2113	148.24	16.5	1.18	< LOD	2.59	921680	1088.02	< LOD	1.05	< LOD	4.74	777.2	12.96	< LOD	49.04	< LOD	38.03	1114	10.4	44394.7	103.41	< LOD
496	TP-MS-07(0.5-1)	2448	117.96	5.86	0.88	< LOD	2.33	954733	786.79	< LOD	1	< LOD	4.15	779.7	11.12	< LOD	24.68	< LOD	37.43	1089.3	9.37	10569.7	45.03	< LOD
497	TP-MS-07(1-2)	15527	196.39	5.48	1.23	< LOD	2.53	895938	982.89	2.01	0.95	< LOD	4.35	597.4	10.52	< LOD	23.23	< LOD	42.47	867.5	8.74	8647.38	42.17	< LOD
498	TP-MS-07(2.75-3.5)	66436	570.09	16.16	1.95	< LOD	4.11	639392	1901.7	12.14	1.57	< LOD	6.08	347.3	14.07	< LOD	48.73	< LOD	65.07	328.49	7.71	28121.4	94.38	< LOD
499	TP-MS-07(3.5-4.5)	67937	602.45	5.33	1.97	< LOD	4.18	607698	2014.24	12.46	1.61	< LOD	6.09	339.2	14.81	< LOD	49.51	< LOD	67.25	278.37	7.33	29260.9	95.92	< LOD
500	TP-MS-07(4.5-5.5)	59735	552.21	< LOD	3.75	< LOD	4.2	628778	1954.56	14.01	1.61	< LOD	6.06	368.6	14.71	< LOD	48.24	< LOD	66.25	354.12	7.88	27277.4	92.61	< LOD
501	TP-MS-07(5.5-6.5)	65052	577.64	10.62	1.85	< LOD	3.98	629179	1953.4	11.56	1.56	< LOD	6.14	577	15.33	< LOD	50	< LOD	65.04	414.24	8.39	29270.3	97.23	< LOD
502	TP-MS-07(7.5-8.5)	59694	538.72	8.75	1.87	< LOD	4.28	660332	1896.46	10.01	1.53	< LOD	6.31	578.8	14.6	< LOD	60.52	< LOD	63.3	686.5	10.23	46389.2	126.63	< LOD
503	TP-MS-07(8.5-9.5)	58365	575.63	9.15	2.1	< LOD	4.55	631407	2102.63	12.14	1.68	< LOD	6.66	493.2	15.6	< LOD	70.59	< LOD	62.15	459.45	9.16	61874.1	157.13	< LOD
504	TP-MS-07 REP(3.5-4.5)REP	67777	603.75	9.87	2.01	< LOD	4.27	608190	2045.18	14.43	1.65	< LOD	6.22	323.7	14.67	< LOD	49.95	< LOD	68.22	268.18	7.4	29060.6	97.6	< LOD
505	TP-MS-08(0-0.5)	32236	584.03	121.28	6.66	< LOD	7.28	630115	3491.82	< LOD	6.05	< LOD	8.28	508.8	20.22	< LOD	84.19	< LOD	60.75	943.49	13.11	85046.8	205.88	< LOD
506	TP-MS-08(0.5-1)	41293	758.71	138.81	6.93	< LOD	7.42	564436	4259.34	< LOD	5.76	< LOD	8.6	369.1	22.94	< LOD	89.13	< LOD	65.82	684.35	12.11	85958.3	217.3	< LOD
507	TP-MS-08(1-2)	37691	804.4	179.87	6.61	< LOD	7.63	542493	4947.61	8.71	3.01	< LOD	8.82	464.2	25.53	< LOD	94.16	< LOD	68.2	454.85	10.82	91406.1	235.71	< LOD
508	TP-MS-08(1-2)DUP	51851	1068.52	163.6	6.96	< LOD	8.06	457837	6005.47	< LOD	6.27	< LOD	8.93	515	28.89	< LOD	97.94	< LOD	70.49	414.63	10.64	97504.8	252.97	14199.2
509	TP-MS-08(2-3)	43971	513.1	55.36	3.3	< LOD	4.89	671140	2292.62	12.16	1.92	< LOD	6.52	592.5	16.05	< LOD	61.32	< LOD	62.89	541.82	9.55	44982.7	127.49	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
510	TP-MS-08(4-5)	49420	513.88	15.62	2.27	< LOD	4.66	655898	2002.03	13.26	1.73	< LOD	6.48	413.5	15.23	< LOD	56.33	< LOD	67.95	192.66	7.01	35665.5	112.1	< LOD
511	TP-MS-08(6-6.75)	58737	582.06	13.54	2.32	< LOD	4.53	622760	2143.17	14.53	1.74	< LOD	6.37	365.1	15.44	< LOD	54.69	< LOD	68.19	281.16	7.62	34325.9	108.31	< LOD
512	TP-MS-09(0-0.5)	11816	334.19	132.01	7.94	< LOD	7.95	747829	2194.1	< LOD	6.33	< LOD	7.88	659.2	17.12	< LOD	87.24	< LOD	61	1045.7	14.06	88401.6	214.58	< LOD
513	TP-MS-09(0.5-1)	39359	643.62	148.7	8.47	< LOD	8.45	583323	3528.72	10.35	3.83	< LOD	7.97	414.4	20.01	< LOD	89.05	< LOD	65.27	630.53	11.67	86541.1	219.14	< LOD
514	TP-MS-09(1-2)	51050	633.32	93.53	10.92	< LOD	9.99	611307	2869.88	< LOD	9.03	< LOD	7.64	370.4	17.74	< LOD	72.02	< LOD	60.24	2123.3	18.52	58309.5	158.71	< LOD
515	TP-MS-09(2-3)	73132	706.01	37.49	3.13	< LOD	5	562763	2441.03	14.14	1.92	< LOD	6.45	283.3	15.99	< LOD	61.19	< LOD	63.68	828.92	11.11	46786.4	127.14	< LOD
516	TP-MS-09(3-4)	58525	570.78	21.12	3.15	< LOD	4.81	623875	2088.18	12.3	1.93	< LOD	6.38	385.1	15.18	< LOD	57.23	< LOD	64.6	408.58	8.51	39317.5	115.38	< LOD
517	TP-MS-09(5-6)	59502	573.38	5.17	2.12	< LOD	4.26	628029	2071.88	12.36	1.67	< LOD	6.21	480.4	15.48	< LOD	55.15	< LOD	65.31	238.82	7.14	36913.7	109.94	< LOD
518	TP-MS-09(6-7)	52983	504.73	< LOD	4.43	< LOD	4.32	661111	1873.6	13.69	1.71	< LOD	6.25	354.4	14.08	< LOD	52.62	< LOD	67.77	304.32	7.68	32693.2	103.52	< LOD
519	TP-MS-09 REP(0-0.5)REP	9576	309.21	139.27	8.05	< LOD	8.16	774880	2126.69	< LOD	7.24	< LOD	8.03	676.5	17.15	< LOD	88.33	< LOD	60.78	1048.5	14.31	87218.2	215.24	< LOD
520	TP-MS-101(0-0.5)	36724	509.63	125.88	9.01	< LOD	8.76	645001	2526.23	< LOD	8.1	< LOD	7.95	651.6	16.95	< LOD	89.29	< LOD	58.62	1282.4	15.37	95339.8	228.73	< LOD
521	TP-MS-101(0.5-1)	32304	554.3	206.5	8.02	< LOD	8.39	608675	3233.52	15.95	3.68	< LOD	8.18	621.2	18.6	< LOD	102.38	< LOD	60.85	532.76	11.32	128256	297.37	< LOD
522	TP-MS-102(0-0.5)	37193	536.96	114.63	8.57	< LOD	8.06	613370	2655	< LOD	7.27	< LOD	7.77	490.2	16.91	< LOD	94.63	< LOD	57.18	1082.2	14.16	114401	260.94	< LOD
523	TP-MS-102(0.5-1)	44924	966.56	218.57	8.26	< LOD	8.82	476906	5880.32	8.68	3.68	27.78	9.92	201.3	26	< LOD	107.41	< LOD	69.4	728.36	13.55	115618	294.05	13305.1
524	TP-MS-102(1-1.5)	53626	622.06	60.58	8.74	< LOD	8.02	615319	2609.86	< LOD	7.95	< LOD	7.14	405.9	17.47	< LOD	64.31	< LOD	59.27	1911.8	16.82	50509.8	137.71	< LOD
525	TP-MS-102(1.5-2)	58537	595.9	31.46	2.93	< LOD	4.71	631651	2295.9	15.86	1.91	< LOD	6.53	355.2	15.3	< LOD	60.48	< LOD	61.53	1496.7	14.38	45938	125.55	< LOD
526	TP-MS-102(2.5-2.75)	60260	642.39	11.7	1.98	< LOD	4.7	594788	2461.1	11.94	1.73	< LOD	6.79	320.9	16.01	< LOD	67.69	< LOD	67.92	243.06	7.72	54304.2	147.08	< LOD
527	TP-MS-102 REP(2.5-2.75)REI	62802	662.89	11.95	2	< LOD	4.74	587742	2507.24	14.42	1.76	< LOD	6.82	317	16.09	< LOD	67.81	< LOD	67.35	266.38	7.9	54622.9	147.29	< LOD
528	TP-MS-103(0-0.5)	50015	532.77	44.25	4.32	< LOD	5.11	647081	2140.61	10.3	2.25	< LOD	6.23	307.4	15.2	< LOD	53.5	< LOD	61.26	352.4	8.04	34820.4	106.86	< LOD
529	TP-MS-103(0.5-1)	59157	586.17	12.38	2.24	< LOD	4.54	601147	2137.21	15.27	1.74	< LOD	6.33	273.8	15.4	< LOD	51.93	< LOD	67.37	200.39	6.94	31042.7	101.91	< LOD
530	TP-MS-103(1-1.5)	64669	635.08	13.34	2.22	< LOD	4.53	576442	2256.85	17.21	1.77	< LOD	6.41	197.9	15.62	< LOD	53.97	< LOD	70.73	254.14	7.47	32837.7	106.11	< LOD
531	TP-MS-104(0-0.5)	39845	686.88	159.31	9.64	< LOD	9.66	577490	3778.06	< LOD	7.89	< LOD	8.69	666.7	21.31	< LOD	103.28	< LOD	63.85	1033.8	15.22	118041	286.18	< LOD
532	TP-MS-104(0.5-1)	47414	939.14	151.62	7.15	< LOD	7.89	510373	5228.46	< LOD	6.48	< LOD	8.09	437.2	27.1	< LOD	91.55	< LOD	70.6	452.02	10.73	86707	225.44	< LOD
533	TP-MS-104(1-1.5)	46314	919.91	147.16	7.51	< LOD	8.22	510949	5190.52	7.22	3.42	< LOD	8.92	245.2	25.89	< LOD	95.6	< LOD	71.57	485.96	11.16	91171.1	236.16	< LOD
534	TP-MS-104(1.5-2.5)	49939	624.76	114.8	9.28	< LOD	8.38	619292	2815.11	< LOD	7.55	< LOD	7.17	476.5	18.62	< LOD	65.96	< LOD	62.04	1749.8	16.39	49373.6	139.36	< LOD
535	Tp-Ms-105(0-0.7)	36430	534.5	103.95	8.55	< LOD	8.36	663034	2611.6	< LOD	6.99	45.91	16.4	435.4	16.65	< LOD	83.34	< LOD	59.59	2147.5	19.96	77003.6	195.78	< LOD
536	Tp-Ms-105(0.7-1.0)	44871	565.67	119.21	10.72	< LOD	9.66	639752	2476.3	< LOD	9.58	< LOD	8.32	420.9	16.5	< LOD	96.28	< LOD	60.82	1959.9	19.28	109193	259.98	< LOD
537	Tp-Ms-105(1.0-1.5)	33185	403.4	52.41	3.45	< LOD	4.76	732143	1851.03	9.39	1.91	< LOD	6.26	361.1	13.99	< LOD	56.08	< LOD	56.58	667.11	9.91	41938.6	115.56	< LOD
538	Tp-Ms-105(1.5-2.0)	59450	609.52	10.87	2.18	< LOD	4.46	599245	2284.32	14.94	1.75	< LOD	6.42	238.4	15.68	< LOD	57.83	< LOD	66.62	205.59	7.08	39587.4	117.22	< LOD
539	Tp-Ms-105(2-3.0)	59875	605.5	5.88	1.58	< LOD	4.52	601533	2221.14	12.5	1.65	< LOD	6.59	255.5	15.31	< LOD	61.74	< LOD	69.47	83.63	6.06	44444	128.03	< LOD
540	Tp-Ms-105 REP(0.7-1.0)	48688	600.39	124.32	11.24	< LOD	10.26	631792	2612.08	< LOD	9.31	< LOD	8.58	541	17.28	< LOD	98.86	< LOD	63.15	1998.6	20.09	106329	263.42	< LOD
541	Tp-Ms-106(0-0.5)	37392	563.94	122.14	9.21	< LOD	9.02	633515	2966.81	< LOD	8.29	23.83	8.51	455.6	17.72	< LOD	88.49	< LOD	61.97	2275.4	20.88	86099.2	219.99	< LOD
542	Tp-Ms-106(0.5-0.75)	27894	488.91	147.03	9.53	< LOD	9.49	650041	2740.49	< LOD	8.58	26.15	9.34	592	16.93	< LOD	108.18	< LOD	58.26	2236.4	21.93	138460	327.61	< LOD
543	Tp-Ms-106(0.75-1.0)	50711	868.66	164.34	7.58	< LOD	8	545363	4571.39	< LOD	6.86	< LOD	8.86	606.4	24.65	< LOD	92.81	< LOD	69.04	1103.3	15	91074.2	231.2	< LOD
544	Tp-Ms-106(1.0-1.5)	47827	858.88	115.28	6.73	< LOD	7.6	531665	4792.29	7.12	3.18	< LOD	8.56	465.6	24.25	< LOD	89.21	< LOD	69.83	663.85	11.89	89085	224.29	< LOD
545	Tp-Ms-106(1.5-2.0)	45772	919.65	143.24	7.58	< LOD	8.01	512366	5426.81	8.21	3.48	9.91	4.4	2279	32.76	< LOD	93.57	< LOD	70.39	847.78	13.35	95990.7	242.42	< LOD
546	Tp-Ms-106(2.0-2.5)	50870	811.22	171.3	9.05	< LOD	9.05	540064	4237.89	10.07	4.09	25.18	8.99	361.1	21.78	< LOD	89.39	< LOD	66.95	1443.8	16.37	89909.5	225.53	< LOD
547	TP-MS-108(0-0.5)	27542	512.23	76.22	7.09	< LOD	8.13	676329	2730.27	< LOD	5.8	37.69	13.46	666.5	18.35	< LOD	82.68	< LOD	62.84	2866.4	24.46	69077.6	186.15	< LOD
548	TP-MS-108(0.5-1)	36605	507.64	117.56	7.38	< LOD	7.35	658479	2398.01	< LOD	6.73	< LOD	7.46	617.3	17.11	< LOD	81.37	< LOD	56.63	959.77	13.07	83855.1	197.11	< LOD
549	TP-MS-108(1-1.5)	39488	483.77	20.75	5.86	< LOD	6.15	660495	2239.06	< LOD	5.65	< LOD	6.41	467.2	16.3	< LOD	56.55	< LOD	58.15	544.6	9.45	39568.1	115.51	< LOD
550	TP-MS-108(2-2.5)	48162	507.09	20.76	2.11	< LOD	4.16	638896	2017.75	14.04	1.65	< LOD	6.06	361.4	15.24	< LOD	49.18	< LOD	63.94	113.27	6	28494.8	94.94	< LOD
551	TP-MS-109(0-0.5)	39763	545.16	136.84	9.53	< LOD	8.97	625712	2523.52	< LOD	8.54	< LOD	8.11	522.8	17.34	< LOD	88	< LOD	60.64	1081.9	14.49	88344.8	217.66	< LOD
552	TP-MS-109(0.5-1)	48224	567.98	261.42	17.15	< LOD	14.54	652106	2395.85	< LOD	14.28	< LOD	8.55	517.4	17.37	< LOD	84.14	< LOD	60.48	3219.2	24.36	76466.2	203.78	< LOD
553	TP-MS-109(1-1.5)	42859	541.99	118.57	17.44	< LOD	14.71	649186	2513.73	< LOD	14.62	< LOD	8.41	407.5	17.67	< LOD	68.74	< LOD	62.26	2672	21.1	50041.3	149.74	< LOD
554	TP-MS-109(1.5-2)	54180	564.68	16.8	2.54	< LOD	4.79	623126	2205.97	15.61	1.84	< LOD	6.63	307.8	15.35	< LOD	58.36	< LOD	63.46	290.74	7.97	41537	120	< LOD
555	TP-MS-10A(0-0.5)	34655	539.82	78.93	8.68	< LOD	8.81	652004	2735.59	< LOD	7.88	40.21	14.36	663	17.44	< LOD	85.5	< LOD	60.81	2581.1	22.48	77905.7	199.57	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
556	TP-MS-10A(0.5-1)	47967	822.33	137.97	8.53	< LOD	9.06	525228	4462.27	8.92	3.89	37.27	13.31	505.8	22.58	< LOD	99.46	< LOD	64.6	1337.9	16.91	103154	255.82	< LOD
557	TP-MS-10A(1-2)	35323	571	139.84	8.13	< LOD	8.04	631658	3200.33	10.68	3.68	< LOD	7.61	464.9	19.04	< LOD	78.91	< LOD	64.42	847.3	12.55	68875.9	181.66	< LOD
558	TP-MS-10B(0-0.5)	12887	394.53	22.57	5.76	< LOD	8.66	692677	2676.47	< LOD	4.79	34.42	12.29	521.5	15.98	< LOD	71.05	< LOD	71.32	998.1	16.39	42773.7	143.92	< LOD
559	TP-MS-10B(1-2)	47309	781.31	130.92	9.05	< LOD	8.8	549896	4090.66	< LOD	8.11	< LOD	8.04	411.8	22.31	< LOD	85	< LOD	67.6	930.93	13.74	75209.9	198.23	< LOD
560	TP-MS-10B(2-2.75)	45004	495.59	23.48	2.61	< LOD	4.25	658358	2069.35	12.4	1.71	< LOD	6.05	484	15.38	< LOD	51.31	< LOD	61.83	286.5	7.29	34160.9	102.33	< LOD
561	TP-MS-10C(0-1)	40727	604.71	120.22	9.5	< LOD	9.26	619158	3035.82	< LOD	8.58	10.95	4.65	529.5	18.4	< LOD	93.96	< LOD	61.71	2818.5	23.64	96593.8	235.48	< LOD
562	TP-MS-10C(1-2)	55439	1146.41	171.92	6.82	< LOD	7.99	442058	6358.42	9.65	3.13	< LOD	9.02	265.3	28.59	< LOD	98.55	< LOD	72.41	522.35	11.56	98756.8	252.54	17247.2
563	TP-MS-10c(2-3)	30880	725.39	170.65	7.04	< LOD	7.78	581641	4648.56	< LOD	6.36	< LOD	8.76	375.3	26.05	< LOD	92.1	< LOD	69.24	529.46	11.27	85084.7	222.52	< LOD
564	TP-MS-10c(3-3.75)	26828	411.21	96.59	6.28	< LOD	6.54	719159	2134.87	< LOD	5.82	< LOD	6.71	662.7	17.41	< LOD	63.43	< LOD	61.7	605.19	10.08	49067.6	134.39	< LOD
565	TP-MS-10c REP(2-3)	48859	962.5	158.41	6.98	< LOD	7.66	496696	5359.81	9.95	3.2	< LOD	8.71	195.1	26.1	< LOD	91.92	< LOD	69.72	487.67	10.89	86364.7	222.06	9900.72
566	TP-MS-10cRETEST(1-2)	53551	1125.61	176.91	6.9	< LOD	7.96	446132	6357.58	< LOD	6.25	19.46	6.95	192	28.31	< LOD	100.73	< LOD	71.17	517.31	11.63	99639.7	256.86	15211.9
567	TP-MS-10CRETEST(2-3)	53192	1032.37	152.91	7	< LOD	7.58	473210	5595.64	< LOD	6.34	11.77	4.41	168.1	26.56	< LOD	93.09	< LOD	69.69	511.6	11.16	87255.3	226.67	11785.7
568	TP-MS-10D(0-0.5)	51376	741.28	123.66	10.14	< LOD	9.88	563474	3634.18	11.79	4.6	28.84	10.3	451.2	19.62	< LOD	94.33	< LOD	64.42	2329.7	21.73	93718.9	239.88	< LOD
569	TP-MS-10D(0.5-1.5)	50851	1008.81	187.54	7.31	< LOD	7.77	488132	5627.94	< LOD	6.56	16.07	5.74	224.9	26.51	< LOD	93.24	< LOD	71.38	751.99	12.93	89806.9	231.7	< LOD
570	TP-MS-10D(1.5-2)	57230	1113.96	127.36	7.47	< LOD	8.21	448501	5929.17	7.75	3.43	< LOD	8.96	217.6	27.51	< LOD	94.86	< LOD	72.84	457.93	10.97	90591.5	235.64	21794.9
571	TP-MS-10D(2-3.5)	55620	620.3	64.84	6.71	< LOD	6.73	606334	2533.41	6.49	3.15	< LOD	6.93	384.5	16.99	< LOD	62.59	< LOD	64.65	1005	12.6	45411.5	130.63	< LOD
572	TP-MS-10DRETEST(1.5-2)	53587	1060.6	134.66	7.44	< LOD	8.24	467999	5775.45	15.74	3.47	< LOD	8.86	218.2	27.31	< LOD	94.19	< LOD	69.69	479.1	11	91794.1	239.32	10779.6
573	TP-MS-110(0-0.5)	44712	584.32	114.35	8.4	< LOD	8.11	610240	2680.84	< LOD	7.64	< LOD	7.58	530	17.79	< LOD	87.89	< LOD	57.41	707.62	11.75	96558.6	223.84	< LOD
574	TP-MS-110(0.5-1)	53487	560.68	14.47	2.41	< LOD	4.4	617534	2124.49	13.07	1.74	< LOD	6.27	460.7	16.2	< LOD	56.12	< LOD	62.2	237.58	7.23	39152.9	114.03	< LOD
575	TP-MS-110(1-1.5)	42689	468.68	17.69	1.87	< LOD	4	665804	1949.71	12.73	1.51	< LOD	5.87	368.7	14.89	< LOD	52.56	< LOD	57.21	254.12	6.97	36303.7	105.3	< LOD
576	TP-MS-110(1.5-2)	50434	544.64	15.79	2.1	< LOD	4.4	629356	2219.31	12.97	1.69	< LOD	6.42	317.2	15.3	< LOD	60.73	< LOD	62.2	244.51	7.41	44996.1	126.6	< LOD
577	TP-MS-111(0-0.5)	43171	727.58	172.87	8.84	< LOD	8.85	566508	3978.41	< LOD	7.88	< LOD	8.46	420.5	21.09	< LOD	95.9	< LOD	64.36	1163.3	15.64	98493.6	248.13	< LOD
578	TP-MS-111(0.5-0.75)	48892	671.47	102.96	10.67	< LOD	9.38	591505	3154.6	< LOD	8.74	< LOD	7.35	363.3	19.61	< LOD	70.04	< LOD	61.12	1093.7	13.41	57353.1	153.76	< LOD
579	TP-MS-112(0-0.5)	42402	506.68	< LOD	24.21	< LOD	10.45	665591	2245.32	< LOD	10.14	< LOD	7.8	415.3	15.62	< LOD	83.71	< LOD	59.4	1988.9	18.48	84504.3	208.81	< LOD
580	TP-MS-112(0.5-1)	53637	636.19	61.46	12.15	< LOD	10.64	608219	2764.82	< LOD	10.1	< LOD	8.75	416.7	17.77	< LOD	68.24	< LOD	65.13	1997	18.46	49590.6	146.15	< LOD
581	TP-MS-112(1.75-2)	60539	582.55	12.53	2.26	< LOD	4.37	615788	2115.85	16.65	1.74	< LOD	6.25	270	14.96	< LOD	52.26	< LOD	66.85	237.63	7.16	32116.2	102.73	< LOD
582	TP-MS-112 REP(0.5-1)REP	54610	643.48	< LOD	23.75	< LOD	10.26	605796	2799	< LOD	9.95	8.87	4.29	360.1	17.54	< LOD	67.26	< LOD	63.57	2008	18.11	49674.7	144.08	< LOD
583	TP-MS-113(0-0.5)	36164	486.16	129.8	6.74	< LOD	6.79	647542	2268.6	9.13	3.16	< LOD	7.3	449.5	16.08	< LOD	82.03	< LOD	60.72	497.29	10.02	84891.7	202.62	< LOD
584	TP-MS-113(0.5-1)	47433	541.96	33.41	3.74	< LOD	5.28	657551	2173.59	15.8	2.23	< LOD	6.8	469	16.57	< LOD	69.47	< LOD	63.71	515.54	9.68	59568.7	153.35	< LOD
585	TP-MS-113(1-1.75)	52084	578.46	22.05	2.5	< LOD	4.86	623406	2298.31	17.39	1.87	< LOD	6.75	389.5	15.99	< LOD	71.09	< LOD	62.71	375.11	8.66	65379.5	161.79	< LOD
586	TP-MS-114(0-0.25)	38886	478.5	48.44	3.23	< LOD	5.01	642603	2135.57	11.05	1.93	< LOD	6.91	671.9	15.61	< LOD	83.99	< LOD	55.52	178.14	7.2	96587	213.43	< LOD
587	TP-MS-114(0.25-0.5)	47287	483.1	12.62	1.91	< LOD	4.18	643278	1892.32	12.09	1.62	< LOD	6.28	321	14.21	< LOD	57.72	< LOD	62.35	116.82	6.16	41488.1	118.78	< LOD
588	TP-MS-114(1-1.5)	60327	606.85	28.92	2.4	< LOD	5.24	589697	2233.06	16.32	1.86	< LOD	6.96	333.5	15.23	< LOD	77.25	< LOD	63.05	181.84	7.29	74165.6	179.75	< LOD
589	TP-MS-115(0-0.5)	15153	452.8	58.08	4.32	< LOD	9.06	606018	3189.23	< LOD	3.12	< LOD	11.25	740.4	16.38	< LOD	160.93	< LOD	53.26	317.84	13.25	282354	699.2	< LOD
590	TP-MS-115(0.5-1)	19470	398.45	32.88	2.85	< LOD	5.13	724964	2583.57	< LOD	3.4	< LOD	6.96	676.3	16.54	< LOD	80.39	< LOD	46.29	206.92	8.01	90951.8	204.85	< LOD
591	TP-MS-115(1.25-1.5)	56890	614.66	39.59	2.35	< LOD	4.64	594982	2428.34	11.6	1.82	< LOD	6.91	356.5	15.61	< LOD	79.05	< LOD	59.65	170.62	7.16	80386.1	189.46	< LOD
592	TP-MS-115(1.5-2)	61862	635.76	29.41	2.36	< LOD	4.8	587996	2379.75	14.54	1.83	< LOD	6.88	400	15.9	< LOD	75.25	< LOD	63.2	155.57	6.98	69717.8	171.71	< LOD
593	TP-MS-116(0-0.5)	41576	584.7	165.51	8.83	< LOD	8.08	620647	2945.06	< LOD	7.83	< LOD	7.21	763.8	19.35	< LOD	77.18	< LOD	55.49	906.78	12.34	76556.4	183.4	< LOD
594	TP-MS-116(0.5-1)	44270	546.99	152.12	13.3	< LOD	11.25	664507	2552.47	< LOD	10.92	< LOD	7.5	572.2	17.91	< LOD	68.15	< LOD	57.56	2383.3	19.42	51702.1	147.71	< LOD
595	TP-MS-116(1-1.5)	60922	908.36	< LOD	65.28	< LOD	26.27	536421	4404.76	< LOD	28.61	15.69	6.21	399.4	24.42	< LOD	87.2	< LOD	76.52	3043.7	27.49	58656.5	199.51	< LOD
596	TP-MS-116(1.5-2)	55331	577.03	< LOD	9.6	< LOD	5.34	618840	2234.9	9.41	2.47	< LOD	6.4	383.2	16.13	< LOD	54.24	< LOD	63.72	370.25	8.31	34790.9	107.62	< LOD
597	TP-MS-117(0-0.5)	43804	537.7	68.91	9.29	< LOD	8.6	661325	2353.97	< LOD	7.55	< LOD	7.94	444.8	15.59	< LOD	93.69	< LOD	56.82	2353.3	20.59	106464	246.07	< LOD
598	TP-MS-117(0.5-1)	54999	546.21	19.28	3.48	< LOD	4.75	624933	2012.57	13.72	2.03	< LOD	6.17	353.7	15.26	< LOD	52.11	< LOD	63.01	470.45	8.76	32816.9	102.59	< LOD
599	TP-MS-117(1-1.5)	57950	584.12	19.09	2.51	< LOD	4.37	611063	2171.59	14.31	1.77	< LOD	6.28	279.7	15.3	< LOD	58.23	< LOD	63.5	267.9	7.44	41927.2	118.66	< LOD
600	TP-MS-117(1.5-2)	60681	617.28	21.96	2.43	< LOD	4.71	600603	2265.87	17.57	1.85	< LOD	6.69	337.4	15.84	< LOD	67.02	< LOD	66.04	287.13	7.94	54758.1	144.46	< LOD
601	TP-MS-117(2-2.5)	62373	622.92	11.02	2.19	< LOD	4.56	598134	2283.68	14.42	1.77	< LOD	6.63	355.2	15.78	< LOD	62.78	< LOD	67.04	312.88	8.12	46225.5	130.89	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
602	Tp-Ms-117 REP(1-1.5)REP	52051	548.1	22.67	2.62	< LOD	4.51	628594	2120.72	14.39	1.81	< LOD	6.38	755.1	17.04	< LOD	59.42	< LOD	65.41	276.18	7.61	42709.4	121.43	< LOD
603	TP-MS-118(0-0.5)	29142	415.8	89.67	8.16	< LOD	7.65	726029	1964.74	< LOD	6.62	< LOD	7.22	827.1	16.78	< LOD	79	< LOD	53.67	1969.9	17.61	79956.6	187.58	< LOD
604	TP-MS-118(0.5-1)	48139	506.04	< LOD	9.77	< LOD	5.59	658135	1982.74	9.91	2.52	< LOD	6.69	392	15.18	< LOD	62.5	< LOD	60.08	756.28	10.99	46572.8	130.4	< LOD
605	TP-MS-118(0.5-1)	48356	522.01	11.86	4.85	< LOD	5.51	655411	2088.28	8.93	2.49	< LOD	6.59	369.5	15.23	< LOD	61.59	< LOD	60.78	750.6	10.94	46771.4	130.9	< LOD
606	TP-MS-119(0-0.5)	38385	562.67	148.77	9.48	< LOD	8.91	632077	2811.81	< LOD	8.52	< LOD	8.08	1026	19.81	< LOD	92.98	< LOD	61.65	957.83	13.9	99798.1	238.02	< LOD
607	TP-MS-119(0.5-1)	53517	588.08	84.2	11.62	< LOD	10.01	645228	2373.52	< LOD	9.91	< LOD	7.31	469.8	17.07	< LOD	70.76	< LOD	59.47	1633.9	15.98	57757.5	154.74	< LOD
608	TP-MS-119(1-1.5)	30422	442.38	222.08	14.33	< LOD	11.86	743420	2320.38	< LOD	11.8	< LOD	7.33	618	17.6	< LOD	65.33	< LOD	54.55	2457.3	18.91	52406.6	142.92	< LOD
609	TP-MS-11A(0-0.4)	53715	807.33	171.68	8.94	< LOD	9.08	547548	3941.73	< LOD	7.26	< LOD	9.27	503.3	21.44	< LOD	97.91	< LOD	64.77	1077.8	15.39	99978.6	252.74	< LOD
610	TP-MS-11B(0-0.5)	35997	538.55	81.9	8.23	< LOD	8.76	649007	3042.11	< LOD	6.77	51.57	18.42	471.2	17.06	< LOD	68.7	< LOD	55.45	2194.3	19.65	53456.7	153.63	< LOD
611	TP-MS-11B(1-2)	63619	880.89	89.39	9.08	< LOD	8.75	524180	3929.5	< LOD	8.23	< LOD	8.22	317.6	21.41	< LOD	75.09	< LOD	66.21	961.31	13.02	63631.6	168.1	< LOD
612	TP-MS-11B(2-3)	64150	626.02	8.02	2.9	< LOD	4.71	590069	2257.95	9.08	1.83	< LOD	6.37	313.5	15.55	< LOD	55.73	< LOD	67.62	332.93	7.97	36827.2	111.66	< LOD
613	TP-MS-11B(3-4)	71658	681.64	15.98	2.32	< LOD	4.49	574920	2342.66	16.93	1.77	< LOD	6.44	403.8	16.13	< LOD	58.88	< LOD	66.51	327.16	7.99	41730.9	120.51	< LOD
614	TP-MS-11B(4-5)	70562	665.1	12.06	2.27	< LOD	4.41	577637	2294.22	16.4	1.74	< LOD	6.26	289.3	15.55	< LOD	51.97	< LOD	68.1	347.68	7.98	32081.2	102.5	< LOD
615	TP-MS-11B(5-5.75)	72184	680.83	28.2	2.43	< LOD	4.61	587256	2324.61	14.02	1.83	< LOD	6.71	350.8	15.91	< LOD	57.62	< LOD	73.65	254.15	7.72	35672.6	114.96	< LOD
616	TP-MS-11B REP(3-4)REP	72829	692.96	11.84	2.31	< LOD	4.56	570860	2349.74	15.88	1.76	< LOD	6.41	395.6	16.28	< LOD	59.61	< LOD	67.19	321.26	7.93	43203.1	122.77	< LOD
617	TP-MS-11C(0-0.5)	34037	588.31	103.61	8.66	< LOD	9.07	620693	3355.61	< LOD	7.13	73.05	26.09	689.6	18.67	< LOD	97.05	< LOD	60.68	2051.8	21.01	100815	243.48	< LOD
618	TP-MS-11C(1-2)	55732	840.76	117.92	11.11	< LOD	9.91	541078	4032.24	< LOD	9.17	< LOD	8.58	329.7	21.85	< LOD	78.72	< LOD	61.93	1667.1	17.02	70058	181.88	< LOD
619	TP-MS-11C(2-3)	61317	640.67	27.6	3.88	< LOD	5.22	587235	2432.72	9.8	2.17	< LOD	6.62	334.8	16.15	< LOD	61.68	< LOD	65.57	548.94	9.7	44305.4	126.98	< LOD
620	TP-MS-11C(2-3)DUP	51526	543.22	18.1	2.92	< LOD	4.58	633052	2171.21	15.68	1.91	< LOD	6.34	444.2	15.63	< LOD	58.22	< LOD	63.39	305.1	7.75	41656.1	119.16	< LOD
621	TP-MS-11C(3-4)	70965	672.85	11.6	2.19	< LOD	4.43	580283	2324.38	15.44	1.75	< LOD	6.39	306.4	15.61	< LOD	59.39	< LOD	67.17	221.26	7.11	43253.9	122.59	< LOD
622	TP-MS-11D(0.0-0.1)	61005	638.28	28.95	2.54	< LOD	5.21	600910	2437.14	19.03	1.95	< LOD	7.35	408.3	15.88	< LOD	83.34	< LOD	63.82	338.37	8.96	84211.7	204.31	< LOD
623	TP-MS-12(0-0.5)	57622	549.52	46.05	2.48	< LOD	4.19	649769	2034.01	13.82	1.67	< LOD	5.82	513	15.1	< LOD	55.92	< LOD	56.03	615.84	9.27	43492.3	115.33	< LOD
624	TP-MS-12(0.5-1)	30223	306.55	43.99	1.79	< LOD	3.37	804005	1285.64	9.23	1.25	< LOD	5.08	585.5	11.95	< LOD	42.9	< LOD	49.92	963.15	10.1	26351.6	80.37	< LOD
625	TP-MS-12(1-1.5)	47426	426.19	25.62	2.1	< LOD	3.87	735310	1534.61	13.97	1.56	< LOD	5.74	545.1	13.25	< LOD	48.14	< LOD	57.36	869.35	10.58	30013.7	93.91	< LOD
626	TP-MS-12(1.5-2)	59507	551	24.23	2.32	< LOD	4.55	640671	1918.81	13.57	1.72	< LOD	6.42	386.9	14.55	< LOD	58.98	< LOD	66.63	671.68	10.29	40923.4	119.54	< LOD
627	TP-MS-12(1.5-2)DUP	64432	585.06	20.83	2.14	< LOD	4.16	614598	2015.52	15.16	1.67	< LOD	6.21	338.6	14.58	< LOD	53.84	< LOD	66.83	473.26	8.8	35480.3	107.71	< LOD
628	TP-MS-12(2-3)	50820	471.79	15.48	1.91	< LOD	4.35	666498	1769.48	10.13	1.57	< LOD	6.16	395.8	13.5	< LOD	53.1	< LOD	65.4	310.56	7.62	34473.9	105.74	< LOD
629	TP-MS-12(3-3.4)	57657	547.28	17	1.98	< LOD	4.43	648835	2021.58	16.28	1.71	< LOD	6.31	454.5	14.83	< LOD	51.67	< LOD	67.19	562.3	9.55	30498.4	100.86	< LOD
630	TP-MS-120(0-0.5)	26428	568.97	78.03	16.73	< LOD	20.2	633864	3344.56	< LOD	14.13	119.2	42.59	580.8	18.04	< LOD	198.28	< LOD	134.74	3302	57.91	87812.3	449.77	< LOD
631	TP-MS-120(0.5-1.0)	50075	656.66	116	11.02	< LOD	10.54	603398	2853.01	< LOD	9.19	15.61	5.58	490.3	17.76	< LOD	96.34	< LOD	66.42	2174.3	21.64	89885.9	234.11	< LOD
632	TP-MS-120(1-1.5)	48907	560.56	41.49	14.81	< LOD	12.57	647714	2340.98	< LOD	12.39	< LOD	7.8	504.5	17.21	< LOD	73.91	< LOD	60	2685.2	20.81	62932.8	168.18	< LOD
633	TP-MS-120(1.5-2.5)	50064	530.57	8.38	3.51	< LOD	4.79	636249	2049.72	12.9	2.05	< LOD	6.37	402.2	15.52	< LOD	58.25	< LOD	60.65	488.71	9.02	43216.4	120.01	< LOD
634	TP-MS-121(0-0.5)	34898	571.18	150.61	8.16	< LOD	7.94	635432	3083.24	< LOD	7.32	< LOD	7.75	476.5	19.03	< LOD	86.1	< LOD	59.44	1182.3	14.71	87541.7	213.54	< LOD
635	TP-MS-121(0.5-0.75)	53012	1001.87	185	8.88	< LOD	9.01	478362	5496.93	< LOD	7.16	< LOD	9.08	207.9	25.52	< LOD	99.39	< LOD	68.84	709.17	12.87	100268	254.63	< LOD
636	TP-MS-121(1.5-1.75)	55696	657.72	99.21	12.25	< LOD	10.71	598038	2765.67	< LOD	10.11	< LOD	7.69	373.2	18.25	< LOD	67.2	< LOD	64.45	1519.5	15.89	48320.1	141.39	< LOD
637	TP-MS-122(0-0.5)	19394	486.93	159.06	8.95	< LOD	9.36	655310	3113.19	< LOD	7.26	13.81	5	577.5	18.27	< LOD	106.65	< LOD	63.4	1608.4	19.53	104005	262.82	< LOD
638	TP-MS-122(0.5-1)	58143	695.19	135.08	13.38	< LOD	11.66	573881	2941.75	< LOD	11.19	< LOD	8.32	408.9	18.2	< LOD	86.09	< LOD	63.11	2103.2	19.65	80774.6	204.62	< LOD
639	TP-MS-122(1-1.5)	64012	757.36	62.23	16.02	< LOD	13.45	559043	3167.64	< LOD	13.52	12.52	4.64	383.1	19.26	< LOD	70.81	< LOD	64.96	2724.7	21.92	50817.2	150.84	< LOD
640	TP-MS-122(1.75-3)	52225	576.84	57	6.41	< LOD	6.58	617246	2341.17	11.15	3.04	< LOD	6.46	298.8	16.43	< LOD	55.48	< LOD	61.94	1138.4	12.62	37228.2	111.25	< LOD
641	Tp-Ms-123(0-0.5)	44423	639.05	161.35	9.42	< LOD	8.85	589263	3164.47	< LOD	8.36	< LOD	7.86	573	19.39	< LOD	84.82	< LOD	62.97	1476.6	16.23	83135	204.09	< LOD
642	Tp-Ms-123(0-1.0)	18015	312.92	61.97	5.32	< LOD	6.05	788051	1746.94	< LOD	4.18	< LOD	7.25	516.5	13.77	< LOD	64.46	< LOD	55.35	1818.4	16.65	52515.5	139.9	< LOD
643	Tp-Ms-123(0.5-1.0)	54098	671.8	140.96	14.15	< LOD	11.98	592335	2998.97	< LOD	11.75	< LOD	8.07	564.9	19.21	< LOD	73.41	< LOD	62.73	2120.5	18.95	58838.3	162.36	< LOD
644	Tp-Ms-123(1.1-2.1)	44032	601.72	128.48	11.99	< LOD	10.75	629378	2962.86	< LOD	9.87	< LOD	8.03	800.1	19.75	< LOD	73.64	< LOD	60.92	2179.4	19.22	60467.1	163.64	< LOD
645	Tp-Ms-123(1.1-1.8)	46617	635.57	71.1	8.47	< LOD	8.22	610824	3066.9	< LOD	7.7	< LOD	7.4	552.3	19.11	< LOD	73.03	< LOD	63.47	954.11	12.83	61173	161.64	< LOD
646	Tp-Ms-123(2.5-3.0)	55617	552.38	< LOD	3.04	< LOD	4.5	607109	2043.18	14.84	1.62	< LOD	6.31	171.1	14.89	< LOD	45.46	< LOD	72.75	115.16	6.2	22930.4	87.2	< LOD
647	Tp-Ms-123(2.5-3)	59640	618.43	24.11	2.67	< LOD	4.65	607447	2329.63	14.77	1.85	< LOD	6.57	620.9	17.16	< LOD	60.51	< LOD	65.14	352.59	8.36	44332.1	125.86	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
648	TP-MS-13(0-0.1)	49720	640.49	194.76	9.98	< LOD	9.76	553034	2828.66	< LOD	8.12	< LOD	8.34	509.2	17.58	< LOD	103.35	< LOD	62.45	624.76	12.12	121612	287.25	< LOD
649	TP-MS-13(0-0.5)	36202	430.19	44.88	9.99	< LOD	9.02	701499	1844.85	< LOD	8.19	< LOD	7.24	465.7	14.58	< LOD	73.14	< LOD	58.16	1410.8	14.83	66380.3	165.7	< LOD
650	TP-MS-13(0.5-1)	35991	413.82	25.23	4.2	< LOD	5.25	717098	1756.25	9.9	2.24	< LOD	6.7	516.9	14.13	< LOD	65.34	< LOD	59.95	1241.9	13.54	54117.1	141.75	< LOD
651	TP-MS-13(1-1.9)	44068	464.8	14.55	2.01	< LOD	4.23	681559	1837.21	10.88	1.64	< LOD	6.46	812.9	15.74	< LOD	62.01	< LOD	63.16	479.26	9.11	47433.8	130.43	< LOD
652	TP-MS-14(0-0.2)	13906	366.61	205.63	9.83	< LOD	9.54	719003	2257.96	< LOD	8.77	< LOD	8.49	796.3	18.35	< LOD	106.22	< LOD	65.67	367.3	10.26	126968	303.37	< LOD
653	TP-MS-14(0-0.5)	21475	356.82	68.67	7.54	< LOD	7.3	734672	1850.63	8.78	3.5	< LOD	7.13	644.7	16.09	< LOD	78.4	< LOD	59.94	498.93	9.8	75966.4	184.61	< LOD
654	TP-MS-14(0.5-1)	54534	571.87	19.67	2.62	< LOD	4.92	619309	2187.89	12.39	1.85	< LOD	6.77	442.3	15.72	< LOD	67.68	< LOD	66.38	215.46	7.4	55600.3	147.23	< LOD
655	TP-MS-14(1-2)	57427	570.58	15.47	2.3	< LOD	4.39	612215	2053.15	15.93	1.76	< LOD	6.45	488.1	15.91	< LOD	59.7	< LOD	66.18	201.88	7.02	42180.3	121.52	< LOD
656	TP-MS-14(2-3)	52881	505.29	18.92	2.09	< LOD	4.1	645846	1859.42	12.67	1.6	< LOD	6	339.3	14.25	< LOD	48.35	< LOD	64.44	241.8	6.95	28974.1	94.24	< LOD
657	TP-MS-14(2-3.5)	60472	601.11	15.15	2	< LOD	4.29	607685	2224.32	13.45	1.68	< LOD	6.31	367.7	15.61	< LOD	55.47	< LOD	66.3	384.22	8.31	36801.5	111.4	< LOD
658	TP-MS-15(0-0.5)	28029	459.8	100.83	6.9	< LOD	7.64	671771	2356.96	< LOD	5.49	< LOD	8.54	645.2	16.38	< LOD	105.1	< LOD	55.26	1311.5	16.53	135323	306.73	< LOD
659	TP-MS-15(0.5-1)	35325	400.79	28.64	2.57	< LOD	4.01	718903	1752.22	10.8	1.65	< LOD	5.94	422.4	14.05	< LOD	50.24	< LOD	57.23	251.05	6.94	32604.5	98.95	< LOD
660	TP-MS-15(1-2)	56457	568.56	27.15	2.14	< LOD	4.5	616155	2143.94	12.83	1.66	< LOD	6.38	293.8	14.94	< LOD	61.85	< LOD	65.42	215.07	7.06	48734.6	130.61	< LOD
661	TP-MS-15(1-2)DUP	58206	574.82	19.1	2.1	< LOD	4.41	611417	2098.52	16	1.7	< LOD	6.41	341.4	15.2	< LOD	60.74	< LOD	65.56	228.24	7.21	45057.6	125.28	< LOD
662	TP-MS-15(2-3)	60314	599.47	21.68	2.23	< LOD	4.58	624522	2179.85	15.72	1.79	< LOD	6.67	356.1	15.37	< LOD	65.32	< LOD	67.77	228.33	7.46	50729.8	138.87	< LOD
663	TP-MS-15(3-3.7)	57644	580.83	21.56	2.16	< LOD	4.62	627348	2192.58	15.27	1.75	< LOD	6.54	396.1	15.3	< LOD	63.92	< LOD	66.26	163.4	6.79	50079.6	135.94	< LOD
664	TP-MS-16(0.1-0.2)	31691	409.02	136.1	5	< LOD	5.73	695851	1909.66	9.01	2.37	< LOD	6.64	535.1	14.89	< LOD	74.19	< LOD	56.45	598.28	9.93	75738.1	175.44	< LOD
665	TP-MS-16(0.5-1)	23045	284.46	10.96	1.67	< LOD	3.71	790863	1256.87	9.82	1.39	< LOD	5.65	508.2	12.7	< LOD	43.94	< LOD	59.99	461.25	8.06	25857.4	84.67	< LOD
666	TP-MS-16(0.5-1)DUP	37163	380.72	24.95	1.98	< LOD	3.91	720104	1550.32	7.78	1.49	< LOD	6.11	430.9	13	< LOD	53.1	< LOD	61.64	535.09	9.06	34210.9	104.5	< LOD
667	TP-MS-16(1.7-2.5)	51020	467.02	11.62	1.81	< LOD	4.08	679222	1657.82	11.45	1.5	< LOD	6.01	400.5	13.45	< LOD	52.56	< LOD	61.55	405.82	8.11	36183.1	106.1	< LOD
668	TP-MS-16(3-3.5)	35324	262.64	23.34	1.23	< LOD	3.08	858098	901.7	< LOD	1.97	< LOD	4.99	363.1	8.7	< LOD	24.86	< LOD	52.83	766.09	9.07	7792.75	43.99	< LOD
669	TP-MS-16(3.5-4.5)	67217	528.39	< LOD	4.54	< LOD	4.45	691195	1684.08	10.3	1.68	< LOD	6.07	463.1	13.19	< LOD	45.47	< LOD	68.15	675.22	9.91	23895	86.56	< LOD
670	TP-MS-16(4.5-5)	66637	555.78	8.53	2.77	< LOD	4.57	678778	1807.65	10.34	1.77	< LOD	6.41	458.2	13.92	< LOD	55.81	< LOD	68.93	837.25	11.25	35465.4	110.79	< LOD
671	TP-MS-17(0-0.1)	46088	530.02	102.52	3.91	< LOD	5.31	622252	2158.19	13.99	2.12	< LOD	6.83	511.6	15.62	< LOD	78.15	< LOD	58.61	426.18	9.06	82945.5	191.23	< LOD
672	TP-MS-17(0-0.5)	42692	433.58	29.07	2.67	< LOD	4.28	696240	1707.57	8.88	1.69	< LOD	6.1	461.1	13.53	< LOD	60.81	< LOD	56.07	371.13	7.92	51413.1	130.26	< LOD
673	TP-MS-17(0.5-1)	50228	479.81	7.41	1.91	< LOD	4.22	643766	1780.48	12.64	1.6	< LOD	6.17	519.9	14.5	< LOD	51.83	< LOD	64.53	180.73	6.62	31585.1	101.09	< LOD
674	TP-MS-17(1-2)	42279	324.35	26.39	1.63	< LOD	3.31	811196	1116.07	5.72	1.19	< LOD	5.27	546	10.47	< LOD	37.25	< LOD	53.47	516.46	8.04	18681.3	69.09	< LOD
675	TP-MS-19(0-1)	5745	180.95	16.6	1.24	< LOD	2.98	859284	1323.13	< LOD	1.16	< LOD	5.42	1685	14.44	< LOD	59.12	< LOD	42.77	12.57	4.27	58431.2	129.74	< LOD
676	TP-MS-19(1-2)	54251	642.53	16.8	2.11	< LOD	5.58	567999	2652.06	8.74	1.83	< LOD	8.03	2039	21.81	< LOD	105.73	< LOD	58.77	146.21	7.89	138133	308.94	< LOD
677	TP-MS-19(2-3)	56405	607.1	15.2	1.96	< LOD	4.82	591250	2332.68	13.08	1.72	< LOD	7.02	1786	20.45	< LOD	83.68	< LOD	59.32	121.94	6.75	92317.6	208.88	< LOD
678	TP-MS-19(3-3.4)	49270	505.73	14.05	2.18	< LOD	4.58	657216	1946.31	13.58	1.74	< LOD	6.73	404.7	14.66	< LOD	70.48	< LOD	65.5	254.72	7.7	59903.9	154.39	< LOD
679	TP-MS-19(3.4-3.5)	47615	504.33	12.3	1.99	< LOD	4.59	656842	1957.69	12.11	1.71	< LOD	6.79	473.1	15.23	< LOD	71.77	< LOD	63.25	167.33	7.04	62781	160.23	< LOD
680	TP-MS-20(0-0.5)	44240	443.15	18.05	1.86	< LOD	3.9	715193	1700.16	10.07	1.5	< LOD	5.95	530.2	14.24	< LOD	55.87	< LOD	56.89	189.04	6.52	41056.1	113.2	< LOD
681	TP-MS-20(0.7-1)	59234	567.27	16.45	1.78	< LOD	4.44	655620	2017.36	14.74	1.67	< LOD	6.38	413.5	15.23	< LOD	61.34	< LOD	64.69	110.87	6.23	46215.4	127.32	< LOD
682	TP-MS-20(1-2)	53328	540.6	24.62	2.05	< LOD	4.44	627765	2047.05	12.93	1.71	< LOD	6.71	397	14.81	< LOD	65.38	< LOD	65.84	146.19	6.79	50575.8	138.16	< LOD
683	TP-MS-20(1-2)DUP	57660	572.8	5.97	1.68	< LOD	4.31	585305	2069.76	15.08	1.63	< LOD	6.41	419.9	15.86	< LOD	54.74	< LOD	68.27	105.87	6.19	34166.3	108.33	< LOD
684	TP-MS-21(0-0.75)	32593	423.59	67.76	5.93	< LOD	6.08	717219	1923.17	< LOD	5.21	< LOD	6.98	527.5	14.87	< LOD	74.12	< LOD	55.75	625.99	10.49	70092.6	169.46	< LOD
685	TP-MS-21(1.25-2.5)	63033	562	8.79	1.73	< LOD	4.02	657737	1918.73	9.05	1.49	< LOD	6.23	782.2	15.65	< LOD	60.74	< LOD	62.57	147.62	6.41	45229.4	123.28	< LOD
686	TP-MS-21(2.5-3.25)	57534	579.56	20.51	1.94	< LOD	4.43	608483	2154.99	14.27	1.74	< LOD	6.85	521.6	15.8	< LOD	72.61	< LOD	63.49	232.45	7.65	62817.2	159.62	< LOD
687	TP-MS-22(0-1)	41917	491.36	27.41	2.85	< LOD	5.11	648561	2118.81	5.84	1.84	< LOD	7.13	469.9	14.63	< LOD	85.71	< LOD	58.06	329.76	8.67	95718.3	216.33	< LOD
688	TP-MS-22(1-1.75)	52382	556.22	12.69	2.01	< LOD	4.49	625770	2195.78	12.05	1.73	< LOD	6.81	409.2	15.22	< LOD	74.27	< LOD	62.31	174.69	7.1	67971.8	167.41	< LOD
689	TP-MS-22 REP(0-1)REP	43946	509.35	25.73	2.9	< LOD	5.15	637778	2199.98	10.3	1.91	< LOD	7.2	459.4	14.71	< LOD	87.28	< LOD	57.15	320.36	8.67	97555	222.05	< LOD
690	TP-MS-23(0-1)	55120	609.73	24.66	2.72	< LOD	4.81	609338	2405.8	10.31	1.86	< LOD	6.97	628.5	16.79	< LOD	83.04	< LOD	56.59	288.08	8.27	91119.8	207.78	< LOD
691	TP-MS-23(1-2)	35168	494.19	27.85	2.14	< LOD	5.79	640400	2344.91	< LOD	3.4	< LOD	8.61	659.5	15.27	< LOD	116.33	< LOD	56.68	157.35	8.5	169338	378.02	< LOD
692	TP-MS-23 REP(1-2)REP	31850	472.01	24.2	2.19	< LOD	5.84	649199	2263.69	< LOD	3.5	< LOD	8.64	717.7	15.49	< LOD	116.34	< LOD	57.62	167.56	8.64	169496	378.68	< LOD
693	TP-MS-24(0-1)	56468	578.4	24.26	2.99	< LOD	4.6	602017	2173.36	19.16	1.97	< LOD	6.48	367.9	15.65	< LOD	59.08	< LOD	64.23	255.81	7.5	40794.6	120.14	< LOD

	G	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AP
1	SAMPLE	Al	Al Error	As	As Error	Au	Au Error	Bal	Bal Error	Bi	Bi Error	Cd	Cd Error	Cl	Cl Error	Co	Co Error	Cr	Cr Error	Cu	Cu Error	Fe	Fe Error	Mg
694	TP-MS-24(0.1-0.15)	50135	560.6	81.29	7.12	< LOD	6.73	621104	2212.72	< LOD	6.56	< LOD	6.85	490	16.52	< LOD	72.57	< LOD	59.31	402.66	8.86	66328.9	164.15	< LOD
695	TP-MS-24(1-2)	54564	529.25	14.8	2.09	< LOD	4.62	625502	1960.43	10.69	1.64	< LOD	6.39	391.5	14.64	< LOD	55.74	< LOD	66.95	190.04	6.89	35463.9	110.48	< LOD
696	TP-MS-24(2-3)	55697	523.26	10.9	2.01	< LOD	4.33	649721	1900.67	11.8	1.6	< LOD	6.32	654.8	14.99	< LOD	57.52	< LOD	65.41	215.53	7.03	40522.5	117.31	< LOD
697	TP-MS-24(3-4)	64210	594.74	18.51	2.4	< LOD	4.55	631407	2053.23	11.62	1.74	< LOD	6.54	629.7	15.57	< LOD	65.45	< LOD	64.33	339.98	8.17	53260.4	139.83	< LOD
698	TP-MS-24(4.5-5.3)	62433	609.03	12.56	2.03	< LOD	4.6	589241	2189.2	12.85	1.68	< LOD	6.66	358.7	15.24	< LOD	66.78	< LOD	65.37	427.42	8.93	54900.5	144.34	< LOD
699	TP-MS-24(5.3-5.75)	64470	632.19	9.14	3.2	< LOD	5.12	591560	2299.14	14.65	2.04	< LOD	6.84	414.4	15.74	< LOD	67.8	< LOD	69.44	589.32	10.25	52805.4	144.23	< LOD
700	TP-MS-25(0-0.3)	38045	475.82	49.73	6.61	< LOD	6.83	688568	2060.69	< LOD	5.44	< LOD	7.06	700.5	16.5	< LOD	76	< LOD	55.15	1048.2	13.05	75140.7	178.31	< LOD
701	TP-MS-25(0.3-0.5)	45727	590.38	75.53	9.33	< LOD	9.19	595848	2639.67	< LOD	8.23	< LOD	8.08	751	18.25	< LOD	93.64	< LOD	62.85	794.66	12.9	98958.4	241.27	< LOD
702	TP-MS-25(0.5-1)	42033	480.55	62.31	10.91	< LOD	9.47	701043	2009.97	< LOD	8.94	< LOD	7.21	648.5	16.11	< LOD	69.1	< LOD	55.26	2437.2	18.95	60151.8	154.07	< LOD
703	TP-MS-25(0.5-1)DUP	46085	513.9	92.1	10.89	< LOD	9.67	681204	2109.55	< LOD	9	< LOD	7.49	520.5	15.82	< LOD	74.02	< LOD	60.05	2196.7	18.67	65707.8	167.4	< LOD
704	TP-MS-25(1-2)	52930	553.74	22.96	3.51	< LOD	5.1	641752	2103.08	12.7	2.11	< LOD	6.92	402.8	15.36	< LOD	69.87	< LOD	62.97	511.5	9.77	58134.6	152.66	< LOD
705	TP-MS-25(2-3)	46402	488.69	18.18	1.95	< LOD	4.31	672205	1896.19	14.34	1.73	< LOD	6.7	426	14.75	< LOD	65.08	< LOD	65.91	237.59	7.57	51021.6	139.5	< LOD
706	TP-MS-26(0-0.5)	35228	417.77	54.57	5.26	< LOD	5.8	707429	1778.36	10.55	2.6	< LOD	6.7	770.7	15.51	< LOD	69.92	< LOD	58.14	525.17	9.61	62884.5	157.17	< LOD
707	TP-MS-26(0.5-1)	50660	532.28	26.5	2.53	< LOD	4.43	637974	2066.53	12.75	1.76	< LOD	6.43	444.5	15.31	< LOD	65.53	< LOD	61.02	311.09	7.86	56204.6	142.06	< LOD
708	TP-MS-26(1-2)	47998	508.66	16.05	1.97	< LOD	4.48	655241	1998.11	13.08	1.65	< LOD	6.5	493.3	15.39	< LOD	64.9	< LOD	61.86	263.97	7.62	52703.1	138.84	< LOD
709	TP-MS-26(2-2.5)	60287	627.87	22.53	2.14	< LOD	4.6	594105	2329.66	14.66	1.75	< LOD	6.79	436.2	16.37	< LOD	69.51	< LOD	64.69	300.49	8.13	59159.7	152.67	< LOD
710	TP-MS-27(0-0.5)	43532	469.8	21.97	2.21	< LOD	4.25	666100	1900.42	11.94	1.68	< LOD	6.34	560.6	15.2	< LOD	62.3	< LOD	60.73	216.15	7.08	49371.3	132.18	< LOD
711	TP-MS-27(0.5-1)	58899	589.43	16.98	2.21	< LOD	4.6	612257	2177.95	12.85	1.76	< LOD	6.69	421.3	15.56	< LOD	67.26	< LOD	65.27	354.09	8.46	54041.2	143.63	< LOD
712	TP-MS-27(1-1.5)	56527	569.5	14.88	2.24	< LOD	4.81	620699	2101.13	16.18	1.78	< LOD	6.63	437.9	15.46	< LOD	67.51	< LOD	63.11	362.5	8.47	56508.5	146.4	< LOD
713	TP-MS-27(1.5-2)	58569	591.03	20.56	2.16	< LOD	4.67	606975	2170.24	14.72	1.76	< LOD	6.73	449	15.85	< LOD	66.26	< LOD	66.85	289.23	8.03	51237	140.49	< LOD
714	TP-MS-27(2-2.5)	65876	635.8	15.41	2.19	< LOD	4.62	592435	2204.7	14.87	1.77	< LOD	6.69	360.6	15.69	< LOD	64.52	< LOD	68.41	419.78	8.97	48984.8	136.11	< LOD
715	TP-MS-27(2.5-3)	67519	679.01	21.23	2.29	< LOD	4.93	576953	2427.52	11.28	1.76	< LOD	6.86	396.5	16.27	< LOD	72.07	< LOD	65.38	475.32	9.49	63390.8	160.91	< LOD
716	TP-MS-27(3-3.5)	57794	613.66	31.95	2.26	< LOD	4.86	605207	2354.39	11.65	1.75	< LOD	7.19	501.5	15.77	< LOD	84.23	< LOD	61.51	602.2	10.68	91120.7	211.28	< LOD
717	TP-MS-27(3.5-4)	76119	740.72	35.66	2.28	< LOD	5.88	575868	2509.42	17.54	1.8	< LOD	7.16	746.5	17.41	< LOD	81.43	< LOD	63.71	904.1	12.66	80561.1	193.57	< LOD
718	TP-MS-4A(0-1.0)	20527	378.23	146.91	7.55	< LOD	7.49	711892	2286.95	< LOD	6.85	< LOD	7.78	564.9	15.45	< LOD	91.67	< LOD	60.45	356.16	9.44	104449	246.99	< LOD
719	TP-MS-4A(1-2)	23275	446.51	160.34	6	< LOD	7.14	670272	2803.13	< LOD	5.14	< LOD	8.77	680.8	17.35	< LOD	99	< LOD	63	397.5	10.19	118454	281.02	< LOD
720	TP-TS-01(.5-1)	33874	516.01	197.03	7.15	< LOD	7.19	623991	2766.97	11.06	3.26	< LOD	7.51	492.5	17.09	< LOD	90.96	< LOD	59.84	276.15	8.52	108362	244.66	< LOD
721	TP-TS-02(.6-.9)	34620	556.66	298.59	9.34	< LOD	8.99	599941	3023.13	8.64	4.09	< LOD	8.14	480.5	18.09	< LOD	100.17	< LOD	63.41	292.89	9.35	117172	278.7	< LOD
722	TP-TS-02(1.5-2)	49851	525.93	17.45	2.15	< LOD	4.4	594332	2089.09	12.45	1.66	< LOD	6.3	306.6	15.1	< LOD	54.59	< LOD	66.99	107.61	6.07	35113.3	108.47	< LOD
723	TP-TS-03(.1-.2)	34719	542.19	257.93	8.05	< LOD	7.75	603807	2912.02	16.43	3.61	< LOD	7.67	541.9	17.88	< LOD	93.01	< LOD	60.67	323.33	9.11	108209	249.97	< LOD
724	TP-TS-03(1.8-2)	51368	530.93	14.28	1.67	< LOD	4.2	596341	2046.2	14.13	1.54	< LOD	6.2	223.8	14.89	< LOD	51.85	< LOD	66.12	59.49	5.56	32173.9	102.16	< LOD
725	TP-TS-03A(1.8-2)	51736	525.33	12.88	1.56	< LOD	4.06	606055	2028.76	13.69	1.49	< LOD	6.19	218.1	14.4	< LOD	53.08	< LOD	66.92	83.77	5.76	34123.6	105.13	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
4	TP-FP 27 (2-2.4)	3924.36	2176	37.79	< LOD	1.28	14.75	0.59	< LOD	16.31	315.37	100.75	64.13	2.22	< LOD	3.17	92.87	0.99	34879.87	130.98	< LOD	6.65	< LOD
5	TP-FP 27 (3.8-4.2)	3589.24	696.4	29.63	< LOD	1.08	16.14	0.63	< LOD	17.96	< LOD	194.56	39.98	2.05	< LOD	3.38	130.59	1.22	19348.86	94.39	< LOD	7.18	< LOD
6	TP-FP 27 (5-5.5)	3495.02	7527	64.24	< LOD	1.27	14.83	0.67	25.73	9.95	543.84	89.85	747.66	7.04	< LOD	3.71	112.05	1.23	10449.92	69.62	< LOD	7.92	< LOD
7	TP-FP 27 (6.5-7)	3351.44	3355	45.56	< LOD	1	15.44	0.63	< LOD	17.83	509.47	93.25	374.58	4.75	< LOD	3.45	117.93	1.18	12939.59	76.6	< LOD	7.34	< LOD
8	TP-FP 27 (9.5-10)	2953.53	1741	36.64	< LOD	1	16.35	0.64	< LOD	17.68	311.79	81.5	519.59	5.54	< LOD	3.43	122.4	1.21	7945.42	59.92	< LOD	7.33	< LOD
9	TP-FP 27 (13-19)	3599.76	1412	33.81	1.93	0.69	16.07	0.61	< LOD	17.3	507.69	91.81	74.26	2.39	< LOD	3.28	122.33	1.16	30647.87	119.87	< LOD	6.99	< LOD
10	TP-FP 28 (1-1.5)	2943.62	1133	31.49	< LOD	1.3	14.96	0.61	< LOD	17.25	848.31	86.44	211.03	3.53	< LOD	3.29	109.48	1.1	3876.84	46.85	< LOD	6.97	< LOD
11	TP-FP 28 (1.5-2)	8432	451.6	31.4	3.21	0.85	12.76	0.75	49.45	11.93	< LOD	232.15	3259.35	18.19	< LOD	5.06	71.79	1.16	126013.12	424.83	< LOD	9.41	< LOD
12	TP-FP 28 (3-3.5)	3707.72	2566	42.08	< LOD	1	16.6	0.64	< LOD	18.09	386.3	100.19	165	3.31	< LOD	3.44	121.54	1.2	17493.88	90.88	< LOD	7.28	< LOD
13	TP-FP 28 (4.6-5)	3375.81	1371	34.69	< LOD	1.48	19.36	0.67	24.97	9.74	545.73	93.75	58.28	2.34	< LOD	3.99	136.55	1.29	7551.79	60.92	< LOD	7.52	< LOD
14	TP-FP 28 (5.5-7)	3102.44	2116	38.6	< LOD	1.43	15.57	0.62	< LOD	18.42	755.49	92.81	348.74	4.52	< LOD	3.39	118.2	1.17	1315.25	38.28	< LOD	7.14	< LOD
15	TP-FP 28 (8-8.5)	3567.89	842.2	30.38	< LOD	1	16.38	0.63	< LOD	17.8	1226.13	98.34	343.81	4.53	< LOD	3.44	112.03	1.15	13249.2	78.33	< LOD	7.28	< LOD
16	TP-FP 28 (9-9.5)	3144.4	843.2	30.11	< LOD	1	15.83	0.62	< LOD	17.43	494.6	93.76	104.78	2.7	< LOD	3.33	121.45	1.16	2311.46	42.72	< LOD	7.06	< LOD
17	TP-FP 28 REP(4.6-5)	3297.66	1198	32.33	< LOD	1	17.21	0.63	< LOD	18.49	497.49	93.8	59.96	2.27	< LOD	3.49	124.97	1.19	8091.04	62.51	< LOD	7.16	< LOD
18	TP-FP 30 (0.5-0.8)	8807.48	12279	84.85	3.44	0.85	10.75	0.73	33.35	12.09	< LOD	283.36	1954.32	13.48	5.79	2.54	69.13	1.13	99641.66	415.94	< LOD	9.44	< LOD
19	TP-FP 30 (1.6-2)	5558.7	9646	71.23	< LOD	1.57	13.7	0.69	43.37	10.67	621.27	109.65	1661.66	11.31	< LOD	4.62	99.63	1.23	46368.3	254.77	< LOD	8.48	< LOD
20	TP-FP 30 (2.3-3.3)	3978.61	1566	35.84	< LOD	1	12.4	0.66	62.88	10.07	1275.59	80.46	104	2.94	< LOD	4.44	112.43	1.23	36975.64	128.8	< LOD	8.04	< LOD
21	TP-FP 30 (3-3.5)	3173.99	2377	39	< LOD	1	17.14	0.61	< LOD	18.02	796.73	90.5	82.12	2.45	< LOD	3.23	105.77	1.07	7864.63	60.54	< LOD	6.86	< LOD
22	TP-FP 30 (3.5-4)	3213.63	6865	59.32	< LOD	1.24	15.07	0.61	< LOD	18.3	551.88	91.51	181.26	3.36	< LOD	4.02	127.52	1.2	6686.5	57.97	< LOD	7.12	< LOD
23	TP-FP 30 (4.8-5)	3389.4	32366	125.1	< LOD	1.4	15.78	0.65	< LOD	19.22	< LOD	171.2	100.33	2.81	< LOD	3.56	115.57	1.21	6383.62	57.58	< LOD	7.65	< LOD
24	TP-FP 30 (7.5-8)	3856.25	6604	60.46	< LOD	1.39	15.3	0.66	< LOD	19.91	434.87	100.21	400.26	5.11	< LOD	3.65	99.83	1.14	16620.74	89.76	< LOD	7.74	< LOD
25	TP-FP 30 (10-10.5)	3409.45	9821	71.25	< LOD	1.43	17.18	0.64	< LOD	18.97	< LOD	203.17	144.11	3.13	< LOD	3.43	110.68	1.14	1522.92	40.92	< LOD	7.27	< LOD
26	TP-FP 30A (0.5-0.8) DUP	8532.49	13165	87.66	2.1	0.83	12.9	0.74	33.38	12.07	< LOD	280.56	1855.43	12.97	8.5	3.04	77.27	1.18	96085.21	406.53	< LOD	9.34	< LOD
27	TP-FP 30A (0.8-1)	10146.6	7913	70.3	< LOD	1.79	12.43	0.79	93.27	13.32	< LOD	267.62	2250.79	15.43	8.55	3.05	63.39	1.15	143696.42	478.55	< LOD	10.08	< LOD
28	TP-FP 31 (0.1-0.4)	6452.8	1542	38.55	2.3	0.86	12.17	0.75	52.22	11.79	582.8	105.53	2942.74	17.1	< LOD	4.39	73.46	1.17	71609.05	310.9	< LOD	9.4	< LOD
29	TP-FP-01A(0-3)	3014.57	754.2	29.68	< LOD	1.41	17.08	0.62	< LOD	17.56	280.88	98.25	51.05	2.14	< LOD	4.01	97.36	1.05	162.26	33.16	< LOD	7.03	< LOD
30	TP-FP-01B(0-2)		285.7	67.65	< LOD	3.2	9.34	1.63	60.42	25.84			2046.76	30.83	< LOD	10.59	87.45	2.84			< LOD	21.51	< LOD
31	TP-FP-01B(0-2)	4601.02	361.4	27.38	< LOD	1.51	12.46	0.66	32.68	10.01	1198.93	96.68	2015.73	12.01	< LOD	3.76	86.62	1.1	43458.98	233.99	< LOD	8.02	< LOD
32	TP-FP-02(3-8.5)	3103.22	794	29.88	< LOD	1	14.25	0.61	< LOD	17.67	659.55	94.26	141.71	3.06	< LOD	3.37	109.02	1.11	1752.69	39.93	< LOD	7.19	< LOD
33	TP-FP-02(8.5-9.5)	5444.78	330.2	28.32	< LOD	1.6	13.86	0.7	63.72	10.95	1659.4	116.09	2566.27	14.59	7.17	2.56	93.64	1.21	52230.13	271	< LOD	8.56	< LOD
34	TPFP03(2.5-3)	1836.18	1360	70.54	< LOD	1.5	17.8	1.35	< LOD	27.84	< LOD	247.8	69.15	5.28	< LOD	5.74	69.39	1.52	< LOD	80.05	< LOD	11.77	< LOD
35	TP-FP-03(2.5-3.0)		1114	36.77	< LOD	1.99			61.15	11.01			58.75	3.26			145.2	2.3					< LOD
36	TP-FP-03(4-4.5)		402.1	45.19	3.75	1.61			128.43	15.84			2703.85	21.37			111.06	2.55					6.22
37	TP-FP-03(4-4.5)	3275.66	221.3	58.08	< LOD	1.61	14.49	1.56	73.47	22.69	519.7	170.09	2950.26	34.79	< LOD	8.02	49.78	1.59	43837.47	294.78	< LOD	14.42	< LOD
38	TP-FP-03(6-7)		881.4	34.89	2.66	1.36			81.09	11.39			101.05	3.98			150.88	2.35					< LOD
39	TP-FP-03(6-7)	1848.11	970.1	64.22	< LOD	1.5	16.7	1.33	< LOD	35.34	< LOD	244.56	129.92	6.43	< LOD	6.74	72.34	1.53	932.22	61.32	< LOD	11.5	< LOD
40	TP-FP-03(7.6-8.6)	1966.3	12327	160.56	< LOD	1.5	16.84	1.37	< LOD	38.44	< LOD	252.52	151.9	6.97	< LOD	7.44	64.96	1.5	593.15	60.49	< LOD	11.98	< LOD
41	TP-FP-03(7.6-8.6)		< LOD	3019.56	< LOD	79.25	< LOD	51.91	< LOD	788.98			< LOD	312.44	< LOD	177.63	84.37	42.92			< LOD	363.54	< LOD
42	TP-FP-03(9-9.5)	1877.65	1535	72.76	< LOD	1.5	16.44	1.36	< LOD	44.09	< LOD	236.18	96.87	5.98	< LOD	6.83	81.7	1.67	536.76	57.14	< LOD	11.88	< LOD
43	TP-FP-03(11.5-12.5)	1870.4	1768	74.19	< LOD	1.5	16.14	1.32	< LOD	44.01	< LOD	253.57	236.86	8.1	< LOD	6.63	62.96	1.43	969.25	62.92	< LOD	11.46	< LOD
44	TP-FP-04(1.5-2)	3877.69	640.6	67.36	< LOD	1.72	13.44	1.6	96.45	24.71	< LOD	261.04	2285.08	31.49	< LOD	8.45	47.54	1.62	54827.07	343.49	< LOD	15.39	< LOD
45	TP-FP-04(3-4)		12233	234.65	< LOD	2.68	17.54	2.23	53.68	30.84			3701.66	54.86	< LOD	10.56	69.81	2.54			< LOD	20.44	< LOD
46	TP-FP-04(3-4)	2430.09	12383	165.28	< LOD	1.5	16.03	1.52	69.64	21.65	< LOD	230.9	3639.25	37.67	< LOD	10.63	69.27	1.75	19218.87	174.77	< LOD	13.74	< LOD
47	TP-FP-04(5.5-6.5)	2802.11	2683	89.59	< LOD	1.95	14.89	1.55	< LOD	32.57	< LOD	262.61	4758.79	46	< LOD	8.29	61.89	1.73	29832.13	232.47	< LOD	14.15	< LOD
48	TP-FP-04(7-8)	2303.72	6290	119.13	< LOD	1.5	13.78	1.41	< LOD	30.26	< LOD	227.2	1961.81	25	< LOD	6.22	64.52	1.61	16174.76	156.53	< LOD	12.72	< LOD
49	TP-FP-04(9-10)	2415.39	6223	121.81	< LOD	1.54	16.34	1.54	36.01	21.2	< LOD	233.95	3384.63	36.7	< LOD	11.24	67.12	1.75	16114.79	158.11	< LOD	13.99	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
50	TP-FP-05(1-3)	7282.56	347.1	64.3	< LOD	2.15	15.12	1.63	84.49	25.23	< LOD	303.77	1159.18	21.67	< LOD	9.86	58.23	1.75	101876.25	538.95	< LOD	15.25	< LOD
51	TP-FP-05(1-3)DUP	7839.79	365	66.79	< LOD	1.82	14.03	1.71	93.96	26.93	< LOD	292.89	2072.03	31.38	< LOD	11	52.56	1.78	103685.28	545.79	< LOD	16.3	< LOD
52	TP-FP-05(3.8-4.8)	1839.54	3377	93.15	< LOD	1.5	17.63	1.38	< LOD	37.9	< LOD	230.91	512.51	11.82	< LOD	5.83	75.76	1.61	2499.94	73.73	< LOD	12.02	< LOD
53	TP-FP-05(6-7)	2754.53	7755	137.02	< LOD	1.65	15.14	1.59	57.37	22.09	< LOD	258.28	8285.74	68.04	< LOD	7.04	66.72	1.86	24679.91	210.27	< LOD	14.59	< LOD
54	TP-FP-05(7.5-8.0)	1876.68	3508	94.45	< LOD	1.5	18	1.4	< LOD	32.46	< LOD	223.09	793.09	14.83	< LOD	5.93	74.57	1.62	3772.6	81.68	< LOD	12.16	< LOD
55	TP-FP-05(8.5-9.5)	1898.74	1761	74.98	< LOD	1.63	15.51	1.35	< LOD	27.49	< LOD	243.13	789.9	14.44	< LOD	5.75	68.76	1.54	3036.6	79.05	< LOD	11.79	< LOD
56	TP-FP-06(1.3-2)	4692.47	18764	208.03	< LOD	1.68	12.63	1.6	66.59	24.77	< LOD	297.95	1979.06	28.74	< LOD	8.36	55.99	1.72	69431.48	422.79	< LOD	15.21	< LOD
57	TP-FP-06(4.5-5.5)	5125.34	9390	154.63	< LOD	1.78	13.64	1.66	100.45	26.36	< LOD	323.17	2435.87	33.86	< LOD	12.09	45.46	1.65	87562.99	505.45	< LOD	15.95	< LOD
58	TP-FP-06(7-8)	2754.47	4127	103.53	< LOD	1.54	17.52	1.53	32.34	21.12	< LOD	290.88	3877.54	38.62	< LOD	10.48	72.45	1.78	16847.5	175.05	< LOD	13.52	< LOD
59	TP-FP-06(8.5-9)	2407.11	5829	118.31	< LOD	1.5	15.32	1.48	57.83	21.48	< LOD	259.49	3274.88	34.52	< LOD	10.08	71.48	1.74	14423.49	156.61	< LOD	13.38	< LOD
60	TP-FP-07(0.5-1)	13903	1491	85.88	< LOD	2.21	13.96	1.81	170.88	30.11	< LOD	323.81	2151.16	34.24	< LOD	9.48	46.9	1.81	123041.12	633.73	< LOD	17.5	< LOD
61	TP-FP-07(1-1.5)	6389.7	11370	170.34	< LOD	1.81	12.6	1.69	79.12	26.93	< LOD	366.34	2862.83	38.28	< LOD	16.97	46.45	1.72	101597.12	586.75	< LOD	16.24	< LOD
62	TP-FP-07(2.5-3.0)	1625.02	753.8	61.31	< LOD	1.5	17.34	1.35	< LOD	27.21	< LOD	212.45	42.18	4.61	< LOD	9.08	73.17	1.55	274.21	55.22	< LOD	11.46	< LOD
63	TP-FP-07(5-5.5)	1928.63	1046	64.61	< LOD	1.5	17.01	1.34	< LOD	33.18	< LOD	236.92	92.1	5.76	< LOD	6.1	80.4	1.62	918.9	61.47	< LOD	11.64	< LOD
64	TP-FP-07(7-8)	4190.35	5634	122.21	< LOD	1.76	11.79	1.61	103.84	26.04	< LOD	319.52	2149.4	30.78	< LOD	13.1	52.14	1.71	43648.97	316.23	20.55	11.24	< LOD
65	TP-FP-07(11-12)	3599.73	4722	110.75	< LOD	1.57	15.63	1.55	72.51	23.28	< LOD	289.74	1339.23	21.89	< LOD	12.69	67.78	1.76	50551.13	333.23	< LOD	14.04	< LOD
66	TP-FP-07 Rep(0.5-1)	15800.6	1538	86.15	< LOD	3.05	14.27	1.82	114.95	29.12	< LOD	330.3	2146.85	34.19	< LOD	11.31	47.09	1.82	125626.95	656.53	< LOD	17.45	< LOD
67	TP-FP-07 Rep(0.5-1)		11066	408.17	< LOD	7.55	13.56	4.26	< LOD	101.76			2922	95.23	< LOD	26.3	46.68	4.25			< LOD	42.67	< LOD
68	TP-FP-08(1.3-2)	6637.35	274.8	68.06	< LOD	2	12.72	1.78	125.32	28.7	1662.7	228.85	4405.25	52.59	< LOD	9.4	47.68	1.85	132650.27	669.58	< LOD	17.34	< LOD
69	TP-FP-08(2.4-2.9)	6534.01	318.4	68.8	< LOD	2.43	10.54	1.75	134.9	29.03	1685.65	228.15	4339.62	52.2	< LOD	14.95	47.03	1.85	133014.09	670.48	< LOD	17.34	< LOD
70	TP-FP-08(3-3.8)	2805.6	1567	76.13	< LOD	1.54	18.21	1.56	46.6	22.1	< LOD	261.41	773.19	16.15	< LOD	9.3	70.77	1.76	28276.85	226.09	< LOD	13.73	< LOD
71	TP-FP-08(4-4.5)	2039.78	32292	256.97	< LOD	1.5	18.87	1.45	63.1	20.35	< LOD	218.49	185.31	7.91	< LOD	6.13	70.35	1.62	3093.79	80.57	< LOD	12.63	< LOD
72	TP-FP-08(4.5-6.0)	1907.1	1340	69.75	< LOD	1.5	14.22	1.36	< LOD	39.62	< LOD	229.47	367.48	10.22	< LOD	5.86	76.29	1.64	7798.35	109.88	< LOD	12.09	< LOD
73	TP-FP-08(6-6.5)	2503.89	3464	92.8	< LOD	1.79	15.52	1.37	< LOD	29.46	< LOD	198.39	281.3	9.07	< LOD	5.86	72.09	1.59	3252	78.13	< LOD	11.98	< LOD
74	TP-FP-08(8-8.6)	4426.5	2448	83.68	< LOD	1.5	17.47	1.44	< LOD	48.16	< LOD	210.39	212.67	8.38	< LOD	6.15	61.22	1.52	2567.7	75.87	< LOD	12.66	< LOD
75	TP-FP-08b(2.4-2.9)		< LOD	3406.75	< LOD	48.3	< LOD	123.45	< LOD	734.27			3432.55	954.71	< LOD	204.05	< LOD	65.83			< LOD	374.64	< LOD
76	TP-FP-08b(2.4-2.9)		< LOD	3753.11	< LOD	63.27	< LOD	72.98	< LOD	1478.13			3610.8	1128.78	< LOD	219.49	< LOD	68.05			< LOD	419.15	< LOD
77	TP-FP-08b(2.4-2.9)		< LOD	10721.3	< LOD	96.9	< LOD	159.54	< LOD	2391.07			6111.81	2957.6	< LOD	402.68	< LOD	133.51			< LOD	1658.42	< LOD
78	TP-FP-08b(2.4-2.9)	9894.81	1565	81.44	< LOD	1.85	14.3	1.74	120.54	26.82	< LOD	292.44	3653.42	44.09	< LOD	13.1	50.85	1.8	87092.7	486.31	< LOD	16.36	< LOD
79	TP-FP-09(1.5-2.0)	10113.1	165.5	63.61	< LOD	1.8	10.25	1.64	77.75	26.28	< LOD	335.59	3249.24	40.95	< LOD	13.12	37.08	1.58	140110.86	705.4	< LOD	17.8	< LOD
80	TP-FP-09(2.7-3.0)	11471.4	191.8	73.52	< LOD	3.39	13.17	1.94	171.87	33.11	345.02	226.26	2985.61	44.92	< LOD	10.25	37.77	1.82	139031.67	712.34	< LOD	20.24	< LOD
81	TP-FP-09(3.2-3.3)	5420.24	2517	95.12	< LOD	1.86	13.58	1.72	76.08	27.12	< LOD	349.58	3641.13	44.32	< LOD	11.12	45.67	1.71	93598.98	538.15	< LOD	16.48	< LOD
82	TP-FP-09(4.5-5)	4011.69	535.6	63.79	< LOD	1.56	12.88	1.52	67.86	23.29	346.03	192.96	1114.79	20.18	< LOD	9.29	60.27	1.69	63878.54	385.74	< LOD	14.33	< LOD
83	TP-FP-09(7.5-8)	2865.16	908.5	67.6	< LOD	1.52	15.95	1.51	64.62	22.79	< LOD	275.67	612.88	14.32	< LOD	7.65	64.06	1.66	25723.23	216.24	< LOD	13.69	< LOD
84	TP-FP-10(2-2.4)	1991.91	2585	83.85	< LOD	1.5	14.82	1.31	< LOD	27.86	< LOD	257.52	240.48	8.16	< LOD	5.58	69.67	1.51	3572.42	85.37	< LOD	11.35	< LOD
85	TP-FP-10(4-4.5)	1872.53	2650	84.94	< LOD	1.5	15.87	1.36	< LOD	27.34	< LOD	233.07	224.09	8.13	< LOD	5.78	71.44	1.57	1048.61	62.27	< LOD	11.73	< LOD
86	TP-FP-10(5.5-6)	1941.99	6146	117.77	< LOD	1.5	16.97	1.37	39.1	19.64	< LOD	244.04	235.22	8.32	< LOD	6.69	72.79	1.59	1085.51	64.29	< LOD	11.94	< LOD
87	TP-FP-10(8-8.5)	2331.2	12446	163.9	< LOD	2.64	19.71	1.64	101.52	23.48	< LOD	229.5	926.17	18.18	< LOD	10.46	63.45	1.73	957.76	63.03	< LOD	14.16	< LOD
88	TP-FP-10 Rep(5.5-6)	1963.51	6169	117.23	< LOD	1.5	17.62	1.38	31.04	19.48	< LOD	245.76	235.57	8.31	< LOD	5.78	73.89	1.59	1027.93	63.79	< LOD	11.85	< LOD
89	TP-FP-10A(.75-1.0)	3364.85	303.3	68.44	< LOD	2.03	11.22	1.77	121.27	28	903.62	157.28	3018.47	41.78	< LOD	9.76	42.87	1.77	22732.68	201.68	< LOD	20.74	< LOD
90	TP-FP-10A(1.1-1.3)	1968.24	192.3	51.28	< LOD	1.5	14.07	1.32	< LOD	27.08	< LOD	248.34	615.18	12.78	< LOD	5.73	64.69	1.49	4392.97	89.47	< LOD	11.62	< LOD
91	TP-FP-10A(2.1-2.6)	1860.33	3111	89.4	< LOD	1.5	16.49	1.36	< LOD	29.79	< LOD	240.32	320.35	9.4	< LOD	5.71	68.84	1.53	1185.14	64.26	< LOD	11.58	< LOD
92	TP-FP-10A(3.5-4)	1625.98	16064	180.7	< LOD	1.5	16.65	1.38	34.54	19.6	< LOD	180.07	134.67	6.72	< LOD	5.85	76.48	1.63	788.52	57.03	< LOD	11.95	< LOD
93	TP-FP-11(.1-.3)	3683.98	1002	72.71	< LOD	1.77	11.12	1.6	75.64	24.72	623.74	178.66	2821.27	36.1	< LOD	9.91	38.48	1.52	41946.55	292.94	< LOD	15.36	< LOD
94	TP-FP-11(1-1.2)	2219.29	3095	89.29	< LOD	1.5	13.11	1.41	44.57	20.63	< LOD	223.11	1685.53	23.17	< LOD	6.32	58.93	1.54	9518.82	121.96	< LOD	12.87	< LOD
95	TP-FP-11(1.5-2.0)	1936.76	12781	161.21	< LOD	1.5	14.64	1.37	58.76	20.15	< LOD	216.27	96.03	6.11	< LOD	6	67.08	1.56	3410.44	79.95	< LOD	12.33	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
96	TP-FP-11(2.7-3.0)	1950.58	734.8	59.23	< LOD	1.5	11.06	1.31	< LOD	27.1	< LOD	229.14	811.62	14.8	< LOD	5.8	58.19	1.44	5745.23	96.65	< LOD	11.69	< LOD
97	TP-FP-11(3.7-4)	2043.27	12856	165.74	< LOD	1.5	19.27	1.45	43.07	20.28	< LOD	236.01	164.58	7.41	< LOD	5.98	72.3	1.63	3528.66	83.56	< LOD	12.19	< LOD
98	TP-FP-11(6.5-7)	1933.53	1287	68.73	< LOD	1.5	15.82	1.33	< LOD	27.07	< LOD	247.18	92.52	5.74	< LOD	6.91	74.91	1.57	1186.33	64.1	< LOD	11.53	< LOD
99	TP-FP-11(8.5-9.0)	2022.14	1651	73.78	< LOD	1.5	16.11	1.34	< LOD	27.4	< LOD	255.79	191	7.58	< LOD	6.78	76.22	1.6	2707.76	78.56	< LOD	11.84	< LOD
100	TP-FP-11A(6.5-7)	2012.63	874.4	64.21	< LOD	1.5	16.78	1.37	< LOD	33.26	< LOD	254.77	93.83	5.92	< LOD	7.78	75.01	1.61	1148.55	65.63	< LOD	11.94	< LOD
101	TP-FP-12(.9-1.3)	6848.33	483.8	75.88	< LOD	2.23	9.07	1.89	152.08	31.15	462.03	214.55	8427.36	90.08	< LOD	12.91	40.76	1.99	125600.52	678.91	26.27	13.61	< LOD
102	TP-FP-12(1.6-1.8)	2468.25	1953	78	< LOD	1.5	13.89	1.45	< LOD	41.62	< LOD	229.77	1757.24	24.18	< LOD	6.43	58.83	1.58	21901.14	184.58	< LOD	13.16	< LOD
103	TP-FP-12(1.6-2.0)	6130.39	477	74.91	< LOD	2.14	11.66	1.92	107.55	30.38	< LOD	297.43	7139.48	78.77	< LOD	10.17	41.46	1.95	106275.84	588.87	49.32	13.57	< LOD
104	TP-FP-12(2-2.3)	9813.2	7481	157.08	< LOD	4.27	11.67	2.03	133.82	35.22	< LOD	404.02	4801.81	63.78	< LOD	12.44	32.96	1.87	178718.8	901.78	27.71	14.15	< LOD
105	TP-FP-12(3-3.5)	6196.45	6125	65.25	2.31	1	12.81	0.88	39.32	13.29	< LOD	213.82	15653.2	63.1	< LOD	5.91	90.03	1.63	36872.86	280.75	< LOD	12.02	< LOD
106	TP-FP-12(3-3.3)	2131.41	4189	101.58	< LOD	1.5	12.71	1.42	< LOD	29.65	< LOD	221.59	5581.72	47.54	< LOD	7.72	66.72	1.68	13619.62	143.9	< LOD	12.98	< LOD
107	TP-FP-12(6-6.5)	1891.46	3044	90.76	< LOD	1.5	15.96	1.44	36.62	20.2	< LOD	195.53	2573.18	29.36	< LOD	6.24	71.04	1.68	9839.33	120.99	< LOD	12.82	< LOD
108	TP-FP-12(8-8.5)	1886.55	1893	77.48	< LOD	1.5	14.91	1.37	< LOD	31.6	< LOD	230.42	1616.74	21.59	< LOD	5.95	65.43	1.55	6279.3	99.67	< LOD	12.17	< LOD
109	TP-FP-12(9.5-10)	2010.35	1518	72.15	< LOD	1.5	15.63	1.36	< LOD	27.69	< LOD	241.3	1618.46	21.22	< LOD	7.23	66.91	1.54	6814.71	105.57	< LOD	12.02	< LOD
110	TP-FP-13(1-1.3)	2536.33	2953	90.22	< LOD	1.5	12.57	1.4	< LOD	45.1	< LOD	253.52	1771.55	23.81	< LOD	6.32	52.38	1.47	26843.78	214.66	< LOD	12.85	< LOD
111	TP-FP-13(1.5-1.8)	3399.49	375.9	61.43	< LOD	2.46	14.08	1.57	76.51	23.39	< LOD	247.41	3317.83	38.08	< LOD	11.16	51.66	1.64	48796.73	314.02	< LOD	14.71	< LOD
112	TP-FP-13(2.4-2.7)	1887.66	1078	67.38	< LOD	1.5	13.32	1.42	< LOD	31.65	< LOD	181.39	397.63	11.31	< LOD	6.38	51.98	1.46	4790.89	90.11	< LOD	12.94	< LOD
113	TP-FP-13(3.1-3.4)	6155.33	1207	84	< LOD	2.24	13.22	1.94	140.71	30.87	< LOD	311.16	8028.57	85.29	< LOD	13.93	43.53	1.99	99783.65	555.72	< LOD	18.78	< LOD
114	TP-FP-13(3.5-3.7)	2106.96	27257	242.19	< LOD	1.5	13.61	1.44	42.34	21.31	< LOD	192.11	1182.69	19.46	< LOD	7.14	61.47	1.59	12606.64	139.33	< LOD	13.33	< LOD
115	TP-FP-13(4-4.3)	2584.4	7339	125.99	< LOD	1.5	14.74	1.41	< LOD	30.62	< LOD	246.27	1018.97	17.6	< LOD	9.05	61.16	1.55	22925.01	196.08	< LOD	12.8	< LOD
116	TP-FP-14(1-1.3)	2196.62	1039	66.74	< LOD	1.5	15.46	1.4	< LOD	40.72	< LOD	256.63	968.57	16.73	< LOD	7.75	68.29	1.6	12668.25	141.54	< LOD	12.47	< LOD
117	TP-FP-14(1.4-1.9)	2340.99	2206	83.23	< LOD	1.52	12.75	1.51	36.23	21.37	< LOD	225.66	6911.22	58.78	< LOD	9.07	60.93	1.74	17216.2	164.24	< LOD	14.28	< LOD
118	TP-FP-14(3.2-3.5)	1750.99	5339	111.08	< LOD	1.5	16.4	1.39	< LOD	29.2	< LOD	196.64	734.11	14.19	< LOD	7.39	72.32	1.6	2843.07	76.09	< LOD	12.15	< LOD
119	TP-FP-14(4-4.6)	1925.75	17687	198.06	< LOD	1.5	14.36	1.47	31.12	20.42	< LOD	203.66	4742.95	43.68	< LOD	6.48	66.26	1.7	9462.86	118.06	< LOD	13.44	< LOD
120	TP-FP-14(6-6.5)	2450.15	2868	87.81	< LOD	1.5	14.75	1.35	< LOD	38.05	< LOD	189.01	531.07	12.11	< LOD	5.87	71.85	1.59	5909.69	93.58	< LOD	12	< LOD
121	TP-FP-14(10-10.5)	1843.63	1693	74.46	< LOD	1.5	16.79	1.36	< LOD	47.89	< LOD	232.68	234.2	8.26	< LOD	6.14	65.05	1.49	1747.98	70.63	< LOD	11.77	< LOD
122	TP-FP-14 REP(4-4.6)REP	1941.56	17692	195.41	< LOD	1.5	12.08	1.42	< LOD	31.29	< LOD	204.1	4704.26	42.87	< LOD	6.41	66.75	1.68	9583.99	118.71	< LOD	13.27	< LOD
123	TP-FP-15(0-.2)	3550.14	3846	94.95	< LOD	1.5	10.01	1.32	< LOD	28.25	< LOD	216.58	1364.61	20.18	< LOD	6.09	41.15	1.28	24888.83	198.73	< LOD	12.43	< LOD
124	TP-FP-15(0-0.3)	1996.31	2106	79.55	< LOD	1.5	18.45	1.37	< LOD	39.7	< LOD	244.14	112.04	6.21	< LOD	5.75	74.19	1.58	2310.17	75.03	< LOD	11.77	< LOD
125	TP-FP-15(0-0.4)	6442.17	13591	189.31	< LOD	2.86	13.59	1.7	61.99	27.29	< LOD	367.4	2163.22	32.41	< LOD	9.89	41.32	1.62	112421.88	633.31	< LOD	16.3	< LOD
126	TP-FP-15(1.7-1.9)	1619.09	795.5	59.66	< LOD	1.5	12.07	1.22	< LOD	24.72	< LOD	216.42	70.84	5.05	< LOD	5.24	63.32	1.39	2979.9	71.75	< LOD	10.86	< LOD
127	TP-FP-15(6.5-7)	1916.87	2186	80.27	< LOD	1.5	18.67	1.38	< LOD	45.58	< LOD	247.89	144.45	6.82	< LOD	7.19	76.54	1.61	2650.69	78.29	< LOD	11.77	< LOD
128	TP-FP-15A(0.5-1)	13712.1	620.8	73.17	< LOD	2.17	10.03	1.66	60.52	27.74	< LOD	410.9	2772.11	37.79	< LOD	11.3	28.08	1.42	225779.38	1013.02	< LOD	16.41	< LOD
129	TP-FP-15A(2.7-3)	5638.95	12203	174.78	< LOD	1.6	10.93	1.55	47.85	24.52	< LOD	367.83	1699.43	26.08	< LOD	8.24	42.3	1.51	92637.98	547.63	< LOD	14.85	< LOD
130	TP-FP-15A(3.1-3.6)		3407	1218.77	< LOD	336.85	< LOD	260.29	< LOD	4075.81			< LOD	653.89	< LOD	1371.37	< LOD	60.19			< LOD	3152.39	< LOD
131	TP-FP-15A(3.1-3.6)	114463	3220	763.99	< LOD	180.5	< LOD	160.32	< LOD	2679.77	< LOD	4919.65	< LOD	499.57	< LOD	825.92	< LOD	39.75	< LOD	4203.05	< LOD	1894.08	< LOD
132	TP-FP-15A(3.1-3.6)	5103.88	20614	223.65	< LOD	1.77	13.43	1.66	68.15	26	< LOD	302.29	1395.05	24.41	< LOD	9.83	45.46	1.62	89422.24	501.07	< LOD	22.13	< LOD
133	TP-FP-15A(5-5.2)	2347.33	4117	100.9	< LOD	1.5	14.74	1.47	66.03	21.96	< LOD	217.4	282.95	9.95	< LOD	6.89	63.54	1.63	15795.84	154.32	< LOD	13.36	< LOD
134	TP-FP-15A(5-5.7)	1906.29	3879	98.79	< LOD	1.5	16.6	1.39	< LOD	28.27	< LOD	225.15	277.9	9.13	< LOD	5.93	73.94	1.62	4022.75	82.93	< LOD	12.18	< LOD
135	TP-FP-15A(6-6.5)	2054.28	3696	98.53	< LOD	1.5	17.09	1.43	< LOD	31.13	< LOD	248.5	260.98	9.07	< LOD	6.11	58.48	1.5	3025.72	80.81	< LOD	12.52	< LOD
136	TP-FP-15A(8.5-9.0)	2296.87	1835	76.06	< LOD	1.5	15.95	1.35	< LOD	28.06	< LOD	259.87	228.38	8.18	< LOD	5.78	54.33	1.37	13760.66	150.89	< LOD	11.83	< LOD
137	TP-FP-15A DUP(0.5-1)	18045.6	635.7	72.77	< LOD	2.77	10.71	1.63	59.25	27.18	< LOD	431.59	2883.25	38.19	< LOD	8.86	28.14	1.39	231741.73	1054.18	< LOD	16.17	< LOD
138	TP-FP-16(1.1-1.5)	8583.85	1087	75.87	< LOD	1.72	10.76	1.61	94.67	25.47	< LOD	320.65	3859.33	44.78	< LOD	8.73	42.67	1.63	121717.44	623.79	< LOD	15.92	< LOD
139	TP-FP-16(3-3.4)	5326.77	1172	73.78	< LOD	1.61	13.72	1.57	68.05	23.44	< LOD	316.81	3884.19	42.38	< LOD	9	46.98	1.59	111252.55	591.69	< LOD	15.08	< LOD
140	TP-FP-16(3-3.4)DUP	12734.6	943.8	68.45	< LOD	1.52	11.47	1.5	45.6	22.22	< LOD	308.17	4267.46	43.76	< LOD	8.01	42.99	1.51	115247.05	597.41	< LOD	14.36	< LOD
141	TP-FP-16(4.2-4.3)	13740.5	29143	279.43	< LOD	3.96	13.83	1.83	< LOD	50.27	< LOD	423.26	17658.2	145.89	< LOD	12.28	94.04	3.49	53124.09	645.02	< LOD	25.06	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
142	TP-FP-16(4.2-4.3)	5065.78	26365	280.75	< LOD	2.46	12	2.05	55.47	28.25	< LOD	294.16	19806.2	179.05	< LOD	13.57	50.82	2.39	76528.48	474.57	36.41	14.15	< LOD
143	TP-FP-16(4.2-4.3)CHECK	4886.12	25502	272.26	< LOD	2.37	14.3	2.01	44.15	27.12	< LOD	297.09	18667.6	162.96	< LOD	14.8	52.52	2.32	77282.83	501.06	28.42	13.65	< LOD
144	TP-FP-16(4.8-5)	12136.4	22672	221.07	< LOD	2.73	8.48	1.34	< LOD	39.19	< LOD	478.92	3699.42	36.6	< LOD	9.43	66.28	2.12	22147.03	480.72	< LOD	17.46	< LOD
145	TP-FP-16(5.5-6.3)	6806.11	4252	100.35	< LOD	2.94	14.8	1.28	< LOD	37.77	< LOD	382.63	255.54	8.11	< LOD	7.05	115.02	2.38	7935.64	126.06	< LOD	14.95	< LOD
146	TP-FP-16(6.2-7.4)	7102	12462	159.53	< LOD	2	15.21	1.34	< LOD	38.74	939.18	187.88	3507.77	32.86	< LOD	8.06	129.85	2.67	7608	240.89	< LOD	15.83	< LOD
147	TP-FP-16(9-9.4)	6081.35	9929	143.9	< LOD	2.24	17.2	1.35	< LOD	37.26	307.12	148.67	1596.33	20.82	< LOD	7.34	126.83	2.6	4671.48	193.77	< LOD	15.57	< LOD
148	TP-FP-16(11.5-12)	7540.27	11881	156.62	< LOD	2	16.49	1.34	< LOD	39.36	404.92	186.29	739.08	13.86	< LOD	8.7	113.53	2.45	15638.08	171.13	< LOD	15.66	< LOD
149	TP-FP-17(1-1.5)	15763.9	451.5	63.39	< LOD	3.47	11.06	1.5	49.77	23.75	662.36	230.22	4371.13	44.58	< LOD	10.33	68.6	2.35	112272.55	810.35	< LOD	19.27	< LOD
150	TP-FP-17(2.6-3.0)	12561.4	5519	120.12	< LOD	3.69	14.64	1.62	54.86	24.17	568.01	215.92	11095.6	87.76	< LOD	10.77	104.36	3.07	71048.16	669.03	< LOD	21.73	< LOD
151	TP-FP-17(2.6-3.0)		< LOD	7669.82	< LOD	159.07	< LOD	77.41	< LOD	2747.31			10343.2	2711.46	< LOD	499.38	< LOD	356.42			< LOD	838.71	< LOD
152	TP-FP-17(2.6-3.0)	12917.2	5516	121.13	< LOD	2.71	14.85	1.64	< LOD	48.23	560.68	219.01	11062.7	88.25	< LOD	10.86	104.43	3.1	71483.34	677.69	< LOD	20.46	< LOD
153	TP-FP-17(4.6-5)	6755.49	5594	112.55	< LOD	2	15.41	1.3	< LOD	38.36	724.81	192.64	433.03	10.41	< LOD	7.12	112.6	2.37	8244.57	127.19	< LOD	15.13	< LOD
154	TP-FP-17(5-6)	7678.14	5182	107.18	< LOD	2.96	15.62	1.3	< LOD	36.69	651.46	203.54	1770.33	21.45	< LOD	7.17	122.77	2.5	12444.23	277.08	< LOD	15.3	< LOD
155	TP-FP-17(6.3-6.5)	7042.29	6591	120.01	< LOD	2	15.67	1.31	< LOD	38.68	771.82	188.22	329.84	9.21	< LOD	7.18	121.21	2.47	9632.28	136	< LOD	15.31	< LOD
156	TP-FP-17(9-9.5)	6667.14	6232	117.11	< LOD	2.84	17.86	1.3	< LOD	37.79	949.32	191.62	127.5	6.03	< LOD	8.33	116.37	2.36	3272.81	93.71	< LOD	14.79	< LOD
157	TP-FP-17(11.5-12)	6746.89	5721	111.16	< LOD	2.12	16.45	1.27	< LOD	37.75	1045.12	196.65	195.72	7.09	< LOD	6.89	116.07	2.34	2552.05	89.1	< LOD	14.7	< LOD
158	TP-FP-17 (3-3.2)	7564.65	20757	202.98	< LOD	3.1	11.6	1.35	< LOD	36.79	829.69	176.07	6771.16	52.06	< LOD	7.66	76.53	2.24	18048.67	330.83	< LOD	16.19	< LOD
159	TP-FP-18(0-0.3)	18553.9	1932	86.99	< LOD	3.81	11.86	1.64	98.06	27.54	865.54	240.42	3650.31	43.42	< LOD	14.41	65.81	2.49	114951.38	830.81	< LOD	22.74	< LOD
160	TP-FP-18(12-12.5)	6836.8	2111	78.7	< LOD	2.73	16.16	1.29	< LOD	36.04	< LOD	392.94	242.13	7.87	< LOD	6.91	115.22	2.36	8894.08	132.52	< LOD	14.78	< LOD
161	TP-FP-18-(0.6-0.8)	13317.5	9008	146.36	< LOD	2.38	13.36	1.63	60.09	24.65	698.9	222.86	11621.4	93.7	< LOD	10.95	89.94	2.96	60158.45	624.07	< LOD	22.31	< LOD
162	TP-FP-18-(2-2.3)	7689.64	6307	118.47	< LOD	3.15	13.35	1.37	< LOD	39.53	802.76	195.64	4222.54	38.24	< LOD	7.75	102.56	2.5	10075.62	277.26	< LOD	16.54	< LOD
163	TP-FP-18-(4-4.5)	6737.77	1501	70.18	< LOD	2	15.18	1.28	< LOD	37.88	927.43	189.94	131.77	6.17	< LOD	7.04	124.32	2.46	3694.35	97.24	< LOD	14.99	< LOD
164	TP-FP-18A (4-4.5) DUP	6842.36	3079	87.47	< LOD	2.93	17.4	1.3	< LOD	37.72	955.89	201.08	225.54	7.65	< LOD	8.35	127.6	2.49	3511.01	96.89	< LOD	14.99	< LOD
165	TP-FP-18A (9-9.5)	6688.86	1659	72.57	< LOD	2	18.88	1.33	< LOD	38.53	982.63	193.33	310.95	8.9	< LOD	7.11	121.2	2.45	2457.55	87.95	< LOD	15.05	< LOD
166	TP-FP-18A DUP-rep(4-4.5)	6978.42	3075	88.73	< LOD	2	17.07	1.31	< LOD	38.08	1033.34	200.83	227.31	7.78	< LOD	8.47	128.64	2.53	3455.85	96.07	< LOD	15.17	< LOD
167	TP-FP-19(.5-.9)	20049.7	2067	89.83	< LOD	3.83	10.91	1.64	< LOD	53.08	< LOD	505.77	6129.86	61.25	< LOD	11.27	62.81	2.52	158838.42	1007.21	< LOD	21.42	< LOD
168	TP-FP-19(1.8-2.4)	8139.7	17572	187.79	3.34	1.51	15.02	1.3	< LOD	37.17	< LOD	386.52	256.21	8.2	< LOD	7.12	104.14	2.29	33445.68	256.76	< LOD	15.17	< LOD
169	TP-FP-19(1.8-2.4)CHECK	4108.28	17732	93.53	1.97	0.74	16.04	0.65	< LOD	18.57	< LOD	191.5	257.88	4.09	< LOD	3.52	103.36	1.13	33530.98	127.5	< LOD	7.52	< LOD
170	TP-FP-19(3.9-4.6)	3684.87	3556	47.14	< LOD	1.26	15.02	0.67	< LOD	19.56	613.82	92.05	3167.34	15.48	< LOD	3.72	129.04	1.33	16063.98	158.49	< LOD	7.93	< LOD
171	TP-FP-19(4.9-5))	3297.17	3837	46.78	< LOD	1	15.24	0.63	< LOD	17.55	556.34	88.05	365.04	4.68	< LOD	3.4	96.01	1.07	13051.16	75.51	< LOD	7.31	< LOD
172	TP-FP-19(5-5.5)	3501.69	3391	45.29	< LOD	1.35	15.11	0.63	< LOD	18	522.39	98.79	604.67	5.98	< LOD	3.45	107.11	1.14	8943.85	66.31	< LOD	7.39	< LOD
173	TP-FP-19(8-8.5)	3657.25	1365	34.25	< LOD	1.1	14.94	0.64	30.16	9.92	302.02	111.77	329.63	4.51	< LOD	3.51	64.57	0.9	2389.97	46.62	< LOD	7.45	< LOD
174	TP-FP-20(0.3-0.5)	11508	12431	88.78	2.29	0.92	11.64	0.81	75.91	13.98	< LOD	297.97	1916.06	14.59	11.89	4.25	52.31	1.09	144080.19	509.29	12.2	5.66	4.68
175	TP-FP-20(2.1-2.4)	5946.94	12237	85.37	< LOD	1.8	14.47	0.8	24.39	12.01	< LOD	230.03	8768.13	36.4	< LOD	5.3	88.35	1.39	38269.96	261.77	< LOD	9.91	< LOD
176	TP-FP-20(9.5-10)	3990.57	9825	71.71	< LOD	1.32	14.67	0.68	< LOD	19.93	318.53	94.86	3189.59	15.78	< LOD	3.8	116.09	1.28	16921.95	167	< LOD	8.1	< LOD
177	TP-FP-20(9.5-10)D	4340	11217	78.95	< LOD	1.35	16.52	0.73	33.68	10.73	263.3	101.13	4389.99	20.28	5.97	2.37	124.94	1.41	18463.81	185.48	< LOD	8.68	< LOD
178	TP-FP-20 (3.1-3.6)	4712.91	9672	73.11	< LOD	1.74	14.15	0.75	36.15	11.06	354.41	86.41	6522.97	28.04	< LOD	4.34	105.53	1.4	35370.54	222.63	< LOD	9.33	< LOD
179	TP-FP-20 (6-6.5)	3483.27	5871	57.08	< LOD	1.15	19.58	0.67	< LOD	18.4	325.76	93.73	721.44	6.66	< LOD	3.55	137.35	1.31	5084.58	54.6	< LOD	7.56	< LOD
180	TP-FP-20 (8-8.5)	3744.13	14388	87.27	2.62	0.79	14.41	0.67	< LOD	18.75	430.25	94.76	2055.99	12.15	< LOD	3.76	113.61	1.26	15537.58	161.59	< LOD	7.91	< LOD
181	TP-FP-20A (2.1-2.4)DUP	8175.47	10853	80.5	2.27	0.9	14.91	0.8	35.17	12.6	< LOD	262.95	5668.82	27.22	< LOD	5.33	82.11	1.32	85320.91	381.54	< LOD	10.02	< LOD
182	TP-FP-21(1-1.3)	10002.2	1165	37.73	1.88	0.91	13.18	0.79	64.73	12.6	< LOD	253.26	3940.68	21.54	< LOD	5.32	82.89	1.31	159993.98	499.1	< LOD	10.03	< LOD
183	TP-FP-21(3-3.2)	4030.7	8868	68.93	< LOD	1.57	17.46	0.71	31.17	10.22	932.66	93.86	2623.54	14.37	< LOD	4.54	122.99	1.34	18114.75	167.67	< LOD	8.27	< LOD
184	TP-FP-21 (6.5-7)	3385.74	2333	39.9	< LOD	1	15.31	0.63	< LOD	18.82	296.53	97.09	609.79	6	< LOD	3.68	125.88	1.23	10830.51	71.64	< LOD	7.42	< LOD
185	TP-FP-21 (10-10.5)	3504.56	1402	34.13	< LOD	1.19	16.37	0.63	< LOD	18.61	436.42	100.31	637.39	6.07	< LOD	4.1	126.94	1.22	7032.75	61.62	< LOD	7.33	< LOD
186	TP-FP-21A(2.8-3)	4485.47	5238	59.29	< LOD	1.38	9.02	0.79	< LOD	21.1	847.11	96.49	16293.6	60.48	< LOD	4.83	70.2	1.43	17968.73	203.03	< LOD	10.17	< LOD
187	TP-FP-21A(3.4-3.7)	7817.29	7539	74.77	< LOD	1.74	8.53	0.9	41.92	13.48	< LOD	252.57	24528.8	97.03	< LOD	6.36	72.7	1.76	53958.51	393.23	38.72	6.5	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
188	TP-FP-21A(3.4-3.7)	7690.58	7533	75.18	< LOD	1.42	7.6	0.9	27.08	13.52	< LOD	251.21	24598.5	99.29	< LOD	6.41	72.59	1.77	54548.58	391.62	32.84	6.55	< LOD
189	TP-FP-21A(4.7-4.8)	3205.28	1244	33.81	< LOD	1.35	15.14	0.64	< LOD	18.15	355.87	93.99	356.72	4.7	< LOD	3.51	129.57	1.26	4633.46	51.33	< LOD	7.46	< LOD
190	TP-FP-22 (0.1-0.3)	7789.81	895.1	36.05	3.72	0.91	11.7	0.79	35.78	12.85	586.78	113.77	2845.65	17.74	< LOD	4.68	65.65	1.18	92624.35	362.19	< LOD	9.94	< LOD
191	TP-FP-22 (0.4-1.2)	3621.35	3122	43.38	1.63	0.7	12.88	0.6	< LOD	17.01	1066.36	100.38	156.69	3.15	< LOD	3.3	93.04	1.02	25313.28	108.11	< LOD	6.95	< LOD
192	TP-FP-22 (0.7-1.2)	8303.41	13188	86.73	2.28	0.82	11.49	0.72	34.68	11.85	< LOD	283.65	1501.23	11.35	5.93	2.48	61.16	1.04	84293.38	382.48	< LOD	9.09	< LOD
193	TP-FP-22 (2.0-2.3)	3191.3	1327	34.78	< LOD	1	16.27	0.63	< LOD	18.06	1217.11	98.44	28.58	1.93	< LOD	3.43	141.13	1.29	3912.06	49.44	< LOD	7.24	< LOD
194	TP-FP-22 (3.7-3.9)	3834.38	1428	35.01	< LOD	1.3	17.78	0.65	< LOD	18.05	745.73	97.75	227.88	3.85	< LOD	3.63	122.96	1.22	24661.45	106.9	< LOD	7.47	< LOD
195	TP-FP-22 (5.5-6)	3122.77	1018	31.06	< LOD	1	14.69	0.6	< LOD	17.37	985.18	93.08	86.08	2.5	< LOD	3.29	128.25	1.18	2247.41	41.78	< LOD	6.98	< LOD
196	TP-FP-22 (7.5-8)	3130.98	1260	33.53	< LOD	1.01	14.44	0.62	< LOD	17.77	1047.51	93.76	48.92	2.15	< LOD	3.37	119.67	1.17	2054.59	40.85	< LOD	7.13	< LOD
197	TP-FP-22 (9-9.5)	3279.46	1219	33.59	< LOD	1	16.53	0.63	< LOD	17.74	851.91	93.97	68.46	2.39	< LOD	3.37	126.71	1.21	10592.57	69	< LOD	7.16	< LOD
198	TP-FP-22A DUP(0.7-1.2)	8127.2	14038	89.81	3.01	0.82	12.2	0.73	41.24	11.87	< LOD	281.51	1591.43	11.75	< LOD	4.97	61.87	1.05	81486.2	375.93	< LOD	9.13	< LOD
199	TP-FP-25(4.3-4.5)	3531.73	3694	46.94	< LOD	1	40.31	0.76	33.72	9.55	837.55	103.47	311.14	4.34	< LOD	3.84	116.73	1.17	8232.66	65.26	< LOD	7.32	< LOD
200	TP-FP-25(6-6.2)	3496.58	3361	45.06	< LOD	1.45	16.7	0.64	< LOD	19.08	706.02	96.7	447.84	5.19	< LOD	3.5	118.06	1.19	4593.34	52.2	< LOD	7.46	< LOD
201	TP-FP-25(7.5-8)	3366.09	2026	38.12	< LOD	1.26	16.21	0.63	< LOD	17.75	557.43	99.55	330.25	4.41	< LOD	3.39	127.89	1.21	5490.12	55.85	< LOD	7.21	< LOD
202	TP-FP-25(7.5-8)	3423.03	2028	38.66	2.37	0.72	16.71	0.64	< LOD	18.06	755.76	100.67	320.82	4.42	< LOD	3.45	125.05	1.22	5522.87	56.29	< LOD	7.32	< LOD
203	TP-FP-25 (0.4-0.9)	7310.27	548.3	32.94	2.08	0.86	10.39	0.75	55.98	12.48	532.03	110.06	1772.33	13	< LOD	5.19	60.11	1.08	90734.29	349.47	< LOD	9.58	< LOD
204	TP-FP-25 (1.1-1.2)	3940.6	21999	95.09	< LOD	1	10.76	0.58	< LOD	16.34	< LOD	143.77	536.07	5.43	< LOD	3.19	50.76	0.77	40641.01	135.5	< LOD	6.62	< LOD
205	TP-FP-25 (1.7-2.1)	3480.9	1778	35.84	< LOD	1	14.26	0.59	< LOD	16.95	607.45	98.27	37.34	1.93	< LOD	3.2	123.07	1.14	22597.59	101.38	< LOD	6.83	< LOD
206	TP-FP-25 (10-10)	3302.86	3956	48.76	< LOD	1.2	14.71	0.64	< LOD	19.23	< LOD	188	254.6	4.03	< LOD	3.5	124.11	1.23	6519.33	58.11	< LOD	7.44	< LOD
207	TP-FP-25A(1.3-1.8)	7604.7	16595	96.96	2.62	0.84	11.52	0.74	42.66	12.24	< LOD	249.56	2266.22	14.69	8.88	3.17	63.15	1.09	64657.32	336.36	< LOD	9.36	< LOD
208	TP-FP-25A(1.3-1.8)DUP	8936.67	18919	105.36	< LOD	1.69	11.33	0.75	53.43	12.6	< LOD	286.25	2251.77	14.88	7.17	2.59	59.82	1.09	94595.72	407.41	< LOD	9.58	< LOD
209	TP-FP-26(4-4.5)	5676.83	24044	116.88	3.18	0.92	15.98	0.81	69.42	12.33	508.69	101.84	4538.02	23.4	< LOD	5.3	90.65	1.36	30366.22	225.45	< LOD	9.93	< LOD
210	TP-FP-26(6-6.5)	6066.4	10099	76.57	2.44	0.88	15.42	0.77	50.91	11.73	< LOD	223.23	3980.04	20.49	8.66	3.09	100.59	1.36	53302.35	287.4	< LOD	9.44	< LOD
211	TP-FP-26(9-9.5)	6680.05	9642	75.76	2.56	0.91	14.56	0.79	54.05	12.17	859.75	109.28	2797.45	17.19	< LOD	5.27	93.3	1.35	71367.52	318.4	< LOD	9.89	< LOD
212	TP-FP-26 (0.7-1)	10144	210.4	33.22	2.61	0.96	11.4	0.82	93.31	13.9	< LOD	232.61	2593.71	17.73	8.17	2.85	84.44	1.38	153689.02	470.83	< LOD	10.74	< LOD
213	TP-FP-26 (1.8-2)	4643.53	7369	65.32	< LOD	1.8	12.37	0.78	118.06	12.36	303.31	81	3605.71	20.34	< LOD	5.34	91.87	1.36	14165.51	164.98	< LOD	10.01	< LOD
214	TP-FP-27(4-5.2)	3549.86	279.6	26.64	4.74	0.77	17.33	0.67	< LOD	19.83	1738.05	105.22	162.35	3.39	< LOD	4.31	78.36	1.01	470.35	36.33	< LOD	7.66	< LOD
215	TP-FP-27 (0-0.4)	6647.96	14620	92.09	2.92	0.89	14.64	0.79	79.36	12.62	801.23	117.37	1721.48	12.88	9.84	3.52	87.86	1.3	49780.79	282.65	< LOD	9.83	< LOD
216	TP-FP-27 (0.5-0.8)	5354.24	22358	117.32	2.94	0.91	14.06	0.81	82.84	13.67	< LOD	289.17	2451.49	16.58	11.99	4.28	63.61	1.18	123924.27	472.38	< LOD	10.32	< LOD
217	TP-FP-27 (0.9-1.2)	9401.54	2085	42.68	< LOD	1.71	9.99	0.74	69.25	12.27	< LOD	251.76	3654.38	19.93	< LOD	5.16	68.53	1.17	152526.25	486.19	< LOD	9.62	< LOD
218	TP-FP-27A(0.5-0.8) DUP	10617.6	24365	122.31	2.57	0.91	11.87	0.8	79.29	13.74	< LOD	281.78	2488.05	16.74	7.25	2.76	64.48	1.19	127027.53	471.52	< LOD	10.4	< LOD
219	TP-FP-31(1-1.8)	3004.2	1123	32.73	< LOD	1.17	14.95	0.63	< LOD	17.92	< LOD	168.82	66.28	2.38	< LOD	3.42	114.99	1.16	7663.32	60.26	< LOD	7.25	< LOD
220	TP-FP-31(2-2.75)	3552.11	16680	92.49	4.79	0.76	17.28	0.66	< LOD	18.52	331.86	89.66	75.8	2.56	< LOD	3.56	117.12	1.21	17865.45	90.41	< LOD	7.59	< LOD
221	TP-FP-31(4.5-5)	3114.43	2629	41.51	< LOD	1.42	17.81	0.64	< LOD	17.54	451.99	92.44	78.86	2.5	< LOD	3.38	117.13	1.16	3295.33	46.19	< LOD	7.12	< LOD
222	TP-FP-31(6.5-7)	3269	2615	41.3	1.63	0.71	14.88	0.62	< LOD	17.55	578.12	93.02	86.93	2.56	< LOD	3.37	117.09	1.16	5710.21	55.34	< LOD	7.17	< LOD
223	TP-FP-31(7-7.5)	2946.66	< LOD	42.94	2.04	0.66	13.61	0.58	< LOD	15.97	< LOD	171.03	78.37	2.34	< LOD	3.09	98.27	1	6679.09	56.69	< LOD	6.49	< LOD
224	TP-FP-31(9-9.5)	3841.03	1617	35.77	< LOD	1.34	14.44	0.65	< LOD	18.7	974.05	94.84	459.49	5.39	< LOD	3.61	106.74	1.16	20434.4	95.72	< LOD	7.65	< LOD
225	TP-FP-31 REP(9-9.5)	3893.52	1586	36	< LOD	1.12	15.39	0.66	< LOD	18.76	1087.58	96.02	452.64	5.42	< LOD	3.67	105.08	1.17	20615.28	96.74	< LOD	7.79	< LOD
226	TP-FP-32(0-0.4)	7550.38	8401	70.27	2.18	0.85	10.18	0.74	83.09	12.19	374.32	106.48	1415.67	11.4	< LOD	5.14	57.78	1.05	102723.52	374.7	< LOD	9.55	< LOD
227	TP-FP-32(1.3-1.4)	9209.26	3968	51.36	2.91	0.85	11.33	0.74	78.36	12.29	< LOD	237.09	1508.56	11.72	< LOD	5.12	63.26	1.09	142895.58	451.24	< LOD	9.45	< LOD
228	TP-FP-32(1.4-1.5)	5389.94	4086	46.88	< LOD	1	8.83	0.59	< LOD	16.82	< LOD	210.45	1284.86	8.72	< LOD	3.34	65.01	0.89	77511.73	312.73	< LOD	7.11	< LOD
229	TP-FP-32(2.4-2.7)	4509.9	807.4	30.34	1.59	0.73	14.39	0.63	< LOD	19.05	1059.83	101.58	69.28	2.43	< LOD	3.51	113.95	1.17	46813.83	157.21	< LOD	7.45	< LOD
230	TP-FP-32(7-7.5)	3545.23	2765	42.67	< LOD	1.49	16.82	0.65	< LOD	19.29	574.54	96.25	81.44	2.58	< LOD	3.49	119.07	1.2	5453.86	55.52	< LOD	7.46	< LOD
231	TP-FP-32(8.5-9)	3155.75	1425	33.75	< LOD	1.4	17.33	0.62	< LOD	17.4	602.74	101.01	109.82	2.72	< LOD	3.28	111.46	1.11	1249.17	38.61	< LOD	7	< LOD
232	TP-FP-32(10.5-11)	3573.1	3287	45.53	< LOD	1.38	16.5	0.65	< LOD	19.37	796.07	101.77	129.23	3.05	< LOD	4.18	116.64	1.19	3142.81	47.5	< LOD	7.49	< LOD
233	TP-FP-33(0-0.5)	10991.7	11333	85.44	3.44	0.94	12.66	0.83	70.2	14.15	318.77	146.74	3175.9	20.14	12.65	4.52	56.08	1.17	142776.31	500.25	< LOD	10.73	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
234	TP-FP-33(2.3-2.6)	3883.24	1038	31.57	< LOD	1	17.44	0.63	< LOD	18.69	286.35	100.68	185.79	3.43	< LOD	3.39	120.98	1.18	19720.85	96.29	< LOD	7.23	< LOD
235	TP-FP-33(3.5-4)	3529.36	7297	61.22	< LOD	1.39	16.72	0.64	< LOD	17.85	647.42	94.99	781.56	6.8	< LOD	3.47	121.56	1.21	6347.21	57.48	< LOD	7.38	< LOD
236	TP-FP-33(5.9-6.2)	3362.88	8245	65.29	< LOD	1.23	15.69	0.64	< LOD	19.06	507.93	93.61	424.17	5.09	< LOD	4.16	122.02	1.22	3002.89	45.71	< LOD	7.47	< LOD
237	TP-FP-33(8-8.5)	3842.05	4140	49.63	< LOD	1.49	16.81	0.66	< LOD	19.12	759.06	105.1	793.7	7	< LOD	3.57	118.48	1.22	9495.83	70.98	< LOD	7.62	< LOD
238	TP-FP-34(0-0.6)	3232.16	1723	35.04	1.88	0.71	16.79	0.61	< LOD	17.06	922.33	97.68	221.3	3.58	< LOD	3.24	107.56	1.08	940.59	36.72	< LOD	6.83	1.69
239	TP-FP-34(1.2-1.7)	3522.39	1438	33.87	1.61	0.72	15.52	0.62	< LOD	18.54	685.9	106.35	148.35	3.09	< LOD	3.35	111.59	1.12	233.42	35.25	< LOD	7.08	< LOD
240	TP-FP-34(3.5-4)	3282.15	1540	35	< LOD	1.42	16.29	0.63	< LOD	18.03	812.01	97.38	164.09	3.27	< LOD	3.39	114.51	1.15	774.54	36.42	< LOD	7.17	< LOD
241	TP-FP-34(6-6.3)	3337.42	225.5	24.65	2.3	0.7	15.44	0.61	< LOD	17.27	687.79	97.18	360.19	4.5	< LOD	3.3	102.41	1.07	3170.78	47.07	< LOD	6.96	< LOD
242	TP-FP-34(7.5-8)	4184.59	811.5	31.52	2.81	0.79	15.89	0.69	53.47	10.86	838.08	101.05	933.55	8.08	< LOD	4.54	81.31	1.08	1930.25	44.04	< LOD	8.21	< LOD
243	TP-FP-34(8.5-9)	3632.45	991.6	31.88	< LOD	1.45	13.42	0.64	26.02	9.88	1055.47	102.86	600.57	6.12	< LOD	3.58	101.44	1.13	1078.19	39.01	< LOD	7.55	< LOD
244	TP-FP-34(10-10.5)	3324.68	1526	34.57	1.99	0.72	15.51	0.64	35.37	9.63	747.74	94.91	469.97	5.29	< LOD	3.47	108.88	1.14	1145.28	37.9	< LOD	7.4	< LOD
245	TP-FP-34(12.5-13)	3418.13	1379	34.3	1.77	0.72	15.67	0.64	35.07	9.74	845.31	101.62	310.45	4.41	< LOD	4.19	112.92	1.17	695.22	36.88	< LOD	7.44	< LOD
246	TP-FP-34 REP(10-10.5)REP	3410.95	1494	34.91	1.72	0.73	14.14	0.64	25.82	9.73	809.16	94.3	503.18	5.56	< LOD	3.55	107.27	1.15	1142.51	37.35	< LOD	7.5	< LOD
247	TP-FP-35(0.5-0.7)	3149.18	1502	33.92	< LOD	1.29	15.36	0.6	< LOD	16.72	645.37	100.48	136.09	2.9	< LOD	3.22	90.9	0.99	808.28	36.27	< LOD	6.77	< LOD
248	TP-FP-35(2.3-2.8)	2717.89	875.5	29.7	< LOD	1.35	16.8	0.61	< LOD	16.82	< LOD	155.64	78.72	2.39	< LOD	3.46	118.62	1.13	325.68	34.15	< LOD	6.84	< LOD
249	TP-FP-35(4-4.3)	11989.4	366.7	32.75	3.27	0.89	12.6	0.78	72.57	12.91	< LOD	274.87	1949	14.05	< LOD	5.31	71.17	1.19	199974.14	567.48	< LOD	9.7	< LOD
250	TP-FP-35(6-6.4)	4283.25	1068	33.4	< LOD	1	13.2	0.67	36.53	10.19	1642.68	96.66	1333.37	9.81	4.69	2.26	109.73	1.26	34090.63	204.12	< LOD	8.18	< LOD
251	TP-FP-35(8.5-9)	3473.33	4088	48.35	< LOD	1.43	17.79	0.66	37.37	9.75	1183.89	94.5	199.5	3.63	< LOD	4.2	115.84	1.19	4576.78	51.73	< LOD	7.46	< LOD
252	TP-FP-35(9-9.8)	3765.98	7037	61.22	4.37	0.78	20.95	0.7	59.06	10.33	1110.17	96.18	264.82	4.25	< LOD	3.69	115.45	1.23	2969.48	47.25	< LOD	7.82	< LOD
253	TP-FP-35(12.5-13)	3688.31	2089	38.26	2.21	0.74	14.97	0.64	< LOD	19.43	721.7	95.22	464.1	5.32	< LOD	4.21	108.55	1.15	8802.47	65.45	< LOD	7.55	< LOD
254	TP-FP-35A(4-4.3)DUP	13123.9	697.1	36.07	2.8	0.91	11.64	0.79	66.64	13.4	< LOD	293.61	2020.05	14.7	< LOD	5.45	48.45	1.04	219858.88	614.33	< LOD	10.16	< LOD
255	TP-FP-35A(8.5-9)	3036.6	495.2	27.12	< LOD	1.34	15.6	0.61	< LOD	17.15	595.32	91.84	126.89	2.89	< LOD	3.29	107.6	1.09	3078.89	44.95	< LOD	6.91	< LOD
256	TP-FP-36(1-1.5)	3958.46	1076	33.36	< LOD	1.29	15.77	0.7	< LOD	20.4	1579.76	102.39	1788.77	11.53	< LOD	4.12	105.83	1.24	9764.33	131.11	< LOD	8.25	< LOD
257	TP-FP-36(3.5-4)	3350.69	2916	42.77	< LOD	1.21	17.04	0.65	< LOD	19.19	592.48	94.35	185.89	3.49	< LOD	3.48	107.97	1.14	315.96	33.78	< LOD	7.39	< LOD
258	TP-FP-36(6.5-7)	3551.76	1578	36.06	2.18	0.76	17.49	0.66	< LOD	19.44	715.3	99.24	347.79	4.71	< LOD	4.26	112.61	1.19	526.04	36.45	< LOD	7.59	< LOD
259	TP-FP-36(9.5-10)	3393.57	1307	34.08	3.49	0.74	16.09	0.65	< LOD	18.46	568.96	97.76	125.39	3.02	< LOD	3.97	120.61	1.21	604.04	36.35	< LOD	7.49	< LOD
260	TP-FP-36(10-10.5)	3135.92	1927	38.66	< LOD	1.5	17.45	0.67	22.64	9.96	553.4	94.4	142.18	3.23	< LOD	4.28	116.5	1.22	< LOD	63.9	< LOD	7.59	< LOD
261	TP-FP-37(0.5-1)	5066.93	407.5	30.31	< LOD	1.54	12.75	0.73	55.69	11.16	2373.37	96.18	2676.11	15.74	7.12	2.48	89.02	1.25	49019.62	247.34	< LOD	9.12	< LOD
262	TP-FP-37(2.5-3)	7100.09	459.8	29.97	< LOD	1.32	11.18	0.69	63.16	10.89	1303.79	116.89	2355.3	14.03	< LOD	4.74	82.85	1.15	100472.98	381.12	< LOD	8.73	< LOD
263	TP-FP-37(4.5-5)	3836.87	10201	73.01	< LOD	1.56	14.99	0.69	53.65	10.26	861.97	91.37	3588.86	17.23	< LOD	4.55	114.27	1.3	18414.61	165.61	< LOD	8.29	< LOD
264	TP-FP-37(7.5-8)	3732.93	8858	68.48	< LOD	1.52	19.2	0.7	< LOD	20.19	859.42	95.25	1351.11	9.69	5.27	2.24	118.53	1.28	6255.68	109.3	< LOD	8.11	< LOD
265	TP-FP-37(9.5-10)	3732.84	6134	58.55	1.67	0.77	16.47	0.68	41.27	10.35	1130.28	100.85	357.77	4.93	< LOD	4.42	105.69	1.19	2048.08	43.9	< LOD	7.98	< LOD
266	TP-FP-37(11.5-12)	3510.99	4390	51.2	< LOD	1.5	20.48	0.68	39.09	9.99	829.26	101.13	342.32	4.71	< LOD	3.8	111.81	1.19	899.29	38.09	< LOD	7.64	< LOD
267	TP-FP-37 REP(7.5-8)REP	3854.51	8778	67.63	< LOD	1.44	17.44	0.69	43.37	10.22	884.16	96.3	1347.59	9.63	5.88	2.23	119.94	1.28	6200.89	109.89	< LOD	8.04	< LOD
268	TP-FP-38(2-2.5)	3410.73	1438	34.17	< LOD	1	17.28	0.63	< LOD	17.58	478.37	99	138.55	3.02	< LOD	3.37	117.65	1.15	1615.82	41.39	< LOD	7.09	< LOD
269	TP-FP-38(5-5.4)	3586.65	1764	36.61	< LOD	1.34	19.66	0.66	< LOD	19.15	732.75	100.63	104.59	2.81	< LOD	4.19	117.41	1.19	822.09	37.86	< LOD	7.47	< LOD
270	TP-FP-38(7.5-8)	3616.6	2822	42.96	< LOD	1.5	19.51	0.68	23.72	9.93	734.7	97.77	283.92	4.34	< LOD	4.17	116.27	1.22	4122.32	51.24	< LOD	7.75	< LOD
271	TP-FP-38(9.5-10)	3411.1	2419	39.98	< LOD	1.43	15.85	0.63	22.09	9.49	620.9	94.54	120.62	2.93	< LOD	4.15	109.67	1.14	834.11	36.75	< LOD	7.32	< LOD
272	TP-FP-38(11.5-12)	3351.88	2896	43.91	1.74	0.76	17.2	0.67	< LOD	19.82	189.04	89.89	167.46	3.46	< LOD	3.62	106.27	1.17	691.66	36.98	< LOD	7.67	< LOD
273	TP-FP-38(14.5-15)	2914.46	620.3	28.63	< LOD	1.43	18.08	0.63	< LOD	17	< LOD	186.23	75.55	2.42	< LOD	3.31	96.62	1.04	68.23	33.59	< LOD	7	< LOD
274	TP-FP-38A(0.5-1)	5367.63	6950	66.62	< LOD	1.36	12.58	0.78	< LOD	22.65	757.03	114.89	10113.4	40.02	< LOD	5.3	102.85	1.49	29886.6	242.33	< LOD	9.96	< LOD
275	TP-FP-38A(0.5-1)DUP	5151.47	7366	68.34	< LOD	1.73	14.1	0.79	< LOD	22.45	< LOD	224.11	10334.1	40.4	< LOD	5.28	103.72	1.49	27658.5	233.55	< LOD	9.85	< LOD
276	TP-FP-38A(1-1.5)	5219.22	9455	75.85	< LOD	1.03	12.98	0.75	< LOD	21.72	417.51	117.84	9698.73	36.92	6.74	2.55	100.6	1.41	22705.2	236.05	< LOD	9.45	< LOD
277	TP-FP-38A(2.5-3)	9423.11	666.1	38.03	< LOD	2.21	7.37	0.98	51.58	14.76	< LOD	228.32	28499.4	122.76	< LOD	6.9	87.52	2.06	111769.95	469.38	64.83	7.12	< LOD
278	TP-FP-38A(4.5-5)	3876.83	8099	64.49	< LOD	1.24	17.78	0.67	< LOD	19.56	678.92	99.12	1506.24	9.91	4.68	2.16	113.28	1.21	9076.41	126.37	< LOD	7.74	< LOD
279	TP-FP-38B(0.5-1)	5489.99	81.68	28.38	< LOD	1.78	10.97	0.74	43.13	11.62	1569.69	95.42	3329.8	18.5	< LOD	4.92	82.65	1.24	54367.17	261.5	< LOD	9.46	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
280	TP-FP-39(0.9-1.6)	3250.9	1097	32.21	< LOD	1.42	16.16	0.62	< LOD	17.77	502.46	104.87	81.27	2.49	< LOD	4.03	124.25	1.18	< LOD	63.76	< LOD	7.12	< LOD
281	TP-FP-39(3.5-4.2)	3271.25	622.2	28.77	2.27	0.72	19.59	0.65	< LOD	17.85	< LOD	209.84	86.6	2.56	< LOD	3.38	98.45	1.07	< LOD	65.54	< LOD	7.11	< LOD
282	TP-FP-39(12.5-13)	3161.71	811.9	30.11	< LOD	1.35	14.98	0.62	< LOD	18.78	258.85	94.91	172.55	3.34	< LOD	3.48	97.39	1.07	< LOD	60.72	< LOD	7.22	< LOD
283	TP-FP-39A(6-6.5)	4235.14	1662	37.63	2.06	0.8	14.99	0.69	28.04	10.99	787.98	110.25	183.03	3.77	4.65	2.3	65.21	0.98	< LOD	74.57	< LOD	8.35	< LOD
284	TP-FP-39A(9.5-10)	3670.94	910.3	31.77	< LOD	1.42	14.85	0.65	< LOD	20.01	727.71	111.23	219.29	3.83	< LOD	3.59	67.47	0.94	< LOD	68.98	< LOD	7.55	< LOD
285	TP-FP-39A REP(9.5-10)	3693.99	988.5	32.06	1.73	0.75	15.1	0.64	< LOD	18.85	590.64	110.4	217.23	3.78	< LOD	3.56	68.14	0.93	< LOD	68.99	< LOD	7.5	< LOD
286	TP-FP-39DUP(0.9-1.6)	3277.96	969.4	30.91	< LOD	1	17.05	0.62	< LOD	17.13	554.46	107.46	75.28	2.39	< LOD	3.96	119.55	1.14	< LOD	66.81	< LOD	6.98	< LOD
287	TP-FP-40(0-0.5)	3182.57	758.2	28.94	< LOD	1.04	15.91	0.61	< LOD	17	1206.38	102.83	281.85	4.01	< LOD	3.3	98.51	1.04	146.85	33.39	< LOD	6.87	< LOD
288	TP-FP-40(1.5-2)	3173.86	730.3	29.37	< LOD	1.2	15.33	0.62	< LOD	17.62	489.37	90.56	157.81	3.2	< LOD	3.4	110.76	1.13	201.08	32.47	< LOD	7.18	< LOD
289	TP-FP-40(3.5-3.8)	3183.13	1446	34.37	< LOD	1.45	14.66	0.64	< LOD	19.21	514.24	90.61	233.84	3.88	< LOD	3.52	88.33	1.04	636.41	34.64	< LOD	7.44	< LOD
290	TP-FP-40(6-6.2)	3932.64	1054	33.29	5.36	0.82	16.16	0.7	23.34	10.75	469.29	98.58	421.75	5.46	< LOD	4.56	58.06	0.93	2834.19	46.84	< LOD	8.22	< LOD
291	TP-FP-40(6.5-6.8)	3391.6	2214	39.01	3.37	0.73	16.67	0.65	< LOD	18.07	2159.42	105.57	272.36	4.13	< LOD	3.5	66.09	0.91	1235.28	39.02	< LOD	7.32	< LOD
292	TP-FP-40(8.5-9)	3550.9	295.9	26.97	5.36	0.77	12.52	0.65	< LOD	19.16	688.02	94.7	381.26	4.99	< LOD	3.65	54.57	0.86	677.68	36.46	< LOD	7.74	< LOD
293	TP-FP-40(13-13.5)	4252.56	728.4	31.45	5.14	0.81	14.29	0.7	41.43	11.01	694.02	102.17	514.37	6.11	7.65	2.73	51.28	0.89	3541.35	50.83	< LOD	8.39	< LOD
294	TP-FP-40(14.5-15)	3180.76	939.5	31.41	1.77	0.73	17.71	0.65	< LOD	19.29	297.46	90.99	241.04	3.93	< LOD	4.2	116.73	1.19	609.51	34.52	< LOD	7.41	< LOD
295	TP-FP-40A(8.5-9)	3648.12	340.4	27.26	3.57	0.76	11.46	0.64	< LOD	20.15	685.08	96.23	346.13	4.78	< LOD	3.69	56.06	0.88	866.28	37.27	< LOD	7.8	< LOD
296	TP-FP-41(0.3-0.7)	4300.25	193.9	27.64	< LOD	1	9.64	0.68	23.32	10.74	1655.96	83.62	1551.4	11.1	< LOD	4.09	67.13	1.04	30548	186.84	< LOD	8.64	< LOD
297	TP-FP-41(0.5-0.8)	4247.73	19400	104.43	3.48	0.82	11.13	0.72	51.07	11.89	602.34	143.72	1540.06	11.49	12.2	4.36	65.09	1.07	84265.97	385.76	< LOD	9.17	< LOD
298	TP-FP-41(2-2.5)	3795.3	3568	47.99	1.78	0.8	15.02	0.69	35.11	10.36	1214.7	92.74	927.84	8.16	6.4	2.3	105.82	1.24	14827.27	82.7	< LOD	8.3	< LOD
299	TP-FP-41(4-4.5)	3127.33	3296	43.56	1.69	0.71	14.49	0.63	< LOD	18.86	961.59	83.18	575.43	5.85	< LOD	3.46	101.5	1.11	6253.23	54.3	< LOD	7.31	< LOD
300	TP-FP-41(5.5-6)	3460.68	2068	37.89	6.41	0.75	12.84	0.64	< LOD	18.54	761.74	82.61	613.57	6.26	< LOD	3.62	83.78	1.05	11940.82	71.46	< LOD	7.64	< LOD
301	TP-FP-41(8.5-9)	3223.09	2891	42.91	2.28	0.74	16.1	0.65	< LOD	19.44	775.46	86.46	287.91	4.32	< LOD	3.58	105.94	1.15	3736.93	46.59	< LOD	7.52	< LOD
302	TP-FP-41(10.5-11)	3198.15	947.1	31.19	2.41	0.73	16.49	0.64	24.87	9.63	335.95	89.83	166.99	3.33	< LOD	4.16	100.83	1.1	1814.88	39.43	< LOD	7.35	< LOD
303	TP-FP-42(0.5-1)	6933.21	11855	80.76	< LOD	1.58	14.75	0.73	45.26	11.36	287.74	129.09	2891.03	16.36	14.39	5.14	79.36	1.17	61852.18	319.05	< LOD	9.01	2.45
304	TP-FP-42(2-2.6)	3487.5	1452	34.96	1.46	0.72	14.34	0.63	< LOD	19.03	905.49	92.74	209.11	3.69	< LOD	3.5	114.29	1.18	12845.45	76.05	< LOD	7.44	< LOD
305	TP-FP-42(4.2-4.8)	3394.76	1115	32.41	< LOD	1.16	17.46	0.65	< LOD	18.25	1013.08	94.56	105.86	2.8	< LOD	4.17	109.7	1.15	2242.72	42.32	< LOD	7.4	< LOD
306	TP-FP-42(4.8-5.2)	2868.68	< LOD	45.57	< LOD	1	15.04	0.6	< LOD	16.68	508.52	90.18	144.5	3.01	< LOD	3.24	95.29	1.02	1046.37	35.34	< LOD	6.78	< LOD
307	TP-FP-42(6-6.1)	3485.84	2588	41.53	< LOD	1	16.88	0.65	19.51	9.64	1066.89	95.7	117.5	2.94	< LOD	3.96	129.57	1.25	2029.98	42.19	< LOD	7.54	< LOD
308	TP-FP-42(6.6-7)	3449.22	3415	45.68	2.31	0.74	18.08	0.65	21.05	9.59	738.79	94.72	124.22	2.99	5.93	2.1	111.39	1.16	1504.67	39.5	< LOD	7.44	< LOD
309	TP-FP-42(10-10.5)	3678.83	4561	50.91	< LOD	1.51	19.03	0.69	46.71	10.19	1146.09	96.15	184.45	3.63	8.06	2.88	106.58	1.18	1260.77	39.43	< LOD	7.86	< LOD
310	TP-FP-42(12-12.5)	3303.89	1565	35.53	< LOD	1.29	17.37	0.65	< LOD	19.29	713.7	95.36	129.73	3.05	< LOD	4.2	108.61	1.15	526.27	34.47	< LOD	7.49	< LOD
311	TP-FP-42(15.6-16)	3363.89	965.6	31.56	2.01	0.74	14.02	0.63	< LOD	18.36	570.32	101.18	331.67	4.54	< LOD	4.19	89.01	1.05	1259.03	38.7	< LOD	7.44	< LOD
312	TP-FP-42 REP(2-2.6)REP	3338.75	2014	38.28	1.49	0.73	15.65	0.65	< LOD	18.39	882.57	90.18	245.47	3.99	< LOD	3.54	121.7	1.22	8631.91	63.32	< LOD	7.51	< LOD
313	TP-FP-42A(0.5-0.8)	4719.74	586.2	29.35	< LOD	1.53	11.99	0.66	< LOD	20.02	808.18	94.48	2618.81	14.21	< LOD	3.84	79.38	1.08	45857.81	236.42	< LOD	8.1	< LOD
314	TP-FP-43(1.2-1.4)	4101	3916	50.02	< LOD	1.64	12.73	0.71	80.26	10.89	1667.91	89.69	1852.85	12.3	7.75	2.77	109.2	1.32	19139.78	169.47	< LOD	8.75	< LOD
315	TP-FP-43(4-4.3)	3906	6167	58.25	2.57	0.79	19.01	0.71	39.01	10.51	684.76	91.66	621.6	6.62	< LOD	4.55	100.72	1.2	4065.23	50.84	< LOD	8.24	< LOD
316	TP-FP-43(6-6.5)	3395.45	3660	47.5	1.86	0.77	20.59	0.7	23.58	10.12	1226.93	94.28	267.66	4.26	< LOD	4.37	119.6	1.25	324.62	34.33	< LOD	7.82	< LOD
317	TP-FP-43(9-9.5)	3352.63	3267	44.65	< LOD	1.35	18.92	0.67	< LOD	19.34	619.1	92.86	194.75	3.62	< LOD	3.83	116.9	1.2	546.39	35.59	< LOD	7.54	< LOD
318	TP-FP-43(11-11.5)	3078.52	1463	33.85	< LOD	1	14.66	0.61	< LOD	17.38	268.87	88.63	119.34	2.84	< LOD	4.01	110.35	1.11	177.9	32.09	< LOD	7.04	< LOD
319	TP-FP-44(0-0.7)	7203.92	7190	76.65	< LOD	1.67	11.26	1.03	< LOD	27.59	719.67	130.76	32222.6	135.34	13.91	4.97	88.44	2.15	39887.41	306.47	85.63	7.3	< LOD
320	TP-FP-44(0.7-1)	3246.68	13830	83.33	< LOD	1.43	15.09	0.68	< LOD	18.16	934.25	85.96	1068.45	8.57	< LOD	3.77	92.17	1.14	4954.88	97.71	< LOD	8.06	< LOD
321	TP-FP-44(2-2.5)	3323.13	1724	36.63	< LOD	1	16.45	0.66	26.69	9.78	624.3	99.58	129.73	3.11	5.8	2.14	115.23	1.2	1956.47	42	< LOD	7.67	2.26
322	TP-FP-44(2.5-3)	3434.83	1667	35.19	< LOD	1.07	16.12	0.63	< LOD	18.44	1068.68	98.14	593.21	5.84	< LOD	4.09	115.7	1.16	9483	66.88	< LOD	7.23	< LOD
323	TP-FP-44(4-4.5)	3583.71	1940	37.72	2.37	0.75	17.54	0.66	26.21	9.77	440.47	103.07	188.49	3.56	5.71	2.12	115.79	1.19	2415.79	45.23	< LOD	7.56	< LOD
324	TP-FP-44(6-6.5)	4081.64	5354	55	4.83	0.83	16.54	0.72	74.71	10.91	1486.56	91.2	136.43	3.41	< LOD	4.68	94.23	1.18	699.04	36.88	< LOD	8.53	< LOD
325	TP-FP-44(11.5-12)	2869.71	1857	37.17	< LOD	1	15.37	0.63	< LOD	17.99	631.88	79.39	152.35	3.22	< LOD	4.16	108.04	1.14	609.12	33.87	< LOD	7.32	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
326	TP-FP-44(13-13)	3307.72	2728	41.55	< LOD	1	16.07	0.63	< LOD	18.68	778.39	98.55	373.79	4.69	4.95	2.05	111.74	1.14	741.44	36.3	< LOD	7.27	< LOD
327	TP-FP-44A(0-0.7)	6297.13	5656	66.15	< LOD	1.55	10.78	0.96	< LOD	26.99	834.57	115.62	28280.1	115.92	9.81	3.3	84.37	1.95	38491.55	281.37	69.84	6.83	< LOD
328	TP-FP-44A(8-8.5)	2933.73	1744	36.07	< LOD	1	19.36	0.67	< LOD	18.42	< LOD	138.73	438.75	5.2	5.2	2.11	129.02	1.26	1266.64	39.2	< LOD	7.49	< LOD
329	TP-FP-44A REP(8-8.5)REP	2862.66	1589	35.03	1.49	0.73	18.04	0.65	< LOD	19	< LOD	126.53	415.81	5.04	5.58	2.09	126.41	1.24	836.9	36.9	< LOD	7.36	< LOD
330	TP-FP-45(0.5-1)	8047.26	9198	84.75	< LOD	1.59	6.13	0.96	< LOD	26.55	608.2	138.88	32233	132.92	14.46	5.16	75.27	2.04	57360.37	382.4	63.16	7.15	< LOD
331	TP-FP-45(1.2-1.6)	5317.2	6252	60.69	< LOD	1	11.1	0.68	< LOD	20.63	438.04	125.32	4535.64	20.34	6.79	2.33	93.07	1.22	35074.92	255.49	< LOD	8.49	< LOD
332	TP-FP-45(1.6-1.8)	4008.73	11106	95.62	< LOD	1.75	10.52	1.06	< LOD	26.98	913.47	147.25	34253.1	148.71	13.71	4.9	86.07	2.25	49540.09	344.24	106.44	7.94	< LOD
333	TP-FP-45(1.8-2)	6995.34	8508	84.7	< LOD	1.98	10.75	1.09	< LOD	28.68	1100.58	131.04	38272.5	166.16	7.85	3.71	78.48	2.3	27775.88	289.33	138.96	7.94	< LOD
334	TP-FP-45(2-2.3)	2904.13	1757	34.38	< LOD	1	13.83	0.62	< LOD	16.43	413.4	71.7	212.6	3.64	< LOD	3.4	88.35	1.02	1273.58	36.4	< LOD	7.17	< LOD
335	TP-FP-45(3.5-4)	3239.03	2522	40.92	< LOD	1.43	15.2	0.65	< LOD	17.99	916.55	90.07	583.02	6.03	< LOD	3.58	109.03	1.17	4501.68	50.24	< LOD	7.61	< LOD
336	TP-FP-45(7.5-8)	3284.96	5258	55.76	< LOD	1	16.73	0.67	21.53	9.78	761.31	92.91	900.5	7.59	6.88	2.46	120.29	1.25	6521.98	57.54	< LOD	7.73	< LOD
337	TP-FP-45(10.5-11)	2222.71	6864	62.97	< LOD	1.61	17.56	0.73	< LOD	20.4	676.07	104.32	4374.07	20.04	9.48	3.39	109.93	1.32	17930.95	178.26	< LOD	8.49	< LOD
338	TP-FP-45(13.5-14)	3530.52	4091	48.54	< LOD	1.48	18.53	0.68	< LOD	19.29	813.43	90	1483.72	9.86	< LOD	4.31	112.09	1.21	4039.3	94.59	< LOD	7.72	< LOD
339	TP-FP-45A(0.5-1)	8645.55	10431	89.74	< LOD	1.54	9.35	0.97	< LOD	26.72	600.49	140.13	27676.1	115.48	14.59	5.21	71.43	1.91	80752.47	424.59	61.59	7.04	< LOD
340	TP-FP-45A(0.8-1.2)	3367.57	2348	40.37	< LOD	1	15.04	0.65	< LOD	18.47	1418.08	96.49	528.46	5.74	< LOD	3.57	96.45	1.1	1500.63	40.2	< LOD	7.45	1.8
341	TP-FP-45A(3-3.5)	3380.73	3069	44.26	< LOD	1	16.68	0.65	23.66	9.69	744.65	92.06	85.13	2.64	< LOD	4.24	119.28	1.21	405.75	34.16	< LOD	7.58	< LOD
342	TP-FP-45A(5-6)	3380.82	9882	69.74	1.83	0.75	23.53	0.69	44.25	9.77	1107.18	94.45	979.63	7.77	< LOD	3.55	104.69	1.14	1309.58	39.12	< LOD	7.5	< LOD
343	TP-FP-45A(5.5-6)	3399.99	4368	50.06	< LOD	1.35	21.25	0.68	45.62	9.94	898.7	93.5	246.24	4.01	4.68	2.13	110.69	1.17	812.58	36.72	< LOD	7.51	< LOD
344	TP-FP-45A(9-9.5)	3766.76	2503	42.38	1.85	0.77	18.34	0.69	36.02	10.3	603.22	107.76	404.53	5.2	7.76	2.77	106.24	1.19	554.23	37.89	< LOD	7.88	< LOD
345	TP-FP-45A(11-11.5)	1787.56	1308	33.46	< LOD	1.43	18.11	0.64	21.99	9.46	639.84	103.67	295.83	4.22	7.59	2.71	123.32	1.2	394.37	35.84	< LOD	7.26	< LOD
346	TP-FP-45A(13.5-14)	3142.53	916.8	30.55	< LOD	1.3	15.65	0.62	< LOD	17.86	< LOD	178.95	246.2	3.88	< LOD	4.08	113.56	1.15	140.62	32.08	< LOD	7.2	< LOD
347	TP-FP-45A REP(13.5-14)REP	3085.74	920.8	30.23	1.92	0.7	17.58	0.62	< LOD	17.37	298.33	92.89	264.2	3.91	< LOD	3.99	115.93	1.13	147.94	33.03	< LOD	7.03	< LOD
348	TP-FP-46(1-1.5)	2914.64	1409	33.59	3.87	0.73	15.08	0.61	< LOD	17.24	555.76	93.89	150.3	3.1	5.91	2.01	103.39	1.08	153.43	31.76	< LOD	6.99	2.4
349	TP-FP-46(3-3.5)	3124.66	1192	33.07	< LOD	1	14.52	0.63	< LOD	18.83	688.21	94.69	117.56	2.92	4.65	2.09	113.55	1.17	428.65	33.96	< LOD	7.39	< LOD
350	TP-FP-46(6-6.5)	2992.35	1374	33.45	2.85	0.73	17.31	0.64	18.83	9.37	620.78	83.08	127.47	2.98	5.08	2.06	122.34	1.2	608.12	35.22	< LOD	7.27	1.69
351	TP-FP-46(8.5-9)	3476.44	1992	38.45	< LOD	1.31	15.48	0.64	< LOD	19.18	679	98.49	125.27	3.01	6.47	2.31	125.57	1.24	4482.88	52.06	< LOD	7.43	< LOD
352	TP-FP-46(11-11.5)	3418.88	10687	73.61	< LOD	1.49	16.25	0.65	41.36	9.9	903.96	95.07	192	3.61	< LOD	4.25	108.18	1.16	1838.78	41.12	< LOD	7.62	< LOD
353	TP-FP-47(0.1-0.3)	5870.07	2762	45.43	1.96	0.85	14.5	0.75	64.59	11.44	1214.86	102.7	2631.27	15.66	7.46	2.5	98.26	1.31	64433.45	290.63	< LOD	9.17	3
354	TP-FP-47(2-2.5)	3328.7	1050	32.19	1.97	0.73	16.16	0.64	< LOD	18.15	1050.09	95.83	119.03	2.94	< LOD	3.59	119.34	1.2	1484.26	39.97	< LOD	7.39	< LOD
355	TP-FP-47(3.5-4.0)	3541.09	6164	58.8	3.28	0.76	16.29	0.67	45.8	10.19	1143.57	96.77	112.83	2.99	6.82	2.44	116.46	1.23	1723.03	42.11	< LOD	7.85	2.27
356	TP-FP-47(5.5-6)	3221.52	853.9	29.85	3.94	0.72	13.11	0.61	< LOD	17.28	1355.56	103.66	145.29	3.09	< LOD	3.37	102.67	1.09	757.98	36.76	< LOD	7.06	< LOD
357	TP-FP-47(6.5-7)	3570.99	2132	39.09	2.07	0.76	15.99	0.67	54.5	10.22	784.96	91.32	237.14	4.06	< LOD	4.38	121.08	1.26	792.61	35.56	< LOD	7.92	< LOD
358	TP-FP-47A(0.1-0.3)DUP	6543.18	2664	45.1	< LOD	1.27	11.79	0.74	56.04	11.68	816.35	102.56	3071.86	17.61	7.01	2.55	79.66	1.22	81938.78	326.79	< LOD	9.41	< LOD
359	TP-FP-48(0-0.4)	6994.73	9488	74.6	< LOD	1.01	11.56	0.74	58.71	11.9	799.82	118.08	1667.17	12.31	14.52	5.18	87.1	1.25	72723.28	330.04	< LOD	9.52	< LOD
360	TP-FP-48(1.5-2)	6405.32	12860	83.84	< LOD	1	11.75	0.71	67.14	11.4	261.99	116.17	1424.79	10.88	12.72	4.54	92.39	1.24	51473.88	285.86	< LOD	9.1	< LOD
361	TP-FP-48(2.5-3)	3699.01	9472	69.63	< LOD	1	12.39	0.65	30.14	9.74	433.01	86.79	1853.55	11.41	< LOD	3.91	113.82	1.25	13980.13	156.01	< LOD	7.9	< LOD
362	TP-FP-48(3-3.5)	3925.94	11064	78.96	< LOD	1.66	13.32	0.71	54.12	10.65	398.89	90.11	4957.41	22.17	5.54	2.4	117.71	1.39	9136.43	153.97	< LOD	8.78	< LOD
363	TP-FP-48(6-6.5)	3868.04	8029	65.89	1.97	0.76	18.43	0.68	25.65	9.95	656.68	97.88	1075.52	8.42	< LOD	4.37	116.77	1.24	7366.58	121.23	< LOD	7.85	< LOD
364	TP-FP-48(8-8.5)	3870.63	6364	59.79	2.21	0.77	18.27	0.69	30.53	10.21	797.09	102.69	615.81	6.4	8.38	2.99	114.46	1.24	7337	64.08	< LOD	7.96	< LOD
365	TP-FP-48(10-10.5)	3640.57	5105	53.33	1.94	0.73	15.82	0.65	26.83	9.73	653.27	98.56	424.81	5.13	7.85	2.8	118.82	1.21	3541.46	49.45	< LOD	7.55	< LOD
366	TP-FP-48(13.5-14)	4005.07	3182	45.43	1.88	0.77	15.72	0.69	34.88	10.5	787.9	99.62	323.11	4.78	< LOD	4.5	104.83	1.21	4435.09	52.87	< LOD	8.13	< LOD
367	TP-FP-48 REP(13.5-14)REP	3623.07	3331	44.34	1.54	0.72	15.8	0.64	< LOD	18.99	548.58	98.38	432.5	5.12	< LOD	4.2	103.58	1.12	4236.73	51.19	< LOD	7.46	< LOD
368	TP-FP-48A(1-1.5)	6193.5	4671	53.57	2.02	0.83	14.14	0.73	93.19	11.54	968.18	103.04	2134.05	13.73	10.73	3.83	79.77	1.17	74919.41	311.85	< LOD	9.08	< LOD
369	TP-FP-49(0.7-1.2)	6991.85	11365	78.92	2.42	0.82	12.75	0.71	52.75	11.26	544.68	120.57	1459.33	10.89	12.04	4.3	94.85	1.24	71095.41	329.44	< LOD	8.93	< LOD
370	TP-FP-49(1.7-2.4)	4418.63	1009	32.62	< LOD	1	14.21	0.68	45.7	10.17	1697.46	89.77	1736.57	11.31	< LOD	4.56	95.2	1.18	31405.34	201	< LOD	8.27	< LOD
371	TP-FP-49(3-3.4)	3783.96	8392	66.45	< LOD	1.31	12.92	0.67	37.58	10.01	798.45	88.81	3352.37	16.47	10.09	3.6	106.56	1.25	9294.39	142.87	< LOD	8.3	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
372	TP-FP-49(5-5.5)	3632.15	1938	38.18	< LOD	1.31	13.56	0.66	< LOD	18.37	1097.22	99.25	2934.47	14.89	< LOD	3.76	89.16	1.13	8010.73	129.27	< LOD	7.97	< LOD
373	TP-FP-49(6.5-7)	3660.46	2616	41.78	1.95	0.74	14.29	0.64	23.55	9.77	819.17	96.23	754.87	6.86	6.62	2.36	107.82	1.17	6162.26	57.86	< LOD	7.67	< LOD
374	TP-FP-49(8.5-9)	4001.2	3457	48.28	< LOD	1.4	15.45	0.69	< LOD	20.29	958.81	103.89	1215.02	9.54	< LOD	4.48	105.27	1.24	10411.09	137	< LOD	8.07	< LOD
375	TP-FP-49A(1.7-2.4)DUP	6571.21	11359	77.28	< LOD	1.52	12.62	0.69	43.78	10.83	< LOD	250.33	1606.11	11.09	11.5	4.11	82.93	1.13	54133.32	300.84	< LOD	8.58	< LOD
376	TP-FP-49A(2.8-3.2)	3899.57	6391	58.38	< LOD	1	13.62	0.67	56.19	10.15	735.56	85.61	2878.25	14.98	5.52	2.26	106.39	1.24	17478.19	164.11	< LOD	8.22	< LOD
377	TP-FP-50(0.8-1.2)	7902.43	431.2	30.75	2.08	0.82	10.08	0.71	49.75	11.5	347.66	117.51	2204.9	14.04	< LOD	4.25	63.09	1.06	114994.68	408.64	< LOD	9.03	< LOD
378	TP-FP-50(1.6-2.2)	3942.94	11353	80.14	2.43	0.81	13.69	0.72	33.93	11.45	570.03	140.44	2521.2	14.92	5.07	2.44	66.88	1.08	67464.53	347.77	< LOD	8.94	< LOD
379	TP-FP-50(3.5-4)	3351.02	3370	44.29	< LOD	1	15.06	0.62	< LOD	18.33	2055.39	97.65	531.5	5.5	< LOD	3.35	100.77	1.08	6843.75	59.29	< LOD	7.13	< LOD
380	TP-FP-50(5.5-6)	3970.84	21953	103.15	2.33	0.75	17.65	0.67	< LOD	19.55	1471.08	102.39	554.65	5.9	< LOD	3.61	105.26	1.16	2691.84	47.97	< LOD	7.65	< LOD
381	TP-FP-50(7.5-8)	3876.65	3037	43.3	1.97	0.74	15.74	0.65	< LOD	19.12	1147.4	98.56	704.98	6.58	< LOD	3.55	99.77	1.12	13566.02	80.29	< LOD	7.55	< LOD
382	TP-FP-50(9-10)	3059.58	179.5	25.61	2.95	0.76	16.49	0.65	< LOD	19.68	< LOD	165.8	174.19	3.46	< LOD	3.54	79.23	1	128.83	34.8	< LOD	7.52	< LOD
383	TP-FP-50(11.5-12)	3276.12	2022	38.9	1.67	0.77	15.3	0.67	< LOD	20.43	< LOD	154.04	386.95	5.11	< LOD	3.71	97.44	1.15	3362.88	48.3	< LOD	7.92	< LOD
384	TP-FP-50A(0.5-1)	3368.98	7331	62.94	1.95	0.78	13.76	0.68	23.14	10.2	218.82	72.19	1928.83	12.05	< LOD	4.57	95.56	1.19	7627.08	119.2	< LOD	8.32	< LOD
385	TP-FP-50A(1-1.5)	3751.01	266.9	26.22	1.74	0.76	13.74	0.66	20.94	9.76	720.03	78.36	2143.9	12.29	< LOD	3.71	100.55	1.17	18902.78	163.31	< LOD	7.9	< LOD
386	TP-FP-50A(1.6-2.2)	6489.14	11545	80.56	1.92	0.81	13.19	0.72	< LOD	22.55	< LOD	236.07	2065.01	13.42	< LOD	4.85	70.19	1.1	50753.72	293.47	< LOD	8.89	< LOD
387	TP-FP-50A(2.2-2.5)	3447.29	1249	33.32	2.11	0.73	16.96	0.64	< LOD	17.86	748.16	102.97	164.51	3.29	< LOD	3.42	99.63	1.09	1508.86	41.4	< LOD	7.23	< LOD
388	TP-FP-50A(2.3-2.5)	3387.9	919.3	30.27	1.5	0.7	15.53	0.61	< LOD	17.33	2243.77	104.7	139.84	3	< LOD	3.31	95.31	1.03	1009.13	38.66	< LOD	6.98	< LOD
389	TP-FP-50A(3.5-4)	3278.95	648.1	28.71	< LOD	1	16.58	0.63	< LOD	18.63	892.22	98.33	66.15	2.33	< LOD	3.37	120.29	1.17	849.9	37.87	< LOD	7.17	< LOD
390	TP-FP-50A(3.5-4)DUP	3457.87	681.3	29.8	2.37	0.74	18.62	0.66	< LOD	19.55	800.61	98.09	76.77	2.54	< LOD	3.54	115.78	1.19	865.49	38.25	< LOD	7.52	< LOD
391	TP-FP-50A(5-5.5)	4204.98	1103	33.48	2.45	0.77	15.24	0.68	30.18	10.65	509.15	106.21	99.71	2.92	4.56	2.25	58.8	0.93	802.05	41.19	< LOD	8.04	< LOD
392	TP-FP-50A(8.5-9)	3685.92	692.1	30.1	< LOD	1.51	12.64	0.65	35.54	10.24	371.37	102.34	53.27	2.3	< LOD	3.69	45.85	0.8	127.48	34.93	< LOD	7.81	< LOD
393	TP-FP-50A REP(2.3-2.5)REP	3412.07	931.7	30.24	< LOD	1.06	15.95	0.61	< LOD	17.12	2122.95	104.61	141.73	3.01	< LOD	3.3	95.46	1.03	974.59	38.45	< LOD	6.95	< LOD
394	TP-FP-51(1.5-2)	4104.43	888.1	31.95	< LOD	1.4	14.5	0.67	21.94	10.44	800.02	111.47	282.17	4.44	< LOD	4.45	72.21	1	2347.03	47.81	< LOD	8.01	< LOD
395	TP-FP-51(3.5-4)	3974.16	778.8	31.01	< LOD	1.52	16.18	0.67	< LOD	19.97	513.05	113.36	153.82	3.35	< LOD	4.34	75.51	1	960.74	41.46	< LOD	7.73	< LOD
396	TP-FP-51(5.5-6)	3802.46	837.7	31.05	2.3	0.75	17.46	0.66	< LOD	19.89	526.48	113.32	142.61	3.2	< LOD	4.26	75.99	0.99	491.81	38.82	< LOD	7.64	< LOD
397	TP-FP-51(7.5-8)	4481.67	1404	35.67	2.67	0.79	14.52	0.69	54.25	11.08	735.73	110.88	58.48	2.48	< LOD	4.23	53.06	0.89	558.6	41.25	< LOD	8.3	< LOD
398	TP-FP-51(10-10.5)	3976.27	1041	33.32	2.41	0.77	13.08	0.67	< LOD	20.83	800.21	105.08	123.04	3.16	< LOD	3.81	62.77	0.95	< LOD	71.63	< LOD	8.05	< LOD
399	TP-FP-51(11-11.5)	3983.19	1317	34.41	2.04	0.75	15.97	0.67	26.09	10.27	801.54	108.62	192.88	3.69	< LOD	4.38	73.79	0.99	384.11	38.19	< LOD	7.81	< LOD
400	TP-FP-51(12-12.5)	3622.08	783	30.47	2.78	0.75	15.38	0.65	< LOD	18.96	807.35	100.91	91.55	2.72	< LOD	4.29	68.95	0.95	145.23	33.99	< LOD	7.64	< LOD
401	TP-FP-51A(2.5-3)	4605.78	206.8	27.48	1.82	0.81	14	0.71	50.61	10.72	1244.89	97.02	3303.01	17.01	4.75	2.36	89.18	1.2	37294.34	223.58	< LOD	8.62	< LOD
402	TP-FP-51A(4.5-5)	3356.93	382.5	26.67	< LOD	1.43	14.78	0.63	< LOD	18.03	869.36	98.4	147.73	3.15	< LOD	4.13	91.09	1.04	2236.15	42.44	< LOD	7.3	< LOD
403	TP-FP-51A(6-6.2)	3199.3	2400	40.37	< LOD	1	16.18	0.65	< LOD	19.18	1126.19	91.01	130.53	3.06	< LOD	4.21	106.7	1.14	1444.12	38.29	< LOD	7.51	< LOD
404	TP-FP-52(1-1.5)	3264.59	1263	32.25	2.22	0.72	14.79	0.61	< LOD	16.49	1015.54	99.4	2123.98	11.23	< LOD	3.31	86.95	1.01	4834.55	100.45	< LOD	6.98	< LOD
405	TP-FP-52(2.7-3)	3390.73	216.8	25.06	2.11	0.72	15.86	0.62	< LOD	17.54	954.92	102.93	136.62	3	< LOD	3.33	119.25	1.16	3514.83	48.47	< LOD	7.01	1.53
406	TP-FP-52(5-5.5)	3841.93	169.2	28.04	2.85	0.83	12.79	0.72	71.17	11.08	1702.65	84.07	218.89	4.27	< LOD	4.84	93.38	1.22	8308.39	62.69	< LOD	8.85	< LOD
407	TP-FP-52(7.5-8)	3414.18	368	28.63	< LOD	1.38	14.43	0.69	49.73	10.5	1133.13	82.24	162.74	3.6	< LOD	4.58	97.6	1.18	6922.87	56.69	< LOD	8.32	< LOD
408	TP-FP-52(9.5-10)	3664.6	305.1	28.09	1.85	0.79	14.6	0.69	72.39	10.68	2161.17	84.45	155.43	3.53	< LOD	3.91	95.26	1.17	6844.66	57.55	< LOD	8.32	< LOD
409	TP-FP-53(1.8-2.4)	3299.73	3573	45.34	< LOD	1	12.64	0.64	< LOD	17.58	883.93	90.67	4751.45	19.29	< LOD	3.57	80.4	1.05	10811.36	124.13	< LOD	7.52	< LOD
410	TP-FP-53(3-3.6)	3830.45	983	32.75	2.18	0.78	17.62	0.7	51.37	10.57	1308	96	129.62	3.22	5.39	2.25	106.34	1.21	4247.52	51.31	< LOD	8.13	< LOD
411	TP-FP-53(5-5.5)	3248.92	469.2	28.45	< LOD	1.52	14.98	0.67	55.16	10.14	1211.07	81.75	146.75	3.35	< LOD	3.8	102.12	1.17	3313.26	44.29	< LOD	7.97	< LOD
412	TP-FP-53(7.5-8)	3639.85	905.9	32.06	1.69	0.79	13.45	0.69	42.46	10.39	1045.6	81.06	310.27	4.78	< LOD	3.93	96.19	1.18	5813.3	54.03	< LOD	8.37	< LOD
413	TP-FP-53(9.5-10)	3790.77	525.3	29.49	4.85	0.81	14.92	0.69	59.08	10.49	1685.42	86.34	262.28	4.41	< LOD	4.59	101.32	1.21	6526.22	57.8	< LOD	8.33	< LOD
414	TP-FP-53(12-12.5)	4128.69	378.9	29.3	11.34	0.87	16.59	0.73	69.53	11.11	2709.65	99.12	541.54	6.39	< LOD	4.05	87.17	1.16	9830.25	70.49	< LOD	8.63	< LOD
415	TP-FP-53 REP(12-12.5)REP	4024.2	326.6	27.9	11.88	0.85	15.62	0.7	74.79	10.77	2790.21	97.69	530.37	6.11	< LOD	4.57	90.9	1.14	8929.91	66.91	< LOD	8.3	< LOD
416	TP-FP-54(0.6-1)	8126.36	293.1	29.34	3.23	0.83	10.95	0.71	31.96	11.14	< LOD	243.4	3003.06	16.66	< LOD	4.66	76.05	1.15	130054.37	440.75	< LOD	8.89	< LOD
417	TP-FP-54(0.6-1)DUP	7329.1	189.6	27.74	2	0.81	12.97	0.7	41.85	10.84	792.85	118.28	2839.18	15.7	< LOD	4.59	81.1	1.15	104974.09	390.79	< LOD	8.71	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
418	TP-FP-54(1.2-1.4)	5143.17	1259	35.22	1.74	0.84	12.4	0.72	< LOD	21.51	589.71	102.87	6960.74	28.54	< LOD	4.89	84.03	1.25	43244.5	249.89	< LOD	8.94	< LOD
419	TP-FP-54(1.8-2.4)	4932.3	3264	47.39	< LOD	1.03	12.31	0.74	37.37	10.93	1041.53	98.09	6934.53	29.12	< LOD	5	98.28	1.36	39685.07	248.46	< LOD	9.27	< LOD
420	TP-FP-54(3.4-3.8)	3483.55	1205	32	3.13	0.71	16.15	0.62	< LOD	17.3	968.25	102.55	208.46	3.55	< LOD	3.31	104.59	1.08	10747.43	71.73	< LOD	7.05	< LOD
421	TP-FP-54(5-5.5)	3783.41	1168	32.46	4.19	0.74	15.14	0.65	44.99	9.8	1118.82	86.27	715.74	6.7	< LOD	3.6	105.17	1.16	20362.15	94.58	< LOD	7.62	< LOD
422	TP-FP-54(7-7.5)	3531.01	1323	33.74	2.55	0.74	20.03	0.67	26.95	9.75	879.41	92.57	273.59	4.19	< LOD	4.07	117.85	1.21	3734.55	49.22	< LOD	7.53	< LOD
423	TP-FP-54(9-9.5)	3222.93	9789	68.38	6.59	0.74	14.02	0.64	37.02	9.7	1203.59	79.67	437.28	5.22	< LOD	3.56	93.95	1.09	8133.34	60.68	< LOD	7.52	< LOD
424	TP-FP-55(0.6-1)	4980.94	899.8	32.72	< LOD	1.39	13.09	0.73	< LOD	21.43	922.06	101.33	8253.3	32.44	< LOD	4.25	89.91	1.3	34636.89	236.14	< LOD	9.09	< LOD
425	TP-FP-55(2-2.3)	3104.27	2575	40	3.66	0.72	15.23	0.63	< LOD	17.06	611.76	88.9	549.22	5.62	< LOD	3.35	87.93	1.02	3032.73	43.97	< LOD	7.05	< LOD
426	TP-FP-55(2.5-3)	3418.04	4201	49.9	3.59	0.76	17.55	0.67	< LOD	18.55	747.45	96.37	265.59	4.18	< LOD	3.57	112.4	1.19	3044.24	46.96	< LOD	7.56	< LOD
427	TP-FP-55(3.8-4.2)	3466.8	2163	39.48	3.43	0.77	15	0.66	< LOD	19.77	803.11	95.53	161.04	3.44	< LOD	3.66	106.2	1.18	2058.66	42.51	< LOD	7.8	< LOD
428	TP-FP-55(5-5.5)	4617.33	3027	44.8	2.64	0.81	15.47	0.7	42.25	10.6	636.56	99.82	941.58	8.18	< LOD	3.89	104.06	1.23	33878.16	130.77	< LOD	8.35	< LOD
429	TP-FP-56(0.3-0.7)	2927.81	716.9	27.8	< LOD	1.1	14.3	0.58	< LOD	16.1	796.27	91.24	222.28	3.5	< LOD	3.14	88.79	0.96	402.78	32.82	< LOD	6.62	< LOD
430	TP-FP-56(2.6-3)	3504.5	685.8	29.59	2.64	0.74	17.64	0.66	21.46	9.85	1261.83	96.77	189.6	3.58	< LOD	4.24	102.09	1.13	502.24	35.86	< LOD	7.58	< LOD
431	TP-FP-56(4.5-4.9)	4378.7	1138	35.11	3.39	0.83	25.13	0.77	42.63	11.2	1028.71	103.64	253.29	4.44	< LOD	4.67	103.75	1.24	487.05	39.15	< LOD	8.52	< LOD
432	TP-FP-56(6.5-7)	3575.01	2918	44.03	4.63	0.77	17.58	0.68	28.12	10.23	518.04	95.82	178.91	3.59	< LOD	3.95	101.2	1.15	238.74	34.89	< LOD	7.84	< LOD
433	TP-FP-57(0-0.5)	2976.3	1092	31.18	20.51	0.78	15.67	0.61	< LOD	16.69	960.98	96.67	140.88	2.98	< LOD	3.25	80.13	0.94	727.69	35.21	< LOD	6.79	< LOD
434	TP-FP-57(0.5-1)	3062.02	569.5	27.55	9.69	0.73	14.69	0.61	< LOD	17.16	761.02	93.05	188.96	3.38	< LOD	3.27	90.71	1.01	335.97	33.53	< LOD	6.86	< LOD
435	TP-FP-57(1-1.5)	3029.04	379.2	26.29	11.59	0.75	17.24	0.63	< LOD	17.54	718.24	94.45	184.1	3.38	< LOD	3.32	89.92	1.01	169.65	33.09	< LOD	6.96	< LOD
436	TP-FP-57(1-1.5)DUP	2983.52	295.9	25.33	10.42	0.74	15.89	0.61	< LOD	17.14	651.5	92.26	167.12	3.21	< LOD	3.29	92.5	1.01	200.22	32.2	< LOD	6.92	< LOD
437	TP-FP-57 REP(1-1.5)REP	3093.4	404.6	25.9	10.61	0.73	16.29	0.61	< LOD	17.15	631.7	95.27	180.58	3.27	< LOD	3.25	90.66	0.99	216.73	33.42	< LOD	6.82	< LOD
438	TP-FP-58(.1-.3)	5186.46	203.3	27.59	1.68	0.82	13.12	0.71	44.9	10.88	1369.93	97.39	2321.99	13.89	< LOD	4.04	76.86	1.11	44041.99	235.94	< LOD	8.6	< LOD
439	TP-FP-58(1.3-1.6)	2961.81	619.3	28.28	3.6	0.72	14.55	0.62	< LOD	17.36	721.65	91.97	151.17	3.13	< LOD	3.34	91.36	1.02	1367.78	38.11	< LOD	7.02	< LOD
440	TP-FP-58(2.3-2.8)	3362.65	2681	41.26	< LOD	1.33	15.32	0.64	< LOD	19.16	982.41	90.23	141.14	3.15	< LOD	4.22	111.11	1.17	3335.47	46.05	< LOD	7.53	< LOD
441	TP-FP-58(3.6-4)	3879.32	4779	51.16	2.45	0.76	15.44	0.67	42.75	10.19	1155.47	95.2	251.43	4.18	< LOD	3.72	99.87	1.16	6072.81	58.36	< LOD	7.9	< LOD
442	TP-FP-58(4.1-4.7)	3450.91	248.2	24.63	1.44	0.7	16.82	0.6	< LOD	16.58	500.14	105.62	172.77	3.17	< LOD	3.19	86.69	0.96	14019.23	80.92	< LOD	6.66	< LOD
443	TP-FP-58(6-6.5)	3958.2	2131	38.58	8.59	0.79	16.38	0.67	27.34	9.99	768.8	99.38	160.41	3.4	< LOD	4.35	97.47	1.12	8448.65	66.14	< LOD	7.83	< LOD
444	TP-FP-58(8.5-9)	3491.74	578.6	28.54	6.96	0.76	16.65	0.65	35.56	9.81	1289.71	94.24	138.02	3.13	6.23	2.12	101.01	1.12	10826.11	70.32	< LOD	7.55	< LOD
445	TP-FP-58(9.5-10)	3896.38	1083	32.78	13.64	0.84	13.99	0.67	43.72	10.38	1496.75	96.4	171.65	3.6	< LOD	4.47	87.1	1.1	9413.72	67.96	< LOD	8.09	2.56
446	TP-FP-58A(.1-.3)	5294.76	567.2	31.09	< LOD	1.68	13.22	0.72	30.39	11.04	1551.71	105.18	2475.37	14.75	< LOD	4.85	83.17	1.18	41602.59	237.14	< LOD	8.86	< LOD
447	TP-FP-58B(4.1-4.7)	3547.33	82.01	22.79	3.5	0.69	15.94	0.58	< LOD	16.19	371.5	106.64	185.56	3.2	< LOD	3.12	91.11	0.96	18923.54	94.19	< LOD	6.52	< LOD
448	TP-FP-59(.2-.4)	4396.42	898.5	33.53	< LOD	1.33	12.14	0.72	< LOD	21.95	1940.81	97.36	2980.73	16.7	< LOD	4.23	73.44	1.14	18257.97	163.34	< LOD	8.92	< LOD
449	TP-FP-59(1.5-1.8)	3154.85	639.7	28.52	< LOD	1.41	15.99	0.62	< LOD	17.1	909.76	98.11	139.15	3.01	< LOD	3.34	104.19	1.08	1162.83	37.75	< LOD	6.98	< LOD
450	TP-FP-59(1.8-2)	4072.66	14931	84.43	6.13	0.82	13.34	0.68	78.58	10.63	2408.21	90.06	157.81	3.55	< LOD	4.59	95	1.17	1432.65	40.08	< LOD	8.37	< LOD
451	TP-FP-59(2.5-3)	3744.37	5120	54.24	5.56	0.82	16.36	0.71	84.58	10.83	2476.36	89.07	172.97	3.75	< LOD	4.66	110.25	1.28	1459.73	39.48	< LOD	8.51	< LOD
452	TP-FP-59(3.5-4)	3101.72	125.9	23.51	4.73	0.71	16.44	0.6	< LOD	16.56	530.43	96.96	183.61	3.27	< LOD	3.19	91.62	0.99	957.41	36.88	< LOD	6.7	< LOD
453	TP-FP-59(6.5-7)	3600.06	3291	45.76	2.18	0.75	16.38	0.67	38.44	10.12	833.92	98.16	153.56	3.36	< LOD	3.66	107.21	1.18	472.79	36.33	< LOD	7.78	< LOD
454	TP-FP-59(8.5-9)	3691.22	1804	38.61	5.51	0.84	15.95	0.73	90.5	11.33	2030.95	81.59	125.96	3.37	5.11	2.4	93.85	1.21	1430.98	37.96	< LOD	8.79	< LOD
455	TP-FP-59(12-12.5)	3329.17	1049	32.67	1.67	0.78	16.03	0.69	71.02	10.45	1505.28	80.35	168.72	3.61	5.05	2.27	95.46	1.16	2190.61	40.15	< LOD	8.18	< LOD
456	TP-FP-60(.2-.5)	3055.47	1436	33.66	< LOD	1.06	14.13	0.6	< LOD	17.16	1403.18	97	149.19	3.07	< LOD	3.3	94	1.02	781.16	35.9	< LOD	6.96	< LOD
457	TP-FP-60(2-2.2)	3158.69	1015	32.14	< LOD	1	15.45	0.64	< LOD	19.19	797.88	93.35	102.91	2.79	< LOD	3.98	107.71	1.15	66.31	32.5	< LOD	7.42	< LOD
458	TP-FP-60(3.6-4)	3489.95	1372	34.44	< LOD	1.12	18.55	0.66	21.12	9.72	980.96	99.38	307.03	4.4	4.83	2.11	116.48	1.2	1283.26	39.44	< LOD	7.58	< LOD
459	TP-FP-60(5.8-6)	3536.49	1299	34.26	3.2	0.76	21.87	0.69	26.1	9.93	740.15	97.85	126.17	3.08	< LOD	4.28	119.76	1.23	926.65	37.76	< LOD	7.65	< LOD
460	TP-FP-60(8-8)	4417.46	347	26.09	3.18	0.72	15.81	0.62	< LOD	17.74	507.57	102.34	183.93	3.39	< LOD	3.39	90.69	1.02	45482.95	152.69	< LOD	7.17	2.1
461	TP-FP-60(8-8.5)	3235.79	627.4	30.7	3.52	0.81	14.68	0.71	93.16	10.87	2465.24	75.7	100.27	3.05	7.61	2.72	100.14	1.23	555.17	31.61	< LOD	8.59	< LOD
462	TP-FP-60(9.5-10)	3412.58	361.9	27.68	2.99	0.77	15.12	0.67	< LOD	20.05	1135.59	87.62	150.9	3.38	< LOD	3.74	95.13	1.13	3994.01	48.21	< LOD	7.92	< LOD
463	TP-FP-60 REP(.2-.5)REP	3176.12	1496	33.31	1.4	0.69	14.46	0.59	< LOD	16.79	1353.4	96.44	157.21	3.07	< LOD	3.22	94.53	1	846.6	35.98	< LOD	6.77	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
464	TP-FP-6A(2-3)	3385.36	1508	34.44	< LOD	1	17.89	0.62	< LOD	18.06	746.58	107.96	26.11	1.81	< LOD	3.75	117.39	1.13	< LOD	68.17	< LOD	6.97	< LOD
465	TP-FP-6A(5.5-6.5)	3380.08	967.7	31.31	< LOD	1.45	17.28	0.63	< LOD	18.53	393.39	109.63	56.06	2.22	< LOD	3.34	114.28	1.13	< LOD	65.34	< LOD	7.07	< LOD
466	TP-FP-6A(16-16.5)	3404.85	752	29.73	< LOD	1.02	16.82	0.62	< LOD	18.45	446.7	108.33	141.44	3.05	< LOD	4.03	109.81	1.11	639.95	37.2	< LOD	7.13	< LOD
467	TP-FP-6B(2.5-3.5)	2996.06	729.6	29.98	< LOD	1	16.04	0.63	< LOD	17.48	376.15	99.94	30.36	1.91	< LOD	3.36	104.59	1.1	< LOD	64.23	< LOD	7.13	< LOD
468	TP-FP-6B(12-13)	3443.88	1783	36.94	< LOD	1.11	17.04	0.63	23.02	9.45	766.34	108.22	65.51	2.35	< LOD	4.08	119.46	1.18	< LOD	66.99	< LOD	7.2	< LOD
469	TP-MS-01(0-0.5)	5580.96	3880	47.08	2.24	0.74	10.62	0.64	< LOD	18.35	985.84	116.94	3473.6	16.41	< LOD	3.68	65.73	0.98	53774.81	274.47	< LOD	7.74	< LOD
470	TP-MS-01(0.5-1)	3128.22	363.5	25.46	< LOD	1.2	12.66	0.59	< LOD	16.32	617.28	92.75	278.15	3.94	< LOD	3.22	65.76	0.85	10888.51	68.89	< LOD	6.71	< LOD
471	TP-MS-03(0-0.3)	4868.7	21281	107.91	< LOD	1.37	11.35	0.76	< LOD	23.57	1100.8	96.6	3275.73	18.85	< LOD	4.54	59.16	1.11	16360.23	164.22	< LOD	9.56	< LOD
472	TP-MS-03(0.3-0.5)	4701.48	13584	86.68	1.88	0.79	11.43	0.69	58.11	11.43	512.33	156.4	1342.99	10.27	12.06	4.31	55.28	0.96	114759.73	456.16	< LOD	8.81	< LOD
473	TP-MS-03(0.5-1)	5380.39	13860	90.32	2.75	0.83	10.41	0.72	59.41	12.14	668.94	162.53	1250.72	10.35	8.61	3.07	53.4	0.99	145725	517.41	< LOD	9.23	< LOD
474	TP-MS-03(1-2)	10537.8	12794	86.24	3.7	0.83	12.4	0.73	72.41	12.1	< LOD	318.32	1326.87	10.6	14.54	5.19	53.32	0.98	145110.77	513.78	< LOD	9.23	< LOD
475	TP-MS-03(1-2)DUP	4761.04	11531	80.53	2.39	0.78	10.92	0.68	34.04	11.12	< LOD	313.25	1218.04	9.65	12.93	4.62	56.66	0.96	121645.43	466.67	< LOD	8.71	< LOD
476	TP-MS-03(2-2.75)	4171.91	2618	41.32	3.24	0.73	14.87	0.62	< LOD	17.51	806.28	112.31	481.2	5.29	< LOD	3.4	83.23	0.99	26241.76	116.92	< LOD	7.13	2.21
477	TP-MS-03 REP(2-2.75)REP	4234.13	2777	41.71	1.97	0.71	14.12	0.61	< LOD	17.05	745.96	111.85	455.52	5.08	< LOD	3.34	81.05	0.97	25575.28	114.83	< LOD	7	< LOD
478	TP-MS-04(0-0.5)	4706.85	14857	88.87	3.07	0.84	11.18	0.72	25.99	11.1	1323.37	98.35	3317.63	17.91	< LOD	4.24	65.51	1.1	17503.41	168.01	< LOD	8.94	< LOD
479	TP-MS-04(0.5-1)	7883.25	11560	79.69	< LOD	1.5	9.57	0.67	< LOD	21.08	595.74	140.87	1213.67	9.6	< LOD	4.71	56.54	0.95	87563.63	386.04	< LOD	8.56	< LOD
480	TP-MS-04(1-2)	4207.04	2900	41.81	1.74	0.72	12.87	0.61	< LOD	17.29	872.3	101.73	1483.19	9.46	< LOD	3.44	81.43	0.99	33738.77	205	< LOD	7.19	< LOD
481	TP-MS-04(2-2.5)	2775.23	535.2	27.38	1.44	0.69	14.02	0.6	< LOD	16.5	517.95	84.86	233.11	3.68	< LOD	3.25	85.31	0.97	3178.53	43.3	< LOD	6.84	< LOD
482	TP-MS-05(1.2-1.5)	3528.61	191.9	24.97	3.54	0.74	16.5	0.63	< LOD	17.58	1248.81	109.68	175.11	3.33	< LOD	3.35	92.84	1.03	4373.55	53.63	< LOD	7.07	< LOD
483	TP-MS-05(1.8-2)	3673.26	675.3	29.19	1.64	0.72	13.52	0.63	40.95	9.85	1052.61	96.75	100.2	2.76	< LOD	3.51	95.46	1.08	695.65	37.4	< LOD	7.49	< LOD
484	TP-MS-05(3.3-3.5)	3593.55	966	30.93	3.67	0.72	12.41	0.61	< LOD	18.94	843.61	100.18	138.13	3.06	< LOD	3.44	92.78	1.04	138.83	34.69	< LOD	7.32	< LOD
485	TP-MS-05(4-4.5)	3292.18	89.8	23.25	4.01	0.69	15.8	0.6	< LOD	16.69	545.77	104.26	208.3	3.45	< LOD	3.19	92.28	0.99	1354.69	40.49	< LOD	6.71	2.48
486	TP-MS-05(6-6.5)	3413.33	388.4	26.67	7.37	0.76	16.18	0.63	< LOD	17.87	732.09	102.79	195.14	3.5	< LOD	3.39	90.61	1.03	1517.87	40.67	< LOD	7.17	< LOD
487	TP-MS-05(9-9.5)	3683.93	1036	32.17	7.98	0.76	16.89	0.65	< LOD	19.1	606.27	102.34	220.63	3.77	< LOD	3.51	84.97	1.02	6122.14	59.27	< LOD	7.41	< LOD
488	TP-MS-05A(1.2-1.5)	3406.72	159	24.22	3.85	0.72	17.09	0.62	< LOD	16.82	1339.17	106.26	190.37	3.38	< LOD	3.26	91.96	1.01	4804.67	53.76	< LOD	6.83	< LOD
489	TP-MS-06(0.5-1)	3357.35	1103	31.21	< LOD	1.33	14.82	0.6	< LOD	16.81	1439.05	102.26	130.01	2.88	< LOD	3.24	97.34	1.03	983.17	38.43	< LOD	6.83	< LOD
490	TP-MS-06(1-1.5)	3343.24	438.9	26.57	3.23	0.71	16.28	0.61	< LOD	17.1	891.47	101.65	161.58	3.16	< LOD	3.28	93.28	1.02	616.45	36.62	< LOD	6.92	< LOD
491	TP-MS-06(1.6-2.3)	4124.58	190.9	26.82	17.24	0.86	14.77	0.68	< LOD	20.71	1479.59	105.55	153.94	3.46	< LOD	3.81	94.96	1.15	262.41	36.93	< LOD	8.12	< LOD
492	TP-MS-06(2.5-2.7)	3652.15	386.4	26.82	10.45	0.75	15.41	0.63	< LOD	18.95	1241.91	100.34	236.18	3.85	< LOD	3.46	84.54	1.01	1360.48	40.98	< LOD	7.34	< LOD
493	TP-MS-06(4.5-5)	3541.09	371.7	27.7	33.77	0.91	18	0.69	< LOD	20.23	599.01	93.93	317.67	4.62	< LOD	3.68	73.75	1	1931.98	42.52	< LOD	7.84	< LOD
494	TP-MS-06 REP(0.5-1)REP	3244.96	1075	31.07	1.83	0.7	15.45	0.61	< LOD	16.79	1457.16	101.81	129.97	2.88	< LOD	3.26	98.65	1.04	959.68	38.03	< LOD	6.87	< LOD
495	TP-MS-07(0-0.5)	2071.39	< LOD	29.25	3.49	0.53	9.65	0.5	< LOD	11.35	270.46	43.11	51.5	1.69	< LOD	2.38	5.44	0.5	7586.93	49.37	< LOD	4.73	< LOD
496	TP-MS-07(0.5-1)	1492.61	< LOD	23.79	4.49	0.5	8.57	0.5	< LOD	9.61	434.06	37.41	28.39	1.32	< LOD	2.04	10.32	0.5	7073.9	42.28	< LOD	4.1	< LOD
497	TP-MS-07(1-2)	1732.35	< LOD	26.5	4.49	0.5	9.09	0.5	< LOD	10.27	1808.54	48.56	87.15	1.9	< LOD	2.16	24.48	0.5	12610.19	55.59	< LOD	4.36	< LOD
498	TP-MS-07(2.75-3.5)	2717.3	< LOD	43.73	3.69	0.69	13.85	0.58	< LOD	15.84	692.81	89.31	152.36	2.99	< LOD	3.13	78.61	0.91	3279.67	42.94	< LOD	6.52	< LOD
499	TP-MS-07(3.5-4.5)	2867.07	156.1	23.73	2.3	0.68	16.86	0.6	< LOD	16.05	376.1	96.6	172.82	3.14	< LOD	3.12	87.3	0.95	1425.02	37.25	< LOD	6.6	< LOD
500	TP-MS-07(4.5-5.5)	2858.99	171.8	23.86	2.66	0.68	15.5	0.59	< LOD	15.9	< LOD	186.79	153.9	3	< LOD	3.11	86.06	0.95	2105.8	39.69	< LOD	6.53	< LOD
501	TP-MS-07(5.5-6.5)	2806.64	189.5	24.18	1.73	0.68	14.2	0.59	< LOD	16.14	474.14	92.75	135.2	2.88	< LOD	3.17	78.79	0.92	4074.46	47	< LOD	6.63	< LOD
502	TP-MS-07(7.5-8.5)	2804.97	213.3	24.45	2.06	0.68	13.69	0.6	< LOD	16.81	812.36	84	136.93	2.93	< LOD	3.24	68.47	0.87	6361.33	53.03	< LOD	6.81	< LOD
503	TP-MS-07(8.5-9.5)	3190.2	107.7	24.22	3.33	0.72	13.81	0.62	< LOD	18.12	824.79	91.97	168.51	3.31	< LOD	3.43	77.78	0.96	3187.66	45.29	< LOD	7.25	< LOD
504	TP-MS-07 REP(3.5-4.5)REP	2922.63	136.2	24.02	2.02	0.69	15.2	0.6	< LOD	16.38	< LOD	191.21	166.54	3.16	< LOD	3.2	85.83	0.96	1487.63	37.29	< LOD	6.73	< LOD
505	TP-MS-08(0-0.5)	6109.97	9471	69.43	10.01	0.8	7.59	0.64	< LOD	19.7	693.36	108.92	1688.59	11.2	< LOD	3.88	47.76	0.87	70464.39	309.97	< LOD	8.19	< LOD
506	TP-MS-08(0.5-1)	7319.1	10592	76.39	6.01	0.81	9.89	0.68	26.15	11.08	605.33	131.01	1668.64	11.65	< LOD	4.75	53.35	0.95	85683.16	370.81	< LOD	8.66	< LOD
507	TP-MS-08(1-2)	8635.96	13797	88.51	3.25	0.81	10.84	0.71	54.74	11.8	513.15	141.89	1352.21	10.56	8.74	3.12	46.46	0.91	101240.09	416.55	< LOD	8.98	< LOD
508	TP-MS-08(1-2)DUP	5105.91	15039	92.99	2.13	0.82	9.12	0.7	47.86	11.93	799.17	161.84	1514.83	11.4	13.67	4.88	49.27	0.95	124026.9	481.65	< LOD	9.14	< LOD
509	TP-MS-08(2-3)	3699.75	2726	41.34	3.72	0.71	12.79	0.61	< LOD	16.99	913.78	92	444.22	5.04	< LOD	3.35	73.34	0.93	25868.02	107.96	< LOD	7.03	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
510	TP-MS-08(4-5)	3040.22	1236	33.25	< LOD	1.42	14.6	0.61	< LOD	17.27	< LOD	183.27	203.29	3.53	< LOD	3.32	86.51	1	10416.76	69.05	< LOD	7	< LOD
511	TP-MS-08(6-6.75)	3204.6	1037	31.41	< LOD	1.34	16.78	0.62	< LOD	16.83	462.63	97.78	226.36	3.65	< LOD	3.29	84.52	0.97	7140.53	59.79	< LOD	6.91	< LOD
512	TP-MS-09(0-0.5)	4027.62	15708	88.16	2.36	0.79	9.23	0.68	21.31	10.62	158.41	74.95	2326.31	13.89	< LOD	4.01	45.26	0.89	21974.15	166.75	< LOD	8.46	< LOD
513	TP-MS-09(0.5-1)	6019.17	9709	73.06	1.77	0.8	10.61	0.69	< LOD	21.83	852.81	115.08	2602.26	14.97	< LOD	4.78	57.6	1	57515.82	286.97	< LOD	8.72	< LOD
514	TP-MS-09(1-2)	4638.82	5120	53.93	< LOD	1.51	12.7	0.69	< LOD	18.97	788.02	103.55	5018.26	21.62	< LOD	3.9	74.64	1.11	34170.65	215.58	< LOD	8.15	< LOD
515	TP-MS-09(2-3)	3546.35	583.2	27.36	3.93	0.72	15.23	0.61	24.12	9.19	1711.3	109.85	428.53	4.88	< LOD	3.32	87.12	0.99	5927.13	57.65	< LOD	6.95	1.65
516	TP-MS-09(3-4)	3125.78	730.5	28.64	2.14	0.7	14.8	0.6	< LOD	17.06	784.23	95.92	461.75	5.04	< LOD	3.27	86.64	0.98	8070.84	61.46	< LOD	6.92	< LOD
517	TP-MS-09(5-6)	3089.76	254.7	24.59	2.91	0.7	15.94	0.6	< LOD	16.95	541.18	94.73	202.27	3.4	< LOD	3.19	91.3	0.99	1172.62	36.95	< LOD	6.76	< LOD
518	TP-MS-09(6-7)	2820.17	123.4	23.7	< LOD	1.3	15.33	0.6	< LOD	16.94	304.17	86.73	225.18	3.59	< LOD	3.21	91.55	0.99	1327.53	35.83	< LOD	6.76	< LOD
519	TP-MS-09 REP(0-0.5)REP	3945.62	15460	88.99	< LOD	1.58	8.93	0.69	< LOD	21.29	< LOD	138.59	2295.06	14.02	< LOD	4.09	47.04	0.92	17979.31	152.11	< LOD	8.62	< LOD
520	TP-MS-101(0-0.5)	4272.28	12956	80.58	1.8	0.8	10.24	0.69	< LOD	20.99	978.84	88.3	3052.92	16.43	< LOD	4.05	64.36	1.05	23753.41	174.33	< LOD	8.49	< LOD
521	TP-MS-101(0.5-1)	5643.47	364.4	29.82	2.04	0.83	10.65	0.71	64.32	11.55	626.14	97.38	2087.51	13.58	< LOD	4.93	75.54	1.15	61350.7	276.13	< LOD	9.04	< LOD
522	TP-MS-102(0-0.5)	4489.8	7330	61.16	4.49	0.81	11.57	0.69	< LOD	20.26	1204.97	94.69	2826.87	15.52	< LOD	4.01	63.13	1.02	24824.63	179.25	< LOD	8.45	< LOD
523	TP-MS-102(0.5-1)	5104.42	14486	92.77	< LOD	1.73	12.82	0.77	65.3	12.75	< LOD	296.64	1961.41	13.84	< LOD	5.21	48.88	1	123746.98	467.33	< LOD	9.72	< LOD
524	TP-MS-102(1-1.5)	4136.94	3044	42.54	1.93	0.75	12.87	0.65	< LOD	17.54	977.23	103.04	3538.03	16.35	< LOD	3.61	76.89	1.04	21974.93	175.65	< LOD	7.57	< LOD
525	TP-MS-102(1.5-2)	3510.34	946.7	29.69	2.61	0.7	16.31	0.62	< LOD	16.81	1026.65	95.38	364.42	4.57	< LOD	3.32	92.43	1.03	13803.79	78.55	< LOD	6.98	< LOD
526	TP-MS-102(2.5-2.75)	3734.34	779	30.26	1.61	0.78	16.58	0.65	< LOD	19.04	884.14	102.86	136.24	3.09	< LOD	3.52	97.41	1.09	5470.5	56.99	< LOD	7.46	< LOD
527	TP-MS-102 REP(2.5-2.75)REI	3779.07	796.4	30.28	< LOD	1.56	17.69	0.65	< LOD	19.1	981.59	104.17	139.23	3.12	< LOD	3.51	97.6	1.09	5681.54	57.99	< LOD	7.45	< LOD
528	TP-MS-103(0-0.5)	3322.1	984.7	30.12	3.95	0.7	13.75	0.6	< LOD	16.09	423.46	94.88	912.21	7.01	< LOD	3.2	81.32	0.95	12654.85	75.42	< LOD	6.64	< LOD
529	TP-MS-103(0.5-1)	3154.93	539.3	27.6	4.17	0.72	15.4	0.61	< LOD	16.5	225.59	102.62	210.97	3.52	< LOD	3.26	92.57	1.01	3455.69	47.56	< LOD	6.79	< LOD
530	TP-MS-103(1-1.5)	3296.23	322.6	26.12	3.83	0.73	16.84	0.62	< LOD	17.37	241.53	107.34	199.24	3.48	< LOD	3.31	95.37	1.03	1826.49	42.03	< LOD	6.97	< LOD
531	TP-MS-104(0-0.5)	6540.69	26050	118.6	9.71	0.91	9.82	0.74	58.06	11.93	1173.11	112	2977.37	17.55	< LOD	4.46	55.09	1.06	43721.82	262.12	< LOD	9.42	< LOD
532	TP-MS-104(0.5-1)	8875.17	13237	87	3.26	0.81	11.85	0.71	34.34	11.54	< LOD	305.52	1700.79	11.92	< LOD	4.85	51.74	0.96	99546.33	426.69	< LOD	8.92	< LOD
533	TP-MS-104(1-1.5)	8849.76	12785	86.27	2.69	0.83	10.77	0.72	< LOD	23.3	506.43	150.49	1849.19	12.72	< LOD	4.93	52.44	0.98	100312.98	425.92	< LOD	9.09	< LOD
534	TP-MS-104(1.5-2.5)	4534.31	4500	50.75	5.62	0.77	11.84	0.65	< LOD	18.03	726.21	106.22	3806.52	17.33	< LOD	3.67	74.4	1.04	35159.98	219.16	< LOD	7.66	< LOD
535	Tp-Ms-105(0-0.7)	4475.41	43340	150.41	4.43	0.82	9.03	0.71	56.34	10.82	921.07	84.62	2548.92	15.35	< LOD	4.19	49.21	0.96	10080.49	132.26	< LOD	8.81	< LOD
536	Tp-Ms-105(0.7-1.0)	4068.61	4080	50.05	5.76	0.84	9.86	0.72	< LOD	20.72	847.86	88	4122.51	20.65	< LOD	4.23	67.79	1.13	10445.11	134.75	< LOD	8.92	< LOD
537	Tp-Ms-105(1.0-1.5)	3081.1	511.7	25.39	3.8	0.67	10.67	0.57	< LOD	15.44	772.56	78.8	547.89	5.39	< LOD	3.14	72.43	0.89	20115.36	89.24	< LOD	6.56	< LOD
538	Tp-Ms-105(1.5-2.0)	3435.02	544.5	27.56	3.83	0.72	16.26	0.62	< LOD	17.34	259.36	103.11	194.37	3.43	< LOD	3.31	99.04	1.05	5872.52	57.28	< LOD	6.97	< LOD
539	Tp-Ms-105(2-3.0)	3328.83	316.8	26.31	2.33	0.72	15.29	0.62	< LOD	17.53	736.6	100.92	79.68	2.49	< LOD	4.08	104.18	1.1	2286.67	43.4	< LOD	7.19	< LOD
540	Tp-Ms-105 REP(0.7-1.0)	4255.33	4564	54.15	5.16	0.87	9.79	0.74	< LOD	22.69	1187.13	91.07	4260.25	21.75	< LOD	4.4	67.13	1.16	11106.59	140.65	< LOD	9.17	< LOD
541	Tp-Ms-106(0-0.5)	5085.97	18513	98.83	3.58	0.84	11.76	0.74	47.89	11.14	627.62	94.5	2886.35	16.74	< LOD	4.32	65.87	1.11	36274.07	221.91	< LOD	9.17	< LOD
542	Tp-Ms-106(0.5-0.75)	4836.46	9381	71.11	3.58	0.88	8.11	0.75	62.29	12.01	1007.35	83.51	2748.47	17.22	< LOD	4.6	45.12	1	25143.46	183.38	< LOD	9.82	< LOD
543	Tp-Ms-106(0.75-1.0)	7696.69	14055	88.05	< LOD	1.61	13.01	0.73	38.74	11.54	< LOD	264.2	1904.28	12.81	< LOD	4.91	69.7	1.1	76061.12	359.18	< LOD	9	< LOD
544	Tp-Ms-106(1.0-1.5)	8134.75	9046	70.76	3.39	0.8	13.04	0.7	64.27	11.21	< LOD	267.01	1614.59	11.31	10.33	3.69	84.03	1.15	109855.95	417.54	< LOD	8.68	< LOD
545	Tp-Ms-106(1.5-2.0)	9334.76	10035	75	2.89	0.82	13.19	0.72	60.66	11.53	< LOD	283.91	1974.93	12.96	9.89	3.53	70.52	1.09	127869.8	463.43	< LOD	8.96	< LOD
546	Tp-Ms-106(2.0-2.5)	7092.79	6809	62.23	4.38	0.83	12.45	0.71	52.42	11.14	452.63	125.23	2974.49	16.31	6.77	2.41	79.18	1.15	83302.66	358.08	< LOD	8.91	< LOD
547	TP-MS-108(0-0.5)	4844.03	79855	223.47	13.75	0.92	7.76	0.75	147.89	11.98	1721.09	84.85	1503.72	12.1	< LOD	4.44	35.52	0.89	6641	118.35	< LOD	9.2	< LOD
548	TP-MS-108(0.5-1)	4022	14686	82.89	5.33	0.77	10.35	0.66	< LOD	19.13	916.84	89.14	2177.82	12.85	< LOD	3.77	59.48	0.96	15680.95	147.85	< LOD	7.95	< LOD
549	TP-MS-108(1-1.5)	3642.28	890.7	29.12	2.31	0.72	14.37	0.61	< LOD	15.98	< LOD	186.17	1746.32	10.1	< LOD	3.28	97.8	1.06	32231.37	189.9	< LOD	6.83	< LOD
550	TP-MS-108(2-2.5)	3098.49	111.6	23.18	5.16	0.7	15.5	0.59	< LOD	15.99	< LOD	192.01	183.11	3.22	< LOD	3.11	91.03	0.97	11473.31	71.65	< LOD	6.48	< LOD
551	TP-MS-109(0-0.5)	4192.62	19503	99.56	7.17	0.84	11.56	0.71	< LOD	21.4	1014.73	94.65	3343.09	17.62	< LOD	4.12	69.04	1.1	8845.91	129.19	< LOD	8.7	< LOD
552	TP-MS-109(0.5-1)	3860.88	2761	44.26	3.72	0.89	11.86	0.76	< LOD	20.61	773.71	90.44	10960.4	41.26	< LOD	4.37	84.3	1.35	5615.67	139.53	< LOD	9.23	< LOD
553	TP-MS-109(1-1.5)	4127.13	2648	42.73	1.95	0.86	13.33	0.75	< LOD	19.13	917.34	97.39	12557.9	43.83	< LOD	4.25	78.63	1.3	21718	195.28	< LOD	8.98	< LOD
554	TP-MS-109(1.5-2)	3361.61	391.1	25.84	2.25	0.72	16.28	0.63	< LOD	16.94	546.57	97.13	265.11	3.99	< LOD	3.37	91.42	1.03	7531.53	61.33	< LOD	7.1	< LOD
555	TP-MS-10A(0-0.5)	4744.42	67614	197.87	2.65	0.83	7.66	0.72	94.83	11.32	972.09	82.97	2528.37	15.73	< LOD	4.35	40.82	0.92	11953.83	140.84	< LOD	9.12	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
556	TP-MS-10A(0.5-1)	7578.36	22717	112.38	4.96	0.87	10.68	0.74	30.01	11.8	1167.55	127.41	2317.78	15	< LOD	4.42	53.34	1.03	68122.88	329.47	< LOD	9.35	< LOD
557	TP-MS-10A(1-2)	5499.4	9692	72.06	2.79	0.78	8.9	0.66	< LOD	19.53	602.66	106.29	2574.61	14.32	< LOD	3.9	54.37	0.94	59969.04	283.06	< LOD	8.18	< LOD
558	TP-MS-10B(0-0.5)	4969.3	2E+05	374.69	4.05	0.88	2.95	0.74	202.44	12.81	524.75	63.55	910.91	9.73	< LOD	4.77	13.46	0.66	6489.88	61.04	< LOD	10	< LOD
559	TP-MS-10B(1-2)	6883.11	17203	97.11	2.88	0.82	11.67	0.71	< LOD	21.72	574.68	128.35	2985.02	16.54	< LOD	4.13	54.97	1	73719.86	340.17	< LOD	8.71	< LOD
560	TP-MS-10B(2-2.75)	3253.3	6912	56.83	3.48	0.67	13.52	0.57	< LOD	15.77	551.91	92.28	325.29	4.09	< LOD	3.09	79.78	0.9	15655.54	82.08	< LOD	6.48	< LOD
561	TP-MS-10C(0-1)	5142.3	25932	117.31	3.07	0.85	11.31	0.74	49.02	11.44	787.76	96.17	3002.35	17.42	< LOD	4.39	56.95	1.06	22880.96	188.27	< LOD	9.28	< LOD
562	TP-MS-10C(1-2)	5367.97	14070	90.46	1.66	0.81	10.24	0.72	45.69	11.98	346.89	164.09	1412.38	11.04	10.29	3.67	51.3	0.97	134516.92	503.83	< LOD	9.28	< LOD
563	TP-MS-10c(2-3)	8227.22	13239	86.72	< LOD	1.52	10.3	0.7	37.68	11.61	< LOD	279.54	1616.15	11.56	7.03	2.43	54.41	0.97	93021.7	406.46	< LOD	8.92	< LOD
564	TP-MS-10c(3-3.75)	3664.26	3254	43.66	3.45	0.73	13.84	0.63	< LOD	16.93	< LOD	174.11	1815.7	10.68	< LOD	3.43	71.61	0.95	22864.2	169.71	< LOD	7.25	< LOD
565	TP-MS-10c REP(2-3)	4537.72	13200	86.38	< LOD	1.58	10.85	0.7	36.97	11.46	< LOD	304.97	1625.22	11.54	8.14	2.91	54.51	0.97	107397.56	439.38	< LOD	8.86	< LOD
566	TP-MS-10cRETEST(1-2)	5389.79	14281	91.85	2.25	0.83	10.84	0.73	55.28	12.23	< LOD	326.68	1417.2	11.16	11.58	4.13	53.87	1	137997.38	508.68	< LOD	9.37	4.11
567	TP-MS-10CRETEST(2-3)	4692.67	13253	87.2	2.11	0.8	11.81	0.71	51.14	11.67	< LOD	313.53	1611.75	11.57	8.9	3.18	53.87	0.97	112818.38	454.67	< LOD	8.96	< LOD
568	TP-MS-10D(0-0.5)	6054.22	19391	103.23	5.78	0.88	11.74	0.76	51.94	11.66	988.2	110.85	3348.96	18.92	< LOD	4.51	58.42	1.1	42504.45	252.65	< LOD	9.51	< LOD
569	TP-MS-10D(0.5-1.5)	9541.92	13995	89.25	2.41	0.81	10.96	0.71	73.53	11.85	< LOD	304.44	1705.86	12.07	12.12	4.33	55.63	0.99	120634.52	466.05	< LOD	9.04	< LOD
570	TP-MS-10D(1.5-2)	4956.19	13463	89.03	2.06	0.83	10.82	0.72	44.61	11.83	583.88	161.76	1837.88	12.71	5.92	2.49	54.94	1	116563.7	467.51	< LOD	9.15	< LOD
571	TP-MS-10D(2-3.5)	3917.2	1417	34.24	7.34	0.77	15.23	0.65	< LOD	17.81	1610.02	106.2	2030.92	11.58	< LOD	3.58	84.8	1.05	18853.61	162.23	< LOD	7.49	< LOD
572	TP-MS-10DRETEST(1.5-2)	4869.3	13470	87.64	3.54	0.82	11.72	0.72	47.52	11.72	349.21	159.56	1862.93	12.65	8.97	3.2	53.87	0.99	117384.3	467.37	< LOD	9.03	< LOD
573	TP-MS-110(0-0.5)	4404.96	4630	50.98	4.23	0.8	12.27	0.68	< LOD	19.78	1220.24	99.28	2806.27	15.14	< LOD	3.89	74.77	1.08	14942.54	152.28	< LOD	8.24	< LOD
574	TP-MS-110(0.5-1)	3233.22	466.4	26.2	2.99	0.7	16.51	0.61	< LOD	16.25	356.52	100.24	257.27	3.81	< LOD	3.22	89.54	0.99	7716.24	62.72	< LOD	6.71	< LOD
575	TP-MS-110(1-1.5)	3048.06	192	22.98	2.82	0.67	14.24	0.57	< LOD	15.21	263.4	90.66	143.87	2.84	< LOD	3	75.02	0.86	13605.57	76.18	< LOD	6.22	< LOD
576	TP-MS-110(1.5-2)	3417.76	232.7	24.91	4.73	0.73	16.01	0.62	< LOD	16.89	531.79	97.39	168.9	3.25	< LOD	3.3	89.57	1.01	13675.5	78.96	< LOD	6.93	< LOD
577	TP-MS-111(0-0.5)	6807.54	16144	94.24	2.98	0.85	11.51	0.74	27.68	11.49	736.93	118.14	2546.32	15.57	< LOD	4.32	55.88	1.03	56918.05	296.34	< LOD	9.16	< LOD
578	TP-MS-111(0.5-0.75)	5159.24	5369	54.3	1.65	0.76	11.8	0.66	< LOD	18.52	698.11	115.38	5097.57	21.2	< LOD	3.75	71.96	1.06	45274.5	258.19	< LOD	7.93	< LOD
579	TP-MS-112(0-0.5)	3673.48	1332	34.63	3.56	0.82	11.04	0.7	< LOD	19.5	2110.07	87.86	6040.94	25.22	< LOD	4.02	78.68	1.17	11650.13	137.35	< LOD	8.45	< LOD
580	TP-MS-112(0.5-1)	4386.06	1219	34	3.5	0.85	15.66	0.73	< LOD	19.35	844.96	102.8	5918.69	24.97	< LOD	4.09	84.97	1.22	27593.14	200.81	< LOD	8.66	< LOD
581	TP-MS-112(1.75-2)	3131.69	185.8	24.25	2.51	0.71	17.01	0.61	< LOD	16.43	771.76	98.61	219.74	3.55	< LOD	3.22	91.36	0.99	2736.84	43.73	< LOD	6.77	< LOD
582	TP-MS-112 REP(0.5-1)REP	4452.31	1283	33.71	3.39	0.83	15.08	0.72	< LOD	18.87	739.18	102.51	5944.85	24.54	< LOD	4	85.61	1.2	27806.43	200.69	< LOD	8.46	< LOD
583	TP-MS-113(0-0.5)	3764.4	5326	53.68	< LOD	1.53	14.26	0.67	< LOD	19.95	2039.05	93.69	1806.86	11.35	< LOD	3.77	90.17	1.13	8983.46	121.56	< LOD	7.93	< LOD
584	TP-MS-113(0.5-1)	3443.07	1650	35.34	4.19	0.76	14.97	0.64	< LOD	19.07	1401.71	96.49	599.77	6.01	< LOD	3.5	110.69	1.16	3006.18	47.8	< LOD	7.42	< LOD
585	TP-MS-113(1-1.75)	3607.06	1668	35.13	4.37	0.74	15.7	0.64	< LOD	18.94	1152.44	98.18	239.81	3.89	< LOD	3.49	96.18	1.08	1282.45	39.85	< LOD	7.37	< LOD
586	TP-MS-114(0-0.25)	3499.62	373.5	26.62	2.68	0.75	12.18	0.63	< LOD	18.21	2903.45	91.45	389.86	4.96	< LOD	3.58	71.38	0.96	4411.91	48.91	< LOD	7.48	< LOD
587	TP-MS-114(0.25-0.5)	2904.9	< LOD	43.68	2.87	0.71	14.86	0.6	< LOD	16.56	838.61	91.21	140.12	2.96	< LOD	3.23	89.45	0.99	1902.76	38.53	< LOD	6.75	< LOD
588	TP-MS-114(1-1.5)	3370.78	< LOD	48.73	6.02	0.77	15.41	0.65	< LOD	19.66	1468.77	99.02	191.12	3.63	< LOD	4.28	94.86	1.1	1084.19	37.15	< LOD	7.62	< LOD
589	TP-MS-115(0-0.5)	5886.9	3920	55.71	3.61	1.05	2.72	0.88	56.98	15.81	1627.35	72.14	284.24	6.38	< LOD	5.81	20.63	0.84	14390.64	84.04	< LOD	11.99	< LOD
590	TP-MS-115(0.5-1)	4705.7	195.9	24.15	3.69	0.72	6.64	0.62	< LOD	17.15	599.76	81.16	280.61	4.39	< LOD	3.55	54.11	0.87	50897.74	157.72	< LOD	7.2	< LOD
591	TP-MS-115(1.25-1.5)	3784.1	< LOD	48.31	6.75	0.77	13.81	0.64	< LOD	18.54	809.93	98.17	168.7	3.43	< LOD	3.58	113.18	1.19	12621.77	76.6	< LOD	7.53	< LOD
592	TP-MS-115(1.5-2)	3612.5	50.89	24.31	5.75	0.76	12.89	0.63	< LOD	19.39	701.98	99.77	185.94	3.56	< LOD	3.56	101.75	1.12	9537.41	68.02	< LOD	7.49	2.71
593	TP-MS-116(0-0.5)	4931.32	1605	34.59	2.32	0.74	11.02	0.65	< LOD	18.2	1341.9	104.05	3356.33	16.13	< LOD	3.68	63.35	0.97	48832.45	250.04	< LOD	7.62	< LOD
594	TP-MS-116(0.5-1)	4180.69	270.3	25.56	2.36	0.78	10.78	0.68	< LOD	17.86	836.35	94.78	7636.74	28.58	< LOD	3.84	79.49	1.17	36248.87	219.02	< LOD	7.99	< LOD
595	TP-MS-116(1-1.5)	7102.82	5888	69.24	< LOD	1.52	8.24	0.96	< LOD	24.96	477.8	128.44	30417.1	121.77	< LOD	6	82.58	2	68261.59	373.05	< LOD	13.58	< LOD
596	TP-MS-116(1.5-2)	3404.69	259.1	24.59	2.56	0.71	15.48	0.62	< LOD	16.69	329.39	99.39	1166.78	8.09	< LOD	3.28	91.91	1.02	13971.68	135.58	< LOD	6.89	< LOD
597	TP-MS-117(0-0.5)	3888.47	15733	87.47	3.5	0.8	10.47	0.7	< LOD	20.27	1335.4	81.48	3280.49	17.36	< LOD	4.07	59.22	1.02	5226.35	104.83	< LOD	8.53	< LOD
598	TP-MS-117(0.5-1)	3009.49	356.2	25.25	3.02	0.7	15.32	0.6	< LOD	16.24	729.47	98.4	600.76	5.61	< LOD	3.17	88.65	0.98	5057.36	52.35	< LOD	6.63	< LOD
599	TP-MS-117(1-1.5)	3273.4	359.5	25.52	4.57	0.72	15.13	0.6	< LOD	16.77	593.56	99.65	276.64	3.94	< LOD	3.23	91.04	1	2068.25	41.91	< LOD	6.82	< LOD
600	TP-MS-117(1.5-2)	3376.58	530	27.88	5.13	0.74	16.36	0.64	< LOD	18.09	990.08	101.76	225.74	3.76	< LOD	3.44	97.9	1.07	1558.07	41.06	< LOD	7.29	< LOD
601	TP-MS-117(2-2.5)	3411.07	259.2	25.67	3.42	0.74	16.41	0.64	< LOD	17.83	765.9	101.28	185.75	3.46	< LOD	3.41	96.61	1.07	1718.74	40.92	< LOD	7.18	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
602	Tp-Ms-117 REP(1-1.5)REP	3253.54	396.3	26.15	3.82	0.72	15.36	0.61	< LOD	16.98	589.99	97.73	294.18	4.1	< LOD	3.28	88.4	0.99	2826.32	45.44	< LOD	6.92	< LOD
603	TP-MS-118(0-0.5)	3338.84	9993	68.55	2.5	0.74	8.79	0.64	< LOD	18.39	650.56	75.91	2860.97	14.78	< LOD	3.66	48.46	0.87	3938.47	96.55	< LOD	7.66	< LOD
604	TP-MS-118(0.5-1)	3075.34	1227	32.3	1.65	0.73	14.24	0.63	< LOD	17.05	778.64	89.84	1140.42	8.23	< LOD	3.41	83.53	1.01	2148.1	77.44	< LOD	7.16	< LOD
605	TP-MS-118(0.5-1)	3190.51	1225	32.1	1.54	0.72	14.31	0.62	< LOD	16.8	867.18	90.87	1146.44	8.34	< LOD	3.35	84.77	1.02	2151.23	78.46	< LOD	7.05	< LOD
606	TP-MS-119(0-0.5)	4753.14	12914	81.89	3.99	0.83	12.73	0.72	< LOD	21.91	923.3	96.03	3240.57	17.4	< LOD	4.15	65.13	1.08	18942.83	171.04	< LOD	8.71	< LOD
607	TP-MS-119(0.5-1)	3726	1133	32.25	2.7	0.77	13.31	0.68	< LOD	18.09	903.58	95.37	6074.74	23.8	< LOD	3.77	96.22	1.21	7053.03	127.88	< LOD	7.8	< LOD
608	TP-MS-119(1-1.5)	4019.01	1532	33.49	4.36	0.75	9.62	0.66	< LOD	16.71	1612.97	86.06	9526.21	32.63	< LOD	3.68	57.7	1.03	35270.74	214.24	< LOD	7.71	< LOD
609	TP-MS-11A(0-0.4)	6531.12	15734	94.25	3.23	0.86	12.22	0.75	30.61	11.84	742.3	119.98	2543.62	15.76	< LOD	4.38	59.76	1.08	45792.5	268.41	< LOD	9.25	< LOD
610	TP-MS-11B(0-0.5)	5266.82	311.9	25.16	53.75	1.1	8.93	0.72	20.93	9.93	1487.27	94.83	2319.85	14.66	< LOD	4.23	57.07	1.03	68770.27	286.13	< LOD	8.76	5.83
611	TP-MS-11B(1-2)	6245.05	5050	54.03	24.94	0.89	13.22	0.68	< LOD	19.39	1067.65	130.76	3467.94	16.9	< LOD	4.55	75.66	1.08	65418.77	315.83	< LOD	8.19	< LOD
612	TP-MS-11B(2-3)	3331.75	246.2	24.95	4.63	0.72	15.3	0.61	< LOD	16.84	874.05	103.76	395.74	4.68	< LOD	3.29	84.91	0.97	6714.22	58.71	< LOD	6.89	< LOD
613	TP-MS-11B(3-4)	3389.86	294	25.46	2.14	0.72	18.62	0.63	< LOD	17.18	836.54	105.16	221.42	3.62	< LOD	3.32	89.43	1	2501.97	44.35	< LOD	7.01	< LOD
614	TP-MS-11B(4-5)	3314.56	217.6	24.53	4.19	0.72	17.8	0.61	< LOD	16.87	491.57	104.5	224.78	3.57	< LOD	3.22	90.8	0.99	3064.56	46.06	< LOD	6.81	< LOD
615	TP-MS-11B(5-5.75)	3341.35	253.2	26.34	6.18	0.75	18.01	0.65	< LOD	18.09	565.57	103.19	211.54	3.69	< LOD	4.14	100.86	1.1	4782.93	53.07	< LOD	7.33	< LOD
616	TP-MS-11B REP(3-4)REP	3395.76	290.2	25.39	5.01	0.73	16.32	0.62	< LOD	17.43	893.31	106.52	228.21	3.66	< LOD	3.3	90.41	1	2545.59	45.11	< LOD	6.98	< LOD
617	TP-MS-11C(0-0.5)	5884.92	44057	156.07	6.45	0.89	7.1	0.75	77.88	11.84	1077.62	92.18	2250.04	15.4	< LOD	4.59	44.36	0.99	38542.73	229.21	< LOD	9.65	< LOD
618	TP-MS-11C(1-2)	6622.05	10144	73.17	3.51	0.8	12.61	0.7	< LOD	20.73	790.93	129	4983.7	22.16	< LOD	4.03	70.22	1.1	62831.38	316.32	< LOD	8.51	< LOD
619	TP-MS-11C(2-3)	3678.25	727.6	29.14	4.66	0.74	15.45	0.63	< LOD	17.43	856.12	105.53	679.98	6.28	< LOD	3.42	92.99	1.05	13054.38	79.25	< LOD	7.14	< LOD
620	TP-MS-11C(2-3)DUP	3323.03	635.2	27.8	5.79	0.72	15.89	0.61	< LOD	16.69	669.47	96.08	392.54	4.65	< LOD	3.27	91.42	1	12232.53	74.34	< LOD	6.87	< LOD
621	TP-MS-11C(3-4)	3382.62	353.3	25.86	5.43	0.71	17.82	0.62	< LOD	17.14	511.23	102.67	201.44	3.46	< LOD	3.97	101.3	1.06	4205.55	50.41	< LOD	6.97	< LOD
622	TP-MS-11D(0.0-0.1)	3766.29	832.3	31.5	92.81	1.19	13.22	0.67	< LOD	20.19	1003.33	95.91	198.57	3.85	< LOD	4.48	81.09	1.07	10573.48	70.77	< LOD	8.03	< LOD
623	TP-MS-12(0-0.5)	3057.59	96.13	21.92	5.72	0.65	14.34	0.57	< LOD	15.38	2085.21	92.47	267	3.69	< LOD	2.96	92.5	0.95	4505.5	48.66	< LOD	6.13	< LOD
624	TP-MS-12(0.5-1)	2098.74	< LOD	34.42	6.97	0.58	16.34	0.53	< LOD	12.74	3469.87	66.26	131.95	2.49	< LOD	2.56	45.91	0.63	5202.64	42.14	< LOD	5.24	< LOD
625	TP-MS-12(1-1.5)	2326.26	< LOD	40.41	5.07	0.64	14.09	0.56	< LOD	14.88	1508.5	74.02	190	3.16	< LOD	2.93	78.69	0.88	3369.5	40.16	< LOD	6.04	< LOD
626	TP-MS-12(1.5-2)	2821.75	< LOD	46.35	5.08	0.72	19.18	0.64	< LOD	16.82	288.74	89.51	208.32	3.55	< LOD	3.3	83.73	0.98	1895.88	38.63	< LOD	6.94	< LOD
627	TP-MS-12(1.5-2)DUP	2925.56	< LOD	45.58	3.9	0.7	18.07	0.61	< LOD	16.8	318.65	94.39	183.52	3.27	< LOD	3.19	87.72	0.97	1681.41	38.08	< LOD	6.7	< LOD
628	TP-MS-12(2-3)	2629.46	< LOD	44.6	2.75	0.68	14.54	0.59	< LOD	16.28	< LOD	163.09	142.07	2.93	< LOD	3.16	88.12	0.96	1613.29	35.2	< LOD	6.64	< LOD
629	TP-MS-12(3-3.4)	3022.66	88.39	23.53	< LOD	1.37	16.8	0.61	< LOD	17.99	179.18	89.43	144.63	3.02	< LOD	3.25	104.52	1.07	8994.63	62.65	< LOD	6.81	< LOD
630	TP-MS-120(0-0.5)	5416.05	1E+05	583.66	15.42	2.06	9.49	1.69	210.12	27.71	1144.57	78.4	1749.19	29.24	< LOD	10.8	33.51	1.93	4519.19	108.47	< LOD	21.97	< LOD
631	TP-MS-120(0.5-1.0)	4682.62	48537	171.14	11.72	0.95	13.1	0.8	72.92	12.16	718.04	92.09	3794.29	21.08	< LOD	4.6	73.24	1.25	5709.51	119.35	< LOD	9.72	< LOD
632	TP-MS-120(1-1.5)	3746.32	3766	47.42	3.74	0.81	12.65	0.71	< LOD	18.97	1016.88	93.18	9472.15	34.3	< LOD	4.02	88.33	1.27	3963.28	127.13	< LOD	8.45	< LOD
633	TP-MS-120(1.5-2.5)	3140.07	2040	36.35	1.95	0.7	14.25	0.6	< LOD	16.51	603.14	95.82	610.56	5.75	< LOD	3.27	86.67	0.98	3401.74	47.12	< LOD	6.84	< LOD
634	TP-MS-121(0-0.5)	5321.17	15303	87.19	< LOD	1.36	10.34	0.68	< LOD	20.83	762.2	102.93	2491.79	14.34	< LOD	3.96	53.37	0.95	40729.38	238.77	< LOD	8.34	< LOD
635	TP-MS-121(0.5-0.75)	9275.86	10543	78.65	2.72	0.84	12.26	0.74	28.63	11.86	< LOD	295.92	2575.55	15.65	5.8	2.52	60.36	1.06	116146.59	449.32	< LOD	9.26	< LOD
636	TP-MS-121(1.5-1.75)	4362.77	6446	60.49	2.27	0.81	12.35	0.69	< LOD	18.83	865.5	107.63	6403.43	25.46	< LOD	3.93	77.99	1.15	26807.34	204.37	< LOD	8.27	< LOD
637	TP-MS-122(0-0.5)	5711.16	93687	258.85	4.9	0.9	5.88	0.75	97.61	12.79	601.27	81.89	2226.26	15.65	< LOD	4.71	32.85	0.91	29070.1	206.22	< LOD	9.95	< LOD
638	TP-MS-122(0.5-1)	4656.57	9743	73.2	5.27	0.88	13.33	0.74	< LOD	21.96	1177.75	105.96	6741.85	28.42	< LOD	4.29	80.78	1.25	14117.55	165.85	< LOD	9.03	< LOD
639	TP-MS-122(1-1.5)	4929.98	6535	62.4	3.1	0.87	13.67	0.76	< LOD	21.07	925.46	112.83	9946.9	37.74	< LOD	4.34	92.86	1.37	35336.71	237.66	< LOD	9.22	< LOD
640	TP-MS-122(1.75-3)	3634.33	1381	32.71	1.7	0.7	15.61	0.62	< LOD	16.62	680.83	102.64	2081.41	11.1	< LOD	3.3	87.65	1.01	18503.54	158.77	< LOD	6.96	< LOD
641	Tp-Ms-123(0-0.5)	5274.33	13251	82.13	2.62	0.8	10.07	0.68	21.71	10.57	955.53	108.05	3383.76	17.36	< LOD	4.03	59.71	1.01	38318.01	234.1	< LOD	8.48	< LOD
642	Tp-Ms-123(0-1.0)	3124.57	30471	117.21	6.5	0.72	5.53	0.61	< LOD	18	1324.65	63.55	1159.2	8.8	< LOD	3.58	25.26	0.65	13219.15	120.68	< LOD	7.5	< LOD
643	Tp-Ms-123(0.5-1.0)	4802.35	5141	55.06	2.41	0.82	11.11	0.71	< LOD	18.97	686.66	106.87	8098.1	31.25	< LOD	4.12	76.9	1.2	37239.71	234.91	< LOD	8.67	< LOD
644	Tp-Ms-123(1.1-2.1)	4920.83	6979	61.92	3.85	0.81	10.12	0.69	< LOD	20.28	776.31	101.6	5678.52	24.41	< LOD	4.06	63.8	1.08	46152.63	252.46	< LOD	8.55	< LOD
645	Tp-Ms-123(1.1-1.8)	5056.52	12837	80.31	5.06	0.77	10.99	0.65	< LOD	19.6	805.58	106.73	3076.04	15.53	< LOD	3.79	67.06	1.01	47906.66	252.36	< LOD	7.94	< LOD
646	Tp-Ms-123(2.5-3.0)	3021.99	488.8	27.6	6	0.7	15.18	0.6	< LOD	16.93	934.01	103.26	81.07	2.45	< LOD	3.25	96.78	1.03	2513.15	43.46	< LOD	6.87	< LOD
647	Tp-Ms-123(2.5-3)	3484.81	1296	33.02	4.19	0.73	17.16	0.63	< LOD	17.55	914.94	103.12	291.15	4.15	< LOD	3.39	90.15	1.02	9341.29	69.09	< LOD	7.08	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
648	TP-MS-13(0-0.1)	4568.92	1888	40.33	2.21	0.87	12.69	0.75	< LOD	22.72	1409.06	104.6	3318.81	18.27	< LOD	4.34	67.59	1.13	10335.38	135.69	< LOD	9.15	< LOD
649	TP-MS-13(0-0.5)	3002.2	7768	62.16	< LOD	1.47	9.18	0.64	< LOD	17.84	696.95	76.77	4560.7	19.51	< LOD	3.69	66.92	1.01	3509.05	93.2	< LOD	7.76	< LOD
650	TP-MS-13(0.5-1)	2866.56	2050	36.77	2.93	0.71	13.26	0.62	< LOD	17.15	548.75	75.53	807.87	6.92	< LOD	3.43	74.65	0.96	2122.97	38.21	< LOD	7.21	< LOD
651	TP-MS-13(1-1.9)	2875.72	297.9	25.32	2.09	0.7	14.9	0.61	< LOD	17.22	298.94	82.86	152.47	3.12	< LOD	3.31	89.73	1.01	1145.74	35.57	< LOD	6.99	< LOD
652	TP-MS-14(0-0.2)	4089.08	969.1	34.84	3.32	0.9	13.91	0.76	< LOD	23.49	778.12	78.62	3108.27	17.75	< LOD	5.11	68.36	1.15	8146.59	122.69	< LOD	9.32	< LOD
653	TP-MS-14(0-0.5)	3198.46	2086	38.08	3.63	0.76	12.28	0.65	< LOD	18.39	780.32	77.26	2497.41	13.42	< LOD	3.7	80.2	1.06	6103.41	104.39	< LOD	7.77	< LOD
654	TP-MS-14(0.5-1)	3343.54	1659	35.79	3.35	0.74	16.04	0.64	< LOD	18.94	1161.29	97.49	272.15	4.11	< LOD	3.68	94.56	1.07	2038.67	42.01	< LOD	7.38	< LOD
655	TP-MS-14(1-2)	3055.87	517.2	27.33	3.33	0.72	16.01	0.62	< LOD	17.51	902.69	100	217.71	3.6	< LOD	3.32	89.17	1	1154.7	37.78	< LOD	7.01	< LOD
656	TP-MS-14(2-3)	2777.18	77	22.55	3.64	0.68	15.04	0.58	< LOD	15.83	< LOD	180.84	187.85	3.21	< LOD	3.08	86.55	0.94	4678.53	48.64	< LOD	6.47	< LOD
657	TP-MS-14(2-3.5)	3325.22	101.4	23.56	3.75	0.71	16.36	0.61	< LOD	16.83	576.74	100.48	155.48	3.09	< LOD	3.24	100.37	1.04	12181.12	74.74	< LOD	6.82	< LOD
658	TP-MS-15(0-0.5)	4093.61	9851	70.92	10.37	0.87	7.96	0.72	< LOD	21.51	2041.16	82.03	1511.15	11.63	< LOD	4.3	49.33	0.97	8447.92	115.32	< LOD	8.96	< LOD
659	TP-MS-15(0.5-1)	2828.31	< LOD	42.74	3.62	0.66	12.22	0.56	< LOD	15.19	775.26	81.24	311.96	3.97	< LOD	2.99	72.49	0.85	16037.99	79.03	< LOD	6.27	< LOD
660	TP-MS-15(1-2)	3255.87	76.28	23.41	5.01	0.72	16.31	0.61	< LOD	17.01	1265.38	97.68	169.44	3.21	< LOD	3.27	88.67	0.99	4092.55	48.68	< LOD	6.96	< LOD
661	TP-MS-15(1-2)DUP	3142.26	85.92	23.54	4.16	0.72	16.42	0.62	< LOD	17.45	970.08	98.56	168.85	3.23	< LOD	3.29	89.28	1	3831.3	48.1	< LOD	6.98	< LOD
662	TP-MS-15(2-3)	3273.4	253.5	25.8	5.61	0.75	15.5	0.63	< LOD	17.95	983.41	96.36	177.53	3.41	< LOD	3.43	97.73	1.08	2446.52	43.6	< LOD	7.29	< LOD
663	TP-MS-15(3-3.7)	3318.59	255.9	25.41	7.33	0.74	15.77	0.62	< LOD	17.49	299.23	93.35	170.22	3.29	< LOD	3.37	97.59	1.06	5473.95	54.19	< LOD	7.12	< LOD
664	TP-MS-16(0.1-0.2)	3181.81	165.4	24.12	< LOD	1.38	9.58	0.6	< LOD	17.02	1404.18	81.08	1042.59	7.83	< LOD	3.39	56.79	0.84	5927.66	94.03	< LOD	7.15	< LOD
665	TP-MS-16(0.5-1)	2063.66	< LOD	38.78	< LOD	1.1	10.4	0.53	< LOD	14.32	547.08	65.19	123.88	2.58	< LOD	2.86	69.96	0.81	678.39	28.71	< LOD	6.06	< LOD
666	TP-MS-16(0.5-1)DUP	2425.21	< LOD	42.18	3.49	0.68	10.74	0.56	< LOD	15.57	1259.57	76.32	148.11	2.95	< LOD	3.11	70.56	0.86	863.6	30.56	< LOD	6.58	< LOD
667	TP-MS-16(1.7-2.5)	2476.16	< LOD	42.07	4.18	0.68	11.86	0.56	< LOD	15.8	< LOD	159.2	135.34	2.8	< LOD	3.07	71.65	0.86	812.06	31.77	< LOD	6.51	< LOD
668	TP-MS-16(3-3.5)	1396.03	< LOD	31.03	1.53	0.53	5.07	0.5	< LOD	11.89	858.06	43.28	42.8	1.66	< LOD	2.5	24.75	0.5	3004.56	28.54	< LOD	5.19	< LOD
669	TP-MS-16(3.5-4.5)	2356.4	< LOD	43.21	5.14	0.68	9.62	0.56	< LOD	16.16	382.83	75.21	343.01	4.24	< LOD	3.1	58	0.79	1790.51	34.62	< LOD	6.52	< LOD
670	TP-MS-16(4.5-5)	2585.79	108.9	23.98	3.78	0.7	11.44	0.59	< LOD	17.39	424.76	78.65	347.54	4.45	< LOD	3.29	62.98	0.85	2481.05	39.2	< LOD	6.94	< LOD
671	TP-MS-17(0-0.1)	3455.46	128.2	24.47	2.55	0.73	13.73	0.63	< LOD	18.91	1305.2	93.89	565.42	5.87	< LOD	3.53	82.42	1.02	4490.63	50.5	< LOD	7.4	< LOD
672	TP-MS-17(0-0.5)	2685.86	179.7	23.03	1.5	0.65	10.73	0.56	< LOD	15.76	480.85	77.28	328.11	4.14	< LOD	3.12	80.95	0.92	1434.61	34.3	< LOD	6.57	< LOD
673	TP-MS-17(0.5-1)	2656.87	< LOD	45.07	< LOD	1	12.9	0.58	< LOD	16.03	< LOD	177.32	152.44	3.01	< LOD	3.17	84.11	0.95	312.14	30.72	< LOD	6.65	< LOD
674	TP-MS-17(1-2)	1699.34	< LOD	35.35	1.9	0.57	6.98	0.5	< LOD	13.39	1390.9	53.52	109.16	2.35	< LOD	2.67	38.99	0.6	2170.88	29.07	< LOD	5.5	< LOD
675	TP-MS-19(0-1)	2493.5	< LOD	34.27	1.13	0.55	< LOD	1	< LOD	12.87	1015.87	50.48	45.48	1.75	< LOD	2.72	13.44	0.5	30204.25	93.95	< LOD	5.63	< LOD
676	TP-MS-19(1-2)	4229.15	< LOD	52.41	6.36	0.86	10.92	0.71	25.95	11.41	1437.34	97.29	106.98	3.21	< LOD	4.77	86.66	1.18	5106.46	55.21	< LOD	8.84	2.49
677	TP-MS-19(2-3)	3615.31	< LOD	47	2.64	0.75	10.69	0.63	< LOD	18.9	652.21	96.35	119.94	3	< LOD	3.62	87.46	1.06	5737.96	56.01	< LOD	7.68	< LOD
678	TP-MS-19(3-3.4)	3009.6	< LOD	46.55	2.4	0.73	11.31	0.61	< LOD	17.57	< LOD	169.67	174.72	3.41	< LOD	3.47	84.79	1.01	2744.88	42.34	< LOD	7.34	< LOD
679	TP-MS-19(3.4-3.5)	3039.86	< LOD	46.16	2.95	0.74	12.56	0.63	< LOD	18.13	< LOD	173.31	135.15	3.09	< LOD	3.51	90.57	1.05	3537.42	46.16	< LOD	7.41	< LOD
680	TP-MS-20(0-0.5)	2640.26	2543	38.19	1.69	0.63	11.2	0.56	< LOD	15.88	1330.19	80.08	138.02	2.83	< LOD	3.03	80.7	0.9	1473.66	35.62	< LOD	6.33	< LOD
681	TP-MS-20(0.7-1)	3011.97	2081	37.44	2.26	0.69	14.29	0.6	< LOD	17.46	1298.3	91.56	105.32	2.69	< LOD	3.29	107.6	1.09	970.93	36.79	< LOD	6.94	< LOD
682	TP-MS-20(1-2)	3122.26	8304	65.04	< LOD	1	15.28	0.63	25.98	9.54	701.88	92.42	135.59	3.06	< LOD	3.45	96.5	1.07	133.29	31.68	< LOD	7.3	< LOD
683	TP-MS-20(1-2)DUP	3046.98	1226	32.96	< LOD	1	14.4	0.61	< LOD	17.2	435.71	105.17	99.87	2.65	< LOD	3.3	87.03	0.99	< LOD	64.64	< LOD	6.95	< LOD
684	TP-MS-21(0-0.75)	3228.29	26117	108.06	< LOD	1.4	7.87	0.61	< LOD	17.8	1908.07	77.26	1540.68	10.04	< LOD	3.55	57.6	0.89	2827.62	81.9	< LOD	7.46	< LOD
685	TP-MS-21(1.25-2.5)	2825.68	823.2	28.84	1.47	0.69	11.39	0.58	< LOD	16.89	727.51	85.36	115.03	2.71	< LOD	3.19	70.74	0.88	451.61	32.29	< LOD	6.74	< LOD
686	TP-MS-21(2.5-3.25)	3245.12	1302	33.66	1.68	0.74	15.93	0.65	< LOD	19.34	596.63	95.65	112.98	2.9	< LOD	3.54	99.33	1.11	335.95	33.53	< LOD	7.47	< LOD
687	TP-MS-22(0-1)	3436.3	918.4	31.09	4.13	0.76	11.58	0.65	< LOD	19.05	289.99	82.56	292.81	4.45	< LOD	3.67	82.15	1.05	9424.2	64.01	< LOD	7.76	< LOD
688	TP-MS-22(1-1.75)	3404.09	164.2	25.09	12.36	0.78	12.35	0.62	< LOD	18.45	423.95	91.88	140.82	3.14	< LOD	3.5	97.67	1.09	6312.47	56.52	< LOD	7.42	< LOD
689	TP-MS-22 REP(0-1)REP	3558.51	1080	32.33	4.01	0.77	11.49	0.65	< LOD	19.31	472.3	84.54	299.38	4.54	< LOD	3.72	81.32	1.05	10046.37	66.1	< LOD	7.83	< LOD
690	TP-MS-23(0-1)	3805.71	1753	35.62	5.14	0.75	12.85	0.64	< LOD	18.97	858.74	95.3	272.75	4.25	< LOD	3.56	87.75	1.07	3437.91	48.35	< LOD	7.49	< LOD
691	TP-MS-23(1-2)	3960.14	699.9	33.3	7.98	0.89	8.53	0.73	71.91	12.2	898.08	75.67	78.77	3.02	< LOD	4.49	67.12	1.11	3148.79	44.11	< LOD	9.56	< LOD
692	TP-MS-23 REP(1-2)REP	3843.69	577.8	32.56	6.53	0.89	10.76	0.75	77.96	12.3	885.29	74.97	91.65	3.18	< LOD	4.49	75.27	1.17	4083.58	47.89	< LOD	9.56	< LOD
693	TP-MS-24(0-1)	3270.81	1017	31.23	1.75	0.72	14.75	0.62	< LOD	16.78	1084.75	103.23	387.98	4.72	< LOD	3.34	87.77	1.01	1070.18	37.55	< LOD	6.95	< LOD

	G	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	SAMPLE	Mg Error	Mn	Mn Error	Mo	Mo Error	Nb	Nb Error	Ni	Ni Error	P	P Error	Pb	Pb Error	Pd	Pd Error	Rb	Rb Error	S	S Error	Sb	Sb Error	Se
694	TP-MS-24(0.1-0.15)	3476.9	3423	44.27	2.1	0.73	12.79	0.63	< LOD	17.53	1495.45	98.72	2338.91	12.55	< LOD	3.53	78.78	1.02	3736.2	96.22	< LOD	7.39	< LOD
695	TP-MS-24(1-2)	2924.3	223.5	25.01	1.89	0.71	14.98	0.61	< LOD	17.01	863.73	94.94	168.91	3.23	< LOD	3.29	85.22	0.98	484.24	32.66	< LOD	6.92	< LOD
696	TP-MS-24(2-3)	2844.28	278.5	25.07	< LOD	1.38	12.82	0.59	< LOD	17.06	418.35	87	162.42	3.14	< LOD	3.25	75.9	0.92	599.53	32.19	< LOD	6.83	< LOD
697	TP-MS-24(3-4)	3031.1	371.8	26.13	1.87	0.72	15.4	0.62	< LOD	17.58	668.14	90.31	231.96	3.74	< LOD	3.36	86.41	1	481.25	33.14	< LOD	7.13	< LOD
698	TP-MS-24(4.5-5.3)	3252.27	72.8	23.94	< LOD	1.44	17.09	0.64	23.83	9.44	1224.2	100.76	151.83	3.17	< LOD	4.12	83.82	1	607.29	34.72	< LOD	7.28	< LOD
699	TP-MS-24(5.3-5.75)	3373.45	199.6	25.76	3.86	0.76	18.06	0.66	< LOD	19.39	1092.61	100.76	436.95	5.18	< LOD	3.54	85.24	1.03	1066.35	37.78	< LOD	7.5	< LOD
700	TP-MS-25(0-0.3)	3384.38	8676	64.23	4.19	0.74	10.06	0.63	< LOD	17.79	1337.05	84.79	1923.03	11.52	< LOD	3.62	62.89	0.94	5242.77	101.02	< LOD	7.48	< LOD
701	TP-MS-25(0.3-0.5)	4300.28	8572	68.82	2.26	0.84	13.17	0.73	33.49	11.17	1324.54	99.95	3219.02	17.32	< LOD	4.18	77.49	1.16	7839.87	122.74	< LOD	8.83	< LOD
702	TP-MS-25(0.5-1)	3265.69	8511	63.77	2.04	0.74	10.93	0.65	< LOD	17.96	713.04	80.22	5559.72	22.1	< LOD	3.66	71.91	1.05	3525.27	101.56	< LOD	7.71	< LOD
703	TP-MS-25(0.5-1)DUP	3376.29	8143	64.52	< LOD	1.49	11.98	0.67	< LOD	18.53	815.55	82.65	5127.11	21.67	< LOD	3.84	81.44	1.13	3527.96	102.44	< LOD	8.05	< LOD
704	TP-MS-25(1-2)	3235.45	2542	40.93	1.96	0.74	15.31	0.65	< LOD	18.12	915.88	92.6	512.99	5.64	< LOD	3.56	91.93	1.08	1057.54	37.21	< LOD	7.49	< LOD
705	TP-MS-25(2-3)	2950.11	1980	37.69	2	0.73	16.35	0.64	< LOD	18.72	660.86	85.9	124.57	2.96	< LOD	3.46	103.21	1.11	478.01	33.26	< LOD	7.3	< LOD
706	TP-MS-26(0-0.5)	2911.16	5071	51.04	4.66	0.73	12.62	0.62	< LOD	17.27	727.15	77.72	1265.37	8.81	< LOD	3.42	72.65	0.96	2375.9	75.44	< LOD	7.19	< LOD
707	TP-MS-26(0.5-1)	3203.18	3482	43.71	3.01	0.71	14.98	0.61	< LOD	18.1	969.1	92.81	264.03	3.9	< LOD	3.31	86.69	0.99	1154.6	37.06	< LOD	6.96	< LOD
708	TP-MS-26(1-2)	3109.12	2944	41.96	4.19	0.72	13.94	0.61	< LOD	17.51	582.33	89.74	139.34	3.02	< LOD	3.34	86.29	0.99	741.9	35.39	< LOD	7.05	< LOD
709	TP-MS-26(2-2.5)	3529.8	3094	43.57	4.01	0.74	16.06	0.64	< LOD	19.04	898.33	102.53	154.27	3.24	< LOD	3.5	91.01	1.05	961.65	38.29	< LOD	7.37	< LOD
710	TP-MS-27(0-0.5)	2994.99	1201	31.48	4.04	0.71	14.24	0.6	< LOD	17.13	1530.41	90.01	193.2	3.38	< LOD	3.26	91.49	1	1377.95	37.41	< LOD	6.83	< LOD
711	TP-MS-27(0.5-1)	3253.15	1403	34.14	5.89	0.76	17.05	0.64	< LOD	18.01	945.84	97.74	180.25	3.42	< LOD	3.67	95.88	1.07	549.42	35.05	< LOD	7.24	< LOD
712	TP-MS-27(1-1.5)	3166.16	1102	31.7	4.04	0.74	17.11	0.64	22.39	9.48	1020.93	95.88	193.86	3.51	< LOD	3.42	91.94	1.04	543.63	34.86	< LOD	7.2	< LOD
713	TP-MS-27(1.5-2)	3258.91	511.3	28.07	2.72	0.75	17.19	0.65	< LOD	18.05	1114.91	99.97	161.14	3.3	< LOD	3.48	91.66	1.05	683.09	36.08	< LOD	7.32	< LOD
714	TP-MS-27(2-2.5)	3230.63	397.5	27.1	4.18	0.75	17.83	0.65	< LOD	18.94	712.56	101.21	175.92	3.4	< LOD	3.78	92.79	1.06	1049.59	37.86	< LOD	7.3	< LOD
715	TP-MS-27(2.5-3)	3616.18	437.4	27.48	7.13	0.77	17.34	0.66	28.73	9.76	908.24	103.73	183.97	3.51	4.63	2.11	91.61	1.07	1111.1	39.05	< LOD	7.51	< LOD
716	TP-MS-27(3-3.5)	3678.48	383.5	27.46	5.98	0.79	16.47	0.67	38.96	10.23	1344.68	94.53	150.31	3.34	4.7	2.2	80.97	1.04	894.06	36.49	< LOD	7.87	< LOD
717	TP-MS-27(3.5-4)	3614.47	346.5	27.36	7.45	0.8	17.49	0.68	78.97	10.63	1263.6	100.44	146.41	3.33	< LOD	3.7	71.09	0.99	1229.07	39.57	< LOD	7.82	< LOD
718	TP-MS-4A(0-1.0)	4076	3679	47.86	< LOD	1	9.15	0.67	49.51	10.59	577.98	76.19	2048.63	12.9	< LOD	4.03	67.61	1.05	32714.25	189.15	< LOD	8.54	< LOD
719	TP-MS-4A(1-2)	5016.2	3205	46.5	< LOD	1	10.61	0.71	75.65	11.31	537.16	85.73	1091.49	9.41	< LOD	4.88	86.28	1.19	46911.93	236.47	< LOD	8.99	< LOD
720	TP-TS-01(.5-1)	4736.73	965.3	32.12	2.39	0.78	11.7	0.67	35.54	10.4	2432.59	98.66	1877.96	11.9	< LOD	3.9	75.15	1.06	36806.88	213.35	< LOD	8.25	< LOD
721	TP-TS-02(.6-.9)	5174.33	799.9	33.17	< LOD	1.64	11.62	0.73	32.83	11.29	2244.99	104.23	2805.75	16.21	< LOD	4.25	72	1.14	41701.98	236.92	< LOD	9.02	< LOD
722	TP-TS-02(1.5-2)	3177.94	612.8	28.05	< LOD	1	13.96	0.6	< LOD	16.73	569.39	102.87	185.68	3.32	< LOD	3.25	87.03	0.97	9363.17	65.59	< LOD	6.83	< LOD
723	TP-TS-03(.1-.2)	4970.73	1102	33.66	1.67	0.8	12.28	0.69	< LOD	21.1	3192.81	105.91	2271.75	13.56	< LOD	3.98	64.17	1.02	37617.25	221.9	< LOD	8.4	< LOD
724	TP-TS-03(1.8-2)	3087.36	549.5	27.24	< LOD	1	14.96	0.59	< LOD	16.68	649.63	103.83	95.58	2.52	< LOD	3.18	76.28	0.9	1377.08	38.46	< LOD	6.73	< LOD
725	TP-TS-03A(1.8-2)	3069.62	354.6	25.56	< LOD	1.09	14.14	0.59	< LOD	16.56	567.48	99.58	80.53	2.37	< LOD	3.18	69.63	0.86	6361.41	55.68	< LOD	6.71	< LOD

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
4	TP-FP 27 (2-2.4)	1	232122	547.09	< LOD	7.43	61.68	0.79			1964.61	129.01			< LOD	140.88	< LOD	36.69	1713.21	11.83	198.78	1.4
5	TP-FP 27 (3.8-4.2)	1	250078	569.4	< LOD	8.04	33.84	0.65			2402.79	135.82			< LOD	151.08	< LOD	29.56	482.21	6.63	203.88	1.46
6	TP-FP 27 (5-5.5)	1	214769	540.05	< LOD	8.8	91.02	1.07			5116.85	138.63			1069.18	79.29	< LOD	47.33	2444.32	15.91	185.68	1.54
7	TP-FP 27 (6.5-7)	1.55	233336	549.9	< LOD	8.17	46.62	0.75			3948.61	138.04			176.04	75.37	< LOD	35.16	1101.96	9.93	185.36	1.42
8	TP-FP 27 (9.5-10)	1	190671	498.37	< LOD	8.12	45.46	0.74			3661.83	138.37			< LOD	150.58	< LOD	36.32	1238.4	10.52	194.05	1.45
9	TP-FP 27 (13-19)	1	190033	497.35	< LOD	7.81	38.9	0.67			3304.63	134.88			< LOD	148.41	< LOD	28.44	467.3	6.39	181.15	1.35
10	TP-FP 28 (1-1.5)	1	218654	523.7	< LOD	7.77	45.35	0.71			3475.7	131.3			< LOD	143.61	< LOD	26.43	159.41	4.11	202.66	1.43
11	TP-FP 28 (1.5-2)	1.83	118270	425.57	< LOD	10.59	48.54	0.95			8680.58	142.45			757.53	72.05	56.57	23.86	762.98	9.85	125.82	1.47
12	TP-FP 28 (3-3.5)	1	254523	577.66	< LOD	8.13	48.92	0.76			4076.32	142.88			< LOD	154	< LOD	29.21	405.99	6.2	193.87	1.45
13	TP-FP 28 (4.6-5)	1	244114	561.12	< LOD	8.37	31.64	0.65			7791.72	153.07			1126.51	83.03	< LOD	28.79	255.45	5.18	213.51	1.54
14	TP-FP 28 (5.5-7)	1	244760	564.95	< LOD	7.98	74.04	0.9			4835.1	143.08			175.25	76.57	< LOD	34.69	1047.84	9.56	205.62	1.49
15	TP-FP 28 (8-8.5)	1	244670	559.15	< LOD	8.14	45.52	0.74			6250	145.62			213.31	75.59	< LOD	28.51	258.78	5.11	190.48	1.43
16	TP-FP 28 (9-9.5)	1	253161	567.79	< LOD	7.94	43.98	0.71			6567.32	149.46			175.88	77.21	< LOD	28.76	418.91	6.11	182.42	1.37
17	TP-FP 28 REP(4.6-5)	1.18	244127	553.73	< LOD	7.99	38.02	0.67			5461.99	139.15			792.53	77.22	< LOD	27.05	249.55	4.95	215.98	1.5
18	TP-FP 30 (0.5-0.8)	2.3	208245	585.67	< LOD	10.59	62.72	1.04			8595	149.78			757.48	76.48	< LOD	68.87	4159.8	24.46	113.05	1.41
19	TP-FP 30 (1.6-2)	1.29	202936	548.11	< LOD	9.48	40.84	0.8			7885.02	141.67			547.63	72.28	< LOD	53.7	2852.35	18.09	165.76	1.52
20	TP-FP 30 (2.3-3.3)	1	123563	392.96	< LOD	8.97	37.3	0.73			3472.24	119.87			342.79	66.68	< LOD	29.17	195.5	4.85	166.56	1.44
21	TP-FP 30 (3-3.5)	1.32	231234	541.7	< LOD	7.66	59.45	0.79			3777.78	135.05			235.16	74.7	< LOD	29.58	639.63	7.29	304.56	1.75
22	TP-FP 30 (3.5-4)	1	231601	548.2	< LOD	7.94	45.85	0.72			3980.42	134.66			< LOD	145.71	< LOD	35.22	1247.88	10.33	181.94	1.38
23	TP-FP 30 (4.8-5)	1	195346	513.36	< LOD	8.5	93.37	1.05			5688.31	132.86			291.38	70.2	< LOD	41.72	2027.62	13.95	188.03	1.5
24	TP-FP 30 (7.5-8)	1	241784	569.64	< LOD	8.64	60.22	0.87			5398.49	140.58			274.61	74.44	< LOD	40.57	1511.59	12.16	181.57	1.48
25	TP-FP 30 (10-10.5)	1	284143	619.7	< LOD	8.14	73.15	0.91			4408.42	139.95			475.53	77.8	< LOD	30.45	495.65	6.79	195.59	1.47
26	TP-FP 30A (0.5-0.8) DUP	2.28	206198	581.03	< LOD	10.48	58.64	1			10135.9	157.58			700.51	77.93	< LOD	65.84	3844.73	23.16	111.39	1.39
27	TP-FP 30A (0.8-1)	1.83	153972	491.89	< LOD	12.09	44.84	0.96			10925.5	154.13			857.64	75.53	< LOD	66.81	3248.98	22.27	131.7	1.58
28	TP-FP 31 (0.1-0.4)	1.72	160962	476.98	< LOD	10.56	43.43	0.91			10204.4	148.92			760.1	73.41	< LOD	47.53	767.86	9.89	137.76	1.53
29	TP-FP-01A(0-3)	1	281902	611.45	< LOD	7.84	84.81	0.94			3085.98	137.25			< LOD	151.63	< LOD	27.39	273.15	5.12	210.81	1.49
30	TP-FP-01B(0-2)	5.23			< LOD	23.97	39.51	1.95			8576.51	372.52			396.95	185.13	< LOD	110.73	1051.81	26.11	189.49	3.95
31	TP-FP-01B(0-2)	2.03	173400	478.7	< LOD	8.95	35.36	0.73			9860.57	153.02			596.07	75.82	77.4	21.11	1026.94	10.11	183.42	1.52
32	TP-FP-02(3-8.5)	1	257495	572.83	< LOD	7.99	70.46	0.87			3315.81	133.92			< LOD	146.84	< LOD	27.52	168.84	4.29	213.04	1.5
33	TP-FP-02(8.5-9.5)	2.22	233974	569.36	< LOD	9.57	47.63	0.87			6386.66	135.85			767.59	72.84	< LOD	47.67	1463.31	12.67	179.17	1.6
34	TPFP03(2.5-3)	1.56	301660	1304.06	< LOD	12.74	80.75	2.02	19.32	6.03	3580.96	345.15	< LOD	5.01	< LOD	310.48	< LOD	43.06	188.13	9.93	205.87	3.16
35	TP-FP-03(2.5-3.0)	1.92					92.55	1.56	14.57	1.72			6.89	2.78			< LOD	17.35	168.53	5.61	227.69	2.24
36	TP-FP-03(4-4.5)	2.58					107.97	2.07	17.27	5.25			< LOD	4.81			44.23	17.28	1035.79	15.15	198.65	2.65
37	TP-FP-03(4-4.5)	2.63	161589	959.96	< LOD	15.77	87.16	2.51	< LOD	10.2	17463.2	405.68	7.09	4.12	1426.53	172.05	113.83	49.97	1060.34	23.93	176.57	3.5
38	TP-FP-03(6-7)	1.97					83.92	1.51	16.27	1.84			4.72	2.81			17.81	11.81	157.23	5.52	245.33	2.33
39	TP-FP-03(6-7)	1.5	291837	1280.72	< LOD	12.49	73.29	1.91	25.8	6.06	3855.06	341.49	< LOD	6.37	< LOD	395.32	< LOD	42.54	172.66	9.56	221.49	3.24
40	TP-FP-03(7.6-8.6)	1.5	282898	1242.57	< LOD	13.01	88.52	2.13	17.43	6.11	3447.78	319.1	7.13	3.49	254.48	154.27	< LOD	74.22	2824.11	35.11	212.63	3.26
41	TP-FP-03(7.6-8.6)	13.65			< LOD	346.34	119.21	61.11	< LOD	170.2	< LOD	18731	< LOD	143.02	< LOD	5670.89	< LOD	1785.3	2015.02	716.73	164.06	70.24
42	TP-FP-03(9-9.5)	1.5	264352	1206.59	< LOD	12.88	67.35	1.88	20.39	6.11	3897.66	340.28	7.19	3.56	292	163.31	< LOD	68.37	2289.9	31.35	213.33	3.25
43	TP-FP-03(11.5-12.5)	1.5	296447	1284.11	< LOD	12.42	100.71	2.21	21.82	6.03	3913.07	335.38	5.21	3.34	401.6	162.79	< LOD	86.07	767.33	17.63	231.79	3.31
44	TP-FP-04(1.5-2)	2.69	147655	931.75	< LOD	16.71	42.14	1.93	11.28	7.06	16413	388.81	< LOD	6.76	1086.08	161.77	< LOD	77.6	1145.83	26.15	190.84	3.75
45	TP-FP-04(3-4)	4.08			< LOD	22.13	67.14	3.12	20.59	9.73	6628.86	473.6	< LOD	11.66	475.07	217.15	< LOD	147.78	4267.05	69.32	189.7	5
46	TP-FP-04(3-4)	2.4	197347	1051.68	< LOD	14.92	63.27	2.1	19.24	6.68	6655.05	332.77	7.28	4.06	536.74	153.5	< LOD	136.93	4263.45	48.18	191.44	3.47
47	TP-FP-04(5.5-6.5)	2.77	229101	1139.28	< LOD	15.34	71.69	2.31	19.75	6.87	5291.92	324.81	< LOD	9.05	515.9	153.83	< LOD	110.06	5044.54	54.51	193.64	3.61
48	TP-FP-04(7-8)	2	212790	1094.91	< LOD	13.84	73.7	2.11	11.57	6.25	5553.34	326.21	7.62	3.77	407.59	152.75	< LOD	80.19	2836.35	36.75	189.36	3.28
49	TP-FP-04(9-10)	2.58	221017	1111.73	< LOD	15.14	66.08	2.17	16.56	6.72	5800.68	328.45	< LOD	6.02	497.1	153.51	< LOD	141.35	10125.37	84.67	173.44	3.37

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
50	TP-FP-05(1-3)	2.53	169143	979.77	< LOD	16.72	44.02	1.93	19.2	7.22	14759.1	396.82	< LOD	7.02	977.02	167.51	< LOD	106.94	1923.11	34.35	165.75	3.51
51	TP-FP-05(1-3)DUP	5.28	132370	891.95	< LOD	17.85	40.36	1.99	14.59	7.47	16796.7	397.17	< LOD	6.63	1104.62	164.65	130.97	67.72	2534.45	41.7	149.54	3.52
52	TP-FP-05(3.8-4.8)	1.5	250771	1170.98	< LOD	13.01	66.85	1.89	17.55	6.07	5907.17	350.66	< LOD	6.82	244.93	161.19	< LOD	68.17	2220	30.83	213.65	3.26
53	TP-FP-05(6-7)	3.59	226034	1151.16	< LOD	15.87	60.53	2.27	11.23	6.77	5170.91	328.25	< LOD	6.68	398.86	153.63	< LOD	115.25	4952.28	53.82	178.99	3.58
54	TP-FP-05(7.5-8.0)	1.57	241060	1146.45	< LOD	13.14	104.79	2.36	24.56	6.29	5368.04	340.17	< LOD	4.16	287.31	158.46	< LOD	63.74	1580.14	26.08	185.91	3.13
55	TP-FP-05(8.5-9.5)	1.5	279034	1223.84	< LOD	12.81	90.36	2.15	15.88	6.03	4409.38	341.18	9.26	3.58	< LOD	241.44	< LOD	72.27	1339.52	23.5	200.44	3.15
56	TP-FP-06(1.3-2)	3.55	172406	1041.3	< LOD	16.6	46.72	1.98	15.43	7.1	11622	355.23	8.27	4.24	784.61	153.84	< LOD	116.27	5293.26	60.38	150.01	3.33
57	TP-FP-06(4.5-5.5)	4.94	205668	1114.03	< LOD	17.42	56.61	2.25	11.88	7.31	11807.4	369.86	< LOD	8.91	1011.52	162.71	< LOD	126.73	6023.27	68.22	150.26	3.49
58	TP-FP-06(7-8)	2.38	298901	1312.43	< LOD	14.59	65.6	2.12	24.48	6.74	6144.73	342.15	7.97	4.08	851.19	164.03	< LOD	100.44	4420.56	48.5	224.41	3.71
59	TP-FP-06(8.5-9)	2.27	249873	1199.12	< LOD	14.5	73.35	2.19	23.29	6.64	6604.58	343.27	< LOD	5.88	605.92	159.81	< LOD	82.88	2584.12	35.62	203.62	3.5
60	TP-FP-07(0.5-1)	4.84	131371	919.34	< LOD	21.56	42.78	2.17	20.9	8.08	15576	377.76	< LOD	7.99	1112	158.83	< LOD	106.62	2569.87	44.73	140.42	3.66
61	TP-FP-07(1-1.5)	3.81	200634	1174.95	< LOD	17.91	53.98	2.27	< LOD	11.02	13038.1	376.18	8.34	4.53	1042.75	163.06	< LOD	120.78	4754.79	60.26	132.5	3.39
62	TP-FP-07(2.5-3.0)	1.5	205419	1090.93	< LOD	12.41	111.33	2.33	27.01	6.18	2891.67	337.56	6.47	3.47	< LOD	238.58	< LOD	43.75	242.08	10.83	221.05	3.27
63	TP-FP-07(5-5.5)	1.55	265513	1197.68	< LOD	12.61	81.5	2.01	20.15	6	3358.62	327.75	< LOD	5.15	< LOD	232.86	< LOD	64.5	2005.36	28.62	200.19	3.09
64	TP-FP-07(7-8)	2.79	270601	1263.99	26.81	12.2	64.64	2.32	14.37	7.27	12690.5	372.71	6.93	4.32	1274.63	165.3	< LOD	124.23	5921.56	65.96	170.12	3.63
65	TP-FP-07(11-12)	2.25	240374	1175.14	< LOD	15.29	60.16	2.07	17.7	6.81	12674.8	380.57	9.98	4.1	864.49	164.28	92.85	54.6	2113.51	33.9	179.11	3.42
66	TP-FP-07 Rep(0.5-1)	6.37	135153	933.37	< LOD	32.34	41.56	2.15	18.93	8.04	15520.5	375.3	< LOD	6.98	1037.66	157.35	< LOD	164.72	2627.71	45.21	138.73	3.63
67	TP-FP-07 Rep(0.5-1)	9.56			< LOD	67.54	55.66	5.73	< LOD	44.32	11787.4	880.44	< LOD	16.82	719.13	376.15	< LOD	304.55	4788.36	148.68	138.37	8.61
68	TP-FP-08(1.3-2)	5.61	139850	931.6	< LOD	25.01	34.2	2.06	13.53	7.79	12505.6	365.47	< LOD	10.41	1047.29	159.06	< LOD	198.42	4134.81	57.73	141.14	3.65
69	TP-FP-08(2.4-2.9)	3.79	139951	928.34	< LOD	19	36.11	2.1	12.62	7.79	12431.1	366.39	< LOD	7.24	1097.29	160.31	< LOD	162.2	4089.11	57.46	139.47	3.64
70	TP-FP-08(3-3.8)	2.43	244343	1188.84	< LOD	14.89	75.02	2.23	22	6.86	10648.9	380.64	6.54	3.94	594.24	165.64	< LOD	119.33	7340.46	68.75	195.73	3.51
71	TP-FP-08(4-4.5)	2.9	195551	1059.89	< LOD	13.65	81.78	2.15	16.19	6.31	3951.49	298.44	< LOD	7.79	833.78	150.94	< LOD	116.32	8426.13	70.38	188.92	3.21
72	TP-FP-08(4.5-6.0)	1.5	235644	1148.84	< LOD	13.1	69.52	1.94	16.92	6.15	7299.79	362.87	10.92	3.69	< LOD	326.9	< LOD	66.89	2022.7	29.6	217.44	3.32
73	TP-FP-08(6-6.5)	1.5	170936	983.58	< LOD	12.99	77.03	2.02	25.54	6.26	4502.62	328.07	9.36	3.61	< LOD	231.33	< LOD	76.45	3047.03	36.89	194.04	3.15
74	TP-FP-08(8-8.6)	1.5	186662	1033.14	< LOD	13.71	67.98	1.98	18.54	6.35	11020.4	371.55	< LOD	6.48	904.42	165.49	< LOD	79.62	1435.64	25.65	199.68	3.3
75	TP-FP-08b(2.4-2.9)	18			< LOD	520.01	< LOD	85.6	< LOD	309.79	< LOD	11601.9	< LOD	139.94	< LOD	7545.53	< LOD	2433.3	4508.17	1304.11	< LOD	108.44
76	TP-FP-08b(2.4-2.9)	228.87			< LOD	484.53	< LOD	135.19	< LOD	187.74	< LOD	14323.4	< LOD	19.12	< LOD	6361.24	< LOD	2742.8	6256.09	1783.38	175.17	101.12
77	TP-FP-08b(2.4-2.9)	64.98			< LOD	1445.36	< LOD	446.92	< LOD	185.58	< LOD	29616.7	< LOD	1023.45	< LOD	23323.5	< LOD	14888	8236.04	4169.74	< LOD	525.48
78	TP-FP-08b(2.4-2.9)	3.39	156207	974.16	< LOD	22.46	48.11	2.18	17.87	7.61	12928.3	364.65	14.88	4.83	1168.92	159.2	< LOD	140.89	5635.26	66.06	139.95	3.46
79	TP-FP-09(1.5-2.0)	4.28	109314	871.86	< LOD	24.72	58.92	2.34	< LOD	12.49	12097.4	359.1	< LOD	6.61	1169.48	159.57	129.37	56.33	920.25	24.63	128.82	3.33
80	TP-FP-09(2.7-3.0)	4.06	110589	873.2	26.9	14.81	35.2	2.22	< LOD	12.65	12797.3	357.98	< LOD	6.8	1195.7	157.63	137.97	74.98	2032.33	42.23	120.51	3.69
81	TP-FP-09(3.2-3.3)	4.32	233538	1182.05	< LOD	17.97	51.6	2.25	27.82	7.86	12567.7	385.02	< LOD	6.75	940.82	166.19	< LOD	155.16	5718.98	67.27	148.24	3.59
82	TP-FP-09(4.5-5)	2.81	179146	1022.72	< LOD	15.69	61.52	2.11	15.14	6.84	9402.52	343.67	< LOD	8.24	727.84	153.58	< LOD	70.26	1068.37	24.23	164.53	3.34
83	TP-FP-09(7.5-8)	1.8	255591	1208.79	< LOD	14.87	64.72	2.07	20.48	6.74	9411	354.2	6.16	3.83	917.1	161.36	< LOD	85.26	936.57	21.93	199.44	3.51
84	TP-FP-10(2-2.4)	1.5	286535	1266.56	< LOD	12.36	92.04	2.12	15.65	5.94	4637.79	344.14	6.92	3.43	< LOD	242.36	< LOD	47.75	511.86	14.64	230.17	3.3
85	TP-FP-10(4-4.5)	1.5	243643	1170.26	< LOD	12.78	96.92	2.22	20.73	6.16	6198.9	350.15	10.11	3.62	459.37	163.26	< LOD	57.07	1185.39	22.21	202.77	3.19
86	TP-FP-10(5.5-6)	1.5	251520	1187.65	< LOD	12.93	102.3	2.29	17.22	6.13	6371.25	350.07	7.18	3.57	703.15	165.74	< LOD	63.47	1733.08	27.05	205.71	3.22
87	TP-FP-10(8-8.5)	1.95	197281	1077.27	< LOD	15.35	149	3.18	26.28	7.27	3478.66	270.39	14.42	4.42	831.88	140.32	< LOD	80.32	1324.16	26.68	159.41	3.36
88	TP-FP-10 Rep(5.5-6)	1.5	253220	1202.83	< LOD	12.88	104.13	2.31	20.92	6.18	6182.73	346.57	7.19	3.57	849.41	166.75	< LOD	63.12	1739.31	27.02	208.48	3.24
89	TP-FP-10A(.75-1.0)	4.24	135062	919.92	< LOD	19.19	50.01	2.34	< LOD	16.11	14232.2	359.31	< LOD	7.73	1473.49	157.9	< LOD	146.31	1724.63	35.81	144.63	3.72
90	TP-FP-10A(1.1-1.3)	1.5	266584	1210.2	< LOD	12.65	92.23	2.17	24.01	6.12	4179.18	326.15	5.36	3.43	351.67	156.69	< LOD	46.34	333.69	12.37	180.32	3.01
91	TP-FP-10A(2.1-2.6)	1.5	254238	1204.34	< LOD	12.6	153.85	2.78	17.9	6.16	5278.65	341.49	9.14	3.65	< LOD	355.85	< LOD	50.89	722.52	17.4	181.87	3.05
92	TP-FP-10A(3.5-4)	1.5	131938	861.95	< LOD	12.93	75.73	2	15.64	6.06	4488.28	324.47	7.84	3.57	291.08	154.22	< LOD	59.99	1461.57	24.91	187.42	3.08
93	TP-FP-11(.1-.3)	2.89	165054	996.01	< LOD	16.86	56.62	2.21	< LOD	15.65	16920.5	392.66	< LOD	6.28	1378.82	166.01	123.82	52.58	928.45	23.86	177.49	3.69
94	TP-FP-11(1-1.2)	1.82	188932	1021.27	< LOD	14.01	71.06	2.09	9.61	6.22	4723.43	297.9	< LOD	7.74	499.01	143.33	< LOD	58.48	665.56	17.85	154.53	3
95	TP-FP-11(1.5-2.0)	1.5	202462	1053.26	< LOD	13.33	61.27	1.85	17.7	6.16	4089.63	306.5	< LOD	5.19	354.94	147.7	< LOD	60.82	1456.32	25.25	186.53	3.12

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
96	TP-FP-11(2.7-3.0)	1.5	221889	1093.22	< LOD	12.73	88.67	2.15	19.9	6.12	1920.51	288.4	12.28	3.63	< LOD	207.56	< LOD	57.41	1158.32	21.98	168.91	2.94
97	TP-FP-11(3.7-4)	1.5	235562	1160.05	< LOD	13.24	87.13	2.18	23.33	6.39	5188.04	335.97	12.95	3.8	941.75	166.18	< LOD	69.49	2176.88	31.27	196.32	3.23
98	TP-FP-11(6.5-7)	1.5	285383	1261.65	< LOD	12.51	76.72	1.96	21.84	6.04	5643.03	356.29	5.56	3.41	< LOD	241.62	< LOD	58.74	363.22	12.76	217.04	3.22
99	TP-FP-11(8.5-9.0)	1.5	288091	1270.72	< LOD	12.83	65.43	1.84	17.2	5.99	6279.01	357.2	6	3.46	345.82	164.92	< LOD	47.14	405.75	13.47	206.63	3.17
100	TP-FP-11A(6.5-7)	1.5	290518	1291.68	< LOD	12.93	86.84	2.13	20.55	6.16	7757.7	378.85	< LOD	5.19	346.55	170.98	< LOD	46.07	322.95	12.4	195.71	3.15
101	TP-FP-12(.9-1.3)	4.83	113061	869.89	45.58	14.95	36.16	2.43	13.85	8.44	10834.1	348.99	< LOD	9.94	1129.17	157.67	146.37	87.85	3154.12	52.88	123.24	3.86
102	TP-FP-12(1.6-1.8)	2	182248	989.05	< LOD	14.25	65.09	2.05	20.05	6.55	4653.33	295.19	< LOD	5.64	316.92	139.74	< LOD	58.72	664.87	18.17	167.29	3.18
103	TP-FP-12(1.6-2.0)	4.84	111247	855.19	37.05	14.7	42.35	2.48	19.53	8.51	9192.35	324.1	< LOD	12.29	934.07	148.43	144.89	82.12	2637.76	47.32	114.42	3.69
104	TP-FP-12(2-2.3)	4.82	137333	1014.14	46.08	15.68	50.91	2.71	14.49	9.02	12619.9	378.44	< LOD	8.34	1078.82	165.51	< LOD	197.68	2500.85	49.29	138.72	4.16
105	TP-FP-12(3-3.5)	3.63	174999	531.21	21.68	6.69	48.72	1.24			6216.39	138.08			894.14	74.39	293.03	42.28	3214.11	22.68	111.68	1.76
106	TP-FP-12(3-3.3)	2.61	197229	1048.83	< LOD	14.14	55.45	1.97	12.16	6.22	5411.36	331.38	< LOD	5.89	826.32	160.81	< LOD	86.74	3009.15	37.63	158.48	3.09
107	TP-FP-12(6-6.5)	2.12	149688	930.16	< LOD	13.93	74.75	2.14	46.66	6.85	6274.62	343.75	< LOD	5.66	724.56	163.06	< LOD	76.95	2416.38	33.73	185.37	3.3
108	TP-FP-12(8-8.5)	1.72	250272	1182.29	< LOD	13.26	85.86	2.17	17.01	6.16	4346.57	342.14	5.92	3.6	< LOD	242.26	< LOD	71.95	1358.31	24.2	182.53	3.11
109	TP-FP-12(9.5-10)	1.7	267323	1202.57	< LOD	13.05	76.17	2.02	16.75	6.04	4924.74	346.52	< LOD	5.25	286.31	162.65	< LOD	56.14	678.58	17.08	189.49	3.1
110	TP-FP-13(1-1.3)	1.81	231854	1127.12	< LOD	13.96	81.54	2.22	16	6.38	5995.86	332.83	< LOD	5.45	312.91	153.01	< LOD	62.28	1060.39	22.32	168.38	3.14
111	TP-FP-13(1.5-1.8)	3.7	152240	932.38	< LOD	16.04	54.06	2.09	12.92	6.87	14482.2	387.07	< LOD	8.57	916.44	162.86	108.85	55.55	1682.12	30.73	158.29	3.36
112	TP-FP-13(2.4-2.7)	1.62	113710	802.96	< LOD	14.17	74.22	2.12	17.61	6.5	5028.02	304.72	< LOD	5.89	313.99	142.99	< LOD	52.98	489.03	15.73	206.97	3.46
113	TP-FP-13(3.1-3.4)	4.53	137667	950.28	24.04	14.54	35.99	2.36	17.56	8.44	10033.2	333.87	< LOD	11.95	1107.39	152.34	145.69	87.26	3473.81	54.98	134.06	3.9
114	TP-FP-13(3.5-3.7)	1.75	122573	840.51	< LOD	14.39	82.93	2.27	21.15	6.59	5099.58	311.23	< LOD	7.28	280.23	145.37	< LOD	82.02	2804.89	37.65	162.02	3.13
115	TP-FP-13(4-4.3)	1.78	212630	1106.88	< LOD	13.96	71.73	2.07	12.79	6.23	7217.05	328.94	5.77	3.63	370.73	148.74	< LOD	65.71	1477.29	26.16	160.43	3.03
116	TP-FP-14(1-1.3)	1.68	264214	1197.44	< LOD	13.52	68.4	1.98	10.84	6.13	6306.77	347.29	6.43	3.62	279.71	158.56	< LOD	56.44	236.24	11.27	203.54	3.29
117	TP-FP-14(1.4-1.9)	3.15	187228	1026.13	< LOD	15.48	62.38	2.22	18.3	6.69	3908.37	300.53	< LOD	6.22	451.87	146.37	< LOD	71.13	434.22	15.45	147.38	3.22
118	TP-FP-14(3.2-3.5)	1.55	160850	954.05	< LOD	13.16	76.49	2.03	19.4	6.17	8893.01	371.44	9.99	3.67	581.24	167.07	< LOD	70.81	2352.98	32.01	190	3.12
119	TP-FP-14(4-4.6)	2.64	176176	992.39	< LOD	14.55	63.91	2.11	12.01	6.4	3744.65	318.49	< LOD	7.62	496.28	156.17	< LOD	95.76	3882.68	44.63	165.04	3.21
120	TP-FP-14(6-6.5)	1.5	161698	932.63	< LOD	13.03	116.6	2.47	18.65	6.21	4365.25	333.21	< LOD	7.13	256.24	158.07	< LOD	61.56	1523.02	25.48	197.43	3.21
121	TP-FP-14(10-10.5)	1.5	238895	1177.28	< LOD	12.81	94.15	2.19	20.92	6.14	5330.82	349.42	5.22	3.43	449.93	165.53	< LOD	58.35	627.41	16.43	210.47	3.24
122	TP-FP-14 REP(4-4.6)REP	2.58	177567	990.68	< LOD	14.32	63.92	2.08	14.36	6.35	3475.89	310.87	< LOD	5.89	709.65	156.59	< LOD	93.28	3870.38	43.94	167.42	3.18
123	TP-FP-15(0-.2)	1.73	159224	927.82	< LOD	13.5	61.01	1.9	9.75	6.03	5274.44	302.86	< LOD	3.81	< LOD	314.41	< LOD	65.02	1280.94	23.92	149.84	2.88
124	TP-FP-15(0-0.3)	1.5	264909	1208.71	< LOD	12.79	84.37	2.07	15.46	6.01	5707.19	351.56	< LOD	6.04	256.69	162.47	< LOD	49.09	572.31	15.7	211.31	3.22
125	TP-FP-15(0-0.4)	5.11	193949	1155.04	< LOD	17.83	65.7	2.44	14.08	7.5	13565.9	394.08	< LOD	8.78	1382.01	174.5	< LOD	108.43	3443.96	49.96	127.33	3.34
126	TP-FP-15(1.7-1.9)	1.5	250661	1154.31	< LOD	11.7	87.16	2	< LOD	8.27	2723.74	330.25	< LOD	5.69	< LOD	230.23	< LOD	42.59	368.44	12.3	166.66	2.73
127	TP-FP-15(6.5-7)	1.5	268183	1240.24	< LOD	12.74	114.11	2.4	16.36	6.09	5469.73	349.78	< LOD	5.23	266.78	162.76	< LOD	49.81	618.65	16.28	206.9	3.22
128	TP-FP-15A(0.5-1)	5.28	101865	895.27	< LOD	17.99	57.02	2.33	14.5	7.53	14280.4	411.57	< LOD	6.51	939.43	174.19	102.95	55.6	871.39	24.56	106.28	3.12
129	TP-FP-15A(2.7-3)	2.47	228511	1229.56	< LOD	16.21	70.05	2.32	< LOD	10.4	11581.8	387.3	10.45	4.17	952.32	170.81	< LOD	98.14	3132.09	44.01	126.93	3.08
130	TP-FP-15A(3.1-3.6)	497.87			< LOD	3186.28	194.51	121.66	< LOD	1857.74	< LOD	7367.74	< LOD	1179.32	< LOD	2960.79	79578.5	11624	< LOD	1115.47	< LOD	220.08
131	TP-FP-15A(3.1-3.6)	332.13	55088.1	9453.03	< LOD	1883.66	155.2	70.97	< LOD	1093.47	< LOD	4481.57	< LOD	467	< LOD	1481.62	71152.5	8833	< LOD	672.43	< LOD	133.39
132	TP-FP-15A(3.1-3.6)	4.46	163610	1008.71	< LOD	26.48	55.83	2.18	15.22	7.39	11057.9	354.91	10.47	4.35	1141.84	159.75	< LOD	114.97	3256.29	46.79	162.96	3.56
133	TP-FP-15A(5-5.2)	1.62	184031	997.3	< LOD	14.56	64.67	2.03	26.72	6.76	4403.82	290.3	< LOD	7.49	535.79	141.7	< LOD	56.77	688.14	18.66	191.26	3.39
134	TP-FP-15A(5-5.7)	1.5	239337	1143.09	< LOD	13.24	73.82	2	20.18	6.22	4721.44	334.92	< LOD	5.23	433.89	160.27	< LOD	56.14	517.97	15.38	209.98	3.29
135	TP-FP-15A(6-6.5)	1.5	271648	1243.19	< LOD	13.55	98.09	2.34	16.05	6.35	6886.14	355.38	8.82	3.67	537.85	164.49	< LOD	57.21	928.07	20.6	198.12	3.3
136	TP-FP-15A(8.5-9.0)	1.5	270350	1235.07	< LOD	12.85	105.12	2.32	19.74	6.13	6520.12	354.7	< LOD	4.99	363.01	163.2	< LOD	48.99	502.65	14.89	199.83	3.17
137	TP-FP-15A DUP(0.5-1)	3.8	108913	938.55	< LOD	17.77	63.78	2.41	16.29	7.44	17431.6	441.27	< LOD	7.04	1454.41	187.58	100.89	52.59	645.42	21.16	99.59	3.02
138	TP-FP-16(1.1-1.5)	3.15	118449	885.34	< LOD	17.44	48.7	2.15	< LOD	10.74	11359.7	362.44	< LOD	6.69	763.1	156.74	< LOD	86.72	1537.59	31.1	122.51	3.21
139	TP-FP-16(3-3.4)	2.95	123820	904.88	< LOD	16.29	58.09	2.18	< LOD	14.42	12365.3	376.69	< LOD	4.92	1297.08	168.43	116.55	52.42	1020.08	24.09	173.9	3.54
140	TP-FP-16(3-3.4)DUP	2.79	115918	861.59	< LOD	15.65	51.6	2.03	< LOD	9.82	9880.97	351.35	< LOD	8.42	614.08	154.16	124.64	51.42	1094.38	24.2	131.07	3.05
141	TP-FP-16(4.2-4.3)	7.55	136428	946.44	< LOD	27.77	31.65	2.35			5161.98	263.36			623.24	142	< LOD	230.37	9420.67	90.91	134.21	3.9

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
142	TP-FP-16(4.2-4.3)	6.59	147502	998.97	< LOD	22.9	40.31	2.92	< LOD	15.77	6630.62	331.61	< LOD	14.16	791.71	155.99	< LOD	204.08	11520.15	116.79	135.38	4.34
143	TP-FP-16(4.2-4.3)CHECK	6.45	146471	1018.13	< LOD	22.1	42.52	2.84	< LOD	19.35	5575.68	314.01	< LOD	10.55	895.04	154.11	< LOD	187.84	10009.91	102.81	133.17	4.19
144	TP-FP-16(4.8-5)	3.21	172527	1159.9	< LOD	19.32	49.49	1.8			1330.05	231.3			< LOD	272.13	< LOD	157.4	7160.14	62.71	94.25	2.47
145	TP-FP-16(5.5-6.3)	2	249886	1147.98	< LOD	16.63	62.11	1.72			4394.81	280.59			< LOD	299.94	< LOD	109.2	4187.52	41.55	203.2	3.04
146	TP-FP-16(6.2-7.4)	3.92	212841	1085.57	< LOD	17.8	66.86	1.89			5591.74	276.15			1698.81	164.07	< LOD	90.04	1495.09	24.03	179.54	3.03
147	TP-FP-16(9-9.4)	2.25	129604	846.82	< LOD	17.37	62.96	1.81			5129.89	275.93			506.67	150.21	< LOD	84.95	1562.04	24.73	210.62	3.23
148	TP-FP-16(11.5-12)	3.19	213385	1076.27	< LOD	17.44	61.77	1.78			6908.51	290.73			548.56	152.73	< LOD	87.63	1937.21	27.75	177.85	2.96
149	TP-FP-17(1-1.5)	3.96	120544	860.28	69.58	11.9	55.69	2.06			9428.51	295.68			1024.45	150.88	< LOD	99.06	647.92	18.53	129.3	3.06
150	TP-FP-17(2.6-3.0)	5.64	150305	946.03	< LOD	23.93	45.18	2.12			6494.31	279.47			489.96	143.97	< LOD	133.74	1956.95	32.14	158.08	3.56
151	TP-FP-17(2.6-3.0)	355.68			< LOD	980.77	< LOD	242.5			< LOD	24607.5			< LOD	9587.41	< LOD	6442.3	< LOD	2489.2	< LOD	266.02
152	TP-FP-17(2.6-3.0)	5.62	151630	960.41	< LOD	24.26	41.03	2.08			6198.1	278.56			582.02	146.02	< LOD	134.55	1969.34	32.52	156.81	3.58
153	TP-FP-17(4.6-5)	2	251521	1144.29	< LOD	16.9	60.73	1.72			4672.79	281.22			< LOD	297.99	< LOD	100.46	3169.09	35.63	197.53	3.02
154	TP-FP-17(5-6)	2.27	249879	1150.18	< LOD	17.1	85.09	2.02			5586.2	279.49			605.63	151.74	< LOD	93.37	2337.42	29.87	182.28	2.96
155	TP-FP-17(6.3-6.5)	2	231218	1104.99	< LOD	17.05	50.23	1.59			7112.2	297.32			627.04	156.9	< LOD	85.83	2048.71	28.12	197.83	3.03
156	TP-FP-17(9-9.5)	2.46	251824	1145.54	< LOD	16.51	93.56	2.05			5296.58	287.82			475.12	156.22	< LOD	75.9	1530.96	23.64	226.33	3.2
157	TP-FP-17(11.5-12)	2	260598	1154.7	< LOD	16.4	62.32	1.68			4352.63	271.93			< LOD	290.89	< LOD	79.11	1688.11	24.62	205.16	2.99
158	TP-FP-17 (3-3.2)	3.79	175388	971.28	< LOD	17.97	55.82	1.88			1946.46	230.34			< LOD	254.58	< LOD	139.7	5763.06	51.68	135.6	2.82
159	TP-FP-18(0-0.3)	4.37	147807	937.22	< LOD	25.46	31.1	1.8			11582.3	298.2			1256.03	149.1	< LOD	120.2	1390.17	29.15	131.87	3.31
160	TP-FP-18(12-12.5)	2	264110	1190.99	< LOD	16.44	52.66	1.59			4698.25	288.14			< LOD	310.1	< LOD	73.53	1304.72	21.84	196.87	2.96
161	TP-FP-18-(0.6-0.8)	6.07	180919	1024.64	< LOD	24.79	48.26	2.22			7270.33	273.02			718.72	140.7	< LOD	147.49	2799.34	39.77	154.75	3.61
162	TP-FP-18-(2-2.3)	3.25	231660	1124.06	< LOD	18.38	57.71	1.86			4850.86	270.08			< LOD	286.71	< LOD	148.91	7023.79	59.75	167.86	3.05
163	TP-FP-18-(4-4.5)	3.09	246640	1133.78	< LOD	16.7	70.64	1.81			3765.52	270.13			< LOD	296.38	< LOD	99.15	3314.18	36.22	187.99	2.93
164	TP-FP-18A (4-4.5) DUP	3.22	270049	1197.48	< LOD	16.64	76.17	1.87			4498.89	274.29			311.6	149.22	< LOD	108.96	4271.23	41.75	195.3	2.98
165	TP-FP-18A (9-9.5)	2.71	254546	1154.25	< LOD	16.73	57.56	1.67			7818.66	309.1			< LOD	312.03	< LOD	95.91	2963.65	34.18	232.9	3.27
166	TP-FP-18A DUP-rep(4-4.5)	3.07	270512	1206.14	< LOD	16.88	73.59	1.87			4366.38	276.85			350.77	151.66	< LOD	110.68	4282.07	42.41	199.92	3.06
167	TP-FP-19(.5-.9)	5.99	107860	844.64	< LOD	25.5	48.38	2.17			8472.04	295.81			840.64	150.85	< LOD	151.02	3506.12	48.02	151.24	3.59
168	TP-FP-19(1.8-2.4)	3.18	208161	1045.01	< LOD	16.99	62.4	1.74			6557.07	289.07			570.91	153.83	< LOD	80.72	1743.4	25.78	196.92	3.03
169	TP-FP-19(1.8-2.4)CHECK	1.59	208886	520.17	< LOD	8.38	64.08	0.87			6595.14	143.47			521.05	75.97	< LOD	39.89	1734.75	12.75	191.81	1.49
170	TP-FP-19(3.9-4.6)	1.43	200681	524.24	< LOD	8.86	59.67	0.9			4935.32	138.41			856.2	77.98	< LOD	47.53	1834.03	13.43	186.6	1.54
171	TP-FP-19(4.9-5))	1.54	209788	521.25	< LOD	8.1	61.08	0.84			3445.98	130.93			< LOD	137.69	< LOD	56.36	4908.1	22.39	196.13	1.47
172	TP-FP-19(5-5.5)	1	262776	578.73	< LOD	8.22	98.87	1.05			3405.78	132.23			176.13	73.05	< LOD	46.42	2685.03	15.88	197.64	1.5
173	TP-FP-19(8-8.5)	1	314088	643.09	< LOD	8.29	132.64	1.22			7824.96	151.91			484.58	78.36	< LOD	37.12	1146.87	10.24	255.68	1.73
174	TP-FP-20(0.3-0.5)	1.67	174505	544.46	27.65	6.35	55.52	1.08			13129.7	166.48			1056.05	80.25	< LOD	80.97	5033.85	30.12	116.31	1.56
175	TP-FP-20(2.1-2.4)	2.54	220917	578.51	< LOD	11.14	56.86	1.11			6839.89	142.9			674.47	74.68	< LOD	80.47	4973.06	27.2	146.84	1.69
176	TP-FP-20(9.5-10)	1.39	218585	535.58	< LOD	9.02	60.1	0.92			6763.33	142.4			533.98	74.51	< LOD	48.8	2054.26	14.43	183.7	1.55
177	TP-FP-20(9.5-10)D	1.73	223311	560.58	< LOD	9.67	66.31	1.02			6422.73	143.32			565.68	75.53	< LOD	53.58	2160.46	15.51	215.45	1.77
178	TP-FP-20 (3.1-3.6)	2.08	137422	430.32	< LOD	10.43	42.24	0.93			5740.9	129.63			907.34	71.21	121.69	29.03	1844.85	14.91	184.35	1.74
179	TP-FP-20 (6-6.5)	1	231716	559.89	< LOD	8.46	58.72	0.85			6235.51	145.9			731.96	79.17	< LOD	39.77	1496.1	11.82	223.66	1.61
180	TP-FP-20 (8-8.5)	1.23	219259	550.45	< LOD	8.83	47.52	0.82			5447.81	142.21			448.68	76.48	< LOD	48.82	2334.3	15.51	216.51	1.66
181	TP-FP-20A (2.1-2.4)DUP	2.25	202769	564.44	< LOD	11.25	56.54	1.08			9304.64	149.95			719.26	74.76	< LOD	74.79	4045.88	24.65	141.63	1.65
182	TP-FP-21(1-1.3)	2.54	106119	416.18	< LOD	11.22	38.35	0.92			9298.72	147.91			743.08	73.69	75.89	33.26	3005.92	20.94	158.39	1.71
183	TP-FP-21(3-3.2)	1.79	194554	524.57	< LOD	9.26	46.53	0.84			4909.74	133.16			854.27	74.99	< LOD	49.41	2205.13	15.33	183.84	1.57
184	TP-FP-21 (6.5-7)	1	254413	570.04	< LOD	8.28	32.43	0.65			5091.92	141.39			337.48	76.06	< LOD	40.81	1754.78	12.61	202.85	1.48
185	TP-FP-21 (10-10.5)	1	262374	585.31	< LOD	8.13	35.41	0.67			3871.1	136.57			194.87	74.73	< LOD	40.55	1766.73	12.52	191.49	1.43
186	TP-FP-21A(2.8-3)	3.35	186017	522.04	< LOD	11.36	53.74	1.21			4387	133.02			641.01	73.56	169.47	47.17	6891.95	33.22	102.72	1.62
187	TP-FP-21A(3.4-3.7)	4.46	162394	540.14	54.88	7.28	27.65	1.27			5244.08	139.42			896.21	76.87	329.55	47.1	2986.91	22.35	63.44	1.7

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
188	TP-FP-21A(3.4-3.7)	4.65	164004	540.71	50.49	7.34	24.99	1.26			5159.65	139.76			771.16	76.21	266.45	47.79	3018.25	22.64	66.66	1.73
189	TP-FP-21A(4.7-4.8)	1	254002	582.59	< LOD	8.28	37.73	0.7			5938.39	150.36			387	80.02	< LOD	42.39	2009.05	13.74	189.66	1.46
190	TP-FP-22 (0.1-0.3)	2.63	161374	484.04	< LOD	11.3	39.66	0.92			11493	153.19			1069.96	75.73	86.64	26.47	1127.01	12.58	122.12	1.53
191	TP-FP-22 (0.4-1.2)	1	245923	557.93	< LOD	7.76	49.84	0.75			2041.31	126.02			< LOD	136.39	< LOD	26.49	200.2	4.54	183.5	1.38
192	TP-FP-22 (0.7-1.2)	2.22	219809	600.36	< LOD	10.24	64.36	1.02			10304	156.71			676.75	77.21	< LOD	62.28	3334.75	21.05	113.02	1.38
193	TP-FP-22 (2.0-2.3)	1	263869	595.03	< LOD	8.09	44.91	0.73			4337.55	148.9			< LOD	160.53	< LOD	27.48	258.17	5.11	195.84	1.45
194	TP-FP-22 (3.7-3.9)	1.56	235090	547.95	< LOD	8.34	40.2	0.71			5228.42	143.36			641.8	79	< LOD	29.34	308.63	5.58	191.47	1.46
195	TP-FP-22 (5.5-6)	1	248342	558.65	< LOD	7.81	35.86	0.65			3811.35	135.28			307.19	75.07	< LOD	26.2	181.82	4.3	191.93	1.38
196	TP-FP-22 (7.5-8)	1	256190	572.82	< LOD	7.97	65.52	0.85			3639.87	139.61			< LOD	153.3	< LOD	26.44	170.7	4.31	188.77	1.42
197	TP-FP-22 (9-9.5)	1	249027	565.22	< LOD	7.97	37.34	0.67			3301.22	140.78			< LOD	152.83	< LOD	27.05	224.42	4.8	199.75	1.45
198	TP-FP-22A DUP(0.7-1.2)	2.25	223527	603.1	< LOD	10.29	63.21	1.02			8684.38	150.79			869.63	77.79	< LOD	62.3	3290.6	20.93	105.87	1.35
199	TP-FP-25(4.3-4.5)	1.53	277412	595.72	< LOD	8.17	58.87	0.82			4120.94	136.25			425.34	75.63	< LOD	32.17	669.91	7.76	208.21	1.5
200	TP-FP-25(6-6.2)	1	252152	571.79	< LOD	8.3	49.74	0.77			4332.68	135.24			475.37	74.95	< LOD	47.3	2848.63	16.48	188.27	1.45
201	TP-FP-25(7.5-8)	1	266928	587.63	< LOD	8.05	44.45	0.72			4261.34	139.88			< LOD	150.94	< LOD	35.76	1173.22	10.12	186.61	1.4
202	TP-FP-25(7.5-8)	1	267465	593.78	< LOD	8.18	46.1	0.74			4518.57	143.12			< LOD	153.21	< LOD	36.36	1191.17	10.35	187.39	1.43
203	TP-FP-25 (0.4-0.9)	2.36	160856	473.86	< LOD	10.87	44.78	0.92			10628.8	147.29			936.71	73.09	< LOD	47.01	764.61	10.1	122.75	1.48
204	TP-FP-25 (1.1-1.2)	1	59357.9	284.16	< LOD	7.36	61.81	0.81			237.58	97.9			< LOD	111.12	< LOD	45.97	3226.14	16.96	90	1.02
205	TP-FP-25 (1.7-2.1)	1	246248	555.25	< LOD	7.63	47.47	0.71			3305.64	137.16			< LOD	150.89	< LOD	26.31	288.18	5.07	195.97	1.37
206	TP-FP-25 (10-10)	1.16	249624	569.74	< LOD	8.32	41.48	0.72			4988.41	141.99			161.51	75.41	< LOD	34.67	898.09	9.08	183.22	1.43
207	TP-FP-25A(1.3-1.8)	2.13	160017	540.77	< LOD	10.53	65.05	1.06			9143.3	148.78			924	76.24	< LOD	59.25	2644.2	18.8	116.14	1.43
208	TP-FP-25A(1.3-1.8)DUP	1.65	209995	592.26	< LOD	10.77	64.01	1.07			10109.3	154.44			1016.4	78.4	63.6	30.73	2606.16	18.99	103.48	1.39
209	TP-FP-26(4-4.5)	2.11	183765	523.06	< LOD	11.07	48.45	1			9926.98	146.52			1128.65	74.92	< LOD	78.91	5181.1	28.66	175.21	1.79
210	TP-FP-26(6-6.5)	2.63	198279	538.41	< LOD	10.56	44.45	0.92			9443.12	152.45			914.89	77.37	< LOD	72.52	4992.99	26.81	184.86	1.75
211	TP-FP-26(9-9.5)	1.87	169349	494.7	< LOD	11.09	48.95	0.98			9660.93	151.32			946.42	76.61	149.13	46.21	8151.57	38.52	169.29	1.74
212	TP-FP-26 (0.7-1)	2.77	98683.1	389.54	21.37	6.45	41.92	0.99			10455.7	147.84			1183.05	74.74	< LOD	60.45	1799.31	16.86	146.43	1.74
213	TP-FP-26 (1.8-2)	1.98	129827	435.46	< LOD	11.2	41.39	0.94			8847.14	136.02			945.08	69.41	< LOD	60.62	2218.38	17.67	155.13	1.69
214	TP-FP-27(4-5.2)	1	271145	597.01	< LOD	8.57	96.72	1.07			4709.06	132.78			229.33	70.82	< LOD	32.32	528.63	7.28	216.38	1.62
215	TP-FP-27 (0-0.4)	2.39	197850	554.51	< LOD	11.72	81.26	1.2			10805.5	154.78			1166.92	78.31	< LOD	73.29	4946.57	27.9	156.25	1.68
216	TP-FP-27 (0.5-0.8)	1.95	179326	558.67	13.56	6.18	57.72	1.09			12426.5	162.89			1496.61	82.48	< LOD	86.49	6577.81	34.88	124.04	1.58
217	TP-FP-27 (0.9-1.2)	1.88	113629	429.47	< LOD	10.84	46.95	0.96			9246.64	149.1			818.83	75.29	< LOD	52.57	1198.22	12.47	113.77	1.44
218	TP-FP-27A(0.5-0.8) DUP	1.93	163876	528.19	13.38	6.22	58.73	1.1			10975.2	155.21			1146.97	78.14	< LOD	87.59	6700.53	35.43	105.17	1.48
219	TP-FP-31(1-1.8)	1	204888	519.57	< LOD	8.11	45.84	0.74			6716.11	152.49			175.01	78.49	< LOD	26.99	164.56	4.31	206.38	1.49
220	TP-FP-31(2-2.75)	1.56	199204	516.88	< LOD	8.46	60.88	0.86			5119	140.99			747.89	78.77	< LOD	29.12	265.33	5.34	188.76	1.48
221	TP-FP-31(4.5-5)	1	246628	572.28	< LOD	7.95	65.67	0.85			4897.99	143.94			< LOD	152.96	< LOD	41.91	2197.5	14.07	194.95	1.45
222	TP-FP-31(6.5-7)	1	236463	561.31	< LOD	7.98	61.02	0.82			4720.67	141.8			285.6	76.92	< LOD	38.57	1738.68	12.4	194.22	1.44
223	TP-FP-31(7-7.5)	1.01	212628	523.53	< LOD	7.25	57.32	0.76			2401.23	134.61			< LOD	144.86	< LOD	31.13	957.84	8.66	171.2	1.27
224	TP-FP-31(9-9.5)	1	223515	531.6	< LOD	8.56	55.96	0.83			4591.08	131.36			305.57	70.9	< LOD	35.74	933.07	9.41	198.42	1.53
225	TP-FP-31 REP(9-9.5)	1	225957	537.92	< LOD	8.68	58.99	0.87			4766.11	133.5			353.89	72.05	< LOD	36.42	942.84	9.58	196.77	1.54
226	TP-FP-32(0-0.4)	2.25	105569	402.47	< LOD	10.64	45.6	0.92			9069.22	144.07			661.27	71.69	< LOD	49.66	1304.72	13.12	99.19	1.34
227	TP-FP-32(1.3-1.4)	1.48	105965	407.53	< LOD	10.64	44.51	0.91			6885.13	130.36			478.54	66.56	< LOD	48.65	1175.81	12.33	104.49	1.36
228	TP-FP-32(1.4-1.5)	1	160242	471.74	< LOD	7.92	55.13	0.8			2380.23	119.55			< LOD	130.15	< LOD	42.34	2140.04	13.8	118.95	1.17
229	TP-FP-32(2.4-2.7)	1	199076	509.06	< LOD	8.33	41.7	0.72			5926.56	141.81			453.36	75.55	< LOD	27.86	216	4.82	187.22	1.44
230	TP-FP-32(7-7.5)	1	245746	573.03	< LOD	8.28	40.17	0.71			10550.7	164.67			424.89	81.06	< LOD	37.44	1376.75	11.24	234.12	1.61
231	TP-FP-32(8.5-9)	1	290125	610.08	< LOD	7.8	66.28	0.84			3798.05	136.56			< LOD	148.07	< LOD	32.24	896.35	8.65	219.27	1.49
232	TP-FP-32(10.5-11)	1.11	273567	606.41	< LOD	8.35	56.1	0.82			7643.26	153.5			480.36	79.45	< LOD	36.43	1255.11	10.76	199.79	1.5
233	TP-FP-33(0-0.5)	2.14	193206	557.07	< LOD	12.84	64.33	1.18			9794.17	152.23			995.86	77.05	< LOD	82.16	5069.17	30.67	108.51	1.57

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
234	TP-FP-33(2.3-2.6)	1	252113	564.07	< LOD	8.08	46.47	0.73			10772.9	164.09			515.4	81.09	< LOD	29.05	367.91	5.85	197.02	1.44
235	TP-FP-33(3.5-4)	1	246078	564.02	< LOD	8.24	50.14	0.78			6524.28	144.35			523.22	76.51	< LOD	47.48	2991.06	16.81	196.18	1.47
236	TP-FP-33(5.9-6.2)	1	244368	564.87	< LOD	8.34	61.13	0.85			5956.02	142.94			314.81	75.24	< LOD	45.62	2622.56	15.81	189.18	1.46
237	TP-FP-33(8-8.5)	1.52	266160	595.17	< LOD	8.46	55.37	0.83			5795.81	143.99			398.12	76.48	< LOD	43.16	2000.79	13.79	206.02	1.54
238	TP-FP-34(0-0.6)	0.74	269661	587.17	< LOD	7.63	66.51	0.83			2955.94	129.28			< LOD	143.45	< LOD	27.56	342.26	5.51	236.78	1.54
239	TP-FP-34(1.2-1.7)	1	299371	622.2	< LOD	7.94	58.69	0.8			4458.97	136.45			< LOD	146.46	< LOD	28.3	237.11	4.85	246.85	1.6
240	TP-FP-34(3.5-4)	1	265876	592.25	< LOD	8.02	62	0.83			4841.27	141.21			< LOD	150.49	< LOD	28.99	365.3	5.86	186.16	1.42
241	TP-FP-34(6-6.3)	1	254298	569.58	< LOD	7.79	56.46	0.78			4190.33	134.25			< LOD	144.47	< LOD	28.65	384.56	5.88	184.44	1.38
242	TP-FP-34(7.5-8)	1.13	250986	579.83	< LOD	9.2	62.9	0.93			9003.98	146.14			475.96	72.44	< LOD	34.51	351.8	6.34	183.81	1.56
243	TP-FP-34(8.5-9)	1	271375	603.75	< LOD	8.47	67.93	0.91			5331.77	138.32			288.82	73.39	< LOD	30.64	299.62	5.63	155.52	1.37
244	TP-FP-34(10-10.5)	1	249611	564.53	< LOD	8.25	49.73	0.77			5125.27	135.35			< LOD	142.02	< LOD	31.93	538.89	7.11	178.06	1.4
245	TP-FP-34(12.5-13)	1	277539	609.78	< LOD	8.33	59.08	0.84			5096.77	140.5			< LOD	147.95	< LOD	32.64	685.5	8.04	179.55	1.43
246	TP-FP-34 REP(10-10.5)REP	1	251378	566.62	< LOD	8.4	50.14	0.79			5369.19	137.82			< LOD	143.77	< LOD	31.79	548.54	7.27	176.47	1.42
247	TP-FP-35(0.5-0.7)	1	290017	609.44	< LOD	7.56	75.69	0.87			2290.72	130.16			< LOD	141.1	< LOD	27.02	297.34	5.17	229.43	1.51
248	TP-FP-35(2.3-2.8)	1	165781	470.39	< LOD	7.64	61.21	0.8			3740.85	136.42			< LOD	145.28	< LOD	26.22	211.77	4.51	207.62	1.43
249	TP-FP-35(4-4.3)	2.19	85008.3	393.09	< LOD	11.01	52.26	1.01			10868.1	153.62			796.31	75.16	< LOD	47.29	625.93	9.45	121.72	1.51
250	TP-FP-35(6-6.4)	1.12	199068	520.98	< LOD	9.15	50.13	0.85			4927.89	133.67			355.41	71.7	< LOD	33.8	235.62	5.36	189.21	1.59
251	TP-FP-35(8.5-9)	1	233654	550.16	< LOD	8.36	44.91	0.75			10172.5	156.28			843.28	79.37	< LOD	35.72	1066.63	9.89	196.92	1.49
252	TP-FP-35(9-9.8)	1	230170	554.04	< LOD	8.76	48.02	0.8			16176.3	175.54			919	82.72	< LOD	42.07	1822.61	13.45	209.17	1.59
253	TP-FP-35(12.5-13)	1	239062	554.31	< LOD	8.43	51.72	0.79			8079.53	147.98			356.7	74.78	< LOD	34.62	792.07	8.55	190.93	1.47
254	TP-FP-35A(4-4.3)DUP	2.61	84754.2	407.16	< LOD	11.49	56.32	1.06			10197.5	154.34			899.08	77.07	65.08	26.57	930.91	11.67	112.8	1.51
255	TP-FP-35A(8.5-9)	1	247153	561.41	< LOD	7.71	60.61	0.81			5986.66	149.28			< LOD	149.22	< LOD	36.71	1536.88	11.42	216.14	1.49
256	TP-FP-36(1-1.5)	1.3	248881	584.04	< LOD	9.26	53.47	0.88			6624.19	139.7			526.61	73.1	74.34	18.97	449.5	7.08	208.77	1.67
257	TP-FP-36(3.5-4)	1	258482	571.17	< LOD	8.24	61.54	0.85			6564.92	144.23			277.88	74.61	< LOD	40.49	1755.23	12.68	222.9	1.57
258	TP-FP-36(6.5-7)	1	263675	591.65	< LOD	8.47	67.87	0.9			6106.22	146.37			204.57	75.87	< LOD	36.18	909.51	9.29	216.24	1.59
259	TP-FP-36(9.5-10)	1	263133	585.03	< LOD	8.37	57.38	0.83			8939.33	157.64			244.58	77.99	< LOD	32.48	667.73	7.88	190.3	1.47
260	TP-FP-36(10-10.5)	1	259065	588.55	< LOD	8.53	61.34	0.87			5726.16	146.56			285.7	77.37	< LOD	34.03	741.06	8.48	201.68	1.54
261	TP-FP-37(0.5-1)	1.56	152971	451.45	< LOD	10.19	46.03	0.9			9127.76	147.84			976.13	75.89	< LOD	43.72	638.29	8.86	178.89	1.68
262	TP-FP-37(2.5-3)	1.44	137694	455.81	< LOD	9.74	46.1	0.87			9112.33	149.63			954.42	77.07	49.9	20	409.91	7.03	149.47	1.48
263	TP-FP-37(4.5-5)	1.48	199258	509.94	< LOD	9.24	50.87	0.87			4976.3	131.52			488.06	71.27	< LOD	43.66	957.87	9.91	170.72	1.52
264	TP-FP-37(7.5-8)	1.88	229872	554.23	< LOD	9.03	66.14	0.94			10135	155.58			573.94	76.8	< LOD	47.36	2224.43	15.21	167.5	1.48
265	TP-FP-37(9.5-10)	1.71	252872	586.35	< LOD	8.9	60.19	0.89			8784.21	152.44			727.25	78.19	< LOD	48.29	2527.12	16.26	189.02	1.54
266	TP-FP-37(11.5-12)	1.46	272910	608.99	< LOD	8.54	75.96	0.96			5574.57	143.83			348.22	76.54	< LOD	43.82	2134.38	14.46	209.82	1.58
267	TP-FP-37 REP(7.5-8)REP	1.61	232534	562.86	< LOD	8.99	64.54	0.93			10483.5	155.51			710.46	77.31	< LOD	46.89	2245.86	15.2	167.8	1.47
268	TP-FP-38(2-2.5)	1	264926	587.63	< LOD	7.93	45.85	0.72			4827.26	141.55			< LOD	149.31	< LOD	35.69	1310.54	10.63	195.33	1.43
269	TP-FP-38(5-5.4)	1.38	271916	591.96	< LOD	8.34	57.81	0.83			6293.51	144.24			351.42	75.44	< LOD	42.03	2195.63	14.34	196.56	1.48
270	TP-FP-38(7.5-8)	1	248738	572.74	< LOD	8.62	104.26	1.11			13958.3	171.93			957.4	83.52	< LOD	47.83	2812.65	16.86	198.34	1.56
271	TP-FP-38(9.5-10)	1	251258	566.5	< LOD	8.21	62.57	0.85			6799.85	144.74			460.19	75.72	< LOD	39.1	1677.55	12.32	189.93	1.45
272	TP-FP-38(11.5-12)	1	222554	553.15	< LOD	8.55	76.71	0.97			7578.56	152.29			558.95	79.23	< LOD	39.41	1470.61	11.95	206.66	1.58
273	TP-FP-38(14.5-15)	1	254616	587.14	< LOD	7.81	90.07	0.97			2286.82	135.11			< LOD	148.05	< LOD	26.7	198.78	4.51	227.83	1.55
274	TP-FP-38A(0.5-1)	2.74	232127	592.62	< LOD	11.07	49.91	1.07			5553.88	141.76			783.24	77.27	< LOD	95.02	8625.54	38.02	162.43	1.77
275	TP-FP-38A(0.5-1)DUP	2.71	231227	592.36	< LOD	10.99	53.73	1.09			4679.42	137.93			880.29	77.9	< LOD	93.31	8509.85	37.42	159.3	1.75
276	TP-FP-38A(1-1.5)	2.52	231867	609.75	< LOD	10.54	33.08	0.9			4311.97	138.1			446	75.56	< LOD	75.77	4778.14	25.09	142.86	1.59
277	TP-FP-38A(2.5-3)	5.32	62481.5	339.05	68.57	7.97	30.12	1.45			3400.49	121.6			592.22	69.06	378.46	53.39	3255.44	25.42	91.79	2.08
278	TP-FP-38A(4.5-5)	1.07	240597	565.41	< LOD	8.66	92.85	1.06			8313.51	147.97			716.94	76.54	< LOD	44.97	1977.51	13.79	198.93	1.56
279	TP-FP-38B(0.5-1)	1.77	143052	440.23	< LOD	10.56	41.19	0.9			9100.01	143.38			714.82	71.49	47.48	22.65	497.5	8.11	202.97	1.83

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
280	TP-FP-39(0.9-1.6)	1	301565	633.58	< LOD	7.94	54.24	0.78			3437.82	138.15			< LOD	149.98	< LOD	26.43	150	4.09	214.86	1.49
281	TP-FP-39(3.5-4.2)	1	307328	639.02	< LOD	7.98	110.24	1.08			3315.66	137.65			< LOD	151.46	< LOD	28.98	395	6.07	200.62	1.48
282	TP-FP-39(12.5-13)	1	270837	584.09	< LOD	8.06	80.98	0.94			4713.04	139.8			< LOD	145.3	< LOD	27.3	208.72	4.68	195.57	1.46
283	TP-FP-39A(6-6.5)	1.75	281325	643.5	< LOD	9.31	111.46	1.22			11782.1	160.36			1048.2	80.23	< LOD	34.04	359.1	6.52	203.72	1.67
284	TP-FP-39A(9.5-10)	1.6	308283	645.38	< LOD	8.49	127.61	1.22			6759.04	149.34			268.53	77.07	< LOD	29.7	228.75	5.09	210.83	1.6
285	TP-FP-39A REP(9.5-10)	1	309319	641.25	< LOD	8.4	129.09	1.21			6967.74	148.95			322.03	76.93	< LOD	29.2	231.98	5.06	209.37	1.58
286	TP-FP-39DUP(0.9-1.6)	1	310249	638.25	< LOD	7.78	61.59	0.81			3159.88	136.82			< LOD	149.02	< LOD	25.56	143.81	3.96	207.1	1.45
287	TP-FP-40(0-0.5)	1.03	291579	609.3	< LOD	7.7	69.64	0.86			3765.21	134.35			< LOD	142.33	< LOD	28.2	381.05	5.82	205.69	1.45
288	TP-FP-40(1.5-2)	1	249593	558.4	< LOD	8.02	49.03	0.75			7163.77	149.31			< LOD	150.4	< LOD	28.44	299.52	5.38	174.65	1.36
289	TP-FP-40(3.5-3.8)	1	243515	559.24	< LOD	8.32	50.04	0.78			7143.51	143.95			< LOD	145.09	< LOD	29.52	340.12	5.83	193.73	1.48
290	TP-FP-40(6-6.2)	1.04	251770	582.69	< LOD	9.23	75.85	1.01			12775.3	158.93			962.69	77.61	< LOD	34.19	340.53	6.3	205.26	1.66
291	TP-FP-40(6.5-6.8)	1	283867	596.6	< LOD	8.17	86.2	0.99			5626.49	139.16			257.82	73.09	< LOD	30.57	422.71	6.53	173.63	1.42
292	TP-FP-40(8.5-9)	1	241193	559.35	< LOD	8.67	77.25	0.98			9116.51	147.51			270.09	72.07	< LOD	29.65	142.41	4.31	162.9	1.42
293	TP-FP-40(13-13.5)	1.67	251559	591.39	< LOD	9.46	81.69	1.06			12740.1	157.33			733.78	75.29	45.64	16.66	138.7	4.58	173.66	1.56
294	TP-FP-40(14.5-15)	1	249798	566.32	< LOD	8.28	58.43	0.83			3781.64	134.86			290.99	74.52	< LOD	35.03	939.13	9.32	184.6	1.44
295	TP-FP-40A(8.5-9)	1.65	248357	567.11	< LOD	8.7	86.34	1.03			8931.46	146.31			482.95	73.02	< LOD	29.44	152.18	4.42	166.47	1.44
296	TP-FP-41(0.3-0.7)	1.37	134254	414.94	< LOD	9.68	34.95	0.77			8810	137.35			372.91	66.89	47.86	19.72	462.6	7.42	124.27	1.36
297	TP-FP-41(0.5-0.8)	1.48	217659	597.04	< LOD	10.33	67.22	1.04			9722.51	152.23			800.03	76.48	< LOD	62.9	3449.56	21.44	101.63	1.32
298	TP-FP-41(2-2.5)	1.13	208249	525.62	< LOD	9.29	43.61	0.81			8257.22	147.3			633.08	75.18	< LOD	33.16	256.89	5.62	189	1.59
299	TP-FP-41(4-4.5)	1	196762	494.46	< LOD	8.21	43.12	0.73			2985.27	120.37			< LOD	130.93	< LOD	30.95	487.1	6.74	164.56	1.35
300	TP-FP-41(5.5-6)	1	182201	483.64	< LOD	8.52	52.1	0.82			3672.06	121.16			236.91	66.44	< LOD	31.13	434.5	6.65	130.01	1.27
301	TP-FP-41(8.5-9)	1	215508	527.18	< LOD	8.42	53.47	0.81			6356.41	140.96			477.97	74.38	< LOD	30.14	366.5	6.1	191.42	1.49
302	TP-FP-41(10.5-11)	1	244429	556.27	< LOD	8.21	65.71	0.87			6949.54	147.44			320.32	76.08	< LOD	30.09	398.25	6.19	190.85	1.46
303	TP-FP-42(0.5-1)	1.2	230490	601.37	< LOD	10.1	58	0.98			9546.72	150.51			750.96	75.5	< LOD	66.01	4124.95	23.36	130.27	1.45
304	TP-FP-42(2-2.6)	1	225338	541.16	< LOD	8.26	65.18	0.87			4917.92	142.25			608.04	78.77	< LOD	36.8	1257.84	10.72	173.22	1.4
305	TP-FP-42(4.2-4.8)	1	246093	564.18	< LOD	8.25	60.24	0.84			6893.36	147.02			346.97	76.07	< LOD	33.74	856.71	8.84	199.35	1.49
306	TP-FP-42(4.8-5.2)	1	252420	576.84	< LOD	7.54	62.6	0.81			2353.88	136.37			< LOD	146.59	< LOD	34.27	1229.38	10.1	215.49	1.47
307	TP-FP-42(6-6.1)	1	244869	566.14	< LOD	8.4	61.41	0.85			7432.59	149.86			497.05	77.74	< LOD	34.41	943.6	9.31	209.52	1.54
308	TP-FP-42(6.6-7)	1	250002	568.66	< LOD	8.33	54.1	0.8			9244.79	157.19			318.5	77.83	< LOD	38.56	1445.77	11.53	203.44	1.51
309	TP-FP-42(10-10.5)	1	235802	561	< LOD	8.77	92.64	1.06			12235	160.5			937.37	79.21	< LOD	39.84	1502.32	12.17	194.23	1.56
310	TP-FP-42(12-12.5)	1	260778	583.29	< LOD	8.37	56.5	0.82			5264.44	139.62			275.25	74.27	< LOD	32.21	639.26	7.74	195.34	1.49
311	TP-FP-42(15.6-16)	1	286880	614.37	< LOD	8.32	76.18	0.94			5553.73	142.87			192.35	75.04	< LOD	31.24	496.41	6.88	206.83	1.54
312	TP-FP-42 REP(2-2.6)REP	1	222118	535.71	< LOD	8.37	55.24	0.82			5231.03	139.61			498.44	75.85	< LOD	37.29	1323.82	11.08	189.25	1.47
313	TP-FP-42A(0.5-0.8)	1.35	171931	471.27	< LOD	9.07	49.39	0.85			7344.61	139.07			246.48	69.53	< LOD	39.04	510.71	7.36	144.76	1.4
314	TP-FP-43(1.2-1.4)	1.37	174556	481.84	< LOD	9.78	48.61	0.89			8333.75	144.46			893.54	74.87	< LOD	48.06	1795.01	14.37	180.43	1.62
315	TP-FP-43(4-4.3)	1.51	211200	547.05	< LOD	9.21	43.25	0.8			19542.2	182.39			974.48	83.26	< LOD	51.8	2989.52	18.34	184.55	1.56
316	TP-FP-43(6-6.5)	1.63	240963	595.37	< LOD	8.72	66.45	0.91			6848.65	145.75			383.21	75.65	< LOD	40.66	1652.89	12.77	209.72	1.6
317	TP-FP-43(9-9.5)	1.13	238538	560.93	< LOD	8.38	59.7	0.85			6286.46	141.75			271.17	73.64	< LOD	38.57	1520.15	11.9	202.75	1.52
318	TP-FP-43(11-11.5)	1	243031	554.13	< LOD	7.9	127.82	1.15			5532.83	140.86			< LOD	146.97	< LOD	30.18	577.72	7.08	186.15	1.42
319	TP-FP-44(0-0.7)	5.53	243285	643.69	80.43	8.14	30.94	1.52			5678.99	146.02			953.48	79.69	377.19	66.56	8917.43	46.91	102.28	2.2
320	TP-FP-44(0.7-1)	1.79	193590	513.48	< LOD	8.85	61.81	0.91			3457.75	127.37			359.37	71.35	< LOD	91.01	12487.33	43.68	187.4	1.56
321	TP-FP-44(2-2.5)	0.81	273491	595.2	< LOD	8.54	58.79	0.85			6076.58	144.93			675.85	78.3	< LOD	56.13	4406.55	21.68	207.94	1.55
322	TP-FP-44(2.5-3)	1	257644	571.49	< LOD	8.07	58.4	0.81			3518.8	129.66			< LOD	141.4	< LOD	31.45	604.69	7.35	199.72	1.47
323	TP-FP-44(4-4.5)	1	281662	600.04	< LOD	8.42	56.95	0.83			8298.36	151.38			989.11	80.16	< LOD	48.42	3060.77	17.38	219	1.58
324	TP-FP-44(6-6.5)	1.79	195021	517.89	< LOD	9.52	70.35	1			10872	149.48			861.67	73.93	< LOD	50.42	2539.35	17.11	202.62	1.68
325	TP-FP-44(11.5-12)	1	183689	490.6	< LOD	8.18	63.74	0.86			5995.24	145.43			< LOD	150.71	< LOD	36.53	1310.08	10.91	172.04	1.39

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
326	TP-FP-44(13-13)	1.23	271509	585.32	< LOD	8.13	55.06	0.79			4426.53	135.83			175.77	73.03	< LOD	37.32	1446.17	11.26	228.45	1.56
327	TP-FP-44A(0-0.7)	4.93	209068	577.44	53.29	7.56	36.01	1.42			6108.55	142.84			1099.78	78.35	271.11	56.8	6228.06	35.57	122.47	2.14
328	TP-FP-44A(8-8.5)	1	102934	378.58	< LOD	8.34	48.03	0.77			5098.48	135.66			189.52	71.67	< LOD	43.01	2062.66	13.95	197.27	1.5
329	TP-FP-44A REP(8-8.5)REP	1	77453.9	327.5	< LOD	8.23	47.68	0.76			4223.53	132.15			< LOD	141.22	< LOD	42.18	2017.23	13.7	191.16	1.47
330	TP-FP-45(0.5-1)	5.53	229007	636	71.11	7.97	30.03	1.49			6250.33	151.24			1128.77	82.7	< LOD	151.26	14798.24	65.63	90.18	2.11
331	TP-FP-45(1.2-1.6)	1.61	279246	630.09	< LOD	9.42	23.97	0.7			2019.05	122.55			231.74	70.83	< LOD	59.1	3264.95	19.18	123.22	1.34
332	TP-FP-45(1.6-1.8)	5.9	275866	704.23	85.01	8.55	30.28	1.61			4980.49	147.22			994.67	82.64	< LOD	189.58	24097	99.99	79.82	2.19
333	TP-FP-45(1.8-2)	6.43	250303	665.97	82.19	8.65	24.35	1.64			4962.61	142.72			1047.99	80.63	492.12	73.88	10500.42	54.3	75.03	2.26
334	TP-FP-45(2-2.3)	1.45	139544	425.98	< LOD	7.92	62.67	0.84			3540.63	126.56			< LOD	134.19	< LOD	77.67	10357.12	35.46	187.3	1.43
335	TP-FP-45(3.5-4)	1.24	224720	545.47	< LOD	8.44	52.41	0.81			6333.33	145.21			431.89	76.49	< LOD	61.81	5586.51	24.86	176.27	1.44
336	TP-FP-45(7.5-8)	1	239247	563.76	< LOD	8.6	46.88	0.79			5555.27	147.82			375.26	78.92	< LOD	48.71	2873.89	17.07	175.78	1.45
337	TP-FP-45(10.5-11)	2.38	238435	579.77	< LOD	9.54	45.58	0.87			4785.5	137.13			490.74	74.67	< LOD	69.82	5586.82	26.46	168.68	1.56
338	TP-FP-45(13.5-14)	1.61	221392	540.48	< LOD	8.63	48.38	0.8			7712.11	146.71			182.44	73.23	< LOD	52.78	3425.21	18.7	177.25	1.46
339	TP-FP-45A(0.5-1)	5.08	208112	599.91	76.89	7.84	45.28	1.53			4426.28	138.01			1107.65	80.27	218.26	71.15	12953.72	60.13	79.31	1.96
340	TP-FP-45A(0.8-1.2)	0.83	240309	567.58	< LOD	8.35	78.49	0.96			5476.91	142.05			< LOD	145.66	< LOD	38.61	1330.05	11.19	183.13	1.47
341	TP-FP-45A(3-3.5)	1	238286	557.94	< LOD	8.46	48.9	0.78			12545.5	169.73			413.6	80.92	< LOD	35.77	1106.65	10.16	190.14	1.47
342	TP-FP-45A(5-6)	1.74	237795	559.91	< LOD	8.37	60.61	0.86			3422.77	126.45			< LOD	133.79	< LOD	51.84	3458.63	18.52	205.75	1.54
343	TP-FP-45A(5.5-6)	1	238711	559.2	< LOD	8.43	45.55	0.76			9682.34	156.28			520.57	78.06	< LOD	38.31	1398.05	11.44	205.78	1.53
344	TP-FP-45A(9-9.5)	1.68	295212	637.71	< LOD	8.8	82.69	1.02			8089.8	155.17			649.57	80.38	< LOD	37.62	987.72	9.96	210.83	1.62
345	TP-FP-45A(11-11.5)	1	285706	614.21	< LOD	8.14	63.75	0.85			5437.6	142.19			379.89	76.33	< LOD	30.84	544.95	7.02	206.36	1.49
346	TP-FP-45A(13.5-14)	1	248107	561.6	< LOD	8.07	54.82	0.79			3603.82	131.23			< LOD	143.49	< LOD	29.6	430.8	6.31	172.79	1.36
347	TP-FP-45A REP(13.5-14)REP	1	254925	565.84	< LOD	7.86	59.11	0.8			3509.33	132.05			< LOD	143.41	< LOD	29.01	444.33	6.24	190.12	1.4
348	TP-FP-46(1-1.5)	0.86	270059	587.24	< LOD	7.8	76.7	0.9			3881.05	135.82			< LOD	144.24	< LOD	28.21	447.75	6.3	242.11	1.59
349	TP-FP-46(3-3.5)	1	265393	585.24	< LOD	8.24	50.47	0.78			6051.18	145.36			236.56	75.92	< LOD	34.25	953.09	9.31	193.31	1.46
350	TP-FP-46(6-6.5)	0.76	191627	501.39	< LOD	8.1	74.94	0.91			6864.2	144.8			247.54	74.42	< LOD	36.5	1371.97	11.02	216.91	1.54
351	TP-FP-46(8.5-9)	1	263023	590.88	< LOD	8.31	52.03	0.79			5310.39	143.85			< LOD	151.12	< LOD	36.94	1274.68	10.86	188.22	1.46
352	TP-FP-46(11-11.5)	1.29	248413	568.19	< LOD	8.49	60.67	0.86			8615.68	152.48			350.06	76.41	< LOD	41.14	1886.36	13.43	211.54	1.57
353	TP-FP-47(0.1-0.3)	1.21	166998	476.32	< LOD	10.26	43.95	0.89			8962.92	148.82			702.91	74.87	88.23	25.81	1615.89	14.07	165.93	1.63
354	TP-FP-47(2-2.5)	1	252889	572.35	< LOD	8.27	57.96	0.83			5492.28	144.74			< LOD	151.3	< LOD	41.64	2003.85	13.69	197.87	1.49
355	TP-FP-47(3.5-4.0)	0.82	240907	571.92	< LOD	8.76	56.78	0.85			7319.43	149.52			533.97	77.86	< LOD	46.79	2605.34	16.33	173.61	1.45
356	TP-FP-47(5.5-6)	1	290753	612.28	< LOD	7.89	84.07	0.95			2849.39	130.58			< LOD	140.19	< LOD	45.06	2665.44	15.58	187.11	1.42
357	TP-FP-47(6.5-7)	1.43	239466	555.4	< LOD	8.84	51.76	0.82			7400.41	142.5			390.87	72.68	< LOD	40.86	1612.92	12.68	189.13	1.52
358	TP-FP-47A(0.1-0.3)DUP	2.5	147955	446.36	< LOD	10.62	39.16	0.88			10406.8	150.11			1089.2	75.93	< LOD	47.17	718.94	9.6	170.52	1.68
359	TP-FP-48(0-0.4)	2.02	192185	530.11	< LOD	10.63	42.06	0.88			9808.8	152.45			666.85	75.26	< LOD	68.31	4489.57	25.62	142.92	1.54
360	TP-FP-48(1.5-2)	1.97	194287	547.17	< LOD	10.17	41.9	0.85			10456.7	152.87			765.46	75.5	< LOD	63.41	4127.07	23.5	137.94	1.46
361	TP-FP-48(2.5-3)	1.14	179449	496.35	< LOD	8.8	67.97	0.94			5316.22	134.15			516.2	72.59	< LOD	41.69	1432.85	11.88	166.33	1.46
362	TP-FP-48(3-3.5)	1.76	197875	521.63	< LOD	9.78	50.1	0.93			6073.31	141.51			610.83	75.34	68.92	23.59	899.04	10.04	185.99	1.67
363	TP-FP-48(6-6.5)	1.63	239726	565.72	< LOD	8.74	51.76	0.83			11310.1	164.5			666.47	80.71	< LOD	45.62	2215.32	14.93	194.34	1.54
364	TP-FP-48(8-8.5)	1.72	255756	586.35	< LOD	8.89	69.09	0.94			9072.29	155.11			917.24	80.42	< LOD	46.81	2379.94	15.71	187.75	1.54
365	TP-FP-48(10-10.5)	1	254183	577.03	< LOD	8.42	75.46	0.94			9538.17	155.99			468.42	77.71	< LOD	38.69	1405.48	11.45	173.92	1.43
366	TP-FP-48(13.5-14)	1	255038	580.58	< LOD	9.12	66.52	0.94			4549.5	130.08			439.85	71.01	< LOD	41.61	1490.92	12.46	165.02	1.47
367	TP-FP-48 REP(13.5-14)REP	1	262252	575.54	< LOD	8.36	52.63	0.8			4997.29	132.51			332.09	71.08	< LOD	36.67	1200.53	10.44	178.69	1.42
368	TP-FP-48A(1-1.5)	1.55	152024	454.9	< LOD	10.18	53.67	0.95			8855.61	142.12			853.9	72.52	< LOD	49.02	1298.64	12.47	146.86	1.53
369	TP-FP-49(0.7-1.2)	2.11	190704	533.25	< LOD	9.99	51.12	0.91			10439.7	153.43			973.24	77.26	< LOD	59.1	3452.56	20.91	145.73	1.49
370	TP-FP-49(1.7-2.4)	1.25	156237	448.49	< LOD	9.24	59.98	0.92			8460.06	142.68			378.03	70.61	< LOD	36.74	475.52	7.18	190.03	1.59
371	TP-FP-49(3-3.4)	1.48	193478	505.31	< LOD	9.26	55.51	0.9			6085.3	135.63			460.68	71.23	< LOD	42.24	858.29	9.35	220.61	1.71

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
372	TP-FP-49(5-5.5)	1.31	242746	581.13	< LOD	8.77	63.73	0.93			5578.55	144.5			< LOD	148.42	< LOD	69.23	6363.75	27.53	182.68	1.54
373	TP-FP-49(6.5-7)	1.52	241277	560.37	< LOD	8.59	49.06	0.79			8458.28	152.88			674.27	78.74	< LOD	40.13	1562.6	12.15	181.56	1.46
374	TP-FP-49(8.5-9)	1.6	250903	594.23	< LOD	8.97	68.89	0.98			7817.09	154.94			541.5	79.31	< LOD	44.63	1740.49	13.87	221.21	1.76
375	TP-FP-49A(1.7-2.4)DUP	2.04	212672	572.14	< LOD	9.62	52.03	0.88			8433.44	144.32			711.39	73.8	64.2	27.94	2964.75	18.53	126.02	1.35
376	TP-FP-49A(2.8-3.2)	1.38	166551	466.66	< LOD	9.17	41.79	0.8			4165.07	123.25			300.79	66.81	< LOD	37.75	469.33	7.06	223.1	1.7
377	TP-FP-50(0.8-1.2)	1.51	129188	444.07	< LOD	10.13	52.68	0.94			8829.24	145.68			621.99	72.97	56.2	21.28	521.7	8.1	112.29	1.37
378	TP-FP-50(1.6-2.2)	1.52	222633	603.87	< LOD	10.03	65.27	1.02			8839.9	151.15			456.97	74.89	< LOD	50.46	1676.91	14.08	123.8	1.41
379	TP-FP-50(3.5-4)	1	238248	552.63	< LOD	7.92	49.74	0.75			3934.66	132.54			< LOD	141.17	< LOD	32.28	772.02	8.21	184.55	1.4
380	TP-FP-50(5.5-6)	1	241803	570.16	< LOD	8.55	58.07	0.85			10028	151.9			870.54	77.38	< LOD	35.72	942.9	9.45	190.51	1.5
381	TP-FP-50(7.5-8)	1.45	234418	551.64	< LOD	8.44	66.87	0.89			6976.59	142.28			556.94	74.6	< LOD	33.48	520.59	7.08	191.86	1.49
382	TP-FP-50(9-10)	1	180810	504.34	< LOD	8.37	89.78	1.02			4583.39	139.64			253.28	75.47	43.87	16.22	448.77	6.68	243.93	1.69
383	TP-FP-50(11.5-12)	1.71	136560	440.15	< LOD	8.8	68.93	0.94			7936.24	148.38			535.98	76.13	< LOD	34.51	490.78	7.18	200.31	1.59
384	TP-FP-50A(0.5-1)	1.7	106295	386	< LOD	9.25	54.02	0.89			6576.3	137.62			495.26	71.67	< LOD	42.45	1199.36	11.22	165.8	1.5
385	TP-FP-50A(1-1.5)	1.3	110525	387.64	< LOD	8.87	55.55	0.86			12576.7	161.77			649.43	77.5	< LOD	42.69	1151.99	10.57	181.61	1.51
386	TP-FP-50A(1.6-2.2)	1.49	155898	528.44	< LOD	9.96	67.24	1.03			8400.59	148.57			587.82	75.22	< LOD	50.25	1731.76	14.45	118.38	1.39
387	TP-FP-50A(2.2-2.5)	1	279232	612.89	< LOD	8.05	71.1	0.89			4277.61	138.37			< LOD	149.38	< LOD	29.08	331.38	5.69	220.3	1.56
388	TP-FP-50A(2.3-2.5)	1	274003	594.99	< LOD	7.78	66.76	0.84			5000.44	138.92			< LOD	146.17	< LOD	27.89	306.16	5.35	191.56	1.41
389	TP-FP-50A(3.5-4)	1	260911	579.36	< LOD	8.01	39.75	0.69			5696.24	143.98			< LOD	149.82	< LOD	27.42	238.38	4.88	196.14	1.43
390	TP-FP-50A(3.5-4)DUP	1.23	256549	580.49	< LOD	8.37	57.81	0.83			10936	166.17			362.43	80.7	< LOD	29.15	281.9	5.4	194.71	1.49
391	TP-FP-50A(5-5.5)	1	262095	610.73	< LOD	8.96	76.42	1.01			8465.26	144.86			461.83	72.03	< LOD	30.29	149.82	4.58	159.19	1.48
392	TP-FP-50A(8.5-9)	1	271197	610.89	< LOD	8.75	78.91	0.98			7617.55	142.66			306.03	71.98	< LOD	27.86	69.53	3.47	181.57	1.5
393	TP-FP-50A REP(2.3-2.5)REP	1	276378	598.34	< LOD	7.77	66.99	0.84			5029.9	138.49			< LOD	145.3	< LOD	27.57	305.45	5.33	194.57	1.42
394	TP-FP-51(1.5-2)	1	289785	622.96	< LOD	8.94	105.08	1.15			9770.36	153.02			600.38	76.13	< LOD	30.3	181.82	4.8	171.99	1.5
395	TP-FP-51(3.5-4)	1	306406	643.6	< LOD	8.62	95.01	1.07			6676.32	146.12			338.05	75.66	< LOD	28.76	139.98	4.29	207.29	1.6
396	TP-FP-51(5.5-6)	1	313876	641.49	< LOD	8.55	91.85	1.04			6263.49	142.8			192.04	73.62	< LOD	29.38	143.52	4.28	202.98	1.55
397	TP-FP-51(7.5-8)	1.01	264773	610.39	< LOD	9.32	72.71	0.99			11226.1	153.09			879.48	75.71	< LOD	31.8	127.73	4.43	170.19	1.52
398	TP-FP-51(10-10.5)	1	270719	605.17	< LOD	9.02	82.6	1.04			8220.19	147.32			423.49	74.05	< LOD	30.05	135.91	4.4	167.83	1.49
399	TP-FP-51(11-11.5)	1	282371	610.69	< LOD	8.73	84.35	1.02			7151.44	142.24			317.53	72.29	< LOD	29.33	190.09	4.81	172.64	1.47
400	TP-FP-51(12-12.5)	1	272314	594.26	< LOD	8.52	92.42	1.05			8475.15	148.47			< LOD	145.25	< LOD	28.01	135.5	4.18	188.18	1.51
401	TP-FP-51A(2.5-3)	1.55	185250	495.4	< LOD	9.65	47.47	0.88			13070.7	164.16			698.85	77.84	89.83	20.81	409.84	6.97	173.76	1.58
402	TP-FP-51A(4.5-5)	1	268381	580.61	< LOD	8.16	59.05	0.82			4439.1	133.34			< LOD	141.5	< LOD	28.81	249.89	5.06	187.06	1.43
403	TP-FP-51A(6-6.2)	1	233080	549.78	< LOD	8.34	70.01	0.9			6033.02	141.86			246.81	73.94	< LOD	28.1	242.9	5.08	176.7	1.43
404	TP-FP-52(1-1.5)	1.05	271720	590.04	< LOD	7.8	65.77	0.86			2421.83	127.96			< LOD	137.25	< LOD	37.03	1109.43	9.63	215.61	1.51
405	TP-FP-52(2.7-3)	0.74	284159	614.28	< LOD	7.81	68.23	0.86			5307.5	147.72			< LOD	156.88	< LOD	34.38	1153.7	9.91	232.3	1.55
406	TP-FP-52(5-5.5)	1	166048	469.36	< LOD	9.89	42.83	0.83			4862.8	118.17			460.77	63.38	< LOD	32.92	281.27	6.13	154.64	1.52
407	TP-FP-52(7.5-8)	1	183469	485.2	< LOD	9.25	37.92	0.76			9931.49	150.83			481.22	73.56	< LOD	33.02	430.14	6.99	197.31	1.62
408	TP-FP-52(9.5-10)	1	166871	466.42	< LOD	9.33	46.14	0.82			10334.9	148.03			1088.15	75.33	< LOD	31.97	331.93	6.26	169.63	1.51
409	TP-FP-53(1.8-2.4)	1.44	232212	535.42	< LOD	8.37	56.83	0.87			2500.38	120.98			< LOD	131.59	< LOD	40.86	896.61	9.05	176.54	1.47
410	TP-FP-53(3-3.6)	1.34	231479	551.36	< LOD	9.09	71.43	0.97			21160.1	190.95			1062.14	86.62	< LOD	36.73	897.82	9.64	199.01	1.6
411	TP-FP-53(5-5.5)	1	183310	494.15	< LOD	8.88	40.08	0.75			7510.27	141.15			680.08	73.71	< LOD	31.25	441.5	6.82	182.96	1.51
412	TP-FP-53(7.5-8)	1	167565	465.23	< LOD	9.37	46.68	0.83			9653.5	140.67			817.76	70.58	< LOD	34.51	568.37	7.9	166.11	1.5
413	TP-FP-53(9.5-10)	1.01	174468	480.84	< LOD	9.28	56.61	0.89			9791.94	143.87			768.51	71.82	< LOD	32.9	390.2	6.71	183.92	1.57
414	TP-FP-53(12-12.5)	1.13	211916	537.38	< LOD	9.62	77.06	1.05			7491.58	139.75			805.23	73.21	< LOD	35.9	503.68	7.75	191.27	1.66
415	TP-FP-53 REP(12-12.5)REP	1.03	209103	523.48	< LOD	9.28	73.94	1			10225.8	146.28			762.61	72.55	< LOD	34.94	481.74	7.35	195.69	1.62
416	TP-FP-54(0.6-1)	1.57	126081	443.93	< LOD	10.01	53.39	0.95			7264.37	141.75			635.9	73.51	< LOD	42	455.43	7.51	132.6	1.45
417	TP-FP-54(0.6-1)DUP	1.48	142322	463.17	< LOD	9.73	53.11	0.92			9287.15	148.88			682.74	74.44	45.64	20.52	385.44	6.84	150.59	1.5

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
418	TP-FP-54(1.2-1.4)	2.04	206043	525.54	< LOD	10.07	51.54	0.97			4253.33	125.51			274.09	67.34	78.19	25.21	711.82	9.08	160.98	1.61
419	TP-FP-54(1.8-2.4)	2.2	174657	491.33	< LOD	10.33	45.66	0.95			6612.71	137.55			570.43	71.57	69.7	25.99	799.75	9.77	173.94	1.7
420	TP-FP-54(3.4-3.8)	1.1	274976	598.12	< LOD	7.84	62.44	0.82			4746.62	140.22			< LOD	149.57	< LOD	47.22	3320.56	17.37	207.09	1.47
421	TP-FP-54(5-5.5)	1.27	171509	473.32	< LOD	8.48	43.2	0.75			5511.46	132.36			347.3	70.06	< LOD	35.59	936.46	9.43	156.55	1.36
422	TP-FP-54(7-7.5)	1	220127	539.1	< LOD	8.44	52	0.8			12620.6	164.23			562.13	78.75	< LOD	30.97	462.61	6.73	186.46	1.46
423	TP-FP-54(9-9.5)	1	158546	454.88	< LOD	8.4	39.08	0.71			5276.95	129.13			335.96	68.76	< LOD	33.16	707	8.26	148.54	1.32
424	TP-FP-55(0.6-1)	2.27	196418	519.03	< LOD	10.18	49.7	0.98			5539.55	130.78			373.83	68.38	133.41	24.69	436.99	7.38	177.29	1.7
425	TP-FP-55(2-2.3)	1.43	234745	547.41	< LOD	7.86	70.82	0.89			3050.34	128.51			< LOD	137.92	< LOD	44.54	2579.35	15.29	181.15	1.4
426	TP-FP-55(2.5-3)	1	244973	573.52	< LOD	8.46	53.76	0.82			6824.03	147.57			497.18	77.46	< LOD	39.77	1569.88	12.26	201.38	1.53
427	TP-FP-55(3.8-4.2)	1	243468	573.54	< LOD	8.7	63.64	0.9			5900.53	140.15			406.03	74.1	< LOD	43.82	2021.7	14.3	200.25	1.57
428	TP-FP-55(5-5.5)	1.18	211783	527.58	< LOD	9.29	48.2	0.84			12072	161.08			866.76	78.85	< LOD	50.36	2495.74	16.58	213.09	1.68
429	TP-FP-56(0.3-0.7)	1	247784	550.86	< LOD	7.42	68.24	0.82			4026.73	133.69			< LOD	140.26	< LOD	27.07	399.98	5.77	190.97	1.36
430	TP-FP-56(2.6-3)	1	238649	563.9	< LOD	8.47	54.15	0.81			15478.9	175.2			901.95	83.49	< LOD	29.18	252.49	5.19	191.23	1.48
431	TP-FP-56(4.5-4.9)	1.81	237623	579.69	< LOD	9.55	60.69	0.94			38002.3	232.41			1775.93	99.93	< LOD	34.53	304.1	6.13	217.58	1.74
432	TP-FP-56(6.5-7)	1.23	243140	573.22	< LOD	8.77	65.16	0.91			12558.8	167.92			870.38	82.33	< LOD	31.31	254.35	5.37	181.82	1.49
433	TP-FP-57(0-0.5)	1	268047	578.12	< LOD	7.58	72.86	0.87			5022.73	140.39			< LOD	143.57	< LOD	27.34	341.21	5.54	198.22	1.42
434	TP-FP-57(0.5-1)	1	248405	563.92	< LOD	7.67	69.38	0.86			3958.06	136.48			< LOD	142.12	< LOD	28.62	429.35	6.16	185.79	1.39
435	TP-FP-57(1-1.5)	1	253859	579.42	< LOD	7.79	76.05	0.9			4576.82	140.37			< LOD	149.83	< LOD	29.45	444.7	6.34	197.64	1.45
436	TP-FP-57(1-1.5)DUP	1	252869	571.25	< LOD	7.71	68.32	0.85			4572.36	139.08			< LOD	144.68	< LOD	28.22	403.89	6	205.75	1.45
437	TP-FP-57 REP(1-1.5)REP	1	258655	571.06	< LOD	7.61	76.17	0.88			5217.15	140.29			< LOD	145.42	< LOD	28.83	441.94	6.19	197.08	1.41
438	TP-FP-58(.1-.3)	1.47	171263	477.18	< LOD	9.83	53.36	0.92			9042.86	143.55			736.3	72.27	49.34	20.58	578.41	8.16	186.47	1.64
439	TP-FP-58(1.3-1.6)	1	246518	559.78	< LOD	7.86	65.13	0.84			4824.57	139.89			< LOD	144.51	< LOD	27.84	316.12	5.48	193.65	1.43
440	TP-FP-58(2.3-2.8)	1	223744	537.13	< LOD	8.38	45.77	0.75			10669.7	155.05			461.41	75.72	< LOD	30.88	485.8	6.82	192.17	1.48
441	TP-FP-58(3.6-4)	1	217408	548.51	< LOD	8.83	63.41	0.9			9006.83	143.26			574.38	71.98	< LOD	36.49	971.34	9.86	164.51	1.44
442	TP-FP-58(4.1-4.7)	1	295524	616.03	< LOD	7.43	81.68	0.9			4334	143.37			< LOD	150.35	< LOD	27.42	366.23	5.62	250.13	1.56
443	TP-FP-58(6-6.5)	1	245399	563.16	< LOD	8.72	61.57	0.88			9167.49	145.2			524.88	72.36	< LOD	33.11	632.27	7.9	200.04	1.55
444	TP-FP-58(8.5-9)	1	232091	543.97	< LOD	8.42	53.26	0.8			8133.16	148.55			337.26	74.73	< LOD	33.21	751.01	8.44	200.53	1.51
445	TP-FP-58(9.5-10)	0.86	225447	552.81	< LOD	9.03	57.2	0.87			10123.4	150.2			667.31	74.62	< LOD	36.34	981.76	10.08	191	1.56
446	TP-FP-58A(.1-.3)	2.17	201541	523.91	< LOD	9.93	54.44	0.95			11387.1	154.95			917.34	76.28	< LOD	42.16	655.18	8.8	189.56	1.69
447	TP-FP-58B(4.1-4.7)	1	290581	604.78	< LOD	7.31	81.26	0.88			3318.12	135.64			< LOD	143.55	< LOD	27.39	308.22	5.13	242.17	1.51
448	TP-FP-59(.2-.4)	2.36	205173	524.75	< LOD	10.03	46.47	0.91			8820.05	143.98			604.02	71.7	62.69	21.58	572.36	8.39	165.16	1.61
449	TP-FP-59(1.5-1.8)	1	270482	596.36	< LOD	7.78	72.16	0.88			5721.77	147.52			< LOD	151.33	< LOD	31.42	737.34	7.98	208.13	1.48
450	TP-FP-59(1.8-2)	1	166475	482.79	< LOD	9.36	60.78	0.92			8677.71	134.5			1465.99	72.71	< LOD	35.94	776.13	9.09	199.83	1.64
451	TP-FP-59(2.5-3)	1.01	171261	487.45	< LOD	9.5	49.82	0.86			9218.96	143.65			954.66	73.65	< LOD	34.73	541.67	7.82	177.23	1.56
452	TP-FP-59(3.5-4)	1	267918	587.24	< LOD	7.49	76.14	0.87			5883.29	145.23			< LOD	150.77	< LOD	27.49	377.06	5.71	219.72	1.47
453	TP-FP-59(6.5-7)	1	246489	578.1	< LOD	8.71	61.03	0.88			10111.4	158.5			406.63	77.45	< LOD	37.42	1179.69	10.75	181.77	1.49
454	TP-FP-59(8.5-9)	1.08	152121	452.9	< LOD	9.79	49.22	0.88			11576.5	149.5			962.02	73.41	< LOD	35.93	587.4	8.34	173.81	1.59
455	TP-FP-59(12-12.5)	1.49	166817	463.42	< LOD	9.13	98.38	1.13			7691.36	135.46			223.25	66.76	< LOD	33.07	570.76	7.84	170.79	1.52
456	TP-FP-60(.2-.5)	1	257876	570.93	< LOD	7.73	58.09	0.79			3038.97	129.86			< LOD	140	< LOD	27.46	339.97	5.55	204.77	1.45
457	TP-FP-60(2-2.2)	1	248974	575.4	< LOD	8.32	54.02	0.81			7301.08	153.05			333.72	78.78	< LOD	28.19	237.49	5.03	198.38	1.5
458	TP-FP-60(3.6-4)	1.4	263627	588.18	< LOD	8.44	61.74	0.86			12679.2	169.47			473.69	81.09	< LOD	29.16	247.13	5.13	195.08	1.49
459	TP-FP-60(5.8-6)	1	257322	584.44	< LOD	8.56	61.33	0.87			13092.7	170.82			686	82.45	< LOD	29.4	274.15	5.44	211.19	1.57
460	TP-FP-60(8-8)	0.77	223175	525.16	< LOD	8.02	62.57	0.83			13289.3	168.89			192.65	78.67	< LOD	31.36	659.6	7.6	197.58	1.45
461	TP-FP-60(8-8.5)	1	134507	413.71	< LOD	9.66	52.84	0.89			7443.34	130.2			493.23	65.81	< LOD	33.93	522.48	7.78	155.56	1.49
462	TP-FP-60(9.5-10)	1.33	206665	516.33	< LOD	8.83	68.83	0.94			8276.62	145.48			418.16	72.98	< LOD	33.29	587.5	7.78	188.4	1.54
463	TP-FP-60 REP(.2-.5)REP	1	257788	564.03	< LOD	7.56	59.37	0.78			3171.93	127.85			< LOD	136.46	< LOD	27.16	337.24	5.43	203.87	1.41

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
464	TP-FP-6A(2-3)	1	311768	637.23	< LOD	7.77	69.73	0.85			3282.07	135.11			163.23	75.24	< LOD	26.21	174.5	4.22	224.75	1.51
465	TP-FP-6A(5.5-6.5)	1	328374	657.16	< LOD	7.91	84.04	0.94			2957.41	136.41			< LOD	151.32	< LOD	26.17	116.64	3.73	257.06	1.64
466	TP-FP-6A(16-16.5)	1	313869	647.27	< LOD	7.95	75.52	0.9			3424.5	138.59			< LOD	152.08	< LOD	27.82	331.09	5.55	197.31	1.44
467	TP-FP-6B(2.5-3.5)	1	299834	629.77	< LOD	7.94	114.71	1.1			3099.4	141.13			< LOD	151.79	< LOD	25.86	131.8	3.93	230.62	1.58
468	TP-FP-6B(12-13)	1	307829	642.67	< LOD	8.05	80.96	0.94			3655.97	138.49			206.23	76.6	< LOD	31.34	621.42	7.47	224.95	1.56
469	TP-MS-01(0-0.5)	1.43	233459	562.19	< LOD	8.65	52.19	0.85			6296.49	135.39			< LOD	134.66	65.91	25.47	2331.24	15.22	131.96	1.32
470	TP-MS-01(0.5-1)	1.19	251233	549.74	< LOD	7.5	67.57	0.83			4113.92	134.39			< LOD	136.56	< LOD	28.51	484.23	6.44	156.3	1.26
471	TP-MS-03(0-0.3)	1.8	186435	521.94	< LOD	10.65	53.46	1.02			4970.52	120.9			437.32	64.64	< LOD	77.48	5485.49	29.61	129.71	1.55
472	TP-MS-03(0.3-0.5)	1.32	223252	601.97	< LOD	9.88	70.17	1.02			10198.2	155.87			764.68	77.67	< LOD	50.61	1882.23	14.79	123.77	1.38
473	TP-MS-03(0.5-1)	2.17	207969	585.71	< LOD	10.4	68.08	1.06			10092.8	157.92			840.92	79.19	< LOD	56.03	2317.2	17.33	120.06	1.42
474	TP-MS-03(1-2)	2.19	203747	579.91	< LOD	10.35	70.13	1.06			10891.8	160.4			1111.53	81.26	58.72	27.66	2185.59	16.63	108.75	1.36
475	TP-MS-03(1-2)DUP	1.27	227533	599.83	< LOD	9.76	73.5	1.03			10219.4	158.56			831.4	79.5	< LOD	50.95	2094.39	15.54	111.92	1.31
476	TP-MS-03(2-2.75)	0.8	268953	600.99	< LOD	7.95	71.46	0.89			4700.39	140.96			< LOD	149.52	< LOD	32.98	770.88	8.26	200.62	1.48
477	TP-MS-03 REP(2-2.75)REP	1.26	269558	597.5	< LOD	7.82	70.58	0.87			4397.6	138.68			< LOD	146.63	< LOD	32.57	766.76	8.13	213.58	1.5
478	TP-MS-04(0-0.5)	1.74	193003	525.61	< LOD	9.97	54.54	0.97			5719.22	129.2			359.42	67.32	< LOD	66.55	4072.6	23.3	139.99	1.51
479	TP-MS-04(0.5-1)	1.26	206607	579.8	< LOD	9.57	63.83	0.97			9296.46	152.54			598.79	76.25	< LOD	48.46	1709.91	13.88	120.41	1.34
480	TP-MS-04(1-2)	1.03	224183	563.48	< LOD	8.03	63.13	0.85			3959.89	130.93			< LOD	135.25	< LOD	39.03	1424.46	11.17	179.55	1.41
481	TP-MS-04(2-2.5)	1	226921	532.96	< LOD	7.62	67.34	0.84			3410.97	137.51			< LOD	143.59	< LOD	29.02	467.02	6.39	193.85	1.41
482	TP-MS-05(1.2-1.5)	1.51	298385	626.32	< LOD	7.92	72.34	0.89			5064.24	144.05			< LOD	150.41	< LOD	29.46	405.75	6.13	237.49	1.59
483	TP-MS-05(1.8-2)	1	241023	561.59	< LOD	8.39	54.48	0.81			6808.95	141.64			483.83	73.99	< LOD	28.92	302.39	5.55	167.81	1.38
484	TP-MS-05(3.3-3.5)	1	262999	580.07	< LOD	8.19	77.79	0.93			5254.95	135.2			166.91	71.04	< LOD	29.58	324.43	5.62	166.49	1.36
485	TP-MS-05(4-4.5)	0.89	291595	615.52	< LOD	7.52	83.17	0.91			4814.21	142.62			156.78	76.66	< LOD	26.68	293.21	5.14	195.59	1.39
486	TP-MS-05(6-6.5)	1	288615	612.24	< LOD	8.02	72.39	0.89			6004.85	144.5			< LOD	148.43	< LOD	29.15	325.12	5.59	261.66	1.68
487	TP-MS-05(9-9.5)	1	266746	588.94	< LOD	8.3	74.68	0.93			12495.6	171.55			455.41	82.24	< LOD	30.37	374.23	6.08	183.66	1.44
488	TP-MS-05A(1.2-1.5)	1	291680	613.82	< LOD	7.65	75.1	0.88			4456.91	141.45			< LOD	147.86	< LOD	28.45	394.57	5.91	223.45	1.51
489	TP-MS-06(0.5-1)	1.45	272544	595.97	< LOD	7.65	63.38	0.81			4728.34	138.51			< LOD	143.57	< LOD	27.65	381.48	5.79	217.61	1.48
490	TP-MS-06(1-1.5)	1.05	280408	606.22	< LOD	7.74	77.29	0.9			5382.32	143.22			< LOD	150.34	< LOD	27.85	352.72	5.65	216.48	1.49
491	TP-MS-06(1.6-2.3)	1.47	263556	597.78	< LOD	9.07	59.9	0.9			3700.73	122.75			263.74	67.29	< LOD	30.88	289.79	5.78	178.25	1.52
492	TP-MS-06(2.5-2.7)	1	250695	575.73	< LOD	8.2	99.47	1.05			9925.37	155.99			314.56	76.41	< LOD	28.76	275.78	5.26	164.57	1.37
493	TP-MS-06(4.5-5)	1.41	233775	560.8	< LOD	8.82	94.76	1.08			9326.28	150.42			460.13	74.7	< LOD	31.3	181.48	4.76	178.63	1.51
494	TP-MS-06 REP(0.5-1)REP	1	274242	595.78	< LOD	7.65	63.13	0.81			5398.02	141.67			< LOD	144.78	< LOD	27.73	369.63	5.72	214.96	1.47
495	TP-MS-07(0-0.5)	1	21935.7	156.71	< LOD	5.26	10.42	0.5			< LOD	119.54			< LOD	71.36	< LOD	17.09	18.73	2.2	11.63	0.5
496	TP-MS-07(0.5-1)	1	22777.8	140.93	< LOD	4.55	7.32	0.5			< LOD	132.76			< LOD	76.54	< LOD	15.08	14.19	1.94	14.82	0.5
497	TP-MS-07(1-2)	1	63785.9	228.33	< LOD	4.86	12.25	0.5			< LOD	151.97			< LOD	87.36	< LOD	15.96	39.07	2.23	32.54	0.53
498	TP-MS-07(2.75-3.5)	1	258620	571.52	< LOD	7.3	56.59	0.76			2090.92	134.12			< LOD	144.56	< LOD	24.58	154.34	3.98	203.25	1.39
499	TP-MS-07(3.5-4.5)	1	289403	605.34	< LOD	7.34	68.7	0.82			2358.64	134.13			< LOD	147.22	< LOD	25.3	189.42	4.28	210.59	1.42
500	TP-MS-07(4.5-5.5)	1	278544	597.93	< LOD	7.31	75.71	0.86			1879.43	133.27			< LOD	144.84	< LOD	24.67	162.72	4.04	202.01	1.39
501	TP-MS-07(5.5-6.5)	1	268357	587.15	< LOD	7.41	85.07	0.92			1691.52	132.31			< LOD	141.74	< LOD	24.6	188.85	4.32	193.4	1.38
502	TP-MS-07(7.5-8.5)	1	222277	517.12	< LOD	7.65	53.77	0.76			1993.73	124.06			< LOD	135.74	< LOD	25.99	215.71	4.64	151.65	1.25
503	TP-MS-07(8.5-9.5)	1.25	239601	552.58	< LOD	8.13	53.99	0.79			2969.64	124.31			< LOD	131.96	< LOD	27.08	185.87	4.52	184.63	1.42
504	TP-MS-07 REP(3.5-4.5)REP	1	289445	613.65	< LOD	7.48	67.93	0.83			2416.48	137.27			< LOD	147.72	< LOD	25.47	201.49	4.44	208.26	1.44
505	TP-MS-08(0-0.5)	2.02	157088	476.49	< LOD	9.15	57.9	0.91			6267.41	132.12			227.04	67.34	< LOD	63.57	4898.26	24.39	94.51	1.19
506	TP-MS-08(0.5-1)	1.88	196273	562.97	< LOD	9.7	68.7	1.02			7959.05	145.6			426.84	73.29	< LOD	59.29	3588.58	21.22	118.54	1.36
507	TP-MS-08(1-2)	2.17	190985	564.2	< LOD	10.1	68.33	1.04			10264.3	157.38			829.05	78.71	66.24	27.99	2402.49	17.28	94.95	1.27
508	TP-MS-08(1-2)DUP	2.23	221995	606.16	< LOD	10.28	73.01	1.08			10522.3	158.02			846.96	78.84	< LOD	56.62	2391.41	17.46	106.41	1.35
509	TP-MS-08(2-3)	1	203022	508.36	< LOD	7.85	66.02	0.85			3988.05	135.43			< LOD	141.48	< LOD	34.64	1060	9.59	173.23	1.36

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
510	TP-MS-08(4-5)	1	240963	559.52	< LOD	7.86	68.21	0.86			4755.49	147.07			< LOD	153.2	< LOD	29.12	419.67	6.18	207.51	1.48
511	TP-MS-08(6-6.75)	1	267165	592.98	< LOD	7.72	76.01	0.89			6599.39	153.64			< LOD	157.58	< LOD	28.78	433.74	6.2	240.96	1.57
512	TP-MS-09(0-0.5)	1.4	96018.3	368.17	< LOD	9.45	44.85	0.85			6420.41	129.37			528.78	67.56	< LOD	75.17	6752.83	30.68	104.54	1.27
513	TP-MS-09(0.5-1)	1.49	206201	543.75	< LOD	9.77	54.2	0.93			8083.94	145.28			649.88	74.31	< LOD	61.51	3657.42	21.3	129.73	1.41
514	TP-MS-09(1-2)	1.74	220621	547.34	< LOD	9.08	55.91	0.93			3192.29	124.33			< LOD	133.41	< LOD	78.14	7556.79	31.52	134.32	1.4
515	TP-MS-09(2-3)	0.78	302712	615.47	< LOD	7.75	70.68	0.86			3072.01	128.14			< LOD	138.01	< LOD	36.55	1301.85	10.47	214.61	1.49
516	TP-MS-09(3-4)	1	262580	579.13	< LOD	7.68	74.19	0.88			3510.19	135.07			< LOD	145.6	< LOD	33.08	947.72	8.9	191.95	1.41
517	TP-MS-09(5-6)	1	265743	585.27	< LOD	7.53	70.09	0.84			6183.43	147.42			< LOD	150.56	< LOD	27.1	315.51	5.3	224.35	1.49
518	TP-MS-09(6-7)	1.22	245709	560.47	< LOD	7.54	71.96	0.86			4081.43	141.76			< LOD	150.76	< LOD	26.99	366.04	5.66	220.69	1.48
519	TP-MS-09 REP(0-0.5)REP	1.51	77486.8	333.85	< LOD	9.58	43.46	0.86			5964.79	129.71			374.25	67.35	< LOD	76.07	6683.3	30.96	105.56	1.3
520	TP-MS-101(0-0.5)	1.57	169987	472.93	< LOD	9.53	52.02	0.92			4719.25	121.01			345.13	64.7	< LOD	66.74	4798.41	24.85	135.42	1.44
521	TP-MS-101(0.5-1)	1.52	153226	454.03	< LOD	10.17	44.09	0.88			9566.71	143.38			668.01	70.73	< LOD	46.36	1123.04	11.6	133.21	1.46
522	TP-MS-102(0-0.5)	1.51	188896	498.04	< LOD	9.48	45.62	0.86			6522.13	125.46			188.51	62.8	67.72	22.93	1213.64	11.55	137.12	1.42
523	TP-MS-102(0.5-1)	1.72	192162	565.95	< LOD	10.95	62.26	1.06			10568.9	156.76			907.11	78.1	< LOD	67.44	3587.43	22.99	118.06	1.48
524	TP-MS-102(1-1.5)	1.43	237801	567.39	< LOD	8.45	59.54	0.89			2950.27	122.71			< LOD	129.97	< LOD	73.8	7549.62	29.88	158.27	1.41
525	TP-MS-102(1.5-2)	1.21	238240	544.73	< LOD	7.81	61.58	0.82			2758.81	124.93			< LOD	133.43	< LOD	53.26	4487.33	20.7	172.65	1.35
526	TP-MS-102(2.5-2.75)	1	263712	589.04	< LOD	8.31	59.83	0.84			17432.2	187.27			206.98	83.84	< LOD	34.96	941.21	9.3	319.15	1.91
527	TP-MS-102 REP(2.5-2.75)REI	1	267078	591.48	< LOD	8.32	61.24	0.85			17615.7	187.29			463.06	85.16	< LOD	34.81	957.76	9.35	323.3	1.92
528	TP-MS-103(0-0.5)	1	247450	563.57	< LOD	7.46	84.25	0.93			3100.15	133.74			< LOD	138.83	< LOD	37.31	1475.77	11.02	183.38	1.37
529	TP-MS-103(0.5-1)	1	299135	627.9	< LOD	7.58	96.07	0.99			3662.83	142.6			< LOD	151.87	< LOD	29.26	473.3	6.42	239.31	1.57
530	TP-MS-103(1-1.5)	1.11	316207	649.99	< LOD	7.8	101.16	1.02			5972.65	153.22			< LOD	158.42	< LOD	28.02	329.07	5.53	251.17	1.62
531	TP-MS-104(0-0.5)	2.57	174838	523.2	< LOD	10.62	60.26	1.05			6139.31	124.76			776.27	67.15	< LOD	81.62	6730.56	33.34	110.1	1.43
532	TP-MS-104(0.5-1)	1.47	221966	611	< LOD	10.01	72.03	1.06			9251.73	154.82			824.44	78.88	< LOD	54.84	2276.46	16.67	112.69	1.36
533	TP-MS-104(1-1.5)	1.53	218511	605.61	< LOD	10.22	71.29	1.07			9743.45	157.08			681.29	78.29	< LOD	56.9	2434.68	17.57	122.69	1.43
534	TP-MS-104(1.5-2.5)	2.22	226640	554.96	< LOD	8.55	63.92	0.93			2722.12	125.15			< LOD	134.72	< LOD	64.31	5212.28	24.07	128.07	1.31
535	Tp-Ms-105(0-0.7)	1.62	141231	457.24	< LOD	9.79	51.7	0.95			4048.77	111.3			747.39	63.81	< LOD	117.71	17638.47	63.34	73.04	1.17
536	Tp-Ms-105(0.7-1.0)	1.77	173132	493.03	< LOD	9.97	64.32	1.05			4216.91	118.75			1025.03	69.13	< LOD	74.71	5492.49	27.97	94.34	1.32
537	Tp-Ms-105(1.0-1.5)	1.49	162667	444.69	< LOD	7.29	53.53	0.75			982.51	113.48			< LOD	127.79	< LOD	57.44	5783.41	23.39	121.19	1.12
538	Tp-Ms-105(1.5-2.0)	1.07	287341	613.05	< LOD	7.77	80.8	0.92			5931.87	147.82			< LOD	153.47	< LOD	30.79	632	7.38	223.09	1.52
539	Tp-Ms-105(2-3.0)	1	276946	607.89	< LOD	8.02	75.1	0.91			12664.5	174.56			< LOD	164.39	< LOD	27.66	242.28	4.94	194.65	1.45
540	Tp-Ms-105 REP(0.7-1.0)	1.82	178726	509.05	< LOD	10.25	65.05	1.09			4393.65	124.74			1144.81	73.07	< LOD	72.72	4882.38	26.8	98.28	1.38
541	Tp-Ms-106(0-0.5)	1.67	162399	482.78	< LOD	10.18	45.3	0.91			4639.05	123.22			434.85	66.68	< LOD	108.78	14043.79	53.69	110.54	1.38
542	Tp-Ms-106(0.5-0.75)	1.79	124314	421.34	< LOD	10.95	41.5	0.93			4817.51	115.54			571.53	62.75	< LOD	107.38	12333.09	52.05	92.55	1.36
543	Tp-Ms-106(0.75-1.0)	1.51	200771	569.43	< LOD	10.06	63.73	1.01			8677.63	147.67			584.69	74.14	< LOD	70.48	5176.63	26.96	115.01	1.38
544	Tp-Ms-106(1.0-1.5)	2.07	194465	541.51	< LOD	9.76	65.06	0.99			8825.39	148.39			860.47	76.31	< LOD	62.63	4233.76	23.16	124.79	1.37
545	Tp-Ms-106(1.5-2.0)	1.5	182873	540.14	< LOD	9.98	58.76	0.97			11871	160.75			948.47	79.03	< LOD	66.31	4500.67	24.55	133.21	1.44
546	Tp-Ms-106(2.0-2.5)	1.63	207944	547.69	< LOD	9.96	62.62	1			8944.4	147.93			914.7	76.07	< LOD	70.27	5392.03	26.94	149.8	1.52
547	TP-MS-108(0-0.5)	2.39	104956	418.7	< LOD	10.22	54.42	1.02			2220.01	96.34			1018.65	62.2	< LOD	147.82	25190.82	90.85	34.95	1
548	TP-MS-108(0.5-1)	1.33	173308	482.91	< LOD	8.88	52.64	0.87			5063.23	121.2			233.02	63.54	< LOD	73.08	7061.55	30.34	104.79	1.23
549	TP-MS-108(1-1.5)	1	218142	520.3	< LOD	7.66	66.72	0.86			1980.37	123.61			< LOD	132.42	< LOD	52.43	3984.63	19.16	201.37	1.46
550	TP-MS-108(2-2.5)	1	269175	586.02	< LOD	7.24	76.03	0.86			2373.22	135.01			< LOD	143.67	< LOD	25.31	191.2	4.27	222.68	1.46
551	TP-MS-109(0-0.5)	1.66	199114	528.66	< LOD	9.71	54.7	0.95			5358.95	125.18			368.55	65.98	< LOD	77.57	6541.92	30.58	124.7	1.41
552	TP-MS-109(0.5-1)	2.59	189550	523.93	< LOD	10.34	51.75	1.06			3638.31	124.16			242.93	67.44	81.41	40.1	5267.52	26.84	134.39	1.61
553	TP-MS-109(1-1.5)	2.7	203958	538.29	< LOD	10.03	55.3	1.06			4229.54	131.9			166.78	69.9	< LOD	88.53	8189.08	33.91	162.49	1.69
554	TP-MS-109(1.5-2)	1	260120	574.55	< LOD	7.92	71.07	0.88			5132.36	140.68			< LOD	144.87	< LOD	63.53	6120.83	25.38	213.27	1.51
555	TP-MS-10A(0-0.5)	1.6	128588	440.17	< LOD	10.1	35.09	0.84			2225.37	96.26			347.18	56.89	< LOD	121.33	17591.44	65.5	69.29	1.17

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
556	TP-MS-10A(0.5-1)	1.74	204866	563.1	< LOD	10.48	65.63	1.08			7622.56	138.27			794.87	72.02	< LOD	92.26	8835.93	39.73	107.95	1.41
557	TP-MS-10A(1-2)	1.39	178995	502.59	< LOD	9.17	53.04	0.89			6204.48	139.25			289.87	71.93	< LOD	61.16	4104.87	21.96	127.85	1.35
558	TP-MS-10B(0-0.5)	1.56	47764.5	288.88	< LOD	11.09	21.32	0.75			2814.09	91.47			1348.44	61.05	< LOD	155.07	25141.88	94.29	21.05	0.89
559	TP-MS-10B(1-2)	1.64	218927	584.82	< LOD	9.74	63.05	1.01			6546.97	140.23			490.51	73.18	< LOD	70.8	5361.31	27.13	135.89	1.47
560	TP-MS-10B(2-2.75)	1	232639	528.34	< LOD	7.24	59.76	0.76			3706.38	129.86			< LOD	135.44	< LOD	34.57	1536.33	10.84	187.48	1.32
561	TP-MS-10C(0-1)	1.77	169689	502.44	< LOD	10.33	49.18	0.96			5125.83	121.93			609.95	66.22	< LOD	101.05	11707.37	47.6	99.81	1.35
562	TP-MS-10C(1-2)	1.52	218970	605.21	< LOD	10.37	72.99	1.09			10947.9	160.42			1084.73	80.86	78.2	32.69	3691.17	22.51	97.13	1.31
563	TP-MS-10c(2-3)	2.16	180510	565.3	< LOD	10.02	72.29	1.06			9279.21	154.55			793.51	78.47	< LOD	54.58	2421.54	17.21	101.62	1.3
564	TP-MS-10c(3-3.75)	1.05	168468	480	< LOD	8.07	61.18	0.85			4442.42	133.17			< LOD	137.47	< LOD	45.03	2309.1	14.54	168.46	1.39
565	TP-MS-10c REP(2-3)	1.42	221766	602.58	< LOD	9.89	69.73	1.03			9363.2	154.32			884.7	78.75	< LOD	56.39	2610.05	17.85	109.59	1.33
566	TP-MS-10cRETEST(1-2)	1.47	214810	600.38	< LOD	10.53	72.94	1.1			11034.6	161.95			942.15	80.56	111.9	31.79	3282.7	21.21	102.57	1.35
567	TP-MS-10CRETEST(2-3)	2.15	232613	613.12	< LOD	10.12	73.48	1.07			9486.61	156.03			825.09	79.08	< LOD	56.76	2698.86	18.33	109.4	1.34
568	TP-MS-10D(0-0.5)	1.81	201346	550.11	< LOD	10.63	55.67	1.03			5608.08	128.93			771.42	70.33	< LOD	111.63	14192.75	55.8	114.1	1.46
569	TP-MS-10D(0.5-1.5)	2.18	210655	590.7	< LOD	10.16	67.72	1.04			9736.89	155.33			758.84	77.85	< LOD	64.46	4124.76	23.59	100.45	1.31
570	TP-MS-10D(1.5-2)	2.28	234984	621.12	< LOD	10.28	75.31	1.1			9808.89	158.51			758.8	79.39	< LOD	58.26	2614.56	18.33	123.17	1.44
571	TP-MS-10D(2-3.5)	1.15	258202	581.97	< LOD	8.37	66.61	0.91			4548.39	138.7			< LOD	143.09	< LOD	55.99	4143.27	20.6	193.42	1.51
572	TP-MS-10DRETEST(1.5-2)	1.48	227799	612.62	< LOD	10.18	73.31	1.08			10251.1	157.56			805.87	78.78	< LOD	58.27	2631.46	18.18	120.19	1.41
573	TP-MS-110(0-0.5)	2.21	214753	537.06	< LOD	9.23	57.57	0.93			5993.18	128.46			< LOD	129.82	< LOD	52.53	2333.1	15.96	142.7	1.43
574	TP-MS-110(0.5-1)	1	272792	593.31	< LOD	7.53	75.43	0.88			5482.44	142.9			< LOD	145.13	< LOD	37.33	1635.7	11.63	208.77	1.45
575	TP-MS-110(1-1.5)	1	237317	532.23	< LOD	6.96	61.91	0.77			2201.1	125.45			< LOD	130.37	< LOD	26.76	465.56	6.03	206.64	1.37
576	TP-MS-110(1.5-2)	1.18	255994	566.76	< LOD	7.75	72.5	0.88			3186.52	133.25			< LOD	139.76	< LOD	28.66	428.36	6.2	222.44	1.52
577	TP-MS-111(0-0.5)	1.67	192341	545.49	< LOD	10.27	58.32	1.01			8606.6	144.85			670.48	73.2	< LOD	82.57	7002.92	33.42	121.3	1.45
578	TP-MS-111(0.5-0.75)	1.62	235078	577.71	< LOD	8.86	64.74	0.96			4452.45	130.51			< LOD	134.85	< LOD	62.25	4414.84	21.98	148.94	1.43
579	TP-MS-112(0-0.5)	1.87	178038	483.07	< LOD	9.45	50.87	0.94			3115.99	118.36			< LOD	128.44	< LOD	56.8	2397.96	16.37	136.8	1.46
580	TP-MS-112(0.5-1)	1.93	229912	565.88	< LOD	9.64	63.89	1.03			7994.63	155.6			< LOD	149.29	< LOD	98.43	12225.92	44.76	186.69	1.69
581	TP-MS-112(1.75-2)	1	282127	604.91	< LOD	7.53	80.21	0.9			4162.18	142.69			< LOD	150.66	< LOD	27.85	383.04	5.78	242.03	1.55
582	TP-MS-112 REP(0.5-1)REP	1.87	231260	563.05	< LOD	9.43	61.7	0.99			7825.22	151.4			< LOD	146.93	< LOD	97.33	12244.71	44.01	187.57	1.66
583	TP-MS-113(0-0.5)	1.16	202662	515.68	< LOD	8.82	50.21	0.84			7933.47	139.63			289.18	69.36	< LOD	39.68	910.17	9.57	178.4	1.51
584	TP-MS-113(0.5-1)	1	220888	550.21	< LOD	8.32	71.96	0.91			5067.49	134.85			203.01	71.44	< LOD	36.72	1154.96	10.25	231.03	1.62
585	TP-MS-113(1-1.75)	1.13	243519	567.1	< LOD	8.25	69.63	0.89			8468.54	146.14			207.01	72.27	< LOD	37.58	1380.08	11.16	203.85	1.51
586	TP-MS-114(0-0.25)	1	209219	503.35	< LOD	8.37	56.17	0.83			3154.34	111.73			< LOD	119.42	< LOD	29.18	224.57	4.97	194.44	1.51
587	TP-MS-114(0.25-0.5)	1	261199	570.99	< LOD	7.56	65.53	0.83			2833.74	131.54			< LOD	138.63	< LOD	25.32	170.18	4.18	226.59	1.51
588	TP-MS-114(1-1.5)	1.21	268266	583.15	< LOD	8.51	68.68	0.91			3340.37	124.06			243.46	68.8	< LOD	29.31	214.73	4.91	202.49	1.55
589	TP-MS-115(0-0.5)	2.01	65183.8	322.49	< LOD	13.48	26.66	0.95			825.14	79.72			252.38	50.08	< LOD	110.84	8684.36	51.17	22.09	1.06
590	TP-MS-115(0.5-1)	1.41	95540.7	354.22	< LOD	8.02	31.08	0.68			< LOD	164.29			< LOD	94.02	< LOD	100.91	16040.68	53.06	42.85	0.85
591	TP-MS-115(1.25-1.5)	1	249793	562.19	< LOD	8.44	62.85	0.87			3016.25	119.03			< LOD	128.94	< LOD	29.45	338.21	5.88	187.27	1.49
592	TP-MS-115(1.5-2)	0.97	264146	580.21	< LOD	8.36	63.43	0.87			4256.44	129.95			277.85	70.61	< LOD	29.07	265.33	5.29	206.49	1.54
593	TP-MS-116(0-0.5)	1.35	194548	503.19	< LOD	8.51	51.43	0.85			3744.23	119.67			< LOD	124.86	< LOD	66.41	5711.42	25.64	112.66	1.24
594	TP-MS-116(0.5-1)	1.95	186057	499.2	< LOD	8.91	43.49	0.88			1136.47	116.34			< LOD	125.44	< LOD	63.79	3984.9	20.96	104.71	1.29
595	TP-MS-116(1-1.5)	5.28	214459	598.76	20.36	7.54	38.47	1.49			4009.19	140.24			720.16	78.87	200.31	74.68	15643.96	66.19	87.72	2.02
596	TP-MS-116(1.5-2)	1	267594	589.94	< LOD	7.7	68.35	0.86			3574.04	136.56			< LOD	142.86	< LOD	47.61	2950.7	16.18	213.83	1.5
597	TP-MS-117(0-0.5)	1.53	153843	455.8	< LOD	9.51	37.32	0.82			2581.92	105.04			132.18	58.62	< LOD	58.55	3205.24	19.77	91.29	1.23
598	TP-MS-117(0.5-1)	1	275918	592.64	< LOD	7.42	75.4	0.87			2400.2	131.4			< LOD	139.29	< LOD	32.72	926.19	8.64	222.56	1.48
599	TP-MS-117(1-1.5)	1	280248	601.29	< LOD	7.6	71.76	0.86			3898	135.01			< LOD	142.4	< LOD	29.89	620.3	7.21	230.88	1.53
600	TP-MS-117(1.5-2)	1	270846	590.41	< LOD	8.14	67.67	0.87			8034.88	151.48			< LOD	150.39	< LOD	31.74	608.05	7.43	200.15	1.48
601	TP-MS-117(2-2.5)	1.29	280723	608.66	< LOD	8.04	86.77	0.98			7017.06	151.65			< LOD	154.12	< LOD	35.2	1146.41	10.09	226.52	1.58

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
602	Tp-Ms-117 REP(1-1.5)REP	1	265292	587.73	< LOD	7.75	72.39	0.87			5138.02	141.68			< LOD	147.78	< LOD	30.35	633.64	7.35	226.17	1.53
603	TP-MS-118(0-0.5)	1.3	137711	426.26	< LOD	8.52	41.47	0.79			2556.64	109.37			< LOD	118.05	< LOD	59.64	4078.69	21.14	85.52	1.12
604	TP-MS-118(0.5-1)	1	232966	549.75	< LOD	7.98	68.62	0.89			4541.64	136.88			< LOD	138.05	< LOD	47.18	2815.21	16.18	199.18	1.49
605	TP-MS-118(0.5-1)	1	235197	544.73	< LOD	7.88	69.02	0.89			4521.73	135.49			< LOD	136.3	< LOD	46.7	2842.25	16.45	198.81	1.5
606	TP-MS-119(0-0.5)	1.65	180654	508.44	< LOD	9.73	62.05	1.01			5660.83	126.85			700.23	68.57	< LOD	65.74	4261.18	23.6	128.15	1.44
607	TP-MS-119(0.5-1)	1.67	220672	547.99	< LOD	8.77	60.15	0.95			2403.05	120.73			< LOD	131.06	< LOD	55.91	2749.48	16.71	122.12	1.33
608	TP-MS-119(1-1.5)	2.09	115795	394.5	< LOD	8.53	35.89	0.83			< LOD	199.49			< LOD	117.35	< LOD	74.43	6536.89	27.24	52.83	1.04
609	TP-MS-11A(0-0.4)	1.74	214852	577	< LOD	10.38	61.93	1.05			8819.93	147.53			713.49	74.53	< LOD	81.36	6492.58	32.23	116.44	1.44
610	TP-MS-11B(0-0.5)	2.08	145891	444.93	< LOD	9.66	52.69	0.96			894.57	106.08			< LOD	116.6	< LOD	173.49	38799.05	117.54	67.05	1.15
611	TP-MS-11B(1-2)	1.56	255668	598.24	< LOD	9.16	90.38	1.11			5804.34	138.45			309.61	72.26	< LOD	68.89	5691.03	26.29	147.47	1.45
612	TP-MS-11B(2-3)	1.5	294452	615.35	< LOD	7.68	73.81	0.88			4303.92	140.86			< LOD	148.33	< LOD	32.79	901.43	8.68	221.81	1.5
613	TP-MS-11B(3-4)	1	298254	619.17	< LOD	7.84	84.83	0.94			7958.63	155.01			< LOD	153.61	< LOD	28.89	419.09	6.12	245.67	1.6
614	TP-MS-11B(4-5)	1	305230	628.68	< LOD	7.59	92.6	0.96			7615.78	156.96			< LOD	157.72	< LOD	27.14	283.94	5.1	250.9	1.58
615	TP-MS-11B(5-5.75)	1.27	288898	630.75	< LOD	8.17	175.98	1.4			8488.7	166.95			212.4	84.25	< LOD	29.84	297.62	5.51	199.08	1.54
616	TP-MS-11B REP(3-4)REP	1.15	297978	620.18	< LOD	7.81	78.87	0.91			9476.91	159.32			< LOD	156.24	< LOD	29.08	430.66	6.17	232.09	1.55
617	TP-MS-11C(0-0.5)	1.81	124878	437.23	< LOD	10.71	38.61	0.91			3843.57	108.39			983.89	64.27	< LOD	150.57	25652.42	91.2	59.45	1.17
618	TP-MS-11C(1-2)	1.83	232260	596.16	< LOD	9.53	64.64	1.01			6008.22	135.33			294.71	69.91	< LOD	78.52	7063.03	31.01	128.74	1.42
619	TP-MS-11C(2-3)	1	281958	605.92	< LOD	7.99	66.85	0.87			6486.55	148.4			< LOD	149.92	< LOD	41.82	2072.49	13.66	205.02	1.5
620	TP-MS-11C(2-3)DUP	1.02	252817	559.73	< LOD	7.65	62.59	0.81			4662.88	139.03			< LOD	143.12	< LOD	34.58	1197.98	9.96	198.69	1.42
621	TP-MS-11C(3-4)	1.04	290941	609.1	< LOD	7.72	68.66	0.85			7845.33	152.64			160.96	77.12	< LOD	27.51	323.73	5.43	204.07	1.44
622	TP-MS-11D(0.0-0.1)	1.28	235126	561.41	< LOD	9.01	192.63	1.58			3577.82	124.09			159.78	67.6	< LOD	37.72	1052.25	10.43	161.75	1.53
623	TP-MS-12(0-0.5)	1	239099	528.71	< LOD	6.86	53.49	0.72			1149.95	114.92			< LOD	126.35	< LOD	26.65	440.24	5.88	118.37	1.06
624	TP-MS-12(0.5-1)	1	128585	354.85	< LOD	5.85	30.06	0.52			< LOD	188.88			< LOD	107.55	< LOD	21.35	243.02	4.21	73.16	0.78
625	TP-MS-12(1-1.5)	1	179976	455.39	< LOD	6.73	44.83	0.66			< LOD	236.21			< LOD	129.94	< LOD	24.26	278.75	4.85	117.59	1.04
626	TP-MS-12(1.5-2)	1	252542	572.41	< LOD	7.73	63.78	0.83			2207.21	130.32			< LOD	147.13	< LOD	27.05	252.79	5.01	201.58	1.45
627	TP-MS-12(1.5-2)DUP	1	278379	592.59	< LOD	7.47	71.02	0.85			3317.95	135.81			< LOD	146.76	< LOD	26.15	318.77	5.32	222.66	1.48
628	TP-MS-12(2-3)	1	241533	536.22	< LOD	7.46	68.77	0.83			3402.54	136.69			< LOD	148.31	< LOD	27	414.49	5.9	187.27	1.35
629	TP-MS-12(3-3.4)	1	248821	568.85	< LOD	7.6	61.83	0.81			2594.72	137.48			< LOD	150.39	< LOD	30.94	757.26	8.01	183.91	1.37
630	TP-MS-120(0-0.5)	5.77	82596.2	476.98	< LOD	24.35	51.71	2.22			3135.36	188.69			1254.22	121.69	< LOD	393.17	37230.9	270.9	35.22	2.23
631	TP-MS-120(0.5-1.0)	1.94	175586	521.14	< LOD	10.87	64.48	1.13			5120.58	120.95			1267.99	70.69	< LOD	110.19	12728.34	53.17	105.34	1.47
632	TP-MS-120(1-1.5)	2.28	210268	539.39	< LOD	9.49	52.86	0.98			2826.33	118.3			< LOD	130.58	< LOD	74.09	5462.34	25.69	115.57	1.4
633	TP-MS-120(1.5-2.5)	1	254702	565.14	< LOD	7.64	74.58	0.88			4470.22	133.57			< LOD	136.8	< LOD	47.68	3340.99	17.19	210.69	1.47
634	TP-MS-121(0-0.5)	1.47	168848	496.61	< LOD	9.33	50.71	0.89			6236.39	129.8			< LOD	130.81	< LOD	69.53	5586.18	26.99	101.62	1.25
635	TP-MS-121(0.5-0.75)	1.68	215659	584.99	< LOD	10.41	67.91	1.07			9487.2	153.72			786.36	77.37	< LOD	65.26	3544.76	21.98	130.59	1.49
636	TP-MS-121(1.5-1.75)	1.82	245193	591.09	< LOD	9.24	65.02	1.01			3584.46	130.78			159.81	71.23	< LOD	74.31	6162.89	27.58	167.11	1.57
637	TP-MS-122(0-0.5)	1.78	78261.1	363.47	< LOD	11.16	30.24	0.85			4369.14	105.29			890.3	61.3	< LOD	97.99	9555.74	44.97	65.9	1.23
638	TP-MS-122(0.5-1)	2.12	240867	579.81	< LOD	10.15	66.65	1.09			3984.56	123.49			609.3	69.36	< LOD	82.49	6911.46	31.74	163.06	1.66
639	TP-MS-122(1-1.5)	2.47	252278	593.58	< LOD	10.3	54.94	1.06			3792.3	130.58			< LOD	139.76	< LOD	108.19	13634.63	49.67	150.16	1.64
640	TP-MS-122(1.75-3)	1.07	262243	579.39	< LOD	7.77	65.59	0.85			4351.47	136.67			< LOD	139.85	< LOD	44.05	2197.88	13.7	184.02	1.4
641	Tp-Ms-123(0-0.5)	1.59	211104	541.47	< LOD	9.54	56.22	0.94			6359.46	132.35			571.19	69.54	< LOD	76.58	6649.45	30.17	130.9	1.41
642	Tp-Ms-123(0-1.0)	1	79349	311.73	< LOD	8.28	24.85	0.63			383.32	95.49			< LOD	115.23	< LOD	91.68	13004.44	44.71	31.85	0.79
643	Tp-Ms-123(0.5-1.0)	2.16	226351	556.08	< LOD	9.72	55.4	1			4525.02	131.78			244.68	70.04	< LOD	89.93	9307.78	37.09	124.9	1.45
644	Tp-Ms-123(1.1-2.1)	1.94	185668	506.12	< LOD	9.5	49.88	0.93			3671.44	124.85			198.27	67.75	< LOD	103.56	13653.92	48.74	102.82	1.31
645	Tp-Ms-123(1.1-1.8)	1.39	204140	527.27	< LOD	8.84	53.17	0.87			5020.91	131.05			337.26	69.97	< LOD	66.2	5417.17	25.25	122.63	1.3
646	Tp-Ms-123(2.5-3.0)	1.13	302193	640.28	< LOD	7.67	214.08	1.47			7079.55	163.76			< LOD	167.06	< LOD	27.23	237.78	4.79	179.66	1.41
647	Tp-Ms-123(2.5-3)	1	267108	587.64	< LOD	7.96	77.11	0.91			5831.38	144.79			< LOD	149.11	< LOD	43.17	2363.67	14.56	211.59	1.51

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
648	TP-MS-13(0-0.1)	1.71	245545	582.46	< LOD	10.28	50.39	0.96			10194.6	149.65			620.7	72.8	< LOD	46.68	609.98	8.85	169.41	1.67
649	TP-MS-13(0-0.5)	1.46	169950	459.71	< LOD	8.62	51.22	0.86			4187.05	123.14			< LOD	129.99	< LOD	55.56	2979.41	17.38	110.93	1.24
650	TP-MS-13(0.5-1)	1	175102	471.48	< LOD	8.03	62.74	0.85			6098.56	137.5			< LOD	137.23	< LOD	52.37	3965.29	19.73	149.41	1.31
651	TP-MS-13(1-1.9)	1	213296	519.08	< LOD	7.83	67.76	0.85			9192.46	156.48			< LOD	151.19	< LOD	31.9	877.25	8.67	185.73	1.4
652	TP-MS-14(0-0.2)	1.71	112653	412.94	< LOD	10.54	58.81	1.03			11115.6	151.61			1075.33	75.47	70.73	22.54	404.1	7.47	189.67	1.79
653	TP-MS-14(0-0.5)	1.23	148706	440.59	< LOD	8.68	60.19	0.9			5412.4	130.59			235.31	68.18	< LOD	36.93	504.2	7.14	163.75	1.44
654	TP-MS-14(0.5-1)	1	253567	572.55	< LOD	8.23	82.4	0.96			9676.3	157.66			256.68	77.19	< LOD	33.3	822.09	8.62	202.15	1.51
655	TP-MS-14(1-2)	1	277649	601.25	< LOD	7.83	80.14	0.92			5967.12	146.46			< LOD	149.16	< LOD	30.3	632.01	7.38	226.35	1.54
656	TP-MS-14(2-3)	1	262669	569.85	< LOD	7.22	72.75	0.83			3202.66	136.25			< LOD	143.26	< LOD	25.92	303.26	5.08	220.95	1.43
657	TP-MS-14(2-3.5)	1	275994	593.92	< LOD	7.61	73.88	0.87			4438.75	141.77			< LOD	149.06	< LOD	27.85	404.09	5.96	213.55	1.47
658	TP-MS-15(0-0.5)	1.46	129677	427.86	< LOD	9.96	48.48	0.93			2616.39	101.97			326.25	58.17	< LOD	85.19	8163.25	37.44	68.74	1.16
659	TP-MS-15(0.5-1)	1	192199	476.92	< LOD	6.98	60.65	0.76			1026.04	120.63			< LOD	131.08	< LOD	35.29	1755.04	11.53	167.69	1.24
660	TP-MS-15(1-2)	1	267524	579.95	< LOD	7.75	71.46	0.86			4260.81	134.21			< LOD	143.93	< LOD	27.01	257.39	4.93	212.15	1.47
661	TP-MS-15(1-2)DUP	1.04	274697	592.64	< LOD	7.79	71.25	0.87			4133.4	136.27			< LOD	147.83	< LOD	27.33	278.12	5.12	228.24	1.53
662	TP-MS-15(2-3)	1.17	252426	579.23	< LOD	8.16	76.21	0.92			6438.09	147.57			412.31	77.79	< LOD	27.62	250.5	5.06	228.12	1.59
663	TP-MS-15(3-3.7)	1.5	247701	560.03	< LOD	7.99	73.09	0.89			9585.62	158.66			182.15	77.67	< LOD	28.02	273.87	5.16	194.15	1.44
664	TP-MS-16(0.1-0.2)	1	181947	468.89	< LOD	7.97	37.59	0.69			4361.89	122.06			< LOD	125.88	< LOD	30.52	368.26	5.91	118.28	1.16
665	TP-MS-16(0.5-1)	1	155559	416.39	< LOD	6.74	51.51	0.68			1887.33	126.32			< LOD	132.64	< LOD	22.24	139.49	3.61	176.76	1.22
666	TP-MS-16(0.5-1)DUP	1	202748	488.45	< LOD	7.32	52.89	0.73			2045.01	129.42			< LOD	137.01	< LOD	24	141.68	3.89	178.22	1.31
667	TP-MS-16(1.7-2.5)	1	226278	519.7	< LOD	7.25	55.13	0.74			5001.6	139.54			< LOD	140.37	< LOD	24.06	124.98	3.65	203.33	1.37
668	TP-MS-16(3-3.5)	1	93488.1	276.8	< LOD	5.76	20.9	0.5			< LOD	197.53			< LOD	113.28	< LOD	18.99	132.43	3.32	52.11	0.68
669	TP-MS-16(3.5-4.5)	1	209203	502.2	< LOD	7.28	57.76	0.76			4214.88	146.52			< LOD	159.72	< LOD	25.59	192.04	4.34	167.85	1.27
670	TP-MS-16(4.5-5)	1	206393	508.2	< LOD	7.75	60.12	0.81			7009.18	155.8			475.37	82.19	< LOD	27.46	268.6	5.16	157.19	1.29
671	TP-MS-17(0-0.1)	1.43	234659	550.69	< LOD	8.28	52.75	0.8			5810.61	128.06			< LOD	130.06	< LOD	31.31	339.94	5.84	183.17	1.45
672	TP-MS-17(0-0.5)	1	203547	486.65	< LOD	7.33	47.41	0.7			2280.68	118.26			< LOD	126.68	< LOD	25.15	242.19	4.65	149.77	1.2
673	TP-MS-17(0.5-1)	1	270295	581.49	< LOD	7.4	65.46	0.81			2310.03	133.74			< LOD	141.39	< LOD	25.37	164.7	4.09	223.43	1.47
674	TP-MS-17(1-2)	1	122681	336.86	< LOD	6.11	37.86	0.57			< LOD	209.52			< LOD	118.14	< LOD	20.88	209.2	4.01	101.42	0.91
675	TP-MS-19(0-1)	1	42241.3	195.98	< LOD	6.21	12.88	0.5			< LOD	145.14			< LOD	86.45	< LOD	28.65	1275.71	9.28	14.32	0.52
676	TP-MS-19(1-2)	0.95	226528	549.47	< LOD	9.9	49.92	0.89			3457.68	110.92			244.58	60.65	< LOD	33.46	136.79	4.7	173.4	1.61
677	TP-MS-19(2-3)	1	247614	556.52	< LOD	8.61	59.55	0.86			3325.54	116.27			140.81	63.58	< LOD	28.43	162.28	4.43	176.85	1.46
678	TP-MS-19(3-3.4)	1.34	226124	536.86	< LOD	8.14	62.28	0.85			3086.85	127.46			255	71.54	< LOD	27.31	193.32	4.61	180.9	1.43
679	TP-MS-19(3.4-3.5)	1	224001	536.74	< LOD	8.27	58.32	0.83			3451.99	128.91			276.92	71.71	< LOD	27.83	175.98	4.5	195.97	1.49
680	TP-MS-20(0-0.5)	1.16	192090	478.89	< LOD	7.06	58.04	0.75			226.22	111.68			< LOD	127.11	< LOD	28.48	702.34	7.35	106.94	1.03
681	TP-MS-20(0.7-1)	1.11	229665	542.84	< LOD	7.74	61.11	0.81			3326.21	130.75			< LOD	143.91	< LOD	29.33	490.38	6.54	161.06	1.29
682	TP-MS-20(1-2)	1	254239	570.51	< LOD	8.16	65.9	0.87			2838.35	126.54			307.39	72.06	< LOD	31.77	710.76	8.04	174.99	1.4
683	TP-MS-20(1-2)DUP	1	316044	644.64	< LOD	7.76	90.54	0.97			3666.51	141.61			< LOD	149.83	< LOD	28.57	438.04	6.24	216.72	1.5
684	TP-MS-21(0-0.75)	1.04	142662	425.4	< LOD	8.27	46.9	0.79			1837.62	103.6			158.73	60.06	< LOD	42.18	1614.72	12.36	87.63	1.08
685	TP-MS-21(1.25-2.5)	1	227195	529.42	< LOD	7.53	97.46	0.98			2632.97	126.01			< LOD	138.57	< LOD	29.63	699.17	7.56	201.07	1.43
686	TP-MS-21(2.5-3.25)	1	264045	579.3	< LOD	8.31	67.19	0.89			2881.95	125.49			< LOD	138.44	< LOD	31.93	657.66	7.87	211.76	1.56
687	TP-MS-22(0-1)	1	197788	493.26	< LOD	8.65	54.2	0.84			3329	115.35			< LOD	124.96	< LOD	32.19	552.83	7.46	150.78	1.37
688	TP-MS-22(1-1.75)	1	240251	550.36	< LOD	8.31	64.61	0.87			5279.97	134.9			< LOD	139.49	< LOD	28.5	291.53	5.46	176.54	1.42
689	TP-MS-22 REP(0-1)REP	1	203475	500.41	< LOD	8.72	57.02	0.87			3593.34	116.97			< LOD	125.62	< LOD	32.73	559.81	7.57	152.98	1.4
690	TP-MS-23(0-1)	1	233384	556.08	< LOD	8.38	61.25	0.87			2758.34	112.25			< LOD	121.81	< LOD	33.36	688.68	8.18	148.32	1.35
691	TP-MS-23(1-2)	1.94	144864	442.63	< LOD	10.69	36.89	0.84			3403.07	105.25			542.9	59.67	< LOD	35.37	277.13	6.43	110.56	1.39
692	TP-MS-23 REP(1-2)REP	1.16	138133	432.46	< LOD	10.73	39.7	0.86			3504.5	105.78			642.24	60.48	< LOD	35.08	252.78	6.19	123.46	1.47
693	TP-MS-24(0-1)	1	291622	619.04	< LOD	7.8	75.3	0.9			3885.97	138.68			< LOD	144.86	< LOD	30.68	589.74	7.22	215.18	1.51

	G	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
1	SAMPLE	Se Error	Si	Si Error	Sn	Sn Error	Sr	Sr Error	Th	Th Error	Ti	Ti Error	U	U Error	V	V Error	W	W Error	Zn	Zn Error	Zr	Zr Error
694	TP-MS-24(0.1-0.15)	1.14	244787	570.2	< LOD	8.24	60.64	0.87			4478.5	127.13			< LOD	131.56	< LOD	37.66	863.95	8.91	157.41	1.37
695	TP-MS-24(1-2)	1.01	277270	599.14	< LOD	7.69	77.17	0.9			4044.6	142.75			< LOD	150.21	< LOD	28.71	410.48	6.06	217.62	1.5
696	TP-MS-24(2-3)	1	247269	558.04	< LOD	7.63	75.53	0.88			3436.28	134.65			< LOD	148.74	< LOD	28.68	509.11	6.6	197.55	1.42
697	TP-MS-24(3-4)	1	242551	554.99	< LOD	7.92	79.75	0.93			4656.28	134.94			173.85	72.25	< LOD	30.33	575.31	7.13	228.58	1.56
698	TP-MS-24(4.5-5.3)	1	284313	600.26	< LOD	8.08	86.34	0.97			5023.35	137.63			< LOD	142.96	< LOD	32.53	796.56	8.43	208.35	1.52
699	TP-MS-24(5.3-5.75)	1	277621	597.75	< LOD	8.39	76.74	0.94			8391.46	157.15			197.21	78.09	< LOD	34.49	694.58	8.1	230.61	1.63
700	TP-MS-25(0-0.3)	1.2	171534	474.6	< LOD	8.4	61.91	0.9			2788.4	112.53			< LOD	118.77	< LOD	59.39	4686.52	22.64	119.69	1.25
701	TP-MS-25(0.3-0.5)	1.6	225905	560.38	< LOD	9.88	65.41	1.03			7989.04	141.45			528.29	71.35	< LOD	53.81	2082.94	15.75	161.5	1.59
702	TP-MS-25(0.5-1)	1.6	167381	464.86	< LOD	8.54	56.25	0.9			2517.14	113.02			< LOD	126.6	< LOD	64.31	5048.74	23.32	103.12	1.22
703	TP-MS-25(0.5-1)DUP	1.68	177340	482.08	< LOD	8.99	58.16	0.94			3966.84	123.12			234.79	66.58	< LOD	64.92	4757.51	23.31	126.98	1.36
704	TP-MS-25(1-2)	1.63	233776	557.34	< LOD	8.39	64.84	0.88			4980.15	136.52			< LOD	141.24	< LOD	43.32	2079.72	14.11	191.92	1.5
705	TP-MS-25(2-3)	1	217074	532.67	< LOD	8.14	66.08	0.87			7763.74	151.53			< LOD	151.18	< LOD	34.48	1099.84	9.94	216.52	1.55
706	TP-MS-26(0-0.5)	1	179114	477.11	< LOD	8.04	58.93	0.84			3254.65	120.96			< LOD	127.19	< LOD	35.86	984.86	9.42	154.73	1.34
707	TP-MS-26(0.5-1)	1	242956	549.05	< LOD	7.8	75.48	0.89			4534.14	129.26			< LOD	135.27	< LOD	31.08	608.82	7.22	209.73	1.48
708	TP-MS-26(1-2)	1	233968	545.39	< LOD	7.86	69.15	0.87			3988.56	131.06			< LOD	138.87	< LOD	29.72	533.28	6.87	198.96	1.45
709	TP-MS-26(2-2.5)	1	273595	601.23	< LOD	8.23	72.29	0.91			5613.24	138.44			296.2	73.15	< LOD	31.79	657.83	7.8	205.19	1.52
710	TP-MS-27(0-0.5)	1	231201	536.21	< LOD	7.64	71.28	0.86			3750.34	129.82			< LOD	135.11	< LOD	28.97	531.75	6.72	217.93	1.49
711	TP-MS-27(0.5-1)	1	265210	582.13	< LOD	8.13	75.53	0.92			4746.81	137.45			< LOD	142.52	< LOD	31.67	528.19	7.01	234.44	1.61
712	TP-MS-27(1-1.5)	1	255864	569.35	< LOD	8.1	79.17	0.93			5536.56	138.55			< LOD	144.31	< LOD	31.52	617.95	7.46	223.12	1.56
713	TP-MS-27(1.5-2)	1	272616	601.87	< LOD	8.19	79.71	0.95			6312.55	147.64			157.47	76.25	< LOD	30.36	463.43	6.64	233.42	1.62
714	TP-MS-27(2-2.5)	1	281896	614.27	< LOD	8.18	78.92	0.94			6347.79	148.39			409.34	78.36	< LOD	30.12	473.43	6.69	221.08	1.57
715	TP-MS-27(2.5-3)	1	279431	607.28	< LOD	8.41	76.26	0.94			7758.64	147.91			443.89	75.72	< LOD	31.62	512.16	7.03	219.42	1.59
716	TP-MS-27(3-3.5)	1	235903	560.36	< LOD	8.8	70.99	0.95			4553.57	123			434.28	67.04	< LOD	33.31	639.97	8.04	206.72	1.61
717	TP-MS-27(3.5-4)	1	255776	577.69	< LOD	8.74	97.43	1.11			5112.05	131.44			624.86	71.89	< LOD	34.64	757.66	8.8	210.17	1.65
718	TP-MS-4A(0-1.0)	1.36	115773	384.04	< LOD	9.52	35.74	0.78			6031.8	129.91			204.01	66.08	< LOD	40.69	720.8	9.01	123.88	1.35
719	TP-MS-4A(1-2)	2.03	122841	407.37	< LOD	10.06	32.87	0.77			8779.17	141.37			803.94	71.89	< LOD	51.45	2211.81	16.46	144.99	1.49
720	TP-TS-01(.5-1)	1.28	182457	483.71	< LOD	9.34	64.74	0.96			6937.64	130.43			351.33	65.98	< LOD	38.51	602.38	8.03	151.84	1.45
721	TP-TS-02(.6-.9)	1.64	187624	507.27	< LOD	10.13	45.79	0.9			10371.6	151.38			754.46	74.43	62.99	21.75	464.39	7.7	158.38	1.59
722	TP-TS-02(1.5-2)	1	306188	615.78	< LOD	7.64	68.39	0.84			2732.74	134.91			< LOD	144.04	< LOD	26.4	204.03	4.48	232.97	1.53
723	TP-TS-03(.1-.2)	1.36	198017	511.01	< LOD	9.46	56.22	0.92			8594.22	140.58			511.99	69.94	< LOD	39.05	459.63	7.27	162.31	1.53
724	TP-TS-03(1.8-2)	1	314232	632.48	< LOD	7.49	86.02	0.92			2275.7	133.18			< LOD	147.17	< LOD	25.59	217.42	4.51	230.67	1.5
725	TP-TS-03A(1.8-2)	1	296373	605.71	< LOD	7.47	98.02	0.97			3374.34	136.58			< LOD	147.32	< LOD	25.63	228.86	4.6	233.49	1.51

Drill Hole No. TP-BULK-01

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/24/12 - 7/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5408.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1026331.9, E1257247.5	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist to Saturated, Brown, Rusty brown zones, POORLY GRADED GRAVEL with SAND, GP, angular, non-plastic, DEBRIS FLOW with MIXED TAILINGS, estimated 10% Boulders, 30% Cobble, 40% Gravel, 20% Sand, max. particle size is 14-in.						
		2												
		3												
		4												Water seeping in at 4 ft. during excavation
		5												Trees, roots and logs mixed in from 4.5' to 6.5'.
		6												
		7												
		8			X			Saturated, Brown, WELL GRADED GRAVEL with SAND, GW, subangular, non-plastic, ALLUVIUM, max particle size = 24-in. Bulk Sample Gradation from 8.0 to 8.5 ft: 16% Boulders and Cobbles, 57% Gravel, 23% Sand, and 4% Fines (15% finer than #10 sieve). BOH = 8.5 ft.						(8) 5-Gallon Buckets No Piezometer Installed
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

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Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-BULK-02

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/30/12 - 7/30/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5351.70 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1027606.9, E1256810.5	HAMMER TYPE:

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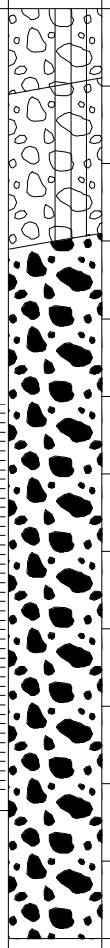
WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist, Orangish Brown, POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, contains fine roots, MIXED TAILINGS, max particle size is 10-in. Estimated 20% Cobbles, 40%Gravels, 40%Sand.						
		2						Moist, Orangish Brown, POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, MIXED TAILINGS, surface of Cobbles and Gravels are stained black.						
		3						Moist to Saturated, Brown, WELL GRADED GRAVEL with SAND, GW, non-plastic, ALLUVIUM, Boulders and Cobbles are subangular, Gravels are subrounded, max particle size is 16-in.						Groundwater at 3 ft. while excavating
		4												
		5												
		6			X									(8) 5-Gallon buckets
		7						Bulk Sample Gradation from 6.0 to 7.0 ft: 16% Boulders and Cobbles, 59% Gravel, 22% Sand, and 3% Fines (17% finer than #10 sieve).						
		8												
		9												
		10												
		11												
		12						BOH = 12 ft.						Piezometer installed
		13												
		14												
		15												
		16												
		17												

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Billings, Montana 59101

PHONE NUMBER: 406-259-2412

Drill Hole No. TP-BULK-03

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/6/12 - 8/6/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5318.60 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1028458.9, E1255732.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist, Light orangish brown, SILTY SAND with Gravel, SM, subangular, Debris flow.						
▼		2						Saturated, Brown [7.5YR 4/2], WELL GRADED GRAVEL with SAND, GW, subrounded, ALLUVIUM, Black Manganese staining on surface of particles.						Groundwater at 2 ft. while excavating Sidewalls of alluvium continually caved in
		3						Saturated, Brown, WELL GRADED GRAVEL with SAND, GW, subrounded, non-plastic, ALLUVIUM, max particle size is 14-in.						
		4												Groundwater at 2' 431.9vrmV 250.2µ/cm pH=6.55 @ start pH=6.57 @end (39 minutes)
		5			X			Bulk Sample Gradation from 5.0 to 5.5 ft: 11% Boulders and Cobbles, 67% Gravel, 21% Sand, and 1% Fines (13% finer than #10 sieve).						Piezometer not installed.
		6						BOH = 5.5 ft						
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-BULK-04

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/14/12 - 8/14/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5271.85 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1029138.9, E1254374.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist to wet, Brown, POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM, estimated 10% Subangular Cobble, 50% Subrounded generally fine Gravel, and 40% Sand. Gravels generally flat, elongated, and laying flat.						TP-BULK-04 located in flood plain about 50 feet from stream. (1) 5-Gallon Bucket 2.5-3.5'
▼		2						Saturated, Brown, POORLY GRADED SAND with GRAVEL, SP, non-plastic, ALLUVIUM, Bulk Sample Gradation from 2.5 to 3.5 ft: 26% Gravel, 73% Sand, and 1% Fines (58% finer than #10 sieve).						Groundwater observed at 2 to 2.5' while excavating GW@2.5' 509 rmV 405 µs/cm pH=6.60 @ start pH=6.22 @ end (43 minutes)
		3												
		4						Saturated, Brown, POORLY GRADED SAND with GRAVEL, SP, non-plastic, ALLUVIUM, Black Manganese staining on surface of particles..						GW @ 4.0' 453.4 rmv 389 µs/cm pH=6.47 @ start pH=6.47 @ end
								Saturated, Brown, WELL GRADED SAND, SW, non-plastic, fine to medium grained, iron staining at bottom of layer.						
		5						Saturated, Gray, POORLY GRADED SAND, SP, non-plastic, MIXED TAILINGS with pockets of black organics, fine grain, visible pyrite.						
		6						BOH = 5.7 ft.						
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-BULK-04A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/14/12 - 8/14/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5271.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1029148.9, E1254384.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		0–3						Dry, Rusty brown, POORLY GRADED GRAVEL with SAND, GP, subangular to subrounded, non-plastic, MIXED TAILINGS, with Cobbles.						Groundwater not observed. Approximately 50' NE of TP-Bulk-04
		3–10						Moist, Brown, WELL GRADED GRAVEL with SAND, GW, subrounded, non-plastic, ALLUVIUM, moisture content increases with depth, max particle size = 10-in.						
		7			X			Bulk Sample Gradation from 7.0 to 7.5 ft: 18% Boulders and Cobbles, 59% Gravel, 22% Sand, and 1% Fines (13% finer than #10 sieve).						(8) 5-Gallon Buckets from 7-7.5'
		9												No groundwater encountered
		10						BOH = 10 ft.						Piezometer not installed.

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-BULK-05

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/15/12 - 8/15/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5239.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1030373.9, E1252931.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Rusty brown, SILTY SAND, SM, non-plastic, MIXED TAILINGS, pockets of brownish gray tailings with Pyrite.						
		1			X			Moist to Saturated, Brown, WELL GRADED GRAVEL with SAND, GW, non-plastic, ALLUVIUM, wood debris (branches/stump) from 2 to 3 ft depth, Black Manganese staining on surface of gravels at 4 ft., max particle size = 6-in.						
		2						Sample Gradation from 1.0 to 2.0 ft: 1% Boulders and Cobbles, 62% Gravel, 34% Sand, and 3% Fines (22% finer than #10 sieve).						
		3												
		4												
		5			X									(8) 5-Gallon buckets
▼		6												Groundwater at 5.5 ft. while excavating
		7						Bulk Sample Gradation from 5.0 to 6.0 ft: 2% Boulders and Cobbles, 63% Gravel, 33% Sand, and 2% Fines (21% finer than #10 sieve).						
		8						BOH = 8 ft.						Piezometer not installed.
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-BULK-06

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/28/12 - 8/28/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5211.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1030242.9, E1251368.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist to Saturated, Brown, GRAVEL with Sand, GP, gravels are generally flat and subrounded, cobbles are generally blocky and subangular, trace black Manganese staining on surface of particles, particles are horizontally layered. Alluvium						Test pit located in dry stream channel
		2												Groundwater at 2.3 ft while excavating
		3			X			Bulk Sample Gradation from 3.0 to 4.0 ft: 10% Cobbles, 59% Gravel, 27% Sand, and 4% Fines (17% finer than #10 sieve).						Bulk sample (8) 5-Gallon buckets
		4												GW@2.5' 459.2 mV 252.9 µs/cm pH= 6.54 @ start pH=6.54 @ end (18 minutes)
		5												
		6						BOH = 6 ft.						Piezometer not installed.
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-BULK-07

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/29/12 - 8/29/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5200.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1030703.9, E1250409.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X	07		Wet, Very dark brown [10YR 2/2], PEAT, PT, medium plasticity, organic odor, dilatent Bulk Sample Gradation: 5% Gravel, 42% Sand, and 53% Fines (92% finer than #10 sieve).						Test pit located about 12 ft upstream from TP-MS-05. (1) 5-Gallon bucket
		2			X	07		Wet to Saturated, Dark brown [7.5YR 3/3] Brown [7.5YR 4/4], POORLY GRADED GRAVEL with SAND, GP, subangular to subrounded, non-plastic, ALLUVIUM. Bulk Sample Gradation: 60% Gravel, 32% Sand, and 8% Fines (28% finer than #10 sieve).						(8) 5-Gallon buckets Groundwater at 2 ft. while excavating
		3						BOH = 3.0 ft.						Piezometer not installed.
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-01 East

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/23/12 - 7/23/12	DRILLER: ESD
LOGGED BY: PR	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5432.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1026040.9, E1257029.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Yellow-rusty brown, CLAYEY GRAVEL with Sand, GC, loose, Fill, mixed tailings.						Test pit excavated into hill side below (east) townsite. Test pit excavated to a depth of 7 ft (Measuring Point for test pit is the highest point excavated into hill side).
		1												
		2												
		3												Fill layer first observed at 0.5 ft depth. Horizontal thickness of Fill increases with depth to a maximum horizontal thickness of 3 ft at the bottom of the test pit.
		4												
		5												Possible fill, but no tailings at GWT interface
		6												
▼		7						BOH = 7 ft.						Groundwater encountered at 7 ft depth which is approximately corresponds with Beartrap Creek surface water elevation.
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-01 West

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/23/12 - 7/23/12	DRILLER: ESD
LOGGED BY: PR	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5432.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1026041, E1257030-Est from Map	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Light reddish gray brown, POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, dense, Native Soil.						Test pit excavated into hill side below (east) townsite. Test pit excavated to a depth of 7 ft (Measuring Point for test pit is the highest point excavated into hill side).
		1												
		2												
		3												Fill layer first observed at 0.5 ft depth. Horizontal thickness of Fill increases with depth to a maximum horizontal thickness of 3 ft at the bottom of the test pit.
		4												
		5												Possible fill, but not tailings at GWT interface
		6												
▼		7						BOH = 7 ft.						Groundwater encountered at 7 ft depth which is approximately corresponds with Beartrap Creek surface water elevation.
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-02

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/23/12 - 7/23/12	DRILLER: ESD
LOGGED BY: PR	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5435.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1026135.9, E1257102.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist, Reddish Brown, CLAYEY GRAVEL with Sand, GC, low plasticity, loose, Gravels and Cobbles up to 12" in diameter and angular.						
		2												
		3												Test pit caves easily at 3 ft
		4												
		5												(3) 5-Gallon buckets
		6							33	18				
		7												
		8												
		9						Moist to Saturated, Yellowish Rust, POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, Mixed tailings with cobbles up to 12 in. diameter. Grades to rust color at 10.5 to 11.5'.	22	19				Panned abundant fine pyrite approximately #20 size
		10												Groundwater at 9.5' while excavating
		11												
		12						Saturated, Grayish brown [2.5Y 5/2], SILTY GRAVEL with Sand, GM, MN layer at 12 ft. Grades to greyish brown color at 12 ft..						Black MN stained layer at 11.5 -12.0'. Variable in thickness from 4 to 6". Changes to gray-brown below 12'.
		13						BOH = 13' from upper side of test pit.						No Piezometer Installed
		14												
		15												
		16												
		17												

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ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-03

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/24/12 - 7/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5412.70 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026267.2 ,E1257161.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist, Dark brown [10YR 3/3], CLAYEY GRAVEL with Sand, GC, angular, low plasticity, Rock particles are approximately 12" minus and are well graded. Debris flow. Layer of coarse gravel at 3.5'.						
		2			X									
		3			X									
		4			X			Moist, Dark yellowish brown [10YR 4/6], SILTY GRAVEL with Sand, GM, angular, Rock particles are approximately 4-in minus and are well graded. Debris flow..						Mixed tailings, panned & observed trace pyrite at 3.5-5ft
		5			X			Moist to Saturated, Brown [7.5YR 4/3], CLAYEY GRAVEL with Sand, GC, angular to subangular, low plasticity.						
		6			X									
		7												
▼		8			X			Saturated, Dark brown [7.5YR 3/2] Black, GRAVEL with Silt and Sand, GP-GM, subangular, Particles are subangular and 2 to 3-in in size at 7.6 ft. Particle size decreased with depth.						Groundwater at 7.5' while excavating @7.5' GW 443.4 rmv, 1030 µs/cm, pH start 6.58, pH end 6.36 (12 min)
		9			X									@ 9' GW 439.6 rmv, 580µs/cm, pH start 6.94, pH end 6.35 (8 min)
		10						Saturated, Dark brown [7.5YR 3/4], CLAYEY GRAVEL with Sand, GC, subangular, low plasticity, Rock particles are 4-in minus and colored black.						
		11												Stream Water, 340.9 Rmv, 229.4 µs/cm, ph start 7.60, pH end 8.18 (13 min)
		12			X									Installed 2" PVC to 9.3' Stickup 4.75' 0-4' Blank 4-9' 0.020" slot
		13						BOH = 12.5 ft.						
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-04

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/24/12 - 7/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5413.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83)1026254.5, E1257208.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist, Olive [5Y 5/6] Purplish gray, POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, angular, non-plastic, Argillite cobbles imbedded with mixed tailings. Debris flow. Argillite is angular 1-in to 12-in in size. Estimated 25% Cobbles, 40% Gravel, and 35% Sand.						
		2			X									
		3			X									Groundwater at 2.7' while excavating @ 2.7ft GW 449.4 rmv, 594.0 µs/cm, pH start 7.86 pH end 6.56 (17 Minutes) Appreciable amount of pyrite observed when silty sand was panned.
		4			X			Saturated, Dark reddish brown [5YR 3/3] Very dark brown [7.5YR 2.5/2], SILTY SAND with Gravel, SM, low plasticity, Estimated 20% gravel, 80 % sand. Sand particles are primarily fine to medium grained. Max particle size is 4", contains wood, roots and black coatings on gravels, debris flow.						
		5												
		6						Saturated, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, Estimated 30% Cobble, 40% Gravel, 20% Sand and 10% Fines. Particles approximately 7-in minus. Alluvium.						Water flowing freely at 6.0' Appreciable amount of pyrite observed when panned.
		7			X									
		8			X									@ 7.5ft GW 396.7 rmv, 581 µs/cm, pH start 6.63 pH end 6.70 (6 Minutes)
		9			X			Saturated, Very dark brown [10YR 2/2], SILTY GRAVEL with Sand, GM, subangular, Estimated 5% Boulder, 20% Cobbles, 40% Gravel, 25% Sand, and 10% Fines. Approximately 10" minus particle size. Alluvium.						
		10						BOH = 10 ft.						Installed 2" diameter PVC to 8.1' Screened 0.020" 2.8-7.8' Blank 2.8' to surface
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering

ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-05

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/24/12 - 7/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5412.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83) N1026246.2, E1257254.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/4], GRAVEL with Sand, GP, non-plastic, Mixed Tailing: Gravelly Sand with Silt and Argillite Cobbles. Estimated 20% Cobbles, 20% Gravel, 50% Sand, and 10% Fine, approximate 12 inch maximum particle size, Debris flow.						
		2			X									
		3			X									Groundwater at 2.5' while excavating @ 2.5ft GW 387.1 rmv, 701 µs/cm, pH start 7.23 pH end 5.85 (12 minutes) Lots of roots encountered Encountered wood debris and Test Pit repeatedly caved in at 4 ft
		4			X			Saturated, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, angular, non-plastic, Random pockets of black, wet, Sandy CLAY. Estimated 5% Boulder, 40% Cobbles, 30% Gravel, 20% Sand, and 5% Fines between 3.8 and 8.5 ft. Particles are randomly oriented. Debris flow. Large cobbles 8 -8.5'..						
		5												Very black from 5 to 5.5', potential Mn staining. Blackish brown 3.8-5.0' and 5.5-8.5'
		6			X									
		7												
		8			X									High rock content and difficult to dig from 8 to 8.5 ft Relatively easy to dig at 8.5 to 9.5 ft @ 8.5ft GW 467.5 rmv, 683 µs/cm, pH start 5.75 pH end 5.17 (12 Minutes)
		9			X			Saturated, Dark reddish brown [5YR 3/2], GRAVEL with Sand, GP, subrounded, loose, Estimated 30% Cobble, 45% Gravel, 20% Sand and 5% Fines between 8.5 and 9.5'. Alluvium..						
		10						BOH = 9.5 ft.						Installed 2" diameter PVC to 8.4 0.020" screen at 3.1-8.1' Blank 3.1' to surface
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-06

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/24/12 - 7/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5411.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83)N1026243.9 E1257286.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Very dark brown [10YR 2/2], SILTY SAND with Gravel, SM, non-plastic, MIXED TAILINGS, with organic roots, Debris Flow.						Test Pit immediately caved in.
		1						Moist to Saturated, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, angular, DEBRIS FLOW. Estimated 15% Cobble, 40% Gravel, 30% Sand and 15% Fines. Rock predominately argillite composition.						Twigs and Trees buried from 1 to 4 ft
		2			X									Groundwater at 2' while excavating @ 2 ft 368.9 rmv, 680 ms/cm pH start 6.05 pH end 6.15 (17 Minutes) Visually observe abundant pyrite from 1 to 7'
		3												
		4												Layer of organic roots bisects through debris flow from a depth 4 to 6 ft
		5			X									
		6												
		7			X			Wet, Dark brown [7.5YR 3/4], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, angular, low plasticity, loose, DEBRIS FLOW. Estimated 15% Cobbles, 40% Gravel, 25% Sand, and 20% Clay. Rock particles are predominately Argillite. Max particle size is approximately 6-in.						
		8						Wet, Dark brown [7.5YR 3/3], GRAVEL with Sand, GP, subangular, ALLUVIUM, Sandy Gravel with Cobbels. Estimated 5% Boulder, 30% Cobble, 50% Gravel, and 25% Sand. Rock particles are 12-in minus.						Visually observe pyrite in soil from 8 to 9', but less than 1-7'
		9			X			BOH = 9 ft.						@ 8.5ft 372.6 rmv, 603µs/com, pH start 7.19 pH end 6.57 (16 Minutes) Bedrock at 9 ft
		10												No Piezometer Installed
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-06A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/25/12 - 7/25/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5411.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83)N1026243.9 E1257286.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist, Brown, POORLY GRADED SAND with Clay and Gravel, SP-SC, angular, low plasticity, Maximum particle size is approximately 16 in. Gravel content increases at 3 ft depth.						Test pit excavated into hill side adjacent to TP-FP-06. The measuring point references the elevation on the hill side the test excavation started. The flood plain is located at a depth of 6 ft relative to the Measuring Point.
		2			X				28	21				
		3												
		4												
		5												
		6			X			Moist to wet, Yellowish rusty brown, POORLY GRADED GRAVEL with Clay and Sand, GP-GC, Debris Flow, MIXED TAILINGS, Maximum particle size is approximately 8-in.	22	17				The Mixed Tailing was only observed in the portion of the test pit excavated below the flood plain.
		7												
		8												Black Mn layer not observed
		9						Moist to wet, Brown, POORLY GRADED GRAVEL with Clay and Sand, GP-GC, subangular, low plasticity, Moisture content increases at 11.5 ft depth. Color grades to light brown and subangular particles below the 11.5 ft depth.						Water not visually flowing into the test pit
		10												
		11												
		12												
		13												
		14												Installed 2" diameter PVC to 13.5' 0.020" Screen 8.2-13.2' Blank 8.2' to surface
		15												
		16			X									
		17						BOH = 16.5 ft.						

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-06B

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/25/12 - 7/25/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5399.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD83)N1026670.8, E1257135.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist to wet, Brown, POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, angular to subangular, medium dense, NATIVE SOIL, maximum particle size is approximately 15-in.						Test pit excavated into hill side. The measuring point references the elevation on the hill side the test excavation started. The flood plain is located at a depth of 4 ft relative to the Measuring Point. Live tree roots observed in the top 2 ft
		2												
		3							21	18				
		4						Moist to Saturated, POORLY GRADED GRAVEL with Clay and Sand, GP-GC, angular to subangular, medium dense.						
		5												Mixed tailings and black Mn layer not observed
		6												
		7												
		8												Soil profile very consistent throughout entire test pit
		9												
		10												Piezometer bent during backfilling. Piezometer is aligned approximately 10 degrees from vertical Groundwater at 11' while excavating
▼		11												
		12							28	17				
		13						BOH = 13 ft.						Installed 2" diameter PVC to 13' 0.020" screened 7.7-12.7' Blank 7.7' to surface
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-07

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/25/12 - 7/25/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5379.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026934.1, E1257034.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist to wet, Brown [7.5YR 4/4], SILTY SAND, SM.						Test pit excavated into hill side. The measuring point references the elevation on the hill side the test excavation started. The flood plain is located at a depth of 5 ft relative to the Measuring Point.
		1			X			Moist to wet, Brown [7.5YR 4/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, medium dense to dense, NATIVE SOIL (Colluvium) Max particle size is 14-in. Estimated 10% Boulders, 30% Cobbles, 40% Gravel, 20% Sand. Debris Flow.						
		2			X									
		3			X									Water immediately filled pit to 4.0' below ground surface of floodplain
		4												
		5												The Mixed Tailing and Manganese were only observed on the north end of the test pit (closest to Beartrap Creek) @ 5ft GW 472.8 rmv, 473µs/cm, pH start 8.34 pH end 6.77 (14 Minutes) Manganese coated layer contains high visible pyrite content
		6						Moist, Reddish brown [5YR 4/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, low plasticity, medium dense to dense, Debris Flow.						
								Wet, Black [5Y 2.5/1], GRAVEL with Sand, GP, subangular to subrounded, medium dense to dense, Black Manganese coated Gravels, Estimated 70% Gravel and 30% Sand.						
		7			X			Wet, Dark reddish brown [5YR 3/3], GRAVEL with Sand, GP, subangular to subrounded, medium dense to dense, ALLUVIUM, contains Cobbles and Boulders. Max particle size is 20-in. Estimated 10% Boulder, 25% Cobble, 40% Gravel, 20% Sand, and 5% Clay. Some Colluvium towards slope.						
		8			X									
		9												
		10												Old Townsite septic system may be located above test pit
		11			X									
		12			X			BOH = 12 ft.						Installed 2" diameter PVC to 12.0' 0.020" screen 5-10' Blank 0-5'
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-08

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/25/12 - 7/25/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5378.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026954.6, E1257088.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist to Saturated, Dark yellowish brown [10YR 3/6] Dark brown [7.5YR 3/4], SILTY GRAVEL with Sand, GM, subangular to subrounded, MIXED TAILINGS with Cobbles, Material orientation is jumbled, Max particle size is 6-in. At 2 ft depth, estimated 30% Cobble, 40% gravel, 30% Sand, and 5% Clay. Coloring transitions from a rusty color to a brown color at 3 ft depth. White calcite observed on surface of some of the gravels at 3 ft depth, below rust colored layer. Below 3' contains mixed tailings with high percentage of pyrite. Debris flow.						Tree roots observed to 3 ft depth
▼		2			X									Groundwater at 2 ft while excavating (approximately corelates with Beartrap Creek water elevation)
		3			X									@ 2ft GW 475.7 rmv, 357.0 µs/cm, pH start 6.64 pH end 4.83 (15 Minutes) Visual pyrite content increases at 3 ft
		4			X			Wet, Black [7.5YR 2.5/1], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, Black Manganese coated Gravels.						
		5			X			Wet, Dark brown [7.5YR 3/4], SILTY GRAVEL with Sand, GM, subangular to subrounded, MIXED TAILINGS with Cobbles. Debris Flow.						
		6			X			Very dark brown [7.5YR 2.5/2] Dark brown [7.5YR 3/4], SILTY GRAVEL with Sand, GM, subrounded, ALLUVIUM, At 6 ft depth estimated 40% Cobble, 40% Gravel, and 20% Sand with a little clay. At 8 ft depth estimated 10% Boulder, 30% Cobble, 30% Gravel, and 30% Sand. Maximum particle size is approximately 18-in.						@ 6ft GW 452.2 rmv, 966.0 ms/cm, pH start 5.62 pH end 5.79 (14 Minutes)
		7												
		8			X									Installed 2" diameter PVC to 8.0' 0.020" Screen 2.7-7.7' Blank 0-2.7'
								BOH = 8.5 ft.						
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-09

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/25/12 - 7/25/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5380.20 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026966.2, E 1257106.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist to Saturated, Dark reddish brown [5YR 3/4] Dark gray [10YR 4/1], SILTY GRAVEL with Sand, GM, subangular, DEBRIS FLOW with MIXED TAILINGS, pockets of highly plastic clay. Maximum particle size is approximately 12-in., estimated 20% Cobble, 30% Gravel, 40% Sand, and 10% Fine Reddish layer 2.5-3.0'.						Minor amounts of Pyrite visually observed between 2 and 3 ft depths Wood debris observed at 2 ft depth Groundwater at 2.5' while excavating @ 2.5ft GW 620.3 rmv, 1744 µs/cm, pH start 3.03 pH end 3.02 (13 Minutes) Reddish colored groundwater slowly seeped into test pit at 3 ft depth. pH of water was measured at 3.0
		2			X									
		3			X									
		4						Wet, Dark gray [10YR 4/1], SANDY ELASTIC SILT, MH, high plasticity, Layer thickness varies from 0.2 ft on the north side to 0.8 ft on south side of test pit.						
		5			X			Wet, Dark brown [7.5YR 3/4], POORLY GRADED GRAVEL with SAND, GP, subangular, medium dense, ALLUVIUM, fresh Pyrite visible throughout alluvium layer, larger particles are subangular, 1/2-in minus particles tend to be subrounded. Alluvium gets cleaner (less fines) with depth. At 4.5 ft depth maximum particle size is approximately 12-in and estimated 30% Cobbles, 40% Gravel, 30% Sand. At 8.0 ft depth maximum particle size is approximately 28-in and estimated 20% Boulders, 30% Cobbles, 30% Gravel, 20% Sand.						Large tree root observed on north side of test pit at 3.5 to 4.0 ft depth. Tree root may have been near original ground surface prior to dam breach
		6												
		7												
		8			X									@ 7.5ft GW 331.9 rmv, 292.0 µs/cm, pH start 5.48 pH end 6.18 (13 Minutes) Installed 2" diameter PVC to 8.25' 0.020" Screen 3-8' Blank 0-3'
								BOH = 8.5 ft.						
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-10

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/26/12 - 7/26/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5379.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026981.4, E1257138.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist to Saturated, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, subangular, low plasticity, NATIVE soil. Estimated 15% Cobble, 20% Gravel, 45% Sand, and 20% Fines Colluvium from slope.						TP-FP-10A was logged in the same test pit at TP-FP-10. TP-FP-10A is located 10 ft closer to Beartrap Creek than TP-FP-10. Measuring point for TP-FP-10A is about 2 ft lower than TP-FP-10
		2			X									
		3												@ 4' GW 563.3 rmv, 203.6 µs/cm, pH start 7.92 pH end 6.80 (18 Minutes) TP-FP-10 excavated into hill side on east side of Beartrap Creek. Measuring point is located on hill side about 2 ft above surface of flood plain Groundwater flowed into test pit from upstream side at 4 ft depth Tree roots at 4 ft
▼		4			X									
		5												
		6			X			Saturated, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, rounded to subrounded, Maximum particle size is approximately 20-in, estimated 10% Boulder, 25% Cobble, 40% Gravel, 25% Sand Alluvium.						
		7												
		8			X			Wet, Dark yellowish brown [10YR 4/4], Argillite BEDROCK. Excavator able to break rock into angular, gravel size particles. BOH = 8.5 ft.						Bedrock at 8 ft, Excavator breaking rock particles to dig @ 8.5ft GW 554.9 rmv, 200.7 µs/cm, pH start 7.78 pH end 6.99 (23 Minutes) Piezometer installed in TP-FP-10A location
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-10A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/26/12 - 7/26/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5379.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026981.4, E1257138.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist to wet, Very dark brown [7.5YR 2.5/2], POORLY GRADED SAND with Silt and Gravel, SP-SM, subangular, low plasticity, Debris Flow.						TP-FP-10A was logged in the same test pit at TP-FP-10. TP-FP-10A is located 10 ft closer to Beartrap Creek than TP-FP-10. Measuring point for TP-FP-10A is about 2 ft lower than TP-FP-10
		1			X			Wet, Yellowish red [5YR 4/6], SILTY GRAVEL with Sand, GM, subangular, medium plasticity, MIXED TAILINGS. Estimated 30% Gravel, 40% Sand, 30% Fines Possible Debris Flow.						
		2			X			Wet, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, Black Manganese Layer. Estimated 10% Cobble, 20% Gravel, 50% Sand, and 20% Fines with organic roots.						Lots of plant roots in Mixed Tailing at 0.25 ft depth
		3						Wet, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SAND, GP, subrounded, non-plastic, ALLUVIUM. Estimated 30% Cobble, 50% Gravel, and 20% Sand.						
▼		4			X									Groundwater at 4 ft while excavating
		5												
		6						BOH = 5.5 ft.						Installed 2" diameter PVC to 3.7' 0.020" screen 0-3.7'
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-11

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/26/12 - 7/26/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5359.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027428.9 E1256833.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Brown, ORGANIC SILTY SAND, SM, TOPSOIL.						
								Moist, Dark reddish brown [5YR 3/4], SILT with Gravel, ML, MIXED TAILINGS. Plant roots at 0.1 - 0.5 ft.						
		1			X			Moist, Dark reddish brown [5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, Former Topsoil?, fine to medium grain, high percentage of plant and tree roots from 0.5 to 1.5 ft						
▼		2			X			Large particles subangular, small particles subround to round.						
								Wet, Dark reddish brown [5YR 2.5/2] Black, POORLY GRADED GRAVEL with SAND, GP, low plasticity, Black Manganese layer. Layer is about 0.2 ft thick. Appreciable amount of organic roots.						@ 2ft GW 525.6 rmv, 488.0 µs/cm, pH start 7.36 pH end 6.18 (22 Minutes)
		3						Saturated, Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, ALLUVIUM, large particles are subangular, 1/2-in minus particles are subrounded and rounded. Max particle size is approximately 12-in, estimated 25% Cobble, 50% Gravel, and 25% Sand. Alluvium contained fewer fines below 4 ft depth.						Groundwater freely flowing into test pit from all sides at 8.5 ft depth
		4			X									
		5												
		6												
		7			X									
		8												
		9						BOH = 9 ft.						@ 9ft GW 507.4 rmv, 455.0 µs/cm, pH start 7.59 pH end 6.91 (31 Minutes)
		10												
		11												Installed 2" PVC to 7.5' 0.020" Screen 2-7' Blank 0-2'
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-12

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/26/12 - 7/30/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5358.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027451.4 E1256895.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, MIXED TAILINGS. Estimated 30% cobble, 40% gravel and 30% sand Debris flow becomes reddish brown from 1.3-1.6'.						
		2			X			Moist, Black [7.5YR 2.5/1], ORGANIC SILTY SAND, OL, Black Manganese Layer.						
					X			Moist, Dark reddish brown [5YR 2.5/2], SILTY SAND with Gravel, SM, visible Pyrite.						@ 2ft GW 701.2 rmv, 1733 µs/cm, pH start 3.23 pH end 3.27 (20 Minutes)
▼		3			X			Wet, Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, subangular to subrounded, ALLUVIUM, max particle size is approximately 20-in, particles horizontally deposited.	26	24				
		4												
		5												
		6			X									
		7												
		8			X									
		9												
		10			X			BOH=10.0'.						Installed 2" diameter PVC to 10.0' 0.020" Screen 4.7-9.7' Blank 0-4.7'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-13

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/30/12 - 7/30/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5358.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027486.5, E1256925.8	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/3], POORLY GRADED SAND with GRAVEL, SP, subangular, Estimated 40% Gravel, 60% Sand. Soil layer contains a lot of dead tree roots.						
		2			X			Moist, Dark reddish brown [5YR 2.5/2], SILTY SAND with Gravel, SM, subangular, no to low plasticity, MIXED TAILINGS, medium grained sand, visible Pyrite on surface of gravels, occasional layers with a darker reddish hue, largest particle is approximately 6-in. Debris flow.						@ 2.6ft GW 447.8 rmv, 288.5 µs/cm, pH start 6.87 pH end 5.51 (26 Minutes) Groundwater at 2.6ft while excavating
▼		3			X									
		4			X			Wet, Black [10YR 2/1], SILTY GRAVEL with Sand, GM, subangular, Black Manganese Layer, generally 2 to 3-in thick, depth of layer varies across test pit profile from 1.9 to 3.9 ft depth. Estimated 20% Cobbles, 50% Gravel, and 30% sand.						Bedrock particles are angular due to fracturing with excavator. Largest particle is approximately 20-in diameter as excavated
		5						Very dark brown [7.5YR 2.5/2], angular, BEDROCK, max particle size is approximately 20-in as excavated. BOH = 5.0 ft.						@ 5ft GW 456.9 rmv, 326.0 µs/cm, pH start 5.73 pH end 5.63 (25 Minutes) Bottom of test pit is approximately 2 ft below Beartrack Creek elevation. Installed 2" diameter PVC to 4.0' 0.020" Screen 0-4'
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-14

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/30/12 - 7/30/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5358.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027466.8, E1256911.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, subrounded, non-plastic, Max particle size is approximately 8-in, estimated 20% Cobble, 50% Gravel and 30% Sand. Depth of layer varies between 0.2 and 1.4 ft. Random orientation of particles. Debris flow.						
		2			X			Wet, Dark reddish brown [2.5YR 3/4], SILTY GRAVEL with Sand, GM, subrounded, non-plastic, MIXED TAILINGS, Max particle size is 8-in, estimated 20% Cobble, 50% Gravel and 30% Sand Debris Flow. Roots appear to be pre-flood.						Groundwater at 1.4 ft which is approximately same elevation as Beartrap Creek @ 2ft GW 702.0 rmv, 1074 µs/cm, pH start 3.42 pH end 3.51 (11 Minutes)
		3			X			Saturated, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, Black Manganese stained ALLUVIUM. Max particle is approximately 8-in, estimated 30% Cobbles, 50% Gravel, and 20% Sand. Cobbles are subangular, gravels and sands are subangular to subrounded. Sand particles are primarily coarse grained.						
		4			X			Saturated, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, subangular to subrounded, ALLUVIUM, Max particle size is approximately 18-in, estimated 15% Boulder, 30% Cobble, 30% Gravel, and 25% Sand. Particles appear to be randomly oriented.						Static groundwater level approximately the same as the creek
		5												
		6			X									Groundwater rapidly flows into test pit at 6 ft depth
		7												
		8												@ 8ft GW 559.7 rmv, 821.0 µs/cm, pH start 5.03 pH end 5.64 (4 Minutes)
		9												
		10			X			BOH = 10.5 ft.						
		11												Installed 2" diameter PVC to 8.0' 0.020" Screen 3.3-8.3' Blank 0-3.3'
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-15

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/30/12 - 7/31/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5344.60 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027809.1, E1256614.8	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Dry to moist, Dark brown [7.5YR 3/4], SILTY SAND, SM, non-plastic, MIXED TAILINGS, occasional pockets of poorly graded, medium to coarse sand.						TP-FP-15 and TP-FT-15A are two separate soil profiles from within the same test pit. TP-FP-15 is excavated into the hill side on the west side of Beartrap Creek.
		1						Moist to wet, Very dark brown [7.5YR 2.5/2], CLAYEY GRAVEL with Sand, GP-GC, subrounded, low plasticity, COLLUVIUM, roots in top 3 ft. Estimated 10% cobble, 60% gravel, and 30% sand.						
		2												The groundsurface of TP-FP-15 is approximeatly 2 ft higher in elevation than TP-FP-15A. TP-FP-15 and TP-FP-15A are horizontally separated by 7 ft
		3												
		4												
		5												Groundwater at 5ft while excavating
		6												
		7												
		8						Wet, Brown, POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM with occasional pockets of Colluvium (Clayey Gravel), Maximum particle is 4-ft, near 11' estimated 10% Boulder, 20% Cobble, 40% Gravel and 30% Sand.						@ 8ft GW 748.4 rmv, 225.4 µs/cm, pH start 3.03 pH end 3.12 (25 Minutes)
		9												
		10												@ 9.5 ft GW 629.0 rmv, 832.0 µs/cm, pH start 4.43 pH end 4.60 (11 Minutes)
		11						BOH = 11 ft.						
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-15A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/30/12 - 7/31/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5344.60 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027809.1, E1256614.8	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Dry to moist, Dark brown [10YR 3/3], FAT CLAY, CH, Randomly oriented MIXED TAILINGS composed of three soil types: Approximately 30% rusty yellowish brown, low plasticity, CLAYEY SAND; 30% grayish brown, POORLY GRADED SAND; and 40% subangular GRAVELS and COBBLES with SAND.						TP-FP-15 and TP-FT-15A are two separate soil profiles from within the same test pit. TP-FP-15A is excavated in the flood plain.
		2												TP-FP-15's measuring point is 2 ft above the measuring point of TP-FP-15A. TP-FP-15 is separated by 7 ft from TP-FP-15A
		3			X			Saturated, Dark brown [10YR 3/3] Black [10YR 2/1], GRAVEL with Sand, GP, MIXED TAILINGS, visible Pyrite, some rusty brown stains, estimated 10% Cobble, 50% Gravel, and 40% Sand. Layer is approximately same elevation as Beartrap Creek.						
		4						Saturated, Dark reddish brown [5YR 3/3], SILTY GRAVEL with Sand, GM, subrounded, no to low plasticity, MIXED TAILING, Estimated 20% Cobble, 50% Gravel, and 30% Sand.						
		5			X									Groundwater at 5.0' while excavating
					X									
		6			X			Saturated, Dark brown [7.5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP, ALLUVIUM with occasional pockets of Clayey Gravel (Colluvium). Estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand. Max particle size is 4 ft near 9'. Black staining from 6 to 8 ft.						
		7												
		8												@ 8ft GW 748.4 rmv, 225.4 µs/cm, pH start 3.03 pH end 3.12 (25 Minutes)
		9			X			BOH=9.0'.						
		10												@ 9.5 ft GW 629.0 rmv, 832.0 µs/cm, pH start 4.43 pH end 4.60 (11 Minutes)
		11												Installed 2" Diameter PVC to 2" 0.020" screen 3.5-8.5' Blank 0-3.5'
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-16

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/31/12 - 7/31/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5346.70 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027826.3, E1256674.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Yellowish red [5YR 5/8], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, loose, MIXED TAILINGS with pockets of medium plasticity CLAY (CL), estimated 20% Cobble, 40% Gravel and 40% Sand, max particle size is 8" diameter.						
		2												
		3			X									
		4			X									
		5			X			Moist, Dark reddish brown [5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP, subangular, loose, Black Manganese stained MIXED TAILINGS with pockets of medium plastic CLAY (CL).						
		6			X			Moist, Dark reddish brown [5YR 2.5/2], POORLY GRADED SAND with GRAVEL, SP, loose, Primarily medium grained, larger gravel particles are subround, live cotton wood tree roots at bottom of layer.						
		7			X			Moist, Brown, POORLY GRADED SAND with Clay and Gravel, SP-SC, subrounded, loose, Live tree roots in layer, estimated 30% gravel and 70% Sand and Clay, no visible indication of tailings.						Rust colored sedimentation has been horizontally deposited. No indication of sedimentation into this layer from above or below gravel layer (6.3 to 7.9 ft)
		8						Wet, Brown with rust colored deposition between gravels, POORLY GRADED GRAVEL with SAND, GP, subangular to subrounded, loose, Poorly Graded GRAVEL with rust colored sedimentation infilling between particles, estimated 80% Gravel and 20% Sand, particles have been horizontally deposited, highly permeable.						
		9			X			Saturated, Dark reddish brown [5YR 2.5/2] Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SAND, GP, subrounded, loose, ALLUVIUM, estimated 10% Cobble, 40% Gravel, 50% Sand, no visible tailing deposition/staining, small (1/8-in diam.) roots observed at 11 ft depth.						
		10												
		11												@ 11ft GW 750.8 rmv, 1941 µs/cm, pH start 3.59 pH end 3.79 (22 Minutes) Soil is wet at 8 ft depth. Groundwater flows into test pit at 11 ft
		12			X			BOH = 12 ft.						Installed 2" Diameter PVC to 12' 0.020" Screen 5.8-10.8' Blank 0-5.8'
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-17

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/31/12 - 7/31/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5346.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027838.8 E1256724.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Yellowish brown [10YR 5/8], SILTY GRAVEL with Sand, GM, subangular, MIXED TAILINGS, estimated 10% Cobble, 40% Gravel, and 50% Sand, max particle size is approximately 6-in diameter.						Wood debris (lumber) observed in Mixed Tailings
		2												
		3			X			Moist, Dark reddish brown [2.5YR 2.5/4], CLAYEY SAND, SC, with roots, field classified color of grayish brown.						
								Moist, Very dark brown [7.5YR 2.5/3], SANDY CLAY, CL, medium plasticity, Black Manganese Layer, generally about 2-in thick.						
		4						Saturated, Very dark brown [7.5YR 2.5/3], WELL GRADED GRAVEL with SAND, GP, loose, Estimated 10% Boulder, 20% Cobble, 40% Gravel and 30% Sand, boulders and cobbles are subangular, gravels and sands are subrounded, Iron staining/deposition randomly located on surface of gravels from 5 to 6 ft depth, but not around the entire perimeter of the test pit.						
		5			X									
		6			X									
		7												
		8												
▼		9			X									Groundwater inflow at 9 ft while excavating
		10												
		11												
		12			X			BOH = 12 ft.						@ 12ft GW 588.4 rmv, 933.0 µs/cm, pH start 4.60 pH end 4.90 (24 Minutes) Installed 2" diameter PVC to 12' 0.020" Screen 6.2-11.2' Blank 0-6.2'
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-18

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/31/12 - 7/31/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5346.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027851.5, E1256780.8	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Rusty Brown, POORLY GRADED GRAVEL with SILT AND SAND, GP, subangular, estimated 30% Cobble, 40% Gravel and 30% Sand, approximate max particle size is 5-in in diameter. Contains lumber.						
		1			X			Moist, Brown, POORLY GRADED GRAVEL with SAND, GP, subrounded.						
		2			X			Moist, Dark brown, POORLY GRADED GRAVEL with Clay and Sand, GP-GC, angular to subangular, low plasticity, estimated 30% Cobble, 40% Gravel, 30% Sand & Clay, approximate max particle size is 10-in diameter.						Wood debris (lumber) at surface and from 1.2 to 3.0 ft
		3						Moist, POORLY GRADED GRAVEL, subangular, consists of BOULDERS and COBBLES with little sand.						
		4			X			Moist to Saturated, Very dark brown [7.5YR 2.5/3] Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, estimated 20% Boulder, 20% Cobble, 40% Gravel, and 20% Sand, boulders and cobbles are subangular, gravels and sands are subrounded, max particle size is approximately 18-in diameter.						6-in diameter black pipe observed at 4 ft depth
		5												
		6												
		7												
		8												Test pit side walls caved readily between 4 and 11 ft
		9			X									No iron staining as in TP-FP-16 and 17
		10												
▼		11												Groundwater at 11 ft while excavating
		12			X									@ 12ft GW 477.9 rmv, 347.0 µs/cm, pH start 5.70 pH end 6.48 (15 Minutes)
								BOH = 12.5 ft.						
		13												Installed 2" diameter PVC to 11.5' 0.020" Screened 6.5-11.5' Blank 0-6.5'
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-19

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 7/31/12 - 7/31/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5348.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027853.8, E1256825.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist, Light yellowish brown [10YR 6/4], POORLY GRADED GRAVEL with SAND, GP, MIXED TAILINGS with pockets of medium plasticity clay (CL), estimated 10% Cobble, 50% Gravel, and 40% Sand & Clay, max particle size is approximately 4-in diameter.						
		2						Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, non-plastic, ALLUVIUM, max particle size is approximately approximately 6-in., cobbles and gravels are subangular, sand particles are subrounded.						Plant roots (1/4-in diam.) from 1.0 to 3.5 ft depth
		3												Test pit side walls were layed back at 1.5H:1V slope due to safety concerns. Soil profile was logged in detail from 0 to 5 ft prior to sloping side walls.
		4						Moist, Strong brown [7.5YR 4/6], POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM, primarily 1.5-in minus gravels with pockets of 3/8-in minus gravels, iron staining/deposition between gravel particles and on surface of particles, iron staining/deposition appear to be remnants of horizontal flow.						
		5			X			Moist, Very dark brown [7.5YR 2.5/2] Black [10YR 2/1], SANDY SILT with Gravel, ML, ALLUVIUM with Black Manganese staining, layer is generally 1/2-in thick.						Piezometer was placed at an angle of 50 degrees from horizontal due to sloping back side walls. The graphic profile of the well log (left side of test pit log) has been corrected for slope and displays vertical alignment of screen interval.
		6						Moist, Dark brown [7.5YR 3/4], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, subrounded, ALLUVIUM, estimated 50% Gravel, 40% Sand, and 10% Clay, max particle size is approximately 3-in diameter.						
		7												No groundwater encountered
		8			X									
								BOH=8.5'.						Installed 2" diameter PVC to 8.5' 0.020" Screened 3.3-6.3' Blank 0-3.3'
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-19A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/1/12 - 8/1/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5356.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027887.0, E1256874.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Brown, SILTY SAND, SM, TOPSOIL with ORGANICS including large tree roots.						Excavated into hill side (31 ft east of TP-FP-19) to determine lateral extents of mixed tailing observed in TP-FP-19.
		1						Moist, Pale brown, SILTY SAND with Gravel, SM, subrounded, Estimated 15% subangular Cobbels, 30% subangular to subrounded Gravels, and 55% Sand and Silt.						
		2												No visual evidence of Mixed Tailing observed in test pit
		3						BOH = 3 ft.						
		4												Piezometer not installed at TP-FP-19A
		5												No Groundwater Encountered
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering

ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-20

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/1/12 - 8/1/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5340.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027958.8, E1256565.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, MIXED TAILINGS, estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand, max particle size is approximately 12-in diameter Vertical inclusion in the center of the test pit contains: 1) moist, very dark brown, subangular sandy GRAVEL (from 0 to 2 ft) 2) moist, very dark brown, fine grained, poorly graded SAND (from 2.0 to 2.5 feet) 3) moist, very dark brown, subangular sandy GRAVEL (from 2.5 to 3.0 ft).						Top of test pit is 2.8 ft above Beartrap Creek stream elevation. Beartrap Creek approximately 20' West
		2			X									Mixed tailings laterally surrounds inclusion of sandy gravel and poorly graded sand
		3			X									
		4						Moist to Saturated, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM, estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand. Boulders and cobbles are subangular, gravel and sand particles are subrounded, max particle size is approximately 14-in diameter.						Roots from 4.3 to 4.5 ft
		5												
		6			X									Groundwater at 6.0' while excavating @ 6.5ft GW 479.0 rmv, 348.0 µs/cm, pH start 5.57 pH end 5.61 (20 Minutes)
		7												
		8			X									
		9												
		10			X			BOH = 10 ft.						@ 10ft GW 532.9 rmv, 590.0 µ s/cm, pH start 5.57 pH end 5.36 (14 Minutes) Installed 2" Diameter PVC to 10.0' 0.020" Screen 4.8-9.8' 0-4.8' Blank
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-21

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/1/12 - 8/1/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5339.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1027986.2, E1256610.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [2.5YR 3/4] Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SAND, GP, MIXED TAILINGS, estimated 20% Cobble, 50% Gravel, and 30% Sand, max particle size is approximately 5-in. diameter.						Numerous 1-in diam. tree roots at 1.4 ft depth Burned tree stem at 2.8 ft
		2												
		3			X			Moist, Black [5Y 2.5/1], SILTY SAND, SM, contains estimated 50% organics, (layer is only prevelant on end of test pit nearest to stream).						Black silty sand from 2.8 to 3.0 ft may have been forest floor prior to inundation by flood.
		4						Moist, Dark reddish brown [5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, ALLUVIUM, estimated 10% Cobble, 50% Gravel, and 40% Sand. Moist, Dark reddish brown [5YR 3/3], POORLY GRADED SAND, SP, soil color was field classified as tannish brown, (layer is only prevelant on end of test pit nearest to stream).						@ 5ft GW 537.0 rmv, 324.0 µs/cm, pH start 4.34 pH end 6.19 (24 Minutes)
▼		5						Moist to Saturated, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, ALLUVIUM, some gravels rust stained at 6 ft depth. Estimated 20% Boulder, 30% Cobble, 30% Gravel, and 20% Sand. Particles are elongated and flat. Approximately 6" maximum size.						Groundwater at 4.8' while excavating, groundwater entering very quickly at 6'
		6												
		7			X									
		8												
		9												
		10			X									
		11						BOH = 10.5 ft.						Installed 2" diameter PVC to 8.8' 0.020" Screen 3.8-8.8' Blank 0-3.8'
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-22

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/1/12 - 8/1/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5338.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028096.3, E1256576.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/4], SILTY SAND, SM, no to low plasticity, MIXED TAILINGS, visible Pyrite, fine to medium grained.						Thin layer (0.5-in) of brownish black plant decay on ground surface
		1			X			Moist, Black [5Y 2.5/1], SILTY GRAVEL with Sand, GM, low plasticity, estimated 50% Gravel, 30% Sand, and 20% Clay,abundant plant roots. Appeared to be buried topsoil horizon.						
		2			X			Moist to Saturated, Dark reddish brown [5YR 3/3] Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, non-plastic, loose, ALLUVIUM, at 4 ft depth estimated 30% Cobble, 40% Gravel, and 30% Sand, below 6 ft depth boulders (max particle size approximately 14-in) observed, particles are generally elongated.						
		3												
		4			X									
		5												Groundwater at 5 ft while excavating Test pit sides caved in very easily below water @ 6ft GW 509.7 rmv, 201.1 µs/cm, pH start 5.70 pH end 5.69 (28 Minutes)
		6			X									
		7												
		8			X									
		9			X									
								BOH = 9.5 ft.						@ 9.5 ft GW 484.1 rmv, 232.7 µs/cm, pH start 5.79 pH end 5.90 (7 Minutes)
		10												
		11												Installed 2" Diameter PVC to 7.6' 0.020" Screen 2.6-7.6' Blank 0-2.6'
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-25

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/2/12 - 8/2/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5331.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028071.6, E1256293.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Dark brown, SANDY SILT, ML, TOPSOIL, organic plant decay.						TP-FP-25 and TP-FT-25A are two separate soil profiles from within the same test pit. TP-25 is on uphill side The test pit is on a slope; therefore, TP-FP-25A's measuring point is 2 ft below the measuring point of TP-FP-25.
		1			X			Moist, Dark yellowish brown [10YR 4/6], SANDY SILT, ML, low plasticity, MIXED TAILING.						
					X			Moist, Black [2.5Y 2.5/1], ORGANIC SANDY SILT, OL, TOPSOIL, high organic content possible, topsoil prior to flood.						
		2			X			Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, non-plastic, ALLUVIUM, estimated 10% Cobble, 50% Gravel, and 40% Sand, max particle size is 5-in, increased rock content (boulders and cobbles) from 3.4 to 4.3 ft.						
		3												
		4			X			Moist to wet, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, non-plastic, ALLUVIUM, iron colored staining on surface of gravels.						
▼		5												Groundwater at 5.3 ft while excavating
		6			X									
		7						Moist, Dark reddish brown [5YR 3/3] Very dark grayish brown [10YR 3/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, non-plastic, ALLUVIUM, estimated 15% Boulder, 25% Cobble, 40% Gravel, and 20% Sand. Maximum particle size approximately 30" long x 12"x 12".						
		8			X									@ 7.5ft GW 605.2 rmv, 401.0 µs/cm, pH start 6.27 pH end 5.39 (19 Minutes)
		9												
		10			X			BOH = 10 ft.						@ 10ft GW 625.4 rmv, 510.0 µs/cm, pH start 5.05 pH end 5.05 (12 Minutes) Installed 2" diameter PVC to 8.5' 0.020" Screen 3.5-8.5' Blank 0-3.5'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-25A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/2/12 - 8/2/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5331.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028071.6, E1256293.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X	25A		Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, non-plastic, ALLUVIUM, estimated 10% Cobble, 50% Gravel, and 40% Sand, max particle size is 5-in, increased rock content (boulders and cobbles) from 1.4 to 2.3 ft.						TP-FP-25 and TP-FT-25A are two separate soil profiles from within the same test pit. TP-25 is on uphill side The test pit is on a slope; therefore, TP-FP-25A's measuring point is 2 ft below the measuring point of TP-FP-25.
		2												
		3						Moist to wet, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, non-plastic, ALLUVIUM, iron colored staining on surface of gravels.						Groundwater at 3.3 ft while excavating
		4												
		5						Moist, Dark reddish brown [5YR 3/3] Very dark grayish brown [10YR 3/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, non-plastic, ALLUVIUM, estimated 15% Boulder, 25% Cobble, 40% Gravel, and 20% Sand. Maximum particle size approximately 30" long x12" x12".						@ 5.5' GW 605.2 rmv, 401 µs/cm, pH starts 6.27 pH end 5.39 (19 minutes)
		6												
		7												
		8						BOH = 8 ft.						@8.0' GW 625.4 rmv, 510 µs/cm, pH start 5.05 pH end 5.05 (12 minutes) Installed 2" Diameter PVC to 8.5' 0.020" Screen 3.5-8.5' Blank 0-3.5'
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering

ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-26

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/2/12 - 8/2/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5328.90 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028120.2, E1256316.3	HAMMER TYPE:

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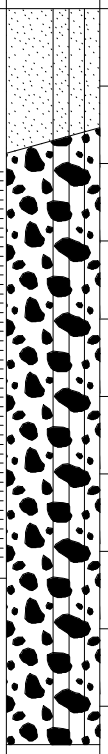

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/3], POORLY GRADED SAND with Silt and Gravel, SP-SM, subangular, MIXED TAILING, estimated 60% Sand, 40% Gravel, gravel content increases with depth, layer thickness varies between 1.7 and 3.2 ft.						
		2			X			Wet, Dark reddish brown [5YR 2.5/2] Very dark brown [7.5YR 2.5/3], WELL GRADED GRAVEL with Silt and Sand, GW-GM, top 6-in of layer has iron staining on surface of gravels, at 4 ft depth estimated 60% Gravel and 40% Sand, at 6 ft depth estimated 10% Boulder, 30% Cobble, 40% Gravel, and 20% Sand, boulders and cobbles are flat, elongated, and subangular, sands and gravels are subrounded.						Groundwater at 1.7 ft, entered rapidly from upstream side of test pit @ 2ft GW 518.0 rmv, 208.2 µs/cm, pH start 6.05 pH end 6.52 (23 Minutes) water was orange and cloudy
		3												
		4			X									
		5												
		6			X									Piezometer was partially bent during backfilling
		7												
		8												
		9			X									@ 9ft 552.4 rmv, 805.0 µs/cm, pH start 5.06 pH end 5.23 (24 Minutes)
								BOH = 9.5 ft.						
		10												Installed 2" Diameter PVC to 7.1' 0.020" Screen 2.1-7.1' Blank 0-2.1'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-27

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/2/12 - 8/2/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5332.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028181.9, E1256345.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Very dark brown [7.5YR 2.5/2], POORLY GRADED SAND, SP, medium to coarse grained, gravels are elongated and flat, trace of organics.						1-in diameter tree roots observed to depth of 3 ft
					X			Moist, Very dark brown [7.5YR 2.5/2], SILTY SAND, SM, fine grain, visible pyrite, visually appears non-native.						
		1			X			Moist, Yellowish brown [10YR 5/6], CLAYEY SAND with Gravel, SC, medium plasticity, MIXED TAILINGS.						
					X			Moist, Brown, POORLY GRADED GRAVEL with SAND, GP, subrounded, ALLUVIUM, estimated 60% Gravel and 40% Sand. Sand fraction coarse grained.						
		2			X			Moist, Very dark brown [7.5YR 2.5/2], SILTY SAND, SM, low plasticity, gravels are generally 1/2-in minus and rounded, trace organics.						
		3						Moist, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SAND, GP, subrounded, ALLUVIUM, estimated 60% Gravel and 40% Sand.						
		4			X									
		5			X			Moist, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SAND, GP, subrounded, ALLUVIUM, iron/tailing staining and deposition on surface of gravels, estimated 20% Boulder, 20% Cobble, 40% Gravel, 20% Sand.						
▼		6												Groundwater encountered at 5.7 ft depth while excavating. Note Creek elevation is 5.7 feet below top of test pit.
		7			X			Moist, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SAND, GP, subrounded, ALLUVIUM.						
		8												@ 7.5ft GW 486.9 rmv, 357.0 µs/cm, pH start 5.80 pH end 6.05 (17 Minutes)
		9												
		10			X			BOH = 10 ft.						@ 9.5ft GW 526.6 rmv, 715.0 µs/cm, pH start 5.63 pH end 5.40 (26 Minutes)
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-28

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/6/12 - 8/6/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5331.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028234.5, E1256369.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Very dark brown [7.5YR 2.5/2] Dark brown [10YR 3/3], CLAYEY GRAVEL, GC, subrounded, ROAD FILL, with cobbles, roots in top 2 ft.						
		1			X									
					X			Moist, Yellowish brown [10YR 5/6], SILTY SAND with Gravel, SP, low plasticity, MIXED TAILINGS, visible Pyrite, pockets of grayish brown, poorly graded Sand with abundant visible Pyrite. Include interface at upper Alluvium.						Note: Mixed Tailings deposit was only observed on west side of test pit between depths of 1.5 and 3.6 feet.
		2												
		3			X									
								Moist, Dark yellowish brown [10YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, estimated 10% Boulder, 30% Cobble, 40% Gravel, and 20% Sand, max particle size is approximately 22-in., trace amounts of visible pyrite.						
		4												
					X			Moist to wet, Dark yellowish brown [10YR 3/4] Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, ALLUVIUM contains poorly consolidated Ferricrete.						
		5												
					X			Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, estimated 10% Boulder, 30% Cobble, 40% Gravel, and 20% Sand, with trace of Pyrite.						@ 6ft GW 420.5 rmv, 226.7 µs/cm, pH start 6.21 pH end 6.65 (36 Minutes)
		6												
▼		7												Groundwater at 6' while excavating
		8			X									
		9			X									@ 9ft GW 485.5 rmv, 374.0 µs/cm, pH start 5.84 pH end 5.69 (33 Minutes)
								BOH = 9.5 ft.						
		10												Install 2" diameter PVC to 7.25' 0.020" Screen 2-7' Blank 0-2'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-30

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/7/12 - 8/7/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5313.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028444.3, E1255597.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		0–1						Moist, Very dark brown [10YR 2/2], SILTY SAND, SM, no to low plasticity, MIXED TAILINGS , varying layers of grayish brown and rusty brown, visible Pyrite, organics in top 1.5 ft.						Test pit located in water treatment plant storage yard
		1			X									
		2			X			Moist, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, estimated 60% Gravel, 20% Sand, 10% Cobble, and 10% Clay, iron staining noted on surface of gravels between 2.5 and 3.3 feet on northeast (nearest to stream) side of test pit.						
		3			X									
		4			X			Moist, Very dark brown [7.5YR 2.5/3] Black [10YR 2/1], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, Black Manganese staining on surface of particles.						
▼		5			X			Moist, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, estimated 20% Boulder, 25% Cobble, 40% Gravel, and 15% Sand, max particle size is approximately 30-in. Paticle size increases below 5'.						@ 5ft GW 620.1 rmv, 1275 µs/cm, pH start 4.91 pH end 4.95 (26 Minutes) Groundwater at 5ft while excavating
		6												
		7												
		8			X									Rock content increased below 8 ft
		9												
		10			X									@ 10ft GW 603.5 rmv, 941.0µs/cm, pH start 4.99 pH end 4.61 (29 Minutes)
		10–17						BOH = 10.5 ft.						Installed 2" diameter PVC to 10.0' 0.020" Screen 4.7-9.7' Blank 0-4.7'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-31

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/7/12 - 8/7/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5312.60 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028496.0, E1255621.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Strong brown [7.5YR 4/6], SANDY SILT with Gravel, ML, MIXED TAILING, fine grain, trace organics.						Test pit located in water treatment plant storage yard
		1			X			Moist, Dark brown [7.5YR 3/3] Yellowish brown [10YR 5/6], SILTY GRAVEL with Sand, no to low plasticity, FILL; mixed layers of Clayey SAND with Gravel and Poorly Graded SAND with Gravel.						
		2			X			Black Manganese staining from 2.0 to 2.75 ft.						
		3			X									
		4						Wet to Saturated, Very dark brown [7.5YR 2.5/3] Dark reddish brown [5YR 3/4], WELL GRADED GRAVEL with SAND, GW, subrounded, ALLUVIUM, at 5 ft depth estimated estimated 10% Cobble, 50% Gravel, 30% Sand, and 10% clay, at 8 ft depth estimated 10% Boulder, 30% Cobble, 40% Gravel, 20% Sand and max. particle size of approximately 16-in. Iron staining observed on upstream side of test pit from 4.5 to 6.0 ft depth.						
		5			X									Groundwater at 4.5ft @ 4.5ft GW 667.1 rmv, 1099 µs/cm, pH start 3.41 pH end 3.51 (37 Minutes)
		6												
		7			X			Pocket of Organic SILT with Sand (OH) observed at 7 ft depth.						Organic Silt (OL) pocket was excavated below groundwater; therefore, could not observe extent of OL on test pit side wall. Sampled from the bucket
		8												
		9			X									@ 9ft GW 636.9 rmv, 579.0 µs/cm, pH start 4.66 pH end 3.96 (38 Minutes)
		10						BOH = 10 ft.						
		11												Installed 2" diameter PVC 0.020" Screened 3.5-8.5' Blank 0-3.5'
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-32

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/7/12 - 8/7/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5311.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028521.8, E1255636.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/4], SILTY SAND with Gravel, SM, non-plastic, MIXED TAILING, trace organics and pine needles.						Test pit located in water treatment plant storage yard
		1			X			Moist, Grayish brown, SAND, SP, non-plastic, MIXED TAILING, fine grain, visible Pyrite.						
								Moist, Dark reddish brown [5YR 3/4], SILTY SAND with Gravel, SM, non-plastic, FERRICRETE.						
		2						Moist, Very dark brown [7.5YR 2.5/3], SANDY SILT with Gravel, ML, medium plasticity, with organics.						
					X			Moist to Saturated, Dark reddish brown [5YR 3/3] Brown [7.5YR 4/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, at 3 ft depth estimated 20% Cobble, 50% Gravel, 30% Sand.						Roots observed in top 2.5 ft
		3												
		4						Iron staining and deposition observed on surface of gravels at an approximate depth of 4 to 5 ft on the south end of the test pit. Irregular staining in test pit.						
▼														Groundwater at 4.5 ft while excavating @ 4.5ft GW 564.5 rmv, 384 µs/cm, pH start 6.1 pH end 5.25 (19 Minutes)
		5												
		6												
		7			X									
		8												
		9			X									@ 9ft GW 586.0 rmv, 901.0 µs/cm, pH start 5.07 pH end 4.92 (29 Minutes)
		10												
		11			X			BOH = 11 ft.						Installed 2" diameter PVC to 9.5' 0.020" Screen 4.5-9.5' Blank 0-4.5'
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-33

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/7/12 - 8/7/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5309.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1028553.4, E1255647.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Very dark brown [7.5YR 2.5/3], SILTY SAND, SM, MIXED TAILINGS, fine grained, visible pyrite, trace roots. Grayish Brown when sampled.						Test pit located in water treatment plant storage yard
		1						Moist to Saturated, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, trace clay, gravel particles are generally flat and elongated, at 4 ft depth estimated 20% Cobble, 60% Gravel, 20% Sand, rock content increases with depth, max particle approximately 1.5 ft x 3.0 ft.						
		2						Did not observe any rust colored tailings or iron staining anywhere in test pit. Standing at stream looking south at test pit there is some rust-colored fine grained mixed tailingson the ground surface near test pit.						
		3												
		4												
		5												Groundwater at 5 ft while excavating Test pit frequently caved in below 5 ft depth @ 5.3ft GW 499.2 rmv, 420.0 µs/cm, pH start 5.78 pH end 6.51 (19 Minutes)
		6												
		7												
		8												Depths shown for screen interval on well log are approximate Installed 2" diameter PVC to 8.3' 0.020" Screen 3.3-8.3' Blank 0-3.3'
								BOH = 8.5 ft.						
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-34

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/7/12 - 8/7/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5281.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029054.0, E1254363.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X	34		Moist, Very dark brown [7.5YR 2.5/3], SILTY SAND with Gravel, SM, subangular, low plasticity, Colluvium, estimated 15% gravel.						Test pit located near Mary P Mine Waste Pile
		1			X	34								
		2												
		3						Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SAND, GP, subangular to subrounded, ALLUVIUM, at 4 ft depth estimated 20% Cobble, 60% Gravel, and 20% Sand. Particles generally elongated.						
		4			X	34								
		5												
		6			X	34		Moist to wet, Brown [7.5YR 4/4] Dark yellowish brown [10YR 4/4], CLAYEY SAND with Gravel, SC, subangular, medium plasticity, pockets of Sandy CLAY (CL) observed from 6 to 7 ft depth, medium to coarse grained sand. Deposit contains rusty brown layers of medium plasiticity lean Clay. Appears to be native and not mine waste..						The Clayey Sand with Gravel layer appears to be native and not remnants of Mike Horse Dam break. The yellowish brown color could potentially be from Mary P mine activities.
		7												
		8			X	34								
		9			X	34								
		10			X	34								No Groundwater observed
		11												
		12												
		13			X	34								Depths shown for screen interval on well log are approximate
		14						BOH=14.0'.						Installed 2" diameter PVC to 12.7' 0.020" Screen 7.7-12.7' Blank 0-7.7'
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-35

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/8/12 - 8/8/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5276.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029154.1, E1254309.8	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Dry, Light brown, SILTY SAND with Gravel, SM, rounded, low plasticity, TOPSOIL, abundant plant and tree roots.						Test pit excaved into side of hill. Mike Horse road located to south of test pit, stream located to north of test pit Two soil profiles observed in test pit; Soil profile for TP-FP-35 represents soil profile of hill side (farthest from flood plain)
		1						Dry to Saturated, Dark brown [10YR 3/3] Dark yellowish brown [10YR 3/6], WELL GRADED GRAVEL with SAND, GW, subrounded, ALLUVIUM, plant and tree roots, estimated 10% Cobble, 60% Gravel, 30% Sand.						
		2												
		3												The Measuring Point (MP) for TP-FP-35 and TP-FP-35A is based on ground surface of TP-FP-35. TP-FP-35 is 2 ft higher in elevation than TP-FP-35A
		4												
		5												
		6												
		7												
		8												A 3 ft diameter stump was removed from ground surface prior to excavating TP-FP-35. Size of stump indicates material observed underneath it is native and was in place prior to dam break
		9												
		10												
		11												@ 9ft GW 675.9 rmv, 1586 µs/cm, pH start 5.22 pH end 4.72 (36 Minutes)
		12												
		13						BOH = 13 ft.						@ 12.5ft GW 677.7 rmv, 978.0 µs/cm, pH start 4.30 pH end 4.15 (33 Minutes)
		14												Installed 2" diameter PVC to 10.4' 0.020" Screen 5.4-10.4' Blank 0-5.4'
		15												
		16												
		17												

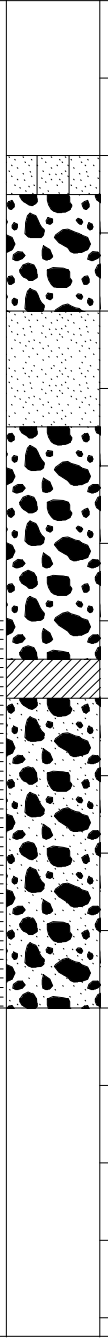
PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-35A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/8/12 - 8/8/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5276.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029154.1, E1254309.8	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.



WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						.						Test pit excaved into side of hill. Mike Horse road located to south of test pit, stream located to north of test pit Two soil profiles observed in test pit; Soil profile for TP-FP-35A represents soil profile closest to stream. This profile is approximately 5 ft wide before it transition into the profile described in TP-FP-35
		2						Dry, Light brown, SILTY SAND with Gravel, SM, rounded, low plasticity, TOPSOIL, abundatn plant and tree roots.						
		3						Dry to moist, Dark brown [7.5YR 3/2], WELL GRADED GRAVEL with SAND, GW, subrounded, ALLUVIUM, plant and tree roots, estimated 10% Cobble, 50% Gravel, 40% Sand.						The Measuring Point (MP) for TP-FP-35 and TP-FP-35A is based on ground surface of TP-FP-35. TP-FP-35 is 2 ft higher in elevation than TP-FP-35A. Therefore no lithology is shown from 0-2' on this log
		4						Moist, Rusty brown, POORLY GRADED SAND with GRAVEL, SP, MIXED TAILINGS, layers of poorly graded sand/tailing mixed with gravel alluvium.						
		5												
		6						Moist, Dark brown [10YR 3/3], WELL GRADED GRAVEL with SAND, GW, subrounded, ALLUVIUM, estimated 10% Cobble, 60% Gravel, 30% Sand.						
		7												
		8												Toe of test pit is in floodplain and 8 ft below the top (MP) of the test pit
					X			Moist to wet, Very dark brown [7.5YR 2.5/3] Black [10YR 2/1], LEAN CLAY, CL, medium plasticity, fine grain sand particles.						
		9						Wet, Dark brown [10YR 3/3] Dark yellowish brown [10YR 3/6], GRAVEL with Sand, GW, subrounded, ALLUVIUM.						Groundwater at 9 ft (1 ft below ground surface of floodplain)
		10												
		11												
		12												
		13						BOH = 13 ft.						Installed 2" diameter PVC to 13' 0.020" Screen 8-13' Blank 0-8'
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-36

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/13/12 - 8/13/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5274.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029190.6, E1254353.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark brown [7.5YR 3/4], SILTY GRAVEL with Sand, GM, angular, no to low plasticity, MIXED TAILINGS, layers of poorly graded, fine grained sand/tailing mixed with gravel and cobbles.						
		2						Moist to wet, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, angular to subangular, low plasticity, estimated 20% Cobble, 40% Gravel, 30% Sand, and 10% Clay, max particle size is approximately 10-in. Alluvium.						
		3												
		4			X				26	17				
		5												
		6												
		7			X									Groundwater at 6.0 ft while excavating. Estimated 20 gpm at 6.5' @ 7ft GW 538.9 rmv, 336.0 µs/cm, pH start 6.23 pH end 5.93 (24 Minutes)
		8						Saturated, Very dark brown [7.5YR 2.5/2] Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, subrounded, estimated 10% Cobble, 40% Gravel, 40% Sand, and 10% Fines, particles are generally flat and elongated. Alluvium.						
		9												
		10			X									
		11			X									
		12												
		13						BOH = 13 ft.						@ 13ft GW 489.8 rmv, 343.0 µs/cm, pH start 6.56 pH end 6.72 (12 Minutes) Installed 2" diameter PVC to 12.8' 0.020" Screen 7.8-12.8' Blank 0-7.8'
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-37

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/14/12 - 8/14/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5275.20 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029253.4, E1254398.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark yellowish brown [10YR 3/6], SILTY GRAVEL with Sand, GM, subangular to subrounded, MIXED TAILINGS; tailing composed of poorly graded, fine grain, rusty brown SAND; Alluvium composed of Poorly Graded GRAVEL with Sand and Cobbles; estimated 20% Cobble, 40% Gravel, and 40% Sand. Mixed Tailing is random from 0 to 2 ft and layered from 2 to 3.4 ft.						
		2												
		3			X									
		4						Moist, Very dark brown [10YR 2/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular, very coarse layer, estimated 30% Cobble, 60% Gravel, and 10% Sand, max particle size is approximately 6-in., Black Manganese and iron staining/deposition on surface of particles						
		5			X			Moist to Saturated, Very dark brown [10YR 2/2] Dark brown [10YR 3/3], WELL GRADED GRAVEL with SAND, GW, ALLUVIUM, at 5 ft depth estimated 20% Cobble, 40% Gravel, and 40% Sand, at 10 ft depth estimated 10% Boulder, 30% Cobble, 30% Gravel, and 30% Sand, boulders and cobbles are subangular, gravels are subrounded.						
		6												
		7												
		8			X									
		9												
		10			X									
		11												
		12			X									
▼		13												Soil wet at 13.0 feet however no visible water flowing into test pit
		14												Depths shown for screen interval on well log are approximate
		15			X			BOH = 15 ft.						Installed 2" diameter PVC to 14.5' 0.020" Screen 9.5-14.5' Blank 0-9.5'
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-38

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/14/12 - 8/14/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5277.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029306.1, E1254439.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, ALLUVIUM/COLLUVIUM, estimated 30% Cobble, 40% Gravel, and 30% Sand and Fines. Roots in top 3' No visual indication of tailings.						Test pit excaved into side of hill. Toe of test pit (MP) is 2 ft higher than heel of test pit. Three soil profiles observed in test pit; Soil profile for TP-FP-38B represents soil profile closest to stream (southern most). Soil profile TP-FP-38 in northern most profile. TP-FP-38 is middle soil profile. The Measuring Point (MP) for all profiles is based on ground surface of TP-FP-38. Tree roots in observed in top 3 ft.
		2			X									
					X									
		3												
		4												
		5			X									
		6						Moist to wet, Very dark brown [7.5YR 2.5/3] Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM, layered, estimated 30% Cooble, 50% Gravel, and 20% Sand, cobbles are subangular, gravels are subangular and subrounded.						
		7												
		8			X									
		9												
		10			X									Samples were wet at 10 ft depth; however, no visual observation of water flowing into test pit
		11												
		12			X									
		13						Moist to wet, Brown [7.5YR 4/3], CLAYEY GRAVEL with Sand, GC, angular, medium plasticity, Estimated 20% Cobble, 30% Gravel, 20% Sand, and 30% Clay, rock particles are black.						
		14												
		15			X			BOH = 15 ft.						Installed 2" diameter PVC to 14.5' 0.020" Screen 9.5-14.5' Blank 0-9.5'
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-38A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/14/12 - 8/14/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5277.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029306.1, E1254439.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/4], SILTY GRAVEL with Sand, GM, subangular to subrounded, low to medium plasticity, MIXED TAILINGS. Tailings is rusty brown, rock particles are light gray, brown, and light purple. Estimated 20% Cobble and Boulder, 30% Gravel, 20% Sand, and 30% Tailing.						Test pit excaved into side of hill. Toe of test pit (MP) is 2 ft higher than heel of test pit.
		1			X			Moist, Very dark brown [10YR 2/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, ALLUVIUM, layered, estimated 30% Cooble, 50% Gravel, and 20% Sand, cobbles are subangular, gravels are subangular and subrounded.						Three soil profiles observed in test pit; Soil profile for TP-FP-38B represents soil profile closest to stream (southern most). Soil profile TP-FP-38 in northern most profile. TP-FP-38 is middle soil profile.
		2						Moist, Yellowish brown [10YR 5/4], CLAYEY GRAVEL with Sand, GC, medium plasticity, MIXED TAILING.						
		3			X			Moist to wet, Very dark brown [10YR 2/2], POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM, layered, estimated 30% Cooble, 50% Gravel, and 20% Sand, cobbles are subangular, gravels are subangular and subrounded.						The Measuring Point (MP) for all profiles is based on ground surface of TP-FP-38.
		4												
		5			X									Tree roots in observed in top 3 ft.
		6												
		7												
		8												
		9												
		10												Samples were wet at 10 ft depth; however, no visual observation of water flowing into test pit
		11												
		12												old mine/waste rock observed on hillside to the north of the test pit
		13						Moist to wet, Brown [7.5YR 4/3], CLAYEY GRAVEL with Sand, GC, angular, medium plasticity, Estimated 20% Cobble, 30% Gravel, 20% Sand, and 30% Clay. Rock particles are black.						
		14												
		15						BOH = 15.						Installed 2" diameter PVC in TP-FP-38
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-38B

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/14/12 - 8/14/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5277.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029306.1, E1254439.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						.						Test pit excaved into side of hill. Toe of test pit (MP) is 2 ft higher than heel of test pit. Three soil profiles observed in test pit; Soil profile for TP-FP-38B represents soil profile closest to stream (southern most). Soil profile TP-FP-38 in northern most profile. TP-FP-38 is middle soil profile. The Measuring Point (MP) for all profiles is based on ground surface of TP-FP-38.
		2						Moist, Dark reddish brown [5YR 3/4], GRAVEL with Sand, GM, subangular to subrounded, low to medium plasticity, MIXED TAILINGS. Tailings are rusty brown, rock particles are light gray, brown, and light purple. Estimated 20% Cobble and Boulder, 30% Gravel, 20% Sand, and 30% Tailing.						
		3												
		4						Moist, Very dark brown [10YR 2/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, ALLUVIUM, layered, estimated 30% Cooble, 50% Gravel, and 20% Sand, cobbles are subangular, gravels are subangular and subrounded.						Tree roots in observed in top 3 ft.
		5						Moist, Rusty Brown, GRAVEL with Clay and Sand, GP-GC, ALLUVIUM. Rusty brown, clayey sediment depsotion on surface of gravels and cobbles.						
		6						Moist to wet, Very dark brown [10YR 2/2], POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM, layered, estimated 30% Cooble, 50% Gravel, and 20% Sand, cobbles are subangular, gravels are subangular and subrounded.						
		7												
		8												
		9												
		10												Samples were wet at 10 ft depth; however, no visual observation of water flowing into test pit
		11												
		12												
		13						Moist to wet, Brown [7.5YR 4/3], CLAYEY GRAVEL with Sand, GC, angular, medium plasticity, Estimated 20% Cobble, 30% Gravel, 20% Sand, and 30% Clay. Rock particles are black.						
		14												
		15						BOH = 15.						Installed 2" diameter PVC in TP-FP-38
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-39

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/13/12 - 8/13/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5285.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029392.9, E1254485.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Brown, SILTY SAND with Gravel, SM, subangular, TOPSOIL, numerous tree roots (1.5-in. minus).						Test pit excaved into side of hill.
		1			X			Moist, Brown [7.5YR 4/4], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, subrounded, COLLUVIUM.						Two soil profiles observed in test pit (TP-FP-39 and TP-FP-39A); Soil profile for TP-FP-39A represents soil profile closest to stream.
		2												
		3												The Measuring Point (MP) for TP-FP-39 and TP-FP-39A is based on ground surface of TP-FP-39. TP-FP-39 is 2 ft higher in elevation than TP-FP-39A
		4			X				23	17				
								Moist, Dark grayish brown [10Y 4/2] Dark yellowish brown [10YR 3/4], angular, Highly fractured SHALE with Gravel and Clay infilling, excavated rock particles generally 6-in. size, visible pyrite, hard digging.						
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13			X									
		14						BOH = 14 ft.						Installed 2" diameter PVC to 14' 0.020" Screen 9-14' Blank 0-9'
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-39A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/13/12 - 8/13/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5285.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029392.9, E1254485.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								.						Test pit excavated into side of hill.
		1												Two soil profiles observed in test pit (TP-FP-39 and TP-FP-39A); Soil profile for TP-FP-39A represents soil profile closest to stream.
		2						Moist, Brown, SILTY SAND with Gravel, SM, subangular, TOPSOIL, numerous tree roots (1.5-in. minus).						
		3						Moist, Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, subrounded, ALLUVIUM, estimated 20% Cobble, 40% Gravel, 40% Sand.						The Measuring Point (MP) for TP-FP-39 and TP-FP-39A is based on ground surface of TP-FP-39. TP-FP-39 is 2 ft higher in elevation than TP-FP-39A
		4												
		5						Moist, Dark grayish brown [10Y 4/2], angular, Highly fractured SHALE with Gravel and Clay infilling, excavated rock particles generally 6-in. size, visible pyrite, hard digging.						
		6			X									
		7												
		8												
		9												
		10			X				23	17				
		11												
		12												
		13												
		14						BOH = 14 ft.						Installed 2" diameter PVC in TP-FP-39
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-40

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/8/12 - 8/8/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5264.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029521.3, E1253720.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, subrounded, TOPSOIL, organic roots.						Excavated on hill side. Toe of test pit (MP) is 2 ft higher than bottom.
		1						Moist, Dark brown [7.5YR 3/3] Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, low plasticity, ALLUVIUM, Cobbles, plant roots, random thin layers of Well-Graded SAND 2 to 4" thick						
		2			X									
		3						Two inch thick layer of reddish brown, low plasticity, Clayey SAND at 4.5 ft depth.						
					X									
		4												
		5						Moist, Dark yellowish brown [10YR 4/4] Very dark brown [10YR 2/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, low to medium plasticity,						
		6			X									
					X			Pocket of brownish black, medium plastic, Organic SILT and CLAY on south side of test pit from 7.0 to 8.0 ft.						
		7												
		8						Moist, Yellowish brown [10YR 5/6] Yellowish brown [10YR 5/8], CLAYEY GRAVEL with Sand, GC, medium to high plasticity, trace sand, medium grained, Reddish colored mottling.						
					X									
		9												
		10												
		11												
		12												@ 15ft GW 514.4 rmv, 374.0 µs/cm, pH start 6.24 pH end 6.16 (24 Minutes)
		13			X									
▼		14						Saturated, Dark yellowish brown [10YR 3/4], POORLY GRADED GRAVEL with SAND, GP, subrounded, cobbles. Possible bedrock at 15'.						Groundwater at 14 ft. while excavating
					X									
		15						BOH = 15 ft.						Excavator scraping on large rock at 15.0 ft depth. Could not determine if it was bedrock or large boulder(s). Installed 2" diameter PVC to 14.5' 0.020" Screen 9.5-14.5' Blank 0-9.5'
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering

ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-41

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/8/12 - 8/8/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5260.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029588.6, E1253712.6	HAMMER TYPE:

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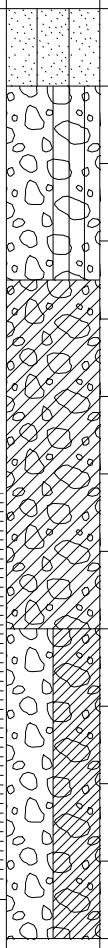

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Yellowish red [5YR 4/6] Black [7.5YR 2.5/1], SILTY SAND, SM, MIXED TAILINGS, visible Pyrite, majority of layer was yellowish red in color with occasional pockets of black.						
		1						Moist, Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, ALLUVIUM, estimated 30% Cobble, 40% Gravel, and 30% Sand, frequent pockets of rust coloration throughout.						
		2			X									
		3												
								Moist to wet, Dark reddish brown [5YR 3/3], CLAYEY GRAVEL, GC, subangular to subrounded, estimated 10% Cobble, 40% Gravel, 10% Sand, and 40% Clay, clay fraction is medium to high plasticity, some iron staining.						
		4			X									
		5												
		6			X									
		7												
▼		8						Wet to Saturated, Dark reddish brown [5YR 3/3] Brown [7.5YR 4/4], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, subangular to rounded, ALLUVIUM, estimated 10% Boulder, 20% Cobble, 40% Gravel, 15% Sand, and 15% Clay, gravels are flat and elongated.						Soil was wet from 8 to 12 ft depth, no visible groundwater flowing into test pit
		9			X									
		10												
		11			X									Depths shown for screen interval on well log are approximate
		12						BOH = 12 ft.						Installed 2" PVC to 11.3' 0.020" Screen 6.3-11.3' Blank 0-6.3'
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-42

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/8/12 - 8/8/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5259.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029653.6, E1253753.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/4], SANDY SILT with Gravel, ML, non-plastic, ALLUVIUM, poorly graded, some roots, pockets of grayish brown tailing with visible Pyrite. Mixed Tailings.						Excavated on hillside. Upper side (MP) of test pit is 3.5 ft higher in elevation than bottom of test pit. Ground surface at bottom of test pit is located in floodplain.
		2			X			Moist, Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, ALLUVIUM, estimated 60% Gravel, 30% Sand, and 10% Fines. Approximately 3" maximum size.						
		3						Moist, Rusty brown to grayish black, CLAYEY SAND, SC, low plasticity, with roots.						
		4						Moist, Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM, estimated 90% 1-in minus Gravel, 10% Sand.						
		5			X			Moist, Dark reddish brown [5YR 3/3] Black [7.5YR 2.5/1], SILTY GRAVEL with Sand, GM, low plasticity, some roots.						
		6			X			Moist, Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, subangular to subrounded, ALLUVIUM.						
		7			X									
		8												Wet below depth of 8'. Possible GWT
		9												
		10			X									
		11						Wet to Saturated, Reddish brown [5YR 4/4] Brown [7.5YR 4/3], CLAYEY GRAVEL with Sand, GC, subangular, ALLUVIUM, estimated 10% Boulder, 20% Cobble, 30% Gravel, 20% Sand, and 20% Clay, with pockets of Sandy CLAY (SC).						
		12			X									
		13												
		14												@ 16ft GW 502.6 rmv, 365.0 µs/cm, pH start 6.92 pH end 6.21 (18 Minutes)
		15												Groundwater flowing in at 15 ft while excavating
		16			X			BOH = 16 ft.						Installed 2" PVC to 16' 0.020" Screen 11-16' Blank 0-11'
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-43

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/9/12 - 8/9/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5257.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029679.6, E1253787.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Dark reddish brown [5YR 3/3] Brown [7.5YR 4/4], WELL GRADED GRAVEL with SAND, GW, subangular to subrounded, ALLUVIUM, gravels have some black Manganese s staining from 1.3 1.5 ft, gravels generally flat and elongate						
		1			X									
		2												
		3						at 3 ft estimated 20% Cobble, 50% Gravel, 30% Sand and Fines						
		4			X									
		5												
		6			X									
		7												
		8						at 8 ft estimated 10% Boulder, 20% Cobble, 40% Gravel, 30% Sand. Approximately 16" maximum size.						
▼		9			X									Groundwater estimated at 9 ft while excavating @ 9.5ft GW 636.4 rmv, 350.0 µs/cm, pH start 7.13 pH end 6.66 (22 Minutes)
		10												
		11			X									Depths shown for screen interval on well log are approximate
		12						BOH = 12 ft.						Installed 2" PVC to 11.3' 0.020" Screen 6.3-11.3' Blank 0-6.3'
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-44

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/9/12 - 8/9/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5258.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029744.3, E1253826.2	HAMMER TYPE:

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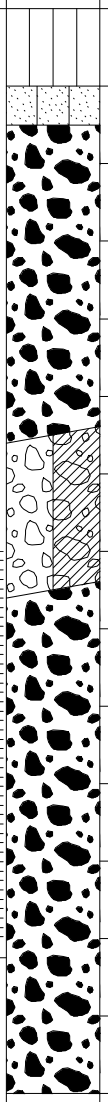

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Pale brown, SANDY SILT, ML, MIXED TAILINGS, includes pockets rusty brown in color.						Test pit excavated into side of hill.
		1			X			Moist, Dark brown, SILTY SAND, SM, TOPSOIL, abundant plant debris and large dead tree roots, sands fine grained.						Two soil profiles (TP-FP-44 and TP-FP-44A) observed in test pit; Soil profile for TP-FP-44A represents soil profile closest to stream.
		2			X			Moist, Brown, WELL GRADED GRAVEL with SAND, GW, subangular to subrounded, ALLUVIUM, at 4 ft depth estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand with max particle size of approximately 16-in, gravels are generally flat and elongated..						The Measuring Point (MP) for TP-FP-44 and TP-FP-44A is based on ground surface of TP-FP-44. TP-FP-44 is 4.5 ft higher in elevation than TP-FP-44A
		3												
		4			X									
		5												
		6			X			Moist to wet, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, ALLUVIUM, some small zones of Black Manganese staining on gravels at approximately 6', intermittent thin diagonal layers of black sandy clay.						Wet at approximately 6'
		7												
		8						Wet to Saturated, Dark reddish brown [5YR 3/4], WELL GRADED GRAVEL with SAND, GW, subangular to subrounded, ALLUVIUM, estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand.						
		9												Groundwater at 9 ft while excavating @ 9.5' GW 636.4 rmv, 350 µs/cm, pH start 7.13 pH end 6.66 (23 minutes)
		10												
		11												
		12												
		13			X									@ 13ft GW 593.5 rmv, 459.0 µs/cm, pH start 6.93 pH end 6.34 (58 Minutes)
		14						BOH = 14 ft.						Installed 2" diameter PVC to 12' 0.020" Screen 7-12' Blank 0-7'
		15												
		16												
		17												

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CLIENT: Spectrum Engineering

ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

DRILL HOLE LOG MIKE HORSE FLOOD PLAIN TEST PITS LOGS MB 11-08-2012.GPJ 12/10/12

Drill Hole No. TP-FP-44A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/9/12 - 8/9/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5258.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029744.3, E1253826.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1, 2						.						Test pit excaved into side of hill. The heel of the test pit is 4.5 ft lower than the toe of the test pit. Two soil profiles (TP-FP-44 and TP-FP-44A) observed in test pit; Soil profile for TP-FP-44A represents soil profile closest to stream.
		3			X			Moist, Dark reddish brown [5YR 3/4], WELL GRADED GRAVEL with SAND, GW, subangular to subrounded, ALLUVIUM, at 4 ft depth estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand , gravels are generally flat and elongated, iron stained.						The Measuring Point (MP) for TP-FP-44 and TP-FP-44A is based on ground surface of TP-FP-44. TP-FP-44 is 2.5 ft higher in elevation than TP-FP-44A
		4						Moist, Brown, WELL GRADED GRAVEL with SAND, GW, subangular to subrounded, ALLUVIUM, at 4 ft depth estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand with max particle size of approximately 16-in, gravels are generally flat and elongated.						
		5						Thin layer of Black Manganese staining observed at bottom of layer (5.5 ft).						
		6						Moist to wet, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, ALLUVIUM, some small zones of Black Manganese staining on gravels at approximately 6', intermittent thin diagonal layers of black sandy clay.						Wet at approximately 6'
		7												
		8			X			Wet to Saturated, Dark reddish brown [5YR 3/4], WELL GRADED GRAVEL with SAND, GW, subangular to subrounded, ALLUVIUM, estimated 10% Boulder, 20% Cobble, 40% Gravel, and 30% Sand.						
▼		9												Groundwater at 9 ft while excavating
		10												
		11												
		12												
		13												
		14						BOH = 14 ft.						Installed 2" diameter PVC in TP-FP-44
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-45

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/9/12 - 8/9/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5261.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029781.1, E1253867.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Very dark brown [7.5YR 2.5/3], SILTY SAND with Gravel, SM, MIXED TAILINGS, deposited as inclusions in deposit, visible pyrite.						
		1			X			Moist, Brown [7.5YR 4/3] Orangish brown, SILTY SAND, SM, no to low plasticity, MIXED TAILINGS, some pockets of lean Clay.						Abundant wood debris and organics from 0 to 3 ft
		2			X			Moist, Very dark brown [7.5YR 2.5/3], ORGANIC SILT with GRAVEL, OL, TOPSOIL, trace small rounded gravels, considerable roots and wood debris.						
		3						Moist to Saturated, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, ALLUVIUM, at 5 ft depth estimated 20% Cobble, 50% Gravel, and 30% sand with max particle size of approximately 6-in, at 8 ft depth estimated 10% Boulder, 20% Cobble, 40% Gravel, 30% Sand with max particle size of approximately 18-in. Cobble and boulder content increases with depth..						
		4			X									
		5												
		6												
		7												
		8			X									Becoming wet at 8'
		9												
		10												
		11			X									
		12												Groundwater flowing in at 12 ft while excavating
		13												@ 13ft GW 528.5 rmv, 358.0 µs/cm, pH start 6.47 pH end 6.39 (16 Minutes)
		14			X			BOH = 14 ft.						Depths shown for screen interval on well log are approximate
		15												Installed 2" diameter PVC to 13' 0.020" Screen 8-13' Blank 0-8'
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-45A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/13/12 - 8/13/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5261.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1029820.5, E1253894.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Very dark brown [7.5YR 2.5/2], SILTY SAND with Gravel, SM, subangular, no to low plasticity, TOPSOIL, trace small gravels.						
		1			X									Abundant roots in top 2 ft
								Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SAND, GP, subangular to subrounded, non-plastic, ALLUVIUM, at 3 ft depth estimated 20% Cobble, 50% Gravel, 30% Sand, maximum size approximately 5".						
		2												
		3			X									
		4												
								Moist, Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, ALLUVIUM, fine grained yellowish brown deposition on surface of gravels and cobbles.						
		5			X									
					X									
		6						Moist, Brown [7.5YR 4/4] Very dark brown [7.5YR 2.5/3], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, subangular to subrounded, ALLUVIUM						Boulder content increases from 5.3-10'
		7												
		8						at 8 ft estimated 20% Boulder, 20% Cobble, 30% Gravel, and 30% Sand with approxiamte 14-in max particle size						
		9			X									
								at 11.5 ft depth estimated 20% Cobble, 40% Gravel, 40% Sand with approximate 6-in max particle size (subangular).						
		10												
		11			X									
		12												
		13												
					X									
		14						BOH = 14 ft.						Installed 2" diameter PVC to 13' 0.020" Screen 8-13' Blank 0-8'
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-46

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/16/12 - 8/16/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5236.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030308.5, E1252680.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark brown [7.5YR 3/3], CLAYEY SAND with Gravel, SC, Colluvium, abundant live roots.						Test pit excavated into hill side, upper side of test pit (MP) is 4.5 ft higher than lower side of the test pit.
		2						Moist to Saturated, Very dark brown [7.5YR 2.5/3] Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, with Cobbles, cobbles are subangular, gravels are subrounded, cobbles and gravels are laying flat, fresh faces on cobbles are purple quartzite and argillite.						Slope wash layer is 2.5 ft thick at (south end) and 1 ft thick on bottom side
		3			X									
		4												Caving badly at 4.0'
		5												
		6			X									Groundwater at 6 ft while excavating @ 6ft GW 471.3 rmv, 385.0 µs/cm, pH start 6.69 pH end 6.81 (24 Minutes)
		7												
		8												
		9			X									
		10												@ 11.5ft GW 533.1 rmv, 365.0 µs/cm, pH start 6.81 ph end 6.77 (16 Minutes)
		11			X									
								BOH = 11.5 ft.						
		12												
		13												Installed 1.5" PVC to 11.3' 0.020" Screen 6.3-11.3' Blank 0-6.3'
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-47

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/16/12 - 8/16/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5235.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030327.7, E1252726.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/4], SILTY SAND with Gravel, SM, MIXED TAILINGS, sands fine grained, trace organics.						
		1						Moist, Dark reddish brown [5YR 2.5/2], SILTY SAND, SM, no to low plasticity, TOPSOIL, fine to coarse grain, trace of organic and contains abundant small (1/2-in minus) roots.						
		2			X									Topsoil layer appears to be native forest floor prior to inundation by flood
		3												
					X			Wet to Saturated, Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SAND, GP, subrounded, with Cobbles, ALLUVIUM, at 4 ft depth estimated 10% Cobble, 50% Gravel, and 40% Sand.						
▼		4												Groundwater at 4.2 ft
		5						Some Black Manganese staining observed on surface of particles at 4 ft depth.						@ 4ft GW 395 rmv, 595.5 µs/cm, pH start 6.69 pH end 6.77 (18 Minutes)
		6			X			Saturated, Very dark brown [7.5YR 2.5/2], SANDY CLAY with Gravel, CL, subangular, medium plasticity, estimated 10% Gravel, 40% Sand, and 50% Clay. Contains pockets of alluvium.						@ 7ft GW 391 rmv, 384 µs/cm, pH start 6.44 pH end 6.11 (18 Minutes)
		7			X			Saturated, Dark reddish brown [5YR 3/3], GRAVEL with Sand, GP, at 6.5 ft depth estimated 10% Boulder, 40% Cobble, 30% Gravel, and 20% Sand, max particle size is 14-in., boulders and cobbles are subangular, gravels are subrounded. Alluvium.						Sandy Clay layer was below groundwater, could not visually see extents (depths) of layer.
								BOH = 7 ft.						
		8												
		9												Installed 1.5" PVC to 7' 0.020" Screen 1.7-6.7' Blank 0-1.7'
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering

ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-48

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/15/12 - 8/15/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5237.70 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030416.0, E1252852.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X	A		Moist, Very dark brown [7.5YR 2.5/3] Grayish brown, SAND with Silt, SP-SM, MIXED TAILING, estimated 30% Tailing and 70% Alluvium.						Samples designated with"A" were collected from downstream face of test pit. All other samples collected from upstream face of test pit.
		2			X			Moist to Saturated, Very dark brown [7.5YR 2.5/3] Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM, flat elongated particles deposited in horizontal layers.						
		3			X			Black Manganese staining on surface of particles at 2.5 ft depth. Rust colored below mixed tailings at 3.5'						
		4												Groundwater at 4.4 ft while excavating @ 4ft GW 479.4 rmv, 290.7 µs/cm, pH start 5.66 pH end 5.64 (15 Minutes)
		5												
		6			X									
		7												
		8			X			At 8 ft depth estimated 25% subangular Cobble, 50% subround Gravel, and 25% Sand.						
		9												
		10			X									
		11												
		12												
		13												@ 13ft GW 439.2 rmv, 373.0 µs/cm, pH start 6.41 pH end 6.48 (48 Minutes)
		14			X			BOH = 14 ft.						Installed 1.5" PVC to 12.0' 0.020" Screen 7-12' Blank 0-7'
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-49

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/14/12 - 8/15/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5238.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030475.5, E1252908.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Yellowish red [5YR 4/6], SILTY SAND, SM, non-plastic, MIXED TAILINGS, visible pyrite, sand particles fine grained.						
		1			X									
								Moist, Dark reddish brown [5YR 2.5/2], SILTY SAND with Gravel, SM, subrounded, no to low plasticity, MIXED TAILING, estimated 30% Gravel, 50% Sand, and 20% Silt.						
		2			X									
								Moist, Dark reddish brown [5YR 3/3], WELL GRADED GRAVEL with SAND, GW, subrounded, ALLUVIUM, generally 1-in minus particles.						
		3			X									
								At 2.5 ft depth estimated 60% Gravel and 40% Sand.						
		4						At 3 ft depth on upstream side of test pit observe a 2-in thick layer which contains iron colored staining and deposition on surface of gravels. No staining on downstream side.						
								Saturated, Dark reddish brown [5YR 2.5/2], SANDY SILT, ML, medium plasticity, organic odor, estimated 10% Coarse Sand, 60% Fine Sand, and 30% Silt.						Groundwater at 5 ft while excavating
		5			X									
▼		6						Saturated, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, ALLUVIUM,						
														@ 6.5ft GW 540.2 rmv, 300.0 µs/cm, pH start 6.77 pH end 6.18 (9 Minutes)
		7			X									
		8												
		9			X			At 9 ft depth estimated 10% Cobble, 50% Gravel, and 40% Sand.						Could not collect representative sample below 9 ft depth due to side wall continually caving.
		10												
		11												@ 11ft GW 714.1 rmv, 425.0 µs/cm, pH start 6.60 pH end 5.94 (24 Minutes)
		12						BOH = 12 ft.						
		13												Installed 1.5" PVC to 11.7' 0.020" Screen 6.7-11.7' Blank 0-6.7'
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-50

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/15/12 - 8/15/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5239.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030636.1, E1253005.2	HAMMER TYPE:

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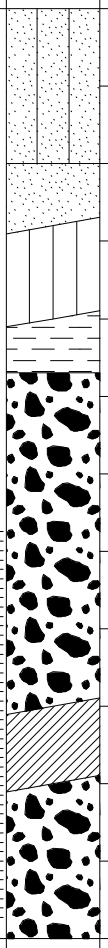

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Yellowish red [5YR 4/6], SILTY SAND, SM, no to low plasticity, MIXED TAILINGS, fine grained.						
		2			X			Moist, Very dark brown [7.5YR 2.5/3], SAND, SP, MIXED TAILINGS, fine grained, visible Pyrite.						
		3						Moist, Very dark brown [10YR 2/2], SILT with Gravel, ML, no to low plasticity, randomly MIXED TAILINGS and TOPSOIL.						
		4			X			Moist, Dark brown, ORGANIC SILTY SAND, OL, low plasticity, pre-flood TOPSOIL with small gravels.						
		5						Moist to Saturated, Very dark brown [10YR 2/2] Dark brown [7.5YR 3/3], WELL GRADED GRAVEL with SAND, GW, subrounded, ALLUVIUM, Black Manganese staining on gravels from 5.0 to 5.4 ft.						
▼		6			X			At 6.0 depth estimated 10% Cobble, 50% Gravel, and 40% Sand.						Groundwater at 6 ft while excavating @ 6ft GW 503.0 rmv, 408.0 µs/cm, pH start 6.77 pH end 6.77 (11 Minutes)
		7												
		8			X									
		9			X			Saturated, Brown [7.5YR 4/4], SANDY CLAY, CL, medium plasticity, estimated 10% Sand and 90% Fines.						
		10						Saturated, Very dark brown [7.5YR 2.5/3], WELL GRADED GRAVEL with SAND, GW, ALLUVIUM						
		11						at 11 ft depth, estimated 20% Cobble, 50% Gravel, and 30% Sand, max particle size is approximately 10-in., Cobbles are block shaped and subangular, gravels are subrounded.						
		12			X			BOH = 12 ft.						@ 12ft GW 502.5 rmv, 378.0 µs/cm, pH start 7.25 pH end 5.89 (14 Minutes) Installed 1.5" PVC to 11.7' 0.020" Screen 6.7-11.7' Blank 0-6.7'
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-50A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/15/12 - 8/15/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5239.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030636.1, E1253005.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Very dark brown [7.5YR 2.5/3], SILTY GRAVEL with Sand, GM, subrounded, ALLUVIUM, estimated 60% Sand and 40% Gravel (generally 1-in minus).						Mixed Tailings only observed on south side of test pit (nearest stream) from depth of 0 to 2.5 ft. Samples of the Mixed Tailing are designated with an asterisk. Excavated in dry streambed between TP-FP-50 and TP-FP-51
		1			X	*		Moist, Very dark brown (Y.5YR 3/4) to Dark Brown (7.5 YR 2/3), poorly graded, fine grain, Silty SAND, SP-SM, MIXED TAILING						
								Moist, Dark brown [7.5YR 3/4], SILTY SAND, SM, ALLUVIUM, estimated 60% Sand and 40% Gravel (generally 1-in minus).						
		2			X	*		Moist, Very dark brown (Y.5YR 3/4) to Dark Brown (7.5 YR 2/3), poorly graded, fine grain, Silty SAND, SP-SM, MIXED TAILING						
								Moist, Very dark brown [7.5YR 2.5/3], SILT, ML, low plasticity, organic with roots.						
		3						Saturated, Dark brown [7.5YR 3/4], POORLY GRADED GRAVEL with SAND, GP, ALLUVIUM in top 6-in of GP, coarse grained						
▼		4						at 4 ft depth estimated 30% Cobble, 40% Gravel, 30% Sand and Silt, Cobbles are subangular and block shaped.						Groundwater at 4 ft. while excavating
		5						Saturated, Strong brown [7.5YR 4/6], CLAYEY SAND with Gravel, SC, medium plasticity, Gravels are mineralized, angular, and orange brown in color.						
		6												@ 5.5ft GW 483.6 rmv, 244.2 µs/cm, pH start 5.98 pH end 4.91 (17 Minutes)
		7												
		8												Depths shown for screen interval on well log are approximate.
		9						BOH = 9 ft.						
		10												Installed 1.5" PVC 0.020" Screen 4-9' Blank 0-4'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-51

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/15/12 - 8/15/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5238.90 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030675.3, E1253026.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Brown [7.5YR 4/4], SILTY SAND with Gravel, SM, angular, low plasticity, Colluvium, estimated 20% Gravel, 60% Sand, and 30% Clay, roots in top 6-in.						Test pit excaved into side of hill. Two soil profiles (TP-FP-51 and TP-FP-51A) observed in test pit; Soil profile for TP-FP-51A represents soil profile closest to stream.
		2						Moist, Strong brown [7.5YR 4/6], CLAYEY SAND with Gravel, SC, angular, medium plasticity, SLOPE WASH, estimated 20% Gravel, 60% Sand, and 30% Clay, roots in top 6-in, visible pyrite, some gravels contain pyrite, 6" maximum size.						The Measuring Point (MP) for TP-FP-51 and TP-FP-51A is based on ground surface of TP-FP-51. TP-FP-51 is 2 ft higher in elevation than TP-FP-51A.
		3												
		4			X									
		5												
▼		6			X			Moist to wet, Dark brown [7.5YR 3/4] Strong brown [7.5YR 4/6], CLAYEY SAND with Gravel, SC, medium plasticity.						Groundwater at 6 ft. while excavating
		7												
		8			X									
		9												Could not observe soil profile below 9 ft depth due to standing water. Classification based on soil retrivied in excavator bucket.
		10			X									
		11			X			Saturated, Dark brown [7.5YR 3/4], CLAYEY GRAVEL with Sand, GC, subangular, estimated 40% Gravel, 30% Sand, and 30% Clay, maximum size approximately 4".						
		12			X			Moist to wet, Strong brown [7.5YR 4/6], CLAYEY SAND with Gravel, SC, medium plasticity.						@12' GW 533.6 rmv, 190.6 µs/cm
		13						BOH = 12.5 ft.						Installed 1.5" PVC to 12.5' 0.020" Screen 7.5-12.5' Blank 0-7.5'
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-51A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/15/12 - 8/15/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5238.90 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030675.3, E1253026.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								.						Test pit excaved into side of hill.
		1												Two soil profiles (TP-FP-51 and TP-FP-51A) observed in test pit; Soil profile for TP-FP-51A represents soil profile closest to stream.
		2						Moist, Dark reddish brown [5YR 3/4], SILTY SAND with Gravel, SP-SM, no to low plasticity, MIXED TAILINGS.						
		3			X			Moist, Very dark brown [7.5YR 2.5/2], SILTY SAND with Gravel, SM, angular, low plasticity, Alluvium, estimated 20% Gravel, 60% Sand, and 30% Clay.						The Measuring Point (MP) for TP-FP-51 and TP-FP-51A is based on ground surface of TP-FP-51. TP-FP-51 is 2 ft higher in elevation than TP-FP-51A.
		4												
		5			X									
▼		6			X			Saturated, Very dark brown [7.5YR 2.5/3], SILTY GRAVEL with Sand, GM, subrounded, ALLUVIUM, estimated 60% Gravel, 40% Sand, generally 1-in. minus particle size.						Groundwater at 6 ft. while excavating
		7												
		8												
		9						BOH = 9 ft.						
		10												Installed 1.5" PVC in TP-FP-51
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-52

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/27/12 - 8/27/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5221.20 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030356.4, E1251918.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Wet to Saturated, Black [7.5YR 2.5/1], ORGANIC SILT with Sand, OL, low plasticity, with MIXED TAILING.						Wetland vegetation on surface of test pit.
		1			X	52								
		2												Groundwater at 2 ft. while excavating
		3			X	52		Saturated, Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, ALLUVIUM, cobbles are subangular, gravels are subrounded.						@ 3ft GW 404.9 rmv, 185.6 µs/cm, pH start 6.75 pH end 5.24 (25 Minutes)
		4												
		5			X	52		At 5 ft depth estimated 20% Cobble, 50% Gravel, and 30% Sand.						Test pit location on edge of tailing area. Wetland vegetation covers all ground to the south. To the north the ground is covered by tailings with limited plant growth.
		6												
		7												
		8			X	52								@ 10ft GW 444.4 rmv, 270.5 µs/cm, pH start 4.68 pH end 4.33 (9 Minutes)
		9						Particle size becomes more coarse at 9 ft.						
		10			X	52		At 10 ft depth estimated 30% Cobble, 40% Gravel, 30% Sand and Fines, with maximum size of aproximately 8".						
								BOH = 10 ft.						
		11												Installed 1.5" PVC to 9.7' 0.020" Screen 4.7-9.7' Blank 0-4.7'
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-53

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/27/12 - 8/27/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5222.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030397.5, E1251929.5	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Dark reddish brown [5YR 3/3], ORGANIC SANDY SILT, OL, low plasticity, very soft, MIXED TAILING, wood debris observed at 2 ft.						
		1												Very little vegetation on surface
		2			X									
		3			X			Saturated, Dark reddish brown [5YR 3/3], WELL GRADED GRAVEL with Silt and Sand, GW-GM, ALLUVIUM with Cobbles, cobbles are subangular, gravels are subrounded. At 3.5 ft depth estimated 25% Cobble, 40% Gravel, and 35% Sand, max particle size is approximately 8-in.						Groundwater at 3 ft while excavating
		4						6" thick rust colored layer at 5'						@ 4ft GW 505.6 rmv, 348 µs/cm, pH start 3.95 pH end 3.95 (13 Minutes)
		5			X			@ 8' Cobble fraction and size increases						
		6												
		7												
		8			X									
		9						At 8 ft depth estimated 10% Boulder, 30% Cobble, 30% Gravel, and 30% Sand, max. particle size is approximately 14-in.						
		10			X									@ 12ft GW 400.1 rmv, 292.8 µs/cm, pH start 4.65 pH end 4.64 (16 Minutes)
		11												
		12			X									Depths shown for screen interval on well log are approximate.
								BOH = 12.5 ft.						
		13												Installed 1.5" PVC to 12.3' 0.020" Screen 7.3-12.3' Blank 0-7.3'
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-54

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/27/12 - 8/28/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5222.70 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030437.4, E1251972.8	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Yellowish brown [10YR 5/6], SILTY SAND, SM, MIXED TAILING.						A solvent type odor was noted on 8/27/2012 when test pit was excavated to 4 ft depth. Odor was still present on 8/28/2012 when excavation of test pit resumed.
					X			Moist, Dark brown [7.5YR 3/2], SANDY SILT, ML, low plasticity, with roots.						
		2			X			Moist, Dark reddish brown [5YR 3/3], SILTY SAND with Gravel, SM, non-plastic, ALLUVIAL SANDS, black staining on bottom 2-in of layer.						
		3						Moist to wet, Very dark brown [7.5YR 2.5/3], SILT with Gravel, ML, low plasticity, color grades to a pale brown below water table.						Multiple trees at 2.5'; 10" tree still standing with former ground surface at 2.5'
▼					X									Groundwater at 3.4 ft. while excavating
		4						Wet, Dark reddish brown [5YR 3/3], WELL GRADED GRAVEL with Silt and Sand, GW-GM, ALLUVIUM, estimated 10% Cobble, 40% Gravel, 40% Sand, and 10% Fines, max particle size is approximately 6-in.						@ 4ft GW 646.9 rmv, 1275 µs/cm, pH start 2.94 pH send 2.92 (10 Minutes)
		5			X									
		6												
		7			X									
		8												
		9			X									@ 10ft GW 597.5 rmv, 501 µs/cm, pH start 4.88 pH end 4.88 (15 Minutes)
		10						BOH = 10 ft.						
		11												Installed 1.5" PVC to 9' 0.020" Screen 4-9' Blank 0-4'
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-55

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/28/12 - 8/28/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5222.60 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030509.6, E1252030.8	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Dark reddish brown [5YR 3/4], SILTY SAND, SM, low plasticity, MIXED TAILING, wood debris.						Ground surface barren of vegetation.
		2			X			Wet, Dark reddish brown [5YR 2.5/2], ORGANIC SILT with Sand, OL, low to medium plasticity, with pockets of MIXED TAILING.						
		3			X			Wet, Dark reddish brown [5YR 3/3], WELL GRADED GRAVEL with Silt and Sand, GW-GM, ALLUVIUM, some Black Manganese staining in top 2-in of layer.						Test pit caving in on all sides starting at 2.6 ft depth. Water level at 3 ft. while excavating
		4			X			Rusty brown color observed at 3.8 ft depth. At 4 ft depth estimated 10% Cobble, 40% Gravel, 30% Sand, 20% Fines, particles are subangular.						@ 3ft GW 371.6 rmv, 175.2 µs/cm, pH start 6.15 pH end 5.88 (29 Minutes)
		5			X									@ 5ft GW 413.4 rmv, 267.6 µs/cm, pH start 5.25 pH end 5.08 (18 Minutes)
		6						At 6 ft depth estimated 20% Cobbles, 40% Gravel, 30% Sand, 10% Fines with max particle size of approximately 8-in., cobbles are subangular, gravels are subrounded.						Did not collect representative sample below 5.5 ft depth due to side wall continually caving.
		7												
		8						BOH = 8 ft.						Installed 1.5" PVC to 7.6' 0.020" Screen 2.6-7.6' Blank 0-2.6'
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-56

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/16/12 - 8/16/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5229.70 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030693.8, E1252226.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Dry to moist, Black [10YR 2/1], CLAYEY GRAVEL with Sand, GC, subangular, low to medium plasticity, TOPSOIL, abundant grass roots to 1.5 ft depth, estimated 10% Cobble, 40% Gravel, 30% Sand, and 20% Clay.						
		2						Moist to wet, Dark reddish brown [5YR 3/3] Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GC, subrounded, ALLUVIUM.						
		3			X			From 1.5 to 2.5 ft depth estimated 10% Cobble, 50% Gravel, 30% Sand, and 10% Silt						
		4			X			From 3.5 - 5 ft depth estimated 10% Cobble, 30% Gravel, 50% Gravel, and 10% Silt						
		5												
▼		6												Groundwater at 6 ft. while excavating
		7			X			At 7 ft depth estimated 20% Cobble, 40% Gravel, 30% Sand, 10% Fines.						@ 7ft GW 437.4 rmv, 141.9 µs/cm, pH start 6.56 pH end 6.57 (10 Minutes) Did not sample below 5.5 ft depth due to side wall continually caving (could not collect representative sample).
		8												
		9						BOH = 9 ft.						Installed 1.5" PVC to 8.6' 0.020" Screen 3.6-8.6' Blank 0-3.6'
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-57

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/25/12 - 9/25/12	DRILLER: Pioneer
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5216.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030161.7, E1251403.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Very dark brown [10YR 2/2], SILTY SAND with Gravel, SM, subrounded, low plasticity, gravels are flat, abundant plant roots in top 0.6 ft. Gravels are 2" maximum diameter.						Groundwater not observed.
		1			X			Dry, Very dark brown [10YR 2/2], SANDY CLAY, CL.						Piezometer not screened, has an open bottom
					X			BOH = 1.5 ft.						Hand auger refusal at 1.5 ft on rock. Refusal on Rock, diameter of rock was greater than diameter of hole that was 8" diameter
		2												
		3												No Groundwater encountered
		4												Installed open ended 4" PVC to 1.5'
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-FP-58

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/28/12 - 8/28/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5211.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030315.3, E1251336.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/4], SANDY SILT, ML, non-plastic, MIXED TAILINGS, fine grained.						
		1						Moist, Dark reddish brown [5YR 3/2], SANDY SILT, ML, subangular, low plasticity, trace cobbles, abundant tree roots (1-in minus).						
					X									
		2						Moist, Dark reddish brown [5YR 3/4], GRAVEL with Sand, GP, ALLUVIUM, At 2.5 ft depth estimated 20% Cobble, 40% Gravel, and 40% Sand, max particle size is 6-in., cobbles are subangular, gravels are subrounded.						
▼					X									
		3						Saturated, Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP, subangular to subrounded, ALLUVIUM, iron staining/deposition prominent on surface of gravels						Groundwater at 2.8 ft. while excavating
		4			X			@3' 20% Cobble, 40% Gravel, approximate 6" maximum size.						
					X			Saturated, Black [2.5Y 2.5/1] Brown, CLAY with Gravel, CL, medium plasticity, ALLUVIUM, pockets of highly plastic clay (CH) with trace of organics frequently observed between 4 and 6 ft, Alluvium surrounding clay pockets had a greenish hue, gravels are subangular to subrounded.						@ 4ft GW 441.6 rmv, 250.8 µs/cm, pH start 6.55 pH end 6.31 (32 Minutes)
		5												
		6			X			Saturated, Dark reddish brown [5YR 3/3] Black, POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, with zone of black organic Sandy Silt.						Sandy Silt was below water table, estimated depth and profile from excavator cuttings.
		7						Saturated, Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subangular to subrounded, ALLUVIUM.						
		8												
		9			X									@ 10ft GW 260.0 rmv, 211.2 µs/cm, pH start 6.07 pH end 6.03 (24 Minutes)
		10			X			BOH = 10 ft.						Installed 1.5" PVC to 9.7' 0.020" Screen 4.7-9.7' Blank 0-4.7'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-59

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/28/12 - 8/28/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5213.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030387.1, E1251343.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/4], SILTY SAND with Gravel, SM, MIXED TAILING.						No vegetation growing on ground surface.
		1						Moist, Very dark brown [7.5YR 2.5/2], SAND with Gravel, SP, non-plastic, abundant tree roots (1/2-in. minus).						
		2			X			Moist to Saturated, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, subrounded, non-plastic, ALLUVIUM, estimated 60% Gravel, 40% Sand, max particle size is 6-in, gravel particles are flat and layered In center of test pit, observe a 0.3 ft thick layer Black Manganese running diagonal from 1.8 to 2.0 ft.						
		3			X									
		4			X			On upstream side of test pit observe a Silty, Clayey SAND with Iron oxide inclusions (1/4-in diam.) from 3.3 to 6.0 ft.						
		5												
▼		6						Saturated, Dark reddish brown [5YR 3/3], SILTY GRAVEL with Sand, GP-GM, non-plastic, ALLUVIUM, estimated 60% Sand and 40% Gravel, particles are flat and elongated.						Groundwater rapidly flowing into test pit at 6 ft @ 6ft GW 497.7 rmv, 231.6 µs/cm, pH start 6.16 pH end 6.23 (25 Minutes)
		7			X			Black Manganese staining observed from 7 to 8 ft.						
		8						Saturated, Dark reddish brown [5YR 3/4], SILTY GRAVEL with Sand, GM, subrounded, non-plastic, ALLUVIUM, gravel particles are flat and layered.						
		9			X									
		10												
		11												
		12			X									@ 12ft GW 404.7 rmv, 207.7 µs/cm, pH start 5.36 pH end 5.26 (24 Minutes)
								BOH = 12.5 ft.						Installed 1.5" PVC at 12.2' 0.020" Screen 7.2-12.2' Blank 0-7.2'
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-FP-60

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/28/12 - 8/28/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5215.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030584.2, E1251376.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Very dark brown [7.5YR 2.5/2], SANDY SILT with Gravel, ML, subangular, low plasticity, TOPSOIL.						Lush grass vegetation growing on ground surface.
		1												
								Dry to moist, Dark reddish brown [5YR 3/3], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, non-plastic, ALLUVIUM.						
		2			X									
		3												
		4			X									
								At 4 ft depth estimated 20% Cobble, 30% Gravel, and 30% Sand. Gravels are flat and deposited in horizontal layers, Cobbles are blocky.						
		5			X									
								Soil moisture increases from dry to moist at 4.5 ft and from moist to wet at 5.9 ft.						
▼		6			X									Groundwater at 5.9 ft. while excavating @ 6ft GW 548.0 rmv, 69.6 µs/cm, pH start 5.52 pH end 5.06 (31 Minutes)
		7												
		8			X			Pocket of wet, medium plastic, Black [2.5Y 2.5/1] Clayey SAND with Gravel from 7.5 to 8.5 on downstream (west) side of test pit. Pocket includes wood debris ad roots in it. Only noticable on downstream side of pit..						
					X									
		9			X									
		10												
		11												
		12						BOH = 12 ft.						Installed 1.5" diameter PVC to 11.8' 0.020" Screen 6.8-11.8' Blank 0-6.8'
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-01

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/24/12 - 9/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5197.70 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030400.3, E1250072.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet, Very dark grayish brown [10YR 3/2], PEAT wtih Silt, PT, no to low plasticity, TAILINGS.						Lush wetland vegetation at ground surface. Groundwater not observed. Installed 4-inch solid wall PVC with an open bottom at 1'
		1			X			Wet, Very dark brown [10YR 2/2], ORGANIC SILT with GRAVEL, OL, subangular, medium plasticity, gravels are flat and 1-in minus. BOH = 1 ft.						Auger refusal at 1' on gravels
		2												
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-03

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/24/12 - 9/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5198.00 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030557.8, E1250220.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist, Very dark brown [7.5YR 2.5/3], PEAT with SILT, PT, low plasticity.						Lush wetland vegetation at ground surface.
		1						Moist to Saturated, Very dark grayish brown [10YR 3/2] Dark grayish brown [10Y 4/2], SANDY SILT, ML, non-plastic, TAILING, fine grain sands, some rusty brown areas, visible pyrite.						
		2												Piezometer is solid wall PVC with an open bottom at 2.75' Groundwater at 2.3 ft while augering
								Saturated, Black [10YR 2/1], PEAT with SILT and GRAVEL, PT, subrounded, low plasticity, trace flat gravels.						Groundwater at 2.25' 339.7 rmv, 420 µs/cm pH begin 7.09 pH end 6.13 (15 min)
		3						BOH = 2.75 ft.						Auger refusal at 2.75' on gravel
		4												Installed 4-inch solid wall PVC with an open bottom at 2.75'
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-04

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/21/12 - 9/21/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5199.10 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030688.6, E1250296.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark brown, SILT, ML, no to low plasticity, TOPSOIL with organics and pockets of TAILINGS.						Lush wetland vegetation at ground surface.
					X			Tailings are composed of poorly graded, fine grained, rusty brown and dark gray, Silty SAND with visible Pyrite.						
		1			X			Moist, Dark gray and rusty brown, SILTY SAND, SM, non-plastic, TAILINGS with visible Pyrite.						No visible indication of tailings below 1.0 ft.
▼		2			X			Moist, Black, SANDY ORGANIC SILT with GRAVEL, OL, medium plasticity, trace subangular gravels at 2.4 ft. Possible surface soils prior to flooding..						Groundwater at 2'; 385.7 rmv, 1586 µs/cm, pH start 5.70 pH end 5.48
								BOH = 2.5 ft.						Auger refusal at 2.5' on Gravel
		3												Installed 4" solid wall PVC with open bottom at 2.5'
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-MS-04A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/21/12 - 9/21/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5199.00 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030801.3, E1250318.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Rusty brown, SAND with Gravel, SP, subrounded, MIXED TAILING, sand is coarse grain, estimate 20% Gravel.						White precipitate observed on ground surface (no vegetation growing). Test pit excavated on north bank of stream. Groundwater not observed. Installed 4" solid wall PVC with an open bottom to 2.0'
		2			X			BOH = 2.0 ft (auger refusal).						Auger refusal at 2' on gravel
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering
ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-05

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/29/12 - 8/29/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5199.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: State Plane (NAD83) N1030983.2, E1250643.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Wet, Very dark brown [10YR 2/2], ORGANIC SILT, OL, medium plasticity, organic odor, dilatent.						Lush wetland vegetation at ground surface.
		1			X									
		2			X			Saturated, Dark brown [7.5YR 3/3], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, subangular to subrounded, ALLUVIUM, estimated 60% Gravel and 40% Sand.						Groundwater at 1.75 ft. while excavating
		3			X			Saturated, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, medium plasticity, with organics, ALLUVIUM..						
		4			X									
		5												
		6			X									GW at 9.5', 336.7 rmv, 134 µs/cm, pH start 6.21 pH end 6.17
		7						Saturated, Very dark brown [7.5YR 2.5/2], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, ALLUVIUM, estimated 20% Cobble, 50% Gravel, and 30% Sand and fines, max particle size is approximately 7-in., Cobbles are subangular and blocky, Gravels are subrounded and flat.						
		8												
		9			X									
								BOH = 9.5 ft.						
		10												Installed 1.5" PVC to 7.5' 0.020" Screen 2.5-7.5' Blank 0-2.5'
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-MS-06

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/29/12 - 8/29/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION: 5200.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: State Plane (NAD83) N1031040.4, E1250682.8	HAMMER TYPE:

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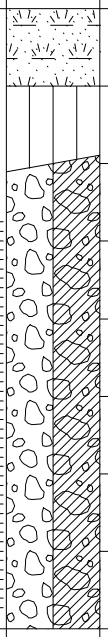
WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Moist to wet, Very dark brown [7.5YR 2.5/2], SILTY SAND with Gravel, SM, subangular, TOPSOIL.						Clayey Gravel visually appears to be native material (no tailings). The soil color (yellowish brown) is similar to other areas where mixed tailing was observed. The test pit is located in a highly mineralized area. Groundwater at 1 ft. while excavating
		1			X			Saturated, Very dark brown [7.5YR 2.5/2], SILT with Gravel and Peat, ML, medium plasticity, soft, with PEAT.						
		2			X			Saturated, Dark yellowish brown [10YR 4/6], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, angular to subangular, ALLUVIUM, trace organics, estiamted 15% Cobble, 25% Gravel, 30% Sand and 30% Clay, fine grain fraction has medium plasticity, approximate 6" maximum particle size.						Groundwater at 2', 472.1 rmv, 103.5 µs/cm, pH start 5.90 pH end 5.67 (19 min)
		3			X									
		4												
		5			X									
		6												Groundwater at 6', 472.1 rmv, 103.5 µs/cm, pH start 5.90 pH end 5.67 (19 min)
		7												
		8						BOH = 8.0 ft.						Installed 1.5" PVC to 7.7' 0.020" Screen 2.7-7.7' Blank 0-2.7'
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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ADDRESS: 1413 4th Ave North
Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-07

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/24/12 - 9/24/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5185.20 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030777.5, E1249168.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [5Y 2.5/1], PEAT with SILT, PT, low plasticity, trace fine sand.						Lush vegetation at ground surface.
▼		1			X									Groundwater at 1 ft. while excavating Groundwater at 1', 273.9 rmv, 97.6 µs/cm pH start 4.78 end 5.35
		2												
								Saturated, Very dark brown [10YR 2/2] Very dark grayish brown [10YR 3/2], CLAY with Sand, CL, medium to high plasticity, very soft, trace roots.						
		3			X									
		4			X			Color transition to grayish black and increasing organic content at 4.5'						
		5			X									
		6			X									
		7												
		8			X									
		9			X									
		10												Installed 4-inch solid wall PVC with open end at 9.5'
		11						Greenish black hue observed at 7.5 ft depth with trace of fine sand						
		12												
		13												
		14						Trace coarse sand observed on auger tip at 9.5 ft.						
		15						BOH = 9.5 ft (maximum could advance hand auger).						
		16												
		17												

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Drill Hole No. TP-MS-08

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/21/12 - 9/21/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5188.80 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031128.8, E1249590.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Dark gray [7.5YR 4/1], PEAT with Sand and Silt, PT, non-plastic, organic odor, Organic sandy silt.						Groundwater at 0.2 ft above top of TP-MS-08.
		1			X									Lush vegetation at ground surface.
		2			X			Saturated, Very dark brown [10YR 2/2], SILT with Gravel, ML, low plasticity, trace fine Sand and Peat						
		3												Groundwater at 3'; 159.1 rmv, 443 µs/cm, pH start 6.15 pH end 6.59 (18 min)
		4			X									
		5												
		6			X									Installed 4-inch solid wall PVC with open bottom at 6.75'
		7												
		8												
		9						Trace subangular Gravels at 6 ft.						
								Saturated, Very dark gray [10YR 3/1], POORLY GRADED GRAVEL with Clay and Sand, GP-GC, medium plasticity.						
								BOH = 6.75 ft.						
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-09

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/20/12 - 9/20/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5190.00 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031168.3, E1249646.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 2.5/2], ORGANIC SILT with Sand, OL, low plasticity, TOPSOIL with pockets of Tailings. Tailings pockets are dark gray, poorly graded Sandy Silty with visible Pyrite.						Wetland vegetation at ground surface. Samples are wet at 0.5 ft; however, no standing water in auger hole.
		1			X			Saturated, Very dark grayish brown [10YR 3/2] Black [10YR 2/1], PEAT, PT, low plasticity.						
		2			X			Saturated, Very dark brown [10YR 2/2], ORGANIC SILT, OL, low to medium plasticity, trace subrounded gravels, soft..						Groundwater at 4'; 161.1 rmv, 524 µs/cm pH start 6.83 pH end 6.66 (12 min)
		3			X			Saturated, Very dark brown [10YR 2/2], LEAN CLAY, CL, medium plasticity, Trace of fine subrounded gravels, firm consisitency at 4', trace subrounded 1" minus flat gravel at 7'.						
		4			X									
		5			X									
		6			X									
		7			X			BOH=7' maximum depth with hand auger.						Installed 4-inch solid wall PVC with open bottom at 7'
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-101

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/18/12 - 10/18/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5198.60 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030903.7, E1250353.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/2], ORGANIC SANDY SILT, OL, low plasticity, abundant vegetation, no pyrite was observed.						No Groundwater Encountered
		1			X			Wet, Dark reddish brown [5YR 3/3], SANDY SILT, ML, sand grains fine to medium, well graded, some angular to subangular fine to coarse gravel (~5%), trace fine pyrite. BOH=1.0 ft.						Appears to be predominantly alluvium that was transported by a flood event carrying trace amounts of tailings BOH = 1ft
		2												
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-102

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/18/12 - 10/18/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5194.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030836.8, E1249916.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Very dark brown [7.5YR 2.5/3], ORGANIC SANDY SILT, OL, low plasticity, abundant organics and trace fine pyrite.						
		1			X			Wet, Very dark gray [10YR 3/1], SILT, ML, low plasticity, and fine pyrite, possible TAILINGS.						
					X			Wet, Black [10YR 2/1], ORGANIC SILT, OL, medium plasticity, with PEAT and trace fine pyrite. Possible original topsoil horizon.						Groundwater at 1.5ft while excavating
		2			X			Wet, Black [10YR 2/1], CLAYEY SILT with Sand, CL-ML, medium plasticity, organics and trace fine pyrite.						
					X			Wet, Very dark brown [7.5YR 2.5/2], SILTY GRAVEL with Sand, GM, no pyrite observed, small amounts of clay and silt [2.75 ft].						
		3						BOH=3 ft..						BOH = 3ft
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-103

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/17/12 - 10/17/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5194.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031363.8, E1250128.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [10YR 2/1], ORGANIC SANDY CLAY, OL, low plasticity, some subrounded fine gravel, heavy organics and trace pyrite to 0.25'						Water at surface while excavating
		1			X									
					X			Becomes dark gray less organic at 0.5'. Saturated, Very dark gray [10YR 3/1], ORGANIC SILTY CLAY, OL, medium plasticity, some subrounded fine gravel, trace pyrite. BOH=1.5'.						BOH = 1.5ft
		2												
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-104

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/18/12 - 10/18/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5191.60 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031312.8, E1249739.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Saturated, Dark brown [7.5YR 3/2] to rust colored, ORGANIC SANDY SILT, OL, abundant organics with PEAT, fine pyrite.						Water at Surface
		1			X			Saturated, Very dark gray [10YR 3/1], SILT, ML, low plasticity, some organics and fine pyrite, possible TAILINGS						
		2			X			More organics and pyrite at 1'. Saturated, Black [10YR 2/1], ELASTIC SILT, OL, abundant organics and some pyrite. Possible original surface soil horizon.						Auger refusal at 2.5', subangular to subrounded gravel collected at BOH.
		3						BOH=2.5 ft.						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-105

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/29/12 - 10/29/12	DRILLER: EG
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5185.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031584.5, E1249464.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet, Very dark brown [10YR 2/2], PEAT wtih Silt, PT, with grass, roots, wood, no visible pyrite.						
		1			X			Saturated, Very dark brown [10YR 2/2], ORGANIC SILT, OL, low plasticity, abundant organics with PEAT, no visible pyrite.						Groundwater at 0.5ft while excavating
					X									
		2			X			Becomes dark brown to black [10YR 2/1] at 1'.						
								Saturated, Black [10YR 2/1], ORGANIC SANDY SILT, OL.						
		3			X			Wet to Saturated, Very dark brown [10YR 2/2], SILTY SAND with Gravel, SM, some clay visible, fine to medium subangular gravel, no visible pyrite.						Auger refusal at 3', wet, well-graded, subangular to subrounded gravel, no visible pyrite encountered at BOH.
								BOH=3 ft.						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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ADDRESS: 1413 4th Ave North
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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-106

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/29/12 - 10/29/12	DRILLER: EG
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5188.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031791.1, E1249633.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Very dark brown [10YR 2/2], PEAT with Sandy Silt, PT, organics with interbedded fine sand and silt, trace pyrite.						Water at Surface
		1			X			Becomes very dark brown [7.5YR 2.5/2] with more pyrite at 0.5'.						Appears to be intermixed tailings and alluvium
		2			X			Saturated, Very dark brown [10YR 2/2], SILTY SAND, SM, some organics, abundant very fine angular pyrite intermixed with fine, subangular to subrounded sand and trace gravel, possible TAILINGS.						Unable to retrieve sample below 2.5'
		3						Becomes brown to gray [10YR 3/2] at 1'.						
		4						Saturated, Very dark brown [10YR 2/2], SILTY SAND, SM, sand grains fine to coarse, trace fine subangular to subrounded gravel, abundant very fine pyrite, ALLUVIUM.						
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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ADDRESS: 1413 4th Ave North
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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-107

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/29/12 - 10/29/12	DRILLER: EG
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5185.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031802.4, E1249289.3	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [10YR 2/1], ORGANIC SILT, OL, PEAT, no visible pyrite.						Water at surface
		1			X			Saturated, Very dark brown [10YR 2/2], ORGANIC SANDY SILT, OL, low plasticity, abundant organics, PEAT, abundant very fine pyrite						
		2			X			Becomes dark brown to black at 0.5'.						
					X			Saturated, Very dark brown [10YR 2/2], ORGANIC SANDY SILT, OL, fine sand with some organics, no visible pyrite.						
		3						BOH=2.5 ft..						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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ADDRESS: 1413 4th Ave North
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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-108

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/20/12 - 10/20/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5178.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031698.2, E1248897.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [10YR 2/1], PEAT wtih Silt, PT, organics (roots, wood and grass), no visible pyrite.						Water at surface
		1			X			Saturated, Very dark brown [7.5YR 2.5/2], ORGANIC SANDY SILT, OL, low plasticity, some fine sand, abundance of roots, PEAT and small trace of very fine pyrite.						
		2			X			Dark gray with no visible pyrite at 1'.						
								Saturated, Very dark brown [10YR 2/2], ORGANIC SANDY SILT, OL, low plasticity, no visible pyrite.						BOH = 2.5ft
		3						BOH= 2.5 ft.						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-109

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/20/12 - 10/20/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5178.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031476.2, E1249091.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet, Very dark brown [7.5YR 2.5/2], ORGANIC SANDY SILT, OL, low plasticity, some fine sand with abundant organics, PEAT, no visible pyrite.						
		1			X			Wet, Very dark brown [7.5YR 2.5/2], ORGANIC SANDY SILT, OL, low plasticity, abundant organics, PEAT, no visible pyrite.						
▼		2			X			BOH=2.0 ft.						Groundwater at 2ft while excavating
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-10A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/19/12 - 9/19/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5189.20 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031459.1, E1249699.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Very dark brown [10YR 2/2], PEAT with SILT, PT, non-plastic,						Wetland vegetation at ground surface. Groundwater at 0.2 ft above top of TP-MS-10A. Groundwater at surface; 387.1 rmv, 283.1 µs/cm, pH start 6.22 pH end 7.06 (`12 min)
		1			X									
		2			X			Gravels at 2 ft. BOH = 2 ft.						Installed 4-inch solid wall PVC with open bottom at 2.0' Auger refusal on gravel at 2'
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-10B

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/20/12 - 9/20/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5188.40 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031491.0, E1249656.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [10YR 2/1] Very dark gray [10YR 3/1], PEAT with SILT, PT, non-plastic.						Wetland vegetation at ground surface. Groundwater at 0.25 ft above top of TP-MS-10B.
		1			X									Groundwater at surface 540.1 rmV, 302 µs/cm, pH start 7.22 pH end 6.83 (15 min)
		2			X									
								Saturated, Very dark gray [10YR 3/1], SILTY GRAVEL, GM, subrounded. BOH = 2.75 ft.						Installed 4-inch solid wall PVC with open bottom at 2.75'
		3												Auger refusal at 2.75' on gravels
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-10C

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/19/12 - 9/19/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5190.00 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031575.3, E1249894.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Saturated, Very dark brown [10YR 2/2], PEAT with Sand and Silt, PT, non-plastic, Sandy silt mixed throughout Peat.						Wetland vegetation at ground surface. Groundwater at 0.25 ft above top of TP-MS-10C. Surface water 375.2 rmV, 449 µs/cm, pH start 6.38 pH end 6.69 (15 min)
		1			X			Saturated, Dark gray [10YR 4/1] Very dark brown [10YR 2/2], SANDY SILT with organics, ML, non-plastic, organics, visible Pyrite.						
		2			X									
		3			X									
		4												Installed 4-inch solid wall PVC with open bottom @ 3.75
		5												Auger refusal at 3.75'
		6						Trace of Subangular, flat gravels at 3.75 ft. BOH = 3.75'.						
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-10D

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/19/12 - 9/19/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5189.90 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031613.3, E1249867.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Saturated, Very dark brown [10YR 2/2], PEAT wtih Silt, PT.						Wetland vegetation at ground surface. Groundwater at 0.75 ft above top of TP-MS-10D.
		1						Saturated, Dark gray [10YR 4/1] Very dark brown [10YR 2/2], SANDY SILT, ML, non-plastic, with organics, visible Pyrite, sand is very fine grained						Surface water 345.9 rmV, 404 µs/cm, pH start 5.01 pH end 6.73 (10 min)
		2												
		3												
		4						trace coarse sand and flat, subangular gravels at 3.5 ft. BOH = 3.5'.						Installed 4-inch solid wall PVC with open bottom at 3.75' Auger refusal at 3.5' on gravels
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-110

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/19/12 - 10/19/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5170.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031271.3, E1248475.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet to Saturated, Dark reddish brown [5YR 3/3], SILT, ML, low plasticity, with PEAT, organics, no visible pyrite.						Groundwater at 0.25ft while excavating
		1			X			Saturated, Very dark brown [7.5YR 2.5/2], ORGANIC SANDY SILT, OL, low plasticity, PEAT, abundant organics, no visible pyrite.						
					X			Saturated, Black [10YR 2/1], ORGANIC SILT, OL, low to medium plasticity, PEAT, abundant organics, no visible pyrite.						
		2			X			BOH= 2.0ft.						
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-111

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/17/12 - 10/17/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5192.50 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031164.5, E1249899.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
▼					X			Wet, Very dark brown [7.5YR 2.5/3], ORGANIC SANDY SILT, OL, abundant organics, abundant pyrite, occasional pine cone, possible TAILINGS less organic at 0.25'.						Groundwater at 0.5ft while excavating
		1						Moist, Very dark brown [7.5YR 2.5/2], ORGANIC SILT, OL, abundant organics and PEAT, no visible pyrite, possible original soil surface. BOH=0.75 ft.						Auger refusal at 0.75', subangular fine to medium gravel collected at BOH. BOH = 0.75ft
		2												
		3												
		4												
		5												
		6												
		7												
		8												
		9												
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		11												
		12												
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		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-112

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/20/12 - 10/20/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5175.20 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031450.6, E1248848.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet to Saturated, Dark reddish brown [5YR 3/3], ORGANIC SANDY SILT, OL, low plasticity, sand grains are rounded to subrounded, some organics and no visible pyrite.						Groundwater at 0.5ft while excavating
		1			X									
								Becomes dark gray with more sand, less organics at 0.5'.						
		2			X			Saturated, Very dark gray [7.5Y 3/1], ORGANIC SANDY SILT, OL, low to medium plasticity, fine sand, no organics and no visible pyrite.						
								BOH=2.0 ft.						
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
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		16												
		17												

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Drill Hole No. TP-MS-113

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/19/12 - 10/19/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5169.80 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031027.0, E1248335.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 2.5/2], SILTY SAND, SM, sand grains are fine, abundant roots, no visible pyrite.						No groundwater encountered
		1			X			Moist, Dark reddish brown [5YR 2.5/2], SILTY SAND, SM, sand grains are fine to coarse and subrounded to rounded with some roots, no visible pyrite.						
		2			X			BOH=1.75'.						Auger refusal at 1.75', moist, brown, angular to subangular gravel encountered at BOH.
		3												BOH = 1.75ft
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
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		16												
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Drill Hole No. TP-MS-114

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/19/12 - 10/19/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5170.30 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031202.8, E1248234.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/2], ORGANIC SANDY SILT, OL, sand grains are fine and subrounded, abundant roots with trace very fine pyrite.						
		1			X			Moist to wet, Dark reddish brown [5YR 2.5/2], LEAN CLAY, CL, low plasticity, no visible pyrite and abundant roots.						
								Some fine, angular to subangular gravel at 0.5'.						Groundwater at 1.5ft while excavating
		2												
		3						Becomes light brown to gray and saturated at 1'.						
								BOH=2 ft..						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
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		16												
		17												

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Drill Hole No. TP-MS-115

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/19/12 - 10/19/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5168.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031258.8, E1247938.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Very dusky red [2.5YR 2.5/2], PEAT wtih Silt, PT, no visible pyrite.						Water at surface
		1			X			Saturated, Very dark brown [7.5YR 2.5/2], LEAN CLAY, CL, organics and no visible pyrite.						
		2			X			BOH=2.0 ft.						Unable to retrieve significant sample below 2'.
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
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		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-116

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/19/12 - 10/19/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5167.20 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031126.8, E1247853.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [10YR 2/1], PEAT, PT, interbedded light gray silty clay, CL, with trace very fine pyrite..						Water at surface
		1			X			Saturated, Black [10YR 2/1], ORGANIC CLAY, OL, medium plasticity, Less organics, trace sand at 1.5'.						
		2			X			BOH=2.0'.						Auger refusal at 2', wet, subrounded to subangular gravel, no pyrite encountered at BOH.
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-117

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/18/12 - 10/18/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5163.10 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030857.7, E1247592.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Very dark brown [7.5YR 2.5/3], ORGANIC SILT, OL, with PEAT, abundant organic material and no visible pyrite.						Water at surface
		1			X			Becomes dark gray with less organics at 0.5'.						
		2			X			Saturated, Dark brown [7.5YR 3/2], SILTY GRAVEL with Sand, GM, low plasticity, some roots and no visible pyrite.						
					X			Saturated, Very dark brown [7.5YR 2.5/3], SILTY GRAVEL with Sand, GM, well graded, no visible pyrite.						BOH = 2.5ft
		3						Saturated, Very dark brown [7.5YR 2.5/3], SANDY CLAY with Gravel, CL, sand grains fine to medium grained, with some fine subangular to subrounded gravel, no visible pyrite.						
								BOH=2.5 ft.						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
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		12												
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		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-118

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/18/12 - 10/18/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5159.70 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1030867.7, E1247248.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Very dusky red [2.5YR 2.5/2], PEAT wtih Silt, PT, organics and no visible pyrite.						Water at surface
		1			X			Saturated, Black [10YR 2/1], ORGANIC SILT, OL, low plasticity, abundant roots and no visible pyrite.						
					X			BOH=1.5 ft.						Auger refusal at 1.5', wet, subrounded to subangular gravel with sand encountered at BOH.
		2												
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-119

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/19/12 - 10/19/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5166.40 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031015.2, E1247711.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [10YR 2/1], ORGANIC SILT, OL, abundant organics, with PEAT and no visible pyrite.						Water at surface
		1			X									Sampler unable to retrieve significant sample below 1.5'.
		2			X									
		3						Becomes dark brown to black at 1'. BOH=1.5 ft.						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-11A

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/20/12 - 9/20/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5183.50 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031593.3, E1249332.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X	11A 11A		Wet, Very dark grayish brown [10YR 3/2], PEAT, PT, non-plastic. Wet, Orangish brown, GRAVEL, GP, angular, medium dense, Crushed WASTE ROCK. BOH = 0.5 ft.						Groundwater at 0.3 ft above top of TP-MS-11A. TP-MS-11A located on drill road/pad. Crushed waste rock was encountered for approximately a 30 ft radius around TP-MS-11A. Depth to waste rock ranged between 2 and 6 inches. Piezometer not installed. Auger refusal at 0.5' on gravel

DEPTH (FT): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

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Drill Hole No. TP-MS-11B

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/20/12 - 9/20/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5181.50 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031574.1, E1249306.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Saturated, Black [10YR 2/1] Very dark gray [2.5Y 3/1], PEAT wtih Silt, PT, non-plastic.						Lush wetland vegetation at ground surface. Groundwater at 0.4 ft above top of TP-MS-11B.
		1			X									
		2			X									Surface water 386.7 rmV, 280 µs/cm, pH start 6.37 pH end 6.81 (17 minutes)
					X			Saturated, Very dark gray [2.5Y 3/1], SILT, ML, very soft, with PEAT and TAILINGS,						
		3			X									
		4			X			Trace fine sands at 3.5 ft,						
		5			X			Trace coarse sand at 4.5 ft,						
		6												Installed 4-inch solid wall PVC with open bottom at 5.75'. Auger refusal at 5.75' on gravel
		7						Trace fine, subrounded, flat gravels at 5.25 ft. BOH = 5.75 ft.						
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-11C

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/20/12 - 9/20/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5183.20 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031619.0, E1249377.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet, Black [10YR 2/1] Very dark gray [2.5Y 3/1], PEAT wtih Silt, PT, non-plastic.						Wetland vegetation at ground surface. Groundwater at 0.5 ft above top of TP-MS-11C.
		1			X									
		2			X			Wet, Very dark brown [10YR 2/2], SILT with Sand, ML, medium plasticity, very soft, with Organics,						Surface water 327.3 rmV, 314 µs/cm, pH start 8.49 pH end 7.14 (19 minutes)
		3			X									
		4			X									
		5						Trace flat, subangular gravels at 4 ft. BOH = 4.2 ft.						Installed 4-inch solid wall PVC with open bottom at 4.2', Auger refusal at 4.2' on gravels
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-12

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/18/12 - 9/18/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5175.30 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031096.1, E1248846.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Black [10YR 2/1], ORGANIC SILT, OL, medium plasticity, with Organics, TOPSOIL.						Wetland vegetation at ground surface. Groundwater not observed
		1			X									
					X			Moist, Very dark brown [10YR 2/2], LEAN CLAY, CL, medium plasticity, rust color mottling observed from 1.3 to 1.7 ft.						No water samples
		2			X									
		3			X			Trace sand and gravel from 2.0 to 2.5 ft.						
		4						1" minus angular gravels at 3.2 ft. BOH = 3.4 ft.						Installed 4-inch solid wall PVC with open bottom @ 3.4', Auger refusal at 3.4' on gravels
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-120

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/20/12 - 10/20/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5180.90 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1031641.6, E1249086.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet to Saturated, Very dark brown [7.5YR 2.5/2], PEAT wtih Silt, PT, organics (roots, wood), no visible pyrite.						Groundwater at 0.5ft while excavating
		1			X			Saturated, Very dark brown [7.5YR 2.5/3], SILT, ML, low plasticity, trace fine sand, abundant roots, PEAT, no visible pyrite.						
		2			X			Saturated, Very dark brown [7.5YR 2.5/3], SANDY SILT, ML, with clay, some organics and no visible pyrite.						
								BOH=2.5 ft.						BOH = 2.5ft
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-121

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/17/12 - 10/17/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5192.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N394812.0, E5210784.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet to Saturated, Very dark brown [7.5YR 2.5/2], ORGANIC SILT, OL, sand grains fine, heavy organics and abundant fine pyrite, possible TAILINGS.						Groundwater at 0.5ft
		1			X			Saturated, Very dark grayish brown [10YR 3/2], ORGANIC SILT, OL, low to medium plasticity, some PEAT and abundant organic, trace fine pyrite, possible TAILINGS.						
		2			X			Saturated, Very dark brown [7.5YR 2.5/2], ORGANIC SANDY SILT, ML, low plasticity, abundant organics, fine pyrite, possible Tailings. BOH= 1.75 ft.						Auger refusal at 1.75', angular to subangular gravel collected at BOH.
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-122

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/17/12 - 10/17/12	DRILLER: MP
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5192.00 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N394819.0, E5210784.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
▼					X			.						Groundwater at 0.3ft while excavating
		1			X			Wet, Black [10YR 2/1] Dark brown [7.5YR 3/2], ORGANIC SANDY SILT, OL, abundant organics, abundant fine pyrite, possible TAILINGS						
		2			X			Less sand and organics at 0.5'.						
		3			X			Wet, Black [7.5YR 2.5/1], ORGANIC SANDY SILT, OL, medium plasticity, some sand and fine to coarse subangular to angular gravel, abundant organics, PEAT, some fine pyrite, possible soil horizon before flood						Auger refusal at 3', appears to be gravel at BOH, not able to retrieve sample.
		4												
		5						More sand and trace pyrite at 2.5'. BOH= 3 ft.						
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-123

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 10/29/12 - 10/29/12	DRILLER: EG
LOGGED BY: NJ	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION:	HOLE DIAMETER:
BOREHOLE LOCATION:	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Saturated, Very dark brown [10YR 2/2], PEAT wtih Silt, PT, with Silt, organics, visible pyrite.						Water at surface
		1						Saturated, Very dark gray [7.5Y 3/1], ORGANIC SILT, OL, low plasticity, abundant organics, with PEAT, trace very fine pyrite.						
		2												
		3						Saturated, Very dark brown [10YR 2/2], SILTY GRAVEL with Sand, GM, particles fine to coarse and angular to subangular, no visible pyrite. BOH=3 ft.						Auger refusal at 3'
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-13

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/18/12 - 9/18/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5172.50 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031217.5, E1248761.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Dry, Dark reddish brown [5YR 3/4], SILT with Gravel, ML, MIXED TAILINGS.						Ground surface generally well vegetated with wetland species. Tailings observed on ground surface. Groundwater not observed.
					X			Moist, Very dark brown [10YR 2/2], ORGANIC CLAY, OL, medium plasticity, TOPSOIL.						
		1			X			Moist, Very dark brown [7.5YR 2.5/2], SILTY SAND, SM, low plasticity, fine grained						
		2			X			Flat, subangular 2" minus gravels at 1.0 ft. BOH = 1.9 ft.						Installed 4-inch solid wall PVC with open bottom at 1.9'. Auger refusal at 1.9' on gravels
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-14

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/18/12 - 9/18/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5172.50 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031319.3, E1248656.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark reddish brown [5YR 3/4], SILTY SAND, SM, fine grain sands, MIXED TAILINGS.						Ground surface generally well vegetated with wetland species Groundwater not observed.
					X			Moist, Dark reddish brown [5YR 2.5/2], ORGANIC SANDY SILT, OL, low plasticity, with Organics.						
		1			X			Moist to wet, Dark reddish brown [5YR 2.5/2] Very dark brown [10YR 2/2], SANDY SILT, ML, medium plasticity, rust colored mottling,						
		2			X			becomes wet at 2' and color transitions to dark gray						
		3			X									
		4												Installed 4-inch solid wall PVC with open bottom at 3.5'. Auger refusal at 3.5' on gravels
		5						trace 1.5" flat, subrounded Gravel at 3.4 ft.						
		6						BOH = 3.5 ft.						
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-15

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/19/12 - 9/19/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5175.10 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031528.4, E1248629.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist to wet, Very dark brown [10YR 2/2] Black [10YR 2/1], PEAT wtih Silt, PT, low plasticity, Peat with silt and high percentage of organics						Wetland vegetation at ground surface.
		1			X			Becomes wet and grayish black at 1.0'.						
		2			X									Solid wall piezometer with open bottom.
▼		3			X			Wet to Saturated, Very dark grayish brown [10YR 3/2] Very dark brown [10YR 2/2], SILT with Sand, ML, low plasticity, with organics						Groundwater at 3.2 ft while excavating; @ 3.2' rmV 687 µs/cm pH start 6.63 pH end 6.55 (12 minutes)
		4						Flat, subrounded Gravels at 3.5 ft. BOH = 3.7 ft.						Installed 4-inch solid wall PVC with open bottom at 3.7', auger refusal on gravel
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Billings, Montana 59101
PHONE NUMBER: 406-259-2412

Drill Hole No. TP-MS-16

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/13/12 - 9/13/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5167.90 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030826.4, E1248109.9	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Organic decay and pine needles.						Forest vegetation at ground surface.
								Moist, Dark reddish brown [5YR 3/3], SILTY SAND, SM, low plasticity, TAILINGS.						
		1			X			Moist, Very dark brown [10YR 2/2], SANDY SILT, ML, low plasticity, trace roots, trace rust colored mottling.						
		2			X			Moist to Saturated, Dark reddish brown [5YR 3/2] Brown [7.5YR 4/3], SANDY SILT, ML, trace rust colored mottling, occasional lenses of black organic silt, sand fine grained, abundant rust colored mottling						
▼		3			X									Groundwater at 3.0 ft. while excavating
					X			No rust colored mottling 3-3.5', but resumes at 3.5'						Groundwater at 3.5' 647.1 rmV, 218.2 µs/cm, pH start 4.31 pH end 4.23 (15 minutes)
		4			X			Sand content increases at 4.3 ft.						
					X			Wet, Brown [7.5YR 4/4], SANDY SILT, ML, fine to coarse grain sands, Gravels encountered at 5.0 ft.						Installed 4-inch solid wall PVC with open bottom at 5.0', auger refusal at 5.0' on gravels
		5						BOH = 5.0 ft.						
		6												
		7												
		8												
		9												
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		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-17

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/13/12 - 9/13/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5165.30 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030799.6, E1247950.0	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Dark brown [7.5YR 3/3] Dark reddish gray [5YR 4/2], SANDY CLAY, CL, medium plasticity, Sandy Clay is intermixed with TAILING.						Groundwater not observed.
					X			Tailing is a rusty brown, poorly graded, Silty Sand.						
		1			X			Moist, Dark brown [7.5YR 3/2], LEAN CLAY, CL, medium plasticity,						
		2			X									Installed 4-inch solid wall PVC with open bottom at 2.3', slotted 1.75' to 2.25' Auger refusal at 2.3' on gravel
		3						Cobble at 2.0 ft.						
								BOH = 2.3 ft.						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
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		15												
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Drill Hole No. TP-MS-19

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/13/12 - 9/13/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5166.70 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031265.0, E1247800.4	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
								Saturated, Black [10YR 2/1], PEAT wtih Silt, PT.						Wetland vegetation at ground surface. Groundwater at 0.1 ft.
		1												
								Saturated, Dark reddish brown [5YR 3/2] Black [5YR 2.5/1], ORGANIC SILTY CLAY, OL, medium to high plasticity, with Silt.						
		2												
		3												Installed 4-inch solid wall PVC with open bottom at 3.5' Auger refusal at 3.5' on gravels
								Saturated, Black [7.5YR 2.5/1], CLAY with Gravel, CL, angular, 1.5" minus.						
		4						BOH = 3.5 ft.						
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-20

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/12/12 - 9/12/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5165.00 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030571.9, E1247452.8	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Black [7.5YR 2.5/1] Very dark brown [7.5YR 2.5/3], ORGANIC SILT with GRAVEL, OL, angular to subangular, low plasticity, with roots, TOPSOIL. No gravel 0-6"						Groundwater not observed.
					X			Gravel content increases at 0.5 ft.						
		1			X			Moist, Very dark brown [10YR 2/2], CLAYEY SAND with Gravel, SC, angular to subangular.						
		2						BOH = 2.0 ft.						Auger refusal at 2.0' on gravel
		3												Installed 4-inch solid wall PVC with open bottom at 2.0'
		4												
		5												
		6												
		7												
		8												
		9												
		10												
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		12												
		13												
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		15												
		16												
		17												

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Drill Hole No. TP-MS-21

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/12/12 - 9/12/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5160.40 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030763.2, E1247270.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet, Very dark brown [10YR 2/2], PEAT wtih Silt, PT, low plasticity, organic odor.						Wetland vegetation at ground surface.
		1												
					X			Wet to Saturated, Very dark grayish brown [10YR 3/2], SANDY SILT, ML, low to medium plasticity, rust colored mottling.						
		2			X									Groundwater at 1.9 ft. while excavating
					X			Wet to Saturated, Very dark grayish brown [10YR 3/2], SANDY CLAY with Gravel, CL, medium plasticity,						No groundwater sampling
		3			X									Solid wall piezometer with open bottom.
								Gravel content increases at 3.25 ft.						
		4						BOH = 3.25 ft.						Installed 4-inch solid wall PVC with open bottom at 3.25', Auger refusal on gravel at 3.25'
		5												
		6												
		7												
		8												
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		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-22

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/12/12 - 9/12/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5160.90 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030967.9, E1247355.6	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet to Saturated, Very dark brown [10YR 2/2], PEAT with Sandy Silt, PT, medium plasticity, very soft, @ 0.75' trace gravels and color transitions to grayish black.						Wetland vegetation at ground surface. Groundwater at 0.75 ft while excavating
		1			X									
					X			Saturated, Very dark brown [10YR 2/2], SILTY GRAVEL with Sand, GM, angular to subangular, estimated 60% Gravel and 40% Sand/Silt approximately 1.5" max size. BOH = 1.75 ft.						Installed 4-inch solid wall PVC with open bottom at 1.75', Auger refusal @ 1.75' on gravel
		2												
		3												
		4												
		5												
		6												
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		11												
		12												
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Drill Hole No. TP-MS-23

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/12/12 - 9/12/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5162.50 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031059.6, E1247378.2	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Wet, Black [10YR 2/1], PEAT wtih Silt, ML, low plasticity, trace of fine subrounded gravel.						No water sample
		1			X			Saturated, Dark reddish brown [5YR 3/4], POORLY GRADED GRAVEL with SILT AND SAND, GP-GM, rounded to subrounded, flat particles, approximately 1.5" maximum size.						Groundwater at 1 ft while excavating Installed 4-inch solid wall PVC with open bottom and slotted 1.5-2'
		2			X			BOH = 2.0 ft.						
		3												Auger refusal due to silty gravel caving into hole. Unable to drive casing through silty gravel or auger past 2'
		4												
		5												
		6												
		7												
		8												
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		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-24

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/11/12 - 9/11/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5154.70 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030881.4, E1246796.7	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Very dark brown [7.5YR 2.5/2], SILT with Gravel, ML, low plasticity, trace Sand, organic roots in top 3-in, thin layer of rust colored tailing from 0.1 to 0.15 ft,						Lush vegetation at ground surface with trees. TP-MS-24 in a low spot on the ground surface which may receive a minor amount of flow during a precipitation event. Located in bank approximately 5' above beaver pond
		1			X			Rust colored mottling between 1.0 and 4.0 ft.,						
		2			X			moisture content increases at approximately 2'. Color transitions from brown to grayish black at 3.5', trace of subangular gravel at 3.75'						No water sample
		3			X									
		4			X									
		5			X									
		6												Installed 4-inch solid wall PVC with open bottom at 5.75'
		7						Trace subangular sandstone gravels at 3.75 ft.						Auger refusal at 5.75' on gravel
		8						Moist to wet, Very dark brown [7.5YR 2.5/3], CLAY with Gravel, CL, medium plasticity, rust colored mottling.						
								Moist to wet, Brown [7.5YR 4/4], SANDY CLAY, CL, low plasticity, rust colored mottling, fine to coarse grained.						
		9						Saturated, Brown [7.5YR 4/4], LEAN CLAY, CL, low to medium plasticity, fine to coarse grain.						
								BOH = 5.75 ft.						
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-25

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/11/12 - 9/11/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5150.70 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1030947.9, E1246716.1	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, SILTY SAND, SM, with appreciable amount of pine needles and organic decay.						
					X			Moist, Very dark brown [7.5YR 2.5/2], SILTY SAND, SM, low plasticity, MIXED TAILINGS with appreciable amount of pine needles and organic decay, rusty brown color.						Could not attain water sample
		1			X			Moist to wet, Very dark brown [7.5YR 2.5/3], POORLY GRADED SAND with Silt and Sand, SP-SM, subrounded, no to low plasticity, with organics,						
		2			X			Organic content decreases and moisture content increases at 1.0 ft.						Sand continually falls out of auger head switch to sand head
					X			Wet, Very dark brown [7.5YR 2.5/3], SAND with Silt and Gravel, SP-SM.						
▼		3						BOH = 3.0 ft.						Groundwater at 3 ft while excavating
		4												Installed 4-inch solid wall PVC with open bottom at 3.0', Auger refusal at 3.0' on gravel
		5												
		6												
		7												
		8												
		9												
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		11												
		12												
		13												
		14												
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		16												
		17												

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Drill Hole No. TP-MS-26

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/11/12 - 9/11/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5149.80 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031024.5, E1246663.5	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1			X			Moist, Very dark brown [7.5YR 2.5/2], SILT with Gravel, ML, rounded, medium plasticity, organics in top 1 ft., moisture increases with depth, thin rusty brown Tailing layer near surface, gravels flat and rounded.						Lush vegetation at ground surface. Groundwater was not observed
		2			X									Installed 4-inch solid wall PVC with open bottom at 2.5' Auger refusal at 2.5' on gravel
		2.5						Moist to wet, Very dark brown [7.5YR 2.5/2], SILTY SAND with Gravel, SM, subrounded, generally 1" minus, sand fine grained.						
		3						BOH 2.5 ft.						
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

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Drill Hole No. TP-MS-27

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 9/10/12 - 9/10/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Hand Auger
GROUND SURFACE ELEVATION: 5151.30 ft	HOLE DIAMETER: 3 inch
BOREHOLE LOCATION: State Plane (NAD83) N1031212.7, E1246518.3	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Moist, Very dark brown [7.5YR 2.5/3], SILT, ML, contains roots and fibrous organics, TOPSOIL.						Lush vegetation at ground surface.
		1			X			Moist, Very dark brown [7.5YR 2.5/2], SILTY SAND, ML, medium plasticity, organics to 1.0 ft.						
		2			X			Moist, Very dark brown [7.5YR 2.5/3], CLAY with Gravel, CL, trace of gravels, occasional thin sand layers, rust colored mottling observed in sand layers, gravels have black spots.						Solid wall piezometer with open bottom.
		3			X			Moist to wet, Dark brown [7.5YR 3/4], GRAVELLY CLAY, CL, medium plasticity, rust colored mottling, gravels are subrounded, flat, and generally 1/2" minus in size.						
		4			X									
▼		5			X									Groundwater at 4.5 ft while excavating
								BOH = 5.2 ft.						Installed 4-inch solid wall PVC with open bottom at 5.2', Auger refusal at 5.2' on gravel
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-TS-01

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/6/12 - 8/6/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION:	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026068.5, E1256949.8	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Dry, Dark reddish brown [5YR 3/3], SILT with Gravel, ML, low plasticity, DUFF, with organics.						Test pit excaved on hill side near Mikehorse Townsite. Profile displayed on log is represenative of the center of the test pit.
		1						Dry, Brown [10YR 5/3], CLAYEY GRAVEL with Sand, GC, subangular, medium plasticity, Weathered Argillitic Bedrock, estimated 80% Rock and 20% Soil matrix.						
		2												
		3						BOH = 3 ft.						Piezometer not installed.
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-TS-02

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/6/12 - 8/6/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION:	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026101.9, E1026101.9	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X			Dry, Dark reddish brown [5YR 3/4], SANDY SILT with Gravel, ML, low plasticity, DUFF, contains some pockets of rust staining with organics, subangular to subrounded gravels,.						Test pit excaved on hill side near Mikehorse Townsite. Profile displayed on log is represenative of the center of the test pit.
		1						Dry, Brown [10YR 5/3] to purplish brown, SILTY GRAVEL with Sand, GM, subangular, low plasticity, Weathered Argillitic Bedrock, estimated 50% Cobbles and Gravels, 50% Silty Sand.						
					X									
		2												
		3												
								BOH = 3.5 ft.						Piezometer not installed.
		4												
		5												
		6												
		7												
		8												
		9												
		10												
		11												
		12												
		13												
		14												
		15												
		16												
		17												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering	
ADDRESS: 1413 4th Ave North Billings, Montana 59101	
PHONE NUMBER: 406-259-2412	

Drill Hole No. TP-TS-03

PROJECT NAME: Mike Horse Floodplain	
DATE STARTED / FINISHED: 8/6/12 - 8/6/12	DRILLER: ESD
LOGGED BY: MB	DRILL TYPE: Cat 312 C
GROUND SURFACE ELEVATION:	HOLE DIAMETER:
BOREHOLE LOCATION: (State Plane NAD 83) N1026196.8, E1257060.1	HAMMER TYPE:

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
					X	03		Dry, Dark brown [7.5YR 3/4] to purplish brown, SANDY SILT with Gravel, ML, low plasticity, DUFF, some pockets of rust staining, organics.						Test pit excaved on hill side near Mikehorse Townsite. Profile displayed on log is represenative of the center of the test pit.
		1						Dry, Brown [7.5YR 4/3] Brown [7.5YR 4/4], CLAY with Gravel, CL, medium plasticity, Weathered Argillitic Bedrock, pockets of higher clay content, 6-in. max particle size, estimated 50% Cobble and Gravel, 50% Sand, gravels subangular.						
		2			X	03								
		3						BOH = 3 ft.						Piezometer not installed.
		4												
		5												
		6												
		7												
		8												
		9												
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PIONEER TECHNICAL SERVICES, INC.

CLIENT: Spectrum Engineering

ADDRESS: 1413 4th Ave North
Billings, Montana 59101

PHONE NUMBER: 406-259-2412

PROJECT: MIKE HORSE DAM

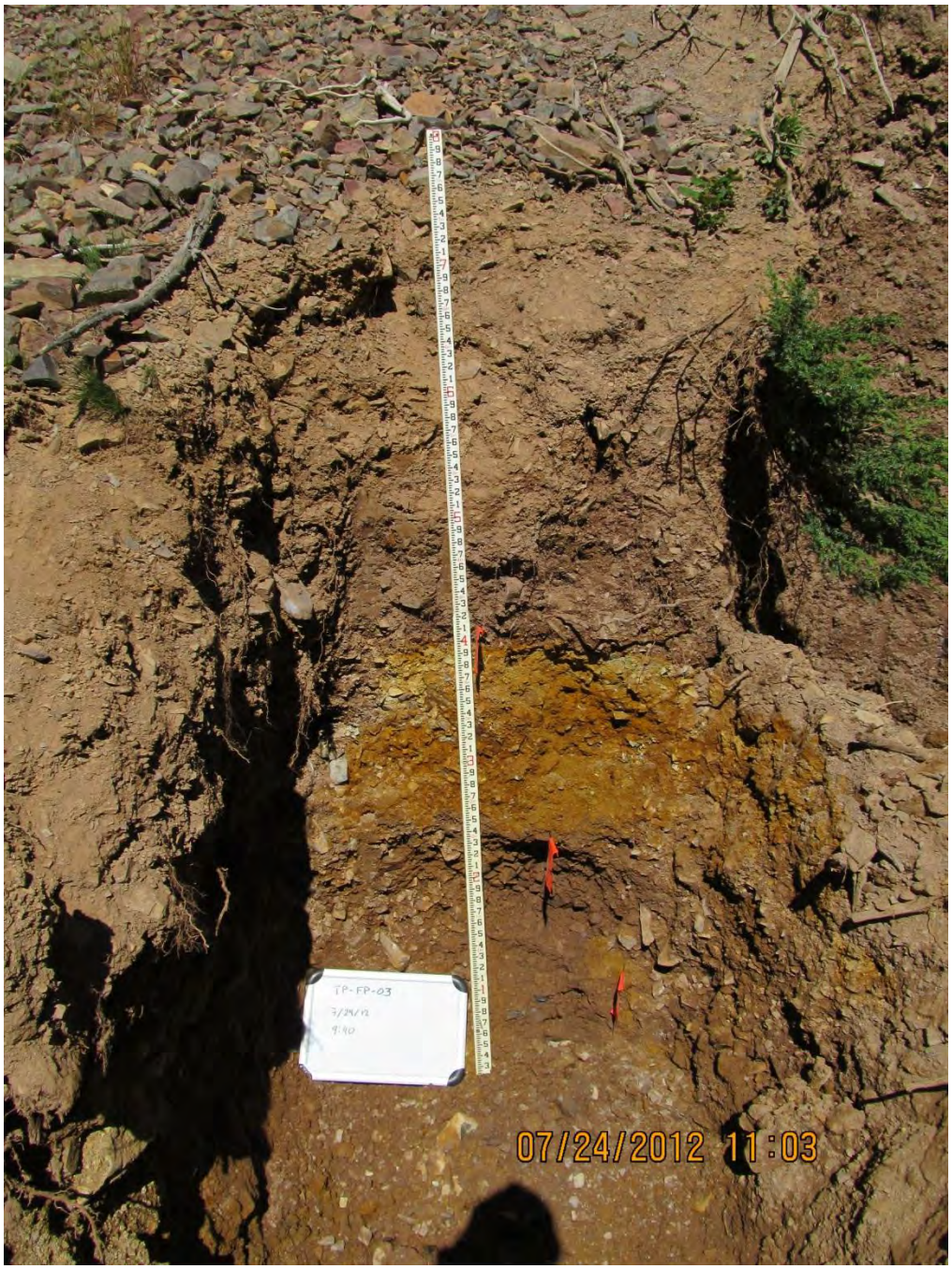
PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-01
DATE: 7/23/2012
DESCRIPTION: Pin flags denote interface between mixed tailing (on right side) and native soils (on left side).

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-02
DATE: 7/23/2012
DESCRIPTION: Note black Manganese layer near bottom of test pit.



PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-03
DATE: 7/24/2012
DESCRIPTION: Note the mixed tailing layer in the center of the test pit, facing west.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-04
DATE: 7/24/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-05
DATE: 7/24/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-6
DATE: 7/24/2012
DESCRIPTION: Facing south.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-6A
DATE: 7/25/2012
DESCRIPTION: Facing west.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-6B
DATE: 7/25/2012
DESCRIPTION: Facing west.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-07
DATE: 7/25/2012
DESCRIPTION: Facing south.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-08
DATE: 7/25/2012
DESCRIPTION: Note top of survey rod is 8 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

Near TP-FP-08
DATE: 7/25/2012
DESCRIPTION: Elevated flow within Beartrap Creek immediately after heavy rain event, looking upstream.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-09
DATE: 7/25/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-10
DATE: 7/26/2012
DESCRIPTION: Facing east.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-10A
DATE: 7/26/2012
DESCRIPTION: Located in west end of TP-10 (nearest stream).

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

Beartrap Creek channel between TP-FP-10 and TP-FP-11
DATE: 7/26/2012
DESCRIPTION: Black Manganese soil observed on surface of stream channel. Only location within the flood plain this was observed on surface of stream channel.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-11
DATE: 7/26/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-12
DATE: 7/26/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-13
DATE: 7/30/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-14
DATE: 7/30/2012
DESCRIPTION: Black Manganese staining on surface of gravels near the 2 ft mark on the survey rod.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-15
DATE: 7/30/2012
DESCRIPTION: Black Manganese staining at a depth of approximately 3.52 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-16
DATE: 7/31/2012
DESCRIPTION: Test pit is 11 ft deep.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-17
DATE: 7/31/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-18
DATE: 7/31/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-19
DATE: 7/31/2012
DESCRIPTION: Iron colored deposition in gravels and black Manganese layer near 3 ft and 1.5 ft mark on survey rod.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-19
DATE: 7/31/2012
DESCRIPTION: Close up of Iron colored deposition in gravels and black Manganese layer. Orange tape measure is approximately 6 ft below ground surface.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-19A
DATE: 8/1/2012
DESCRIPTION: Facing east.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-20
DATE: 8/1/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-21
DATE: 8/1/2012
DESCRIPTION: Rust colored mixed tailing observed to 4 ft depth.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-22
DATE: 8/1/2012
DESCRIPTION: Test pit excavated to 9.5 ft depth. Only the top portion of test pit is displayed in photo. The bottom portion of test pit (below groundwater at 5 ft depth) continually caved in during excavation.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-25
DATE: 8/2/2012
DESCRIPTION: Groundwater at 5.3 ft depth.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-26
DATE: 8/2/2012
DESCRIPTION: Groundwater was first encountered at 1.7 ft depth.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-27
DATE: 8/2/2012
DESCRIPTION: Note interface of mixed tailing and alluvium at 2.6 ft depth.

PROJECT: MIKE HORSE DAM

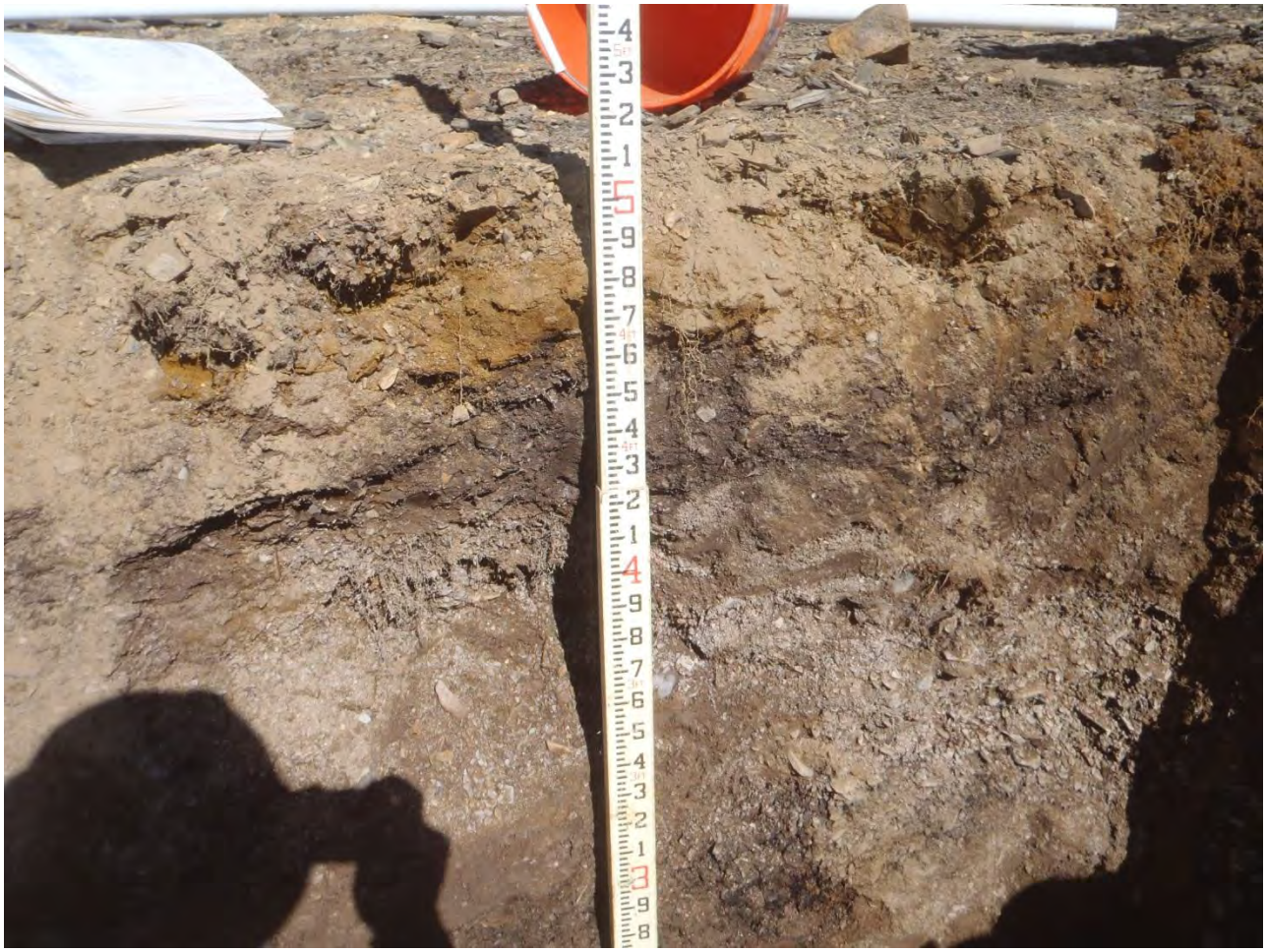
PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-28
DATE: 8/6/2012
DESCRIPTION: In general the top 3.6 ft of the test pit is composed of road fill. One pocket of rust colored mixed tailing observed on the southwest corner of the test pit (nearest Beartrap Creek), as shown in the photo.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-30
DATE: 8/7/2012
DESCRIPTION: Test pit located in water treatment plant storage yard. Top photo displays mixed tailing observed near the ground surface. Bottom photo displays some black Manganese stained gravels observed between the 4.25 to 5 ft depth.



PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-31
DATE: 8/7/2012
DESCRIPTION: Test pit located in water treatment plant storage yard. Mixed tailing observed near the surface which was underlain with fill.

ROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-32
DATE: 8/7/2012
DESCRIPTION: Test pit located in water treatment plant storage yard, facing south. Note iron staining/deposition between 4 and 5 ft depth on south end of test pit (only became evident after a portion of the test pit sidewall caved in).

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-33
DATE: 8/7/2012
DESCRIPTION: Test pit located in water treatment plant storage yard, facing north. Water treatment plant is located just above the top left corner of picture.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-34
DATE: 8/7/2012
DESCRIPTION: Measuring tape is extended to 10 ft in photo.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-35
DATE: 8/8/2012
DESCRIPTION: Excavated into bank, facing northwest. Stream channel is located to the right while Meadow Creek road is located to the left.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-36
DATE: 8/13/2012
DESCRIPTION: Measuring tape is extended to 10 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-37
DATE: 8/14/2012
DESCRIPTION: Measuring tape extended to 12 ft. Mixed tailing observed in top 3.4 ft. Test pit excavated to total depth of 15 ft, groundwater was not observed entering the test pit at any time.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-38
DATE: 8/14/2012
DESCRIPTION: Test pit excavated into bank on north side (river right) of flood plain. Note the diagonal line which marks the visual interface between mixed tailing and native soils.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-39
DATE: 8/13/2012
DESCRIPTION: Total length of survey rod is 8 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-40
DATE:8/8/2012
DESCRIPTION: Measuring tape is extended to 15 ft in photo.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-41
DATE: 8/8/2012
DESCRIPTION: Top photo shows mixed tailing observed in the top 1 ft of the test pit. Bottom photo shows some clayey gravel with iron staining (observed from 3.5 to 8.0 ft).

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-42
DATE: 8/8/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

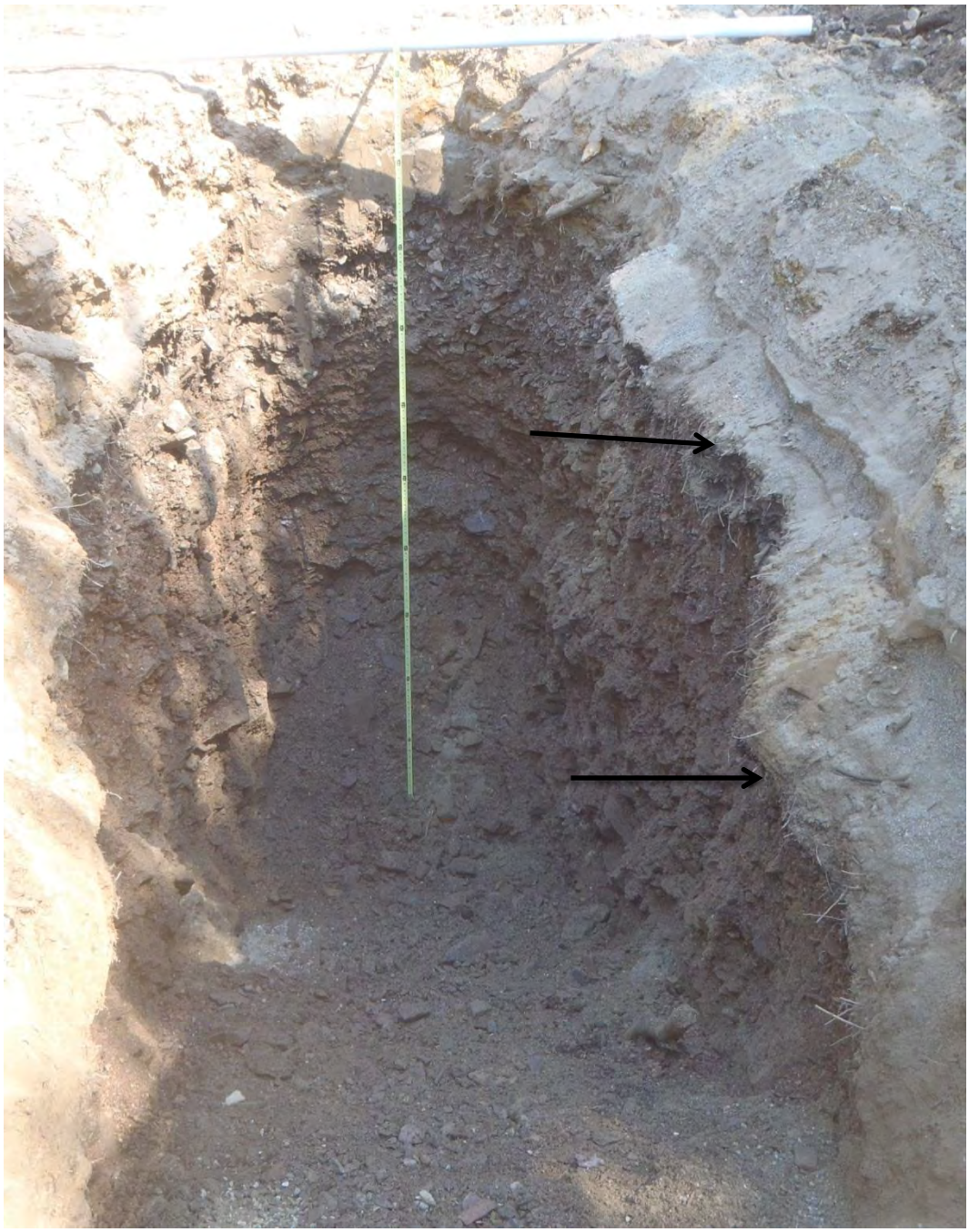
PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-43
DATE: 8/9/2012
DESCRIPTION: Soil profile was generally very consistent throughout entire test pit.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-44
DATE: 8/9/2012
DESCRIPTION: Excavated into bank on north side (river right) of stream channel. Facing north.



PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-45
DATE: 8/9/2012
DESCRIPTION: Tape measure showing depth of 10.5 ft in photo. Note top soil layer (with roots) observed from 2 to 3 ft depth which was covered with mixed tailing and wood debris.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-45A
DATE: 8/13/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-46
DATE: 8/16/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

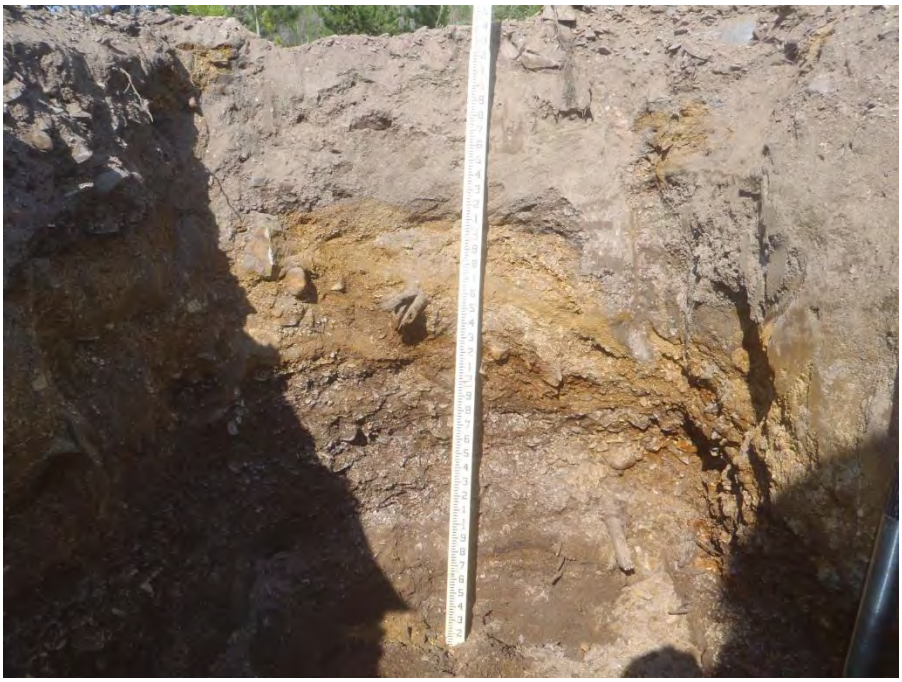
PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-47
DATE: 8/16/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-48
DATE: 8/15/2012
DESCRIPTION: Top photo displays the top 4 ft of the test pit. Bottom photo shows tape extended to 13 ft depth.



PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-49
DATE: 8/14/2012
DESCRIPTION: Top photo displays the top 4.5 ft of the test pit. Bottom photo shows tape extended to 12 ft depth.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-50
DATE: 8/15/2012
DESCRIPTION: Tape measure is extended to 12 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-50A
DATE: 8/15/2012
DESCRIPTION: Tape measure is extended to 9 ft. Facing North. Note the mixed tailing only observed in the south end of the test pit.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-51
DATE: 8/15/2012
DESCRIPTION: Note the pyrite observed in the sandy clay at a depth of 10.5 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-52
DATE: 8/27/2012
DESCRIPTION: Alluvium starts at 2.7 ft depth.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-53
DATE: 8/27/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-54
DATE: 8/27/2012
DESCRIPTION: A solvent type odor was noted when test pit excavation initiated on 8/27/2012. The odor was still present when excavation of the test pit was finished on 8/28/2012.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-55
DATE: 8/28/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-56
DATE: 8/16/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-57
DATE: 9/25/2012
DESCRIPTION: Test pit excavated with hand auger. PVC pipe represents piezometer installed in hand auger hole.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-58
DATE: 8/28/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-59
DATE: 8/28/2012
DESCRIPTION:

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-FP-60
DATE: 8/28/2012
DESCRIPTION: Measuring tape is extended to 8.5 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-TS-01
DATE: 8/6/2012
DESCRIPTION: Town site

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-TS-02
DATE: 8/6/2012
DESCRIPTION: Town site

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-TS-03
DATE: 8/6/2012
DESCRIPTION: Town site

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-BULK-01
DATE: 7/24/2012
DESCRIPTION: Bulk sample collected from Alluvium at the 8 ft depth.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-BULK-02
DATE: 7/30/2012
DESCRIPTION: : Bulk sample collected from 6 to 7 ft depth.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-BULK-03
DATE: 8/6/2012
DESCRIPTION: Bulk sample collected from 5 to 5.5 (below water table), looking west.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-BULK-04
DATE: 8/14/2012
DESCRIPTION: Bulk sample collected from 2.5 to 3.5 ft, looking southeast.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-BULK-04A
DATE: 8/14/2012
DESCRIPTION: Bulk sample collected from 7.5 to 8.0 ft, looking north.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-BULK-05
DATE: 8/15/2012
DESCRIPTION: Bulk sample collected from 5 to 6 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

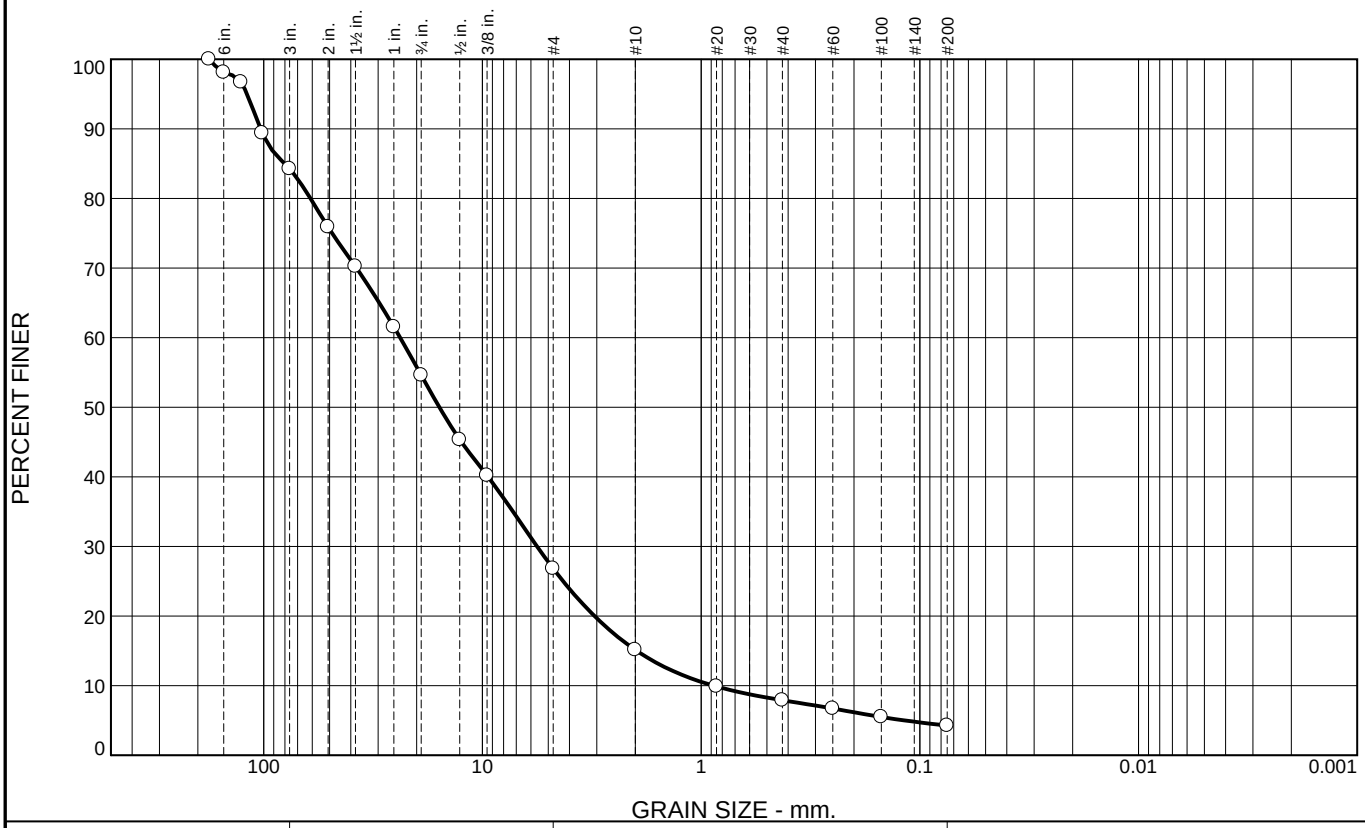
TEST PIT# TP-BULK-06
DATE: 8/29/2012
DESCRIPTION: Bulk sample collected from 3 to 4 ft.

PROJECT: MIKE HORSE DAM

PIONEER TECHNICAL SERVICES, INC.

TEST PIT# TP-BULK-07
DATE: 8/29/2012
DESCRIPTION: Bulk sample collected from 2 to 3 ft.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
16	29	28	12	7	4	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
7	100		
6	98		
5	97		
4	89		
3	84		
2	76		
1.5	70		
1	62		
.75	55		
.5	45		
.375	40		
#4	27		
#10	15		
#20	10		
#40	8		
#60	7		
#100	6		
#200	4.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 103.5277 D_{85}= 80.2800 D_{60}= 23.7847
D_{50}= 15.7311 D_{30}= 5.6226 D_{15}= 1.9689
D_{10}= 0.8753 C_u= 27.17 C_c= 1.52

Classification

USCS= AASHTO=

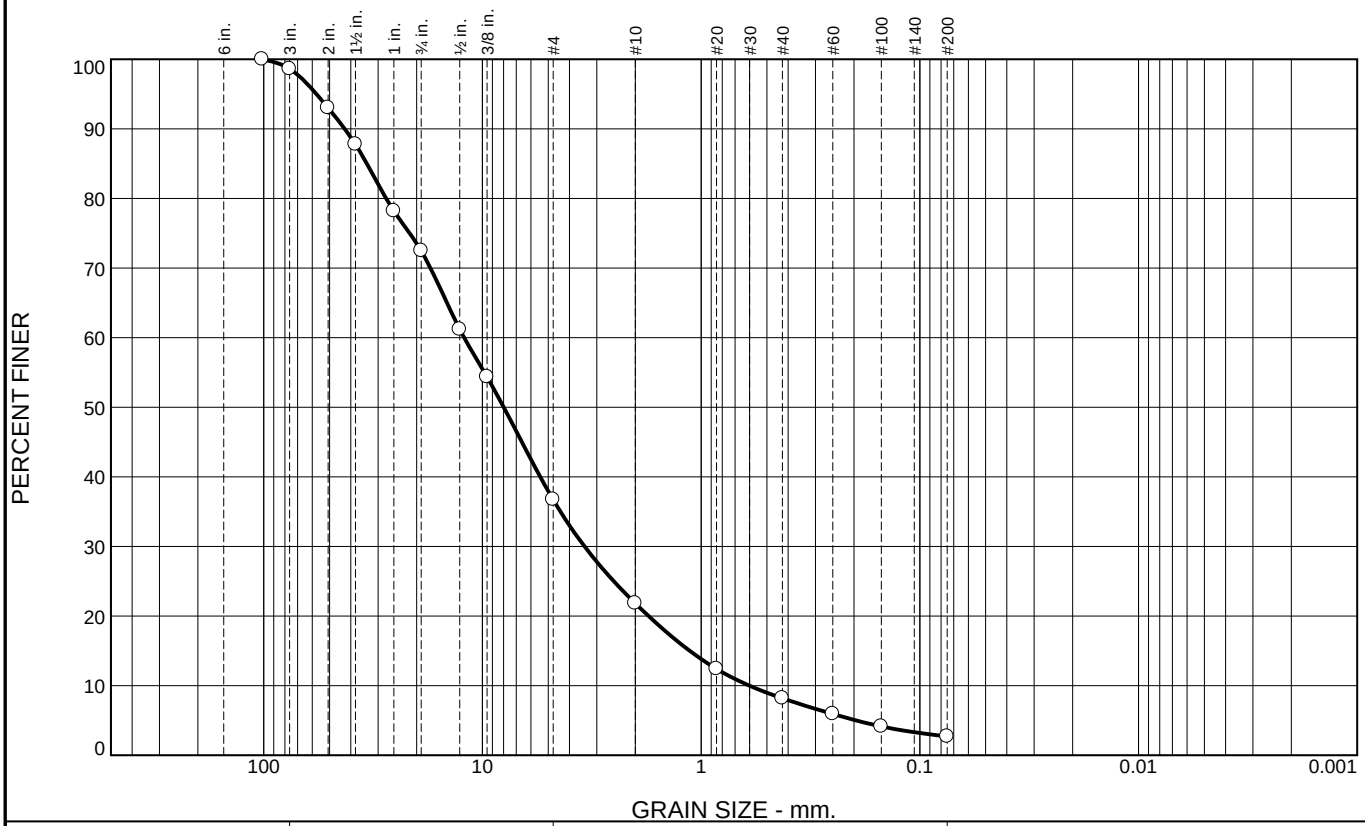
Remarks

Location: TP-Bulk-01
Sample Number: 12912 **Depth:** 8-8.5 **Date:** 8-29-12

Pioneer Technical Services, Inc.
1215 Apple's Way - Belgrade, MT 59714
Ph. 406-388-8578 - Fax 406-388-8579

Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
1	27	35	15	14	5	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	99		
2	93		
1.5	88		
1	78		
.75	72		
.5	61		
.375	54		
#4	37		
#10	22		
#20	12		
#40	8		
#60	6		
#100	4		
#200	2.7		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 42.6168 D_{85}= 33.7938 D_{60}= 12.1226
D_{50}= 7.9895 D_{30}= 3.4125 D_{15}= 1.1268
D_{10}= 0.6011 C_u= 20.17 C_c= 1.60

Classification

USCS= GW AASHTO=

Remarks

May not be representative due to sample size

Location: TP-Bulk-05
Sample Number: 13043 **Depth:** 1-2' **Date:** 9-5-12

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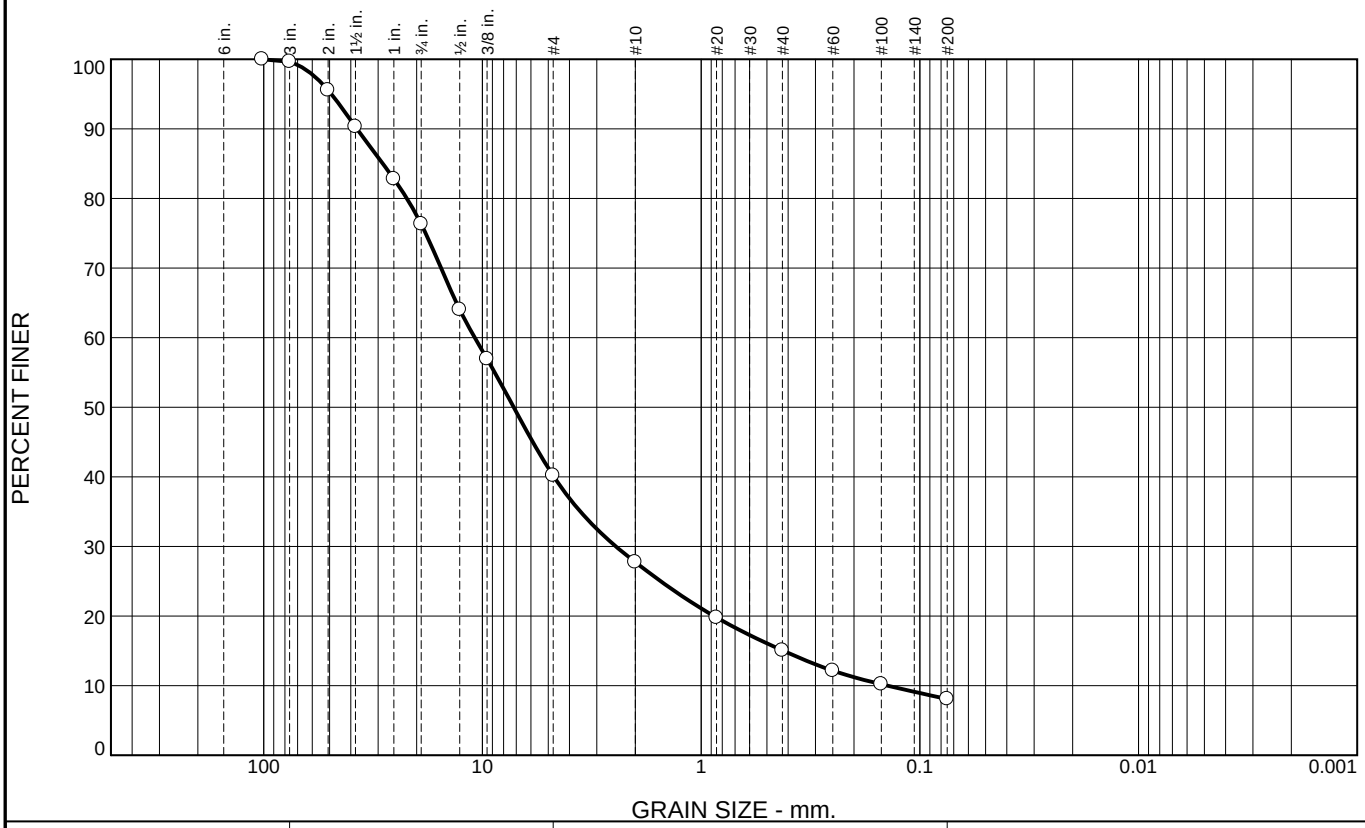
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	24	36	12	13	7	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	100		
2	96		
1.5	90		
1	83		
.75	76		
.5	64		
.375	57		
#4	40		
#10	28		
#20	20		
#40	15		
#60	12		
#100	10		
#200	8.1		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 37.4981 D_{85}= 28.5408 D_{60}= 10.8452
D_{50}= 7.1956 D_{30}= 2.4511 D_{15}= 0.4194
D_{10}= 0.1403 C_u= 77.32 C_c= 3.95

Classification

USCS= AASHTO=

Remarks

Location: TP-Bulk-07
Sample Number: 13096 **Depth:** 2-3' **Date:** 9-4-12

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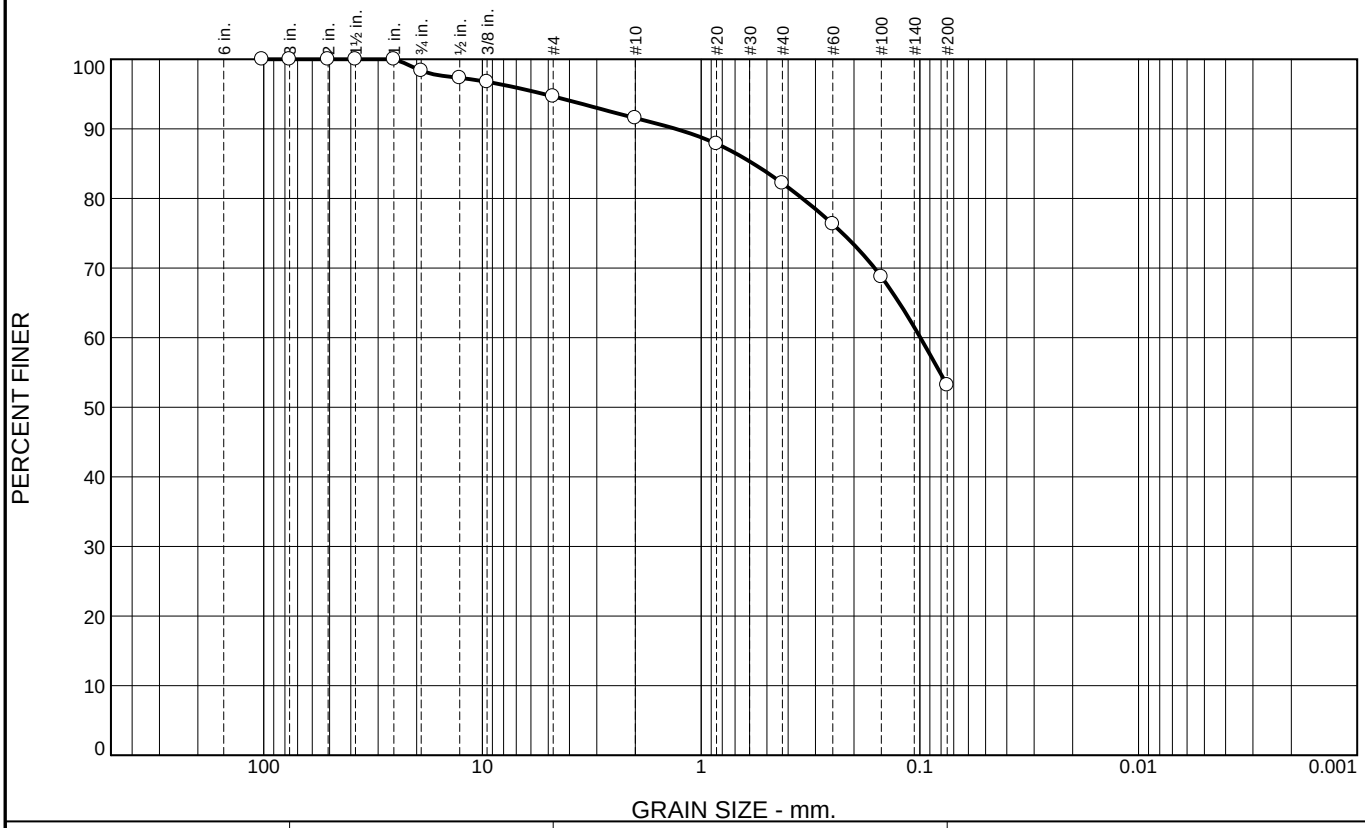
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	3	3	10	29	53	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	100		
2	100		
1.5	100		
1	100		
.75	98		
.5	97		
.375	97		
#4	95		
#10	92		
#20	88		
#40	82		
#60	76		
#100	69		
#200	53		

* (no specification provided)

Material Description

sandy silt

Atterberg Limits

PL= 26 LL= 38 PI= 12

Coefficients

D_{90}= 1.3079 D_{85}= 0.5766 D_{60}= 0.0994
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-6(4)

Remarks

Location: TP-Bulk-07
Sample Number: 13097 **Depth:** 0.5-1.0' **Date:** 9-13-12

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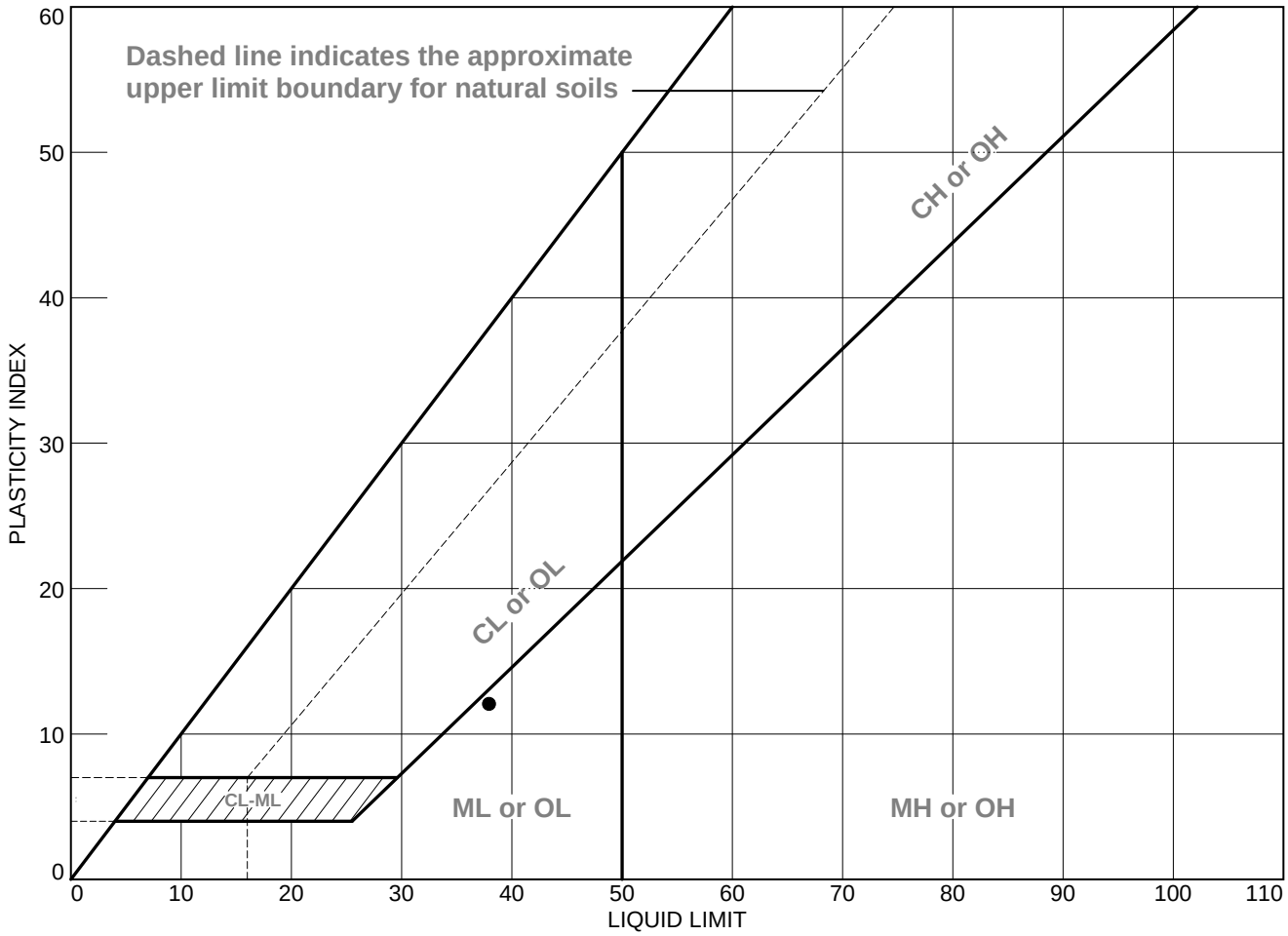
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-Bulk-07	13097	0.5-1.0'		26	38	12	ML

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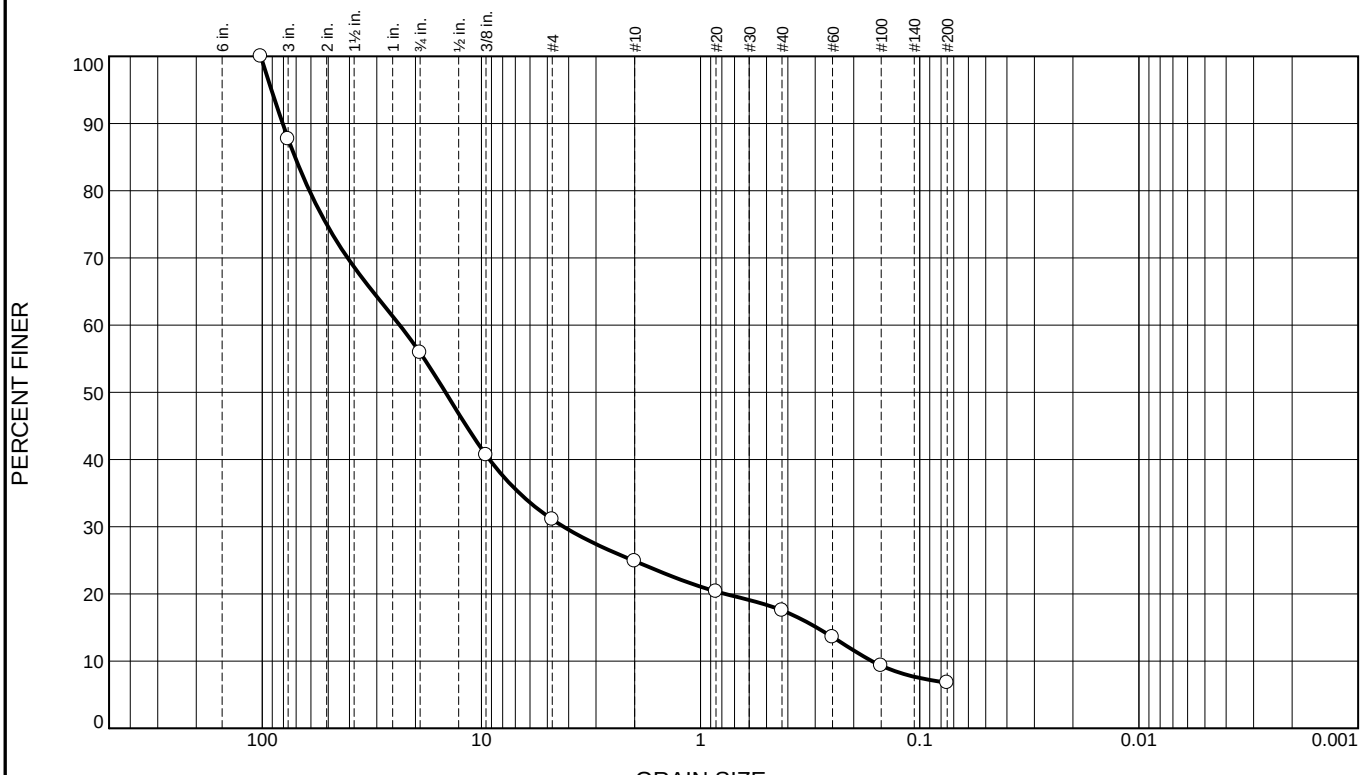
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C **Figure**

Tested By: TH **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
12	32	25	6	7	11	7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	88		
.75	56		
.375	41		
#4	31		
#10	25		
#20	20		
#40	18		
#60	14		
#100	9		
#200	6.8		

* (no specification provided)

Material Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= 24 LL= 24 PI= NP

Coefficients

D_{90}= 80.7419 D_{85}= 70.8905 D_{60}= 23.6007
D_{50}= 14.5814 D_{30}= 4.2159 D_{15}= 0.2954
D_{10}= 0.1651 C_u= 142.94 C_c= 4.56

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Location: TP-FP-01B
Depth: 0-2'

Date:

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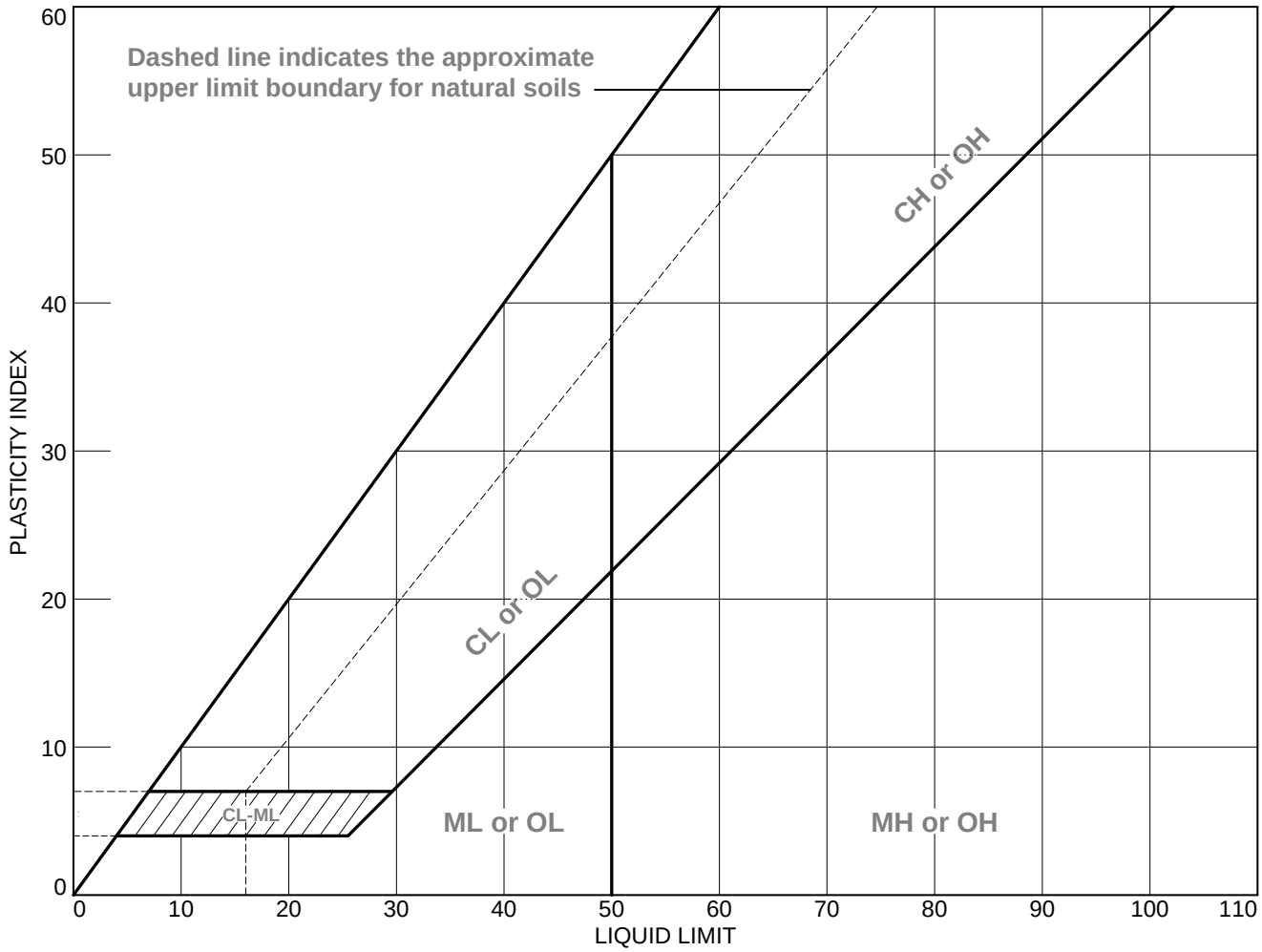
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Tested By: BG **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-01A		0-2'		24	24	NP	GP-GM

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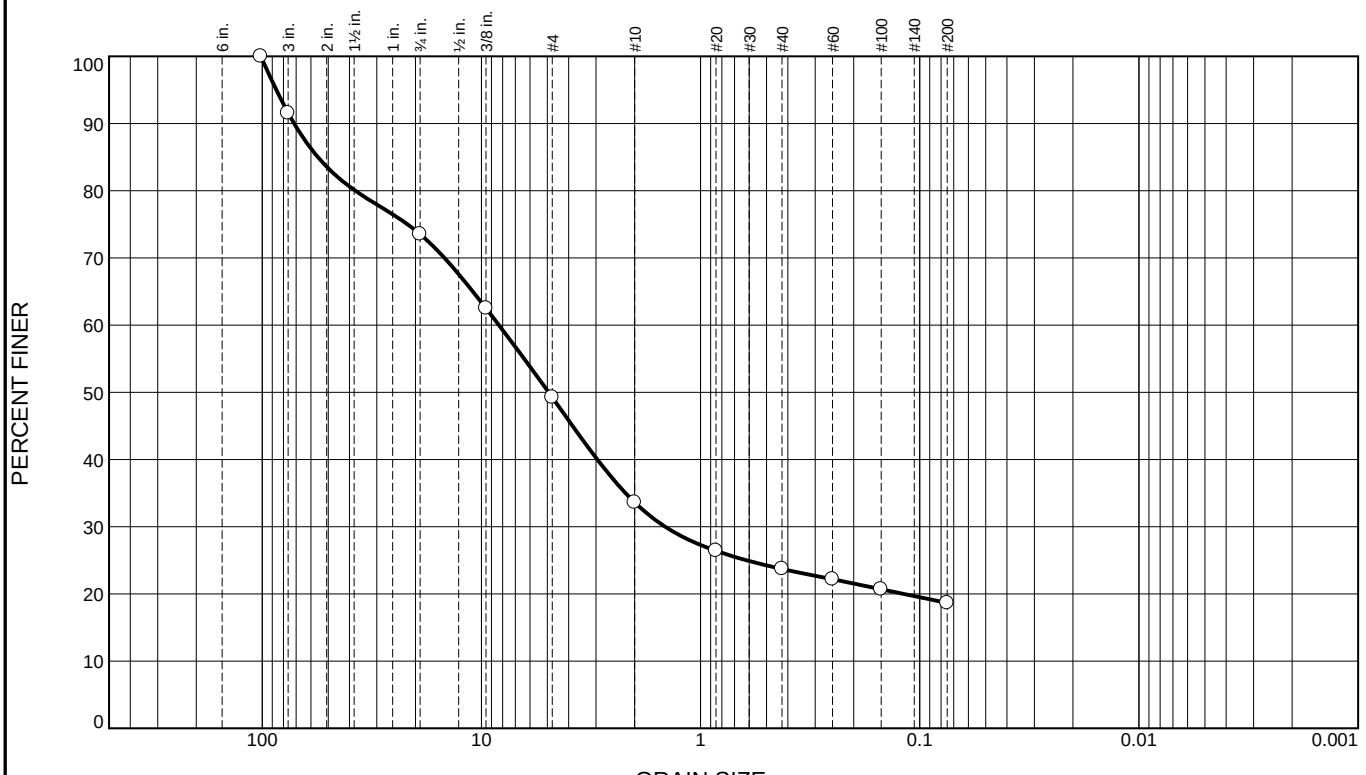
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
8	18	25	15	10	5	19	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	92		
.75	74		
.375	62		
#4	49		
#10	34		
#20	26		
#40	24		
#60	22		
#100	21		
#200	19		

* (no specification provided)

Material Description

clayey gravel with sand

Atterberg Limits

PL= 15 LL= 32 PI= 17

Coefficients

D_{90}= 71.6245 D_{85}= 55.7579 D_{60}= 8.3230
D_{50}= 4.9369 D_{30}= 1.4512 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

Location: TP-FP-01A
Depth: 0-3'

Date:

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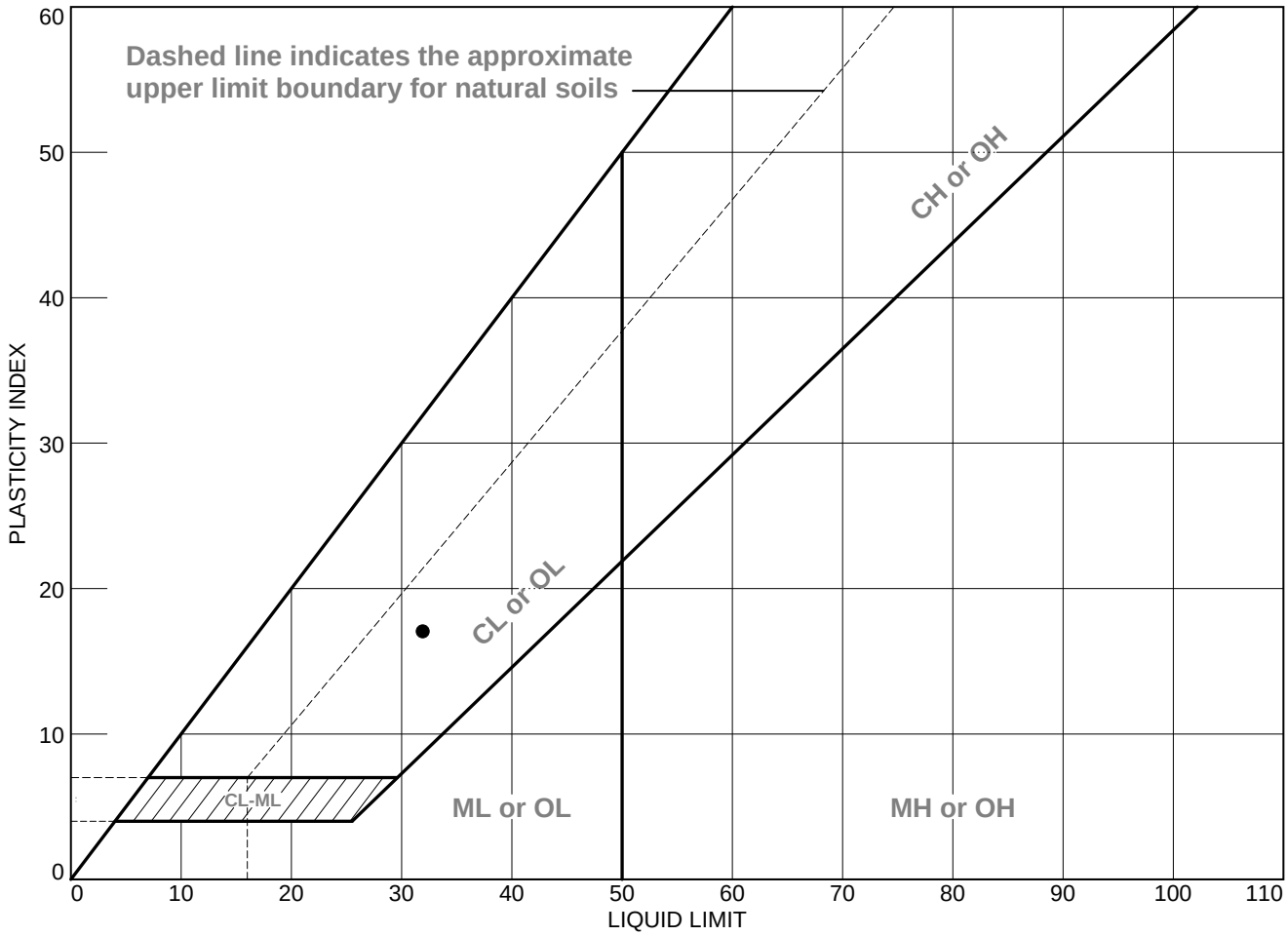
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling

Project No: 15313C **Figure**

Tested By: BG **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-01B		0-3'		15	32	17	GC

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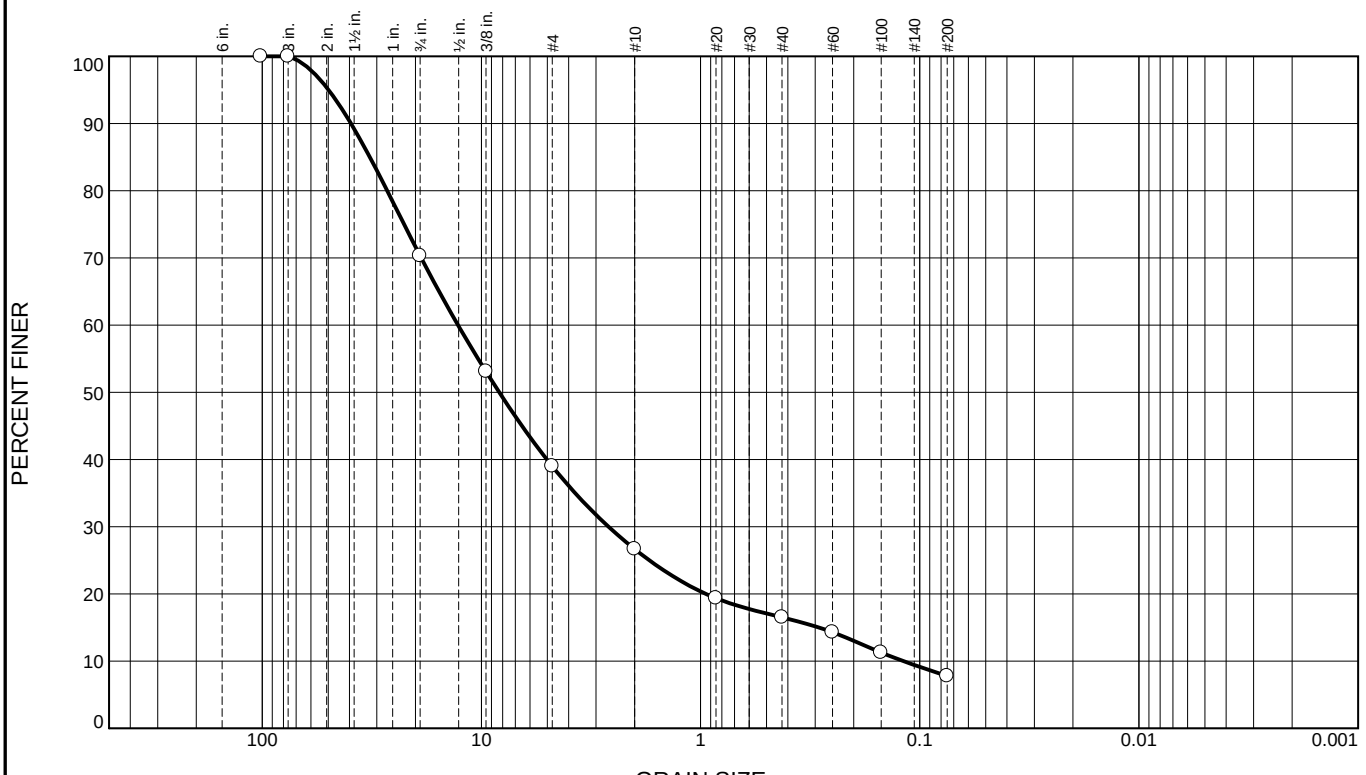
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C **Figure**

Tested By: BG **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	30	31	12	10	9	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	100		
.75	70		
.375	53		
#4	39		
#10	27		
#20	19		
#40	17		
#60	14		
#100	11		
#200	7.8		

* (no specification provided)

Material Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= 19 LL= 22 PI= 3

Coefficients

D_{90}= 39.3738 D_{85}= 32.3013 D_{60}= 12.7884
D_{50}= 8.2924 D_{30}= 2.6312 D_{15}= 0.2887
D_{10}= 0.1187 C_u= 107.72 C_c= 4.56

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Location: TP-FP-02
Depth: 8.5-9.5'

Date:

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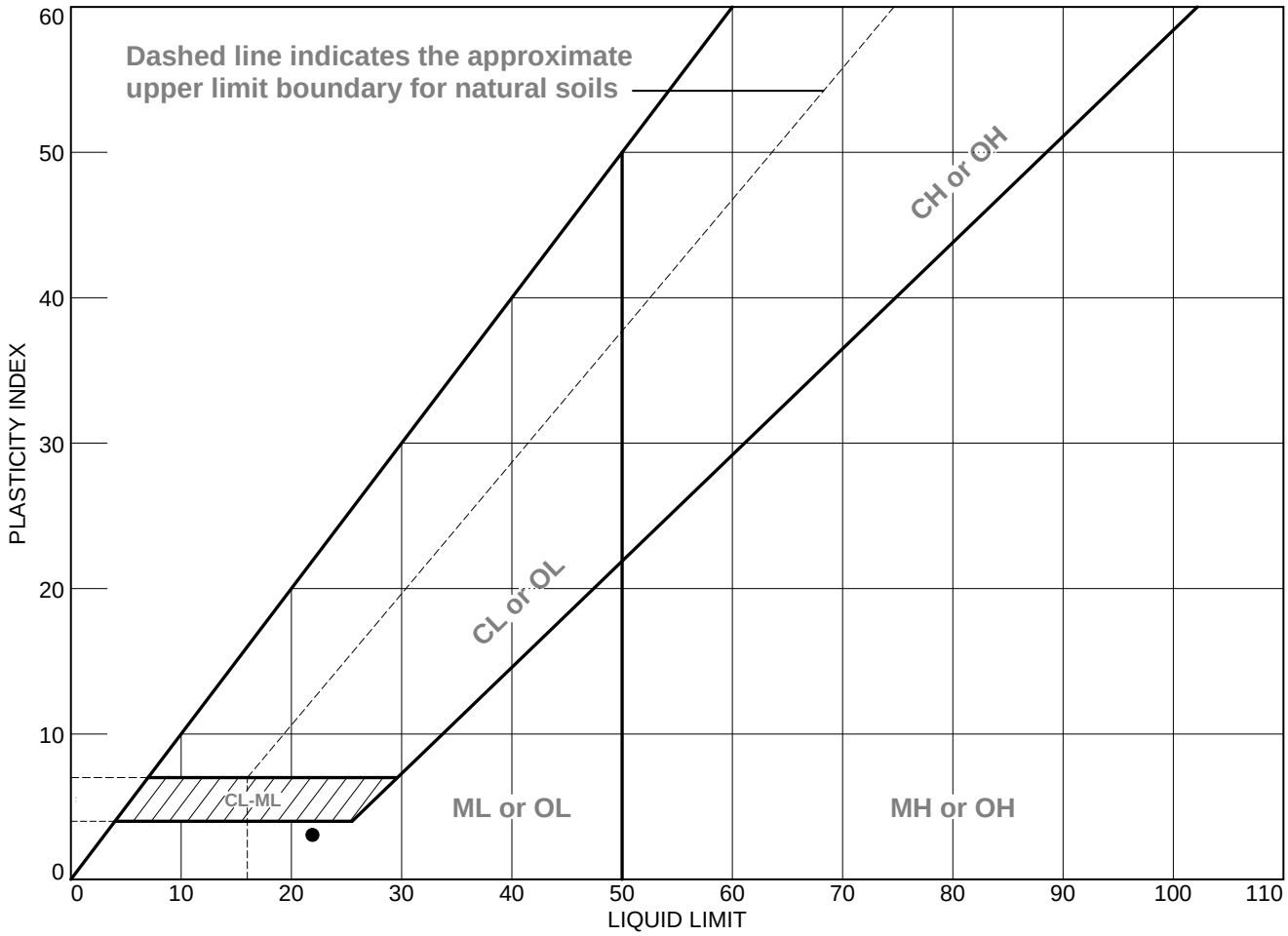
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling

Project No: 15313C **Figure**

Tested By: BG **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●			8.5-9.5'		19	22	3	GP-GM

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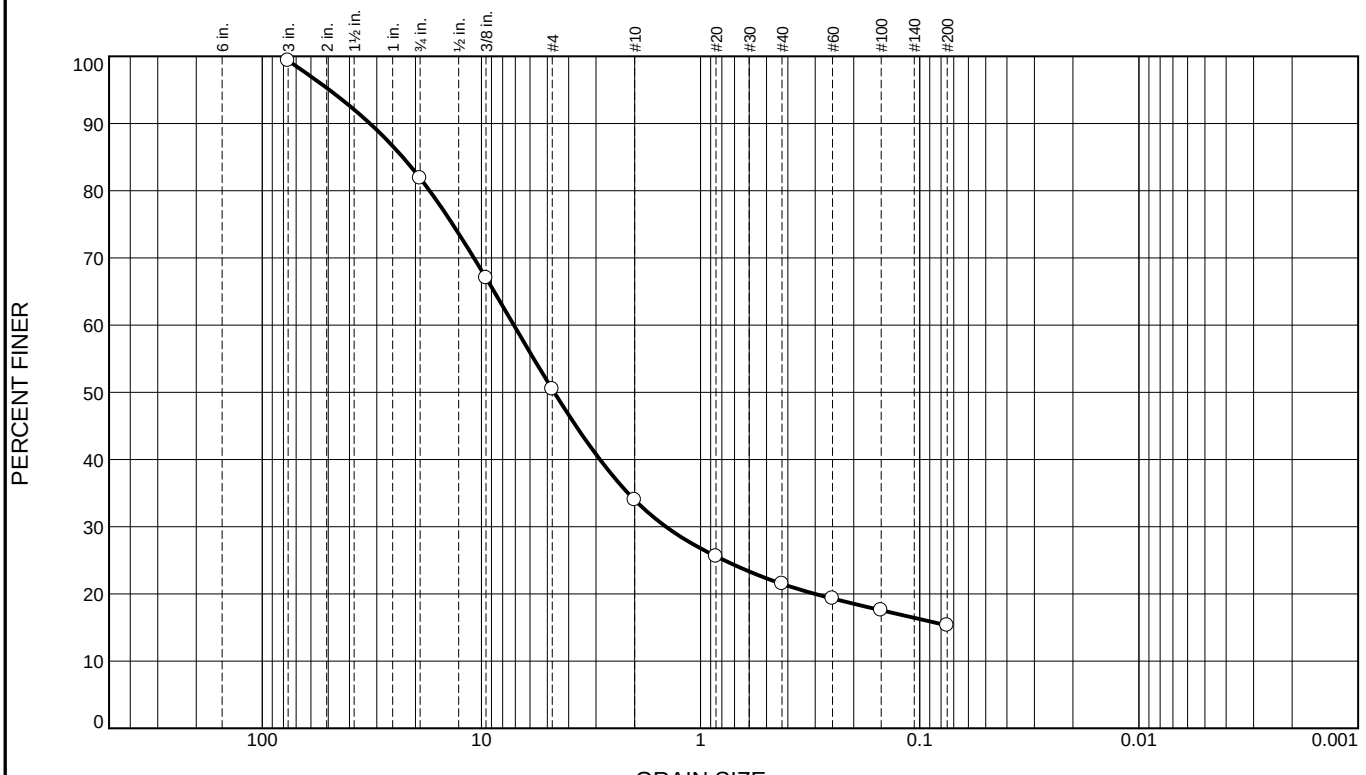
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C **Figure**

Tested By: BG **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	17	32	16	13	6	15	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	99		
.75	82		
.375	67		
#4	50		
#10	34		
#20	26		
#40	21		
#60	19		
#100	18		
#200	15		

* (no specification provided)

Material Description

clayey gravel with sand

Atterberg Limits

PL= 18 LL= 33 PI= 15

Coefficients

D_{90}= 32.2533 D_{85}= 22.8553 D_{60}= 7.1108
D_{50}= 4.6545 D_{30}= 1.4398 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

Location: TP-FP-02
Depth: 3-8.5'

Date:

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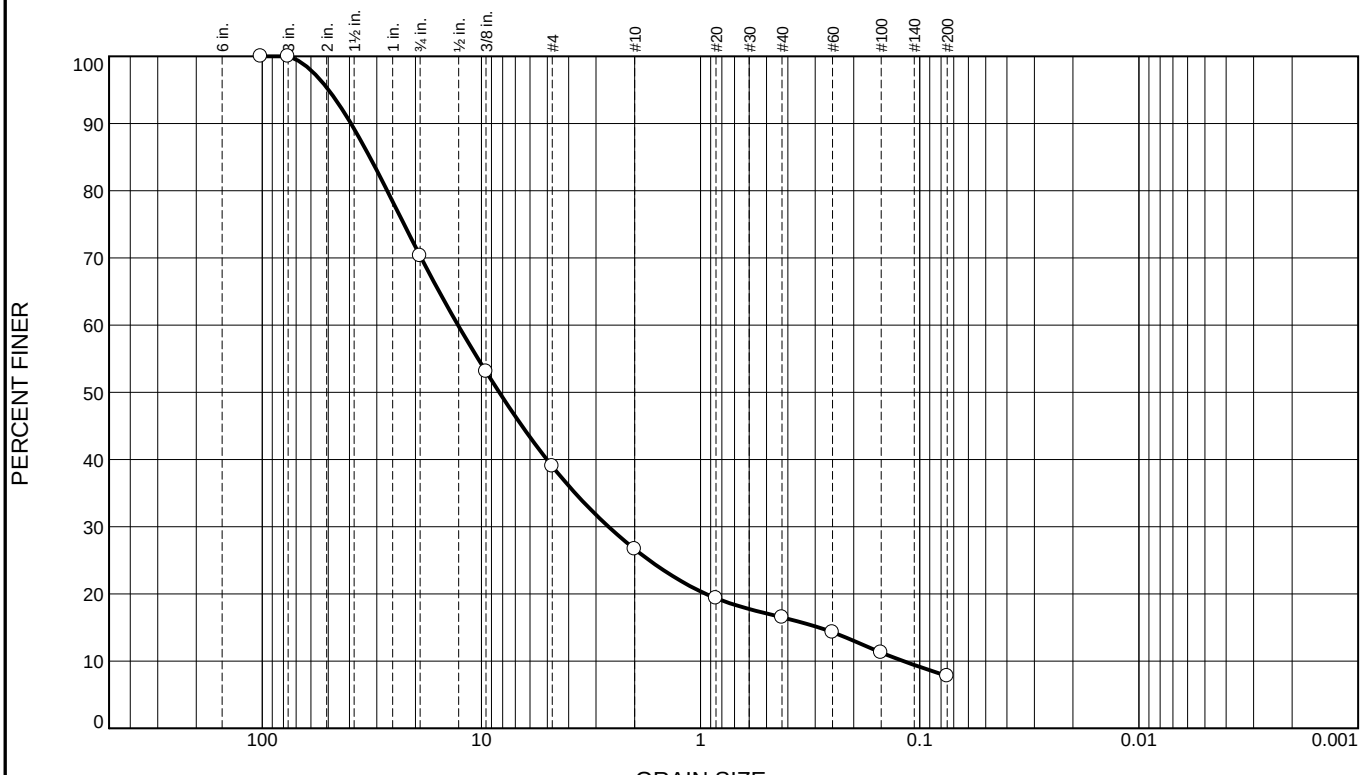
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Tested By: BG **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	30	31	12	10	9	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	100		
.75	70		
.375	53		
#4	39		
#10	27		
#20	19		
#40	17		
#60	14		
#100	11		
#200	7.8		

* (no specification provided)

Material Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= 19 LL= 22 PI= 3

Coefficients

D_{90}= 39.3738 D_{85}= 32.3013 D_{60}= 12.7884
D_{50}= 8.2924 D_{30}= 2.6312 D_{15}= 0.2887
D_{10}= 0.1187 C_u= 107.72 C_c= 4.56

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Location: TP-FP-02
Depth: 8.5-9.5'

Date:

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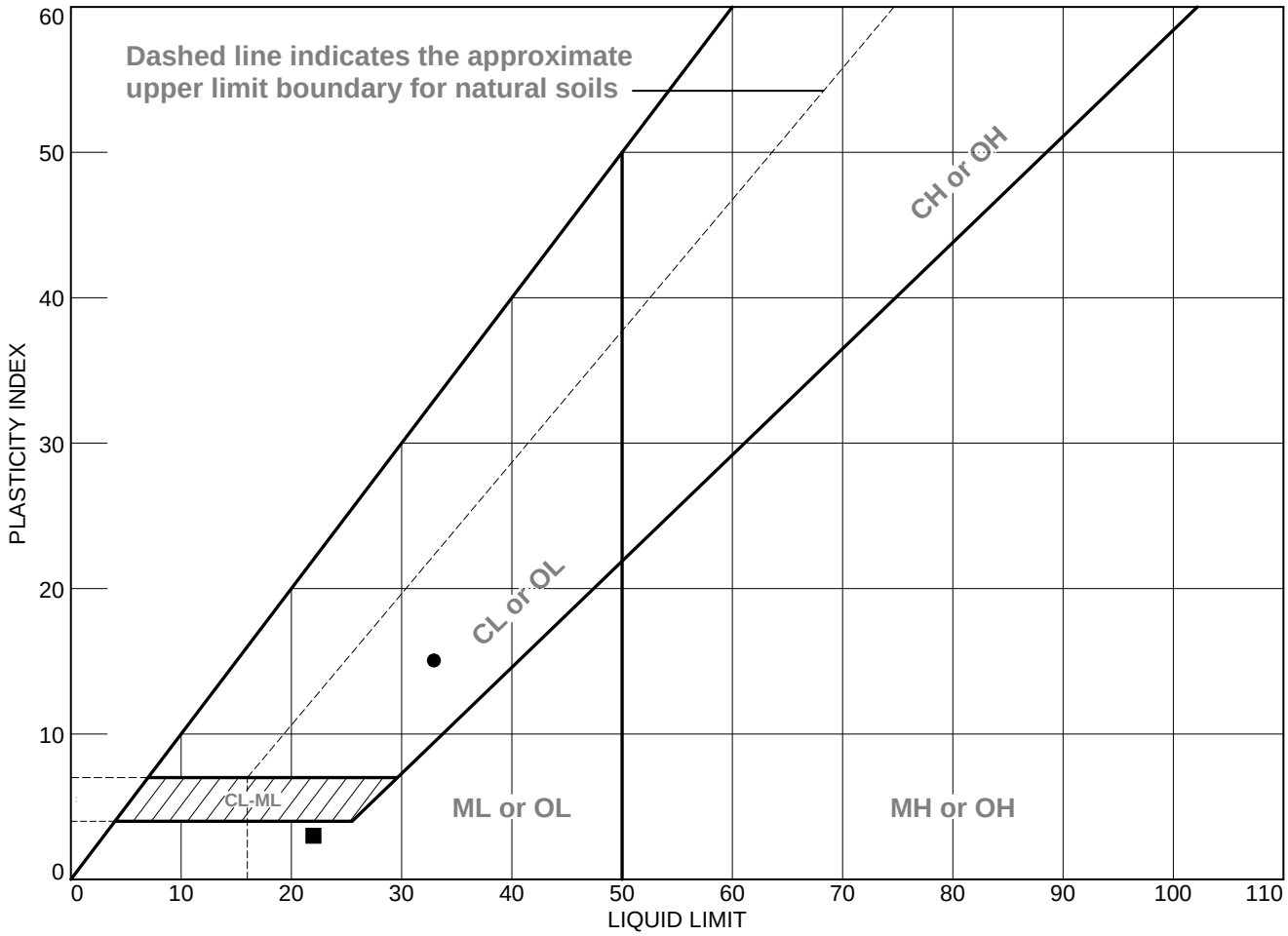
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling

Project No: 15313C **Figure**

Tested By: BG **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-02		3-8.5'		18	33	15	GC
■	TP-FP-02		8.5-9.5'		19	22	3	GP-GM

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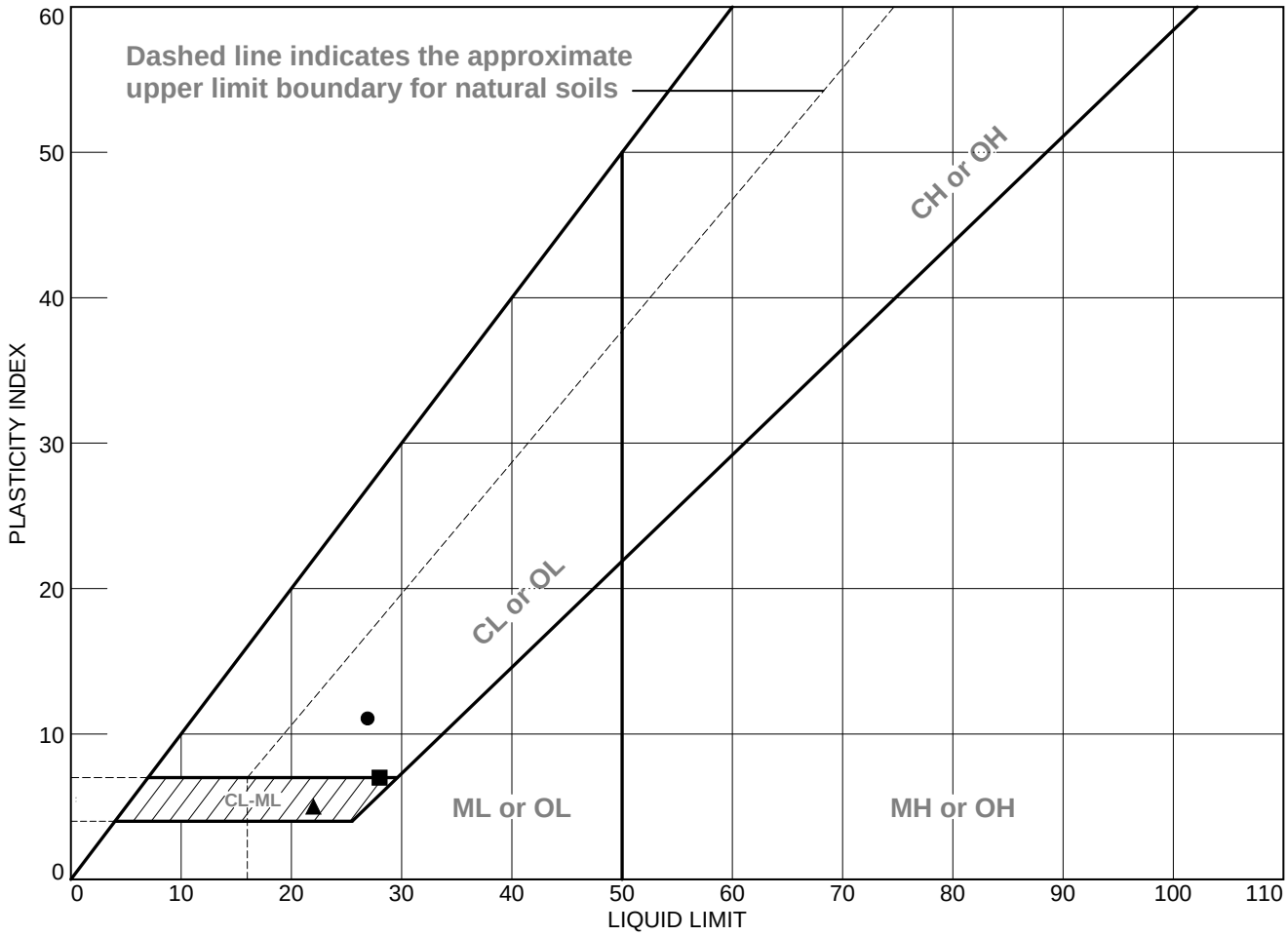
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C **Figure**

Tested By: BG **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-6A		16-16.5'		16	27	11	GC
■	TP-FP-6A		2-3'		21	28	7	SP-SC
▲	TP-FP-6A		5.5-6.5'		17	22	5	GP-GC

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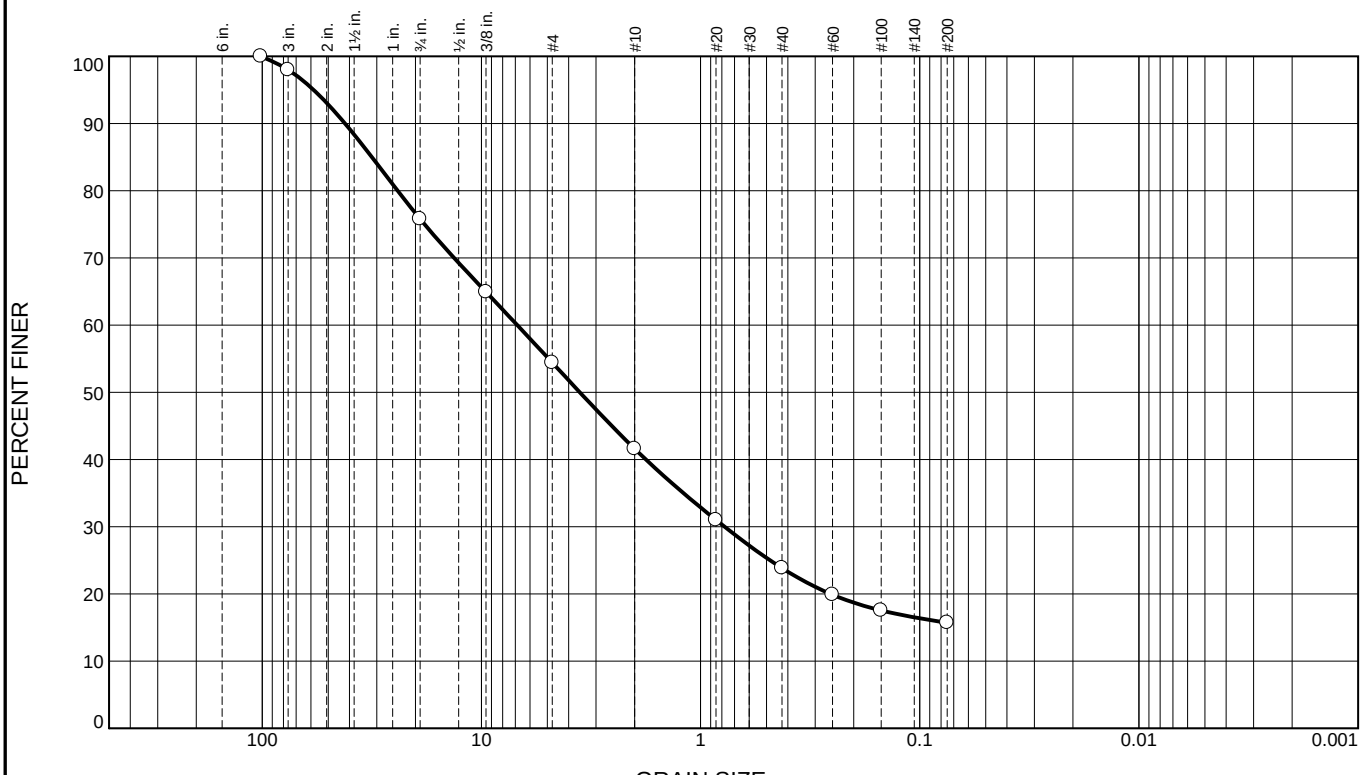
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C **Figure**

Tested By: ○ NG/BG □ Lance Sorensen △ BG **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
2	22	22	12	18	8	16	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	98		
.75	76		
.375	65		
#4	54		
#10	42		
#20	31		
#40	24		
#60	20		
#100	18		
#200	16		

* (no specification provided)

Material Description

clayey gravel with sand

Atterberg Limits

PL= 16 LL= 27 PI= 11

Coefficients

D_{90}= 41.9414 D_{85}= 31.6139 D_{60}= 6.8639
D_{50}= 3.5556 D_{30}= 0.7774 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

Location: TP-FP-6A
Depth: 16-16.5'

Date:

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1215 Apple's Way - Belgrade, MT 59714
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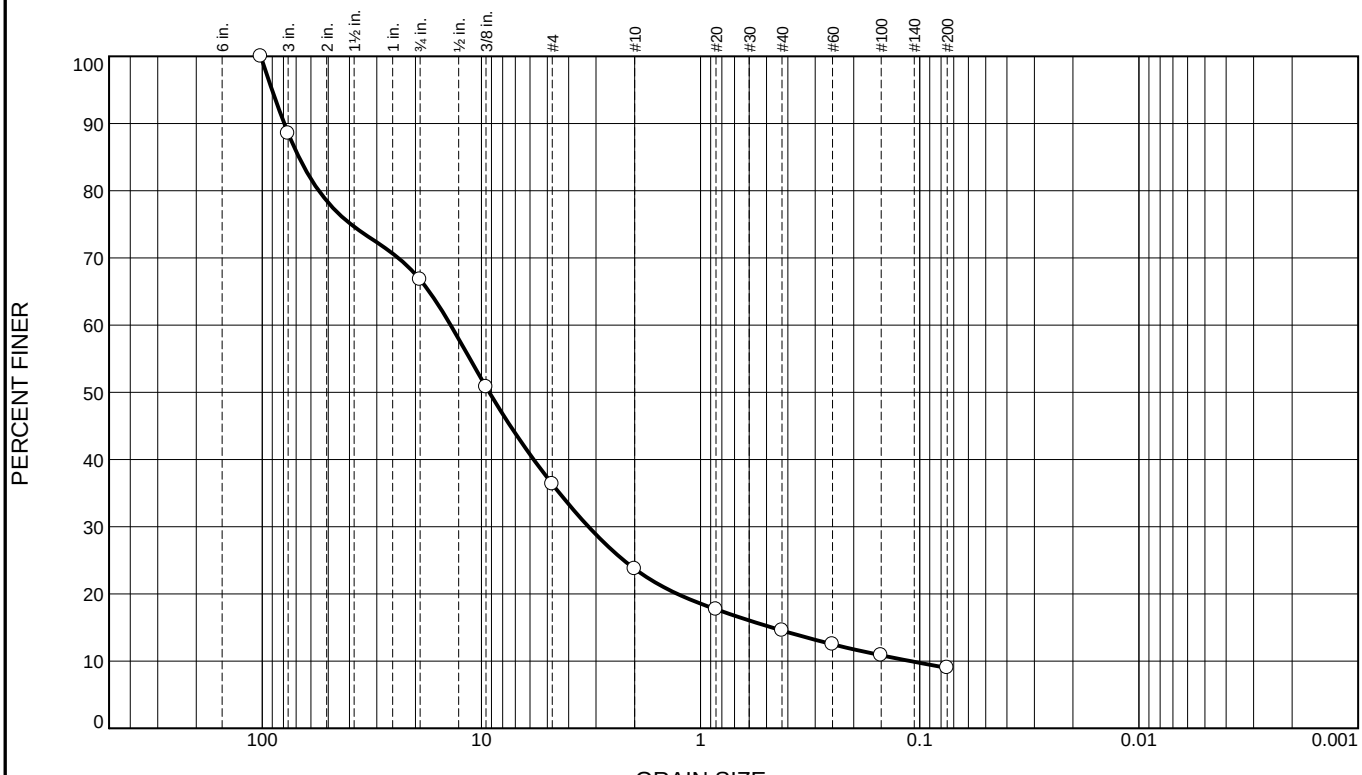
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Tested By: LS **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
11	22	31	12	9	6	9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	89		
.75	67		
.375	51		
#4	36		
#10	24		
#20	18		
#40	15		
#60	13		
#100	11		
#200	9.0		

* (no specification provided)

Material Description

poorly graded gravel with silty clay and sand

Atterberg Limits

PL= 17 LL= 22 PI= 5

Coefficients

D_{90}= 79.3999 D_{85}= 68.0893 D_{60}= 13.8153
D_{50}= 9.2098 D_{30}= 3.2463 D_{15}= 0.4730
D_{10}= 0.1101 C_u= 125.49 C_c= 6.93

Classification

USCS= GP-GC AASHTO= A-1-a

Remarks

Location: TP-FP-6A
Depth: 5.5-6.5'

Date:

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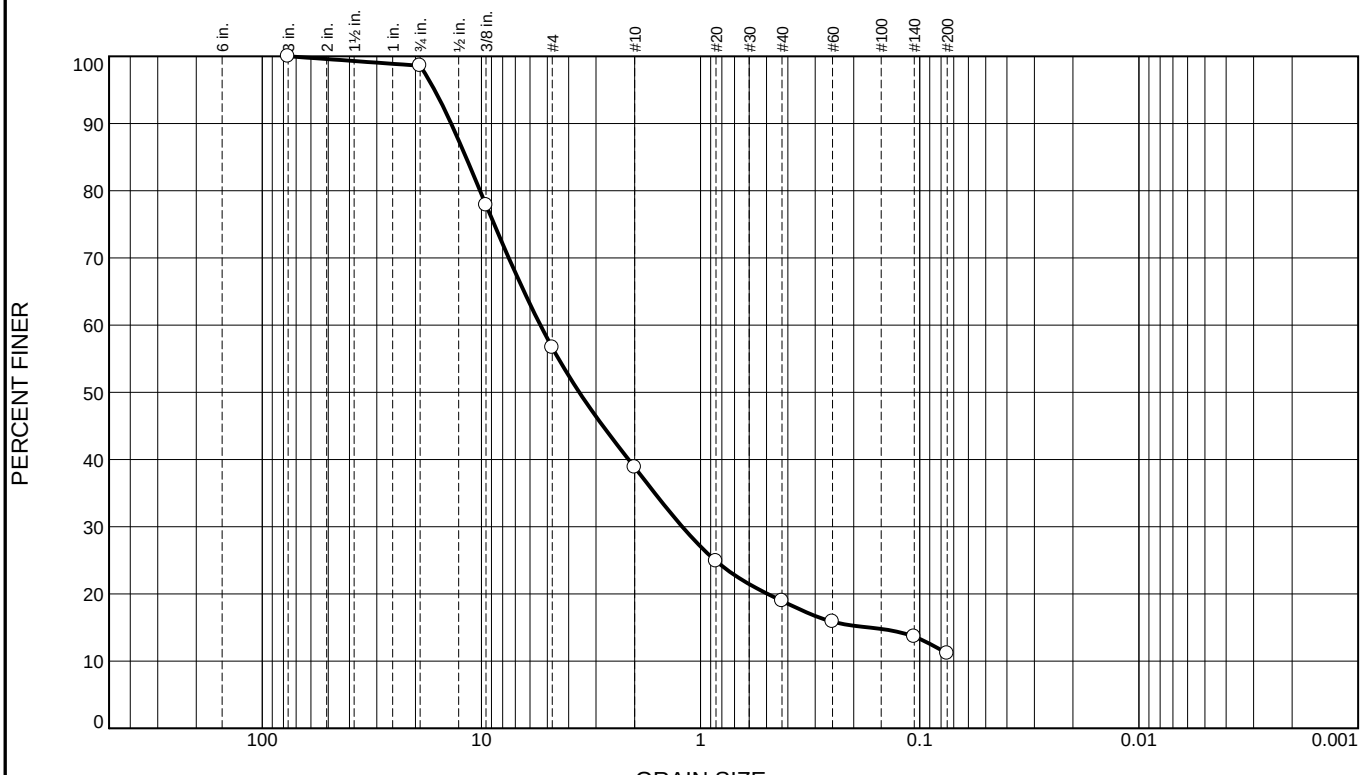
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Tested By: BG **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	1	42	18	20	8	11	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100		
.75	99		
.375	78		
#4	57		
#10	39		
#20	25		
#40	19		
#60	16		
#140	14		
#200	11		

* (no specification provided)

Material Description

poorly graded sand with siltyclay and gravel

Atterberg Limits

PL= 21 LL= 28 PI= 7

Coefficients

D_{90}= 13.7501 D_{85}= 11.7698 D_{60}= 5.3826
D_{50}= 3.5761 D_{30}= 1.2123 D_{15}= 0.1704
D_{10}= C_u= C_c=

Classification

USCS= SP-SC AASHTO= A-2-4(0)

Remarks

Location: TP-FP-6A
Depth: 2-3'

Date:

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1215 Apple's Way - Belgrade, MT 59714
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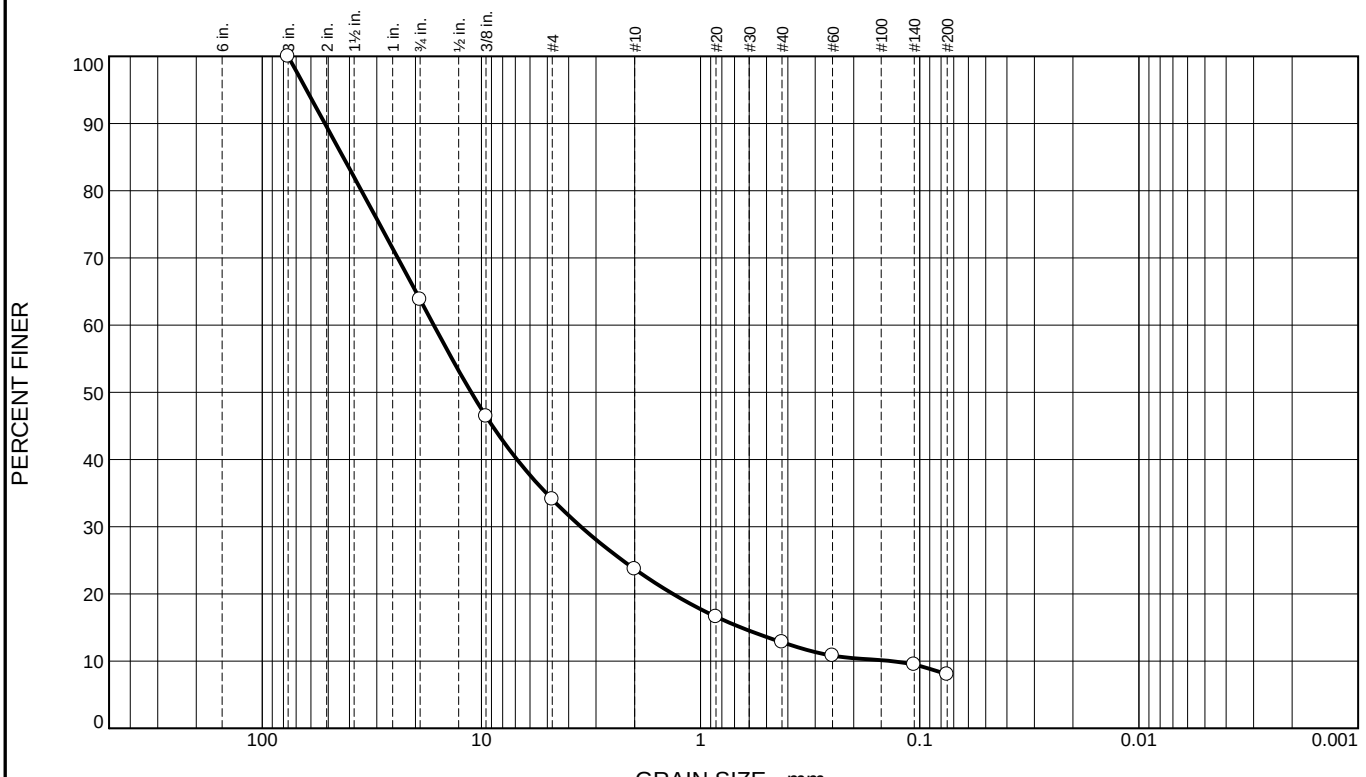
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Tested By: NG/LS **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	36	30	10	11	5	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100		
.75	64		
.375	46		
#4	34		
#10	24		
#20	17		
#40	13		
#60	11		
#140	9		
#200	8.0		

* (no specification provided)

Material Description

poorly graded gravel with clay and sand

Atterberg Limits

PL= 17 LL= 28 PI= 11

Coefficients

D_{90}= 51.7978 D_{85}= 42.7260 D_{60}= 16.5004
D_{50}= 11.1361 D_{30}= 3.5159 D_{15}= 0.6539
D_{10}= 0.1347 C_u= 122.51 C_c= 5.56

Classification

USCS= GP-GC AASHTO= A-2-6(0)

Remarks

Location: TP-FP-6B
Depth: 12-13'

Date:

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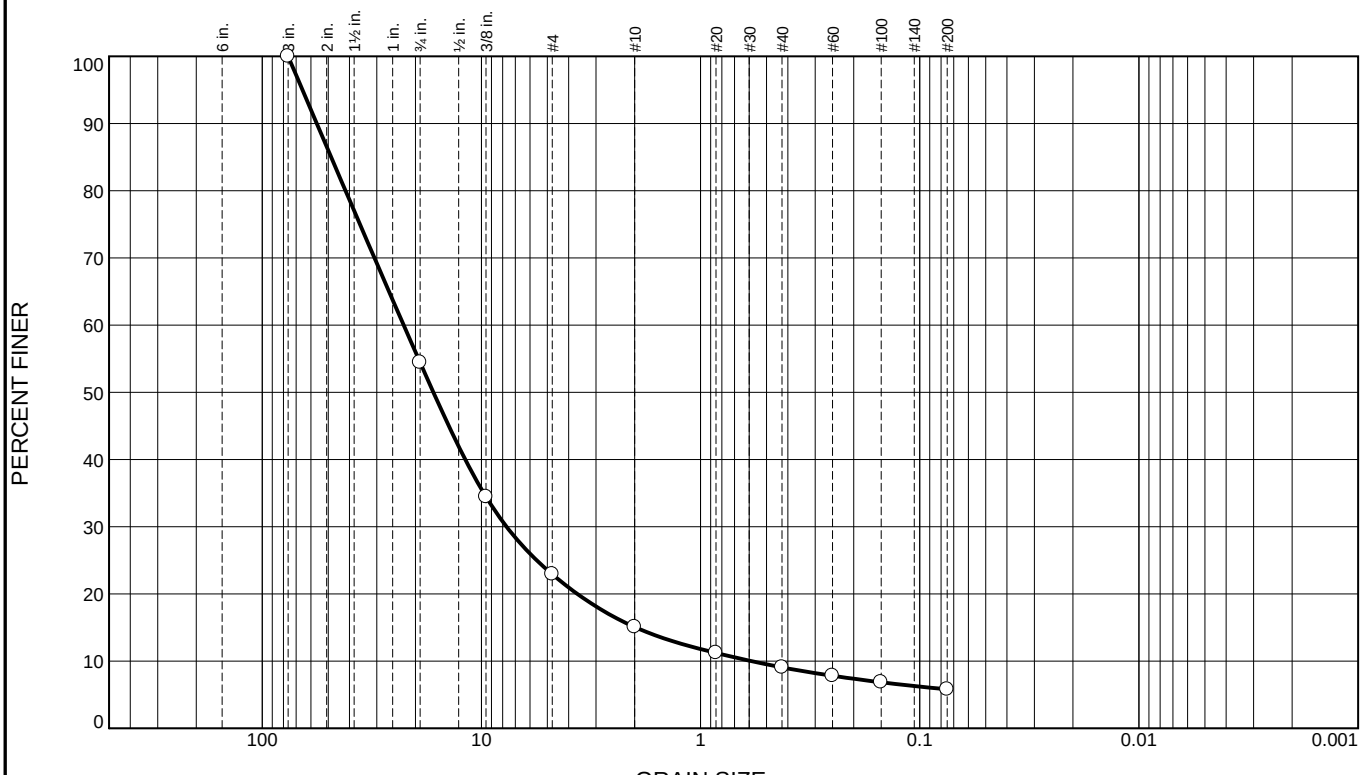
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Tested By: NG/LS **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	46	31	8	6	3	6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100		
.75	54		
.375	34		
#4	23		
#10	15		
#20	11		
#40	9		
#60	8		
#100	7		
#200	5.8		

* (no specification provided)

Material Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= 18 LL= 21 PI= 3

Coefficients

D_{90}= 56.3943 D_{85}= 48.4999 D_{60}= 22.6284
D_{50}= 16.5644 D_{30}= 7.6815 D_{15}= 1.9778
D_{10}= 0.5868 C_u= 38.57 C_c= 4.44

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Location: TP-FP-6B
Depth: 2.5-3.5'

Date: 10-29-12

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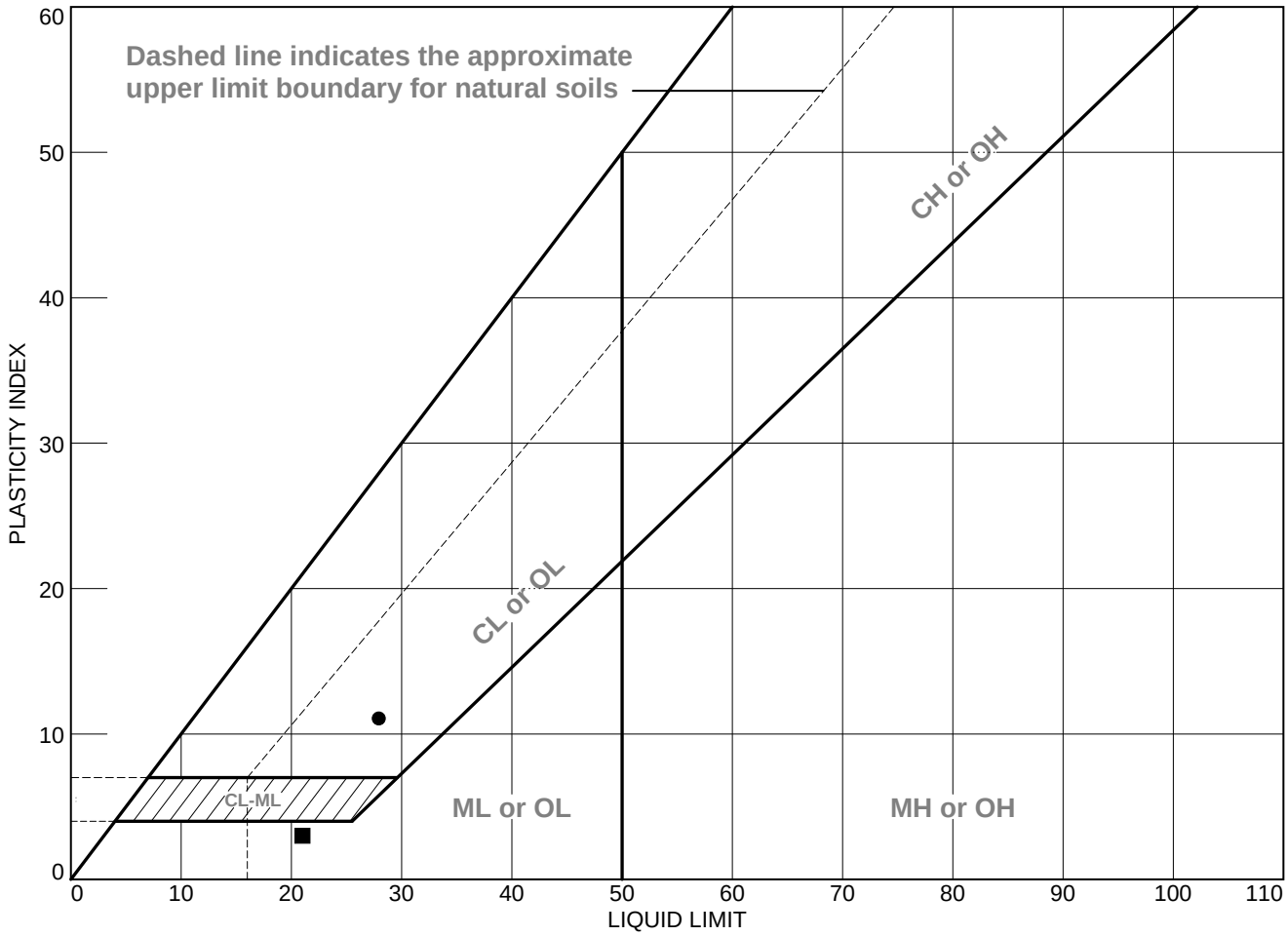
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Tested By: LS/NG **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-6B		12-13'		17	28	11	GP-GC
■	TP-FP-6B		2.5-3.5'		18	21	3	GP-GM

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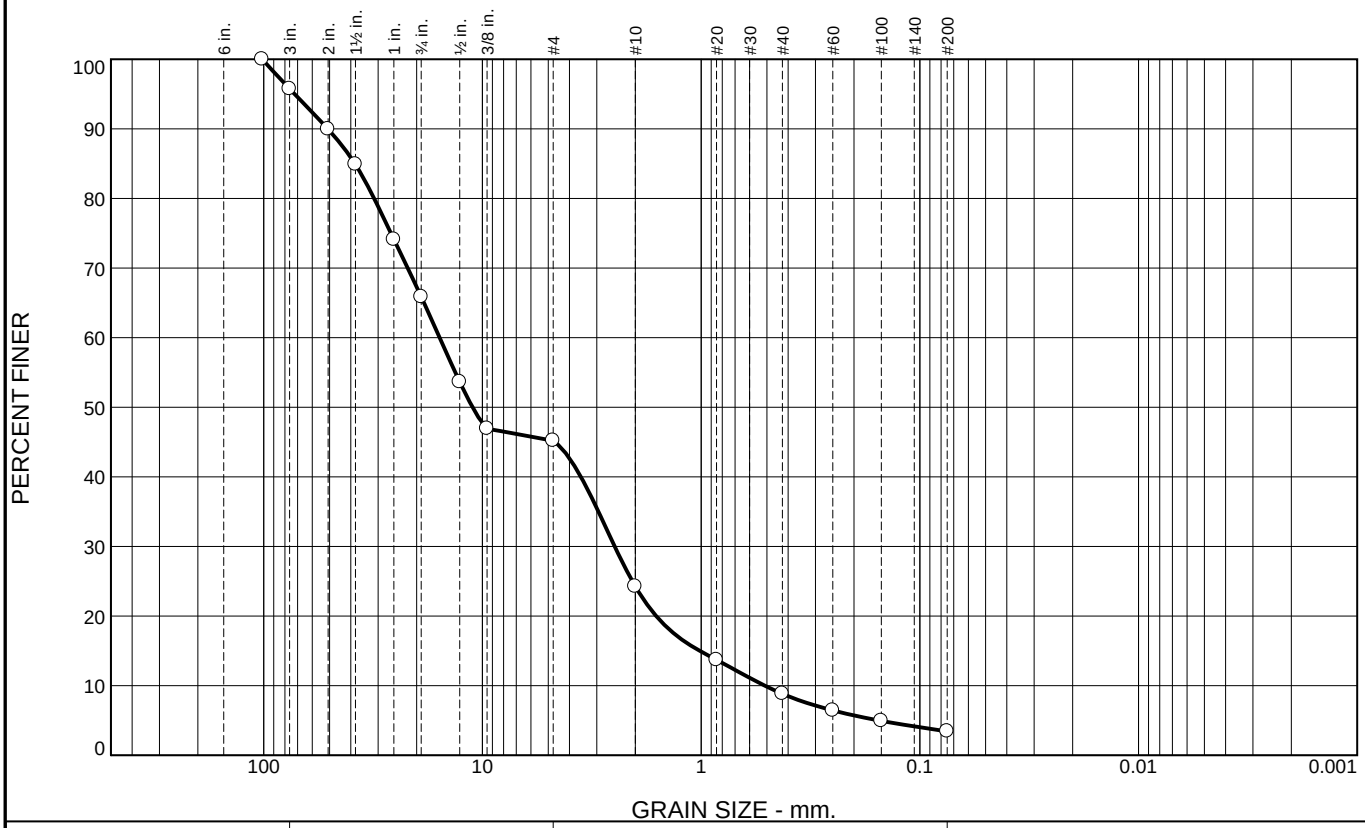
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C **Figure**

Tested By: LS **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
4	30	21	21	15	6	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	96		
2	90		
1.5	85		
1	74		
.75	66		
.5	54		
.375	47		
#4	45		
#10	24		
#20	14		
#40	9		
#60	6		
#100	5		
#200	3.4		

* (no specification provided)

Material Description

poorly graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 50.9559 D_{85}= 38.2933 D_{60}= 15.6911
D_{50}= 11.1064 D_{30}= 2.4829 D_{15}= 1.0133
D_{10}= 0.5106 C_u= 30.73 C_c= 0.77

Classification

USCS= GP AASHTO=

Remarks

Location: TP-FP-16
Sample Number: 12944 **Depth:** 9-9.4' **Date:** 8-21-12

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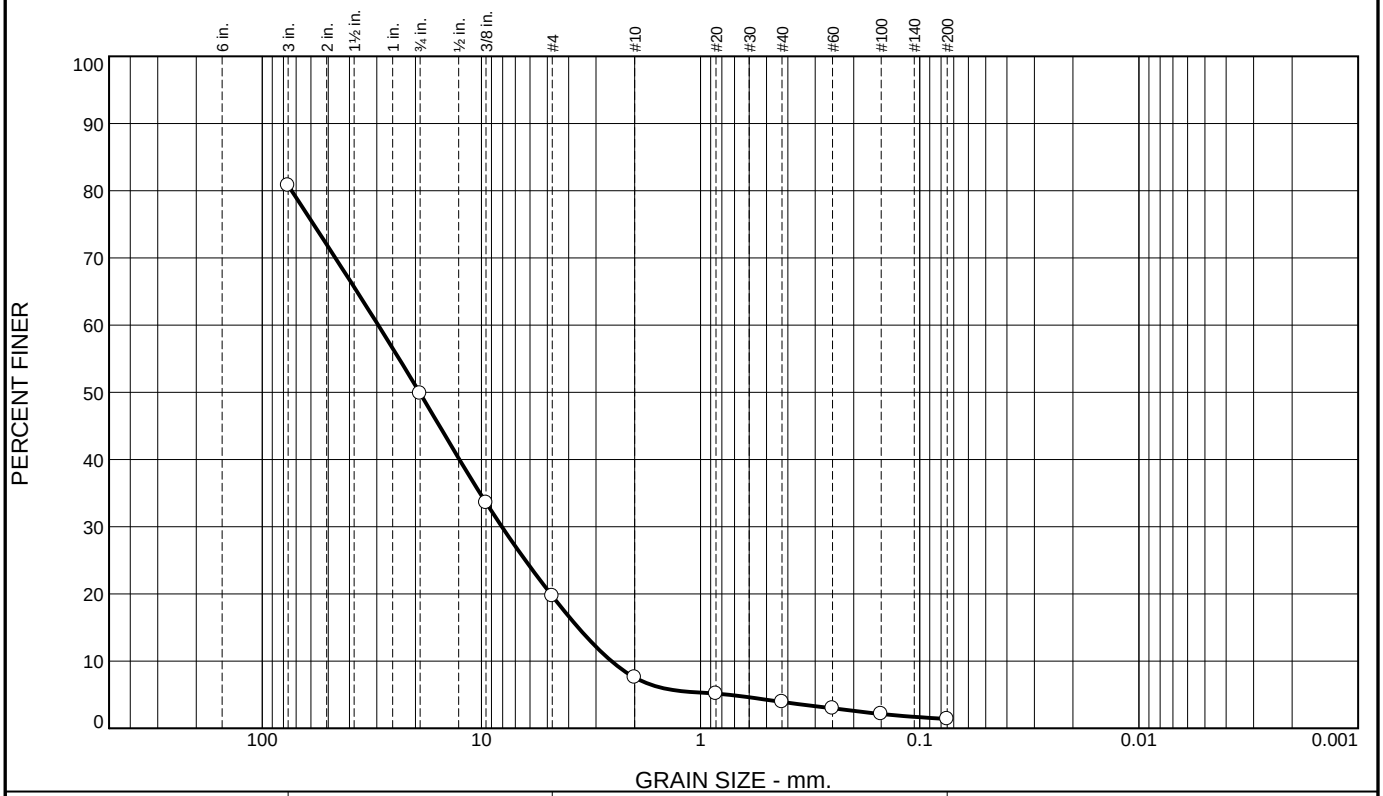
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	31	30	12	4	3	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	81		
.75	50		
.375	34		
#4	20		
#10	8		
#20	5		
#40	4		
#60	3		
#100	2		
#200	1.4		

* (no specification provided)

Material Description

poorly graded gravel with sand

Atterberg Limits

PL= 24 LL= 26 PI= 2

Coefficients

D_{90}= D_{85}= D_{60}= 29.5701
D_{50}= 19.1694 D_{30}= 8.0672 D_{15}= 3.6190
D_{10}= 2.5519 C_u= 11.59 C_c= 0.86

Classification

USCS= GP AASHTO= A-1-a

Remarks

Location: TP-FP-12
Depth: @ 3.5'

Date:

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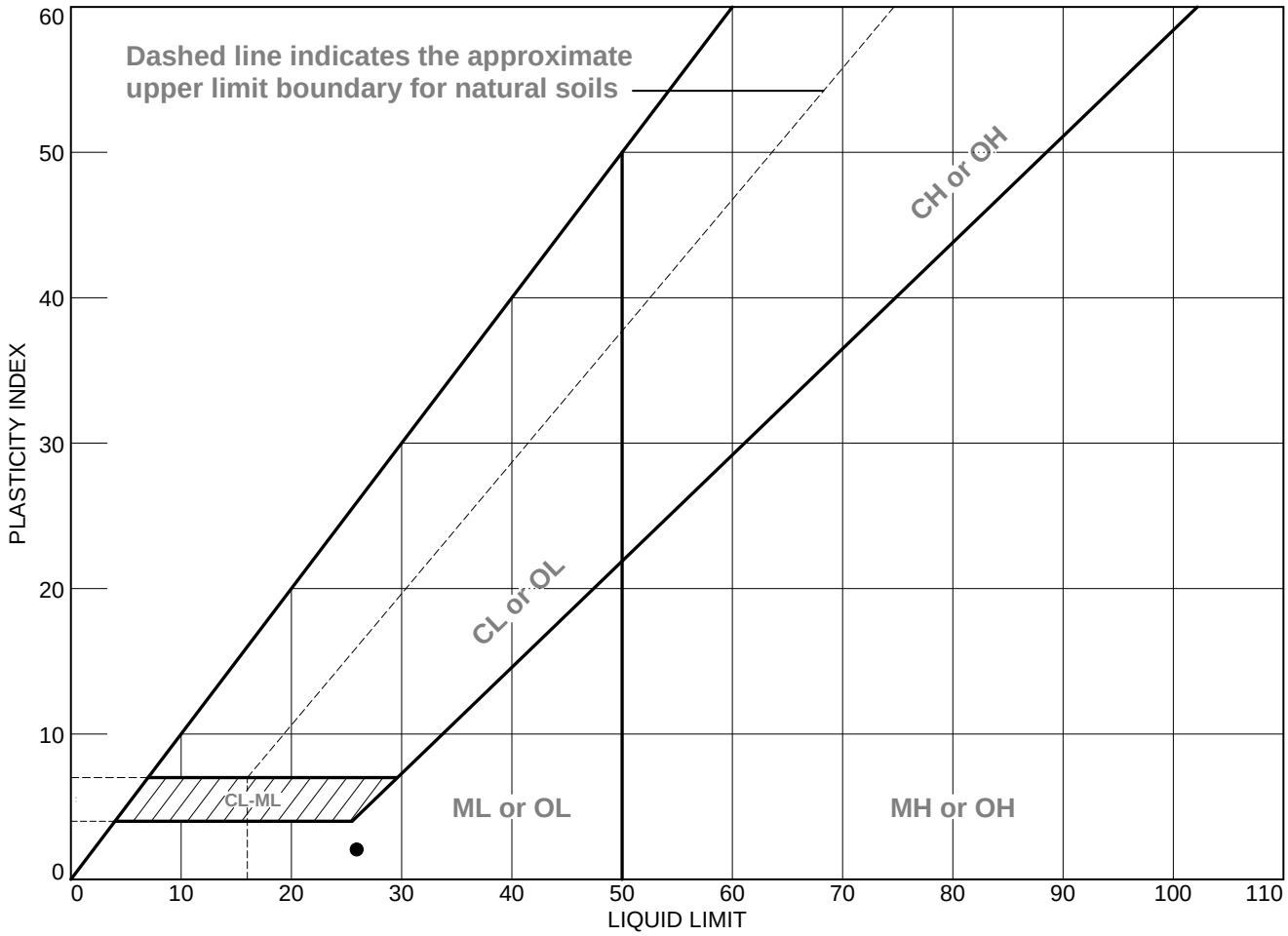
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling

Project No: 15313C **Figure**

Tested By: NG/LS **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-12		@ 3.5'		24	26	2	GP

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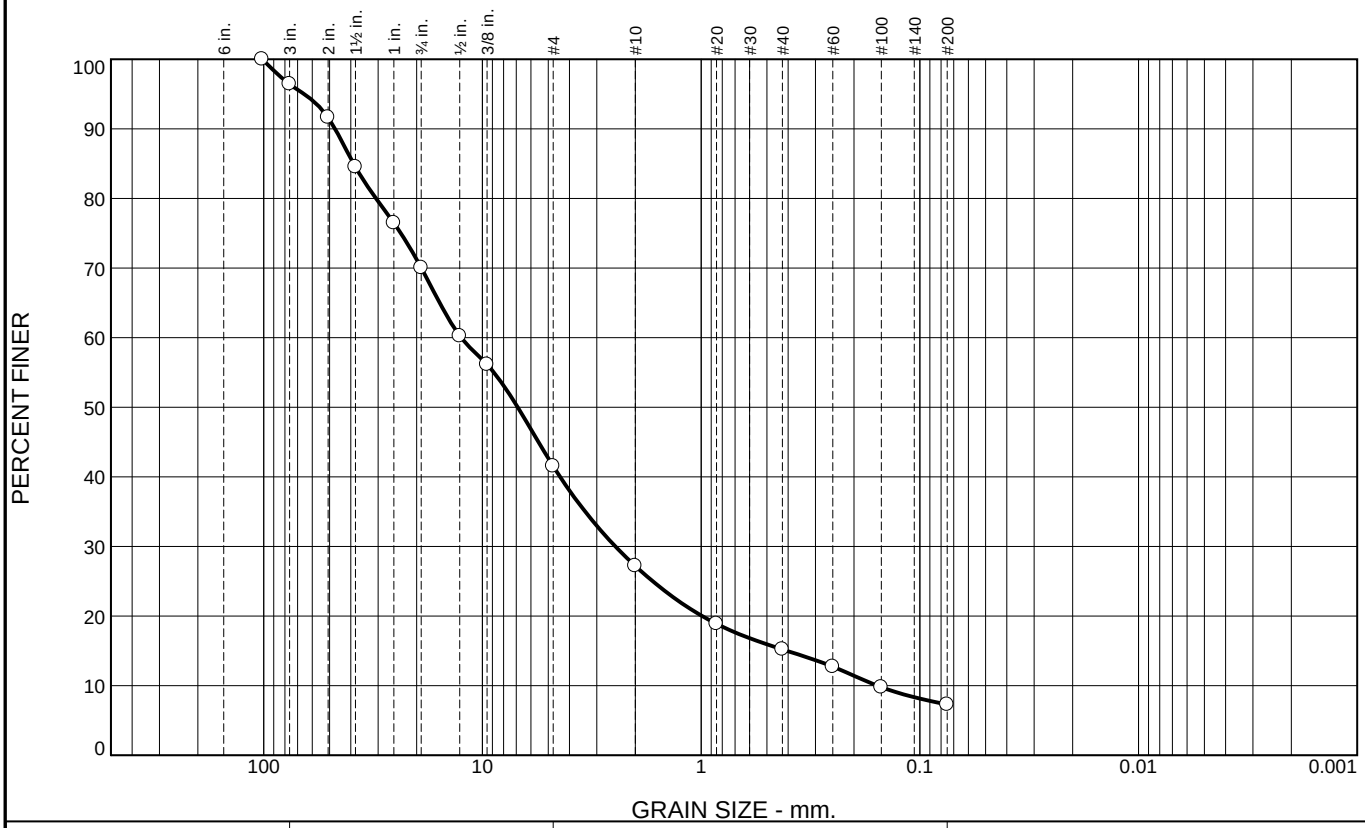
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C **Figure**

Tested By: LS **Checked By:** NG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
4	26	28	15	12	8	7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	96		
2	92		
1.5	85		
1	76		
.75	70		
.5	60		
.375	56		
#4	42		
#10	27		
#20	19		
#40	15		
#60	13		
#100	10		
#200	7.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 47.1792 D_{85}= 38.8363 D_{60}= 12.5249
D_{50}= 6.8964 D_{30}= 2.4653 D_{15}= 0.4045
D_{10}= 0.1562 C_u= 80.18 C_c= 3.11

Classification

USCS= AASHTO=

Remarks

Location: TP-FP-20
Sample Number: 12941 **Depth:** 1-2' **Date:** 8-22-12

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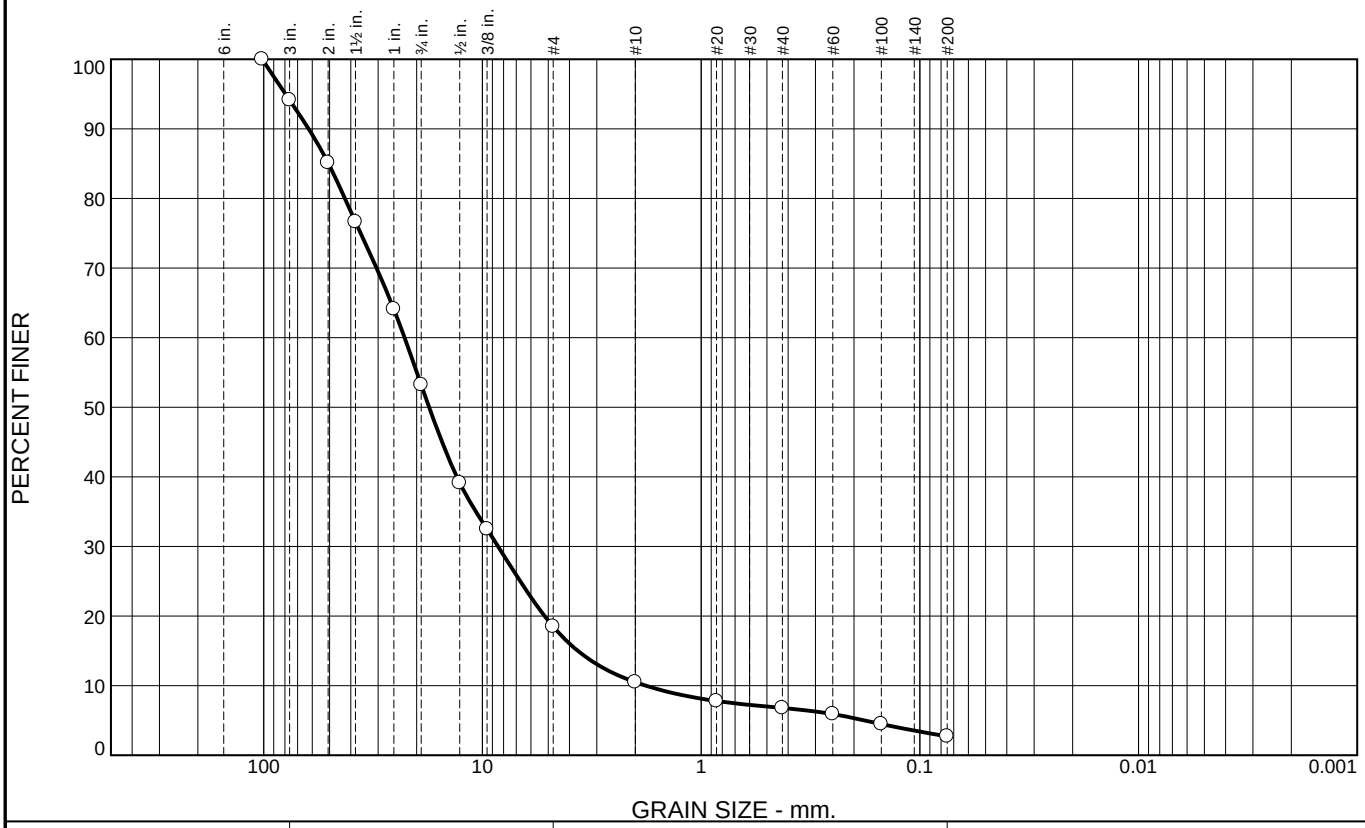
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
6	41	35	7	4	4	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	94		
2	85		
1.5	77		
1	64		
.75	53		
.5	39		
.375	32		
#4	18		
#10	11		
#20	8		
#40	7		
#60	6		
#100	4		
#200	2.7		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 62.3182 D_{85}= 50.5389 D_{60}= 22.6999
D_{50}= 17.5186 D_{30}= 8.4791 D_{15}= 3.6617
D_{10}= 1.7855 C_u= 12.71 C_c= 1.77

Classification

USCS= GW AASHTO=

Remarks

Location: TP-FP-26
Sample Number: BU0076/12939 **Depth:** 4-4.5' **Date:**

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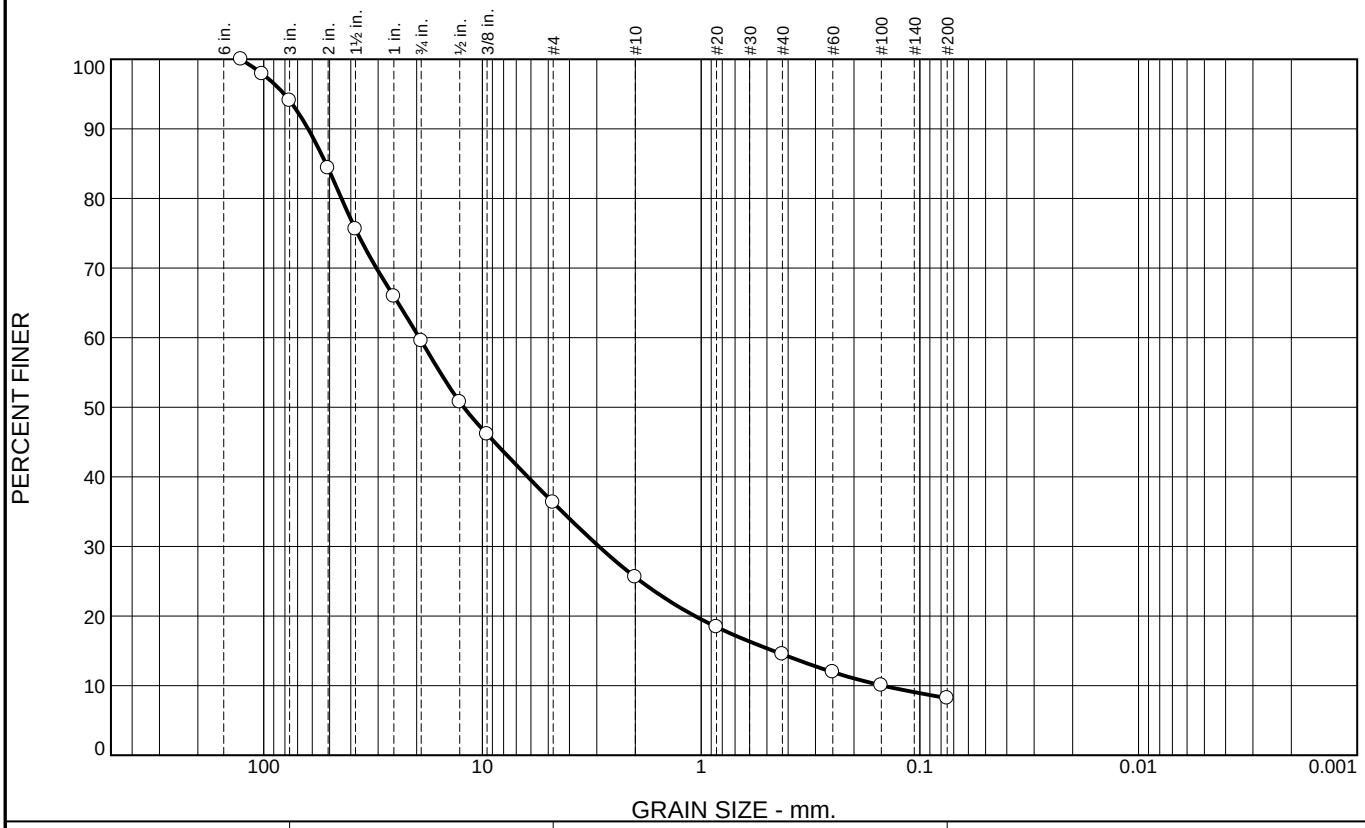
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
6	34	24	10	11	7	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
5	100		
4	98		
3	94		
2	84		
1.5	76		
1	66		
.75	60		
.5	51		
.375	46		
#4	36		
#10	26		
#20	18		
#40	15		
#60	12		
#100	10		
#200	8.2		

* (no specification provided)

Material Description

poorly graded gravel with clay and sand

Atterberg Limits

PL= 17 LL= 26 PI= 9

Coefficients

D_{90}= 62.6229 D_{85}= 51.9100 D_{60}= 19.4308
D_{50}= 12.1817 D_{30}= 2.9319 D_{15}= 0.4666
D_{10}= 0.1471 C_u= 132.14 C_c= 3.01

Classification

USCS= GP-GC AASHTO= A-2-4(0)

Remarks

Location: TP-FP-36
Sample Number: 13024 **Depth:** 5-6' **Date:** 8-29-12

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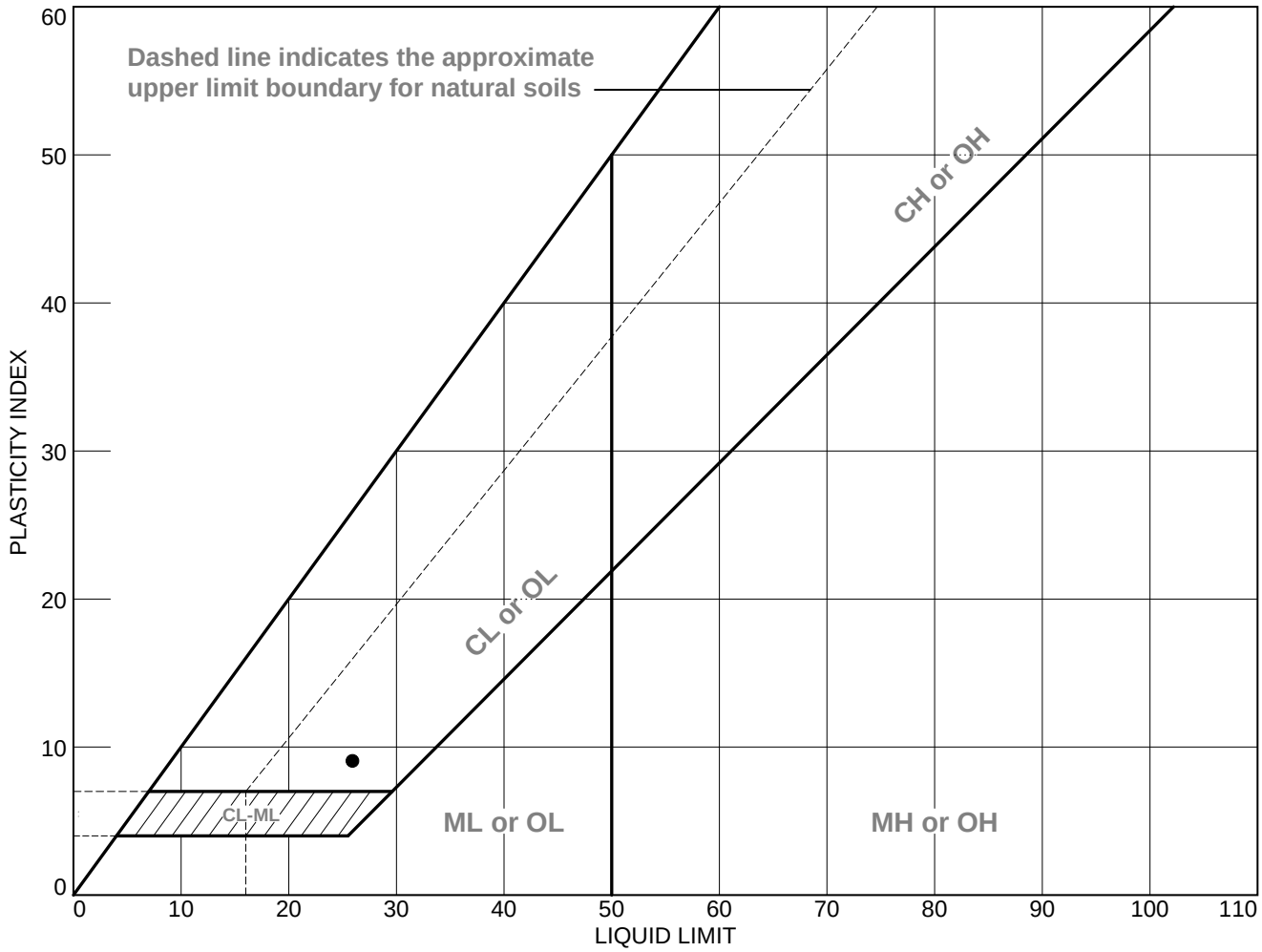
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-36	13024	5-6'		17	26	9	GP-GC

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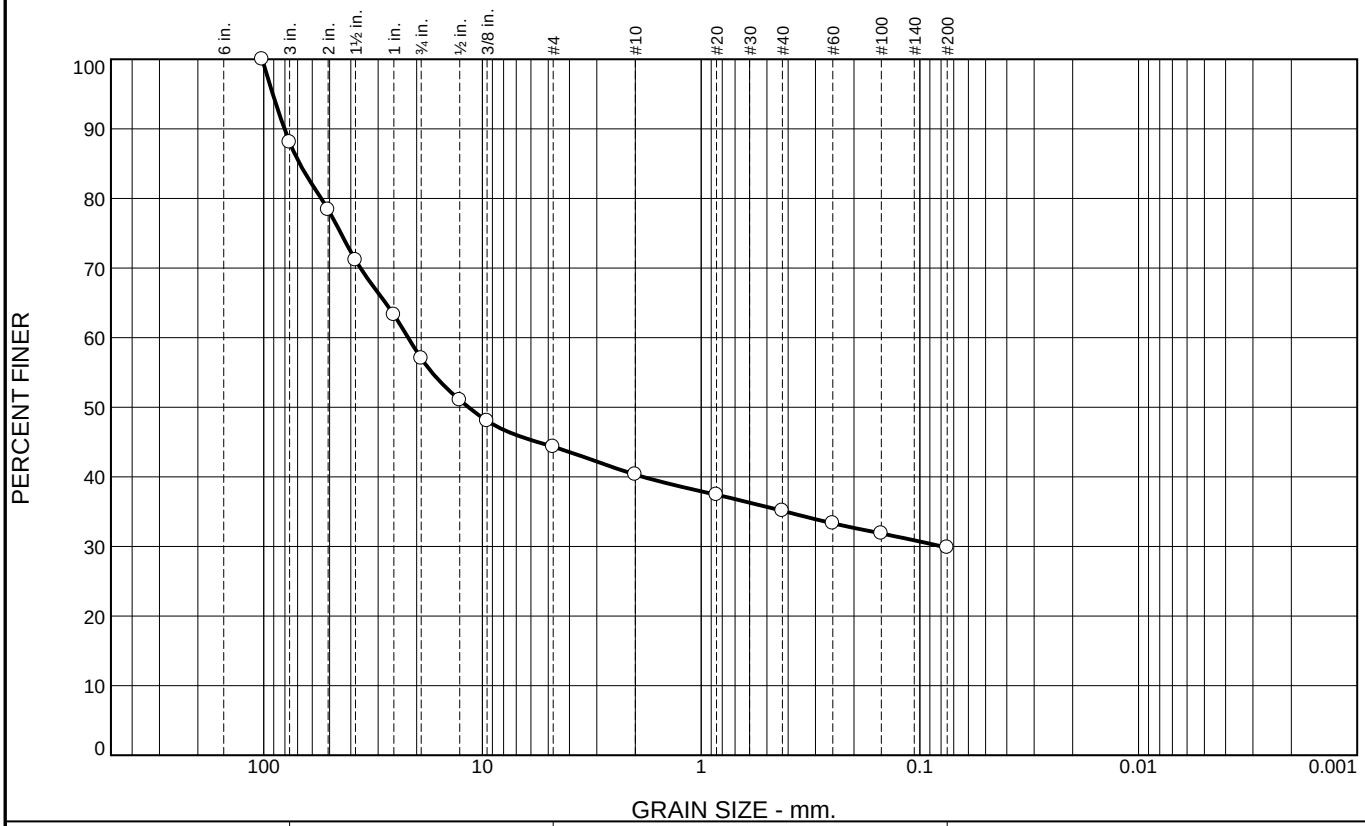
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
12	31	13	4	5	5	30	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	88		
2	78		
1.5	71		
1	63		
.75	57		
.5	51		
.375	48		
#4	44		
#10	40		
#20	37		
#40	35		
#60	33		
#100	32		
#200	30		

* (no specification provided)

Material Description

silty clayey gravel with sand

Atterberg Limits

PL= 17 LL= 23 PI= 6

Coefficients

D_{90}= 80.4694 D_{85}= 68.5098 D_{60}= 21.8629
D_{50}= 11.5817 D_{30}= 0.0788 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC-GM AASHTO= A-2-4(0)

Remarks

Location: TP-FP-39
Sample Number: 13025 **Depth:** 9.5-10A **Date:**

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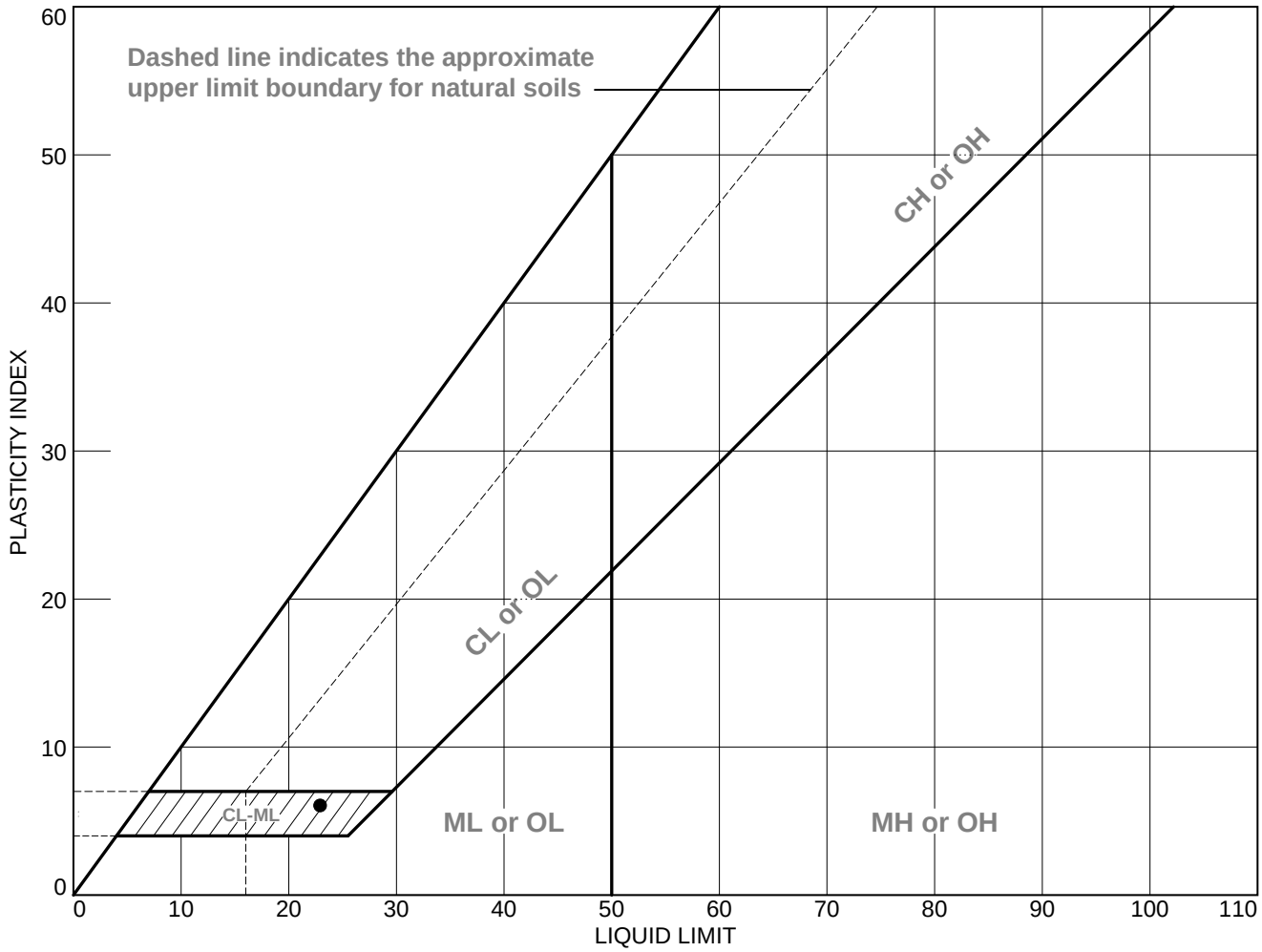
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TP-FP-39	13025	9.5-10A		17	23	6	GC-GM

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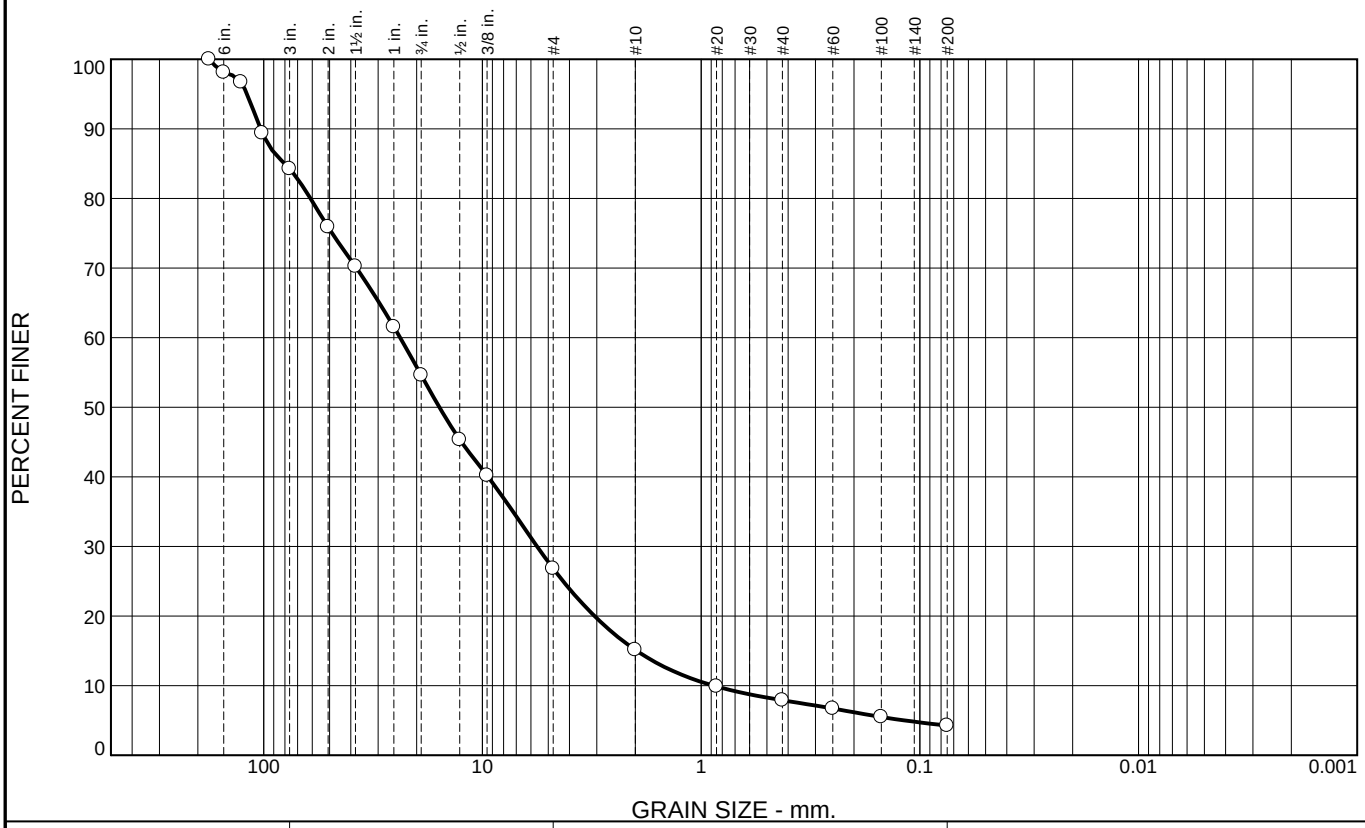
Client: Pioneer Technical Services

Project: Mike Horse Floodplain Sampling

Project No.: 15313C

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
16	29	28	12	7	4	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
7	100		
6	98		
5	97		
4	89		
3	84		
2	76		
1.5	70		
1	62		
.75	55		
.5	45		
.375	40		
#4	27		
#10	15		
#20	10		
#40	8		
#60	7		
#100	6		
#200	4.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 103.5277 D_{85}= 80.2800 D_{60}= 23.7847
D_{50}= 15.7311 D_{30}= 5.6226 D_{15}= 1.9689
D_{10}= 0.8753 C_u= 27.17 C_c= 1.52

Classification

USCS= AASHTO=

Remarks

Location: TP-Bulk-01
Sample Number: 12912 **Depth:** 8-8.5 **Date:** 8-29-12

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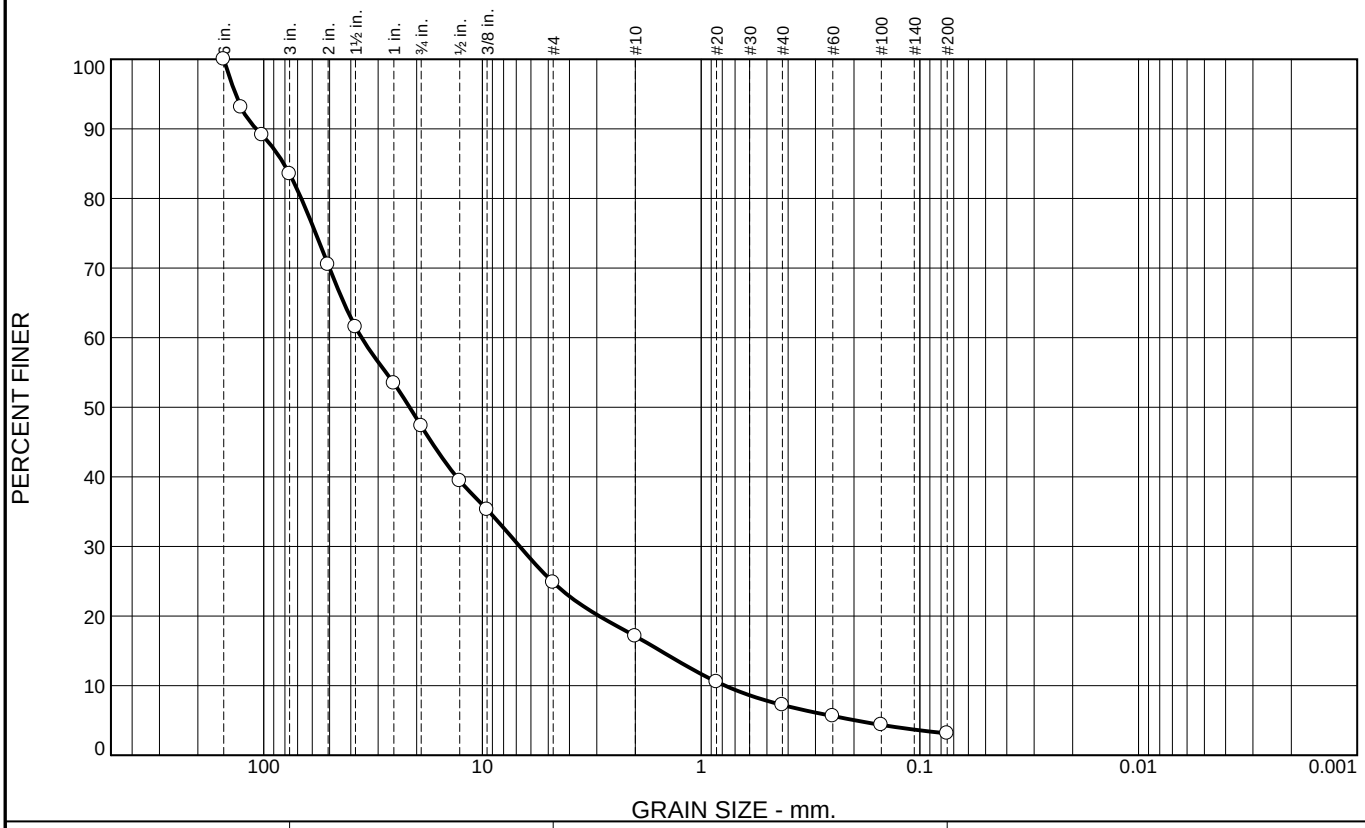
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
16	37	22	8	10	4	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6	100		
5	93		
4	89		
3	84		
2	71		
1.5	62		
1	53		
.75	47		
.5	39		
.375	35		
#4	25		
#10	17		
#20	11		
#40	7		
#60	6		
#100	4		
#200	3.1		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 108.3075 D_{85}= 81.0037 D_{60}= 35.7320
D_{50}= 21.5285 D_{30}= 6.7518 D_{15}= 1.5307
D_{10}= 0.7765 C_u= 46.02 C_c= 1.64

Classification

USCS= GW AASHTO=

Remarks

Source of Sample: TP-Bulk-02 **Depth:** 6-7'
Sample Number: BU0075 **Date:** 9-12-12

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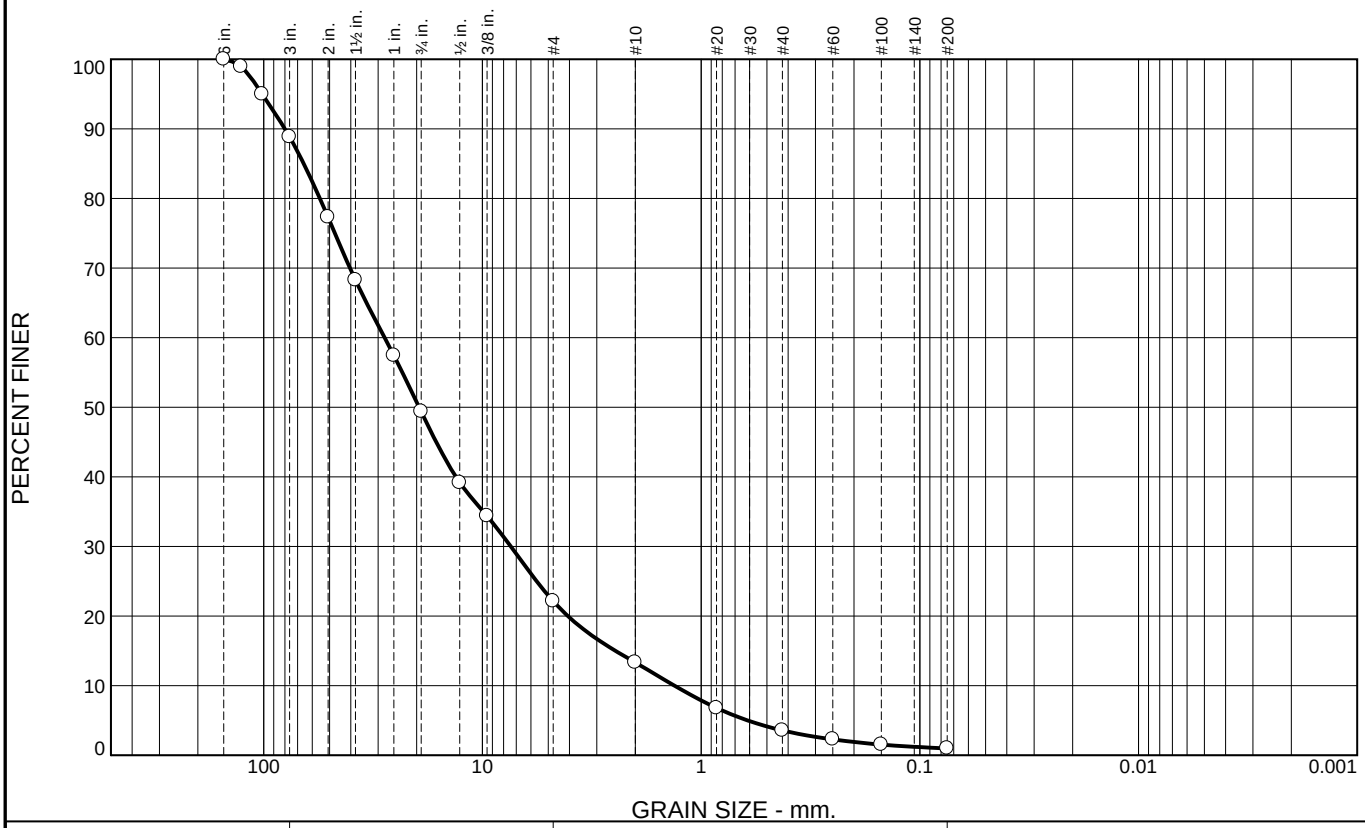
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
11	40	27	9	9	3	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6	100		
5	99		
4	95		
3	89		
2	77		
1.5	68		
1	57		
.75	49		
.5	39		
.375	34		
#4	22		
#10	13		
#20	7		
#40	4		
#60	2		
#100	2		
#200	1.0		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 80.0830 D_{85}= 65.6479 D_{60}= 28.0031
D_{50}= 19.4717 D_{30}= 7.4175 D_{15}= 2.4611
D_{10}= 1.3225 C_u= 21.17 C_c= 1.49

Classification

USCS= GW AASHTO=

Remarks

Location: TP-BULK-03
Sample Number: 12698 **Depth:** 5-5.5' **Date:** 8-20-12

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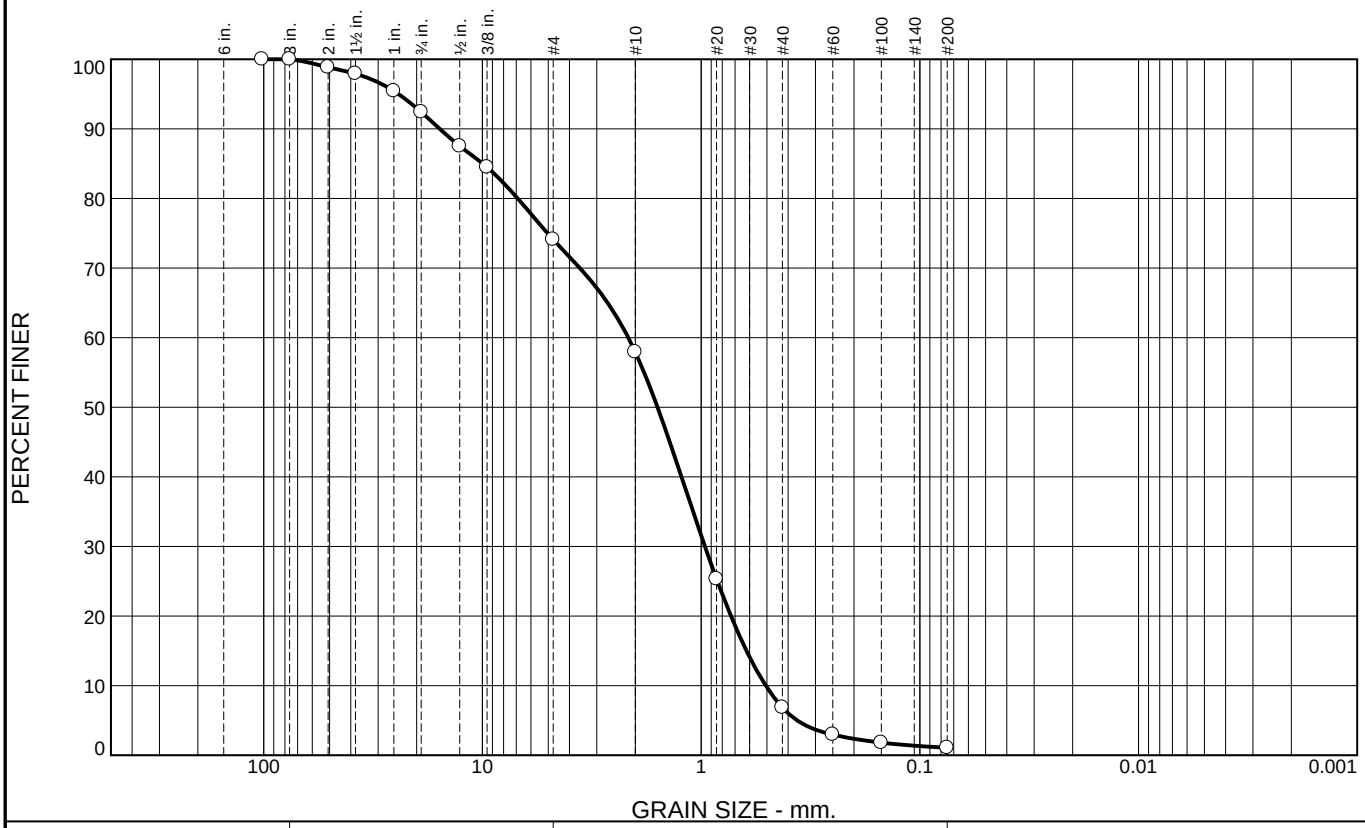
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	8	18	16	51	6	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	100		
2	99		
1.5	98		
1	95		
.75	92		
.5	88		
.375	84		
#4	74		
#10	58		
#20	25		
#40	7		
#60	3		
#100	2		
#200	1.1		

* (no specification provided)

Material Description

Poorly graded sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 15.6697 D_{85}= 9.9576 D_{60}= 2.1527
D_{50}= 1.5826 D_{30}= 0.9605 D_{15}= 0.6199
D_{10}= 0.5062 C_u= 4.25 C_c= 0.85

Classification

USCS= SP AASHTO=

Remarks

Location: TP-Bulk-04
Sample Number: 13038 **Depth:** 2.5-3.5' **Date:**

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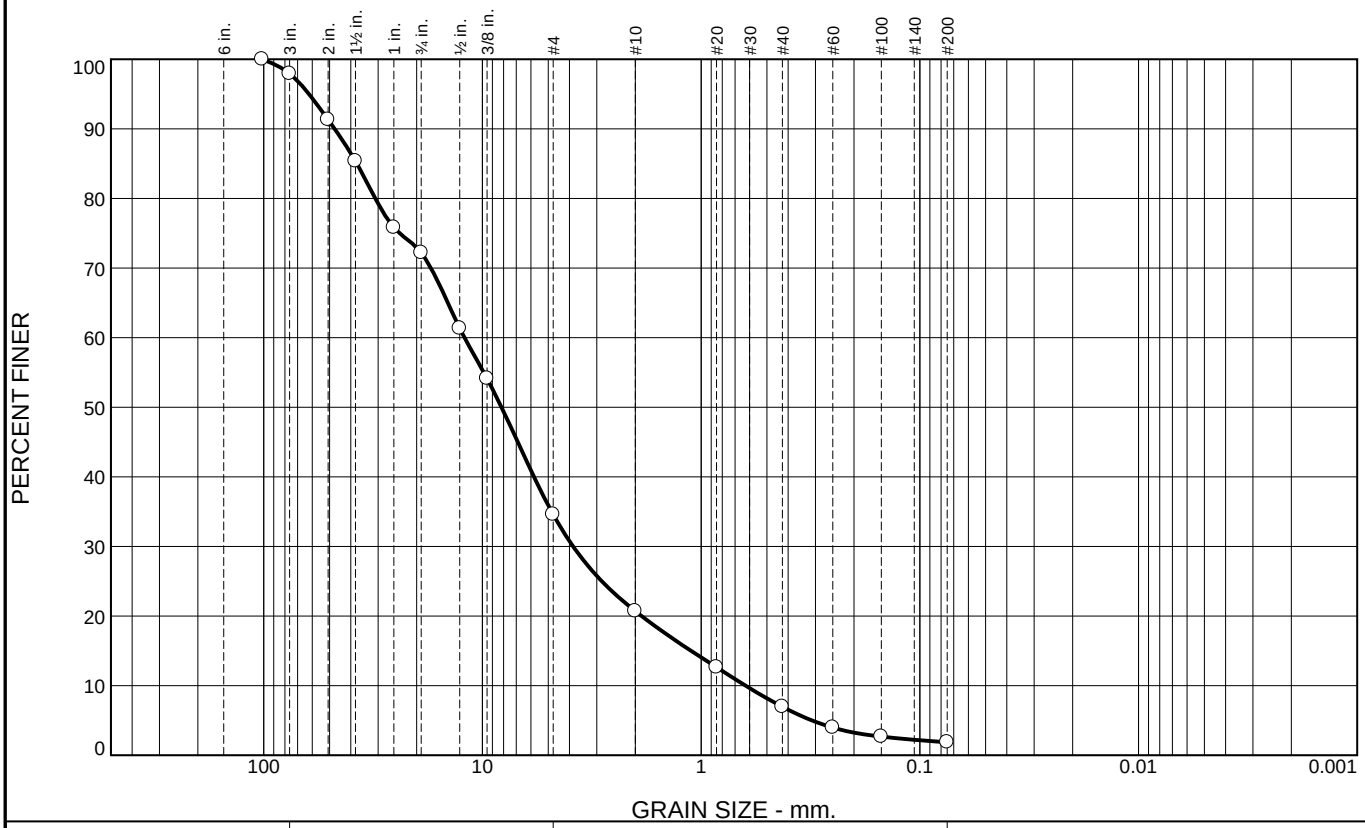
Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
2	26	37	14	14	5	2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	98		
2	91		
1.5	85		
1	76		
.75	72		
.5	61		
.375	54		
#4	35		
#10	21		
#20	13		
#40	7		
#60	4		
#100	3		
#200	1.9		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 47.3989 D_{85}= 37.5199 D_{60}= 12.0774
D_{50}= 8.1802 D_{30}= 3.8477 D_{15}= 1.1100
D_{10}= 0.6252 C_u= 19.32 C_c= 1.96

Classification

USCS= GW AASHTO=

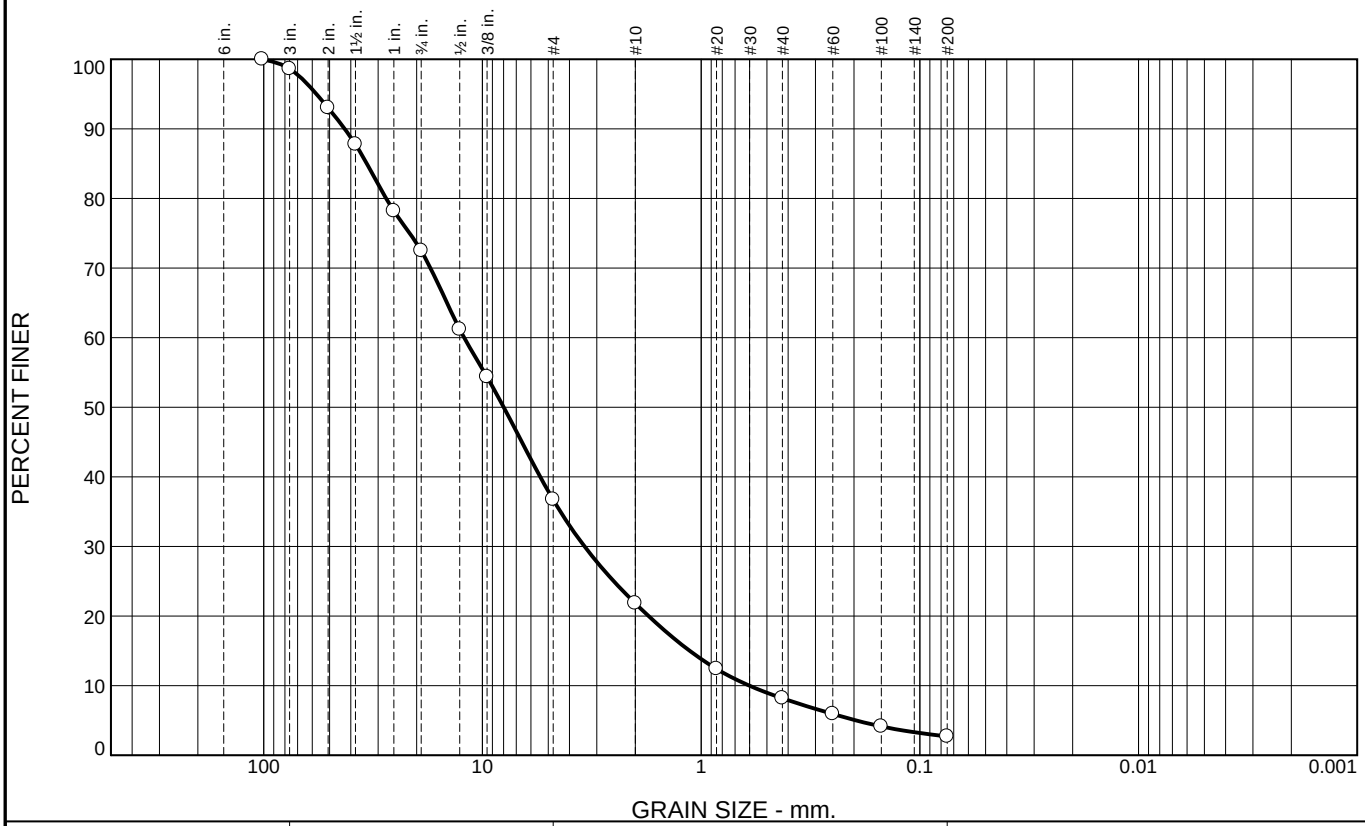
Remarks

Location: TP-Bulk-05
Sample Number: 13042 **Depth:** 5-6' **Date:** 9-10-12

Pioneer Technical Services, Inc.
1215 Apple's Way - Belgrade, MT 59714
Ph. 406-388-8578 - Fax 406-388-8579

Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
1	27	35	15	14	5	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	99		
2	93		
1.5	88		
1	78		
.75	72		
.5	61		
.375	54		
#4	37		
#10	22		
#20	12		
#40	8		
#60	6		
#100	4		
#200	2.7		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 42.6168 D_{85}= 33.7938 D_{60}= 12.1226
D_{50}= 7.9895 D_{30}= 3.4125 D_{15}= 1.1268
D_{10}= 0.6011 C_u= 20.17 C_c= 1.60

Classification

USCS= GW AASHTO=

Remarks

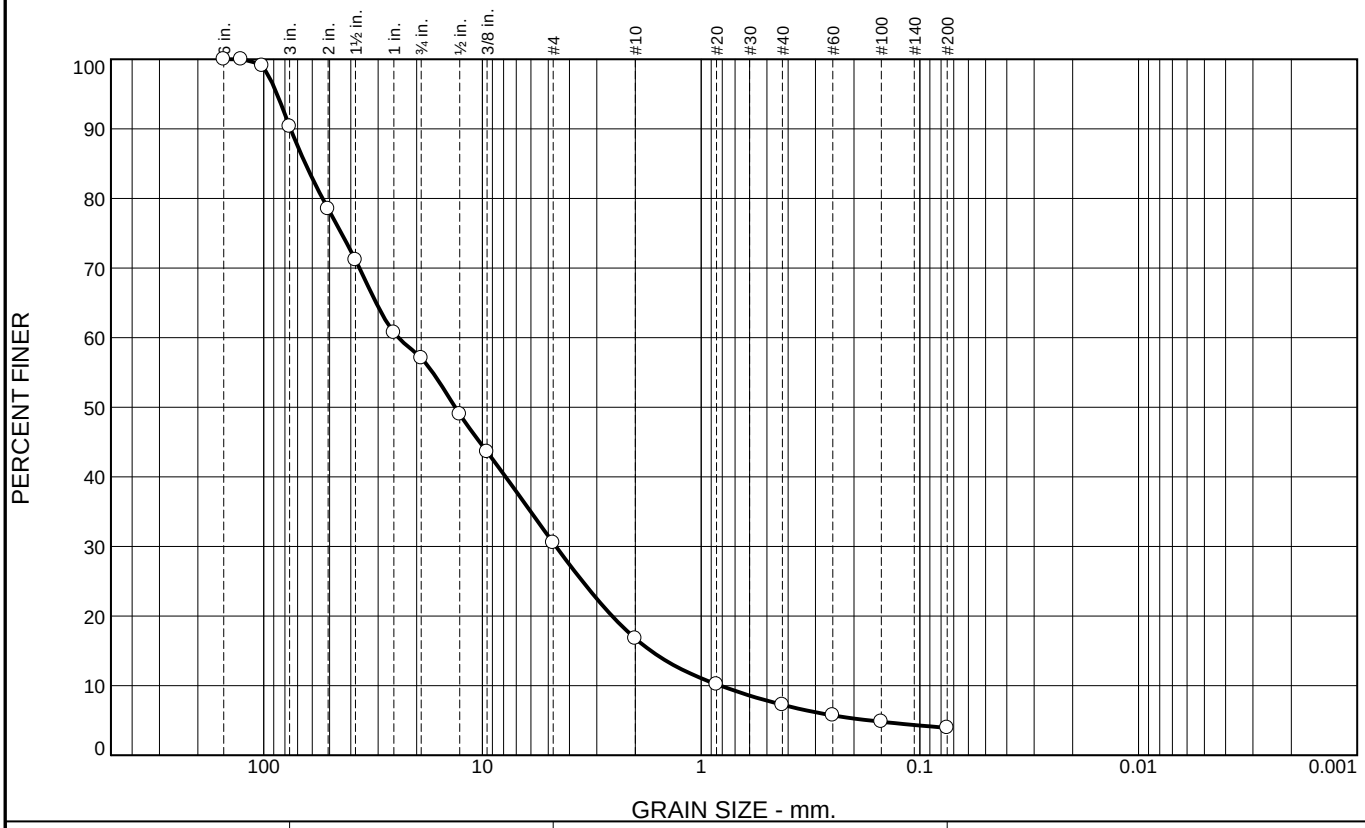
May not be representative due to sample size

Location: TP-Bulk-05
Sample Number: 13043 **Depth:** 1-2' **Date:** 9-5-12

Pioneer Technical Services, Inc.
1215 Apple's Way - Belgrade, MT 59714
Ph. 406-388-8578 - Fax 406-388-8579

Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
10	33	26	14	10	3	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6	100		
5	100		
4	99		
3	90		
2	79		
1.5	71		
1	61		
.75	57		
.5	49		
.375	44		
#4	31		
#10	17		
#20	10		
#40	7		
#60	6		
#100	5		
#200	3.9		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 75.4406 D_{85}= 64.5031 D_{60}= 24.2555
D_{50}= 13.3228 D_{30}= 4.6095 D_{15}= 1.6942
D_{10}= 0.8156 C_u= 29.74 C_c= 1.07

Classification

USCS= GW AASHTO=

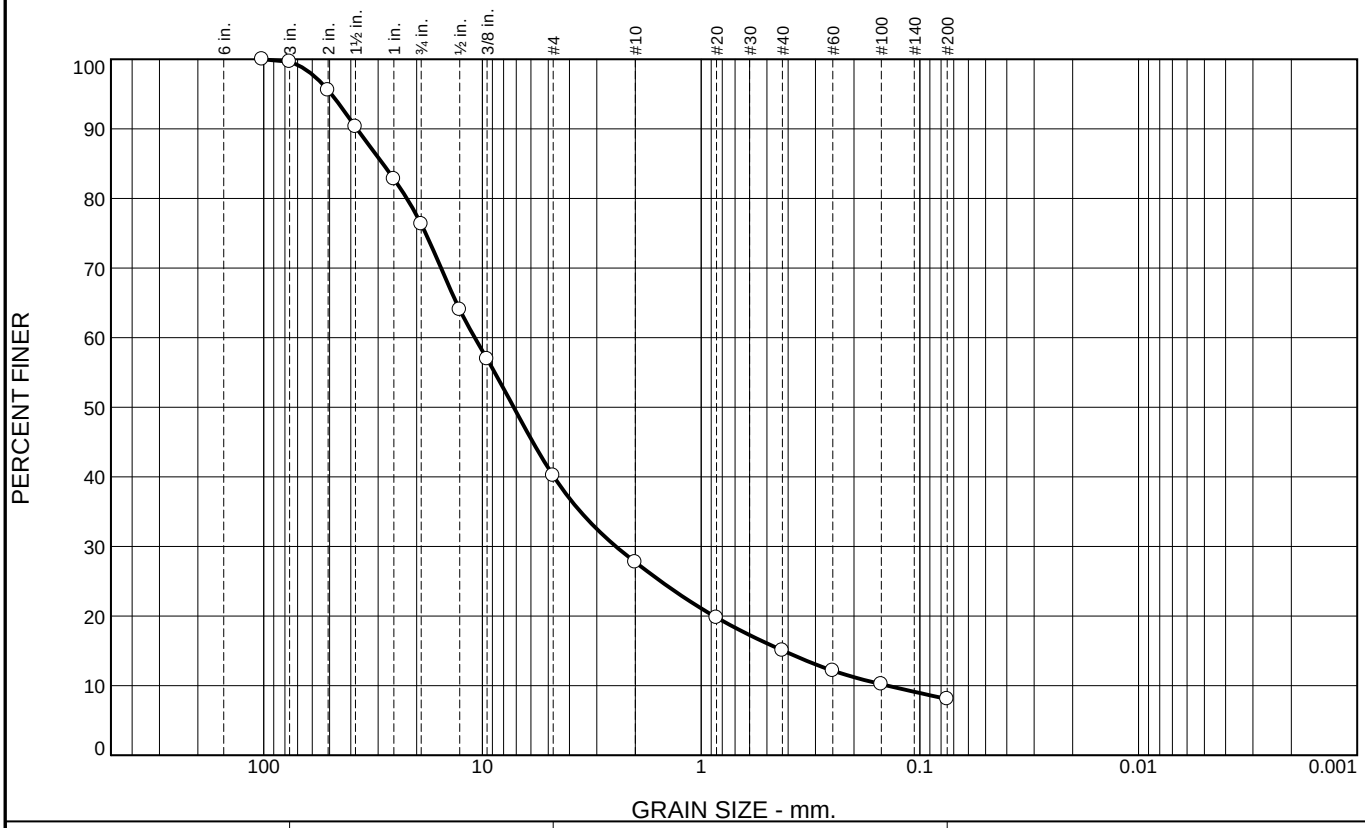
Remarks

Location: TP-Bulk-06
Sample Number: 13085 **Depth:** 3-4' **Date:** 9-7-12

Pioneer Technical Services, Inc.
1215 Apple's Way - Belgrade, MT 59714
Ph. 406-388-8578 - Fax 406-388-8579

Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	24	36	12	13	7	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	100		
2	96		
1.5	90		
1	83		
.75	76		
.5	64		
.375	57		
#4	40		
#10	28		
#20	20		
#40	15		
#60	12		
#100	10		
#200	8.1		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 37.4981 D_{85}= 28.5408 D_{60}= 10.8452
D_{50}= 7.1956 D_{30}= 2.4511 D_{15}= 0.4194
D_{10}= 0.1403 C_u= 77.32 C_c= 3.95

Classification

USCS= AASHTO=

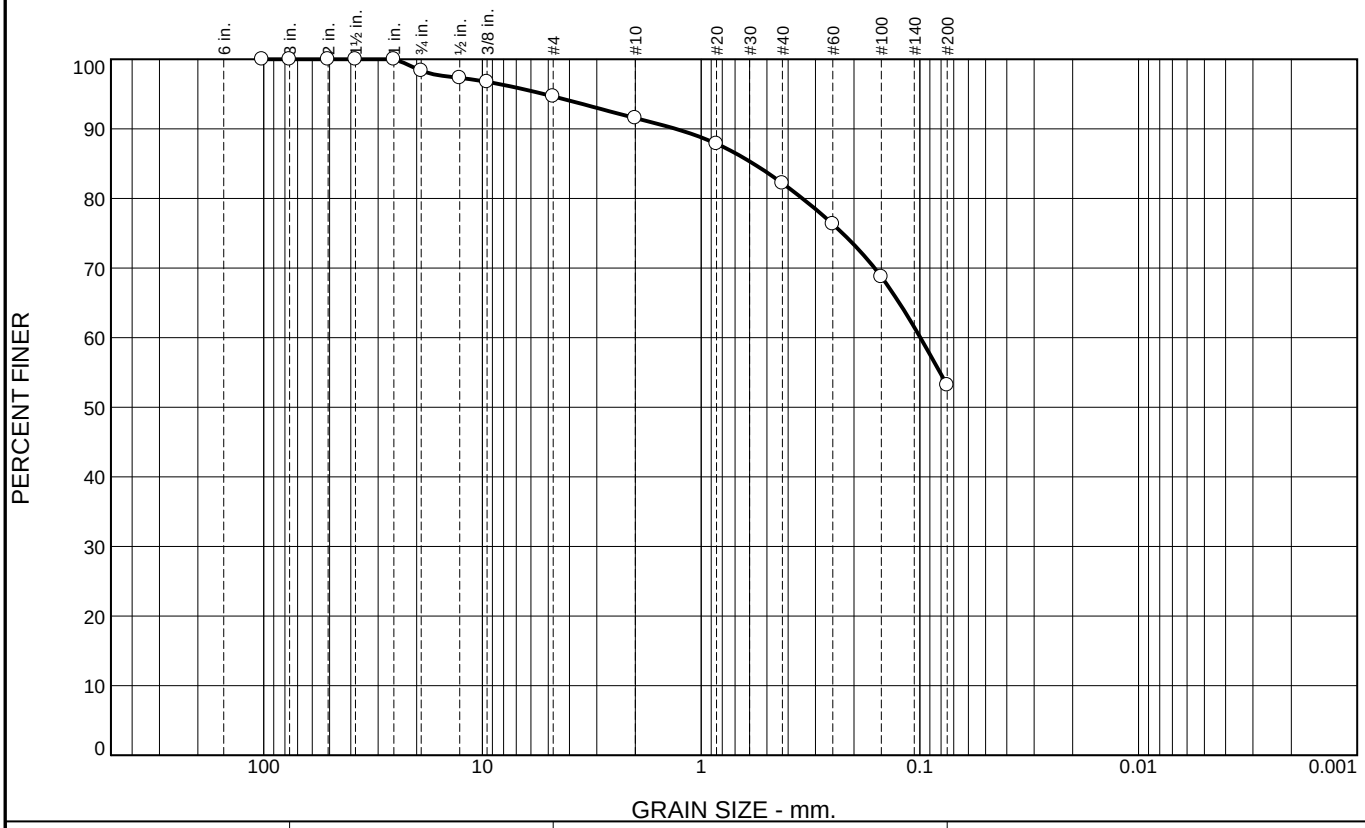
Remarks

Location: TP-Bulk-07
Sample Number: 13096 **Depth:** 2-3' **Date:** 9-4-12

Pioneer Technical Services, Inc.
1215 Apple's Way - Belgrade, MT 59714
Ph. 406-388-8578 - Fax 406-388-8579

Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	3	3	10	29	53	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100		
3	100		
2	100		
1.5	100		
1	100		
.75	98		
.5	97		
.375	97		
#4	95		
#10	92		
#20	88		
#40	82		
#60	76		
#100	69		
#200	53		

* (no specification provided)

Material Description

sandy silt

Atterberg Limits

PL= 26 LL= 38 PI= 12

Coefficients

D_{90}= 1.3079 D_{85}= 0.5766 D_{60}= 0.0994
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-6(4)

Remarks

Location: TP-Bulk-07
Sample Number: 13097 **Depth:** 0.5-1.0' **Date:** 9-13-12

Pioneer Technical Services, Inc.
1215 Apple's Way - Belgrade, MT 59714
Ph. 406-388-8578 - Fax 406-388-8579

Client: Pioneer Technical Services
Project: Mike Horse Floodplain Sampling
Project No: 15313C **Figure**

Sample Preparation

Prior to analysis, the material should be dry and well homogenized. Ideally, the entire sample should be dried to constant weight, sifted to remove gravel and debris, and ground or milled to a fine powder. Dry the sample if it is moist and cohesive. The sample can be dried in any of several ways. Choose one of the following:

- Oven dry the sample for approximately 2 hours at 150° C, until the sample reaches a constant weight. Note: Oven drying is inappropriate when volatile compounds may be present in the sample. For example, lead present as tetraethyl lead would be driven off by the heat of drying. Some forms of mercury and arsenic are volatile. Air drying will preserve more of these volatile substances.
- Air dry the sample overnight at room temperature in a shallow pan.
- Stir gently and warm the sample in a pan over a hot plate or burner.

Coning and Quartering

You may need to divide your sample at various times during preparation. Coning and quartering is a method for dividing the sample into homogenous quarters.

- Pour the dry material slowly and carefully onto a flat sheet or pan, forming a symmetrical cone. Divide the cone into equal piles using a flat thin-bladed tool, such as a knife or ruler. Divide these in half again.
- Now you have four samples, each one-quarter the size of the original and each more homogenous than the original.
- Grind the sample to break up dirt clods and/or paint chips.

WARNING Grinding and sifting dried samples produces dust. Even clean soil contains silica, which may be hazardous when airborne. Prepare all samples in a ventilated area; wear a mask, gloves, and an apron; and spread a drop cloth.

Sift using the #10 (2mm) mesh and separate out the larger pieces (stones, organic matter, metallic objects, etc. Examine the larger particles by eye but do not include in the sample. Grind the sample again so its particles will be finer and more homogenous. Use mortar and pestle, or an electrically powered grinding mill. Sift at least 10 grams of the sample through #60 (250 ?m) and #120 (125 ?m) mesh. Re-grind the un-passed material until the entire fraction is able to pass. Mix the resulting sample.

Placing the Sample in an XRF Sample Cup

Note The sample container should be a sample cup of a type that can be filled from the rear; that is, the side opposite the window (e.g. Thermo NITON Part Number 187-466). Thermo recommends using a 1/4 mil Polypropylene film (e.g. Thermo NITON Part Number 187-461). A supply of cups and films are included.

The container used to hold the sample will affect the accuracy of the measurement. Use a container with as thin-walled a window as is convenient and use the same kind of container and window for each sample. Consistency and careful attention to detail are keys to accurate measurement.

PLACE FILM

Place a circle of polypropylene film on top of an XRF sample cup. This film goes on the end of the cup with the indented ring. Thermo recommends preparing the cup ahead of time, if possible.

SECURE FILM

Secure the film with the collar. The flange inside the collar faces down and snaps into the indented ring of the cup. Inspect the installed film window for continuity and smooth, taut appearance.

FILL CUP

Set the cup on a flat surface film-window-side down. Fill it with at least five grams of the prepared sample, making sure that no voids or uneven layers.

TAMP SAMPLE

Lightly tamp the sample into the cup. The end of the pestle makes a convenient tamper.

PLACE FILTER

Place a filter-paper disk on the sample after tamping it.

STUFF CUP

Fill the rest of the cup with polyester fiber stuffing to prevent sample movement. Use aquarium filter or pillow filling as stuffing. A small supply of stuffing comes with your bulk sample kit.

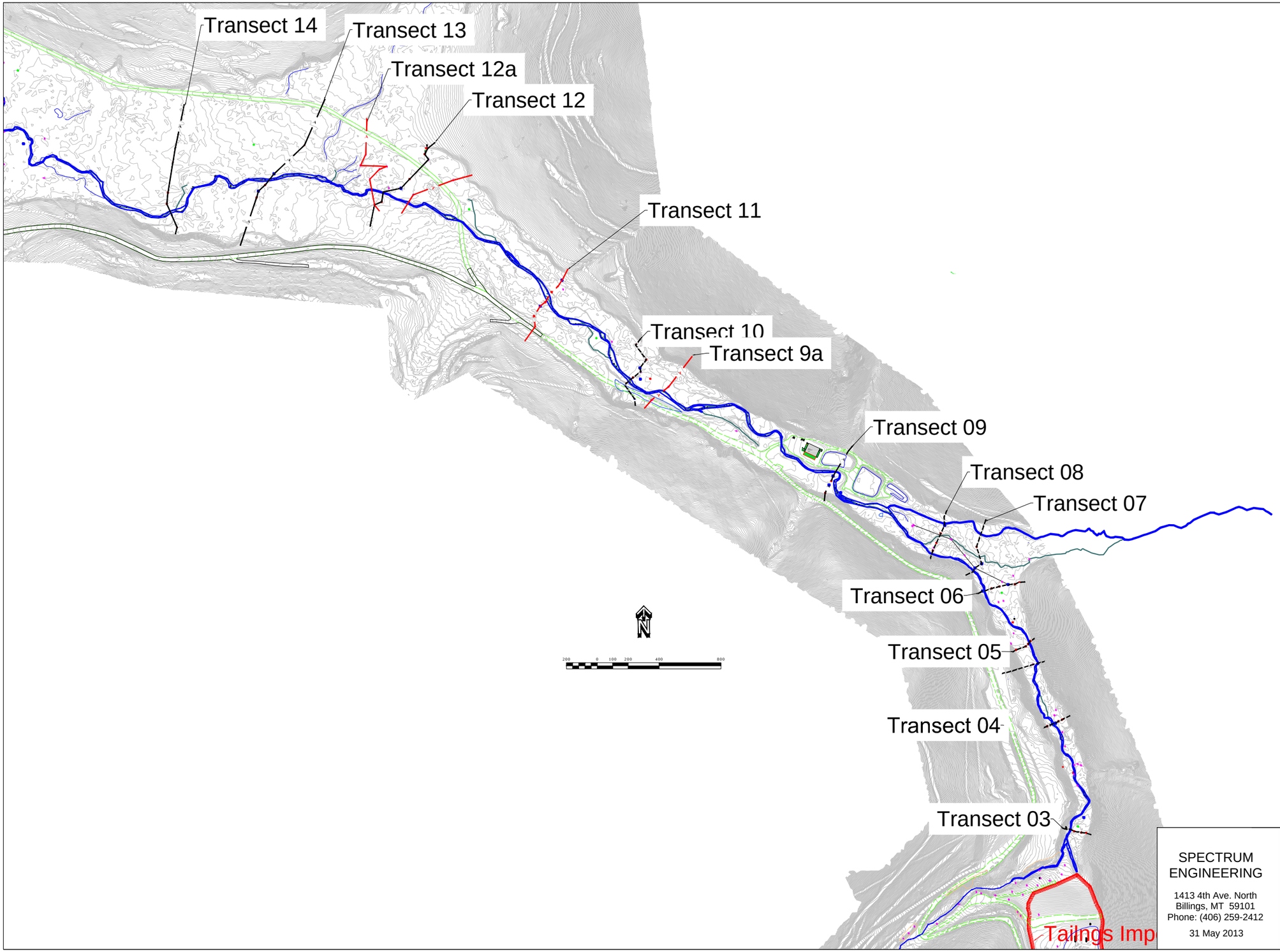
CAP CUP

Place a cap on your cup.

LABEL CUP

Place a label on teh cup. Using a pen with indelible ink, write identifying information on the cup. Keep a record of the sample designation, the site and location, the date of the sample, and any other relevant comments.

Cup is ready for testing.



SPECTRUM ENGINEERING

1413 4th Ave. North
Billings, MT 59101
Phone: (406) 259-2412

31 May 2013

Montana DEQ
Upper Blackfoot mining Complex

Transect Locations

C:\Projects\Mike Horse\Flood Plain Sampling\2012 Flood Plain Data Sampling Report\Excel & Word Files For Report\Map 2012 Test Pits As Built DSR Revised May 2013.dwg

Test Pit Name TP-FP-30		3D Model Representation
	Contaminated with tailings or mine waste	
	Undisturbed with high metal <1,000 mg/kg Pb or Zn	
	Undisturbed	

Groundwater (all samples for this project were taken on Nov 7, 2012)

EOT = Edge Of Tailings contaminated floodplain

Undisturbed is defined to mean that the ground appeared undisturbed by human activity

Undisturbed with high metal is defined to mean that the ground does not appear to have been disturbed by humans or the 1975 flood event, but contains more than 1,000 mg/kg lead or zinc in the -10 mesh portion of the sample.

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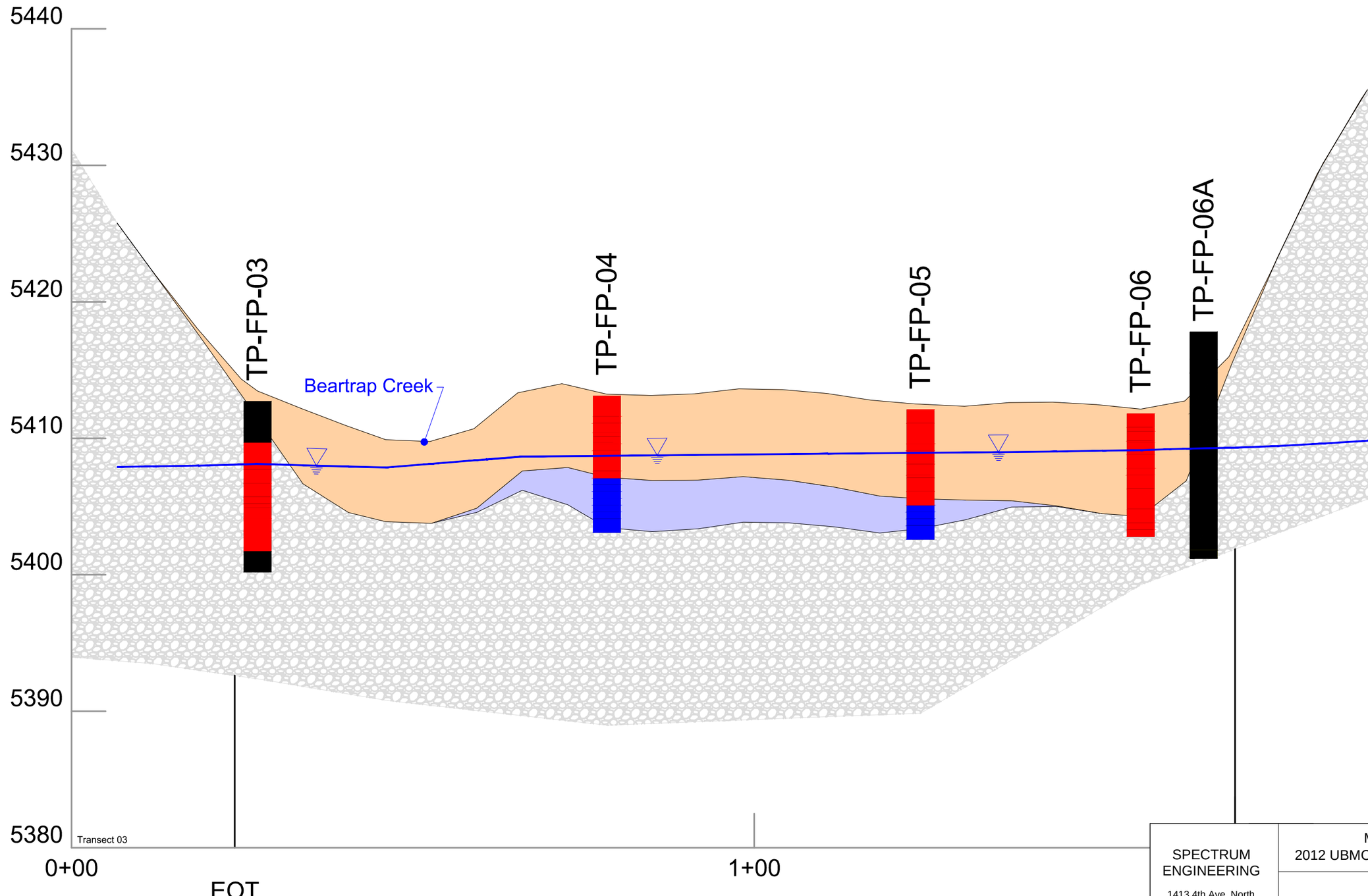
Phone: (406) 259-2412
31 May 2013

Montana DEQ
2012 UBMC Floodplain Investigation

LEGEND

C:\Projects\Mike Horse\Flood Plain Sampling\2012 Flood Plain Data Sampling Report\Excel & Word Files For Report\Map 2012 Test Pits As Built DSR Revised May 2013.dwg



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Phone: (406) 259-2412

31 May 2013

Montana DEQ
2012 UBMC Floodplain Investigation

Transect 3
Vertical Exaggeration 2x

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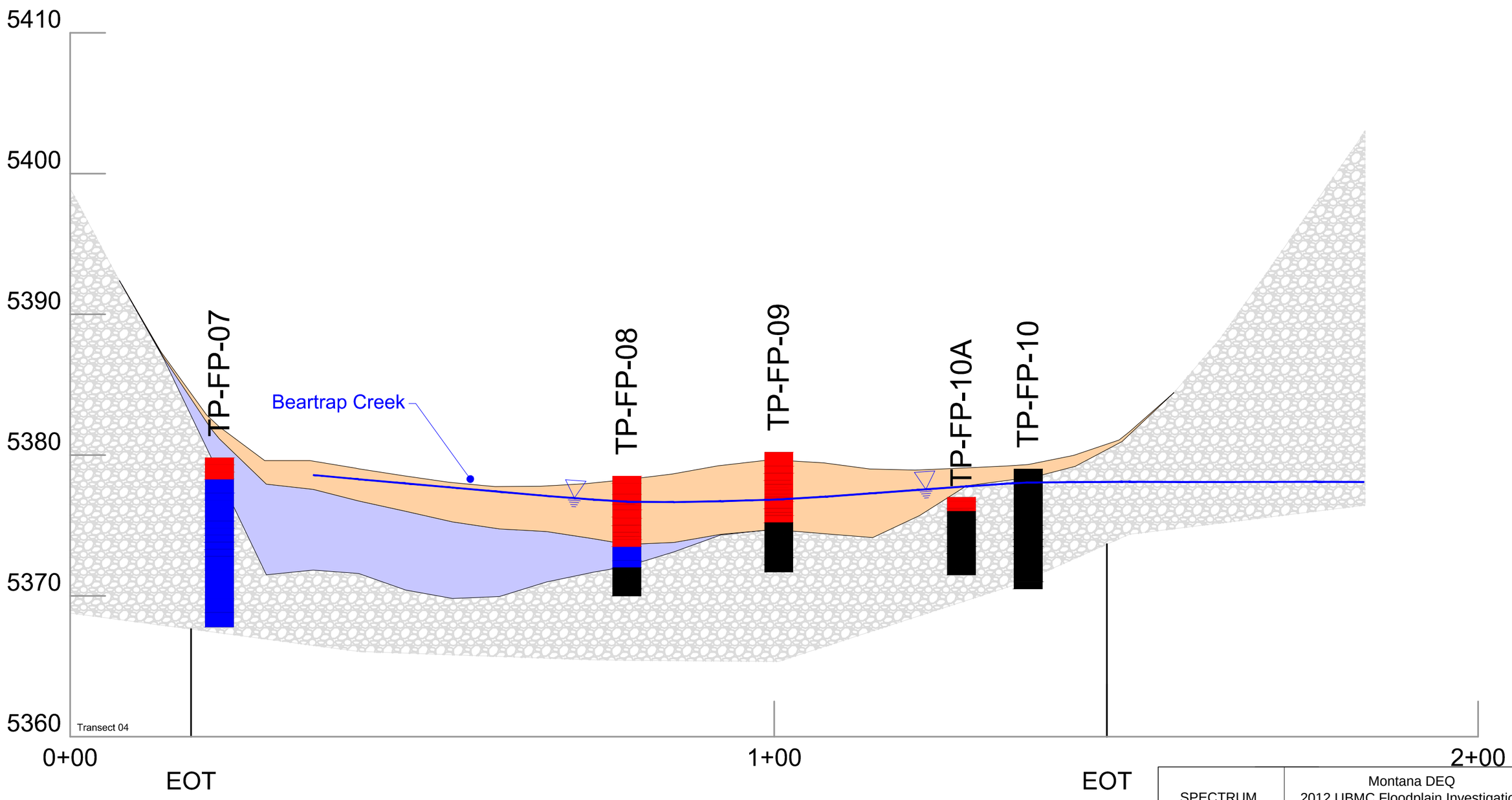

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Billings, MT 59101
Phone: (406) 259-2412

31 May 2013

Montana DEQ
2012 UBMC Floodplain Investigation

Transect 4
Vertical Exaggeration 2x

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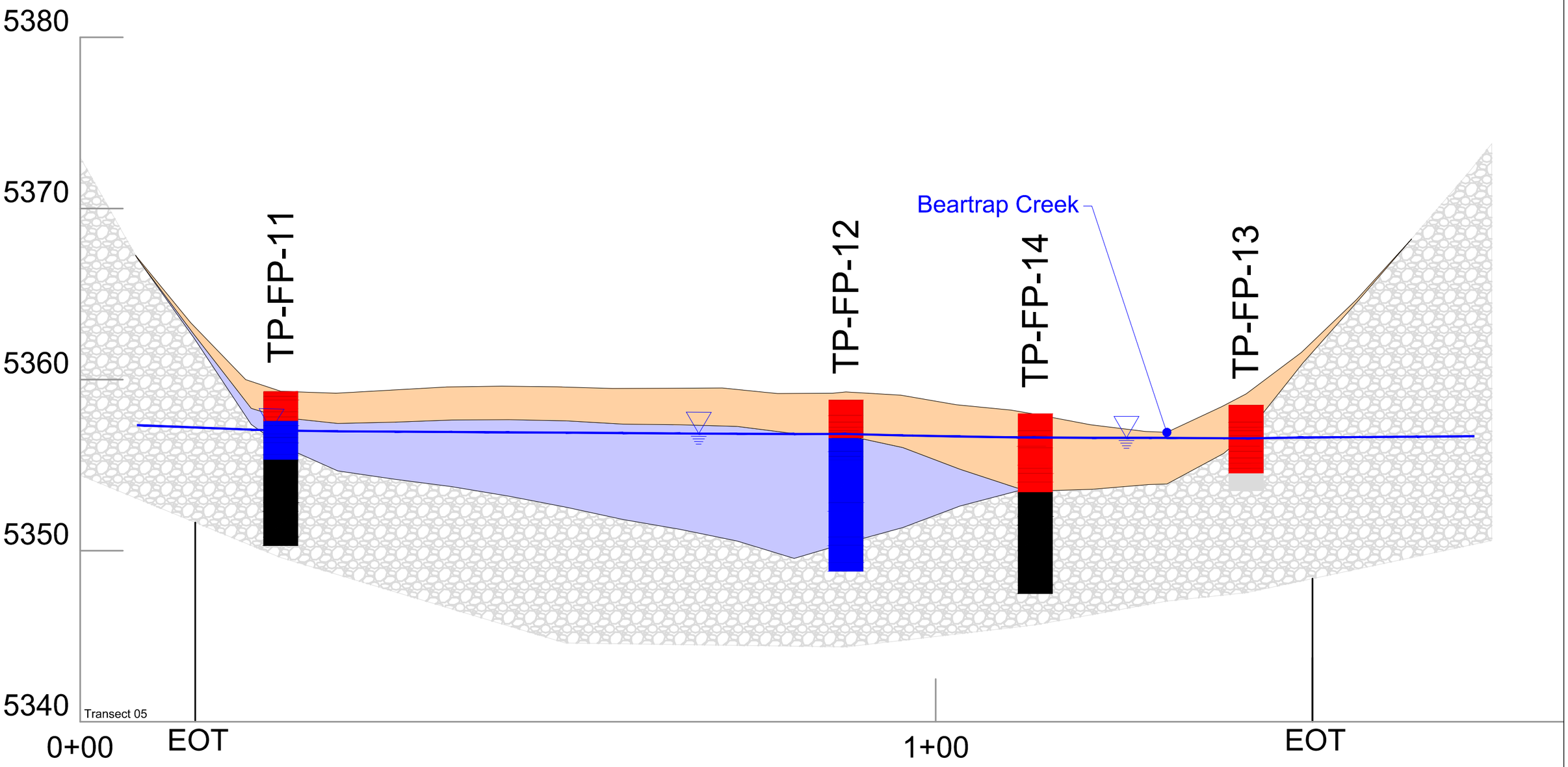
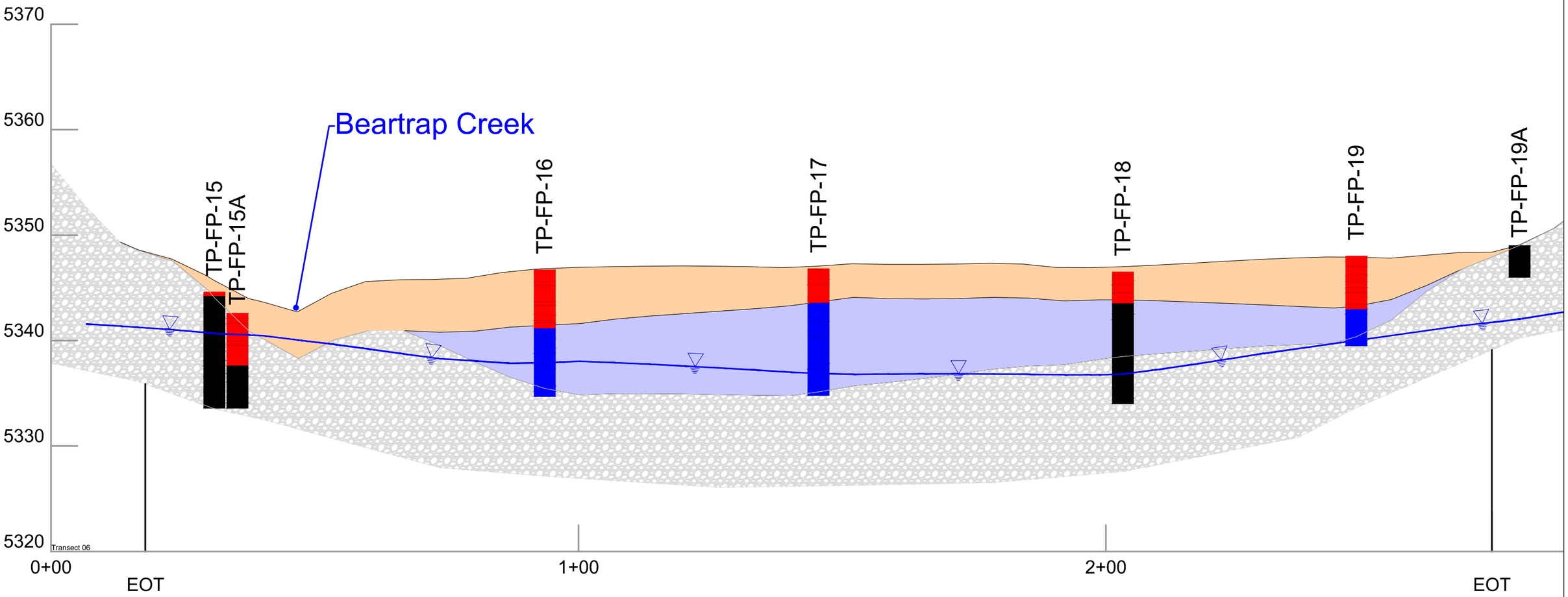


SPECTRUM ENGINEERING 1413 4th Ave. North Billings, MT 59101 Phone: (406) 259-2412 31 May 2013	Montana DEQ 2012 UBMC Floodplain Investigation Transect 5 Vertical Exaggeration 2x C:\Projects\Mike Horse\Flood Plain Sampling\2012 Flood Plain Data Sampling Report\Excel & Word Files For Report\Map 2012 Test Pits As Built DSR Revised May 2013.dwg



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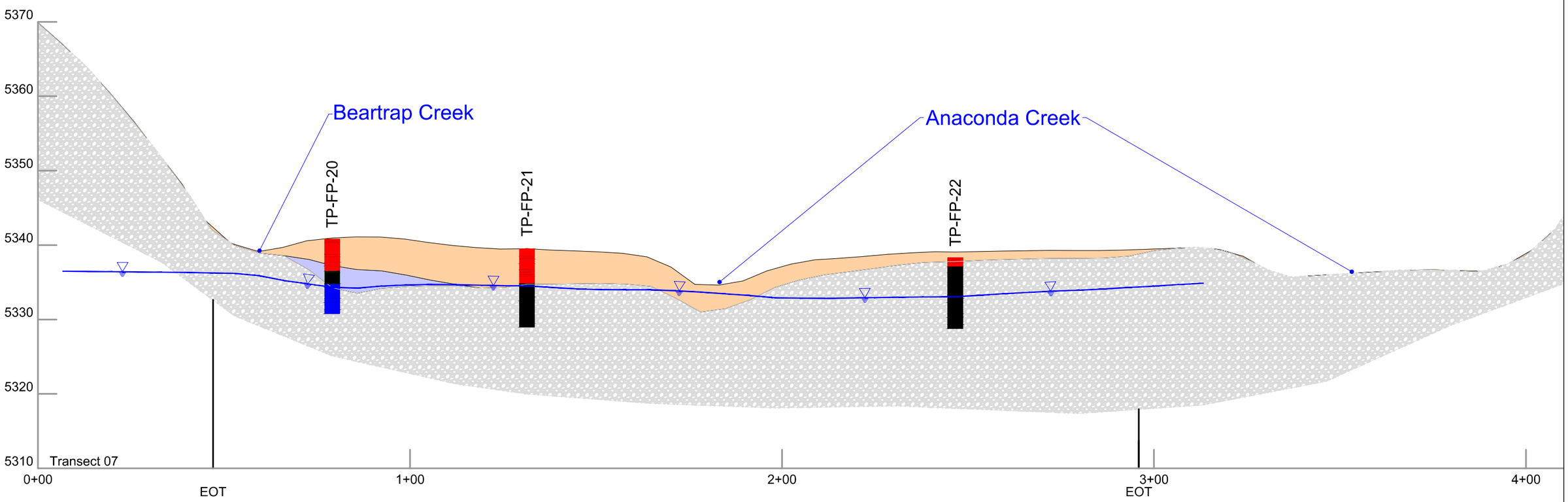

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Billings, MT 59101
Phone: (406) 259-2412

31 May 2013

Montana DEQ
2012 UBMC Floodplain Investigation

Transect 7
Vertical Exaggeration 2x

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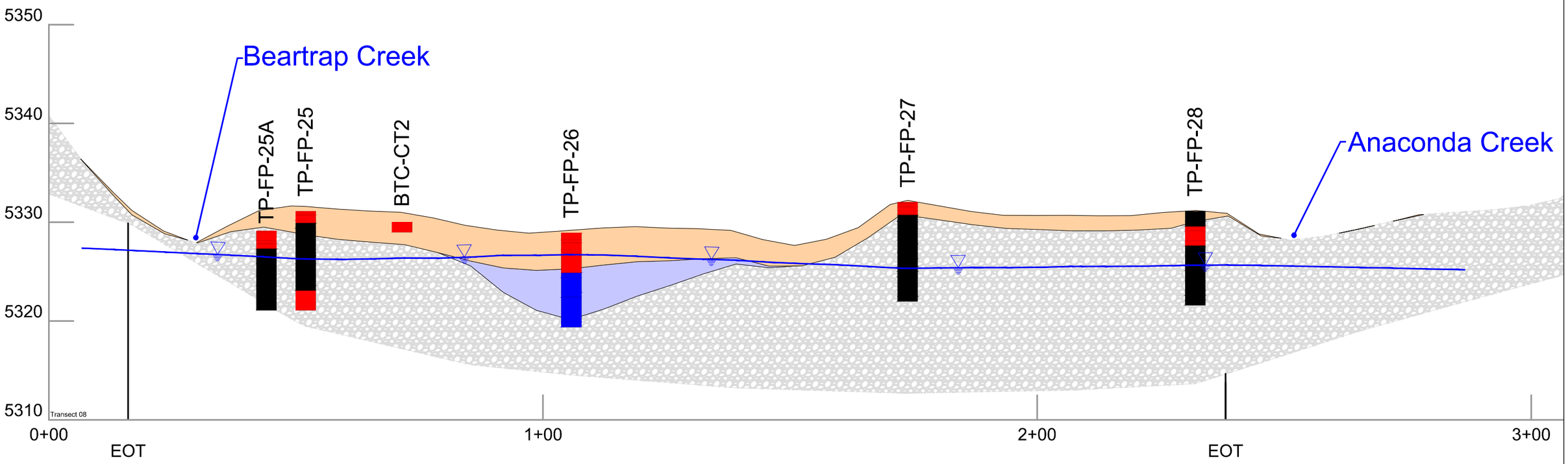

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31 May 2013

Montana DEQ
2012 UBMC Floodplain Investigation

Transect 8
Vertical Exaggeration 2x

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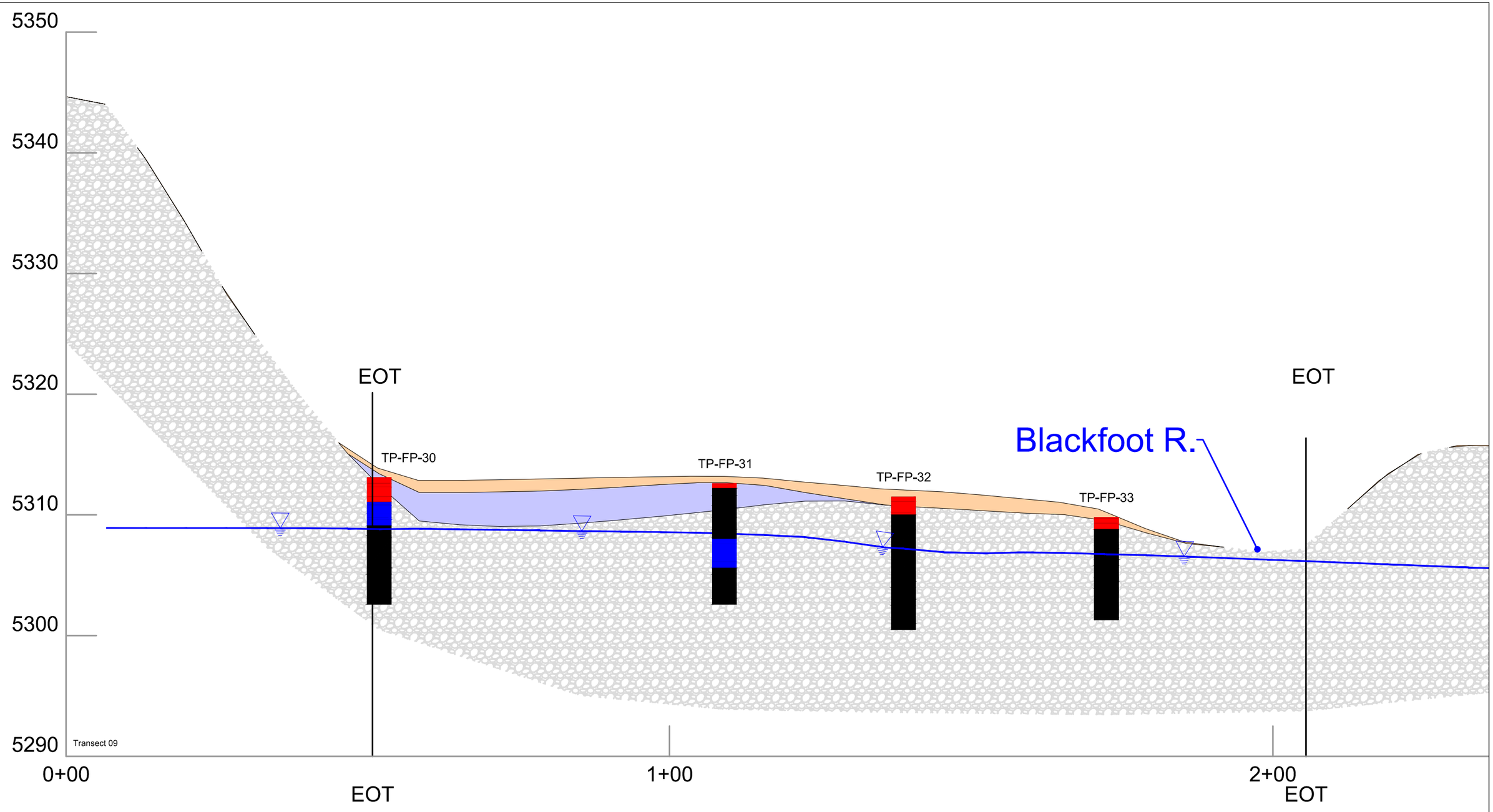
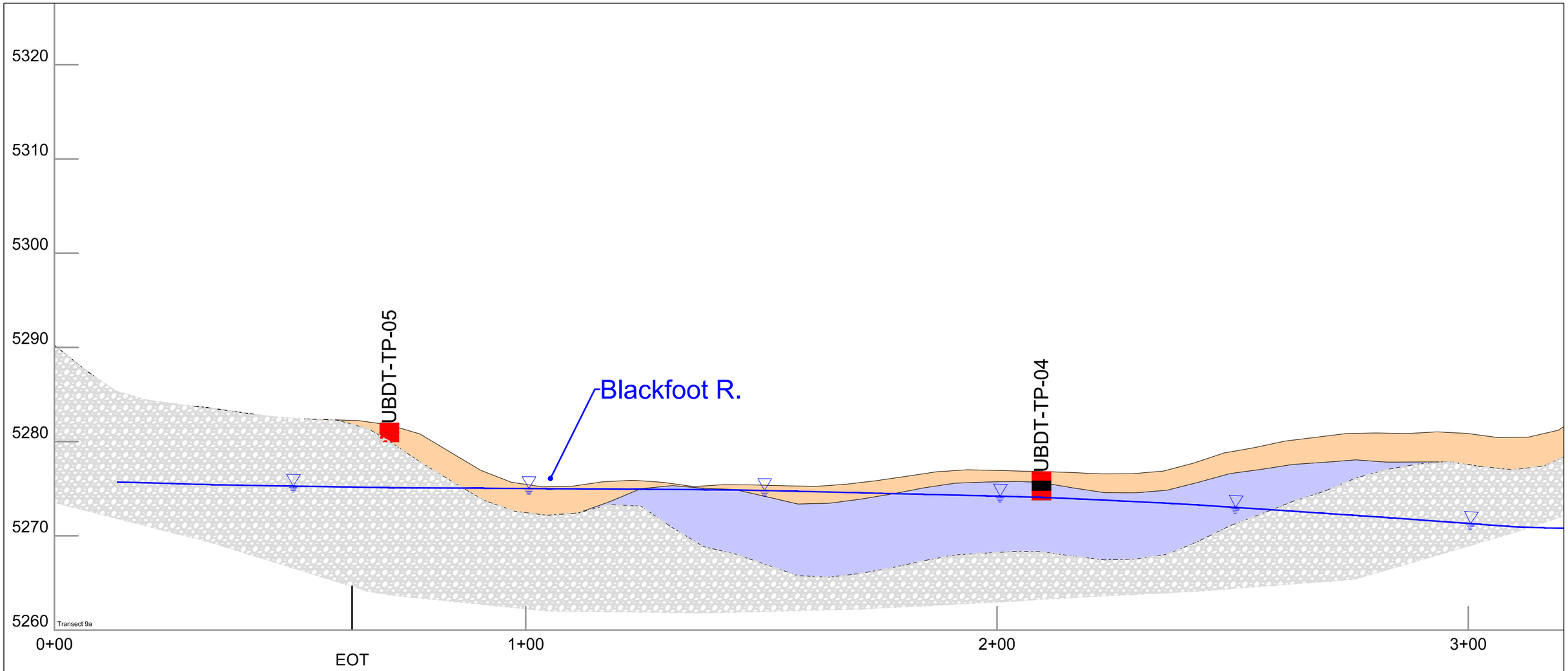


SPECTRUM ENGINEERING 1413 4th Ave. North Billings, MT 59101 Phone: (406) 259-2412 31 May 2013	Montana DEQ 2012 UBMC Floodplain Investigation Transect 9 Vertical Exaggeration 2x C:\Projects\Mike Horse\Flood Plain Sampling\2012 Flood Plain Data Sampling Report\Excel & Word Files For Report\Map 2012 Test Pits As Built DSR Revised May 2013.dwg



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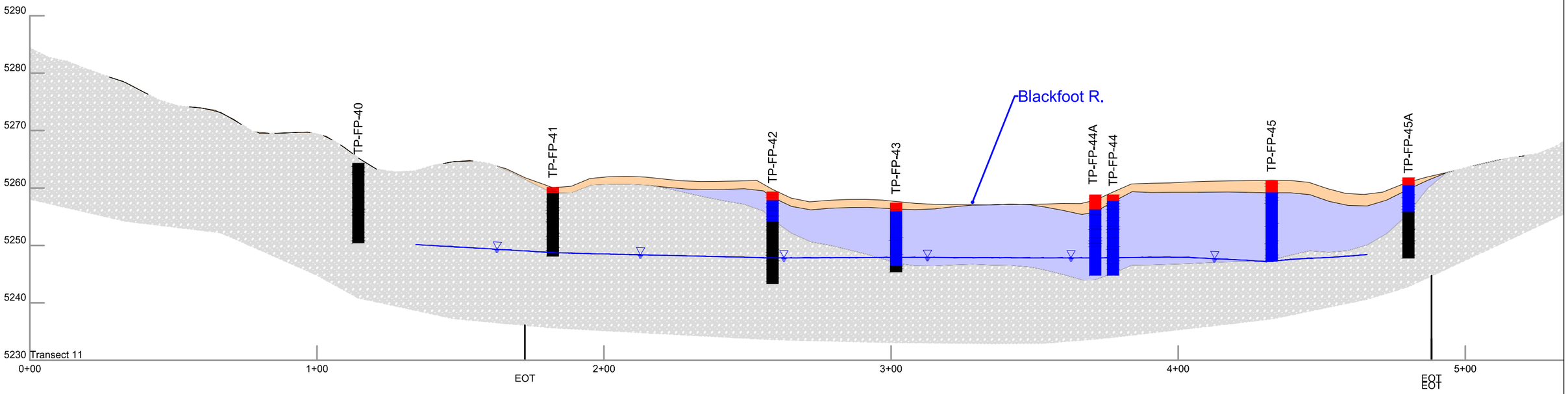

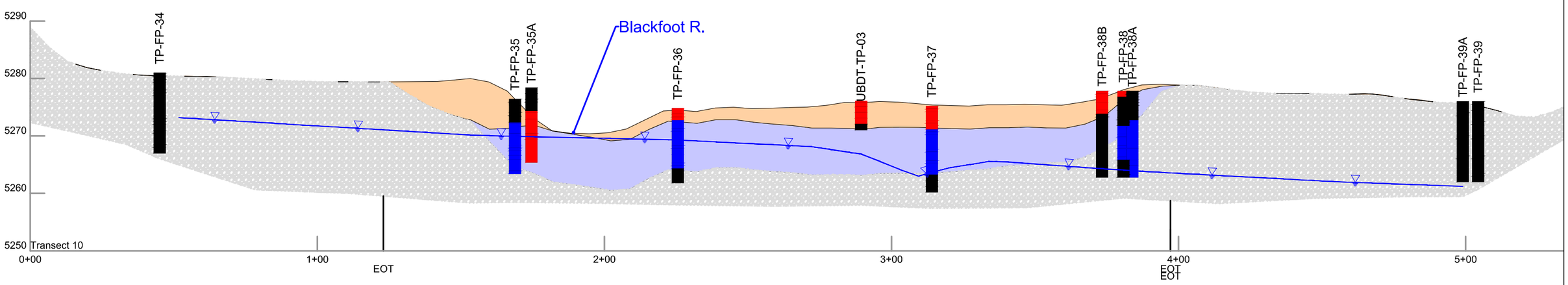

SPECTRUM ENGINEERING

1413 4th Ave. North
Billings, MT 59101
Phone: (406) 259-2412

31 May 2013

Montana DEQ
2012 UBMC Floodplain Investigation

Transect 10 & 11
Vertical Exaggeration 2x

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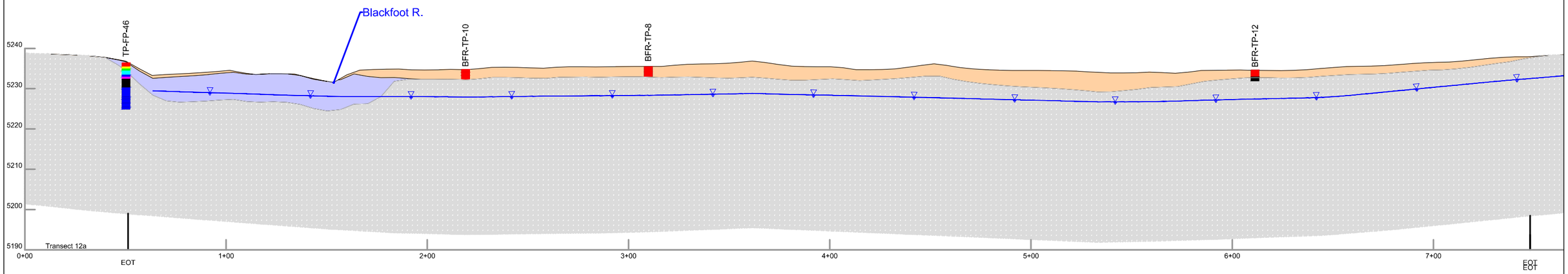

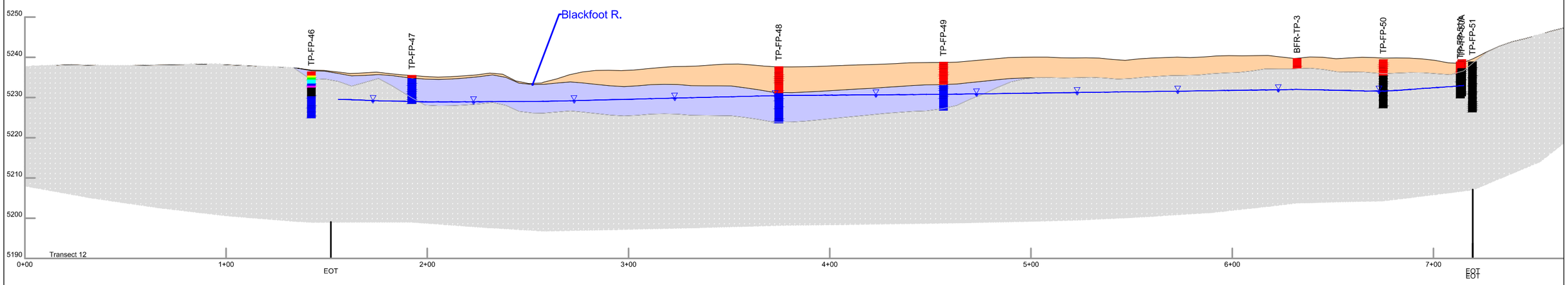

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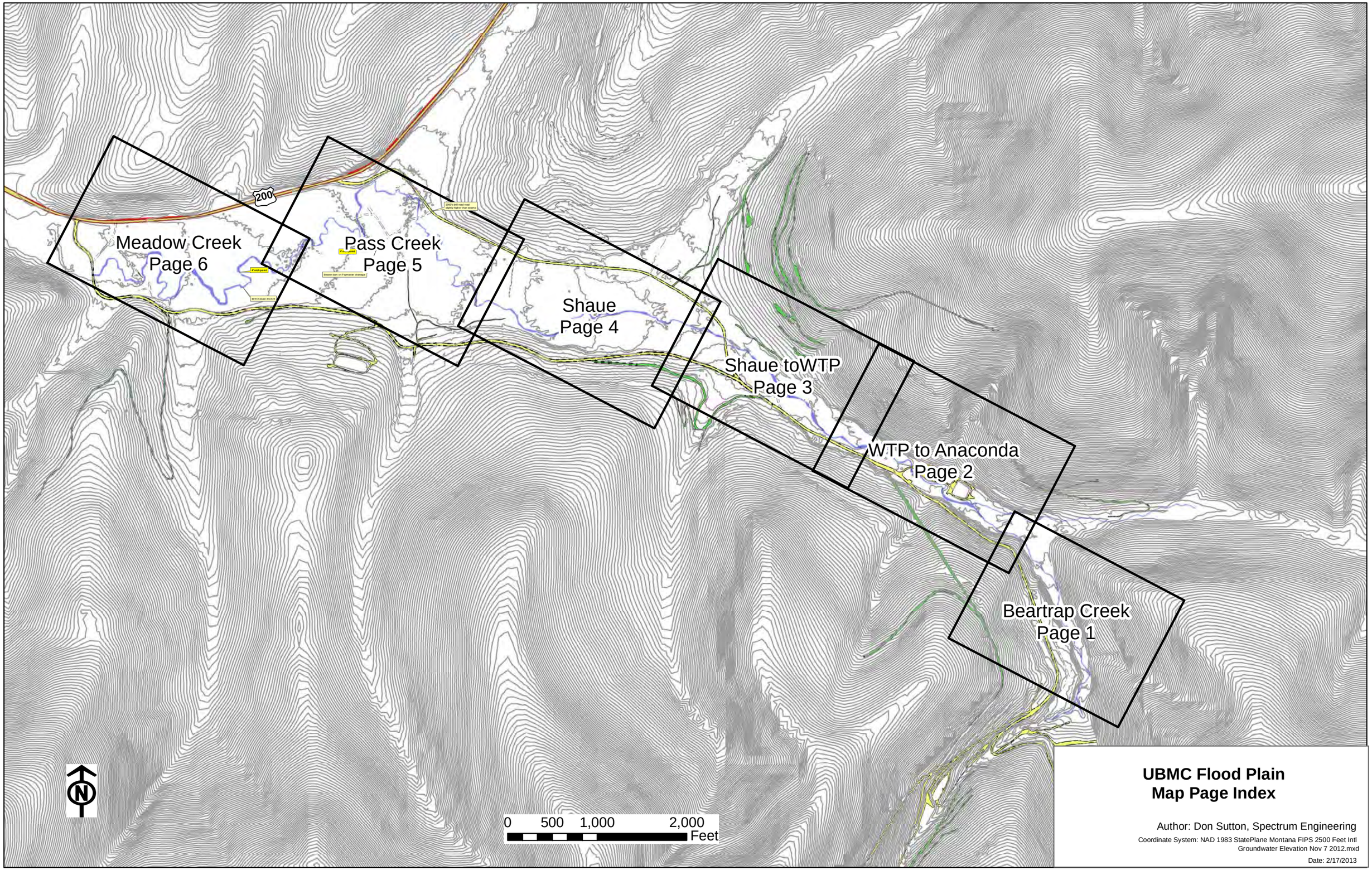
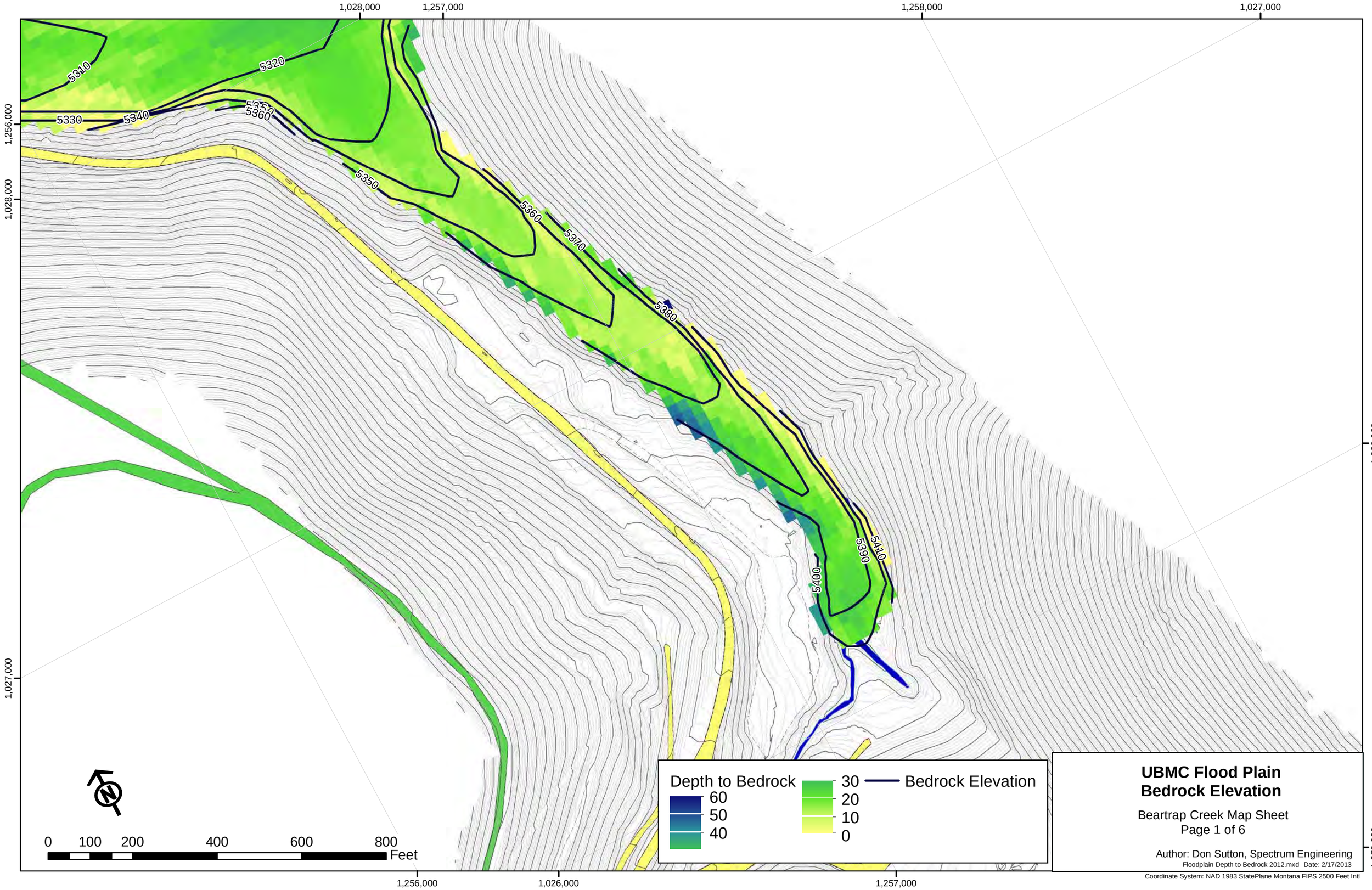


UBMC Flood Plain
Map Page Index

Author: Don Sutton, Spectrum Engineering

Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl
Groundwater Elevation Nov 7 2012.mxd

Date: 2/17/2013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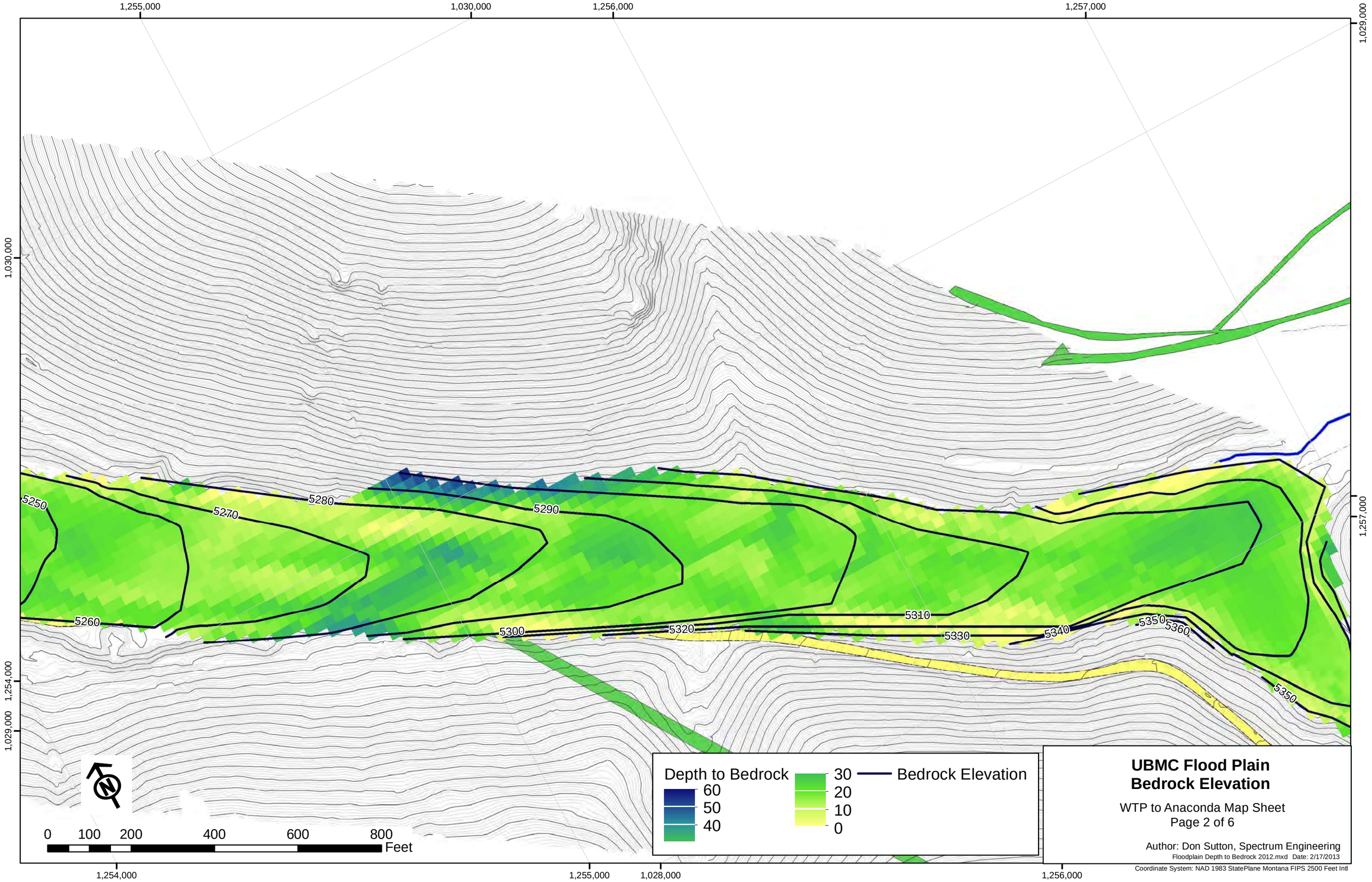
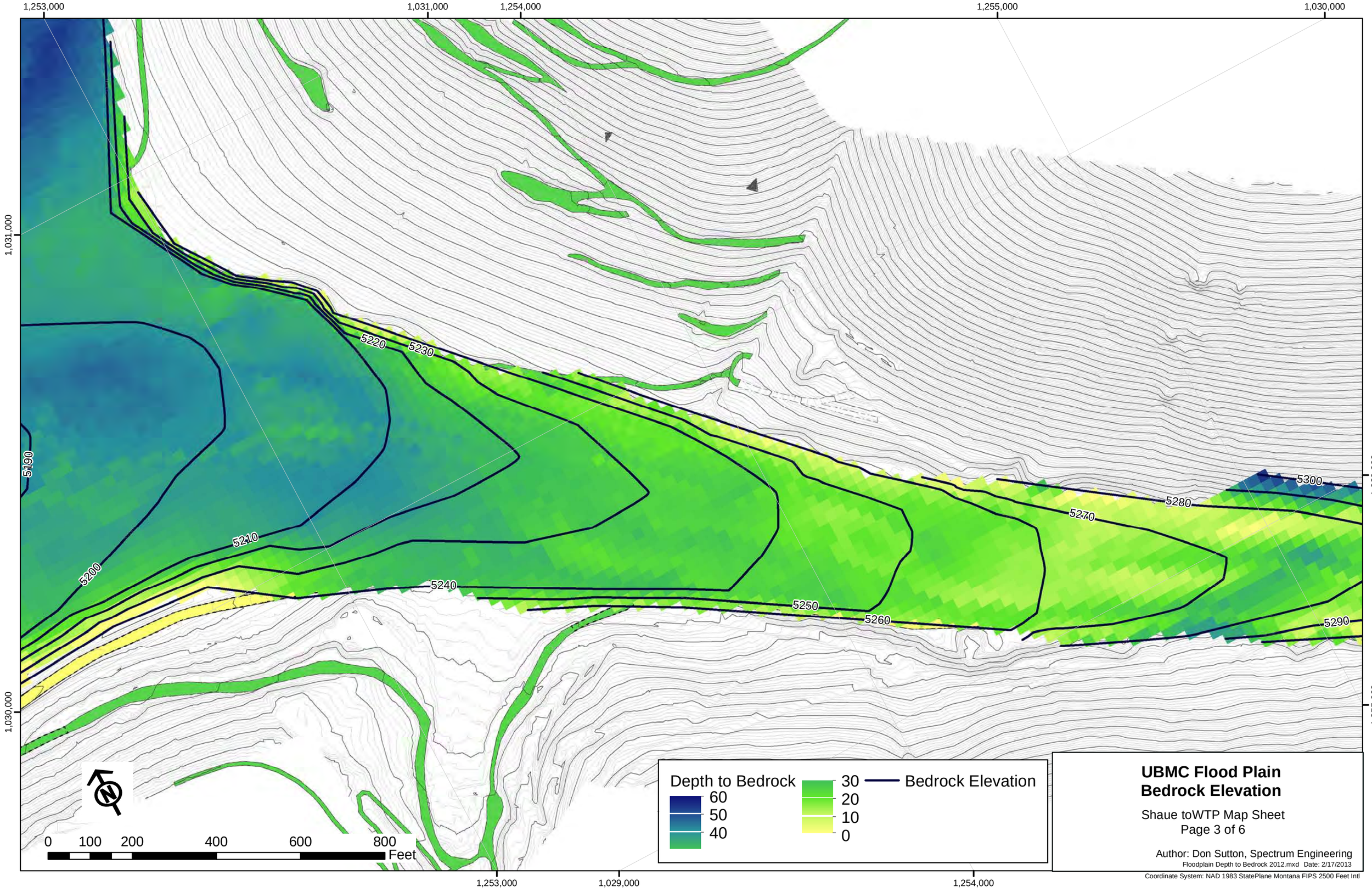
40
30
20
10
0
Bedrock Elevation
0 100 200 400 600 800
Feet
UBMC Flood Plain
Bedrock Elevation
Beartrap Creek Map Sheet
Page 1 of 6
Author: Don Sutton, Spectrum Engineering
Floodplain Depth to Bedrock 2012.mxd Date: 2/17/2013
Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl



UBMC Flood Plain
Bedrock Elevation

WTP to Anaconda Map Sheet
Page 2 of 6

Author: Don Sutton, Spectrum Engineering
Floodplain Depth to Bedrock 2012.mxd Date: 2/17/2013
Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl

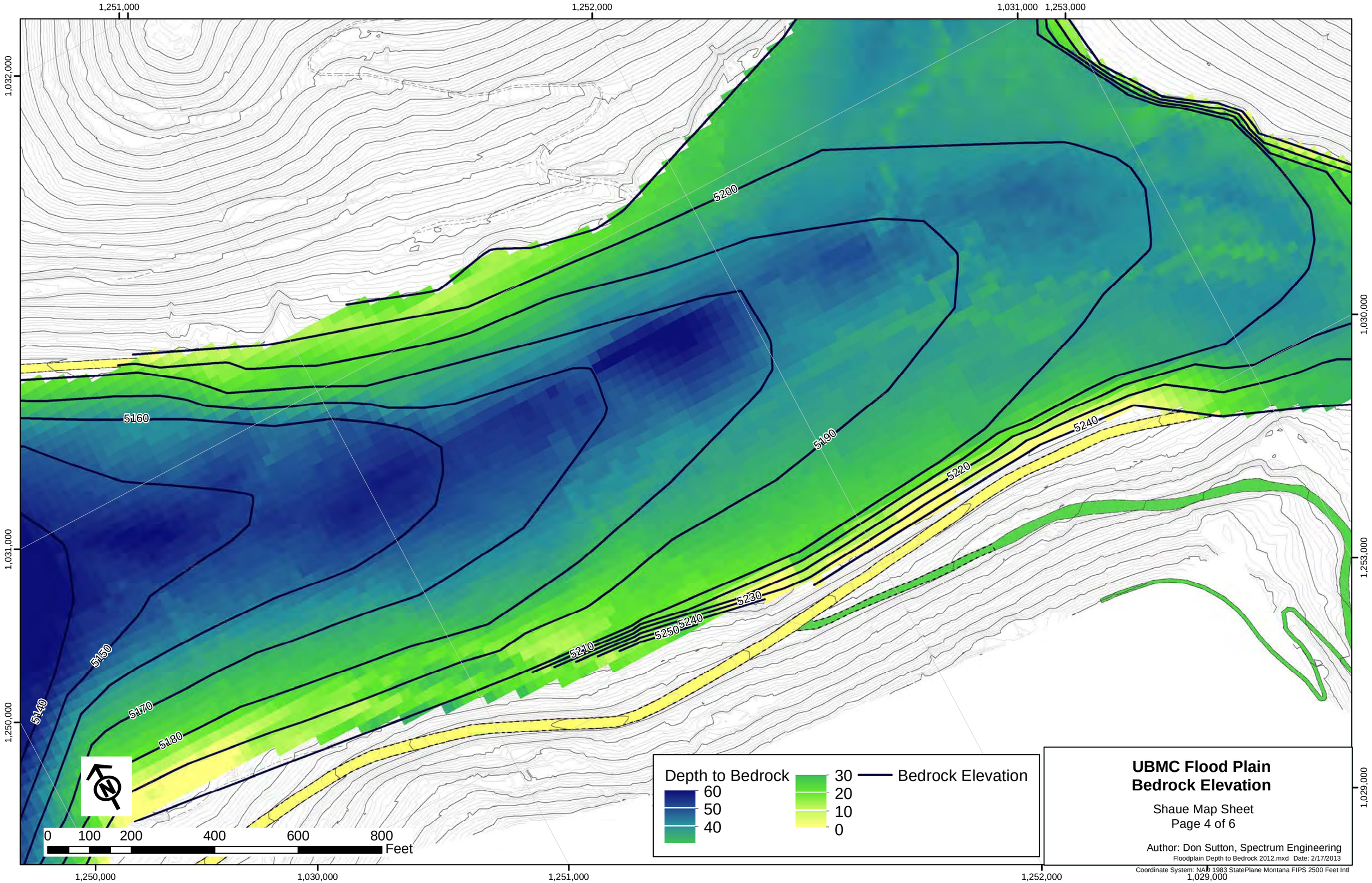


UBMC Flood Plain
Bedrock Elevation

Shaue toWTP Map Sheet
Page 3 of 6

Author: Don Sutton, Spectrum Engineering
Floodplain Depth to Bedrock 2012.mxd Date: 2/17/2013

Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl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5250
5210
5150
5140
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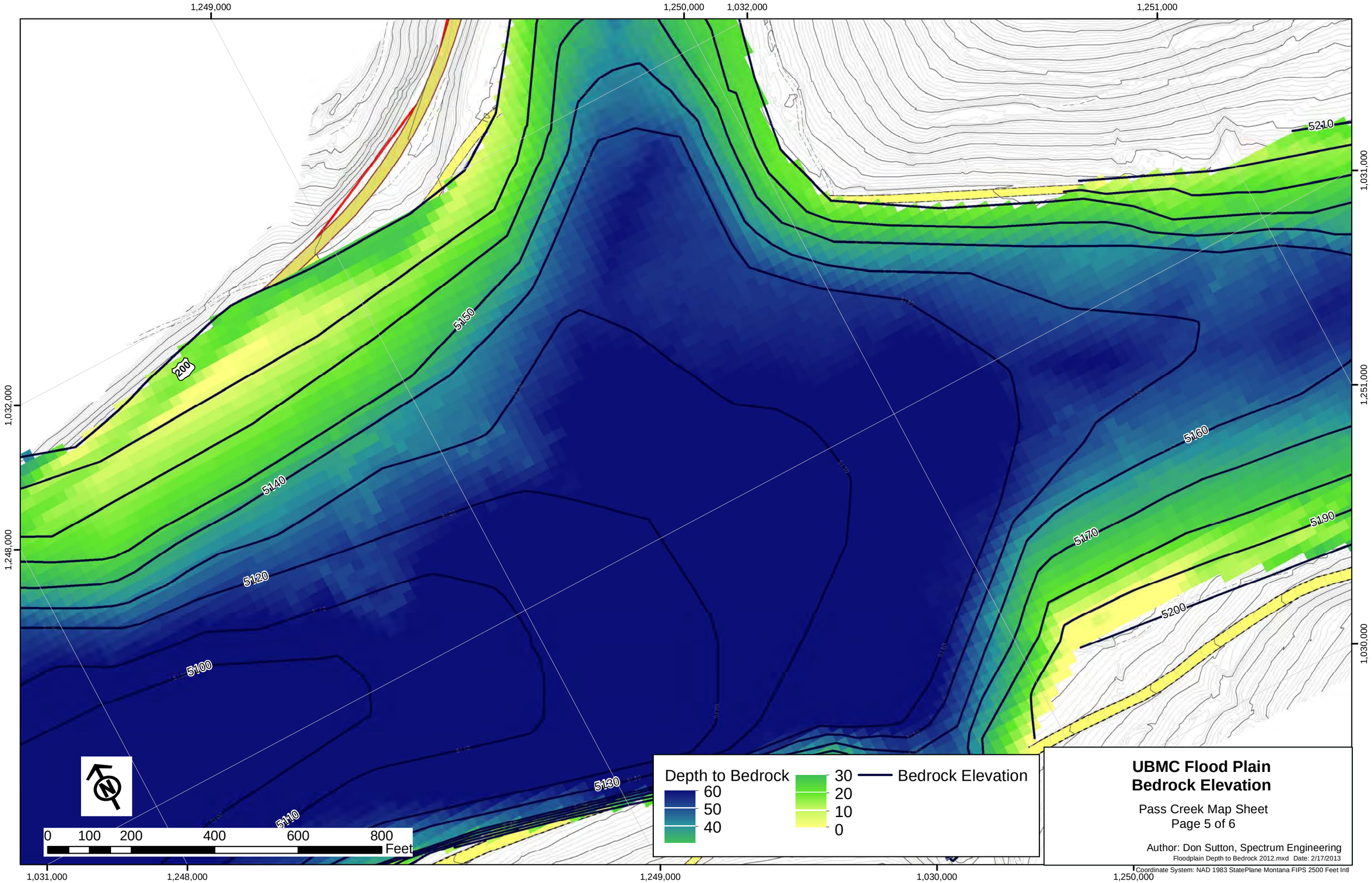
0 100 200 400 600 800
Feet
Depth to Bedrock
60
50
40
30
20
10
0
Bedrock Elevation
UBMC Flood Plain
Bedrock Elevation
Shaue Map Sheet
Page 4 of 6
Author: Don Sutton, Spectrum Engineering
Floodplain Depth to Bedrock 2012.mxd Date: 2/17/2013
Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl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5210
5150
200
5140
5120
5100
5110
5130
5160
5170
5190
5200
0 100 200 400 600 800
Feet
Depth to Bedrock
60
50
40
30
20
10
0
Bedrock Elevation
UBMC Flood Plain
Bedrock Elevation
Pass Creek Map Sheet
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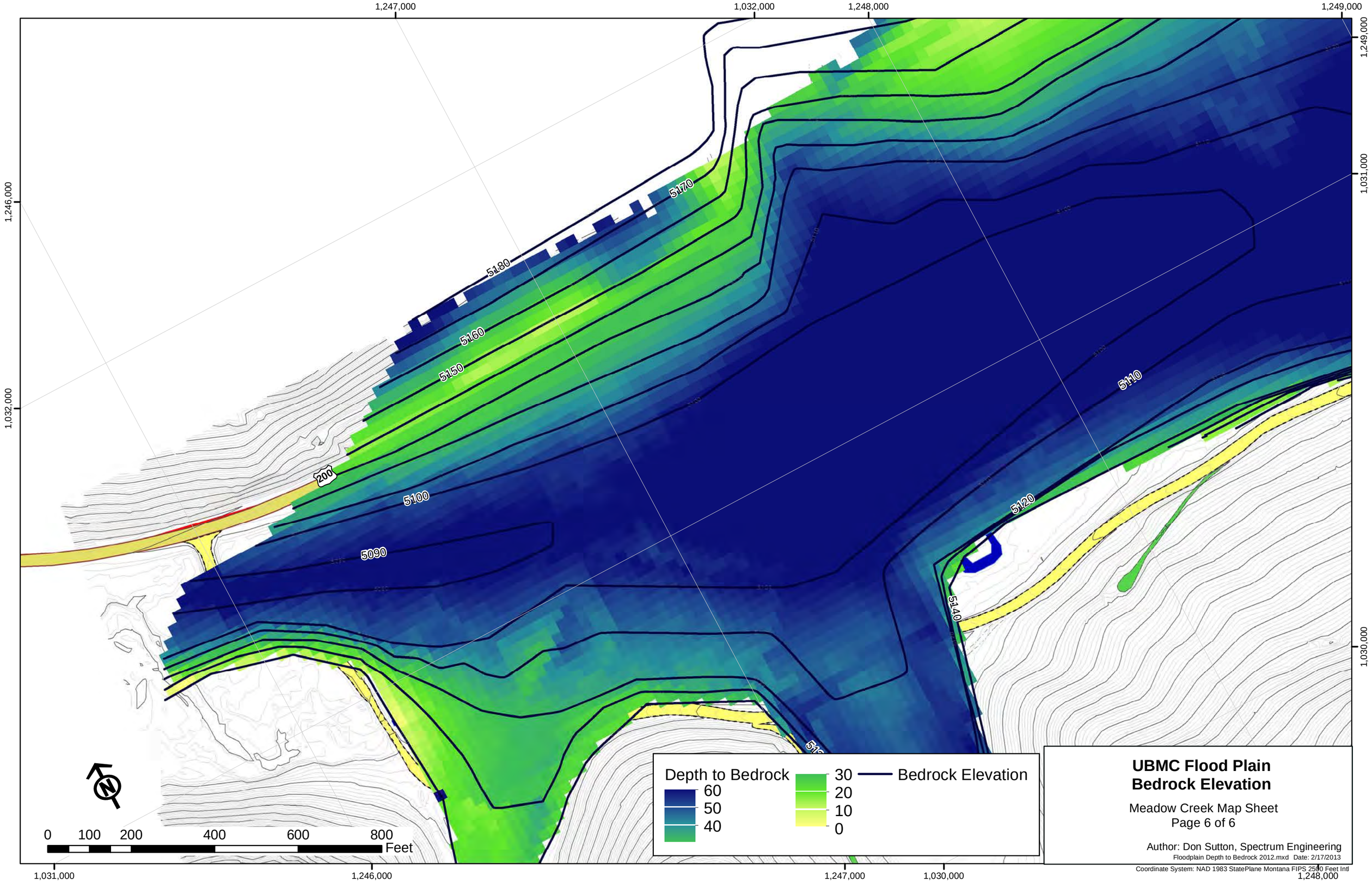
Author: Don Sutton, Spectrum Engineering
Floodplain Depth to Bedrock 2012.mxd Date: 2/17/2013
Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl


1,247,000
1,032,000
1,248,000
1,249,000
1,249,000
1,031,000
1,246,000
1,032,000
1,030,000
1,031,000
1,246,000
1,247,000
1,030,000
1,248,000
5170
5180
5160
5150
5110
200
5100
5120
5090
5140
0 100 200 400 600 800
Feet
Depth to Bedrock
60
50
40
30
20
10
0
Bedrock Elevation
UBMC Flood Plain
Bedrock Elevation
Meadow Creek Map Sheet
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Floodplain Depth to Bedrock 2012.mxd Date: 2/17/2013
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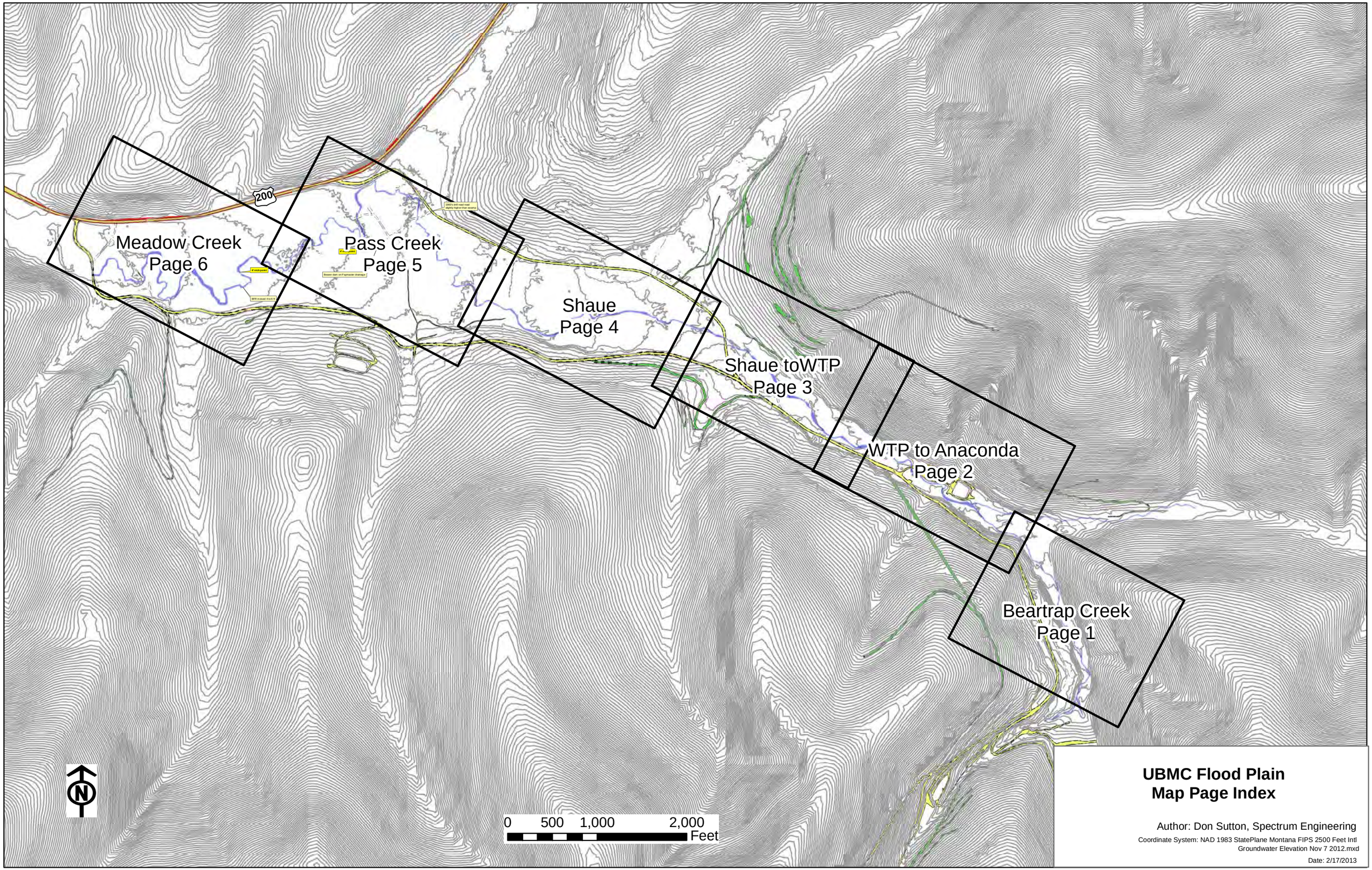

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Author: Don Sutton, Spectrum Engineering

Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl
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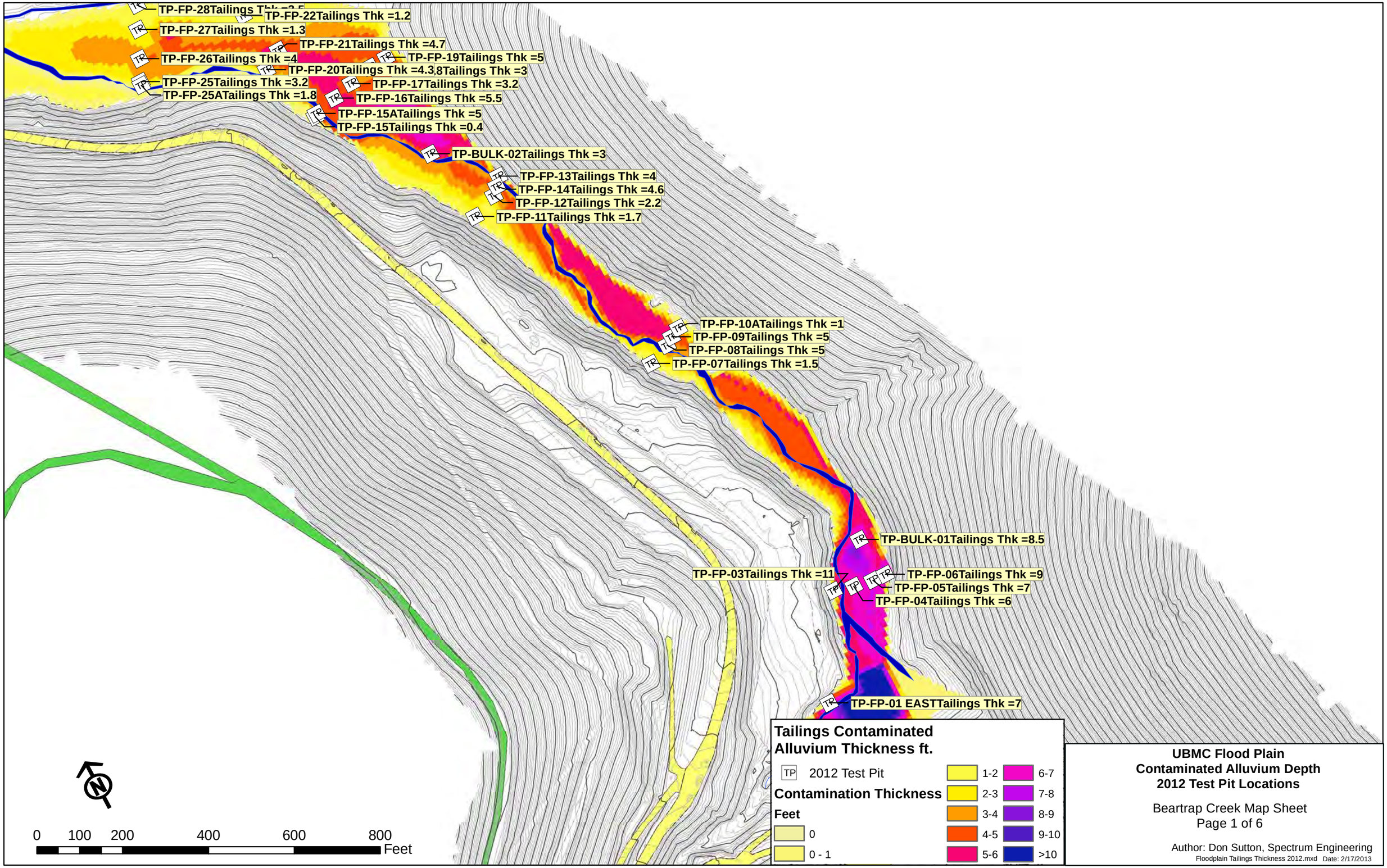
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TP-FP-22Tailings Thk =1.2
TP-FP-27Tailings Thk =1.3
TP-FP-21Tailings Thk =4.7
TP-FP-26Tailings Thk =4
TP-FP-19Tailings Thk =5
TP-FP-20Tailings Thk =4.3
8Tailings Thk =3
TP-FP-25Tailings Thk =3.2
TP-FP-17Tailings Thk =3.2
TP-FP-25ATailings Thk =1.8
TP-FP-16Tailings Thk =5.5
TP-FP-15ATailings Thk =5
TP-FP-15Tailings Thk =0.4
TP-BULK-02Tailings Thk =3
TP-FP-13Tailings Thk =4
TP-FP-14Tailings Thk =4.6
TP-FP-12Tailings Thk =2.2
TP-FP-11Tailings Thk =1.7
TP-FP-10ATailings Thk =1
TP-FP-09Tailings Thk =5
TP-FP-08Tailings Thk =5
TP-FP-07Tailings Thk =1.5
TP-BULK-01Tailings Thk =8.5
TP-FP-03Tailings Thk =11
TP-FP-06Tailings Thk =9
TP-FP-05Tailings Thk =7
TP-FP-04Tailings Thk =6
TP-FP-01 EASTTailings Thk =7
Tailings Contaminated Alluvium Thickness ft.
TP 2012 Test Pit
Contamination Thickness
Feet
0
0 - 1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
>10
0 100 200 400 600 800
Feet
UBMC Flood Plain
Contaminated Alluvium Depth
2012 Test Pit Locations
Beartrap Creek Map Sheet
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Author: Don Sutton, Spectrum Engineering
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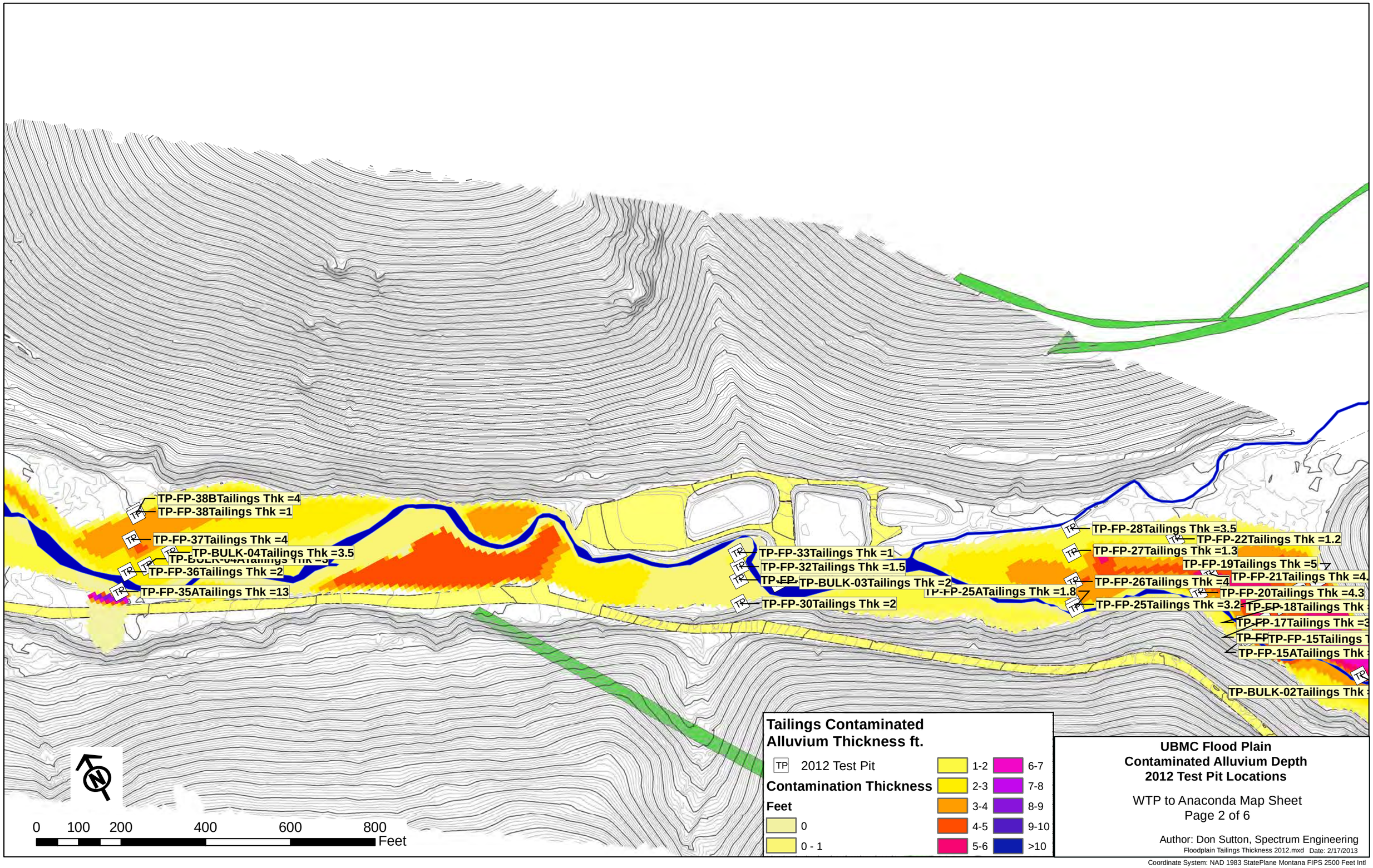
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TP-FP-38Tailings Thk =1
TP-FP-37Tailings Thk =4
TP-BULK-04Tailings Thk =3.5
TP-FP-36Tailings Thk =2
TP-FP-35ATailings Thk =13
TP-FP-33Tailings Thk =1
TP-FP-32Tailings Thk =1.5
TP-BULK-03Tailings Thk =2
TP-FP-30Tailings Thk =2
TP-FP-25ATailings Thk =1.8
TP-FP-28Tailings Thk =3.5
TP-FP-22Tailings Thk =1.2
TP-FP-27Tailings Thk =1.3
TP-FP-19Tailings Thk =5
TP-FP-26Tailings Thk =4
TP-FP-20Tailings Thk =4.3
TP-FP-25Tailings Thk =3.2
TP-FP-17Tailings Thk =3
TP-FP-15ATailings Thk
TP-BULK-02Tailings Thk
TP
N
0 100 200 400 600 800
Feet
Tailings Contaminated
Alluvium Thickness ft.
TP 2012 Test Pit
Contamination Thickness
Feet
0
0 - 1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
>10
UBMC Flood Plain
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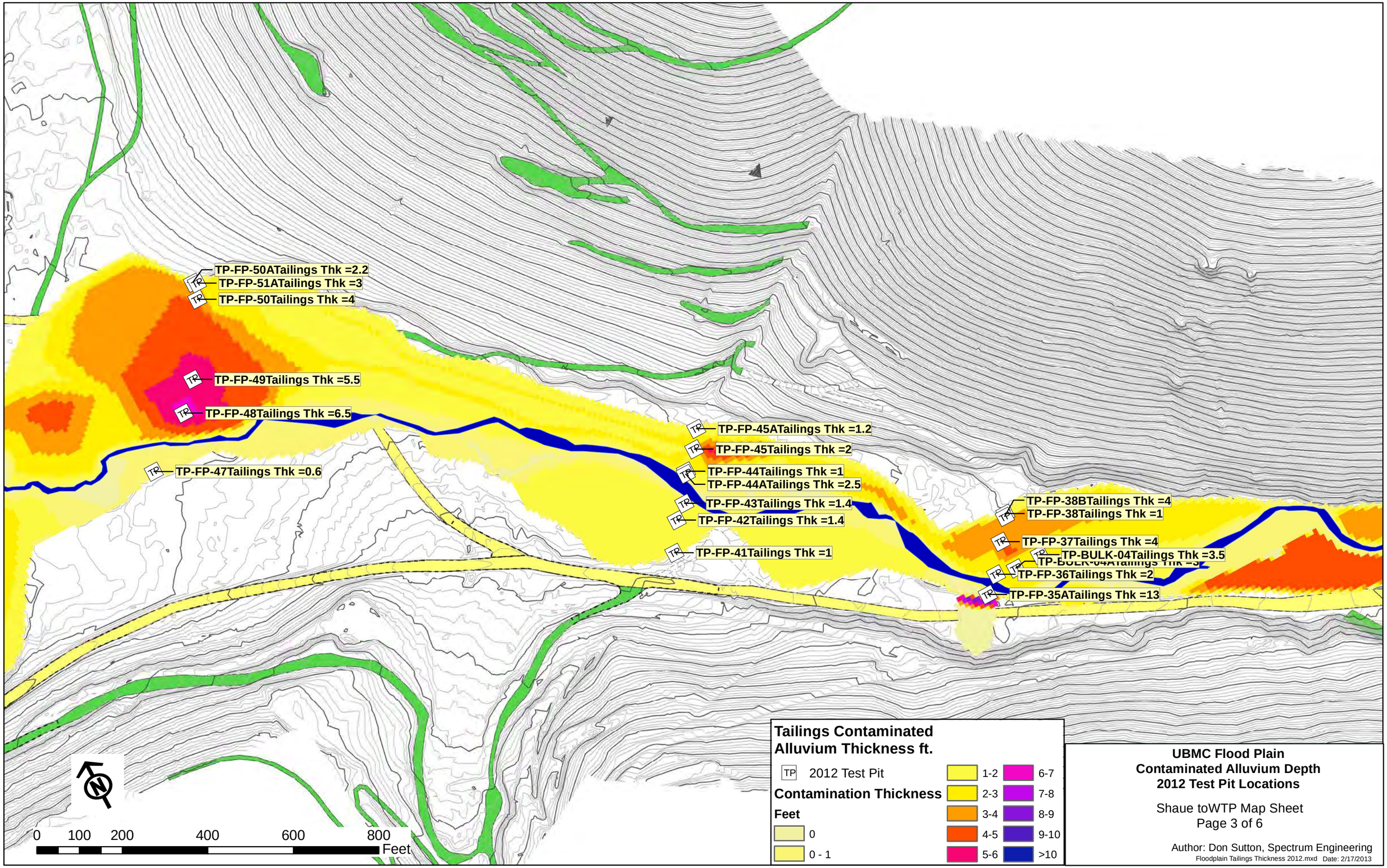
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TP-FP-51ATailings Thk =3
TP-FP-50Tailings Thk =4
TP-FP-49Tailings Thk =5.5
TP-FP-48Tailings Thk =6.5
TP-FP-47Tailings Thk =0.6
TP-FP-45ATailings Thk =1.2
TP-FP-45Tailings Thk =2
TP-FP-44Tailings Thk =1
TP-FP-44ATailings Thk =2.5
TP-FP-43Tailings Thk =1.4
TP-FP-42Tailings Thk =1.4
TP-FP-41Tailings Thk =1
TP-FP-38BTailings Thk =4
TP-FP-38Tailings Thk =1
TP-FP-37Tailings Thk =4
TP-BULK-04Tailings Thk =3.5
TP-FP-36Tailings Thk =2
TP-FP-35ATailings Thk =13
Tailings Contaminated Alluvium Thickness ft.
TP 2012 Test Pit
Contamination Thickness
Feet
0
0 - 1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
>10
0 100 200 400 600 800
Feet
UBMC Flood Plain
Contaminated Alluvium Depth
2012 Test Pit Locations
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TP-FP-50ATailings Thk =2.2
TP-FP-51ATailings Thk =3
TP-FP-50Tailings Thk =4
TP-FP-49Tailings Thk =5.5
TP-FP-48Tailings Thk =6.5
TP-FP-47Tailings Thk =0.6
TP-FP-55Tailings Thk =2.3
TP-FP-54Tailings Thk =2.4
TP-FP-53Tailings Thk =3
TP-FP-52Tailings Thk =2.7
TP-MS-101Tailings Thk =1
TP-FP-59Tailings Thk =0.6
TP-FP-58Tailings Thk =0.5
TP-MS-04ATailings Thk =2
TP-BULK-07Tailings Thk =1.3
TP-MS-04Tailings Thk =2
TP-MS-03Tailings Thk =2
-MS-01Tailings Thk =0.5

0 100 200 400 600 800 Feet

Tailings Contaminated Alluvium Thickness ft.

TP 2012 Test Pit

Contamination Thickness Feet

0
0 - 1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
>10

UBMC Flood Plain
Contaminated Alluvium Depth
2012 Test Pit Locations

Shaue Map Sheet
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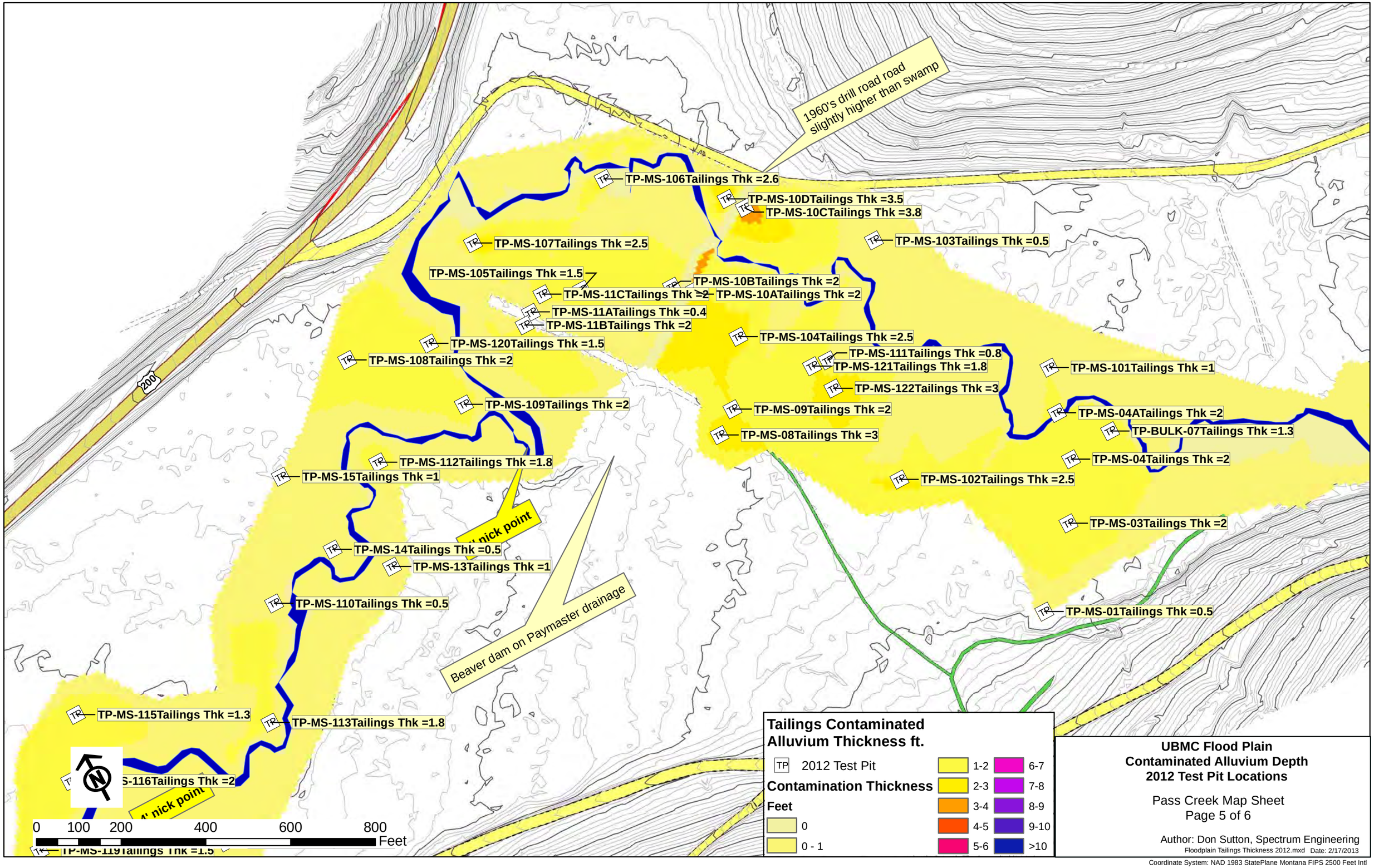
Author: Don Sutton, Spectrum Engineering
Floodplain Tailings Thickness 2012.mxd Date: 2/17/2013

Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl


1960's drill road road slightly higher than swamp
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TP-MS-10DTailings Thk =3.5
TP-MS-10CTailings Thk =3.8
TP-MS-103Tailings Thk =0.5
TP-MS-107Tailings Thk =2.5
TP-MS-105Tailings Thk =1.5
TP-MS-10BTailings Thk =2
TP-MS-11CTailings Thk =2
TP-MS-10ATailings Thk =2
TP-MS-11ATailings Thk =0.4
TP-MS-11BTailings Thk =2
TP-MS-104Tailings Thk =2.5
TP-MS-120Tailings Thk =1.5
TP-MS-108Tailings Thk =2
TP-MS-111Tailings Thk =0.8
TP-MS-121Tailings Thk =1.8
TP-MS-101Tailings Thk =1
TP-MS-122Tailings Thk =3
TP-MS-109Tailings Thk =2
TP-MS-09Tailings Thk =2
TP-MS-04ATailings Thk =2
TP-MS-08Tailings Thk =3
TP-BULK-07Tailings Thk =1.3
TP-MS-04Tailings Thk =2
TP-MS-112Tailings Thk =1.8
TP-MS-15Tailings Thk =1
TP-MS-102Tailings Thk =2.5
TP-MS-03Tailings Thk =2
nick point
TP-MS-14Tailings Thk =0.5
TP-MS-13Tailings Thk =1
TP-MS-110Tailings Thk =0.5
TP-MS-01Tailings Thk =0.5
Beaver dam on Paymaster drainage
TP-MS-115Tailings Thk =1.3
TP-MS-113Tailings Thk =1.8
S-116Tailings Thk =2
nick point
TP-MS-119Tailings Thk =1.5
200
0 100 200 400 600 800 Feet
Tailings Contaminated Alluvium Thickness ft.
TP 2012 Test Pit
Contamination Thickness Feet
0
0 - 1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
>10
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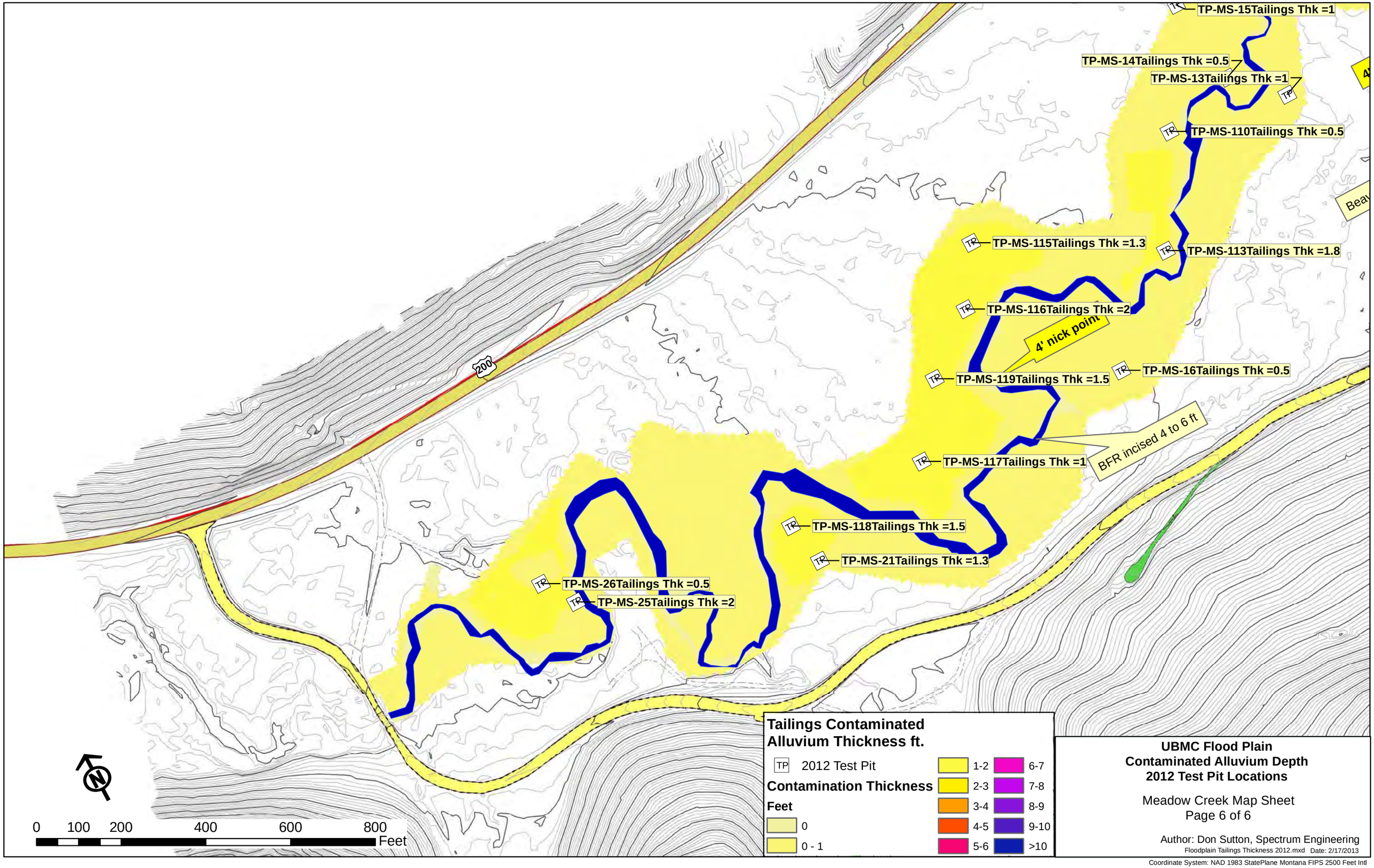
TP-MS-15Tailings Thk =1
TP-MS-14Tailings Thk =0.5
TP-MS-13Tailings Thk =1
TP-MS-110Tailings Thk =0.5
TP-MS-115Tailings Thk =1.3
TP-MS-113Tailings Thk =1.8
TP-MS-116Tailings Thk =2
4' nick point
TP-MS-119Tailings Thk =1.5
TP-MS-16Tailings Thk =0.5
BFR incised 4 to 6 ft
TP-MS-117Tailings Thk =1
TP-MS-118Tailings Thk =1.5
TP-MS-21Tailings Thk =1.3
TP-MS-26Tailings Thk =0.5
TP-MS-25Tailings Thk =2
200
Beav
TP
0 100 200 400 600 800
Feet
Tailings Contaminated
Alluvium Thickness ft.
2012 Test Pit
Contamination Thickness
Feet
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0 - 1
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3-4
4-5
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7-8
8-9
9-10
>10
UBMC Flood Plain
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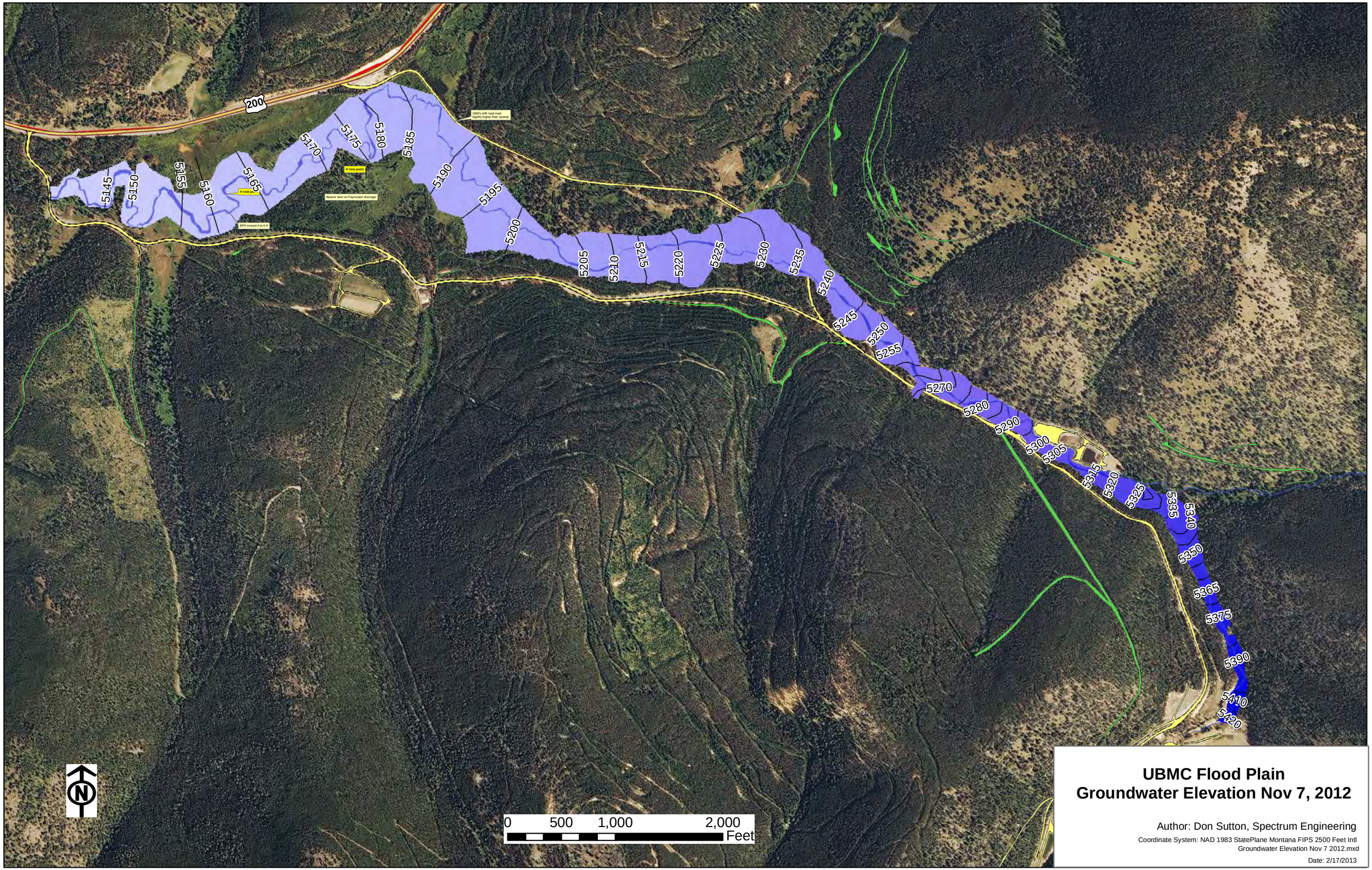

UBMC Flood Plain
Groundwater Elevation Nov 7, 2012

Author: Don Sutton, Spectrum Engineering

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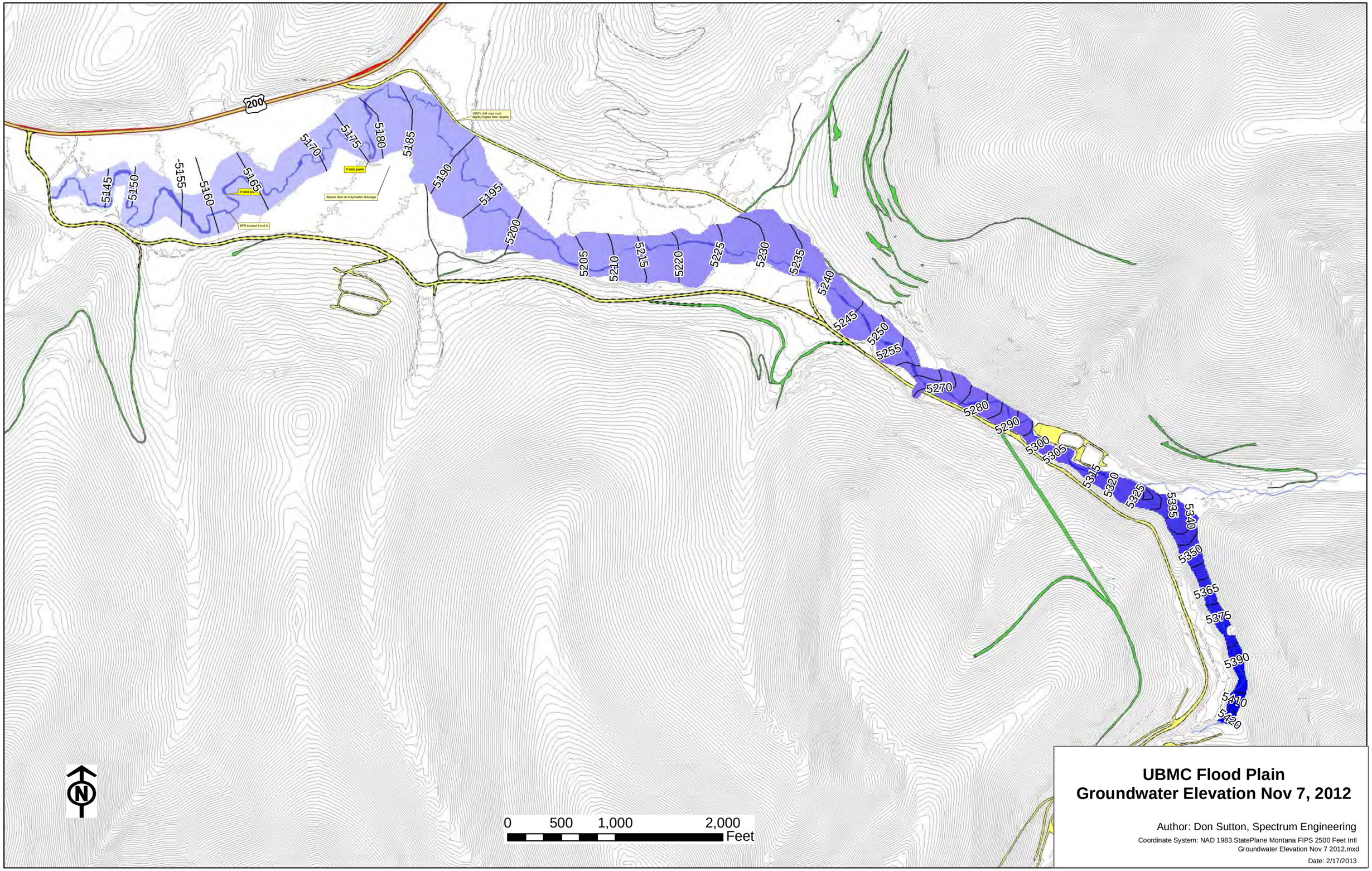
Groundwater Elevation Nov 7 2012.mxd

Date: 2/17/2013



UBMC Flood Plain
Groundwater Elevation Nov 7, 2012

Author: Don Sutton, Spectrum Engineering

Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl

Groundwater Elevation Nov 7 2012.mxd

Date: 2/17/2013

Name	Type	X	Y	Z Ground	Survey Source	Desc	Comment	Company	Date	Logged By	MP_Elev	Piezo Angle from Vertical	Vertical Stickup	Slope distance to transducer	Transducer Elevation	Water Depth BGS Test Pit	Water Elev test Pits	Slope Dist MP to Water Nov 7 2011	Ground Water Elevation Nov 7 2012	Station along valley Cl from MC bridge	Staioning going downstream from sump
SRB-01	2	1257233	1026285	5411.8	DJ&A	Bore Hole	for seismic bedrock depth calibra	Pioneer	22-Aug-2012	JR						7.00				137+87	21+43
SRB-02	2	1256740	1027798	5347.6	DJ&A	Bore Hole	for seismic bedrock depth calibra	Pioneer	22-Aug-2012	JR										121+95	37+35
SRB-03	2	1254117	1029446	5264.6	DJ&A	Bore Hole	for seismic bedrock depth calibra	Pioneer	22-Aug-2012	JR										90+37	68+93
SRB-04	2	1253293	1030279	5244.6	DJ&A	Bore Hole	for seismic bedrock depth calibra	Pioneer	23-Aug-2012	JR										78+60	80+70
SRB-05	2	1251900	1030697	5225.7	DJ&A	Bore Hole	for seismic bedrock depth calibra	Pioneer	23-Aug-2012	JR										64+10	95+20
SRB-06	2	1250373	1031178	5196.8	DJ&A	Bore Hole	for seismic bedrock depth calibra	Pioneer	24-Aug-2012	JR										44+25	115+05
SRB-07	2	1246245	1031149	5148.7	DJ&A	Bore Hole	for seismic bedrock depth calibra	Pioneer	24-Aug-2012	JR										1+20	158+10
TP-Bulk-01	5	1257270.8	1026344.3	5409.0	DJ&A	Test Pit Bulk Sample		Pioneer	24-Jul-2012	MB						4.00	5,404.95			137+20	22+10
TP-Bulk-02	1	1256810.5	1027606.9	5351.7	NS	Test Pit with piezometer		Pioneer	30-Jul-2012	MB	5356.6	15°	4.9			3.00	5,348.70	7.34	5349.7	123+80	35+50
TP-Bulk-03	5	1255698.2	1028446.4	5313.1	DJ&A	Test Pit Bulk Sample		Pioneer	6-Aug-2012	MB						2.00	5,311.07			109+25	50+05
TP-Bulk-04	1	1254465.1	1029182.8	5273.8	DJ&A	Test Pit with piezometer		Pioneer	14-Aug-2012	MB	5276.2	0°	2.3			2.00	5,271.83			94+18	65+12
TP-Bulk-04A	5	1254401.0	1029181.0	5273.0	DJ&A	Test Pit Bulk Sample		Pioneer	14-Aug-2012	MB										94+20	65+10
TP-Bulk-05	5	1252931.5	1030373.9	5239.5	NS	Test Pit Bulk Sample		Pioneer	15-Aug-2012	MB										75+00	84+30
TP-Bulk-06	5	1251368.5	1030242.9	5211.1	NS	Test Pit Bulk Sample		Pioneer	28-Aug-2012	MB						2.30	5,208.80			58+80	100+50
TP-Bulk-07	5	1250409.5	1030703.9	5200.8	NS	Test Pit Bulk Sample		Pioneer	29-Aug-2012	MB										48+30	111+00
TP-FP-01 East	0	1257029.5	1026040.9	5432.0	NS	Test Pit		Pioneer	21-Jul-2012	MB						#N/A	#N/A			110+70	48+60
TP-FP-01 West	0	1257039.5	1026050.9	5432.0	NS	Test Pit		Pioneer	22-Jul-2012	MB										140+63	18+67
TP-FP-02	0	1257102.5	1026135.9	5435.8	NS	Test Pit		Pioneer	23-Jul-2012	PR						9.50	5,426.30			139+75	19+55
TP-FP-03	1	1257161.3	1026267.2	5412.7	DJ&A	Test Pit		Pioneer	24-Jul-2012	MB						5.50	5,407.22			138+24	21+06
TP-FP-04	1	1257208.9	1026254.5	5413.1	DJ&A	Test Pit with piezometer		Pioneer	24-Jul-2012	MB	5417.9	12°	4.8			2.70	5,410.44	8.94	5409.2	138+25	21+05
TP-FP-05	1	1257254.1	1026246.2	5412.1	DJ&A	Test Pit with piezometer		Pioneer	24-Jul-2012	MB	5417.1	3°	5.0			2.50	5,409.56	8.21	5408.9	138+13	21+17
TP-FP-06	1	1257286.3	1026243.9	5411.8	DJ&A	Test Pit with piezometer		Pioneer	24-Jul-2012	MB	5416.2	4°	4.3			2.00	5,409.84	7	5409.2	138+12	21+18
TP-FP-06A	0	1257294.9	1026240.6	5417.8	NS	Test Pit			24-Jul-2012	MB										138+14	21+16
TP-FP-06B	1	1257135.5	1026670.8	5399.5	DJ&A	Test Pit with piezometer			24-Jul-2012	MB	5404.7	0°	5.2					dry at 18.55		133+67	25+63
TP-FP-07	1	1257034.2	1026934.1	5379.8	DJ&A	Test Pit with piezometer		Pioneer	25-Jul-2012	MB	5385.4	21°	5.5			4.00	5,375.84	6.65	5379.2	130+85	28+45
TP-FP-08	5	1257088.2	1026954.6	5378.5	DJ&A	Test Pit with Transducer		Pioneer	25-Jul-2012	MB	5383.3	6°	4.8	12.0	5371.4	2.00	5,376.50	6.69	5376.6	130+80	28+50
TP-FP-09	1	1257106.4	1026966.2	5380.2	DJ&A	Test Pit with piezometer		Pioneer	25-Jul-2012	MB	5384.8	16°	4.7			3.00	5,377.17	8.38	5376.8	130+75	28+55
TP-FP-10	1	1257138.4	1026981.4	5379.0	DJ&A	Test Pit with piezometer		Pioneer	26-Jul-2012	MB	5383.7	35°	4.8			4.00	5,374.97	6.93	5378.1	130+77	28+53
TP-FP-10A	1	1257130.0	1026977.0	5377.0	DJ&A	Test Pit with piezometer		Pioneer	26-Jul-2012	MB						4.00	5,372.97	could not find		130+76	28+54
TP-FP-11	1	1256833.0	1027428.9	5359.3	DJ&A	Test Pit with piezometer		Pioneer	26-Jul-2012	MB	5363.4	16°	4.1			8.50	5,350.80	6.61	5357.0	125+50	33+80
TP-FP-12	1	1256895.1	1027451.4	5358.8	DJ&A	Test Pit with piezometer		Pioneer	26-Jul-2012	MB	5363.1	8°	4.2			1.30	5,357.53	6.33	5356.8	125+40	33+90
TP-FP-13	1	1256925.8	1027486.5	5358.5	DJ&A	Test Pit with piezometer		Pioneer	30-Jul-2012	MB	5363.3	22°	4.9			2.60	5,355.87	7.25	5356.6	125+24	34+06
TP-FP-14	1	1256911.0	1027466.8	5358.0	DJ&A	Test Pit with piezometer		Pioneer	30-Jul-2012	MB	5363.1	7°	5.1			1.40	5,356.58	6.51	5356.6	125+35	33+95
TP-FP-15	5	1256614.8	1027809.1	5344.6	DJ&A	Test Pit with Transducer		Pioneer	30-Jul-2012	MB	5351.6	5°	7.0	15.4	5336.2	4.50	5,340.10	10.8	5340.8	120+95	38+35
TP-FP-15A	0	1256619.8	1027814.1	5342.6	Estimated	Test Pit	Same as 15 but 2ft lower		30-Jul-2012	MB										120+92	38+38
TP-FP-16	1	1256674.1	1027826.3	5346.7	DJ&A	Test Pit with piezometer		Pioneer	31-Jul-2012	MB	5351.3	3°	4.6			11.00	5,335.65	14.3	5337.0	120+05	39+25
TP-FP-17	1	1256724.5	1027838.8	5346.8	DJ&A	Test Pit with piezometer		Pioneer	31-Jul-2012	MB	5350.5	8°	3.7			9.00	5,337.80	13.8	5336.8	121+15	38+15
TP-FP-18	5	1256780.8	1027851.5	5346.5	DJ&A	Test Pit with Transducer		Pioneer	31-Jul-2012	MB	5350.0	19°	3.5	14.6	5336.1	11.00	5,335.47	14.01	5336.7	121+30	38+00
TP-FP-19	1	1256825.0	1027853.8	5348.0	DJ&A	Test Pit with piezometer		Pioneer	31-Jul-2012	MB	5351.7	45°	3.6			5.00	5,343.03	dry	5345.0	121+51	37+79
TP-FP-19A	1	1256853.0	1027867.0	5349.0	NS	Test Pit		Pioneer	1-Aug-2012	MB								could not find		121+50	37+80
TP-FP-20	5	1256565.6	1027958.8	5340.8	DJ&A	Test Pit with Transducer		Pioneer	1-Aug-2012	MB	5345.9	2°	5.0	15.5	5330.3			11.98	5333.9	119+15	40+15
TP-FP-21	5	1256610.2	1027986.2	5339.5	DJ&A	Test Pit with Transducer		Pioneer	1-Aug-2012	MB	5345.7	17°	6.1	11.2	5335.0	4.80	5,334.73	11.72	5334.5	119+30	40+00
TP-FP-22	1	1256576.5	1028096.3	5338.3	DJ&A	Test Pit with piezometer		Pioneer	1-Aug-2012	MB	5345.9	7°	7.6			5.00	5,333.35	12.9	5333.1	118+50	40+80
TP-FP-25	1	1256293.3	1028071.6	5331.1	DJ&A	Test Pit with piezometer		Pioneer	2-Aug-2012	MB	5336.1	0°	5.0			5.30	5,325.80	9.76	5326.3	116+06	43+24
TP-FP-25A	0	1256291.0	1028064.0	5329.1	DJ&A	Test Pit	Same TP as 25 2ft lowe		2-Aug-2012	MB										116+05	43+25
TP-FP-26	5	1256316.3	1028120.2	5328.9	DJ&A	Test Pit with Transducer		Pioneer	2-Aug-2012	MB	5333.7	20°	4.8	11.9	5322.5	1.70	5,327.24	7.28	5326.9	116+10	43+20
TP-FP-27	1	1256345.0	1028181.9	5332.0	DJ&A	Test Pit with piezometer		Pioneer	2-Aug-2012	MB	5337.3	10°	5.2					12.01	5325.4	116+15	43+15
TP-FP-28	5	1256369.9	1028234.5	5331.1	DJ&A	Test Pit with Transducer		Pioneer	6-Aug-2012	MB	5336.1	12°	5.0	11.2	5325.2	6.00	5,325.09	10.69	5325.7	116+20	43+10
TP-FP-30	1	1255597.2	1028444.3	5313.1	DJ&A	Test Pit with piezometer		Pioneer	7-Aug-2012	MB	5318.1	8°	5.1			5.00	5,308.06	9.28	5308.9	108+25	51+05
TP-FP-31	5	1255621.7	1028496.0	5312.6	DJ&A	Test Pit with Transducer		Pioneer	7-Aug-2012	MB	5317.7	5°	5.1	13.3	5304.5	4.50	5,308.14	9.31	5308.5	108+15	51+15
TP-FP-32	1	1255636.4	1028521.8	5311.5	DJ&A	Test Pit with piezometer		Pioneer	7-Aug-2012	MB	5317.2	7°	5.6			4.50	5,307.04	10.59	5306.7	108+10	51+20
TP-FP-33	5	1255647.9	1028553.4	5309.8	DJ&A	Test Pit with Transducer		Pioneer	7-Aug-2012	MB	5314.9	19°	5.1	11.0	5304.5	5.00	5,304.80	8.63	5306.8	108+05	51+25
TP-FP-34	5	1254363.0	1029054.0	5281.0	Garmin Rino	Test Pit with Transducer		Pioneer	7-Aug-2012	MB	5283.6	5°	2.6	14.8	5268.8	6.00	5,275.00	13.34	-13.3	94+50	64+80
TP-FP-35	1	1254309.8	1029154.1	5276.4	DJ&A	Test Pit with piezometer		Pioneer	8-Aug-2012	MB	5281.1	23°	4.7					12.16	5269.9	93+50	65+80
TP-FP-35A	0	1254314.0	1029158.0	5278.4	Estimated	Test Pit	2 ft higher than tp-FP-35		8-Aug-2012	MB										93+55	65+75
TP-FP-36	1	1254353.2	1029190.6	5274.8	DJ&A	Test Pit with piezometer		Pioneer	13-Aug-2012	MB	5278.5	0°	3.6			6.50	5,268.35	9.12	5269.3	93+70	65+60
TP-FP-37	5	1254398.3	1029253.4	5275.2	DJ&A	Test Pit with Transducer		Pioneer	14-Aug-2012	MB	5279.0	0°	3.8	19.1	5259.9	13.00	5,262.16	17.11	5261.9	93+80	65+50
TP-FP-38	1	1254439.2	1029306.1	5277.8	DJ&A	Test Pit with piezometer		Pioneer	14-Aug-2012	MB	5281.6	0°	3.8					17.61	5264.0	93+85	65+45
TP-FP-38A	0	1254442.0	1029312.0	5277.8	Estmated	Test Pit			14-Aug-2012	MB										93+85	65+45
TP-FP-38B	0	1254435.0	1029300.0	5277.8	Estmated	Test Pit			14-Aug-2012	MB										93+85	65+45
TP-FP-39	1	1254374.0	1029405.5	5276	Garmin gps	Test Pit with piezometer		Pioneer	13-Aug-2012	MB								not found		92+65	66+65
TP-FP-39A	0	1254370.0	1029402.0	5276	Estimate	Test Pit		Pioneer	13-Aug-2012	MB										92+60	66+70
TP-FP-40	1	1253720.3	1029521.3	5264.3	DJ&A	Test Pit with piezometer		Pioneer	8-Aug-2012	MB	5268.8	8°	4.5			14.00	5,250.31	18.29	5250.7	87+10	72+20
TP-FP-41	1	1253712.6	1029588.6	5260.1	DJ&A	Test Pit with piezometer		Pioneer	8-Aug-2012	MB	5263.0	17°	2.9					14.89	5248.7	86+50	72+80
TP-FP-42	5	1253753.0	1029653.6	5259.3	DJ&A	Test Pit with Transducer		Pioneer	8-Aug-2012	MB	5263.2	10°	3.9	17.6	5245.9	15.00	5,244.34	15.68	5247.8	86+30	73+00
TP-FP-43	1	1253787.3	1029679.6	5257.4	DJ&A	Test Pit with piezometer		Pioneer	9-Aug-2012	MB	5261.5	3°	4.2			9.00	5,248.37	13.69	5247.9	86+25	73+05

Name	Type	X	Y	Z Ground	Survey Source	Desc	Comment	Company	Date	Logged By	MP_Elev	Piezo Angle from Vertical	Vertical Stickup	Slope distance to transducer	Transducer Elevation	Water Depth BGS Test Pit	Water Elev test Pits	Slope Dist MP to Water Nov 7 2011	Ground Water Elevation Nov 7 2012	Station along valley Cl from MC bridge	Staioning going downstream from sump
TP-FP-44	1	1253826.2	1029744.3	5258.8	DJ&A	Test Pit with piezometer		Pioneer	9-Aug-2012	MB	5262.5	4°	3.7			9.00	5,249.81	14.71	5247.8	86+16	73+14
TP-FP-44A	0	1253823.0	1029739.0	5258.8	Estimated	Test Pit			9-Aug-2012	MB										86+15	73+15
TP-FP-45	1	1253867.4	1029781.1	5261.3	DJ&A	Test Pit with piezometer		Pioneer	9-Aug-2012	MB	5264.8	5°	3.5			12.00	5,249.29	dry TD 16.51	5247.0	86+16	73+14
TP-FP-45A	5	1253894.2	1029820.5	5261.8	DJ&A	Test Pit with Transducer	TD 16.2		9-Aug-2012	MB	5265.1	5°	3.3	15.9	5249.3			16.13	5249.0	86+10	73+20
TP-FP-46	5	1252680.6	1030308.5	5236.4	DJ&A	Test Pit with Transducer		Pioneer	16-Aug-2012	MB	5240.0	12°	3.5	11.8	5228.4	6.00	5,230.41	10.46	5229.7	72+00	87+30
TP-FP-47	1	1252726.7	1030327.7	5235.5	DJ&A	Test Pit with piezometer		Pioneer	16-Aug-2012	MB	5239.7	6°	4.1			4.20	5,231.35	10.79	5228.9	72+80	86+50
TP-FP-48	5	1252852.1	1030416.0	5237.7	DJ&A	Test Pit with Transducer		Pioneer	15-Aug-2012	MB	5240.9	9°	3.1	14.7	5226.3	4.40	5,233.35	10.5	5230.5	74+00	85+30
TP-FP-49	1	1252908.2	1030475.5	5238.8	DJ&A	Test Pit with piezometer		Pioneer	14-Aug-2012	MB	5241.7	8°	2.9			5.00	5,233.81	10.96	5230.8	74+30	85+00
TP-FP-50	1	1253005.2	1030636.1	5239.4	DJ&A	Test Pit with piezometer		Pioneer	15-Aug-2012	MB	5242.0	9°	2.6			6.00	5,233.39	10.65	5231.5	74+70	84+60
TP-FP-50A	1	1253015.2	1030675.0	5239.4	Estimated	Test Pit with piezometer	other side of of TP-FP-50?	Pioneer	15-Aug-2012	MB						4.00	5,235.39	not found		74+70	84+60
TP-FP-51	1	1253026.4	1030675.0	5238.9	DJ&A	Test Pit with piezometer		Pioneer	15-Aug-2012	MB	5242.3	14°	3.3			6.00	5,232.95	9.43	5233.1	71+55	87+75
TP-FP-51A	0	1253023.0	1030670.0	5238.9	Estimated	Test Pit			16-Aug-2012											74+60	84+70
TP-FP-52	1	1251918.1	1030356.4	5221.2	DJ&A	Test Pit with piezometer	adjacent to wet marsh	Pioneer	27-Aug-2012	MB						2.00	5,219.17	5.66	5219.6	61+20	98+10
TP-FP-53	5	1251929.5	1030397.5	5222.1	DJ&A	Test Pit with Transducer		Pioneer	27-Aug-2012	MB	5224.9	8°	2.8	14.4	5210.7	3.00	5,219.07	5.54	5219.4	64+30	95+00
TP-FP-54	1	1251972.8	1030437.4	5222.7	DJ&A	Test Pit with piezometer		Pioneer	27-Aug-2012	MB	5226.5	6°	3.9			3.40	5,219.27	7.28	5219.3	64+80	94+50
TP-FP-55	5	1252030.8	1030509.6	5222.6	DJ&A	Test Pit with Transducer	adjacent to wet marsh	Pioneer	28-Aug-2012	MB	5226.6	13°	4.0	10.6	5216.3	3.00	5,219.58	6.71	5220.1	65+50	93+80
TP-FP-56	1	1252226.7	1030693.8	5229.7	DJ&A	Test Pit with piezometer		Pioneer	16-Aug-2012	MB	5234.1	6°	4.4			6.00	5,223.70	not found		68+20	91+10
TP-FP-57	1	1251403.2	1030161.7	5216.1	DJ&A	Test Pit with piezometer		Pioneer	25-Sep-2012	MB	5221.1	5°	5.0					not found		59+15	100+15
TP-FP-58	1	1251336.7	1030315.3	5211.1	DJ&A	Test Pit with piezometer		Pioneer	28-Aug-2012	MB	5215.9	6°	4.8			2.80	5,208.26	7.77	5208.2	58+40	100+90
TP-FP-59	1	1251343.7	1030387.1	5213.5	DJ&A	Test Pit with piezometer		Pioneer	28-Aug-2012	MB	5216.5	8°	3.0			6.00	5,207.48	8.93	5207.7	58+30	101+00
TP-FP-60	1	1251376.2	1030584.2	5215.3	DJ&A	Test Pit with piezometer		Pioneer	28-Aug-2012	MB	5218.9	15°	3.6			5.90	5,209.43	9.03	5210.2	58+60	100+70
TP-MS-01	0	1250072.2	1030400.3	5197.7	DJ&A	Test Pit		Pioneer	24-Sep-2012	MB	5201.5	6°	3.86							47+80	111+50
TP-MS-03	0	1250220.5	1030557.8	5198.0	DJ&A	Test Pit		Pioneer	24-Sep-2012	MB	5201.8	8°	3.71			2.30	5,195.75			47+90	111+40
TP-MS-04	0	1250296.5	1030688.6	5199.1	DJ&A	Test Pit		Pioneer	21-Sep-2012	MB	5202.7	9°	3.60							47+60	111+70
TP-MS-04A	0	1250318.6	1030801.3	5199.0	DJ&A	Test Pit		Pioneer	21-Sep-2012	MB	5201.3	0°	2.30							47+00	112+30
TP-MS-05	0	1250643.7	1030983.2	5199.8	DJ&A	Test Pit		Pioneer	29-Aug-2012	MB	5203.9	0°	4.10			1.50	5,198.35			48+50	110+80
TP-MS-06	0	1250682.8	1031040.4	5200.3	DJ&A	Test Pit		Pioneer	29-Aug-2012	MB	5204.5	8°	4.20			1.00	5,199.27			48+40	110+90
TP-MS-07	0	1249168.1	1030777.5	5185.2	DJ&A	Test Pit		Pioneer	24-Sep-2012	MB	5189.5	5°	4.30			1.00	5,184.20			27+20	132+10
TP-MS-08	0	1249590.4	1031128.8	5188.8	DJ&A	Test Pit		Pioneer	21-Sep-2012	MB	5192.8	0°	4.00			0.20	5,188.59			39+25	120+05
TP-MS-09	0	1249646.4	1031168.3	5190.0	DJ&A	Test Pit		Pioneer	20-Sep-2012	MB	5195.1	4°	5.02							39+50	119+80
TP-MS-100	0	1250551.5	1030523.4	5203.1	Rec GPS	Test Pit		Pioneer	18-Oct-2012							#N/A				50+50	108+80
TP-MS-101	0	1250353.2	1030903.7	5198.6	Rec GPS	Test Pit		Pioneer	18-Oct-2012	NAJ										46+30	113+00
TP-MS-102	0	1249916.4	1030836.8	5194.8	Rec GPS	Test Pit		Pioneer	17-Oct-2012	NAJ						1.50	5,193.30			44+40	114+90
TP-MS-103	0	1250128.3	1031363.8	5194.1	Rec GPS	Test Pit		Pioneer	18-Oct-2012	NAJ						-	5,194.10			41+40	117+90
TP-MS-104	0	1249739.0	1031312.8	5191.6	Rec GPS	Test Pit		Pioneer	29-Oct-2012	NAJ						-	5,191.60			39+20	120+10
TP-MS-105	0	1249464.7	1031584.5	5185.5	Rec GPS	Test Pit		Pioneer	29-Oct-2012							#N/A				35+10	124+20
TP-MS-106	0	1249633.1	1031791.1	5188.5	Rec GPS	Test Pit		Pioneer	29-Oct-2012							#N/A				35+85	123+45
TP-MS-107	0	1249289.3	1031802.4	5185.1	Rec GPS	Test Pit		Pioneer	20-Oct-2012							#N/A				33+25	126+05
TP-MS-108	0	1248897.9	1031698.2	5178.4	Rec GPS	Test Pit		Pioneer	20-Oct-2012	NAJ						-	5,178.40			30+10	129+20
TP-MS-109	0	1249091.4	1031476.2	5178.1	Rec GPS	Test Pit		Pioneer	19-Oct-2012	NAJ						2.00	5,176.10			30+75	128+55
TP-MS-10a	0	1249699.7	1031459.1	5189.2	DJ&A	Test Pit		Pioneer	19-Sep-2012	MB	5192.4	0	3.21			0.20	5,188.97			37+90	121+40
TP-MS-10b	0	1249656.0	1031491.0	5188.4	DJ&A	Test Pit		Pioneer	20-Sep-2012	MB	5192.3	0	3.90			0.30	5,188.05			37+30	122+00
TP-MS-10c	0	1249894.9	1031575.3	5190.0	DJ&A	Test Pit		Pioneer	19-Sep-2012	MB	5193.5	0	3.45			0.25	5,189.78			38+60	120+70
TP-MS-10d	0	1249867.2	1031613.3	5189.9	DJ&A	Test Pit		Pioneer	19-Sep-2012	MB	5193.1	0	3.25			0.75	5,189.12			38+25	121+05
TP-MS-110	0	1248475.1	1031271.3	5170.3	Rec GPS	Test Pit		Pioneer	17-Oct-2012	NAJ						0.25	5,170.05			24+30	135+00
TP-MS-111	0	1249899.2	1031164.5	5192.5	Rec GPS	Test Pit		Pioneer	20-Oct-2012	NAJ						0.50	5,192.00			40+50	118+80
TP-MS-112	0	1248848.5	1031450.6	5175.2	Rec GPS	Test Pit		Pioneer	19-Oct-2012	NAJ						0.50	5,174.70			28+30	131+00
TP-MS-113	0	1248335.5	1031027.0	5169.8	Rec GPS	Test Pit		Pioneer	19-Oct-2012	NAJ										21+85	137+45
TP-MS-114	0	1248234.4	1031202.8	5170.3	Rec GPS	Test Pit		Pioneer	19-Oct-2012	NAJ						1.50	5,168.80			21+80	137+50
TP-MS-115	0	1247938.5	1031258.8	5168.1	Rec GPS	Test Pit		Pioneer	19-Oct-2012	NAJ						-	5,168.10			19+00	140+30
TP-MS-116	0	1247853.3	1031126.8	5167.2	Rec GPS	Test Pit		Pioneer	18-Oct-2012	NAJ						-	5,167.20			17+80	141+50
TP-MS-117	0	1247592.9	1030857.7	5163.1	Rec GPS	Test Pit		Pioneer	18-Oct-2012	NAJ						-	5,163.10			14+20	145+10
TP-MS-118	0	1247248.4	1030867.7	5159.7	Rec GPS	Test Pit		Pioneer	19-Oct-2012	NAJ						-	5,159.70			10+80	148+50
TP-MS-119	0	1247711.5	1031015.2	5166.4	Rec GPS	Test Pit		Pioneer	20-Oct-2012	NAJ						-	5,166.40			16+00	143+30
TP-MS-11a	0	1249332.6	1031593.3	5183.5	DJ&A	Test Pit		Pioneer	20-Sep-2012	MB	5189.2	10	5.73			0.30	5,183.20			33+70	125+60
TP-MS-11b	0	1249306.4	1031574.1	5181.5	DJ&A	Test Pit		Pioneer	20-Sep-2012	MB	5186.6	0	5.08			0.40	5,181.09			33+50	125+80
TP-MS-11c	0	1249377.1	1031619.0	5183.2	DJ&A	Test Pit		Pioneer	20-Sep-2012	MB	5188.6	0	5.44			0.10	5,183.06			34+13	125+17
TP-MS-12	0	1248846.4	1031096.1	5175.3	DJ&A	Test Pit		Pioneer	18-Sep-2012	MB	5178.5	0	3.20							26+50	132+80
TP-MS-120	0	1249086.6	1031641.6	5180.9	Rec GPS	Test Pit		Pioneer	17-Oct-2012	NAJ						0.50	5,180.40			31+30	128+00
TP-MS-121	0	1249860.0	1031170.0	5192.0	Rec GPS	Test Pit		Pioneer	17-Oct-2012	NAJ						0.50	5,191.50			41+15	118+15
TP-MS-122	0	1249880.0	1031100.0	5192.0	Rec GPS	Test Pit		Pioneer	29-Oct-2012	NAJ						0.30	5,191.70			41+90	117+40
TP-MS-13	0	1248761.6	1031217.5	5172.5	DJ&A	Test Pit		Pioneer	18-Sep-2012	MB	5176.1	4	3.60							26+40	132+90
TP-MS-14	0	1248656.9	1031319.3	5172.5	DJ&A	Test Pit		Pioneer	18-Sep-2012	MB	5176.2	6	3.65							26+00	133+30
TP-MS-15	0	1248629.7	1031528.4	5175.1	DJ&A	Test Pit		Pioneer	19-Sep-2012	MB	5178.9	5	3.74			3.20	5,171.94			27+10	132+20
TP-MS-16	0	1248109.9	1030826.4	5167.9	DJ&A	Test Pit		Pioneer	13-Sep-2012	MB	5171.6	3	3.69			3.00	5,164.91			19+20	140+10
TP-MS-17	0	1247950.0	1030799.6	5165.3	DJ&A	Test Pit		Pioneer	13-Sep-2012	MB	5168.7	6	3.40							17+60	141+70

Name	Type	X	Y	Z Ground	Survey Source	Desc	Comment	Company	Date	Logged By	MP_Elev	Piezo Angle from Vertical	Vertical Stickup	Slope distance to transducer	Transducer Elevation	Water Depth BGS Test Pit	Water Elev test Pits	Slope Dist MP to Water Nov 7 2011	Ground Water Elevation Nov 7 2012	Station along valley Cl from MC bridge	Staioning going downstream from sump
TP-MS-19	0	1247800.4	1031265.0	5166.7	DJ&A	Test Pit		Pioneer	13-Sep-2012	MB	5170.2	5	3.45			0.10	5,166.63			17+75	141+55
TP-MS-20	0	1247452.8	1030571.9	5165.0	DJ&A	Test Pit		Pioneer	12-Sep-2012	MB	5168.7	4	3.73							13+10	146+20
TP-MS-21	0	1247270.6	1030763.2	5160.4	DJ&A	Test Pit		Pioneer	12-Sep-2012	MB	5163.7	5	3.31			1.90	5,158.47			11+20	148+10
TP-MS-22	0	1247355.6	1030967.9	5160.9	DJ&A	Test Pit		Pioneer	12-Sep-2012	MB	5164.6	6	3.63			0.75	5,160.20			11+75	147+55
TP-MS-23	0	1247378.2	1031059.6	5162.5	DJ&A	Test Pit		Pioneer	12-Sep-2012	MB	5165.9	8	3.40			1.00	5,161.53			11+80	147+50
TP-MS-24	0	1246796.7	1030881.4	5154.7	DJ&A	Test Pit		Pioneer	11-Sep-2012	MB	5158.8	2	4.11			5.30	5,149.40			6+30	153+00
TP-MS-25	0	1246716.1	1030947.9	5150.7	DJ&A	Test Pit		Pioneer	11-Sep-2012	MB	5152.7	0	1.91			3.00	5,147.74			5+40	153+90
TP-MS-26	0	1246663.5	1031024.5	5149.8	DJ&A	Test Pit		Pioneer	11-Sep-2012	MB	5152.5	0	2.73							4+75	154+55
TP-MS-27	0	1246518.3	1031212.7	5151.3	DJ&A	Test Pit		Pioneer	10-Sep-2012	MB	5156.2	0	4.90			4.50	5,146.81			3+50	155+80
TPR-01	4	1257180.0	1026269.1	5410.0	DJ&A	River gauge		Pioneer			5415.1	25	5.05							138+18	21+12
TPR-02	4	1257089.9	1026934.1	5378.2	DJ&A	River gauge		Pioneer			5383.8	28	5.53							130+95	28+35
TPR-03	4	1256920.1	1027479.2	5357.4	DJ&A	River gauge		Pioneer			5362.5	31	5.10							125+30	34+00
TPR-04	4	1256624.0	1027808.0	5344.2	DJ&A	River gauge		Pioneer			5348.6	36	4.44							121+03	38+27
TPR-05	4	1256554.6	1027935.0	5340.1	DJ&A	River gauge		Pioneer			5344.6	32	4.47							119+20	40+10
TPR-06	4	1256259.4	1028081.2	5329.8	DJ&A	River gauge		Pioneer			5331.7	63	1.95							115+60	43+70
TPR-07	4	1255677.0	1028537.5	5308.7	DJ&A	River gauge		Pioneer			5312.9	38	4.13							108+50	50+80
TPR-08	4	1254261.2	1029228.6	5269.3	DJ&A	River gauge		Pioneer			5273.3	45	3.95							92+80	66+50
TPR-09	4	1253798.2	1029732.9	5257.1	DJ&A	River gauge		Pioneer			5261.5	40	4.36							86+10	73+20
TPR-10	4	1252737.6	1030392.2	5233.9	DJ&A	River gauge		Pioneer			5237.6	46	3.67							72+80	86+50
TPR-11	4	1252277.8	1030501.3	5223.6	DJ&A	River gauge		Pioneer			5226.3	51	2.68							68+10	91+20
TPR-13	4	1250428.0	1030748.1	5199.5	DJ&A	River gauge		Pioneer			5202.5	45	3.05							48+20	111+10
TPR-14	4	1249839.3	1031452.7	5192.0	DJ&A	River gauge		Pioneer			5195.2	48	3.27							38+95	120+35
TPR-15	4	1248787.8	1031381.2	5172.2	DJ&A	River gauge		Pioneer			5174.9	58	2.75							27+50	131+80
TPR-16	4	1247876.2	1030890.9	5164.7	DJ&A	River gauge		Pioneer			5168.2	41	3.48							17+20	142+10
TPR-17	4	1247248.5	1030986.6	5159.1	DJ&A	River gauge		Pioneer			5162.0	46	2.87							10+50	148+80
TPR-18	4	1246193.3	1030920.8	5144.3	DJ&A	River gauge		Pioneer			5148.1	37	3.80							0+00	159+30
TP-TS-01	0	1256949.8	1026068.5	5457.3	NS	Test Pit		Pioneer	6-Aug-2012	MB										140+60	18+70
TP-TS-02	0	1257025.0	1026101.9	5452.0	NS	Test Pit		Pioneer	6-Aug-2012	MB										140+15	19+15
TP-TS-03	0	1257060.1	1026185.3	5449.8	NS	Test Pit		Pioneer	6-Aug-2012	MB										139+25	20+05
ANMW-3	7	1255712	1028490	5317.02		Well														108+95	50+35
ANMW-7	7	1255270	1028764	5304.46		Well														103+80	55+50
ANMW-9	7	1256914	1028124	5350.01		Well														120+20	39+10
ANWS-1	7	1256174	1028358	5326.69		Well														113+85	45+45
BCGW-115	7	1256784	1027286	5434		Well														126+55	32+75
BCMW-10	7	1256825	1027635	5353.71		Well														123+50	35+80
BRGW-101	7	1246189	1031028	5150.01		Well														0+25	159+05
BRGW-110	7	1254124	1029434	5265.3		Well														90+50	68+80
BRSD-02	6	1249677	1031812	5189.48		Test Pit														36+10	123+20
BRSD-03	6	1249927	1030895	5194.24		Test Pit														44+00	115+30
BRSD-04	6	1250010	1030708	5196.59		Test Pit														45+90	113+40
BRSD-05	6	1249739	1032062	5190.02		Test Pit														35+80	123+50
BRSD-06	6	1247948	1031624	5173.11		Test Pit														21+00	138+30
BRSD-07	6	1247948	1031416	5169.95		Test Pit														19+80	139+50
BRSD-08	6	1247906	1031020	5166.45		Test Pit														17+90	141+40
BRSD-09	6	1247573	1030999	5164.65		Test Pit														14+50	144+80
BRSD-10	6	1246552	1031051	5149.51		Test Pit														3+80	155+50
BRSD-11	6	1246573	1030843	5148.19		Test Pit														3+75	155+55
BRSD-15	6	1250281	1030572	5199.82		Test Pit														48+20	111+10
BRSD-16	6	1250281	1030781	5199.39		Test Pit														46+90	112+40
BRSD-24	6	1249989	1031374	5193.91		Test Pit														40+50	118+80
BRSD-25	6	1250052	1031083	5195.54		Test Pit														43+10	116+20
EDGW-105	7	1250967	1030903	5204.21		Well														53+10	106+20
GW-01A	7	1257219	1025589	5482.61		Well														145+00	14+30
GW-01C	7	1257371	1025509	5483.94		Well														146+10	13+20
GW-02	7	1257376	1024795	5483.64		Well														153+10	6+20
GW-02A	7	1257431	1024658	5484.28		Well														154+58	4+72
LCMW-1	7	1246165	1031111	5150.57		Well														0+25	159+05
LCMW-5	7	1247542	1031671	5172.44		Well														16+75	142+55
LMSD-201	7	1238515	1032560	5102		Well														#N/A	#N/A
LMSD-202	7	1238562	1032496	5100		Well														#N/A	#N/A
LMSD-203	7	1238574	1032145	5095		Well														#N/A	#N/A
LMSD-204	7	1238644	1032015	5093		Well														#N/A	#N/A
MH-B01A	7	1257526	1024671	5480.86		Well														145+80	13+50
MH-B02A	7	1257433	1024868	5480.01		Well														152+65	6+65
MH-B03A	7	1257257	1025318	5480.08		Well														147+80	11+50
MH-B04	7	1257290	1025603	5480.42		Well														145+12	14+18

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MH-B05	7	1257158	1025325	5481.52		Well														145+26	14+04
MH-B06	7	1257173	1025559	5483.17		Well														145+20	14+10
MH-B07	7	1257365	1025578	5483.12		Well														145+20	14+10
MH-B08	7	1257175	1025244	5481.93		Well														148+20	11+10
MH-B09	7	1257593	1024469	5481.93		Well														156+95	2+35
MH-B10	7	1257079	1025667	5498.27		Well														144+05	15+25
MH-B11	7	1257316	1025700	5499.26		Well														144+10	15+20
MH-B12	7	1257304	1025754	5486.29		Well														143+50	15+80
MH-B14	7	1257047	1025551	5490.11		Well														145+00	14+30
MH-B15	7	1257365	1025291	5482.55		Well														148+30	11+00
MH-B16	7	1257380	1024857	5481.18		Well														152+60	6+70
MH-B17	7	1257503	1024861	5480.46		Well														153+00	6+30
MH-B18	7	1257451	1024650	5480.94		Well														154+80	4+50
MH-B19	7	1257571	1024678	5480.73		Well														154+90	4+40
MHGW-109	7	1256215	1025686	5534.53		Well															
MHGW-112	7	1255955	1025335	5580		Well															
MHGW-113	7	1255951	1025335	5580		Well															
MHMW-115	7	1255308	1024593	5664.39		Well															
MHMW-8	7	1256113	1025588	5543.69		Well															
MMSD-201	7	1242675	1031781	5119		Well															
MMSD-202	7	1242596	1031685	5118		Well															
P-1	7	1257159	1025730	5496.37		Well															
P-2	7	1257339	1025713	5498.87		Well															
P-3	7	1257153	1025826	5468.78		Well														142+61	16+69
P-4	7	1257316	1025811	5470.56		Well															
P-5	7	1257164	1025667	5496.9		Well															
P-6	7	1257341	1025692	5498.68		Well															
P-7	7	1256952	1025703	5497		Well															
P-8	7	1257054	1025720	5497.24		Well															
PGBG-1	7	1249909	1032219	5195.09		Well														36+40	122+90
PGBG-2	7	1249923	1032536	5200.48		Well														35+75	123+55
PMGW-116	7	1248382	1030556	5182.73		Well														20+50	138+80
PMGW-117	7	1248662	1030552	5193.82		Well														22+50	136+80
PMGW-118	7	1249113	1030491	5195.46		Well														25+20	134+10
PMGW-119	7	1249119	1030493	5195.48		Well														25+25	134+05
PMGW-120	7	1249454	1030430	5198.52		Well														45+15	114+15
PMMW-13	7	1249565	1029820	5261.91		Well														47+80	111+50
PMMW-14	7	1249268	1028698	5377.14		Well															
PMMW-15	7	1249306	1030421	5202.07		Well														44+50	114+80
SGGW-101	7	1252806	1029271	5331.3		Well														82+25	77+05
SGGW-102	7	1252974	1029193	5307		Well														84+10	75+20
SUMP-N	7	1257673	1024314	5490.09		Well														158+70	0+60
SUMP-S ALLUVIUM	7	1257734	1024219	5493.4		Well														159+75	-0+45
SWGW-101	7	1247400	1032259	5284.79		Well														17+20	142+10
SWGW-102	7	1247394	1031888	5239.56		Well														9+30	150+00
SWGW-103	7	1247661	1032217	5217.61		Well														21+00	138+30
TDMW-2D	7	1257185.34	1025931.34	5438.03		Well		Hydromet	2-Oct-2001	BA	5441.3		3.22							141+51	17+79
TDMW-3D	7	1257021	1025316	5496.34		Well														147+10	12+20
TDMW-3S	7	1257017	1025325	5495.76		Well														147+00	12+30
TDMW-4D	7	1257331	1024778	5496.51		Well														153+10	6+20
TDMW-4S	7	1257333	1024771	5496.43		Well														153+15	6+15
TDMW-5	7	1257046	1025033	5537.8221		Well														150+00	9+30
UM-0250N1750E	6	1248772.6	1031738.0	5178.06		Test Pit														29+25	130+05
UM-0250N2250E	6	1249272.4	1031737.4	5183.8		Test Pit														33+15	126+15
UM-0250N-2500E	6	1249532.5	1031739.3	5187.74		Test Pit														37+60	121+70
UM-0250S-1250E	6	1248266.7	1031738.0	5175.6		Test Pit														25+25	134+05
UM-0250S-1500E	6	1248523.2	1031239.6	5168.68		Test Pit														24+60	134+70
UM-0250S-2500E	6	1249536.2	1031243.3	5188.08		Test Pit														35+20	124+10
UM-0250S-250E	6	1247256.6	1031238.8	5160.53		Test Pit														9+90	149+40
UM-0250S-2750E	6	1249774.7	1031237.3	5192.14		Test Pit														40+00	119+30
UM-0250S-3000E	6	1250042.1	1031242.4	5194.51		Test Pit														41+80	117+50
UM-0250S-3250E	6	1250279.6	1031229.7	5196.46		Test Pit														43+25	116+05
UM-0250S-500E	6	1247510.7	1031236.8	5164.34		Test Pit														14+00	145+30
UM-0500N-2500E	6	1249536.2	1031988.0	5187.43		Test Pit														34+75	124+55
UM-0500S-2000E	6	1249026.6	1030983.6	5181.49		Test Pit														27+25	132+05
UM-0500S-2500E	6	1249532.5	1030982.4	5189.07		Test Pit														34+80	124+50

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UM-0500S-2750E	6	1249779.9	1030987.3	5192.16		Test Pit														42+25	117+05
UM-0500S-3000E	6	1250042.1	1030987.3	5194.78		Test Pit														43+90	115+40
UM-0500S-3250E	6	1250279.6	1030977.4	5196.57		Test Pit														45+25	114+05
UM-0500S-500E	6	1247510.7	1030982.4	5162.72		Test Pit														13+50	145+80
UM-0750S-3000E	6	1250039.9	1030734.4	5196.81		Test Pit														45+80	113+50
UM-0750S-3500E	6	1250546.8	1030737.8	5202.29		Test Pit														49+30	110+00
UM-1000S-3500E	6	1250541.9	1030482.6	5203.99		Test Pit														50+75	108+55
UM-ON-0250E	6	1247256.6	1031487.0	5162.34		Test Pit														9+20	150+10
UM-ON-0500E	6	1247510.7	1031487.6	5167.66		Test Pit														13+50	145+80
UM-ON-0750E	6	1247761.0	1031487.9	5170.1		Test Pit														18+00	141+30
UM-ON-1000E	6	1248018.6	1031487.0	5171.44		Test Pit														21+00	138+30
UM-ON-1500E	6	1248521.9	1031488.3	5174.49		Test Pit														25+90	133+40
UM-ON-2000E	6	1249027.9	1031487.0	5178.18		Test Pit														30+20	129+10
UM-ON-2500E	6	1249536.2	1031487.0	5188		Test Pit														36+20	123+10
Anaconda-1	6	1256918.2	1028016.1	5348.04		Test Pit														120+75	38+55
BFR-TP-1	6	1253190.7	1030468.4	5242.24		Test Pit														76+80	82+50
BFR-TP-10	6	1252649.8	1030474.4	5234.78		Test Pit														71+60	87+70
BFR-TP-11	6	1252588.2	1030563.3	5233.94		Test Pit														71+20	88+10
BFR-TP-12	6	1252623.6	1030634.1	5234.63		Test Pit														71+55	87+75
BFR-TP-3	6	1253030.6	1030601.6	5239.75		Test Pit														75+00	84+30
BFR-TP-6	6	1252773.7	1030417.0	5236.03		Test Pit														73+15	86+15
BFR-TP-7	6	1252761.6	1030557.5	5237.01		Test Pit														72+80	86+50
BFR-TP-8	6	1252713.2	1030539.4	5235.5		Test Pit														72+30	87+00
BTC-CT1	6	1256160.0	1028230.0	5325		Test Pit														114+20	45+10
BTC-CT2	6	1256300.0	1028090.0	5330		Test Pit														116+95	42+35
BTC-CT3	6	1256500.0	1028040.0	5338		Test Pit														118+03	41+27
BTC-CT4	6	1256800.0	1027470.0	5358		Test Pit														142+95	16+35
BTC-CT6	6	1257090.0	1027040.0	5376		Test Pit														130+02	29+28
BTC-TP-1	6	1256169.0	1028236.0	5324.91		Test Pit														114+25	45+05
BTC-TP-10	6	1257207.0	1026624.0	5391.39		Test Pit														134+35	24+95
BTC-TP-2	6	1256412.0	1028144.0	5330.17		Test Pit														116+95	42+35
BTC-TP-3	6	1256814.0	1027909.0	5345.59		Test Pit														121+03	38+27
BTC-TP-4	6	1256719.0	1027738.0	5349.46		Test Pit														122+15	37+15
BTC-TP-5	6	1256817.0	1027536.0	5356.03		Test Pit														124+30	35+00
BTC-TP-6	6	1256942.0	1027334.0	5364.31		Test Pit														126+72	32+58
BTC-TP-7	6	1257081.0	1027005.0	5377.66		Test Pit														130+30	29+00
BTC-TP-8	6	1257133.0	1026897.0	5381.53		Test Pit														131+50	27+80
BTC-TP-9	6	1257252.0	1026682.0	5392.02		Test Pit														133+90	25+40
GC-01	6	1257104.0	1025221.0	5486		Test Pit														148+30	11+00
GC-02	6	1257118.0	1025221.0	5483		Test Pit														148+30	11+00
GC-03	6	1257121.0	1025195.0	5485		Test Pit														148+30	11+00
GC-04	6	1257130.0	1025205.0	5480		Test Pit														148+30	11+00
Grab-1	6	1257230.0	1026550.0	5395.61		Test Pit														135+15	24+15
LMH1-TP-1	6	1256103.0	1025561.0	5538.26		Test Pit														141+00	18+30
LMH1-TP-2	6	1256137.0	1025595.0	5538.25		Test Pit														141+00	18+30
LMH1-TP-3	6	1256175.0	1025639.0	5537.28		Test Pit														141+00	18+30
LMH2-TP-1	6	1256320.0	1025656.0	5507.2		Test Pit														141+00	18+30
LMH3-TP-1	6	1256462.0	1025783.0	5492.2		Test Pit														141+00	18+30
LMH5-TP-1	6	1256575.0	1025862.0	5489.23		Test Pit														141+00	18+30
LMH5-TP-2	6	1256606.0	1025852.0	5493.73		Test Pit														141+00	18+30
LMH6-TP-1	6	1256842.0	1025733.0	5502.21		Test Pit														141+00	18+30
LMH6-TP-2	6	1256862.0	1025708.0	5504.68		Test Pit														141+00	18+30
LMH7-TP-1	6	1256829.0	1025920.0	5452.01		Test Pit														141+00	18+30
LMH8-TP-1	6	1256981.0	1026002.0	5434.1		Test Pit														141+10	18+20
STP-05	6	1256979.1	1025714.5	5496.74		Test Pit														143+50	15+80
STP-06	6	1257100.5	1025509.8	5486.77		Test Pit														145+60	13+70
STP-16	6	1257148.0	1026804.0	5384		Test Pit														132+40	26+90
STP-17 East	6	1257230.0	1026690.0	5391.96		Test Pit														133+71	25+59
STP-18	6	1257209.0	1026684.0	5389.33		Test Pit														133+70	25+60
STP-22	6	1256750.4	1027745.7	5348.58		Test Pit														122+15	37+15
STP-23	6	1256742.0	1027868.9	5346.73		Test Pit														121+02	38+28
UBDT-TP-01	6	1253900.2	1029762.2	5261.02		Test Pit														86+60	72+70
UBDT-TP-02	6	1254217.5	1029423.3	5271.36		Test Pit														91+20	68+10
UBDT-TP-03	6	1254403.9	1029229.4	5276.06		Test Pit														93+95	65+35
UBDT-TP-04	6	1254583.4	1029131.1	5276.82		Test Pit														96+00	63+30
UBDT-TP-05	6	1254474.3	1029046.0	5281.98		Test Pit														95+50	63+80

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UBDT-TP-06	6	1255022.6	1028845.1	5294.83		Test Pit	Toe of impoundment		7-Jul-2009	TG										101+15	58+15
09-MHTP-1	6	1256697.4	1025839.4	5484.2		Test Pit	Toe of impoundment		7-Jul-2009	TG										142+40	16+90
09-MHTP-10	6	1257147.2	1026035.4	5431.3		Test Pit	Toe of impoundment		7-Jul-2009	TG										140+51	18+79
09-MHTP-2	6	1256785.4	1025812.8	5486.4		Test Pit	Toe of impoundment		7-Jul-2009	TG										142+60	16+70
09-MHTP-3	6	1256806.8	1025863.8	5474.2		Test Pit	Toe of impoundment		7-Jul-2009	TG										142+20	17+10
09-MHTP-4	6	1256876.5	1025844.2	5471.5		Test Pit	Toe of impoundment		7-Jul-2009	TG										142+42	16+88
09-MHTP-5	6	1256902.3	1025904.6	5460.7		Test Pit	Toe of impoundment		7-Jul-2009	TG										141+95	17+35
09-MHTP-6	6	1256971.3	1025904.7	5455.8		Test Pit	Toe of impoundment		7-Jul-2009	TG										141+90	17+40
09-MHTP-7	6	1256991.6	1025949.7	5449.8		Test Pit	Toe of impoundment		7-Jul-2009	TG										141+60	17+70
09-MHTP-8	6	1257051.9	1025934.2	5445.0		Test Pit	Toe of impoundment		7-Jul-2009	TG										141+60	17+70
09-MHTP-9	6	1257127.4	1025975.7	5435.8		Test Pit	Toe of impoundment		7-Jul-2009	TG										141+12	18+18

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-BULK-01	0.0	4.0	GP	poorly graded gravel with sand	TAILINGS		0.0 to 8.0 DEBRIS FLOW with MIXED TAILINGS; estimated 10% Boulders; 30% Cobble; 40% Gravel; 20% Sand; max. particle size is 14-in	Water seeping in at 4 ft. during excavation	Moist to Saturated	
TP-BULK-01	4.0	5.0	GP	poorly graded gravel with sand	TAILINGS			Trees; roots and logs mixed in from 4.5; to 6.5;.	Moist to Saturated	
TP-BULK-01	5.0	8.0	GP	poorly graded gravel with sand	TAILINGS				Moist to Saturated	
TP-BULK-01	8.0	8.5	GW	well graded gravel with sand	TAILINGS		max particle size = 24-in. Bulk Sample Gradation from 8.0 to 8.5 ft: 16% Boulders and Cobbles; 57% Gravel; 23% Sand; and 4% Fines (15% finer than #10 sieve)		Saturated	
TP-BULK-02	0.0	1.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS		contains fine roots; MIXED TAILINGS; max particle size is 10-in.			
TP-BULK-02	1.0	3.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS	Black	MIXED TAILINGS; surface of Cobbles and Gravels are stained black	Groundwater at 3 ft.	Moist	
TP-BULK-02	3.0	12.0	GW	well graded gravel with sand	Undisturbed		Boulders and Cobbles are subangular; Gravels are subrounded; max particle size is 16-in. Bulk Sample Gradation from 6.0 to 7.0 ft: 16% Boulders and Cobbles; 59% Gravel; 22% Sand; and 3% Fines (17% finer than #10 sieve)		Moist to Saturated	
TP-BULK-03	0.0	2.0	SM	silty sand with gravel	TAILINGS		Debris flow	Groundwater at 2 ft.	Moist	
TP-BULK-03	2.0	2.3	GW	well graded gravel with sand	Undisturbed	Manganese	Black Manganese staining on surface of particles	Sidewalls of alluvium continually caved in	Saturated	
TP-BULK-03	2.3	3.8	GW	well graded gravel with sand	Undisturbed		max particle size is 14-in.			
TP-BULK-03	3.8	4.0	GW	well graded gravel with sand	Undisturbed			431.9vrmV; 250.2µ/cm		
TP-BULK-03	4.0	4.3	GW	well graded gravel with sand	Undisturbed					
TP-BULK-03	4.3	4.5	GW	well graded gravel with sand	Undisturbed			pH=6.55 @ start ;pH=6.57 @end (39 minutes)		
TP-BULK-03	4.5	5.5	GW	well graded gravel with sand	Undisturbed					
TP-BULK-04	0.0	2.0	GP	poorly graded gravel with sand	TAILINGS		estimated 10% Subangular Cobble; 50% Subrounded generally fine Gravel; and 40% Sand. Gravels generally flat; elongated; and laying flat	Groundwater observed at 2 to 2.5;	Moist to wet	
TP-BULK-04	2.0	2.5	SP	poorly graded sand with gravel	TAILINGS		Bulk Sample Gradation from 2.5 to 3.5 ft:			
TP-BULK-04	2.5	2.8	SP	poorly graded sand with gravel	TAILINGS			509 rmV		
TP-BULK-04	2.8	3.0	SP	poorly graded sand with gravel	TAILINGS			405 µs/cm		
TP-BULK-04	3.0	3.3	SP	poorly graded sand with gravel	TAILINGS			pH=6.60 @ start ;pH=6.22 @ end (43 minutes)		
TP-BULK-04	3.3	3.5	SP	poorly graded sand with gravel	TAILINGS	Manganese				
TP-BULK-04	3.5	3.9	SP	poorly graded sand with gravel	Undisturbed		Black Manganese staining on surface of particles.		Saturated	
TP-BULK-04	3.9	4.0	SW	well graded sand	Undisturbed			GW @ 4.0;	Saturated	
TP-BULK-04	4.0	4.3	SW	well graded sand	Undisturbed			453.4 rmv	Saturated	
TP-BULK-04	4.3	4.5	SW	well graded sand	Undisturbed	iron stain	fine to medium grained; iron staining at bottom of layer	389 µs/cm	Saturated	
TP-BULK-04	4.5	4.8	SP	poorly graded sand	Undisturbed	Organics	MIXED TAILINGS with pockets of black organics; fine grain; visible pyrite	pH=6.47 @ start;pH=6.47 @ end	Saturated	
TP-BULK-04	4.8	5.7	SP	poorly graded sand	Undisturbed	Organics	MIXED TAILINGS with pockets of black organics; fine grain; visible pyrite		Saturated	
TP-BULK-04A	0.0	3.0	GP	poorly graded gravel with sand	TAILINGS		MIXED TAILINGS; with Cobbles		Dry	

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-BULK-01	0.0	4.0	GP	Brown; Rusty brown zones								137+20	22+10
TP-BULK-01	4.0	5.0	GP	Brown; Rusty brown zones								137+20	22+10
TP-BULK-01	5.0	8.0	GP	Brown; Rusty brown zones								137+20	22+10
TP-BULK-01	8.0	8.5	GW	Brown								137+20	22+10
TP-BULK-02	0.0	1.0	GP-GM									123+80	35+50
TP-BULK-02	1.0	3.0	GP-GM	Orangish Brown								123+80	35+50
TP-BULK-02	3.0	12.0	GW	Brown								123+80	35+50
TP-BULK-03	0.0	2.0	SM	Light orangish brown								109+25	50+05
TP-BULK-03	2.0	2.3	GW	Brown [7.5YR 4/2]								109+25	50+05
TP-BULK-03	2.3	3.8	GW									109+25	50+05
TP-BULK-03	3.8	4.0	GW								250.20	109+25	50+05
TP-BULK-03	4.0	4.3	GW									109+25	50+05
TP-BULK-03	4.3	4.5	GW						6.55	6.57		109+25	50+05
TP-BULK-03	4.5	5.5	GW									109+25	50+05
TP-BULK-04	0.0	2.0	GP	Brown								94+18	65+12
TP-BULK-04	2.0	2.5	SP									94+18	65+12
TP-BULK-04	2.5	2.8	SP									94+18	65+12
TP-BULK-04	2.8	3.0	SP								405.00	94+18	65+12
TP-BULK-04	3.0	3.3	SP						6.6	6.2		94+18	65+12
TP-BULK-04	3.3	3.5	SP									94+18	65+12
TP-BULK-04	3.5	3.9	SP	Brown								94+18	65+12
TP-BULK-04	3.9	4.0	SW	Brown								94+18	65+12
TP-BULK-04	4.0	4.3	SW	Brown								94+18	65+12
TP-BULK-04	4.3	4.5	SW	Brown							389.00	94+18	65+12
TP-BULK-04	4.5	4.8	SP	Gray					6.47	6.47		94+18	65+12
TP-BULK-04	4.8	5.7	SP	Gray								94+18	65+12
TP-BULK-04A	0.0	3.0	GP	Rusty brown								94+20	65+10

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-BULK-04A	3.0	10.0	GW	well graded gravel with sand	Undisturbed		moisture content increases with depth; max particle size = 10-in.			
TP-BULK-05	0.0	0.8	SM	silty sand	Undisturbed		MIXED TAILINGS; pockets of brownish gray tailings with Pyrite		Moist	
TP-BULK-05	0.8	4.0	GW	well graded gravel with sand	Undisturbed					
TP-BULK-05	4.0	5.5	GW	well graded gravel with sand	Undisturbed	Manganese	Black Manganese staining on surface of gravels at 4 f	Groundwater at 5.5 ft.		
TP-BULK-05	5.5	8.0	GW	well graded gravel with sand	Undisturbed		wood debris (branches/stump) from 2 to 3 ft depth; .; max particle size = 6-in. Sample Gradation from 1.0 to 2.0 ft: 1% Boulders and Cobbles; 62% Gravel; 34% Sand; and 3% Fines (22% finer than #10 sieve).			
TP-BULK-06	0.0	2.3	GP	gravel with sand	Undisturbed		gravels are generally flat and subrounded; cobbles are generally blocky and subangular; trace black Manganese staining on surface of particles; particles are horizontally layered. Alluvium	Groundwater at 2.3; pH= 6.54 @ start ;pH=6.54 @ end (18 minutes);459.2 rmV; 252.9 µs/cm		
TP-BULK-06	2.3	6.0	GP	gravel with sand	Undisturbed					
TP-BULK-07	0.0	1.3	PT	peat	TAILINGS		dilatent; Bulk Sample Gradation: 5% Gravel; 42% Sand; and 53% Fines (92% finer than #10 sieve)		Wet	Very dark brown [10YR 2/2]
TP-BULK-07	1.3	2.3	GP	poorly graded gravel with sand	Undisturbed			Groundwater at 2 ft.		
TP-BULK-07	2.3	3.0	GP	poorly graded gravel with sand	Undisturbed					
TP-FP-01 EAST	5.0	7.0	GC	clayey gravel with sand	TAILINGS		Fill; mixed tailings	Groundwater encountered at 7 ft	Moist	
TP-FP-01 WEST	0.0	5.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		Native Soil	Possible fill; but not tailings at GWT interface	Moist	
TP-FP-01 WEST	5.0	7.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		Native Soil	Groundwater encountered at 7 ft	Moist	
TP-FP-02	0.0	3.0	GC	clayey gravel with sand	FILL		Gravels and Cobbles up to 12" in diameter and angular	Test pit caves easily at 3 ft	Moist	
TP-FP-02	3.0	8.5	GC	clayey gravel with sand	FILL		Gravels and Cobbles up to 12" in diameter and angular	Panned abundant fine pyrite approximately #20 size	Moist	
TP-FP-02	9.5	11.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		Mixed tailings with cobbles up to 12 in. diameter.Grades to rust color at 10.5 to 11.5'		Moist to Saturated	
TP-FP-02	11.5	12.0	GM	silty gravel with sand	Undisturbed	Manganese	MN layer at 12 ft.Grades to greyish brown color at 12 ft.	Black MN stained layer at 11.5 - 12.0;. Variable in thickness from 4 to 6". Changes to gray-brown below 12;.	Saturated	
TP-FP-02	12.0	13.0	GM		Undisturbed					
TP-FP-03	0.0	3.0	GC	clayey gravel with sand	Fill		Rock particles are approximately 12" minus and are well graded. Debris flow. Layer of coarse gravel at 3.5'	Mixed tailings; panned & observed trace pyrite at 3.5-5ft	Moist	Dark brown [10YR 3/3]
TP-FP-03	5.0	6.0	GC	clayey gravel with sand	TAILINGS				Moist to Saturated	Brown [7.5YR 4/3]
TP-FP-03	6.0	7.0	GC	clayey gravel with sand	TAILINGS				Moist to Saturated	Brown [7.5YR 4/3]
TP-FP-04	0.0	1.5	GP-GM	poorly graded gravel with silt and sand	TAILINGS		0 to 3.4 Argillite cobbles imbedded with mixed tailings.Debris flow.Argillite is angular 1-in to 12-in in size.Estimated 25% Cobbles; 40% Gravel; and 35% Sand		Moist	Olive [5Y 5/6]
TP-FP-04	2.0	2.7	GP-GM	poorly graded gravel with silt and sand	TAILINGS			Groundwater at 2.7;	Moist	Olive [5Y 5/6]
TP-FP-04	2.7	3.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS			@ 2.7ft GW 449.4 rmv; 594.0 µs/cm; pH start 7.86 pH end 6.56 (17 Minutes)	Moist	Olive [5Y 5/6]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-BULK-04A	3.0	10.0	GW									94+20	65+10
TP-BULK-05	0.0	0.8	SM	Rusty brown								75+00	84+30
TP-BULK-05	0.8	4.0	GW									75+00	84+30
TP-BULK-05	4.0	5.5	GW									75+00	84+30
TP-BULK-05	5.5	8.0	GW									75+00	84+30
TP-BULK-06	0.0	2.3	GP						6.54	6.54	252.90	58+80	100+50
TP-BULK-06	2.3	6.0	GP									58+80	100+50
TP-BULK-07	0.0	1.3	PT									48+30	111+00
TP-BULK-07	1.3	2.3	GP									48+30	111+00
TP-BULK-07	2.3	3.0	GP									48+30	111+00
TP-FP-01 EAST	5.0	7.0	GC	Yellow-rusty brown	Not sampled							110+70	48+60
TP-FP-01 WEST	0.0	5.0	GP-GM	Light reddish gray brown	51	273	47	37812				140+63	18+67
TP-FP-01 WEST	5.0	7.0	GP-GM	Light reddish gray brown	Not Sampled							140+63	18+67
TP-FP-02	0.0	3.0	GC	Reddish Brown								139+75	19+55
TP-FP-02	3.0	8.5	GC	Reddish Brown	142	169	78	46167				139+75	19+55
TP-FP-02	9.5	11.5	GP-GM	Yellowish Rust								139+75	19+55
TP-FP-02	11.5	12.0	GM	Grayish brown [2.5Y 5/2]								139+75	19+55
TP-FP-02	12.0	13.0	GM									139+75	19+55
TP-FP-03	0.0	3.0	GC		69	188	66	41269				138+24	21+06
TP-FP-03	5.0	6.0	GC									138+24	21+06
TP-FP-03	6.0	7.0	GC		130	173	70	42669				138+24	21+06
TP-FP-04	0.0	1.5	GP-GM	Purplish gray								138+25	21+05
TP-FP-04	2.0	2.7	GP-GM	Purplish gray								138+25	21+05
TP-FP-04	2.7	3.0	GP-GM	Purplish gray					7.86	6.56	594.00	138+25	21+05

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-04	4.0	5.5	SM	silty sand with gravel	TAILINGS	Black			Saturated	Dark reddish brown [5YR 3/3]
TP-FP-04	6.5	7.0	GP-GM	poorly graded gravel with silt and sand	UHM				Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-04	8.0	8.5	GP-GM	poorly graded gravel with silt and sand	UHM				Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-05	0.0	1.0	GP	gravel with sand	TAILINGS		0 to 3.8 Mixed Tailing: Gravelly Sand with Silt and Argillite Cobbles.Estimated 20% Cobbles; 20% Gravel; 50% Sand; and 10% Fine;approximate 12 inch maximum particle size; Debris flow		Moist	Dark reddish brown [5YR 3/4]
TP-FP-05	3.0	3.8	GP	gravel with sand	TAILINGS			Lots of roots encountered	Moist	Dark reddish brown [5YR 3/4]
TP-FP-05	4.8	5.0	GM	silty gravel with sand	TAILINGS	Black		Very black from 5 to 5.5;; potential Mn staining. Blackish brown 3.8-5.0; and 5.5-8.5;	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-05	5.0	6.0	GM	silty gravel with sand	TAILINGS	Black			Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-05	7.0	7.5	GM	silty gravel with sand	UHM	Black			Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-05	8.0	8.5	GM	silty gravel with sand	UHM	Black	4.0 to 8.5 Random pockets of black; wet; Sandy CLAY.Estimated 5% Boulder; 40% Cobbles; 30% Gravel; 20% Sand; and 5% Fines between 3.8 and 8.5 ft.Particles are randomly oriented. Debris flow. Large cobbles 8 -8.5'.	Relatively easy to dig at 8.5 to 9.5 ft	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-06	0.0	1.0	SM	silty sand with gravel	TAILINGS	Organics	MIXED TAILINGS; with organic roots; Debris Flow	Twigs and Trees buried from 1 to 4 ft	Moist	Very dark brown [10YR 2/2]
TP-FP-06	1.0	1.3	GM	silty gravel with sand	TAILINGS			Groundwater at 2;	Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-06	2.0	2.1	GM	silty gravel with sand	TAILINGS			@ 2 ft 368.9 rmv; 680 ms/cm pH start 6.05 pH end 6.15 (17 Minutes)	Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-06	2.1	3.0	GM	silty gravel with sand	TAILINGS			Visually observe abundant pyrite from 1 to 7;	Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-06	3.0	4.0	GM	silty gravel with sand	TAILINGS				Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-06	4.0	4.5	GM	silty gravel with sand	TAILINGS			Layer of organic roots bisects through debris flow from a depth 4 to 6 ft	Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-06	5.5	7.0	GM	silty gravel with sand	TAILINGS				Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-06	8.0	8.5	GP	gravel with sand	TAILINGS			@ 8.5ft 372.6 rmv; 603µs/com; pH start 7.19 pH end 6.57 (16 Minutes)	Wet	Dark brown [7.5YR 3/3]
TP-FP-06A	0.0	2.0	SP-SC	poorly graded sand with clay and gravel	Undisturbed		Maximum particle size is approximately 16 in.Gravel content increases at 3 ft depth		Moist	
TP-FP-06A	2.0	3.0	SP-SC	poorly graded sand with clay and gravel	Undisturbed		Maximum particle size is approximately 16 in.Gravel content increases at 3 ft depth		Moist	
TP-FP-06A	3.0	5.5	SP-SC	poorly graded sand with clay and gravel	Undisturbed		Maximum particle size is approximately 16 in.Gravel content increases at 3 ft depth		Moist	
TP-FP-06A	5.5	6.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		0 to 9 Debris Flow; MIXED TAILINGS; Maximum particle size is approximately 8-in	The Mixed Tailing was only observed in the portion of the test pit excavated below the flood plain.	Moist to wet	
TP-FP-06A	6.0	7.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Black Mn layer not observed	Moist to wet	
TP-FP-06A	7.5	9.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Water not visually flowing into the test pit	Moist to wet	

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-04	4.0	5.5	SM	Very dark brown [7.5YR 2.5/2]								138+25	21+05
TP-FP-04	6.5	7.0	GP-GM									138+25	21+05
TP-FP-04	8.0	8.5	GP-GM									138+25	21+05
TP-FP-05	0.0	1.0	GP									138+13	21+17
TP-FP-05	3.0	3.8	GP									138+13	21+17
TP-FP-05	4.8	5.0	GM									138+13	21+17
TP-FP-05	5.0	6.0	GM									138+13	21+17
TP-FP-05	7.0	7.5	GM									138+13	21+17
TP-FP-05	8.0	8.5	GM									138+13	21+17
TP-FP-06	0.0	1.0	SM									138+12	21+18
TP-FP-06	1.0	1.3	GM									138+12	21+18
TP-FP-06	2.0	2.1	GM						6.05	6.15	680.00	138+12	21+18
TP-FP-06	2.1	3.0	GM									138+12	21+18
TP-FP-06	3.0	4.0	GM									138+12	21+18
TP-FP-06	4.0	4.5	GM									138+12	21+18
TP-FP-06	5.5	7.0	GM									138+12	21+18
TP-FP-06	8.0	8.5	GP						7.19	6.57		138+12	21+18
TP-FP-06A	0.0	2.0	SP-SC	Brown								138+14	21+16
TP-FP-06A	2.0	3.0	SP-SC	Brown	26	175	16	39153				138+14	21+16
TP-FP-06A	3.0	5.5	SP-SC	Brown								138+14	21+16
TP-FP-06A	5.5	6.0	GP-GC	Yellowish rusty brown	56	117	44	38201				138+14	21+16
TP-FP-06A	6.0	7.5	GP-GC	Yellowish rusty brown								138+14	21+16
TP-FP-06A	7.5	9.0	GP-GC	Yellowish rusty brown								138+14	21+16

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-06A	9.0	13.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed		Moisture content increases at 11.5 ft depth.Color grades to light brown and subangular particles below the 11.5 ft depth	Installed 2" diameter PVC to 13.5;	Moist to wet	
TP-FP-06A	13.5	16.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed				Moist to wet	
TP-FP-06A	16.5	16.6	GP-GC	poorly graded gravel with clay and sand	Undisturbed					
TP-FP-06B	0.0	2.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		NATIVE SOIL; maximum particle size isapproximately 15-in	Live tree roots observed in the top 2 ft	Moist to wet	
TP-FP-06B	2.0	3.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to wet	
TP-FP-06B	3.5	5.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Mixed tailings and black Mn layer not observed	Moist to Saturated	
TP-FP-06B	5.0	8.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Soil profile very consistent throughout entire test pit	Moist to Saturated	
TP-FP-06B	8.0	10.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Piezometer bent during backfilling. Piezometer is aligned approximately 10 degrees from vertical	Moist to Saturated	
TP-FP-06B	10.0	11.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Groundwater at 11;	Moist to Saturated	
TP-FP-07	0.0	0.5	SM	silty sand	TAILINGS				Moist to wet	Brown [7.5YR 4/4]
TP-FP-07	1.5	2.5	GP-GM	poorly graded gravel with silt and sand	UHM		NATIVE SOIL (Colluvium)			
TP-FP-07	2.5	3.0	GP-GM	poorly graded gravel with silt and sand	UHM		NATIVE SOIL (Colluvium)	Water immediately filled pit to 4.0; below ground surface of floodplain		
TP-FP-07	3.0	4.5	GP-GM	poorly graded gravel with silt and sand	UHM	Manganese	NATIVE SOIL (Colluvium)	The Mixed Tailing and Manganese were only observed on the north end of the test pit (closest to Beartrap Creek)		
TP-FP-07	4.5	5.0	GP-GM	poorly graded gravel with silt and sand	UHM		NATIVE SOIL (Colluvium)			
TP-FP-07	5.5	6.0	GP-GM	poorly graded gravel with silt and sand	UHM	Manganese	Debris Flow	Manganese coated layer contains high visible pyrite content	Moist	Reddish brown [5YR 4/4]
TP-FP-07	6.0	6.5	GP	gravel with sand	UHM	Manganese	Black Manganese coated Gravels; Estimated 70% Gravel and 30% Sand. Alluvium		Wet	Black [5Y 2.5/1]
TP-FP-07	6.5	7.0	GP	gravel with sand	UHM		6.5 to 12 contains Cobbles and Boulders.Max particle size is 20-in.	Old Townsite septic system may be located above test pit		
TP-FP-07	8.0	10.0	GP	gravel with sand	UHM					
TP-FP-07	10.0	11.0	GP	gravel with sand	UHM					
TP-FP-08	0.0	0.5	GM	silty gravel with sand	TAILINGS			Tree roots observed to 3 ft depth	Moist to Saturated	Dark yellowish brown [10YR 3/6]
TP-FP-08	0.5	1.3	GM	silty gravel with sand	TAILINGS				Moist to Saturated	Dark yellowish brown [10YR 3/6]
TP-FP-08	2.0	2.1	GM	silty gravel with sand	TAILINGS			@ 2ft GW 475.7 rmv; 357.0 µs/cm; pH start 6.64 pH end 4.83 (15 Minutes)	Moist to Saturated	Dark yellowish brown [10YR 3/6]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-06A	9.0	13.5	GP-GC	Brown								138+14	21+16
TP-FP-06A	13.5	16.0	GP-GC	Brown								138+14	21+16
TP-FP-06A	16.5	16.6	GP-GC		141	331	48	38708				138+14	21+16
TP-FP-06B	0.0	2.0	GP-GM	Brown								133+67	25+63
TP-FP-06B	2.0	3.5	GP-GM	Brown	30	132	< LOD	35062				133+67	25+63
TP-FP-06B	3.5	5.0	GP-GC									133+67	25+63
TP-FP-06B	5.0	8.0	GP-GC									133+67	25+63
TP-FP-06B	8.0	10.0	GP-GC									133+67	25+63
TP-FP-06B	10.0	11.0	GP-GC									133+67	25+63
TP-FP-07	0.0	0.5	SM									130+85	28+45
TP-FP-07	1.5	2.5	GP-GM									130+85	28+45
TP-FP-07	2.5	3.0	GP-GM		42	242	66	39710				130+85	28+45
TP-FP-07	3.0	4.5	GP-GM									130+85	28+45
TP-FP-07	4.5	5.0	GP-GM									130+85	28+45
TP-FP-07	5.5	6.0	GP-GM									130+85	28+45
TP-FP-07	6.0	6.5	GP									130+85	28+45
TP-FP-07	6.5	7.0	GP									130+85	28+45
TP-FP-07	8.0	10.0	GP									130+85	28+45
TP-FP-07	10.0	11.0	GP									130+85	28+45
TP-FP-08	0.0	0.5	GM	Dark brown [7.5YR 3/4]								130+80	28+50
TP-FP-08	0.5	1.3	GM	Dark brown [7.5YR 3/4]								130+80	28+50
TP-FP-08	2.0	2.1	GM	Dark brown [7.5YR 3/4]					6.64	4.83	357.00	130+80	28+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-08	2.1	2.4	GM	silty gravel with sand	TAILINGS				Moist to Saturated	Dark yellowish brown [10YR 3/6]
TP-FP-08	2.9	3.0	GM	silty gravel with sand	TAILINGS				Moist to Saturated	Dark yellowish brown [10YR 3/6]
TP-FP-08	6.5	8.0	GM	silty gravel with sand	Undisturbed					Very dark brown [7.5YR 2.5/2]
TP-FP-09	0.0	1.0	GM	silty gravel with sand	TAILINGS		0 to 3.5 DEBRIS FLOW with MIXED TAILINGS;pockets of highly plastic clay.			
TP-FP-09	1.0	1.5	GM	silty gravel with sand	TAILINGS			Minor amounts of Pyrite visually observed between 2 and 3 ft depths		
TP-FP-09	2.0	2.3	GM	silty gravel with sand	TAILINGS			Groundwater at 2.5;		
TP-FP-09	2.3	2.5	GM	silty gravel with sand	TAILINGS	Acid Seep		@ 2.5ft GW 620.3 rmv; 1744 µs/cm; pH start 3.03 pH end 3.02 (13 Minutes)		
TP-FP-09	2.5	2.7	GM	silty gravel with sand	TAILINGS	Acid Seep		Reddish colored groundwater slowly seeped into test pit at 3 ft depth. pH of water was measured at 3.0		
TP-FP-09	3.0	3.2	GM	silty gravel with sand	TAILINGS					
TP-FP-09	3.3	3.5	GM	silty gravel with sand	TAILINGS					
TP-FP-09	3.5	4.0	MH	sandy elastic silt	TAILINGS		Layer thickness varies from 0.2 ft on the north side to 0.8 ft on south side of test pit	Large tree root observed on north side of test pit at 3.5 to 4.0 ft depth. Tree root may have been near original ground surface prior to dam breach	Wet	Dark gray [10YR 4/1]
TP-FP-09	4.0	4.3	MH	sandy elastic silt	TAILINGS				Wet	Dark gray [10YR 4/1]
TP-FP-09	4.3	4.5	GP	poorly graded gravel with sand	TAILINGS					
TP-FP-09	5.0	7.5	GP	poorly graded gravel with sand	Undisturbed			@ 7.5ft GW 331.9 rmv; 292.0 µs/cm; pH start 5.48 pH end 6.18 (13 Minutes)		
TP-FP-09	8.0	8.3	GP	poorly graded gravel with sand	Undisturbed					
TP-FP-09	8.3	8.5	GP	poorly graded gravel with sand	Undisturbed			Installed 2" diameter PVC to 8.25;		
TP-FP-10	0.0	2.0	GM	silty gravel with sand	Undisturbed		NATIVE soil.			
TP-FP-10	2.4	4.0	GM	silty gravel with sand	Undisturbed		NATIVE soil.	Groundwater flowed into test pit from upstream side at 4 ft depth		
TP-FP-10	4.5	5.0	GM	silty gravel with sand	Undisturbed		NATIVE soil.			
TP-FP-10	5.0	5.5	GM	silty gravel with sand	Undisturbed		NATIVE soil.			
TP-FP-10	6.0	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		Maximum particle size is approximately 20-in; estimated 10% Boulder; 25% Cobble; 40% Gravel; 25% Sand			
TP-FP-10	8.0	8.5	BEDROCK		BEDROCK			Bedrock at 8 ft; Excavator breaking rock particles to dig		
TP-FP-10A	0.0	0.3	SP-SM	poorly graded sand with silt and gravel	TAILINGS		Debris Flow		Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-10A	0.3	0.8	GM	silty gravel with sand	TAILINGS		MIXED TAILINGS.Estimated 30% Gravel; 40% Sand; 30% Fines			
TP-FP-10A	1.0	1.1	GM	silty gravel with sand	Undisturbed					
TP-FP-10A	1.1	1.3	GM	silty gravel with sand	Undisturbed					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-08	2.1	2.4	GM	Dark brown [7.5YR 3/4]								130+80	28+50
TP-FP-08	2.9	3.0	GM	Dark brown [7.5YR 3/4]								130+80	28+50
TP-FP-08	6.5	8.0	GM	Dark brown [7.5YR 3/4]								130+80	28+50
TP-FP-09	0.0	1.0	GM									130+75	28+55
TP-FP-09	1.0	1.5	GM									130+75	28+55
TP-FP-09	2.0	2.3	GM									130+75	28+55
TP-FP-09	2.3	2.5	GM						3.03	3.02	1,744.00	130+75	28+55
TP-FP-09	2.5	2.7	GM						3			130+75	28+55
TP-FP-09	3.0	3.2	GM									130+75	28+55
TP-FP-09	3.3	3.5	GM									130+75	28+55
TP-FP-09	3.5	4.0	MH									130+75	28+55
TP-FP-09	4.0	4.3	MH									130+75	28+55
TP-FP-09	4.3	4.5	GP									130+75	28+55
TP-FP-09	5.0	7.5	GP						5.48	6.18	292.00	130+75	28+55
TP-FP-09	8.0	8.3	GP									130+75	28+55
TP-FP-09	8.3	8.5	GP									130+75	28+55
TP-FP-10	0.0	2.0	GM									130+77	28+53
TP-FP-10	2.4	4.0	GM									130+77	28+53
TP-FP-10	4.5	5.0	GM									130+77	28+53
TP-FP-10	5.0	5.5	GM									130+77	28+53
TP-FP-10	6.0	8.0	GP-GM									130+77	28+53
TP-FP-10	8.0	8.5	BEDROCK									130+77	28+53
TP-FP-10A	0.0	0.3	SP-SM									130+76	28+54
TP-FP-10A	0.3	0.8	GM									130+76	28+54
TP-FP-10A	1.0	1.1	GM									130+76	28+54
TP-FP-10A	1.1	1.3	GM		615	334	114	55519				130+76	28+54

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-10A	1.3	1.6	GM	silty gravel with sand	Undisturbed					
TP-FP-10A	1.6	2.1	GP	poorly graded gravel with sand	Undisturbed			Lots of plant roots in Mixed Tailing at 0.25 ft depth	Wet	Very dark brown [7.5YR 2.5/2]
TP-FP-10A	2.6	3.5	GP	poorly graded gravel with sand	Undisturbed		Estimated 30% Cobble; 50% Gravel; and 20% Sand		Wet	Very dark brown [7.5YR 2.5/2]
TP-FP-10A	4.0	5.5	GP	poorly graded gravel with sand	Undisturbed		Estimated 30% Cobble; 50% Gravel; and 20% Sand	Installed 2" diameter PVC to 3.7;	Wet	Very dark brown [7.5YR 2.5/2]
TP-FP-11	0.0	0.1	SM	organic silty sand	TAILINGS	Topsoil	TOPSOIL			
TP-FP-11	0.3	0.5	ML	silt with gravel	TAILINGS		MIXED TAILINGS.Plant roots at 0.1 - 0.5 ft		Moist	Dark reddish brown [5YR 3/4]
TP-FP-11	0.5	1.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS		Former Topsoil?; fine to medium grain; high percentage of plant and tree roots from 0.5 to 1.5 ft			
TP-FP-11	1.2	1.5	GP-GM	poorly graded gravel with silt and sand	TAILINGS					
TP-FP-11	2.0	2.5	GP-GM	poorly graded gravel with silt and sand	UHM			Groundwater freely flowing into test pit from all sides at 8.5 ft depth	Saturated	Dark brown [7.5YR 3/3]
TP-FP-11	2.5	2.7	GP-GM	poorly graded gravel with silt and sand	UHM				Saturated	Dark brown [7.5YR 3/3]
TP-FP-11	3.0	3.7	GP-GM	poorly graded gravel with silt and sand	UHM				Saturated	Dark brown [7.5YR 3/3]
TP-FP-11	4.0	6.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Saturated	Dark brown [7.5YR 3/3]
TP-FP-11	6.5	7.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Saturated	Dark brown [7.5YR 3/3]
TP-FP-11	7.0	8.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Saturated	Dark brown [7.5YR 3/3]
TP-FP-11	8.5	9.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 9ft GW 507.4 rmv; 455.0 µs/cm; pH start 7.59 pH end 6.91 (31 Minutes)	Saturated	Dark brown [7.5YR 3/3]
TP-FP-12	0.0	0.9	GP-GM	poorly graded gravel with silt and sand	TAILINGS		MIXED TAILINGS. Estimated 30% cobble; 40% gravel and 30% sand			
TP-FP-12	1.3	1.6	GP-GM	poorly graded gravel with silt and sand	TAILINGS		MIXED TAILINGS. Estimated 30% cobble; 40% gravel and 30% sand			
TP-FP-12	2.3	3.0	GP	poorly graded gravel with sand	UHM		particles horizontally deposited		Wet	Dark brown [7.5YR 3/3]
TP-FP-12	3.5	6.0	GP		UHM					
TP-FP-12	6.5	8.0	GP	poorly graded gravel with sand	UHM				Wet	Dark brown [7.5YR 3/3]
TP-FP-12	8.5	9.5	GP	poorly graded gravel with sand	UHM				Wet	Dark brown [7.5YR 3/3]
TP-FP-13	0.0	1.0	SP	poorly graded sand with gravel	TAILINGS		Estimated 40% Gravel; 60% Sand. Soil layer contains a lot of dead tree roots		Moist	Dark reddish brown [5YR 3/3]
TP-FP-13	1.3	1.5	SM	silty sand with gravel	TAILINGS		1 to 4 MIXED TAILINGS; medium grained sand; visible Pyrite on surface of gravels; occasional layers with a darker reddish hue; largest particle is approximately 6-in. Debris flow		Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-13	1.8	2.0	SM	silty sand with gravel	TAILINGS			@ 2.6ft GW 447.8 rmv; 288.5 µs/cm; pH start 6.87 pH end 5.51 (26 Minutes)	Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-13	2.0	2.4	SM	silty sand with gravel	TAILINGS	Manganese			Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-13	2.4	2.6	SM	silty sand with gravel	TAILINGS	Manganese			Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-13	2.6	2.7	SM	silty sand with gravel	TAILINGS	Manganese			Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-13	2.7	3.1	SM	silty sand with gravel	TAILINGS	Manganese			Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-13	3.4	3.5	SM	silty sand with gravel	TAILINGS	Manganese			Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-13	3.7	3.8	SM	silty sand with gravel	TAILINGS	Manganese	Black Manganese Layer; generally 2 to 3-in thick; depth of layer varies across test pit profile from 1.9 to 3.9 ft depth	Groundwater at 2.6ft	Moist	Dark reddish brown [5YR 2.5/2]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-10A	1.3	1.6	GM									130+76	28+54
TP-FP-10A	1.6	2.1	GP									130+76	28+54
TP-FP-10A	2.6	3.5	GP									130+76	28+54
TP-FP-10A	4.0	5.5	GP									130+76	28+54
TP-FP-11	0.0	0.1	SM	Brown								125+50	33+80
TP-FP-11	0.3	0.5	ML									125+50	33+80
TP-FP-11	0.5	1.0	GP-GM									125+50	33+80
TP-FP-11	1.2	1.5	GP-GM									125+50	33+80
TP-FP-11	2.0	2.5	GP-GM									125+50	33+80
TP-FP-11	2.5	2.7	GP-GM									125+50	33+80
TP-FP-11	3.0	3.7	GP-GM									125+50	33+80
TP-FP-11	4.0	6.5	GP-GM									125+50	33+80
TP-FP-11	6.5	7.0	GP-GM		93	363	64	43996				125+50	33+80
TP-FP-11	7.0	8.5	GP-GM									125+50	33+80
TP-FP-11	8.5	9.0	GP-GM		191	406	86	48147	7.59	6.91	455.00	125+50	33+80
TP-FP-12	0.0	0.9	GP-GM									125+40	33+90
TP-FP-12	1.3	1.6	GP-GM									125+40	33+90
TP-FP-12	2.3	3.0	GP									125+40	33+90
TP-FP-12	3.5	6.0	GP									125+40	33+90
TP-FP-12	6.5	8.0	GP									125+40	33+90
TP-FP-12	8.5	9.5	GP									125+40	33+90
TP-FP-13	0.0	1.0	SP									125+24	34+06
TP-FP-13	1.3	1.5	SM									125+24	34+06
TP-FP-13	1.8	2.0	SM						6.87	5.51	288.50	125+24	34+06
TP-FP-13	2.0	2.4	SM									125+24	34+06
TP-FP-13	2.4	2.6	SM		398	489	264	91609				125+24	34+06
TP-FP-13	2.6	2.7	SM		398	489	264	91609				125+24	34+06
TP-FP-13	2.7	3.1	SM									125+24	34+06
TP-FP-13	3.4	3.5	SM									125+24	34+06
TP-FP-13	3.7	3.8	SM									125+24	34+06

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-13	3.8	4.0	GM	silty gravel with sand	TAILINGS		.Estimated 20% Cobbles; 50% Gravel; and 30% sand		Wet	Black [10YR 2/1]
TP-FP-13	4.3	4.9	BEDROCK	bedrock	BEDROCK			@ 5ft GW 456.9 rmv; 326.0 µs/cm; pH start 5.73 pH end 5.63 (25 Minutes)		Very dark brown [7.5YR 2.5/2]
TP-FP-13	4.9	5.0	BEDROCK	bedrock	BEDROCK			Bottom of test pit is approximately 2 ft below Beartrack Creek elevation.		Very dark brown [7.5YR 2.5/2]
TP-FP-14	0.0	1.0	GP	poorly graded gravel with sand	TAILINGS		Max particle size is approximately 8-in; estimated 20% Cobble; 50% Gravel and 30% Sand. Depth of layer varies between 0.2 and 1.4 ft. Random orientation of particles. Debris flow	Groundwater at 1.4 ft which is approximately same elevation as Beartrap Creek	Moist	Dark brown [7.5YR 3/3]
TP-FP-14	1.0	1.3	GP	poorly graded gravel with sand	TAILINGS				Moist	Dark brown [7.5YR 3/3]
TP-FP-14	1.3	1.4	GP	poorly graded gravel with sand	TAILINGS				Moist	Dark brown [7.5YR 3/3]
TP-FP-14	1.4	1.9	GM	silty gravel with sand	TAILINGS					
TP-FP-14	1.9	2.0	GM	silty gravel with sand	TAILINGS	Acid	MIXED TAILINGS; Max particle size is 8-in; estimated 20% Cobble; 50% Gravel and 30% Sand	@ 2ft GW 702.0 rmv; 1074 µs/cm; pH start 3.42 pH end 3.51 (11 Minutes)		
TP-FP-14	2.0	3.0	GM	silty gravel with sand	TAILINGS					
TP-FP-14	3.0	3.2	GM	silty gravel with sand	TAILINGS	Manganese	3 to 4 Black Manganese stained Max particle is approximately 8-in; estimated 30% Cobbles; 50% Gravel; and 20% Sand.Cobbles are subangular; gravels and sands are subangular to subrounded.Sand particles are primarily coarse grained	Static groundwater level approximately the same as the creek	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-14	3.5	4.0	GM	silty gravel with sand	TAILINGS	Manganese			Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-14	4.6	6.0	GM	silty gravel with sand	Undisturbed		Particles appear to be randomly oriented	Visual lithology break	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-14	6.5	8.0	GM	silty gravel with sand	Undisturbed				Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-14	8.0	10.0	GM	silty gravel with sand	Undisturbed			@ 8ft GW 559.7 rmv; 821.0 µs/cm; pH start 5.03 pH end 5.64 (4 Minutes)	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-15	0.4	1.7	GP-GC	clayey gravel with sand	Undisturbed				Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-15	1.7	1.9	GP-GC	clayey gravel with sand	Undisturbed				Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-15	1.9	5.0	GP-GC	clayey gravel with sand	Undisturbed			Groundwater at 5ft	Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-15	5.0	6.5	GP-GC	clayey gravel with sand	Undisturbed				Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-15	7.0	8.0	GP-GC	clayey gravel with sand	Undisturbed	Acid		@ 8ft GW 748.4 rmv; 225.4 µs/cm; pH start 3.03 pH end 3.12 (25 Minutes)	Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-15	8.0	9.5	GP	poorly graded gravel with sand	Undisturbed	Acid	8.0 to 11.0 ALLUVIUM with occasional pockets of Colluvium (Clayey Gravel); Maximum particle is 4-ft; near 11' estimated 10% Boulder; 20% Cobble; 40% Gravel and 30% Sand		Wet	
TP-FP-15	9.5	11.0	GP	poorly graded gravel with sand	Undisturbed	Acid		@ 9.5 ft GW 629.0 rmv; 832.0 µs/cm; pH start 4.43 pH end 4.60 (11 Minutes)	Wet	

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-13	3.8	4.0	GM									125+24	34+06
TP-FP-13	4.3	4.9	BEDROCK						5.73	5.63	326.00	125+24	34+06
TP-FP-13	4.9	5.0	BEDROCK									125+24	34+06
TP-FP-14	0.0	1.0	GP									125+35	33+95
TP-FP-14	1.0	1.3	GP		969	236	137	63031				125+35	33+95
TP-FP-14	1.3	1.4	GP									125+35	33+95
TP-FP-14	1.4	1.9	GM		6911	434	268	83949				125+35	33+95
TP-FP-14	1.9	2.0	GM						3.42	3.51	1,074.00	125+35	33+95
TP-FP-14	2.0	3.0	GM									125+35	33+95
TP-FP-14	3.0	3.2	GM									125+35	33+95
TP-FP-14	3.5	4.0	GM									125+35	33+95
TP-FP-14	4.6	6.0	GM									125+35	33+95
TP-FP-14	6.5	8.0	GM									125+35	33+95
TP-FP-14	8.0	10.0	GM						5.03	5.64	821.00	125+35	33+95
TP-FP-15	0.4	1.7	GP-GC									120+95	38+35
TP-FP-15	1.7	1.9	GP-GC		71	368	34	37308				120+95	38+35
TP-FP-15	1.9	5.0	GP-GC									120+95	38+35
TP-FP-15	5.0	6.5	GP-GC									120+95	38+35
TP-FP-15	7.0	8.0	GP-GC						3.03	3.12	225.40	120+95	38+35
TP-FP-15	8.0	9.5	GP	Brown								120+95	38+35
TP-FP-15	9.5	11.0	GP	Brown					4.43	4.6	832.00	120+95	38+35

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-15A	0.0	0.5	CH	fat clay	TAILINGS		0 to 3 Randomly oriented MIXED TAILINGS composed of three soil types:Approximately 30% rusty yellowish brown; low plasticity; CLAYEY SAND; 30% grayish brown; POORLY GRADED SAND; and 40% subangular GRAVELS and COBBLES with SAND		Dry to moist	Dark brown [10YR 3/3]
TP-FP-15A	1.0	2.7	CH	fat clay	TAILINGS				Dry to moist	Dark brown [10YR 3/3]
TP-FP-15A	3.0	3.1	GP	gravel with sand	TAILINGS		3.0 to 3.75 MIXED TAILINGS; visible Pyrite; some rusty brown stains; estimated 10% Cobble; 50% Gravel; and 40% Sand.Layer is approximately same elevation as Beartrap Creek		Saturated	Dark brown [10YR 3/3]
TP-FP-15A	3.6	3.8	GP	gravel with sand	TAILINGS				Saturated	Dark brown [10YR 3/3]
TP-FP-15A	3.8	5.0	GM	silty gravel with sand	TAILINGS		MIXED TAILING; Estimated 20% Cobble; 50% Gravel; and 30% Sand		Saturated	Dark reddish brown [5YR 3/3]
TP-FP-15A	5.7	5.8	GM	silty gravel with sand	Undisturbed		MIXED TAILING; Estimated 20% Cobble; 50% Gravel; and 30% Sand		Saturated	Dark reddish brown [5YR 3/3]
TP-FP-15A	5.8	6.0	GP	poorly graded gravel with silt and sand	Undisturbed	Black	ALLUVIUM with occasional pockets of Clayey Gravel (Colluvium). Estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand. **Max particle size is 4 ft near 9'.Black staining from 6 to 8 ft**		Saturated	Dark brown [7.5YR 3/4]
TP-FP-15A	6.5	8.0	GP	poorly graded gravel with silt and sand	Undisturbed	Black			Saturated	Dark brown [7.5YR 3/4]
TP-FP-15A	8.0	8.5	GP	poorly graded gravel with silt and sand	Undisturbed	Acid	Acid water pH 3	@ 8ft GW 748.4 rmv; 225.4 µs/cm; pH start 3.03 pH end 3.12 (25 Minutes)	Saturated	Dark brown [7.5YR 3/4]
TP-FP-16	0.0	1.1	GP-GM	poorly graded gravel with silt and sand	TAILINGS		0 to 4 MIXED TAILINGS with pockets of medium plasticity CLAY (CL); estimated 20% Cobble; 40% Gravel and 40% Sand; max particle size is 8" diameter		Moist	Yellowish red [5YR 5/8]
TP-FP-16	1.5	3.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS				Moist	Yellowish red [5YR 5/8]
TP-FP-16	3.4	4.2	GP-GM	poorly graded gravel with silt and sand	TAILINGS				Moist	Yellowish red [5YR 5/8]
TP-FP-16	4.3	4.8	SP	poorly graded sand with gravel	TAILINGS	iron stained	0 to 6 Primarily medium grained; larger gravel particles are subround; live cotton wood tree roots at bottom of layer		Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-16	5.0	5.5	SP	poorly graded sand with gravel	TAILINGS	iron stained			Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-16	7.4	7.9	GP	poorly graded gravel with sand	UHM	iron stained			Wet	
TP-FP-16	7.9	9.0	GP	poorly graded gravel with sand	UHM	iron stained	7.9 to 12.0 estimated 10% Cobble; 40% Gravel; 50% Sand; no visible tailing deposition/staining; small (1/8-in diam.) roots observed at 11 ft depth		Saturated	Dark reddish brown [5YR 2.5/2]
TP-FP-16	9.4	10.9	GP	poorly graded gravel with sand	UHM	iron stained		@ 11ft GW 750.8 rmv; 1941 µs/cm; pH start 3.59 pH end 3.79 (22 Minutes)	Saturated	Dark reddish brown [5YR 2.5/2]
TP-FP-16	10.9	11.0	GP	poorly graded gravel with sand	UHM	iron stained			Saturated	Dark reddish brown [5YR 2.5/2]
TP-FP-16	11.0	11.5	GP	poorly graded gravel with sand	UHM	iron stained	wtaer		Saturated	Dark reddish brown [5YR 2.5/2]
TP-FP-17	0.0	0.1	GM	silty gravel with sand	TAILINGS		0 to 2.7 MIXED TAILINGS; estimated 10% Cobble; 40% Gravel; and 50% Sand; max particle size is approximately 6-in diameter	Wood debris (lumber) observed in Mixed Tailings	Moist	Yellowish brown [10YR 5/8]
TP-FP-17	0.1	1.0	GM	silty gravel with sand	TAILINGS				Moist	Yellowish brown [10YR 5/8]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-15A	0.0	0.5	CH									120+92	38+38
TP-FP-15A	1.0	2.7	CH									120+92	38+38
TP-FP-15A	3.0	3.1	GP	Black [10YR 2/1]								120+92	38+38
TP-FP-15A	3.6	3.8	GP	Black [10YR 2/1]								120+92	38+38
TP-FP-15A	3.8	5.0	GM									120+92	38+38
TP-FP-15A	5.7	5.8	GM									120+92	38+38
TP-FP-15A	5.8	6.0	GP									120+92	38+38
TP-FP-15A	6.5	8.0	GP									120+92	38+38
TP-FP-15A	8.0	8.5	GP						3.03	3.12	225.40	120+92	38+38
TP-FP-16	0.0	1.1	GP-GM									120+05	39+25
TP-FP-16	1.5	3.0	GP-GM									120+05	39+25
TP-FP-16	3.4	4.2	GP-GM									120+05	39+25
TP-FP-16	4.3	4.8	SP									120+05	39+25
TP-FP-16	5.0	5.5	SP									120+05	39+25
TP-FP-16	7.4	7.9	GP	Brown with rust colored deposition between gravels								120+05	39+25
TP-FP-16	7.9	9.0	GP	Very dark brown [7.5YR 2.5/3]								120+05	39+25
TP-FP-16	9.4	10.9	GP	Very dark brown [7.5YR 2.5/3]					3.59	3.79	1,941.00	120+05	39+25
TP-FP-16	10.9	11.0	GP	Very dark brown [7.5YR 2.5/3]								120+05	39+25
TP-FP-16	11.0	11.5	GP	Very dark brown [7.5YR 2.5/3]								120+05	39+25
TP-FP-17	0.0	0.1	GM									121+15	38+15
TP-FP-17	0.1	1.0	GM									121+15	38+15

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-17	1.5	2.6	GM	silty gravel with sand	TAILINGS				Moist	Yellowish brown [10YR 5/8]
TP-FP-17	3.2	4.6	GP	well graded gravel with sand	UHM		3.2 to 12 Estimated 10% Boulder; 20% Cobble; 40% Gravel and 30% Sand; boulders and cobbles are subangular; gravels and sands are subrounded;	Groundwater inflow at 9 ft	Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-17	6.0	6.3	GP	well graded gravel with sand	UHM				Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-17	6.5	9.0	GP	well graded gravel with sand	UHM			Groundwater inflow at 9 ft	Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-17	9.5	11.5	GP	well graded gravel with sand	UHM				Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-18	0.3	0.6	GP	poorly graded gravel with silt and sand	TAILINGS		estimated 30% Cobble; 40% Gravel and 30% Sand; approximate max particle size is 5-in in diameter. Contains lumber		Moist	
TP-FP-18	0.8	1.2	GP	poorly graded gravel with sand	TAILINGS				Moist	
TP-FP-18	1.2	2.0	GP-GC	poorly graded gravel with clay and sand	TAILINGS		0 to 3 estimated 30% Cobble; 40% Gravel; 30% Sand & Clay; approximate max particle size is 10-in diameter		Moist	
TP-FP-18	2.3	3.0	GP-GC	poorly graded gravel with clay and sand	TAILINGS				Moist	
TP-FP-18	3.0	4.0	GP-GC	poorly graded gravel	Undisturbed		consists ofBOULDERS and COBBLES with little sand	6-in diameter black pipe observed at 4 ft depth	Moist	
TP-FP-18	4.5	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Test pit side walls caved readily between 4 and 11 ft	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-18	8.0	9.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		boulders and cobbles are subangular; gravels and sands are subrounded; max particle size is approximately 18-in diameter	No iron staining as in TP-FP-16 and 17	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-18	9.0	11.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Groundwater at 11 ft	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-18	11.0	12.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 12ft GW 477.9 rmv; 347.0 µs/cm; pH start 5.70 pH end 6.48 (15 Minutes)	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-19	0.0	0.5	GP	poorly graded gravel with sand	TAILINGS		0 to 1 MIXED TAILINGS with pockets of medium plasticity clay (CL); estimated 10% Cobble; 50% Gravel; and 40% Sand & Clay; max particle size is approximately 4-in diameter		Moist	Light yellowish brown [10YR 6/4]
TP-FP-19	0.9	1.0	GP	poorly graded gravel with sand	TAILINGS				Moist	Light yellowish brown [10YR 6/4]
TP-FP-19	1.0	1.8	GP-GM	poorly graded gravel with silt and sand	TAILINGS		1 to 3.5 max particle size is approximately approximately 6-in.; cobbles and gravels are subangular; sand particles are subrounded		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-19	2.4	3.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS			Test pit side walls were layed back at 1.5H:1V slope due to safety concerns.	Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-19	3.0	3.5	GP-GM	poorly graded gravel with silt and sand	TAILINGS			Soil profile was logged in detail from 0 to 5 ft prior to sloping side walls.	Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-19	3.5	3.9	GP	poorly graded gravel with sand	TAILINGS	Iron stain	primarily 1.5-in minus gravels with pockets of 3/8-in minus gravels; iron staining/deposition between gravel particles and on surface of particles; iron staining/deposition appear to be remnants of horizontal flow		Moist	Strong brown [7.5YR 4/6]
TP-FP-19	4.6	4.9	GP	poorly graded gravel with sand	TAILINGS				Moist	Strong brown [7.5YR 4/6]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-17	1.5	2.6	GM									121+15	38+15
TP-FP-17	3.2	4.6	GP									121+15	38+15
TP-FP-17	6.0	6.3	GP									121+15	38+15
TP-FP-17	6.5	9.0	GP									121+15	38+15
TP-FP-17	9.5	11.5	GP									121+15	38+15
TP-FP-18	0.3	0.6	GP	Rusty Brown								121+30	38+00
TP-FP-18	0.8	1.2	GP	Brown								121+30	38+00
TP-FP-18	1.2	2.0	GP-GC	Dark brown								121+30	38+00
TP-FP-18	2.3	3.0	GP-GC	Dark brown								121+30	38+00
TP-FP-18	3.0	4.0	GP-GC									121+30	38+00
TP-FP-18	4.5	8.0	GP-GM	Dark brown [7.5YR 3/3]								121+30	38+00
TP-FP-18	8.0	9.0	GP-GM	Dark brown [7.5YR 3/3]								121+30	38+00
TP-FP-18	9.0	11.0	GP-GM	Dark brown [7.5YR 3/3]								121+30	38+00
TP-FP-18	11.0	12.0	GP-GM	Dark brown [7.5YR 3/3]					5.7	6.4 a	347.00	121+30	38+00
TP-FP-19	0.0	0.5	GP									121+51	37+79
TP-FP-19	0.9	1.0	GP									121+51	37+79
TP-FP-19	1.0	1.8	GP-GM									121+51	37+79
TP-FP-19	2.4	3.0	GP-GM									121+51	37+79
TP-FP-19	3.0	3.5	GP-GM									121+51	37+79
TP-FP-19	3.5	3.9	GP									121+51	37+79
TP-FP-19	4.6	4.9	GP									121+51	37+79

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-19	5.5	8.0	GP-GC	poorly graded gravel with clay and sand	UHM				Moist	Dark brown [7.5YR 3/4]
TP-FP-19A	0.0	1.0	SM	silty sand	Undisturbed	Topsoil	TOPSOIL with ORGANICS including large tree roots	Excavated into hill side (31 ft east of TP-FP-19) to determine lateral extents of mixed tailing observed in TP-FP-19.	Moist	
TP-FP-19A	1.0	2.0	SM	silty sand with gravel	Undisturbed		1 to 3 Estimated 15% subangular Cobbels; 30% subangular to subrounded Gravels; and 55% Sand and Silt		Moist	
TP-FP-19A	2.0	3.0	SM	silty sand with gravel	Undisturbed			No visual evidence of Mixed Tailing observed in test pit	Moist	
TP-FP-20	0.0	0.3	GP-GM	poorly graded gravel with silt and sand	TAILINGS		0 to 4.3 MIXED TAILINGS; estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand; max particle size is approximately 12-in diameter	Mixed tailings laterally surrounds inclusion of sandy gravel and poorly graded sand		
TP-FP-20	0.5	2.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS					
TP-FP-20	2.0	2.1	GP-GM	poorly graded gravel with silt and sand	TAILINGS					
TP-FP-20	2.4	3.1	GP-GM	poorly graded gravel with silt and sand	TAILINGS					
TP-FP-20	3.6	4.3	GP-GM	poorly graded gravel with silt and sand	TAILINGS					
TP-FP-20	4.3	4.5	GP	poorly graded gravel with sand	Undisturbed		gravel and sand particles are subrounded; max particle size is approximately 14-in diameter	Roots from 4.3 to 4.5 ft	Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-20	4.5	6.0	GP	poorly graded gravel with sand	Undisturbed		4.3 to 10 estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand. Boulders and cobbles are subangular;	Groundwater at 6.0;	Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-20	6.5	8.0	GP	poorly graded gravel with sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-20	8.5	9.5	GP	poorly graded gravel with sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-21	0.0	1.0	GP	poorly graded gravel with sand	Tailings		0 to 2.8 MIXED TAILINGS; estimated 20% Cobble; 50% Gravel; and 30% Sand; max particle size is approximately 5-in. diameter		Moist	Dark reddish brown [2.5YR 3/4]
TP-FP-21	1.3	1.4	GP	poorly graded gravel with sand	Tailings				Moist	Dark reddish brown [2.5YR 3/4]
TP-FP-21	1.4	2.0	GP	poorly graded gravel with sand	Tailings				Moist	Dark reddish brown [2.5YR 3/4]
TP-FP-21	2.0	2.8	GP	poorly graded gravel with sand	Tailings			Burned tree stem at 2.8 ft	Moist	Dark reddish brown [2.5YR 3/4]
TP-FP-21	3.2	3.4	GP-GM	poorly graded gravel with silt and sand	Tailings		estimated 10% Cobble; 50% Gravel; and 40% Sand		Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-21	3.5	4.7	SP		Tailings					
TP-FP-21	4.8	6.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/4]
TP-FP-21	7.0	10.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/4]
TP-FP-22	0.0	0.1	SM	silty sand	TAILINGS			Thin layer (0.5-in) of brownish black plant decay on ground surface	Moist	Dark reddish brown [5YR 3/4]
TP-FP-22	0.3	0.4	GM	silty gravel with sand	TAILINGS	Topsoil	estimated 50% Gravel; 30% Sand; and 20% Clay;abundant plant roots.Appeared to be buried topsoil horizon		Moist	Black [5Y 2.5/1]
TP-FP-22	1.2	2.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	2.0	2.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	2.3	3.7	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	3.7	3.9	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-19	5.5	8.0	GP-GC									121+51	37+79
TP-FP-19A	0.0	1.0	SM	Brown								121+50	37+80
TP-FP-19A	1.0	2.0	SM	Pale brown								121+50	37+80
TP-FP-19A	2.0	3.0	SM	Pale brown								121+50	37+80
TP-FP-20	0.0	0.3	GP-GM									119+15	40+15
TP-FP-20	0.5	2.0	GP-GM									119+15	40+15
TP-FP-20	2.0	2.1	GP-GM									119+15	40+15
TP-FP-20	2.4	3.1	GP-GM									119+15	40+15
TP-FP-20	3.6	4.3	GP-GM									119+15	40+15
TP-FP-20	4.3	4.5	GP									119+15	40+15
TP-FP-20	4.5	6.0	GP									119+15	40+15
TP-FP-20	6.5	8.0	GP									119+15	40+15
TP-FP-20	8.5	9.5	GP									119+15	40+15
TP-FP-21	0.0	1.0	GP	Very dark brown [7.5YR 2.5/3]								119+30	40+00
TP-FP-21	1.3	1.4	GP	Very dark brown [7.5YR 2.5/3]								119+30	40+00
TP-FP-21	1.4	2.0	GP	Very dark brown [7.5YR 2.5/3]								119+30	40+00
TP-FP-21	2.0	2.8	GP	Very dark brown [7.5YR 2.5/3]								119+30	40+00
TP-FP-21	3.2	3.4	GP-GM									119+30	40+00
TP-FP-21	3.5	4.7	SP									119+30	40+00
TP-FP-21	4.8	6.5	GP-GM									119+30	40+00
TP-FP-21	7.0	10.0	GP-GM									119+30	40+00
TP-FP-22	0.0	0.1	SM									118+50	40+80
TP-FP-22	0.3	0.4	GM									118+50	40+80
TP-FP-22	1.2	2.0	GP-GM	Very dark brown [7.5YR 2.5/3]								118+50	40+80
TP-FP-22	2.0	2.3	GP-GM	Very dark brown [7.5YR 2.5/3]	29	258	23	34800				118+50	40+80
TP-FP-22	2.3	3.7	GP-GM	Very dark brown [7.5YR 2.5/3]								118+50	40+80
TP-FP-22	3.7	3.9	GP-GM	Very dark brown [7.5YR 2.5/3]	228	309	116	51256				118+50	40+80

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-22	3.9	5.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		3.9 to 9.5 at 4 ft depth estimated 30% Cobble; 40% Gravel; and 30% Sand; below 6 ft depth boulders (max particle size approximately 14-in) observed; particles are generally elongated	Groundwater at 5 ft	Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	5.0	5.1	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Test pit sides caved in very easily below water	Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	5.1	5.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	5.5	6.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 6ft GW 509.7 rmv; 201.1 µs/cm; pH start 5.70 pH end 5.69 (28 Minutes)	Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	6.0	7.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	7.5	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	8.0	9.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-22	9.0	9.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 9.5 ft GW 484.1 rmv; 232.7 µs/cm; pH start 5.79 pH end 5.90 (7 Minutes)	Moist to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-25	0.0	0.1	ML	sandy silt	TAILINGS	Topsoil	TOPSOIL; organic plant decay		Moist	
TP-FP-25	0.1	0.4	ML	sandy silt	TAILINGS	Topsoil	TOPSOIL; organic plant decay		Moist	
TP-FP-25	0.9	1.0	ML	sandy silt	TAILINGS		MIXED TAILING		Moist	Dark yellowish brown [10YR 4/6]
TP-FP-25	1.0	1.1	OL	organic sandy silt	TAILINGS	Topsoil	TOPSOIL; high organic content possible; topsoil prior to flood		Moist	Black [2.5Y 2.5/1]
TP-FP-25	1.2	1.7	GP-GM	poorly graded gravel with silt and sand	Undisturbed		1 - 4.3 estimated 10% Cobble; 50% Gravel; and 40% Sand; max particle size is 5-in; increased rock content (boulders and cobbles) from 3.4 to 4.3 ft		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-25	1.7	2.1	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-25	2.1	4.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-25	4.5	5.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed		iron colored staining on surface of gravels		Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-25	5.3	6.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		iron colored staining on surface of gravels	Groundwater at 5.3 ft	Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-25	6.2	6.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		iron colored staining on surface of gravels		Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-25	6.5	7.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		6.5 to 10 estimated 15% Boulder; 25% Cobble; 40% Gravel; and 20% Sand. Maximum particle size approximately 30" long x 12"x 12"	@ 7.5ft GW 605.2 rmv; 401.0 µs/cm; pH start 6.27 pH end 5.39 (19 Minutes)	Moist	Dark reddish brown [5YR 3/3]
TP-FP-25A	0.0	0.1	GP-GM	poorly graded gravel with silt and sand	TAILINGS		estimated 10% Cobble; 50% Gravel; and 40% Sand; max particle size is 5-in; increased rock content (boulders and cobbles) from 1.4 to 2.3 ft		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-25A	0.1	1.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-25A	1.0	1.3	GP-GM	poorly graded gravel with silt and sand	TAILINGS				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-25A	1.8	2.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-25A	2.3	3.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed		iron colored staining on surface of gravels	Groundwater at 3.3 ft	Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-25A	3.3	4.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		iron colored staining on surface of gravels		Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-FP-25A	4.5	5.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		4.5 to 8 estimated 15% Boulder; 25% Cobble; 40% Gravel; and 20% Sand. Maximum particle size approximately 30" long x12" x12"	@ 5.5; GW 605.2 rmv; 401 µs/cm; pH starts 6.27 pH end 5.39 (19 minutes)	Moist	Dark reddish brown [5YR 3/3]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-22	3.9	5.0	GP-GM	Very dark brown [7.5YR 2.5/3]								118+50	40+80
TP-FP-22	5.0	5.1	GP-GM	Very dark brown [7.5YR 2.5/3]								118+50	40+80
TP-FP-22	5.1	5.5	GP-GM	Very dark brown [7.5YR 2.5/3]								118+50	40+80
TP-FP-22	5.5	6.0	GP-GM	Very dark brown [7.5YR 2.5/3]	86	182	56	43453	5.7	5.69	201.10	118+50	40+80
TP-FP-22	6.0	7.5	GP-GM	Very dark brown [7.5YR 2.5/3]								118+50	40+80
TP-FP-22	7.5	8.0	GP-GM	Very dark brown [7.5YR 2.5/3]	49	171	54	40607				118+50	40+80
TP-FP-22	8.0	9.0	GP-GM	Very dark brown [7.5YR 2.5/3]								118+50	40+80
TP-FP-22	9.0	9.5	GP-GM	Very dark brown [7.5YR 2.5/3]	68	224	59	37483	5.79	5.9	232.70	118+50	40+80
TP-FP-25	0.0	0.1	ML	Dark brown								116+06	43+24
TP-FP-25	0.1	0.4	ML	Dark brown								116+06	43+24
TP-FP-25	0.9	1.0	ML									116+06	43+24
TP-FP-25	1.0	1.1	OL									116+06	43+24
TP-FP-25	1.2	1.7	GP-GM									116+06	43+24
TP-FP-25	1.7	2.1	GP-GM		37	288	32	33155				116+06	43+24
TP-FP-25	2.1	4.3	GP-GM									116+06	43+24
TP-FP-25	4.5	5.3	GP-GM									116+06	43+24
TP-FP-25	5.3	6.0	GP-GM									116+06	43+24
TP-FP-25	6.2	6.5	GP-GM									116+06	43+24
TP-FP-25	6.5	7.5	GP-GM	Very dark grayish brown [10YR 3/2]					6.27	5.39	401.00	116+06	43+24
TP-FP-25A	0.0	0.1	GP-GM									116+05	43+25
TP-FP-25A	0.1	1.0	GP-GM									116+05	43+25
TP-FP-25A	1.0	1.3	GP-GM									116+05	43+25
TP-FP-25A	1.8	2.3	GP-GM									116+05	43+25
TP-FP-25A	2.3	3.3	GP-GM									116+05	43+25
TP-FP-25A	3.3	4.5	GP-GM									116+05	43+25
TP-FP-25A	4.5	5.5	GP-GM	Very dark grayish brown [10YR 3/2]					6.27	5.39	401.00	116+05	43+25

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-25A	5.5	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@8.0; GW 625.4 rmv; 510 µs/cm; pH start 5.05 pH end 5.05 (12 minutes)	Moist	Dark reddish brown [5YR 3/3]
TP-FP-26	0.0	0.7	SP-SM	poorly graded sand with silt and gravel	TAILINGS		0 to 1.7 MIXED TAILING; estimated 60% Sand; 40% Gravel; gravel content increases with depth; layer thickness varies between 1.7 and 3.2 ft		Moist	Dark reddish brown [5YR 3/3]
TP-FP-26	1.0	1.7	SP-SM	poorly graded sand with silt and gravel	TAILINGS			Groundwater at 1.7 ft; entered rapidly from upstream side of test pit	Moist	Dark reddish brown [5YR 3/3]
TP-FP-26	1.7	1.8	GW-GM	well graded gravel with silt and sand	TAILINGS				Wet	Dark reddish brown [5YR 2.5/2]
TP-FP-26	2.0	4.0	GW-GM	well graded gravel with silt and sand	TAILINGS				Wet	Dark reddish brown [5YR 2.5/2]
TP-FP-26	4.5	6.0	GW-GM	well graded gravel with silt and sand	UHM			Piezometer was partially bent during backfilling	Wet	Dark reddish brown [5YR 2.5/2]
TP-FP-26	6.5	9.0	GW-GM	well graded gravel with silt and sand	UHM				Wet	Dark reddish brown [5YR 2.5/2]
TP-FP-27	0.4	0.5	SM	silty sand	TAILINGS		fine grain; visible pyrite; visually appears non-native		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	0.8	0.9	SM	silty sand	TAILINGS				Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	1.2	1.3	SC	clayey sand with gravel	TAILINGS		MIXED TAILINGS		Moist	Yellowish brown [10YR 5/6]
TP-FP-27	1.3	1.9	GP	poorly graded gravel with sand	Undisturbed		estimated 60% Gravel and 40% Sand. Sand fraction coarse grained		Moist	
TP-FP-27	1.9	2.0	SM	silty sand	Undisturbed	Organic			Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	2.4	2.6	SM	silty sand	Undisturbed	Organic			Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	2.6	3.8	GP	poorly graded gravel with sand	Undisturbed		estimated 60% Gravel and 40% Sand		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	3.8	4.0	GP	poorly graded gravel with sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	4.0	4.2	GP	poorly graded gravel with sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	5.5	5.7	GP	poorly graded gravel with sand	Undisturbed	iron stain			Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	5.7	6.5	GP	poorly graded gravel with sand	Undisturbed	iron stain			Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	7.0	7.5	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-27	7.5	9.5	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM	@ 9.5ft GW 526.6 rmv; 715.0 µs/cm; pH start 5.63 pH end 5.40 (26 Minutes)	Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-28	0.0	1.0	GC	clayey gravel	Fill		ROAD FILL; with cobbles; roots in top 2 ft	Note: Mixed Tailings deposit was only observed on west side of test pit between depths of 1.5 and 3.6 feet.	Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-28	1.0	1.5	GC	clayey gravel	Fill		ROAD FILL; with cobbles; roots in top 2 ft		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-28	2.0	3.0	SP	silty sand with gravel	TAILINGS				Moist	Yellowish brown [10YR 5/6]
TP-FP-28	3.0	3.5	SP	silty sand with gravel	TAILINGS				Moist	Yellowish brown [10YR 5/6]
TP-FP-28	3.5	3.6	SP	silty sand with gravel	Undisturbed				Moist	Yellowish brown [10YR 5/6]
TP-FP-28	3.6	4.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		estimated 10% Boulder; 30% Cobble; 40% Gravel; and 20% Sand; max particle size is approximately 22-in.; trace amounts of visible pyrite		Moist	Dark yellowish brown [10YR 3/4]
TP-FP-28	4.5	4.6	GP-GM	poorly graded gravel with silt and sand	Undisturbed	Ferricrete	ALLUVIUM contains poorly consolidated Ferricrete		Moist to wet	Dark yellowish brown [10YR 3/4]
TP-FP-28	4.6	5.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed	Ferricrete	ALLUVIUM contains poorly consolidated Ferricrete		Moist to wet	Dark yellowish brown [10YR 3/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-25A	5.5	8.0	GP-GM	Very dark grayish brown [10YR 3/2]					5.05	5.05	510.00	116+05	43+25
TP-FP-26	0.0	0.7	SP-SM									116+10	43+20
TP-FP-26	1.0	1.7	SP-SM									116+10	43+20
TP-FP-26	1.7	1.8	GW-GM	Very dark brown [7.5YR 2.5/3]								116+10	43+20
TP-FP-26	2.0	4.0	GW-GM	Very dark brown [7.5YR 2.5/3]								116+10	43+20
TP-FP-26	4.5	6.0	GW-GM	Very dark brown [7.5YR 2.5/3]								116+10	43+20
TP-FP-26	6.5	9.0	GW-GM	Very dark brown [7.5YR 2.5/3]								116+10	43+20
TP-FP-27	0.4	0.5	SM									116+15	43+15
TP-FP-27	0.8	0.9	SM									116+15	43+15
TP-FP-27	1.2	1.3	SC									116+15	43+15
TP-FP-27	1.3	1.9	GP	Brown	74	467	170	39861				116+15	43+15
TP-FP-27	1.9	2.0	SM									116+15	43+15
TP-FP-27	2.4	2.6	SM									116+15	43+15
TP-FP-27	2.6	3.8	GP									116+15	43+15
TP-FP-27	3.8	4.0	GP		40	482	17	37802				116+15	43+15
TP-FP-27	4.0	4.2	GP		40	482	17	37802				116+15	43+15
TP-FP-27	5.5	5.7	GP									116+15	43+15
TP-FP-27	5.7	6.5	GP									116+15	43+15
TP-FP-27	7.0	7.5	GP									116+15	43+15
TP-FP-27	7.5	9.5	GP						5.63	5.4	715.00	116+15	43+15
TP-FP-28	0.0	1.0	GC	Dark brown [10YR 3/3]								116+20	43+10
TP-FP-28	1.0	1.5	GC	Dark brown [10YR 3/3]	211	159	123	46177				116+20	43+10
TP-FP-28	2.0	3.0	SP									116+20	43+10
TP-FP-28	3.0	3.5	SP		165	406	83	40497				116+20	43+10
TP-FP-28	3.5	3.6	SP									116+20	43+10
TP-FP-28	3.6	4.5	GP-GM									116+20	43+10
TP-FP-28	4.5	4.6	GP-GM	Very dark brown [7.5YR 2.5/3]								116+20	43+10
TP-FP-28	4.6	5.0	GP-GM	Very dark brown [7.5YR 2.5/3]	60	250	86	52337				116+20	43+10

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-28	5.0	5.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed	Ferricrete	ALLUVIUM contains poorly consolidated Ferricrete		Moist to wet	Dark yellowish brown [10YR 3/4]
TP-FP-28	7.0	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-28	8.0	8.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-28	8.5	9.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 9ft GW 485.5 rmv; 374.0 µs/cm; pH start 5.84 pH end 5.69 (33 Minutes)	Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-28	9.0	9.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-30	0.0	0.1	SM	silty sand	TAILINGS	Organics	0 to 2 MIXED TAILINGS;varying layers of grayish brown and rusty brown; visible Pyrite; organics in top 1.5 ft	Test pit located in water treatment plant storage yard	Moist	Very dark brown [10YR 2/2]
TP-FP-30	0.1	0.5	SM	silty sand	TAILINGS	Organics			Moist	Very dark brown [10YR 2/2]
TP-FP-30	2.0	2.3	GP-GM	poorly graded gravel with silt and sand	UHM	Iron stain	2 to 4.25 estimated 60% Gravel; 20% Sand; 10% Cobble; and 10% Clay; iron staining noted on surface of gravels between 2.5 and 3.3 feet on northeast (nearest to stream) side of test pit		Moist	Dark reddish brown [5YR 3/4]
TP-FP-30	2.3	3.0	GP-GM	poorly graded gravel with silt and sand	UHM	Iron stain			Moist	Dark reddish brown [5YR 3/4]
TP-FP-30	4.0	4.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed	Iron stain			Moist	Dark reddish brown [5YR 3/4]
TP-FP-30	4.3	4.8	GP-GM	poorly graded gravel with silt and sand	Undisturbed	Manganese	Black Manganese staining on surface of particles	@ 5ft GW 620.1 rmv; 1275 µs/cm; pH start 4.91 pH end 4.95 (26 Minutes)	Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-30	5.0	7.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		5 to 10.5 estimated 20% Boulder; 25% Cobble; 40% Gravel; and 15% Sand; max particle size is approximately 30-in. Paticle size increases below 5'		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-30	8.0	10.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-30	10.0	10.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 10ft GW 603.5 rmv; 941.0µs/cm; pH start 4.99 pH end 4.61 (29 Minutes)	Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-31	0.0	0.1	ML	sandy silt with gravel	TAILINGS	Organic	MIXED TAILING; fine grain; trace organics		Moist	Strong brown [7.5YR 4/6]
TP-FP-31	0.4	1.0	GM	silty gravel with sand	Fill		0.4 to 2 FILL; mixed layers of Clayey SAND with Gravel and Poorly Graded SAND with Gravel		Moist	Dark brown [7.5YR 3/3]
TP-FP-31	1.0	1.8	GM	silty gravel with sand	Fill				Moist	Dark brown [7.5YR 3/3]
TP-FP-31	1.8	2.0	GM	silty gravel with sand	Fill				Moist	Dark brown [7.5YR 3/3]
TP-FP-31	2.0	2.8	GM	silty gravel with sand	Fill					
TP-FP-31	2.8	3.8	GM	silty gravel with sand	Fill					
TP-FP-31	3.8	4.5	GW	silty gravel with sand	Fill			Groundwater at 4.5ft		
TP-FP-31	5.0	6.5	GW	well graded gravel with sand	UHM					
TP-FP-31	7.5	9.0	GW	well graded gravel with sand	Undisturbed			@ 9ft GW 636.9 rmv; 579.0 µs/cm; pH start 4.66 pH end 3.96 (38 Minutes)		
TP-FP-31	9.5	10.0	GW	well graded gravel with sand	Undisturbed					
TP-FP-32	0.4	1.3	SP	sand	TAILINGS		MIXED TAILING; fine grain; visible Pyrite		Moist	
TP-FP-32	1.5	2.4	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Roots observed in top 2.5 ft		
TP-FP-32	2.4	2.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-32	2.5	2.7	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-32	2.7	4.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		at 3 ft depth estimated 20% Cobble; 50% Gravel; 30% Sand.	Groundwater at 4.5 ft		

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-28	5.0	5.5	GP-GM	Very dark brown [7.5YR 2.5/3]								116+20	43+10
TP-FP-28	7.0	8.0	GP-GM									116+20	43+10
TP-FP-28	8.0	8.5	GP-GM		344	259	132	51458				116+20	43+10
TP-FP-28	8.5	9.0	GP-GM						5.84	5.69	374.00	116+20	43+10
TP-FP-28	9.0	9.5	GP-GM		105	419	33	42655				116+20	43+10
TP-FP-30	0.0	0.1	SM									108+25	51+05
TP-FP-30	0.1	0.5	SM									108+25	51+05
TP-FP-30	2.0	2.3	GP-GM									108+25	51+05
TP-FP-30	2.3	3.0	GP-GM		104	196	91	90347				108+25	51+05
TP-FP-30	4.0	4.3	GP-GM									108+25	51+05
TP-FP-30	4.3	4.8	GP-GM	Black [10YR 2/1]					4.91	4.95	1,275.00	108+25	51+05
TP-FP-30	5.0	7.5	GP-GM									108+25	51+05
TP-FP-30	8.0	10.0	GP-GM									108+25	51+05
TP-FP-30	10.0	10.5	GP-GM		144	496	95	39306	4.99	4.61	941.00	108+25	51+05
TP-FP-31	0.0	0.1	ML									108+15	51+15
TP-FP-31	0.4	1.0	GM	Yellowish brown [10YR 5/6]								108+15	51+15
TP-FP-31	1.0	1.8	GM	Yellowish brown [10YR 5/6]	66	165	104	44627				108+15	51+15
TP-FP-31	1.8	2.0	GM	Yellowish brown [10YR 5/6]								108+15	51+15
TP-FP-31	2.0	2.8	GM		76	265	286	43540				108+15	51+15
TP-FP-31	2.8	3.8	GM									108+15	51+15
TP-FP-31	3.8	4.5	GW									108+15	51+15
TP-FP-31	5.0	6.5	GW									108+15	51+15
TP-FP-31	7.5	9.0	GW						4.66	3.96	579.00	108+15	51+15
TP-FP-31	9.5	10.0	GW									108+15	51+15
TP-FP-32	0.4	1.3	SP	Grayish brown								108+10	51+20
TP-FP-32	1.5	2.4	GP-GM									108+10	51+20
TP-FP-32	2.4	2.5	GP-GM		69	216	81	60153				108+10	51+20
TP-FP-32	2.5	2.7	GP-GM		69	216	81	60153				108+10	51+20
TP-FP-32	2.7	4.5	GP-GM									108+10	51+20

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-32	4.5	4.8	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 4.5ft GW 564.5 rmv; 384 µs/cm; pH start 6.1 pH end 5.25 (19 Minutes)		
TP-FP-32	4.8	7.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-32	7.5	8.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-32	9.0	10.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-33	0.5	1.0	SM	silty sand	TAILINGS				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-33	1.0	2.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed		1.0-8.5 trace clay; gravel particles are generally flat and elongated; at 4 ft depth estimated 20% Cobble; 60% Gravel; 20% Sand; rock content increases with depth; max particle approximately 1.5 ft x 3.0 ft.			
TP-FP-33	2.3	2.6	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-33	2.6	3.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-33	4.0	5.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Groundwater at 5 ft		
TP-FP-33	5.0	5.1	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Test pit frequently caved in below 5 ft depth		
TP-FP-33	5.1	5.3	GP-GM	poorly graded gravel with silt and sand	Undisturbed			@ 5.3ft GW 499.2 rmv; 420.0 µs/cm; pH start 5.78 pH end 6.51 (19 Minutes)		
TP-FP-33	5.3	5.9	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-33	6.2	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-34	0.0	0.1	SM	silty sand with gravel	Undisturbed		Colluvium; estimated 15% gravel		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	0.1	0.6	SM	silty sand with gravel	Undisturbed		Colluvium; estimated 15% gravel		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	0.6	1.2	SM	silty sand with gravel	Undisturbed		Colluvium; estimated 15% gravel		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	1.2	1.7	SM	silty sand with gravel	Undisturbed		Colluvium; estimated 15% gravel		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	1.7	3.0	SM	silty sand with gravel	Undisturbed		Colluvium; estimated 15% gravel		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	3.0	3.5	GP	poorly graded gravel with sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	3.5	4.0	GP	poorly graded gravel with sand	Undisturbed				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	4.0	5.8	GP	poorly graded gravel with sand	Undisturbed		at 4 ft depth estimated 20% Cobble; 60% Gravel; and 20% Sand. Particles generally elongated		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-34	5.8	6.0	SC	clayey sand with gravel	Undisturbed			The Clayey Sand with Gravel layer appears to be native and not remnants of Mike Horse Dam break. The yellowish brown color could potentially be from Mary P mine activities.		
TP-FP-34	6.0	6.3	SC	clayey sand with gravel	Undisturbed					
TP-FP-34	6.3	7.5	SC	clayey sand with gravel	Undisturbed		pockets of Sandy CLAY (CL) observed from 6 to 7 ft depth; medium to coarse grained sand.			
TP-FP-34	7.5	8.0	SC	clayey sand with gravel	Undisturbed			Installed 2" diameter PVC to 8.3;		
TP-FP-34	8.0	8.5	SC	clayey sand with gravel	Undisturbed					
TP-FP-34	8.5	9.0	SC	clayey sand with gravel	Undisturbed					
TP-FP-34	9.0	10.0	SC	clayey sand with gravel	Undisturbed					
TP-FP-34	10.5	12.5	SC	clayey sand with gravel	Undisturbed					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-32	4.5	4.8	GP-GM						6.1	5.25	384.00	108+10	51+20
TP-FP-32	4.8	7.0	GP-GM									108+10	51+20
TP-FP-32	7.5	8.5	GP-GM									108+10	51+20
TP-FP-32	9.0	10.5	GP-GM									108+10	51+20
TP-FP-33	0.5	1.0	SM									108+05	51+25
TP-FP-33	1.0	2.3	GP-GM									108+05	51+25
TP-FP-33	2.3	2.6	GP-GM		186	368	58	49295				108+05	51+25
TP-FP-33	2.6	3.5	GP-GM									108+05	51+25
TP-FP-33	4.0	5.0	GP-GM									108+05	51+25
TP-FP-33	5.0	5.1	GP-GM									108+05	51+25
TP-FP-33	5.1	5.3	GP-GM						5.78	6.51	420.00	108+05	51+25
TP-FP-33	5.3	5.9	GP-GM									108+05	51+25
TP-FP-33	6.2	8.0	GP-GM									108+05	51+25
TP-FP-34	0.0	0.1	SM		221	342	169	42873				94+50	64+80
TP-FP-34	0.1	0.6	SM		221	342	169	42873				94+50	64+80
TP-FP-34	0.6	1.2	SM									94+50	64+80
TP-FP-34	1.2	1.7	SM		148	237	122	48010				94+50	64+80
TP-FP-34	1.7	3.0	SM									94+50	64+80
TP-FP-34	3.0	3.5	GP									94+50	64+80
TP-FP-34	3.5	4.0	GP		164	365	175	46160				94+50	64+80
TP-FP-34	4.0	5.8	GP									94+50	64+80
TP-FP-34	5.8	6.0	SC									94+50	64+80
TP-FP-34	6.0	6.3	SC		360	385	260	49038				94+50	64+80
TP-FP-34	6.3	7.5	SC									94+50	64+80
TP-FP-34	7.5	8.0	SC		934	352	471	92903				94+50	64+80
TP-FP-34	8.0	8.5	SC									94+50	64+80
TP-FP-34	8.5	9.0	SC		601	300	325	63431				94+50	64+80
TP-FP-34	9.0	10.0	SC									94+50	64+80
TP-FP-34	10.5	12.5	SC									94+50	64+80

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-34	13.0	14.0	SC	clayey sand with gravel	Undisturbed			Installed 2" diameter PVC to 12.7;		
TP-FP-35	0.0	0.5	SM	silty sand with gravel	Fill	Topsoil	TOPSOIL; abundant plant and tree roots		Dry	
TP-FP-35	0.5	0.7	GW	well graded gravel with sand	Fill		plant and tree roots; estimated 10% Cobble; 60% Gravel; 30% Sand	Two soil profiles observed in test pit; Soil profile for TP-FP-35 represents soil profile of hill side (farthest from flood plain)	Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	0.7	1.0	GW	well graded gravel with sand	Fill		0- 13.0 plant and tree roots; estimated 10% Cobble; 60% Gravel; 30% Sand		Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	1.0	2.3	GW	well graded gravel with sand	Fill		Road fill?		Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	2.3	2.8	GW	well graded gravel with sand	Fill				Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	2.8	3.0	GW	well graded gravel with sand	Fill				Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	3.0	4.0	GW	well graded gravel with sand	Fill			A 3 ft diameter stump was removed from ground surface prior to excavating TP-FP-35. Size of stump indicates material observed underneath it is native and was in place prior to dam break	Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	4.3	6.0	GW	well graded gravel with sand	UHM				Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	6.0	6.4	GW	well graded gravel with sand	UHM				Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	6.4	8.0	GW	well graded gravel with sand	UHM				Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	8.0	8.5	GW	well graded gravel with sand	UHM				Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	9.8	10.5	GW	well graded gravel with sand	UHM				Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35	10.5	12.5	GW	well graded gravel with sand	UHM	Black		@ 12.5ft GW 677.7 rmv; 978.0 µs/cm; pH start 4.30 pH end 4.15 (33 Minutes)	Dry to Saturated	Dark brown [10YR 3/3]
TP-FP-35A	0.0	1.0	SM	silty sand with gravel	Fill					
TP-FP-35A	1.0	2.0	SM	silty sand with gravel	Fill					
TP-FP-35A	2.0	2.5	SM	silty sand with gravel	Fill	Topsoil	TOPSOIL; abundatn plant and tree roots		Dry	
TP-FP-35A	2.5	4.0	GW	well graded gravel with sand	Fill		plant and tree roots; estimated 10% Cobble; 50% Gravel; 40% Sand		Dry to moist	Dark brown [7.5YR 3/2]
TP-FP-35A	4.3	5.5	SP	poorly graded sand with gravel	Tailings		MIXED TAILINGS; layers of poorly graded sand/tailing mixed with gravel alluvium		Moist	
TP-FP-35A	5.5	8.0	GW	well graded gravel with sand	Tailings		estimated 10% Cobble; 60% Gravel; 30% Sand	Toe of test pit is in floodplain and 8 ft below the top (MP) of the test pit	Moist	Dark brown [10YR 3/3]
TP-FP-35A	8.0	8.5	GW	well graded gravel with sand	Tailings		estimated 10% Cobble; 60% Gravel; 30% Sand		Moist	Dark brown [10YR 3/3]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-34	13.0	14.0	SC									94+50	64+80
TP-FP-35	0.0	0.5	SM	Light brown								93+50	65+80
TP-FP-35	0.5	0.7	GW	Dark yellowish brown [10YR 3/6]	136	297	72	36448				93+50	65+80
TP-FP-35	0.7	1.0	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	1.0	2.3	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	2.3	2.8	GW	Dark yellowish brown [10YR 3/6]	79	212	80	37748				93+50	65+80
TP-FP-35	2.8	3.0	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	3.0	4.0	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	4.3	6.0	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	6.0	6.4	GW	Dark yellowish brown [10YR 3/6]	1333	236	186	78878				93+50	65+80
TP-FP-35	6.4	8.0	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	8.0	8.5	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	9.8	10.5	GW	Dark yellowish brown [10YR 3/6]								93+50	65+80
TP-FP-35	10.5	12.5	GW	Dark yellowish brown [10YR 3/6]					4.3	4.15	978.00	93+50	65+80
TP-FP-35A	0.0	1.0	SM									93+55	65+75
TP-FP-35A	1.0	2.0	SM									93+55	65+75
TP-FP-35A	2.0	2.5	SM	Light brown								93+55	65+75
TP-FP-35A	2.5	4.0	GW									93+55	65+75
TP-FP-35A	4.3	5.5	SP	Rusty brown								93+55	65+75
TP-FP-35A	5.5	8.0	GW									93+55	65+75
TP-FP-35A	8.0	8.5	GW									93+55	65+75

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-35A	9.0	13.0	GW	gravel with sand	Tailings		ALLUVIUM	Installed 2" diameter PVC to 13;	Wet	Dark brown [10YR 3/3]
TP-FP-36	0.0	1.0	GM	silty gravel with sand	TAILINGS		MIXED TAILINGS; layers of poorly graded; fine grained sand/tailing mixed with gravel and cobbles		Moist	Dark brown [7.5YR 3/4]
TP-FP-36	1.0	1.5	GM	silty gravel with sand	TAILINGS				Moist	Dark brown [7.5YR 3/4]
TP-FP-36	1.5	2.0	GM	silty gravel with sand	TAILINGS				Moist	Dark brown [7.5YR 3/4]
TP-FP-36	2.0	3.5	GP-GC	poorly graded gravel with clay and sand	UHM		2.0-13.0 estimated 20% Cobble; 40% Gravel; 30% Sand; and 10% Clay; max particle size is approximately 10-in. Alluvium		Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-36	4.0	6.5	GP-GC	poorly graded gravel with clay and sand	UHM			Groundwater at 6.0 ft. Estimated 20 gpm at 6.5;	Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-36	7.0	8.0	GP-GC	poorly graded gravel with clay and sand	UHM			@ 7ft GW 538.9 rmv; 336.0 µs/cm; pH start 6.23 pH end 5.93 (24 Minutes)	Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-36	8.0	9.5	GP	poorly graded gravel with sand	UHM				Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-36	10.5	13.0	GP	poorly graded gravel with sand	Undisturbed			@ 13ft GW 489.8 rmv; 343.0 µs/cm; pH start 6.56 pH end 6.72 (12 Minutes)	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-37	0.0	0.5	GM	silty gravel with sand	TAILINGS		0.0-3.4 MIXED TAILINGS; tailing composed of poorly graded; fine grain; rusty brown SAND; Alluvium composed of Poorly Graded GRAVEL with Sand and Cobbles; estimated 20% Cobble; 40% Gravel; and 40% Sand.			
TP-FP-37	1.0	2.5	GM	silty gravel with sand rusty	TAILINGS		Jumbled			
TP-FP-37	2.5	3.0	GM	silty gravel with sand rusty	TAILINGS		layered bony			
TP-FP-37	3.0	3.4	GM	silty gravel with sand rusty	TAILINGS					
TP-FP-37	3.4	4.0	GP-GM	poorly graded gravel with silt and sand not rusty	TAILINGS	Manganese	very coarse layer; estimated 30% Cobble; 60% Gravel; and 10% Sand; max particle size is approximately 6-in.; Black Manganese and iron staining/deposition on surface of particles		Moist	Very dark brown [10YR 2/2]
TP-FP-37	4.0	4.5	GW	well graded gravel with sand	UHM				Moist to Saturated	Very dark brown [10YR 2/2]
TP-FP-37	5.0	7.5	GW	well graded gravel with sand	UHM		at 5 ft depth estimated 20% Cobble; 40% Gravel; and 40% Sand; at 10 ft depth estimated 10% Boulder; 30% Cobble; 30% Gravel; and 30% Sand; boulders and cobbles are subangular; gravels are subrounded		Moist to Saturated	Very dark brown [10YR 2/2]
TP-FP-37	8.0	9.5	GW	well graded gravel with sand	UHM				Moist to Saturated	Very dark brown [10YR 2/2]
TP-FP-37	10.0	11.5	GW	well graded gravel with sand	UHM				Moist to Saturated	Very dark brown [10YR 2/2]
TP-FP-37	12.0	13.0	GW	well graded gravel with sand	Undisturbed			Soil wet at 13.0 feet however no visible water flowing into test pit	Moist to Saturated	Very dark brown [10YR 2/2]
TP-FP-37	13.0	14.0	GW	well graded gravel with sand	Undisturbed			Depths shown for screen interval on well log are approximate	Moist to Saturated	Very dark brown [10YR 2/2]
TP-FP-37	14.0	15.0	GW	well graded gravel with sand	Undisturbed			Installed 2" diameter PVC to 14.5;	Moist to Saturated	Very dark brown [10YR 2/2]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-35A	9.0	13.0	GW	Dark yellowish brown [10YR 3/6]								93+55	65+75
TP-FP-36	0.0	1.0	GM									93+70	65+60
TP-FP-36	1.0	1.5	GM		1789	450	344	82575				93+70	65+60
TP-FP-36	1.5	2.0	GM									93+70	65+60
TP-FP-36	2.0	3.5	GP-GC									93+70	65+60
TP-FP-36	4.0	6.5	GP-GC									93+70	65+60
TP-FP-36	7.0	8.0	GP-GC						6.23	5.93	336.00	93+70	65+60
TP-FP-36	8.0	9.5	GP	Dark brown [7.5YR 3/3]								93+70	65+60
TP-FP-36	10.5	13.0	GP	Dark brown [7.5YR 3/3]					6.56	6.72	343.00	93+70	65+60
TP-FP-37	0.0	0.5	GM									93+80	65+50
TP-FP-37	1.0	2.5	GM									93+80	65+50
TP-FP-37	2.5	3.0	GM		2355	410	353	99050				93+80	65+50
TP-FP-37	3.0	3.4	GM									93+80	65+50
TP-FP-37	3.4	4.0	GP-GM									93+80	65+50
TP-FP-37	4.0	4.5	GW	Dark brown [10YR 3/3]								93+80	65+50
TP-FP-37	5.0	7.5	GW	Dark brown [10YR 3/3]								93+80	65+50
TP-FP-37	8.0	9.5	GW	Dark brown [10YR 3/3]								93+80	65+50
TP-FP-37	10.0	11.5	GW	Dark brown [10YR 3/3]								93+80	65+50
TP-FP-37	12.0	13.0	GW	Dark brown [10YR 3/3]								93+80	65+50
TP-FP-37	13.0	14.0	GW	Dark brown [10YR 3/3]								93+80	65+50
TP-FP-37	14.0	15.0	GW	Dark brown [10YR 3/3]								93+80	65+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-38	0.0	1.0	GP-GM	poorly graded gravel with silt and sand	Tailings		0.0-6.0 ALLUVIUM/COLLUVIUM; estimated 30% Cobble; 40% Gravel; and 30% Sand and Fines. Roots in top 3'	Three soil profiles observed in test pit; Soil profile for TP-FP-38B represents soil profile closest to stream (southern most). Soil profile TP-FP-38 in northern most profile. TP-FP-38 is middle soil profile.		
TP-FP-38	1.0	2.0	GP-GM	poorly graded gravel with silt and sand	Mine waste			Tree roots in observed in top 3 ft.		
TP-FP-38	2.5	3.3	GP-GM	poorly graded gravel with silt and sand	Mine waste					
TP-FP-38	3.3	4.5	GP-GM	poorly graded gravel with silt and sand	Mine waste					
TP-FP-38	4.5	5.0	GP-GM	poorly graded gravel with silt and sand	Mine waste					
TP-FP-38	5.4	6.0	GP-GM	poorly graded gravel with silt and sand	Mine waste					
TP-FP-38	6.0	7.5	GP	poorly graded gravel with sand	UHM		6.0-13.0 layered; estimated 30% Cobble; 50% Gravel; and 20% Sand; cobbles are subangular; gravels are subangular and subrounded		Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-38	8.0	9.5	GP	poorly graded gravel with sand	UHM				Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-38	10.0	11.5	GP	poorly graded gravel with sand	UHM				Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-38	12.0	13.0	GP	poorly graded gravel with sand	Undisturbed				Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-38	13.0	14.5	GC	clayey gravel with sand	Undisturbed	Black	13.0-15.0 Estimated 20% Cobble; 30% Gravel; 20% Sand; and 30% Clay; rock particles are black		Moist to wet	Brown [7.5YR 4/3]
TP-FP-38	14.5	15.0	GC	clayey gravel with sand	Undisturbed	Black		Installed 2" diameter PVC to 14.5;	Moist to wet	Brown [7.5YR 4/3]
TP-FP-38A	0.0	0.5	GM	silty gravel with sand	Mine waste		MIXED TAILINGS. Tailings is rusty brown; rock particles are light gray; brown; and light purple.Estimated 20% Cobble and Boulder; 30% Gravel; 20% Sand; and 30% Tailing		Moist	Dark reddish brown [5YR 3/4]
TP-FP-38A	1.5	2.0	GP-GM	poorly graded gravel with silt and sand	Mine waste				Moist	Very dark brown [10YR 2/2]
TP-FP-38A	2.0	2.5	GC	clayey gravel with sand	Mine waste		MIXED TAILING		Moist	Yellowish brown [10YR 5/4]
TP-FP-38A	3.0	3.3	GP	poorly graded gravel with sand	Mine waste		3.0-13.0 layered; estimated 30% Cooble; 50% Gravel; and 20% Sand; cobbles are subangular; gravels are subangular and subrounded		Moist to wet	Very dark brown [10YR 2/2]
TP-FP-38A	3.3	4.5	GP	poorly graded gravel with sand	Mine waste			Tree roots in observed in top 3 ft.	Moist to wet	Very dark brown [10YR 2/2]
TP-FP-38A	5.0	10.0	GP	poorly graded gravel with sand	UHM			Samples were wet at 10 ft depth; however; no visual observation of water flowing into test pit	Moist to wet	Very dark brown [10YR 2/2]
TP-FP-38A	10.0	12.0	GP	poorly graded gravel with sand	UHM				Moist to wet	Very dark brown [10YR 2/2]
TP-FP-38A	12.0	13.0	GP	poorly graded gravel with sand	UHM				Moist to wet	Very dark brown [10YR 2/2]
TP-FP-38A	13.0	15.0	GC	clayey gravel with sand	UHM	Black	Estimated 20% Cobble; 30% Gravel; 20% Sand; and 30% Clay. Rock particles are black	Installed 2" diameter PVC in TP-FP-38	Moist to wet	Brown [7.5YR 4/3]
TP-FP-38B	0.0	0.5	GM	gravel with sand	TAILINGS					
TP-FP-38B	0.5	1.0	GM	gravel with sand	TAILINGS					
TP-FP-38B	1.0	2.0	GM	gravel with sand	TAILINGS					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-38	0.0	1.0	GP-GM									93+85	65+45
TP-FP-38	1.0	2.0	GP-GM									93+85	65+45
TP-FP-38	2.5	3.3	GP-GM									93+85	65+45
TP-FP-38	3.3	4.5	GP-GM									93+85	65+45
TP-FP-38	4.5	5.0	GP-GM									93+85	65+45
TP-FP-38	5.4	6.0	GP-GM									93+85	65+45
TP-FP-38	6.0	7.5	GP	Dark brown [7.5YR 3/3]								93+85	65+45
TP-FP-38	8.0	9.5	GP	Dark brown [7.5YR 3/3]								93+85	65+45
TP-FP-38	10.0	11.5	GP	Dark brown [7.5YR 3/3]								93+85	65+45
TP-FP-38	12.0	13.0	GP	Dark brown [7.5YR 3/3]								93+85	65+45
TP-FP-38	13.0	14.5	GC									93+85	65+45
TP-FP-38	14.5	15.0	GC		76	199	41	34896				93+85	65+45
TP-FP-38A	0.0	0.5	GM									93+85	65+45
TP-FP-38A	1.5	2.0	GP-GM									93+85	65+45
TP-FP-38A	2.0	2.5	GC									93+85	65+45
TP-FP-38A	3.0	3.3	GP									93+85	65+45
TP-FP-38A	3.3	4.5	GP									93+85	65+45
TP-FP-38A	5.0	10.0	GP									93+85	65+45
TP-FP-38A	10.0	12.0	GP									93+85	65+45
TP-FP-38A	12.0	13.0	GP									93+85	65+45
TP-FP-38A	13.0	15.0	GC									93+85	65+45
TP-FP-38B	0.0	0.5	GM									93+85	65+45
TP-FP-38B	0.5	1.0	GM		3330	498	302	131690				93+85	65+45
TP-FP-38B	1.0	2.0	GM									93+85	65+45

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-38B	2.0	3.3	GM	gravel with sand	TAILINGS		2.0-4.0 MIXED TAILINGS. Tailings are rusty brown; rock particles are light gray; brown; and light purple.Estimated 20% Cobble and Boulder; 30% Gravel; 20% Sand; and 30% Tailing	Tree roots in observed in top 3 ft.	Moist	Dark reddish brown [5YR 3/4]
TP-FP-38B	3.3	4.0	GM	gravel with sand	TAILINGS				Moist	Dark reddish brown [5YR 3/4]
TP-FP-38B	4.0	4.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		layered; estimated 30% Cooble; 50% Gravel; and 20% Sand; cobbles are subangular; gravels are subangular and subrounded		Moist	Very dark brown [10YR 2/2]
TP-FP-38B	4.5	5.0	GP-GC	gravel with clay and sand	Undisturbed		ALLUVIUM.Rusty brown; clayey sediment depsotion on surface of gravels and cobbles		Moist	
TP-FP-38B	5.0	10.0	GP	poorly graded gravel with sand	Undisturbed		5.0-13.0 layered; estimated 30% Cobble; 50% Gravel; and 20% Sand; cobbles are subangular; gravels are subangular and subrounded		Moist to wet	Very dark brown [10YR 2/2]
TP-FP-38B	10.0	13.0	GP	poorly graded gravel with sand	Undisturbed			Samples were wet at 10 ft depth; however; no visual observation of water flowing into test pit	Moist to wet	Very dark brown [10YR 2/2]
TP-FP-38B	13.0	15.0	GC	clayey gravel with sand	Undisturbed	Black	Estimated 20% Cobble; 30% Gravel; 20% Sand; and 30% Clay. Rock particles are black	Installed 2" diameter PVC in TP-FP-38	Moist to wet	Brown [7.5YR 4/3]
TP-FP-39	0.0	0.5	SM	silty sand with gravel	Undisturbed	Topsoil	TOPSOIL;numerous tree roots (1.5-in. minus)		Moist	
TP-FP-39	0.5	0.9	GP-GC	poorly graded gravel with clay and sand	Undisturbed		COLLUVIUM	Two soil profiles observed in test pit (TP-FP-39 and TP-FP-39A); Soil profile for TP-FP-39A represents soil profile closest to stream.	Moist	Brown [7.5YR 4/4]
TP-FP-39	0.9	1.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		COLLUVIUM		Moist	Brown [7.5YR 4/4]
TP-FP-39	1.0	1.6	GP-GC	poorly graded gravel with clay and sand	Undisturbed		COLLUVIUM		Moist	Brown [7.5YR 4/4]
TP-FP-39	1.6	3.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed		COLLUVIUM		Moist	Brown [7.5YR 4/4]
TP-FP-39	3.5	4.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		COLLUVIUM		Moist	Brown [7.5YR 4/4]
TP-FP-39	4.0	4.2	SM	silty sand with gravel	Undisturbed		4.0-14.0 Highly fractured SHALE with Gravel and Clay infilling; excavated rock particles generally 6-in. size; visible pyrite; hard digging		Moist	Dark grayish brown [10Y 4/2]
TP-FP-39	4.2	6.0	SM	silty sand with gravel	Undisturbed			Installed 2" diameter PVC to 14;	Moist	Dark grayish brown [10Y 4/2]
TP-FP-39	6.0	6.5	SM	silty sand with gravel	Undisturbed				Moist	Dark grayish brown [10Y 4/2]
TP-FP-39	6.5	9.5	SM	silty sand with gravel	Undisturbed				Moist	Dark grayish brown [10Y 4/2]
TP-FP-39	9.5	10.0	SM	silty sand with gravel	Undisturbed				Moist	Dark grayish brown [10Y 4/2]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-38B	2.0	3.3	GM									93+85	65+45
TP-FP-38B	3.3	4.0	GM									93+85	65+45
TP-FP-38B	4.0	4.5	GP-GM									93+85	65+45
TP-FP-38B	4.5	5.0	GP-GC	Rusty Brown								93+85	65+45
TP-FP-38B	5.0	10.0	GP									93+85	65+45
TP-FP-38B	10.0	13.0	GP									93+85	65+45
TP-FP-38B	13.0	15.0	GC									93+85	65+45
TP-FP-39	0.0	0.5	SM	Brown								92+65	66+65
TP-FP-39	0.5	0.9	GP-GC									92+65	66+65
TP-FP-39	0.9	1.0	GP-GC		75	144	60	36514				92+65	66+65
TP-FP-39	1.0	1.6	GP-GC		75	144	60	36514				92+65	66+65
TP-FP-39	1.6	3.5	GP-GC									92+65	66+65
TP-FP-39	3.5	4.0	GP-GC		87	395	197	41084				92+65	66+65
TP-FP-39	4.0	4.2	SM	Dark yellowish brown [10YR 3/4]	87	395	197	41084				92+65	66+65
TP-FP-39	4.2	6.0	SM	Dark yellowish brown [10YR 3/4]								92+65	66+65
TP-FP-39	6.0	6.5	SM	Dark yellowish brown [10YR 3/4]								92+65	66+65
TP-FP-39	6.5	9.5	SM	Dark yellowish brown [10YR 3/4]								92+65	66+65
TP-FP-39	9.5	10.0	SM	Dark yellowish brown [10YR 3/4]	217	232	408	57199				92+65	66+65

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-39	10.0	12.5	SM	silty sand with gravel	Undisturbed				Moist	Dark grayish brown [10Y 4/2]
TP-FP-39	12.5	13.0	SM	silty sand with gravel	Undisturbed				Moist	Dark grayish brown [10Y 4/2]
TP-FP-39	13.0	14.0	SM	silty sand with gravel	Undisturbed		c C		Moist	Dark grayish brown [10Y 4/2]
TP-FP-39A	0.0	2.0	SM	silty sand with gravel	Undisturbed					
TP-FP-39A	2.0	2.5	SM	silty sand with gravel	Undisturbed	Topsoil	TOPSOIL; numerous tree roots (1.5-in. minus)		Moist	
TP-FP-39A	2.5	6.0	GP	poorly graded gravel with sand	Undisturbed		estimated 20% Cobble; 40% Gravel; 40% Sand		Moist	Dark brown [7.5YR 3/3]
TP-FP-39A	6.0	6.5	GP		Undisturbed					
TP-FP-39A	6.5	9.5	GP		Undisturbed					
TP-FP-39A	9.5	10.0	GP		Undisturbed					
TP-FP-39A	10.0	14.0	GP		Undisturbed					
TP-FP-40	0.0	0.5	GM	silty gravel with sand	Undisturbed	Topsoil	TOPSOIL; organic roots		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-40	0.5	0.8	GM	silty gravel with sand	Undisturbed	Topsoil	TOPSOIL; organic roots		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-40	0.8	1.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		0.0-5 Cobbles; plant roots; random thin layers of Well-Graded SAND 2 to 4" thick Two inch thick layer of reddish brown; low plasticity; Clayey SAND at 4.5 ft depth		Moist	Dark brown [7.5YR 3/3]
TP-FP-40	1.5	2.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark brown [7.5YR 3/3]
TP-FP-40	2.0	3.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark brown [7.5YR 3/3]
TP-FP-40	3.5	3.8	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark brown [7.5YR 3/3]
TP-FP-40	3.8	5.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark brown [7.5YR 3/3]
TP-FP-40	5.0	6.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		5.0-8.0 Pocket of brownish black; medium plastic; Organic SILT and CLAY on south side of test pit from 7.0 to 8.0 ft		Moist	Dark yellowish brown [10YR 4/4]
TP-FP-40	6.0	6.2	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark yellowish brown [10YR 4/4]
TP-FP-40	6.2	6.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark yellowish brown [10YR 4/4]
TP-FP-40	6.5	6.8	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark yellowish brown [10YR 4/4]
TP-FP-40	6.8	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed	Organic Silt			Moist	Dark yellowish brown [10YR 4/4]
TP-FP-40	8.0	8.5	GC	clayey gravel with sand	Undisturbed		8.0-14.0 trace sand; medium grained; Reddish colored mottling		Moist	Yellowish brown [10YR 5/6]
TP-FP-40	8.5	9.0	GC	clayey gravel with sand	Undisturbed				Moist	Yellowish brown [10YR 5/6]
TP-FP-40	9.0	12.0	GC	clayey gravel with sand	Undisturbed			@ 15ft GW 514.4 rmv; 374.0 µs/cm; pH start 6.24 pH end 6.16 (24 Minutes)	Moist	Yellowish brown [10YR 5/6]
TP-FP-40	12.0	13.0	GC	clayey gravel with sand	Undisturbed				Moist	Yellowish brown [10YR 5/6]
TP-FP-40	13.0	13.5	GC	clayey gravel with sand	Undisturbed				Moist	Yellowish brown [10YR 5/6]
TP-FP-40	13.5	14.0	GC	clayey gravel with sand	Undisturbed			Groundwater at 14 ft.	Moist	Yellowish brown [10YR 5/6]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-39	10.0	12.5	SM	Dark yellowish brown [10YR 3/4]								92+65	66+65
TP-FP-39	12.5	13.0	SM	Dark yellowish brown [10YR 3/4]	173	209	220	49276				92+65	66+65
TP-FP-39	13.0	14.0	SM	Dark yellowish brown [10YR 3/4]								92+65	66+65
TP-FP-39A	0.0	2.0	SM									92+60	66+70
TP-FP-39A	2.0	2.5	SM	Brown								92+60	66+70
TP-FP-39A	2.5	6.0	GP									92+60	66+70
TP-FP-39A	6.0	6.5	GP		183	359	897	89494				92+60	66+70
TP-FP-39A	6.5	9.5	GP									92+60	66+70
TP-FP-39A	9.5	10.0	GP		219	229	430	57365				92+60	66+70
TP-FP-39A	10.0	14.0	GP									92+60	66+70
TP-FP-40	0.0	0.5	GM		282	381	117	44246				87+10	72+20
TP-FP-40	0.5	0.8	GM									87+10	72+20
TP-FP-40	0.8	1.5	GP-GM	Dark reddish brown [5YR 3/4]								87+10	72+20
TP-FP-40	1.5	2.0	GP-GM	Dark reddish brown [5YR 3/4]	158	300	83	50296				87+10	72+20
TP-FP-40	2.0	3.5	GP-GM	Dark reddish brown [5YR 3/4]								87+10	72+20
TP-FP-40	3.5	3.8	GP-GM	Dark reddish brown [5YR 3/4]	234	340	338	63315				87+10	72+20
TP-FP-40	3.8	5.0	GP-GM	Dark reddish brown [5YR 3/4]								87+10	72+20
TP-FP-40	5.0	6.0	GP-GM	Very dark brown [10YR 2/2]								87+10	72+20
TP-FP-40	6.0	6.2	GP-GM	Very dark brown [10YR 2/2]	422	341	507	97568				87+10	72+20
TP-FP-40	6.2	6.5	GP-GM	Very dark brown [10YR 2/2]								87+10	72+20
TP-FP-40	6.5	6.8	GP-GM	Very dark brown [10YR 2/2]	272	423	1853	59015				87+10	72+20
TP-FP-40	6.8	8.0	GP-GM	Very dark brown [10YR 2/2]								87+10	72+20
TP-FP-40	8.0	8.5	GC	Yellowish brown [10YR 5/8]								87+10	72+20
TP-FP-40	8.5	9.0	GC	Yellowish brown [10YR 5/8]	381	142	251	82685				87+10	72+20
TP-FP-40	9.0	12.0	GC	Yellowish brown [10YR 5/8]					6.24	6.16	374.00	87+10	72+20
TP-FP-40	12.0	13.0	GC	Yellowish brown [10YR 5/8]								87+10	72+20
TP-FP-40	13.0	13.5	GC	Yellowish brown [10YR 5/8]	514	139	313	105905				87+10	72+20
TP-FP-40	13.5	14.0	GC	Yellowish brown [10YR 5/8]								87+10	72+20

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-40	14.0	14.5	GP	poorly graded gravel with sand	BEDROCK				Saturated	Dark yellowish brown [10YR 3/4]
TP-FP-41	0.0	0.3	SM	silty sand	TAILINGS	Black	0-1.0 MIXED TAILINGS; visible Pyrite; majority of layer was yellowish red in color with occasional pockets of black		Moist	Yellowish red [5YR 4/6]
TP-FP-41	0.3	0.5	SM	silty sand	TAILINGS	Black			Moist	Yellowish red [5YR 4/6]
TP-FP-41	0.8	1.0	SM	silty sand	TAILINGS	Black			Moist	Yellowish red [5YR 4/6]
TP-FP-41	1.0	2.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		1.0-12.0 estimated 30% Cobble; 40% Gravel; and 30% Sand; frequent pockets of rust coloration throughout		Moist	Dark brown [7.5YR 3/3]
TP-FP-41	2.0	2.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark brown [7.5YR 3/3]
TP-FP-41	2.5	3.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Moist	Dark brown [7.5YR 3/3]
TP-FP-41	3.5	4.0	GC	clayey gravel	Undisturbed				Moist to wet	Dark reddish brown [5YR 3/3]
TP-FP-41	4.0	4.5	GC	clayey gravel	Undisturbed				Moist to wet	Dark reddish brown [5YR 3/3]
TP-FP-41	4.5	5.5	GC	clayey gravel	Undisturbed				Moist to wet	Dark reddish brown [5YR 3/3]
TP-FP-41	5.5	6.0	GC	clayey gravel	Undisturbed				Moist to wet	Dark reddish brown [5YR 3/3]
TP-FP-41	6.0	8.0	GC	clayey gravel	Undisturbed				Moist to wet	Dark reddish brown [5YR 3/3]
TP-FP-41	8.0	8.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Soil was wet from 8 to 12 ft depth; no visible groundwater flowing into test pit	Wet to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-41	8.5	9.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Depths shown for screen interval on well log are approximate	Wet to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-41	9.0	10.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed				Wet to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-41	10.5	11.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed				Wet to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-41	11.0	12.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed			Installed 2" PVC to 11.3;	Wet to Saturated	Dark reddish brown [5YR 3/3]
TP-FP-42	0.0	0.5	ML	sandy silt with gravel	TAILINGS		0-2.6 poorly graded; some roots; pockets of grayish brown tailing with visible Pyrite. Mixed Tailings		Moist	Dark reddish brown [5YR 3/4]
TP-FP-42	1.0	1.4	ML	sandy silt with gravel	TAILINGS				Moist	Dark reddish brown [5YR 3/4]
TP-FP-42	1.4	2.0	GP-GM	poorly graded gravel with silt and sand	UHM				Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	2.6	3.0	GP-GM	poorly graded gravel with silt and sand	UHM		estimated 60% Gravel; 30% Sand; and 10% Fines. Approximately 3" maximum size		Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	3.0	3.3	SC	clayey sand	UHM	roots	with roots		Moist	
TP-FP-42	3.3	4.2	GP	poorly graded gravel with sand	UHM		estimated 90% 1-in minus Gravel; 10% Sand		Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	5.2	5.4	GM	silty gravel with sand	Undisturbed		some roots		Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	5.4	6.0	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM	Wet below depth of 8;. Possible GWT	Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	6.1	6.6	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM		Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	7.0	8.0	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM		Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	8.0	10.0	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM		Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	10.5	11.0	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM		Moist	Dark reddish brown [5YR 3/3]
TP-FP-42	11.0	12.0	GC	clayey gravel with sand	Undisturbed		11.0-16.0 estimated 10% Boulder; 20% Cobble; 30% Gravel; 20% Sand; and 20% Clay; with pockets of Sandy CLAY (SC)		Wet to Saturated	Reddish brown [5YR 4/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-40	14.0	14.5	GP									87+10	72+20
TP-FP-41	0.0	0.3	SM	Black [7.5YR 2.5/1]								86+50	72+80
TP-FP-41	0.3	0.5	SM	Black [7.5YR 2.5/1]	1551	463	302	123175				86+50	72+80
TP-FP-41	0.8	1.0	SM	Black [7.5YR 2.5/1]								86+50	72+80
TP-FP-41	1.0	2.0	GP-GM									86+50	72+80
TP-FP-41	2.0	2.5	GP-GM		928	257	284	85438				86+50	72+80
TP-FP-41	2.5	3.5	GP-GM									86+50	72+80
TP-FP-41	3.5	4.0	GC									86+50	72+80
TP-FP-41	4.0	4.5	GC		575	487	529	65483				86+50	72+80
TP-FP-41	4.5	5.5	GC									86+50	72+80
TP-FP-41	5.5	6.0	GC		614	435	659	79767				86+50	72+80
TP-FP-41	6.0	8.0	GC									86+50	72+80
TP-FP-41	8.0	8.5	GP-GC	Brown [7.5YR 4/4]								86+50	72+80
TP-FP-41	8.5	9.0	GP-GC	Brown [7.5YR 4/4]	288	367	401	64294				86+50	72+80
TP-FP-41	9.0	10.5	GP-GC	Brown [7.5YR 4/4]								86+50	72+80
TP-FP-41	10.5	11.0	GP-GC	Brown [7.5YR 4/4]	167	398	205	54985				86+50	72+80
TP-FP-41	11.0	12.0	GP-GC	Brown [7.5YR 4/4]								86+50	72+80
TP-FP-42	0.0	0.5	ML									86+30	73+00
TP-FP-42	1.0	1.4	ML									86+30	73+00
TP-FP-42	1.4	2.0	GP-GM									86+30	73+00
TP-FP-42	2.6	3.0	GP-GM									86+30	73+00
TP-FP-42	3.0	3.3	SC	Rusty brown to grayish black								86+30	73+00
TP-FP-42	3.3	4.2	GP									86+30	73+00
TP-FP-42	5.2	5.4	GM	Black [7.5YR 2.5/1]								86+30	73+00
TP-FP-42	5.4	6.0	GP									86+30	73+00
TP-FP-42	6.1	6.6	GP									86+30	73+00
TP-FP-42	7.0	8.0	GP									86+30	73+00
TP-FP-42	8.0	10.0	GP									86+30	73+00
TP-FP-42	10.5	11.0	GP									86+30	73+00
TP-FP-42	11.0	12.0	GC	Brown [7.5YR 4/3]								86+30	73+00

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-42	12.5	13.5	GC	clayey gravel with sand	Undisturbed			@ 16ft GW 502.6 rmv; 365.0 µs/cm; pH start 6.92 pH end 6.21 (18 Minutes)	Wet to Saturated	Reddish brown [5YR 4/4]
TP-FP-42	13.5	15.0	GC	clayey gravel with sand	Undisturbed			Groundwater flowing in at 15 ft	Wet to Saturated	Reddish brown [5YR 4/4]
TP-FP-42	15.0	15.6	GC	clayey gravel with sand	Undisturbed				Wet to Saturated	Reddish brown [5YR 4/4]
TP-FP-42	15.6	16.0	GC	clayey gravel with sand	Undisturbed			Installed 2" PVC to 16;	Wet to Saturated	Reddish brown [5YR 4/4]
TP-FP-43	0.0	1.2	GW	well graded gravel with sand	TAILINGS					
TP-FP-43	1.4	4.0	GW	well graded gravel with sand	UHM		gravels have some black Manganese s staining from 1.3 1.5 ft; gravels generally flat and elongate			
TP-FP-43	4.3	6.0	GW	well graded gravel with sand	UHM					
TP-FP-43	6.5	9.0	GW	well graded gravel with sand	UHM			Groundwater estimated at 9 ft		
TP-FP-43	9.5	11.0	GW	well graded gravel with sand	UHM			Depths shown for screen interval on well log are approximate		
TP-FP-43	11.5	12.0	GW	well graded gravel with sand	Undisturbed			Installed 2" PVC to 11.3;		
TP-FP-44	1.0	1.5	SM	silty sand	UHM	Topsoil	TOPSOIL; abundant plant debris and large dead tree roots; sands fine grained		Moist	
TP-FP-44	1.5	2.0	GW	well graded gravel with sand	UHM				Moist	
TP-FP-44	3.0	4.0	GW	well graded gravel with sand	UHM				Moist	
TP-FP-44	4.5	5.5	GW	well graded gravel with sand	UHM				Moist	
TP-FP-44	5.5	6.0	GP-GC	poorly graded gravel with clay and sand	UHM			Wet at approximately 6;	Moist to wet	Dark reddish brown [5YR 3/4]
TP-FP-44	6.5	7.5	GP-GC	poorly graded gravel with clay and sand	UHM	Manganese		Wet at approximately 6;	Moist to wet	Dark reddish brown [5YR 3/4]
TP-FP-44	7.5	9.0	GW	well graded gravel with sand	UHM		7.5-14.0 estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand	Groundwater at 9 ft	Wet to Saturated	Dark reddish brown [5YR 3/4]
TP-FP-44	9.0	9.5	GW	well graded gravel with sand	UHM			@ 9.5; GW 636.4 rmv; 350 µs/cm; pH start 7.13 pH end 6.66 (23 minutes)	Wet to Saturated	Dark reddish brown [5YR 3/4]
TP-FP-44	9.5	11.5	GW	well graded gravel with sand	UHM				Wet to Saturated	Dark reddish brown [5YR 3/4]
TP-FP-44A	0.7	2.5	GW	well graded gravel with sand	TAILINGS					
TP-FP-44A	2.5	3.5	GW	well graded gravel with sand	UHM				Moist	Dark reddish brown [5YR 3/4]
TP-FP-44A	3.5	5.5	GW	well graded gravel with sand	UHM		at 4 ft depth estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand with max particle size ofapproximately 16-in; gravels are generally flat and elongated.			
TP-FP-44A	5.5	6.0	GP-GC	poorly graded gravel with clay and sand	UHM	Manganese	some small zones of Black Manganese staining on gravels at approximately 6'; intermittent thin diagonal layers of black sandy clay	Wet at approximately 6;	Moist to wet	Dark reddish brown [5YR 3/4]
TP-FP-44A	6.0	7.5	GP-GC	poorly graded gravel with clay and sand	UHM	Manganese		Wet at approximately 6;	Moist to wet	Dark reddish brown [5YR 3/4]
TP-FP-44A	7.5	8.0	GW	well graded gravel with sand	UHM		estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand		Wet to Saturated	Dark reddish brown [5YR 3/4]
TP-FP-44A	8.5	9.0	GW	well graded gravel with sand	UHM		estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand	Groundwater at 9 ft	Wet to Saturated	Dark reddish brown [5YR 3/4]
TP-FP-44A	9.0	14.0	GW	well graded gravel with sand	UHM		estimated 10% Boulder; 20% Cobble; 40% Gravel; and 30% Sand	Installed 2" diameter PVC in TP-FP-44	Wet to Saturated	Dark reddish brown [5YR 3/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-42	12.5	13.5	GC	Brown [7.5YR 4/3]					6.92	6.21	365.00	86+30	73+00
TP-FP-42	13.5	15.0	GC	Brown [7.5YR 4/3]								86+30	73+00
TP-FP-42	15.0	15.6	GC	Brown [7.5YR 4/3]								86+30	73+00
TP-FP-42	15.6	16.0	GC	Brown [7.5YR 4/3]	332	496	232	53939				86+30	73+00
TP-FP-43	0.0	1.2	GW									86+25	73+05
TP-FP-43	1.4	4.0	GW									86+25	73+05
TP-FP-43	4.3	6.0	GW									86+25	73+05
TP-FP-43	6.5	9.0	GW									86+25	73+05
TP-FP-43	9.5	11.0	GW									86+25	73+05
TP-FP-43	11.5	12.0	GW									86+25	73+05
TP-FP-44	1.0	1.5	SM	Dark brown								86+16	73+14
TP-FP-44	1.5	2.0	GW	Brown								86+16	73+14
TP-FP-44	3.0	4.0	GW	Brown								86+16	73+14
TP-FP-44	4.5	5.5	GW	Brown								86+16	73+14
TP-FP-44	5.5	6.0	GP-GC									86+16	73+14
TP-FP-44	6.5	7.5	GP-GC									86+16	73+14
TP-FP-44	7.5	9.0	GW									86+16	73+14
TP-FP-44	9.0	9.5	GW						7.13	6.66	350.00	86+16	73+14
TP-FP-44	9.5	11.5	GW									86+16	73+14
TP-FP-44A	0.7	2.5	GW									86+15	73+15
TP-FP-44A	2.5	3.5	GW									86+15	73+15
TP-FP-44A	3.5	5.5	GW									86+15	73+15
TP-FP-44A	5.5	6.0	GP-GC									86+15	73+15
TP-FP-44A	6.0	7.5	GP-GC									86+15	73+15
TP-FP-44A	7.5	8.0	GW									86+15	73+15
TP-FP-44A	8.5	9.0	GW									86+15	73+15
TP-FP-44A	9.0	14.0	GW									86+15	73+15

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-45	0.0	0.5	SM	silty sand with gravel	Jig Tailings		MIXED TAILINGS; deposited as inclusions in deposit; visible pyrite	Abundant wood debris and organics from 0 to 3 ft	Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-45	1.0	1.2	SM	silty sand	Jig Tailings		MIXED TAILINGS; some pockets of lean Clay		Moist	Brown [7.5YR 4/3]
TP-FP-45	2.3	3.0	OL	organic silt with gravel	UHM	Topsoil	Native aluvium		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-45	3.0	3.5	GP-GM	poorly graded gravel with silt and sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-45	4.0	7.5	GP-GM	poorly graded gravel with silt and sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-45	8.0	10.5	GP-GM	poorly graded gravel with silt and sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-45	11.0	12.0	GP-GM	poorly graded gravel with silt and sand	UHM			Groundwater flowing in at 12 ft	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-45	12.0	13.0	GP-GM	poorly graded gravel with silt and sand	UHM			@ 13ft GW 528.5 rmv; 358.0 µs/cm; pH start 6.47 pH end 6.39 (16 Minutes)	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-45	13.0	13.5	GP-GM	poorly graded gravel with silt and sand	UHM			Depths shown for screen interval on well log are approximate	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-45A	0.0	0.5	SM	silty sand with gravel	TAILINGS	Topsoil	TOPSOIL; trace small gravels	Abundant roots in top 2 ft	Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-45A	1.2	3.0	GP	poorly graded gravel with sand	UHM				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-45A	3.5	4.5	GP	poorly graded gravel with sand	UHM				Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-45A	4.5	5.0	GP-GM	poorly graded gravel with silt and sand	UHM			Boulder content increases from 5.3 10;	Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-45A	6.0	9.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		NativeALLUVIUM			
TP-FP-45A	9.5	11.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		NativeALLUVIUM			
TP-FP-45A	11.5	13.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed		NativeALLUVIUM			
TP-FP-45A	13.5	14.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		NativeALLUVIUM	Installed 2" diameter PVC to 13;		
TP-FP-46	0.0	1.0	SC	clayey sand with gravel	Undisturbed		Colluvium; abundant live roots		Moist	Dark brown [7.5YR 3/3]
TP-FP-46	1.0	1.5	SC	clayey sand with gravel	Undisturbed		Colluvium; abundant live roots		Moist	Dark brown [7.5YR 3/3]
TP-FP-46	1.5	2.0	SC	clayey sand with gravel	Undisturbed		Colluvium; abundant live roots	Slope wash layer is 2.5 ft thick at (south end) and 1 ft thick on bottom side	Moist	Dark brown [7.5YR 3/3]
TP-FP-46	2.0	3.0	GP	poorly graded gravel with sand	Undisturbed		2.0-11.5 with Cobbles; cobbles are subangular; gravels are subrounded; cobbles and gravels are laying flat; fresh faces on cobbles arepurple quartzite and argillite		Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-46	3.5	4.0	GP	poorly graded gravel with sand	Undisturbed			Caving badly at 4.0;	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-46	4.0	6.0	GP	poorly graded gravel with sand	Undisturbed			Groundwater at 6 ft	Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-46	6.5	8.5	GP	poorly graded gravel with sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-46	9.0	10.0	GP	poorly graded gravel with sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-46	10.0	11.0	GP	poorly graded gravel with sand	UHM				Moist to Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-47	0.0	0.1	SM	silty sand with gravel	TAILINGS		MIXED TAILINGS; 2" - 9' sands fine grained; trace organics		Moist	Dark reddish brown [5YR 3/4]
TP-FP-47	0.3	0.6	SM	silty sand with gravel	TAILINGS				Moist	Dark reddish brown [5YR 3/4]
TP-FP-47	0.6	2.0	SM	silty sand	UHM	Topsoil	0.6-3.5 TOPSOIL; fine to coarse grain; trace of organic and contains abundantsmall (1/2-in minus) roots	Topsoil layer appears to be native forest floor prior to inundation by flood	Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-47	2.5	3.5	SM	silty sand	UHM	Topsoil			Moist	Dark reddish brown [5YR 2.5/2]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-45	0.0	0.5	SM									86+16	73+14
TP-FP-45	1.0	1.2	SM	Orangish brown								86+16	73+14
TP-FP-45	2.3	3.0	OL									86+16	73+14
TP-FP-45	3.0	3.5	GP-GM									86+16	73+14
TP-FP-45	4.0	7.5	GP-GM									86+16	73+14
TP-FP-45	8.0	10.5	GP-GM									86+16	73+14
TP-FP-45	11.0	12.0	GP-GM									86+16	73+14
TP-FP-45	12.0	13.0	GP-GM						6.47	6.39	358.00	86+16	73+14
TP-FP-45	13.0	13.5	GP-GM									86+16	73+14
TP-FP-45A	0.0	0.5	SM									86+10	73+20
TP-FP-45A	1.2	3.0	GP									86+10	73+20
TP-FP-45A	3.5	4.5	GP									86+10	73+20
TP-FP-45A	4.5	5.0	GP-GM									86+10	73+20
TP-FP-45A	6.0	9.0	GP-GC									86+10	73+20
TP-FP-45A	9.5	11.0	GP-GC									86+10	73+20
TP-FP-45A	11.5	13.5	GP-GC									86+10	73+20
TP-FP-45A	13.5	14.0	GP-GC		264	444	187	46067				86+10	73+20
TP-FP-46	0.0	1.0	SC									72+00	87+30
TP-FP-46	1.0	1.5	SC		150	448	214	42832				72+00	87+30
TP-FP-46	1.5	2.0	SC									72+00	87+30
TP-FP-46	2.0	3.0	GP	Dark reddish brown [5YR 3/3]								72+00	87+30
TP-FP-46	3.5	4.0	GP	Dark reddish brown [5YR 3/3]								72+00	87+30
TP-FP-46	4.0	6.0	GP	Dark reddish brown [5YR 3/3]								72+00	87+30
TP-FP-46	6.5	8.5	GP	Dark reddish brown [5YR 3/3]								72+00	87+30
TP-FP-46	9.0	10.0	GP	Dark reddish brown [5YR 3/3]								72+00	87+30
TP-FP-46	10.0	11.0	GP	Dark reddish brown [5YR 3/3]								72+00	87+30
TP-FP-47	0.0	0.1	SM									72+80	86+50
TP-FP-47	0.3	0.6	SM									72+80	86+50
TP-FP-47	0.6	2.0	SM									72+80	86+50
TP-FP-47	2.5	3.5	SM									72+80	86+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-47	4.0	4.5	GP	poorly graded gravel with sand	UHM			@ 4ft GW 395 rmv; 595.5 µs/cm; pH start 6.69 pH end 6.77 (18 Minutes)		
TP-FP-47	4.5	5.5	GP	poorly graded gravel with sand	UHM					
TP-FP-47	6.0	6.5	CL	sandy clay with gravel	UHM			@ 7ft GW 391 rmv; 384 µs/cm; pH start 6.44 pH end 6.11 (18 Minutes)	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-48	0.4	1.5	SP-SM	sand with silt	TAILINGS		Rusty & black		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-48	2.0	2.5	GP-GM	poorly graded gravel with silt and sand	TAILINGS			Native		
TP-FP-48	3.5	4.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS			Groundwater at 4.4 ft		
TP-FP-48	4.0	4.4	GP-GM	poorly graded gravel with silt and sand	TAILINGS			@ 4ft GW 479.4 rmv; 290.7 µs/cm; pH start 5.66 pH end 5.64 (15 Minutes)		
TP-FP-48	4.4	6.0	GP-GM	poorly graded gravel with silt and sand	TAILINGS					
TP-FP-48	6.5	8.0	GP-GM	poorly graded gravel with silt and sand	UHM					
TP-FP-48	8.5	10.0	GP-GM	poorly graded gravel with silt and sand	UHM					
TP-FP-48	10.5	13.0	GP-GM	poorly graded gravel with silt and sand	UHM			@ 13ft GW 439.2 rmv; 373.0 µs/cm; pH start 6.41 pH end 6.48 (48 Minutes)		
TP-FP-48	13.0	13.5	GP-GM	poorly graded gravel with silt and sand	UHM					
TP-FP-49	0.0	0.7	SM	silty sand	TAILINGS		MIXED TAILINGS; visible pyrite; sand particlesfine grained		Moist	Yellowish red [5YR 4/6]
TP-FP-49	1.2	1.7	SM	silty sand with gravel	TAILINGS		MIXED TAILING; estimated 30% Gravel; 50% Sand; and 20% Silt		Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-49	1.7	2.4	SM	silty sand with gravel	TAILINGS		MIXED TAILING; estimated 30% Gravel; 50% Sand; and 20% Silt		Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-49	2.4	2.5	SM	silty sand with gravel	TAILINGS		MIXED TAILING; estimated 30% Gravel; 50% Sand; and 20% Silt		Moist	Dark reddish brown [5YR 2.5/2]
TP-FP-49	2.5	3.0	GW	well graded gravel with sand	TAILINGS		generally 1-in minus particles. Iron stained			
TP-FP-49	3.4	4.0	GW	well graded gravel with sand	TAILINGS		generally 1-in minus particles. Iron stained	roots		
TP-FP-49	4.0	5.0	ML	sandy silt	TAILINGS		4-8.5 estimated 10% Coarse Sand; 60% Fine Sand; and 30% Silt		Saturated	Dark reddish brown [5YR 2.5/2]
TP-FP-49	5.5	6.0	ML	sandy silt	UHM				Saturated	Dark reddish brown [5YR 2.5/2]
TP-FP-49	6.0	6.5	GP-GM	poorly graded gravel with silt and sand	UHM		Cleaner looking gravel	@ 6.5ft GW 540.2 rmv; 300.0 µs/cm; pH start 6.77 pH end 6.18 (9 Minutes)	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-49	7.0	8.5	GP-GM	poorly graded gravel with silt and sand	UHM				Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-49	9.0	11.0	GP-GM	poorly graded gravel with silt and sand	UHM		At 9 ft depth estimated 10% Cobble; 50% Gravel; and 40% Sand		Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-49	11.0	12.0	GP-GM	poorly graded gravel with silt and sand	UHM			@ 11ft GW 714.1 rmv; 425.0 µs/cm; pH start 6.60 pH end 5.94 (24 Minutes)	Saturated	Very dark brown [7.5YR 2.5/2]
TP-FP-50	0.0	0.8	SM	silty sand	TAILINGS		MIXED TAILINGS; fine grained		Moist	Yellowish red [5YR 4/6]
TP-FP-50	1.2	1.6	SM	silty sand	TAILINGS		MIXED TAILINGS; fine grained		Moist	Yellowish red [5YR 4/6]
TP-FP-50	2.2	2.8	SP	sand	TAILINGS		MIXED TAILINGS; fine grained; visible Pyrite		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-50	2.8	3.5	ML	silt with gravel	TAILINGS		randomly MIXED TAILINGS and TOPSOIL		Moist	Very dark brown [10YR 2/2]
TP-FP-50	4.0	4.7	OL	organic silty sand	Undisturbed	Topsoil	pre-flood TOPSOIL with small gravels		Moist	
TP-FP-50	4.7	5.5	GW	well graded gravel with sand	Undisturbed					
TP-FP-50	6.0	6.5	GW	well graded gravel with sand	Undisturbed			@ 6ft GW 503.0 rmv; 408.0 µs/cm; pH start 6.77 pH end 6.77 (11 Minutes)		

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-47	4.0	4.5	GP						6.69	6.77	595.50	72+80	86+50
TP-FP-47	4.5	5.5	GP									72+80	86+50
TP-FP-47	6.0	6.5	CL						6.44	6.11	384.00	72+80	86+50
TP-FP-48	0.4	1.5	SP-SM	Grayish brown								74+00	85+30
TP-FP-48	2.0	2.5	GP-GM									74+00	85+30
TP-FP-48	3.5	4.0	GP-GM									74+00	85+30
TP-FP-48	4.0	4.4	GP-GM						5.66	5.64	290.70	74+00	85+30
TP-FP-48	4.4	6.0	GP-GM									74+00	85+30
TP-FP-48	6.5	8.0	GP-GM									74+00	85+30
TP-FP-48	8.5	10.0	GP-GM									74+00	85+30
TP-FP-48	10.5	13.0	GP-GM						6.41	6.48	373.00	74+00	85+30
TP-FP-48	13.0	13.5	GP-GM									74+00	85+30
TP-FP-49	0.0	0.7	SM									74+30	85+00
TP-FP-49	1.2	1.7	SM									74+30	85+00
TP-FP-49	1.7	2.4	SM		1737	476	279	93357				74+30	85+00
TP-FP-49	2.4	2.5	SM									74+30	85+00
TP-FP-49	2.5	3.0	GW									74+30	85+00
TP-FP-49	3.4	4.0	GW									74+30	85+00
TP-FP-49	4.0	5.0	ML									74+30	85+00
TP-FP-49	5.5	6.0	ML									74+30	85+00
TP-FP-49	6.0	6.5	GP-GM						6.77	6.18	300.00	74+30	85+00
TP-FP-49	7.0	8.5	GP-GM									74+30	85+00
TP-FP-49	9.0	11.0	GP-GM									74+30	85+00
TP-FP-49	11.0	12.0	GP-GM						6.6	5.94	425.00	74+30	85+00
TP-FP-50	0.0	0.8	SM									74+70	84+60
TP-FP-50	1.2	1.6	SM									74+70	84+60
TP-FP-50	2.2	2.8	SP									74+70	84+60
TP-FP-50	2.8	3.5	ML									74+70	84+60
TP-FP-50	4.0	4.7	OL	Dark brown								74+70	84+60
TP-FP-50	4.7	5.5	GW									74+70	84+60
TP-FP-50	6.0	6.5	GW						6.77	6.77	408.00	74+70	84+60

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-50	6.5	7.5	GW	well graded gravel with sand	Undisturbed					
TP-FP-50	8.0	9.0	GW	well graded gravel with sand	Undisturbed					
TP-FP-50	9.0	10.0	CL	sandy clay	Undisturbed		estimated 10% Sand and 90% Fines		Saturated	Brown [7.5YR 4/4]
TP-FP-50	10.0	11.5	GW	well graded gravel with sand	Undisturbed		ALLUVIUM			
TP-FP-50	11.5	12.0	GW	well graded gravel with sand	Undisturbed		ALLUVIUM	@ 12ft GW 502.5 rmv; 378.0 µs/cm; pH start 7.25 pH end 5.89 (14 Minutes)		
TP-FP-50A	0.0	0.1	GM	silty gravel with sand	TAILINGS		0-2.2 estimated 60% Sand and 40% Gravel (generally 1-in minus).			
TP-FP-50A	0.1	0.5	GM	silty gravel with sand	TAILINGS					
TP-FP-50A	1.5	1.6	SM	silty sand	TAILINGS					
TP-FP-50A	2.2	2.3	ML	silt	Undisturbed	Organic	organic with roots		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-50A	2.3	2.5	ML	silt	Undisturbed	Organic	organic with roots		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-50A	2.5	3.0	ML	silt	Undisturbed	Organic	organic with roots		Moist	Very dark brown [7.5YR 2.5/3]
TP-FP-50A	3.0	3.5	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM in top 6-in of GP; coarse grained			
TP-FP-50A	3.5	4.0	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM in top 6-in of GP; coarse grained	Groundwater at 4 ft.		
TP-FP-50A	4.0	5.0	GP	poorly graded gravel with sand	Undisturbed		ALLUVIUM in top 6-in of GP; coarse grained			
TP-FP-50A	5.0	5.5	SC	clayey sand with gravel	Undisturbed		5-9 Gravels are mineralized; angular; and orange brown in color	@ 5.5ft GW 483.6 rmv; 244.2 µs/cm; pH start 5.98 pH end 4.91 (17 Minutes)	Saturated	Strong brown [7.5YR 4/6]
TP-FP-50A	5.5	8.0	SC	clayey sand with gravel	Undisturbed				Saturated	Strong brown [7.5YR 4/6]
TP-FP-50A	8.0	8.5	SC	clayey sand with gravel	Undisturbed				Saturated	Strong brown [7.5YR 4/6]
TP-FP-50A	8.5	9.0	SC	clayey sand with gravel	Undisturbed			Depths shown for screen interval on well log are approximate.	Saturated	Strong brown [7.5YR 4/6]
TP-FP-51	0.0	1.5	SM	silty sand with gravel	Undisturbed		0-2 Colluvium; estimated 20% Gravel; 60% Sand; and 30% Clay; roots in top 6-in		Moist	Brown [7.5YR 4/4]
TP-FP-51	1.5	2.0	SM	silty sand with gravel	Undisturbed				Moist	Brown [7.5YR 4/4]
TP-FP-51	2.0	3.5	SC	clayey sand with gravel	Undisturbed		2-6.0 SLOPE WASH; estimated 20% Gravel; 60% Sand; and 30% Clay; roots in top 6-in; visible pyrite; some gravels contain pyrite; 6" maximum size	Groundwater at 6 ft.	Moist	Strong brown [7.5YR 4/6]
TP-FP-51	3.5	4.0	SC	clayey sand with gravel	Undisturbed				Moist	Strong brown [7.5YR 4/6]
TP-FP-51	4.0	5.5	SC	clayey sand with gravel	Undisturbed				Moist	Strong brown [7.5YR 4/6]
TP-FP-51	5.5	6.0	SC	clayey sand with gravel	Undisturbed			Groundwater at 6 ft.	Moist	Strong brown [7.5YR 4/6]
TP-FP-51	6.0	7.5	SC	clayey sand with gravel	Undisturbed				Moist to wet	Dark brown [7.5YR 3/4]
TP-FP-51	7.5	8.0	SC	clayey sand with gravel	Undisturbed				Moist to wet	Dark brown [7.5YR 3/4]
TP-FP-51	8.0	9.0	SC	clayey sand with gravel	Undisturbed				Moist to wet	Dark brown [7.5YR 3/4]
TP-FP-51	9.0	10.0	SC	clayey sand with gravel	Undisturbed				Moist to wet	Dark brown [7.5YR 3/4]
TP-FP-51	10.0	10.5	SC	clayey sand with gravel	Undisturbed			Could not observe soil profile below 9 ft depth due to standing water. Classification based on soil retrivied in excavator bucket.	Moist to wet	Dark brown [7.5YR 3/4]
TP-FP-51	10.5	11.0	GC	clayey gravel with sand	Undisturbed		2.5-11.5 estimated 40% Gravel; 30% Sand; and 30% Clay; maximum size approximately 4"		Saturated	Dark brown [7.5YR 3/4]
TP-FP-51	11.0	11.5	GC	clayey gravel with sand	Undisturbed				Saturated	Dark brown [7.5YR 3/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-50	6.5	7.5	GW									74+70	84+60
TP-FP-50	8.0	9.0	GW									74+70	84+60
TP-FP-50	9.0	10.0	CL		174	449	201	53678				74+70	84+60
TP-FP-50	10.0	11.5	GW									74+70	84+60
TP-FP-50	11.5	12.0	GW		387	491	269	69669	7.25	5.89	378.00	74+70	84+60
TP-FP-50A	0.0	0.1	GM									74+70	84+60
TP-FP-50A	0.1	0.5	GM									74+70	84+60
TP-FP-50A	1.5	1.6	SM									74+70	84+60
TP-FP-50A	2.2	2.3	ML		165	331	238	48625				74+70	84+60
TP-FP-50A	2.3	2.5	ML		140	306	218	47931				74+70	84+60
TP-FP-50A	2.5	3.0	ML									74+70	84+60
TP-FP-50A	3.0	3.5	GP									74+70	84+60
TP-FP-50A	3.5	4.0	GP		77	282	178	55287				74+70	84+60
TP-FP-50A	4.0	5.0	GP									74+70	84+60
TP-FP-50A	5.0	5.5	SC		100	150	492	91895	5.98	4.91	244.20	74+70	84+60
TP-FP-50A	5.5	8.0	SC									74+70	84+60
TP-FP-50A	8.0	8.5	SC									74+70	84+60
TP-FP-50A	8.5	9.0	SC		53	70	252	81555				74+70	84+60
TP-FP-51	0.0	1.5	SM									71+55	87+75
TP-FP-51	1.5	2.0	SM		282	182	439	82791				71+55	87+75
TP-FP-51	2.0	3.5	SC									71+55	87+75
TP-FP-51	3.5	4.0	SC		154	140	339	66171				71+55	87+75
TP-FP-51	4.0	5.5	SC									71+55	87+75
TP-FP-51	5.5	6.0	SC		143	144	313	64795				71+55	87+75
TP-FP-51	6.0	7.5	SC	Strong brown [7.5YR 4/6]								71+55	87+75
TP-FP-51	7.5	8.0	SC	Strong brown [7.5YR 4/6]	58	128	464	101944				71+55	87+75
TP-FP-51	8.0	9.0	SC	Strong brown [7.5YR 4/6]								71+55	87+75
TP-FP-51	9.0	10.0	SC	Strong brown [7.5YR 4/6]								71+55	87+75
TP-FP-51	10.0	10.5	SC	Strong brown [7.5YR 4/6]	123	136	390	84846				71+55	87+75
TP-FP-51	10.5	11.0	GC									71+55	87+75
TP-FP-51	11.0	11.5	GC		193	190	364	78397				71+55	87+75

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-51	11.5	12.0	SC	clayey sand with gravel	Undisturbed				Moist to wet	Strong brown [7.5YR 4/6]
TP-FP-51	12.0	12.5	SC	clayey sand with gravel	Undisturbed			@12; GW 533.6 rmv; 190.6 µs/cm	Moist to wet	Strong brown [7.5YR 4/6]
TP-FP-51A	0.0	2.0	SP-SM	silty sand with gravel	TAILINGS					
TP-FP-51A	2.0	2.5	SP-SM	silty sand with gravel	TAILINGS		MIXED TAILINGS		Moist	Dark reddish brown [5YR 3/4]
TP-FP-51A	2.5	3.0	SP-SM	silty sand with gravel	TAILINGS		MIXED TAILINGS		Moist	Dark reddish brown [5YR 3/4]
TP-FP-51A	3.0	4.5	SM	silty sand with gravel	Undisturbed		estimated 20% Gravel; 60% Sand; and 30% Clay		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-51A	4.5	5.0	SM	silty sand with gravel	Undisturbed		estimated 20% Gravel; 60% Sand; and 30% Clay		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-51A	5.0	6.0	SM	silty sand with gravel	Undisturbed		estimated 20% Gravel; 60% Sand; and 30% Clay		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-51A	6.0	6.2	GM	silty gravel with sand	Undisturbed		6-9 estimated 60% Gravel; 40% Sand; generally 1-in. minus particle size	Groundwater at 6 ft.	Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-51A	6.2	9.0	GM	silty gravel with sand	Undisturbed				Saturated	Very dark brown [7.5YR 2.5/3]
TP-FP-52	0.0	0.1	OL	organic silt with sand	TAILINGS	Black	with MIXED TAILING	Wetland vegetation on surface of test pit.	Wet to Saturated	Black [7.5YR 2.5/1]
TP-FP-52	0.1	1.0	OL	organic silt with sand	TAILINGS	Black	with MIXED TAILING		Wet to Saturated	Black [7.5YR 2.5/1]
TP-FP-52	1.5	2.0	OL	organic silt with sand	TAILINGS	Black	with MIXED TAILING		Wet to Saturated	Black [7.5YR 2.5/1]
TP-FP-52	2.0	2.7	OL	organic silt with sand	TAILINGS	Black	with MIXED TAILING	Groundwater at 2 ft.	Wet to Saturated	Black [7.5YR 2.5/1]
TP-FP-52	3.0	5.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed	iron stain	cobbles are subangular; gravels are subrounded.	Test pit location on edge of tailing area. Wetland vegetation covers all ground to the south. To the north the ground is covered by tailings with limited plant growth.		
TP-FP-52	5.0	5.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed	iron stain	cobbles are subangular; gravels are subrounded.			
TP-FP-52	5.5	7.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed	iron stain	cobbles are subangular; gravels are subrounded.			
TP-FP-52	7.5	8.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed	iron stain	cobbles are subangular; gravels are subrounded.			
TP-FP-52	8.0	9.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed	iron stain	cobbles are subangular; gravels are subrounded.			
TP-FP-52	9.5	10.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed	iron stain	cobbles are subangular; gravels are subrounded.	@ 10ft GW 444.4 rmv; 270.5 µs/cm; pH start 4.68 pH end 4.33 (9 Minutes)		
TP-FP-53	0.0	1.0	OL	organic sandy silt	TAILINGS		MIXED TAILING; wood debris observed at 2 ft	Very little vegetation on surface	Moist	Dark reddish brown [5YR 3/3]
TP-FP-53	1.0	1.8	OL	organic sandy silt	TAILINGS		MIXED TAILING; wood debris observed at 2 ft		Moist	Dark reddish brown [5YR 3/3]
TP-FP-53	2.4	3.0	OL	organic sandy silt	TAILINGS		MIXED TAILING; wood debris observed at 2 ft	Groundwater at 3 ft	Moist	Dark reddish brown [5YR 3/3]
TP-FP-53	3.6	4.0	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain	Acidic water	@ 4ft GW 505.6 rmv; 348 µs/cm; pH start 3.95 pH end 3.95 (13 Minutes)		
TP-FP-53	4.0	5.0	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain				
TP-FP-53	5.0	5.5	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain				
TP-FP-53	5.5	7.5	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain				
TP-FP-53	8.0	9.5	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain				

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-51	11.5	12.0	SC									71+55	87+75
TP-FP-51	12.0	12.5	SC		92	136	255	72994			190.60	71+55	87+75
TP-FP-51A	0.0	2.0	SP-SM									74+60	84+70
TP-FP-51A	2.0	2.5	SP-SM									74+60	84+70
TP-FP-51A	2.5	3.0	SP-SM		3303	410	360	93691				74+60	84+70
TP-FP-51A	3.0	4.5	SM									74+60	84+70
TP-FP-51A	4.5	5.0	SM		148	250	186	59820				74+60	84+70
TP-FP-51A	5.0	6.0	SM									74+60	84+70
TP-FP-51A	6.0	6.2	GM		131	243	235	59253				74+60	84+70
TP-FP-51A	6.2	9.0	GM									74+60	84+70
TP-FP-52	0.0	0.1	OL									61+20	98+10
TP-FP-52	0.1	1.0	OL									61+20	98+10
TP-FP-52	1.5	2.0	OL									61+20	98+10
TP-FP-52	2.0	2.7	OL									61+20	98+10
TP-FP-52	3.0	5.0	GP-GM									61+20	98+10
TP-FP-52	5.0	5.5	GP-GM		219	281	810	133789				61+20	98+10
TP-FP-52	5.5	7.5	GP-GM									61+20	98+10
TP-FP-52	7.5	8.0	GP-GM		163	430	492	95736				61+20	98+10
TP-FP-52	8.0	9.5	GP-GM									61+20	98+10
TP-FP-52	9.5	10.0	GP-GM		155	332	594	105039	4.68	4.33	270.50	61+20	98+10
TP-FP-53	0.0	1.0	OL									64+30	95+00
TP-FP-53	1.0	1.8	OL									64+30	95+00
TP-FP-53	2.4	3.0	OL									64+30	95+00
TP-FP-53	3.6	4.0	GW-GM						3.95	3.95	348.00	64+30	95+00
TP-FP-53	4.0	5.0	GW-GM									64+30	95+00
TP-FP-53	5.0	5.5	GW-GM		147	442	332	83137				64+30	95+00
TP-FP-53	5.5	7.5	GW-GM									64+30	95+00
TP-FP-53	8.0	9.5	GW-GM									64+30	95+00

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-53	9.5	10.0	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain		@ 12ft GW 400.1 rmv; 292.8 µs/cm; pH start 4.65 pH end 4.64 (16 Minutes)		
TP-FP-53	10.0	12.0	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain		Depths shown for screen interval on well log are approximate.		
TP-FP-53	12.0	12.5	GW-GM	well graded gravel with silt and sand	Undisturbed	iron stain				
TP-FP-54	0.0	0.1	SM	silty sand	TAILINGS		MIXED TAILING	A solvent type odor was noted on 8/27/2012 when test pit was excavated to 4 ft depth. Odor was still present on 8/28/2012 when excavation of test pit resumed.	Moist	Yellowish brown [10YR 5/6]
TP-FP-54	0.1	0.6	SM	silty sand	TAILINGS		MIXED TAILING		Moist	Yellowish brown [10YR 5/6]
TP-FP-54	0.6	1.0	SM	silty sand	TAILINGS		MIXED TAILING		Moist	Yellowish brown [10YR 5/6]
TP-FP-54	1.0	1.2	SM	silty sand	TAILINGS		MIXED TAILING		Moist	Yellowish brown [10YR 5/6]
TP-FP-54	1.4	1.8	ML	sandy silt	TAILINGS		with roots		Moist	Dark brown [7.5YR 3/2]
TP-FP-54	2.4	2.5	ML	silt with gravel	UHM		color grades to a pale brown below water table	Multiple trees at 2.5; 10" tree still standing with former ground surface at 2.5;	Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-54	2.5	3.4	ML	silt with gravel	UHM		color grades to a pale brown below water table	Groundwater at 3.4 ft.	Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-54	3.8	4.0	ML	silt with gravel	Undisturbed	Acid	Water is acidic 2.9 pH	@ 4ft GW 646.9 rmv; 1275 µs/cm; pH start 2.94 pH send 2.92 (10 Minutes)	Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-FP-54	4.0	5.0	GW-GM	well graded gravel with silt and sand	Undisturbed		4-10 estimated 10% Cobble; 40% Gravel; 40% Sand; and 10% Fines; max particle size is approximately 6-in		Wet	Dark reddish brown [5YR 3/3]
TP-FP-54	5.5	7.0	GW-GM	well graded gravel with silt and sand	Undisturbed				Wet	Dark reddish brown [5YR 3/3]
TP-FP-54	7.0	7.5	GW-GM	well graded gravel with silt and sand	Undisturbed				Wet	Dark reddish brown [5YR 3/3]
TP-FP-54	7.5	8.5	GW-GM	well graded gravel with silt and sand	Undisturbed				Wet	Dark reddish brown [5YR 3/3]
TP-FP-54	8.5	9.0	GW-GM	well graded gravel with silt and sand	Undisturbed				Wet	Dark reddish brown [5YR 3/3]
TP-FP-54	9.5	10.0	GW-GM	well graded gravel with silt and sand	Undisturbed			@ 10ft GW 597.5 rmv; 501 µs/cm; pH start 4.88 pH end 4.88 (15 Minutes)	Wet	Dark reddish brown [5YR 3/3]
TP-FP-55	0.0	0.1	SM	silty sand	TAILINGS		MIXED TAILING; wood debris	Ground surface barren of vegetation.	Moist	Dark reddish brown [5YR 3/4]
TP-FP-55	0.1	0.6	SM	silty sand	TAILINGS		MIXED TAILING; wood debris		Moist	Dark reddish brown [5YR 3/4]
TP-FP-55	0.6	1.0	SM	silty sand	TAILINGS		MIXED TAILING; wood debris		Moist	Dark reddish brown [5YR 3/4]
TP-FP-55	1.0	1.6	SM	silty sand	TAILINGS		MIXED TAILING; wood debris		Moist	Dark reddish brown [5YR 3/4]
TP-FP-55	1.6	2.0	OL	organic silt with sand	TAILINGS		with pockets of MIXED TAILING		Wet	Dark reddish brown [5YR 2.5/2]
TP-FP-55	2.3	2.5	OL	organic silt with sand	UHM		with pockets of MIXED TAILING		Wet	Dark reddish brown [5YR 2.5/2]
TP-FP-55	3.0	3.1	GW-GM	well graded gravel with silt and sand	UHM			@ 3ft GW 371.6 rmv; 175.2 µs/cm; pH start 6.15 pH end 5.88 (29 Minutes)		
TP-FP-55	3.1	3.8	GW-GM	well graded gravel with silt and sand	UHM		Water level at 3.5 ft.			
TP-FP-55	4.2	5.0	GW-GM	well graded gravel with silt and sand	UHM			@ 5ft GW 413.4 rmv; 267.6 µs/cm; pH start 5.25 pH end 5.08 (18 Minutes)		
TP-FP-55	5.5	8.0	GW-GM	well graded gravel with silt and sand	Undisturbed			Installed 1.5" PVC to 7.6;		

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-53	9.5	10.0	GW-GM		262	390	811	107922	4.65	4.64	292.80	64+30	95+00
TP-FP-53	10.0	12.0	GW-GM									64+30	95+00
TP-FP-53	12.0	12.5	GW-GM		530	482	1146	104624				64+30	95+00
TP-FP-54	0.0	0.1	SM									64+80	94+50
TP-FP-54	0.1	0.6	SM									64+80	94+50
TP-FP-54	0.6	1.0	SM		2839	385	285	103149				64+80	94+50
TP-FP-54	1.0	1.2	SM									64+80	94+50
TP-FP-54	1.4	1.8	ML									64+80	94+50
TP-FP-54	2.4	2.5	ML									64+80	94+50
TP-FP-54	2.5	3.4	ML									64+80	94+50
TP-FP-54	3.8	4.0	ML						2.94	2.92	1,275.00	64+80	94+50
TP-FP-54	4.0	5.0	GW-GM									64+80	94+50
TP-FP-54	5.5	7.0	GW-GM									64+80	94+50
TP-FP-54	7.0	7.5	GW-GM		274	463	754	66151				64+80	94+50
TP-FP-54	7.5	8.5	GW-GM									64+80	94+50
TP-FP-54	8.5	9.0	GW-GM									64+80	94+50
TP-FP-54	9.5	10.0	GW-GM						4.88	4.88	501.00	64+80	94+50
TP-FP-55	0.0	0.1	SM									65+50	93+80
TP-FP-55	0.1	0.6	SM									65+50	93+80
TP-FP-55	0.6	1.0	SM		8253	437	690	95106				65+50	93+80
TP-FP-55	1.0	1.6	SM									65+50	93+80
TP-FP-55	1.6	2.0	OL									65+50	93+80
TP-FP-55	2.3	2.5	OL									65+50	93+80
TP-FP-55	3.0	3.1	GW-GM						6.15	5.88	175.20	65+50	93+80
TP-FP-55	3.1	3.8	GW-GM									65+50	93+80
TP-FP-55	4.2	5.0	GW-GM						5.25	5.08	267.60	65+50	93+80
TP-FP-55	5.5	8.0	GW-GM									65+50	93+80

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-56	0.0	0.3	GC	clayey gravel with sand	Undisturbed	Topsoil	TOPSOIL;abundant grass roots to 1.5 ft depth; estimated 10% Cobble; 40% Gravel; 30% Sand; and 20% Clay		Dry to moist	Black [10YR 2/1]
TP-FP-56	0.3	0.7	GC	clayey gravel with sand	Undisturbed	Topsoil			Dry to moist	Black [10YR 2/1]
TP-FP-56	0.7	1.5	GC	clayey gravel with sand	Undisturbed	Topsoil			Dry to moist	Black [10YR 2/1]
TP-FP-56	1.5	2.6	GP-GC	poorly graded gravel with silt and sand	Undisturbed		No rusty stain, but some Mn stains			
TP-FP-56	2.6	3.0	GP-GC	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-56	3.0	4.5	GP-GC	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-56	4.5	4.9	GP-GC	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-56	4.9	6.0	GP-GC	poorly graded gravel with silt and sand	Undisturbed			Groundwater at 6 ft.		
TP-FP-56	6.0	6.5	GP-GC	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-56	6.5	6.9	GP-GC	poorly graded gravel with silt and sand	Undisturbed			@ 7ft GW 437.4 rmv; 141.9 µs/cm; pH start 6.56 pH end 6.57 (10 Minutes)		
TP-FP-56	6.9	7.0	GP-GC	poorly graded gravel with silt and sand	Undisturbed			Did not sample below 5.5 ft depth due to side wall continually caving (could not collect representative sample).		
TP-FP-56	7.0	9.0	GP-GC	poorly graded gravel with silt and sand	Undisturbed			Installed 1.5" PVC to 8.6;		
TP-FP-57	0.0	0.5	SM	silty sand with gravel	Undisturbed		0-1 gravels are flat; abundant plant roots in top 0.6 ft. Gravels are 2" maximum diameter		Moist	Very dark brown [10YR 2/2]
TP-FP-57	0.5	1.0	SM	silty sand with gravel	Undisturbed			Piezometer not screened; has an open bottom	Moist	Very dark brown [10YR 2/2]
TP-FP-57	1.0	1.5	CL	sandy clay	Undisturbed			Hand auger refusal at 1.5 ft on rock.	Dry	Very dark brown [10YR 2/2]
TP-FP-58	0.0	0.1	ML	sandy silt	TAILINGS		MIXED TAILINGS; fine grained		Moist	Dark reddish brown [5YR 3/4]
TP-FP-58	0.3	0.5	ML	sandy silt	TAILINGS		MIXED TAILINGS; fine grained		Moist	Dark reddish brown [5YR 3/4]
TP-FP-58	0.5	1.3	ML	sandy silt	Undisturbed		trace cobbles; abundant tree roots (1-in minus)		Moist	Dark reddish brown [5YR 3/2]
TP-FP-58	1.3	1.6	ML	sandy silt	Undisturbed		trace cobbles; abundant tree roots (1-in minus)		Moist	Dark reddish brown [5YR 3/2]
TP-FP-58	1.6	1.7	ML	sandy silt	Undisturbed		trace cobbles; abundant tree roots (1-in minus)		Moist	Dark reddish brown [5YR 3/2]
TP-FP-58	1.7	2.3	GP	gravel with sand	Undisturbed					
TP-FP-58	2.3	2.8	GP	gravel with sand	Undisturbed			Groundwater at 2.8 ft.		
TP-FP-58	2.8	3.6	GP	poorly graded gravel with silt and sand	Undisturbed	Iron stain	iron staining/deposition prominent on surface of gravels			
TP-FP-58	4.0	4.1	GP	poorly graded gravel with silt and sand	Undisturbed	Iron stain	iron staining/deposition prominent on surface of gravels	@ 4ft GW 441.6 rmv; 250.8 µs/cm; pH start 6.55 pH end 6.31 (32 Minutes)		
TP-FP-58	4.1	4.7	CL	clay with gravel	Undisturbed	Manganese &	4-6 pockets of highly plastic clay (CH) with trace of organics frequently observed between 4 and 6 ft; Alluvium surrounding clay pockets had a greenish hue; gravels are subangular to subrounded	Sandy Silt was below water table; estimated depth and profile from excavator cuttings.	Saturated	Black [2.5Y 2.5/1]
TP-FP-58	4.7	6.0	CL	clay with gravel	Undisturbed	Organic			Saturated	Black [2.5Y 2.5/1]
TP-FP-58	6.5	7.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed	Organic	with zone of black organic Sandy Silt		Saturated	Dark reddish brown [5YR 3/3]
TP-FP-58	7.0	8.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM	@ 10ft GW 260.0 rmv; 211.2 µs/cm; pH start 6.07 pH end 6.03 (24 Minutes)	Saturated	Dark reddish brown [5YR 3/3]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-56	0.0	0.3	GC									68+20	91+10
TP-FP-56	0.3	0.7	GC		222	400	210	41102				68+20	91+10
TP-FP-56	0.7	1.5	GC									68+20	91+10
TP-FP-56	1.5	2.6	GP-GC									68+20	91+10
TP-FP-56	2.6	3.0	GP-GC		190	252	154	65864				68+20	91+10
TP-FP-56	3.0	4.5	GP-GC									68+20	91+10
TP-FP-56	4.5	4.9	GP-GC		253	304	207	95758				68+20	91+10
TP-FP-56	4.9	6.0	GP-GC									68+20	91+10
TP-FP-56	6.0	6.5	GP-GC									68+20	91+10
TP-FP-56	6.5	6.9	GP-GC		179	254	201	67911	6.56	6.57	141.90	68+20	91+10
TP-FP-56	6.9	7.0	GP-GC		179	254	201	67911				68+20	91+10
TP-FP-56	7.0	9.0	GP-GC									68+20	91+10
TP-FP-57	0.0	0.5	SM		141	341	184	44176				59+15	100+15
TP-FP-57	0.5	1.0	SM		189	429	210	43741				59+15	100+15
TP-FP-57	1.0	1.5	CL		167	404	275	43283				59+15	100+15
TP-FP-58	0.0	0.1	ML									58+40	100+90
TP-FP-58	0.3	0.5	ML									58+40	100+90
TP-FP-58	0.5	1.3	ML									58+40	100+90
TP-FP-58	1.3	1.6	ML		151	316	237	47681				58+40	100+90
TP-FP-58	1.6	1.7	ML									58+40	100+90
TP-FP-58	1.7	2.3	GP									58+40	100+90
TP-FP-58	2.3	2.8	GP		141	486	238	68030				58+40	100+90
TP-FP-58	2.8	3.6	GP									58+40	100+90
TP-FP-58	4.0	4.1	GP						6.55	6.31	250.80	58+40	100+90
TP-FP-58	4.1	4.7	CL	Brown	173	366	206	30534				58+40	100+90
TP-FP-58	4.7	6.0	CL	Brown								58+40	100+90
TP-FP-58	6.5	7.0	GP-GM	Black								58+40	100+90
TP-FP-58	7.0	8.5	GP-GM						6.07	6.03	211.20	58+40	100+90

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-FP-58	9.0	9.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM		Saturated	Dark reddish brown [5YR 3/3]
TP-FP-59	0.0	0.1	SM	silty sand with gravel	TAILINGS		MIXED TAILING	No vegetation growing on ground surface.	Moist	Dark reddish brown [5YR 3/4]
TP-FP-59	0.1	0.2	SM	silty sand with gravel	TAILINGS		MIXED TAILING		Moist	Dark reddish brown [5YR 3/4]
TP-FP-59	0.4	0.6	SM	silty sand with gravel	TAILINGS		MIXED TAILING		Moist	Dark reddish brown [5YR 3/4]
TP-FP-59	0.6	1.5	SP	sand with gravel	Undisturbed		abundant tree roots (1/2-in. minus)		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-59	2.0	2.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed		2-7 estimated 60% Gravel; 40% Sand; max particle size is 6-in; gravel particles are flat and layered			
TP-FP-59	3.0	3.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-59	3.5	4.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed					
TP-FP-59	4.0	6.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Groundwater rapidly flowing into test pit at 6 ft		
TP-FP-59	6.0	6.1	GP-GM	silty gravel with sand	Undisturbed					
TP-FP-59	6.1	6.5	GP-GM	silty gravel with sand	Undisturbed					
TP-FP-59	7.0	8.0	GP-GM	silty gravel with sand	Undisturbed			@ 6ft GW 497.7 rmv; 231.6 µs/cm; pH start 6.16 pH end 6.23 (25 Minutes)		
TP-FP-59	8.0	8.5	GM	silty gravel with sand	Undisturbed		gravel particles are flat and layered		Saturated	Dark reddish brown [5YR 3/4]
TP-FP-59	9.0	12.0	GM	silty gravel with sand	Undisturbed		gravel particles are flat and layered		Saturated	Dark reddish brown [5YR 3/4]
TP-FP-60	0.0	0.1	ML	sandy silt with gravel	Undisturbed	Topsoil	TOPSOIL	Lush grass vegetation growing on ground surface.	Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-60	0.1	0.2	ML	sandy silt with gravel	Undisturbed	Topsoil	TOPSOIL		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-60	0.2	0.5	ML	sandy silt with gravel	Undisturbed	Topsoil	TOPSOIL		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-60	0.5	1.3	ML	sandy silt with gravel	Undisturbed	Topsoil	TOPSOIL		Moist	Very dark brown [7.5YR 2.5/2]
TP-FP-60	1.3	2.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM.			
TP-FP-60	2.0	2.2	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM.			
TP-FP-60	2.2	3.6	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM.			
TP-FP-60	3.6	4.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM.			
TP-FP-60	4.0	5.8	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM.			
TP-FP-60	5.8	5.9	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM.	Groundwater at 5.9 ft.		
TP-FP-60	5.9	6.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed		ALLUVIUM.	@ 6ft GW 548.0 rmv; 69.6 µs/cm; pH start 5.52 pH end 5.06 (31 Minutes)		
TP-MS-01	0.5	0.8	PT	peat wtih silt	Undisturbed		TAILINGS		Wet	Very dark grayish brown [10YR 3/2]
TP-MS-01	0.8	0.8	OL	organic silt with gravel	Undisturbed		gravels are flat and 1-in minus		Wet	Very dark brown [10YR 2/2]
TP-MS-01	0.8	1.0	OL	organic silt with gravel	Undisturbed		gravels are flat and 1-in minus	Installed 4-inch solid wall PVC with an open bottom at 1;	Wet	Very dark brown [10YR 2/2]
TP-MS-04	2.0	2.5	OL	sandy organic silt with gravel	Undisturbed		trace subangular gravels at 2.4 ft.Possible surface soils prior to flooding.	Auger refusal at 2.5; on Gravel	Moist	
TP-MS-04A	0.0	0.1	SP	sand with gravel	TAILINGS		MIXED TAILING; sand is coarse grain; estimate 20% Gravel	White precipitate observed on ground surface (no vegetation growing). Test pit excavated on north bank of stream.	Moist	
TP-MS-04A	0.1	1.0	SP	sand with gravel	TAILINGS		MIXED TAILING; sand is coarse grain; estimate 20% Gravel	Groundwater not observed.	Moist	

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-FP-58	9.0	9.5	GP-GM									58+40	100+90
TP-FP-59	0.0	0.1	SM									58+30	101+00
TP-FP-59	0.1	0.2	SM									58+30	101+00
TP-FP-59	0.4	0.6	SM									58+30	101+00
TP-FP-59	0.6	1.5	SP									58+30	101+00
TP-FP-59	2.0	2.5	GP-GM									58+30	101+00
TP-FP-59	3.0	3.5	GP-GM									58+30	101+00
TP-FP-59	3.5	4.0	GP-GM		184	377	287	38564				58+30	101+00
TP-FP-59	4.0	6.0	GP-GM									58+30	101+00
TP-FP-59	6.0	6.1	GP-GM									58+30	101+00
TP-FP-59	6.1	6.5	GP-GM									58+30	101+00
TP-FP-59	7.0	8.0	GP-GM						6.16	6.23	231.60	58+30	101+00
TP-FP-59	8.0	8.5	GM									58+30	101+00
TP-FP-59	9.0	12.0	GM									58+30	101+00
TP-FP-60	0.0	0.1	ML									58+60	100+70
TP-FP-60	0.1	0.2	ML									58+60	100+70
TP-FP-60	0.2	0.5	ML		157	337	138	46327				58+60	100+70
TP-FP-60	0.5	1.3	ML									58+60	100+70
TP-FP-60	1.3	2.0	GP-GM									58+60	100+70
TP-FP-60	2.0	2.2	GP-GM		103	237	122	51355				58+60	100+70
TP-FP-60	2.2	3.6	GP-GM									58+60	100+70
TP-FP-60	3.6	4.0	GP-GM		307	247	190	57684				58+60	100+70
TP-FP-60	4.0	5.8	GP-GM									58+60	100+70
TP-FP-60	5.8	5.9	GP-GM		126	274	420	62065				58+60	100+70
TP-FP-60	5.9	6.0	GP-GM		126	274	420	62065	5.52	5.06	69.60	58+60	100+70
TP-MS-01	0.5	0.8	PT		278	484	656	44950				47+80	111+50
TP-MS-01	0.8	0.8	OL		278	484	656	44950				47+80	111+50
TP-MS-01	0.8	1.0	OL		278	484	656	44950				47+80	111+50
TP-MS-04	2.0	2.5	OL	Black	233	467	241	36974				47+60	111+70
TP-MS-04A	0.0	0.1	SP	Rusty brown								47+00	112+30
TP-MS-04A	0.1	1.0	SP	Rusty brown								47+00	112+30

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-MS-04A	1.0	1.5	SP	sand with gravel	TAILINGS		MIXED TAILING; sand is coarse grain; estimate 20% Gravel		Moist	
TP-MS-04A	1.5	2.0	SP	sand with gravel	TAILINGS		MIXED TAILING; sand is coarse grain; estimate 20% Gravel	Installed 4" solid wall PVC with an open bottom to 2.0;	Moist	
TP-MS-05	0.0	0.1	OL	organic silt	Undisturbed		dilatent	Lush wetland vegetation at ground surface.	Wet	Very dark brown [10YR 2/2]
TP-MS-05	0.1	1.2	OL	organic silt	Undisturbed		dilatent		Wet	Very dark brown [10YR 2/2]
TP-MS-05	1.2	1.5	OL	organic silt	Undisturbed		dilatent		Wet	Very dark brown [10YR 2/2]
TP-MS-05	1.5	1.8	OL	organic silt	Undisturbed		dilatent		Wet	Very dark brown [10YR 2/2]
TP-MS-05	1.8	1.8	GP-GC	poorly graded gravel with clay and sand	Undisturbed		estimated 60% Gravel and 40% Sand	Groundwater at 1.75 ft.	Saturated	Dark brown [7.5YR 3/3]
TP-MS-05	1.8	2.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		estimated 60% Gravel and 40% Sand		Saturated	Dark brown [7.5YR 3/3]
TP-MS-05	2.0	2.3	GP-GC	poorly graded gravel with clay and sand	Undisturbed		estimated 60% Gravel and 40% Sand		Saturated	Dark brown [7.5YR 3/3]
TP-MS-05	2.3	3.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		estimated 60% Gravel and 40% Sand		Saturated	Dark brown [7.5YR 3/3]
TP-MS-05	3.0	3.3	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	with organics; ALLUVIUM.		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	3.3	3.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	with organics; ALLUVIUM.		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	3.5	4.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	with organics; ALLUVIUM.		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	4.0	4.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	with organics; ALLUVIUM.		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	4.5	6.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	with organics; ALLUVIUM.		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	6.0	6.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	with organics; ALLUVIUM.		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	6.5	7.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	with organics; ALLUVIUM.	GW at 9.5;; 336.7 rmv; 134 µs/cm; pH start 6.21 pH end 6.17	Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	7.0	9.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed		7-9.5 estimated 20% Cobble; 50% Gravel; and 30% Sand and fines; max particle size is approximately 7-in.;Cobbles are subangular and blocky; Gravels are subrounded and flat		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-05	9.0	9.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed				Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-06	0.0	0.3	SM	silty sand with gravel	Undisturbed	Topsoil	TOPSOIL	Clayey Gravel visually appears to be native material (no tailings). The soil color (yellowish brown) is similar to other areas where mixed tailing was observed. The test pit is located in a highly mineralized area.	Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-MS-06	0.3	0.5	SM	silty sand with gravel	Undisturbed	Topsoil	TOPSOIL		Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-MS-06	0.5	1.0	SM	silty sand with gravel	Undisturbed	Topsoil	TOPSOIL	Groundwater at 1 ft.	Moist to wet	Very dark brown [7.5YR 2.5/2]
TP-MS-06	1.0	1.5	ML	silt with gravel and peat	Undisturbed		with PEAT		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-06	1.5	1.6	ML	silt with gravel and peat	Undisturbed		with PEAT		Saturated	Very dark brown [7.5YR 2.5/2]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-MS-04A	1.0	1.5	SP	Rusty brown								47+00	112+30
TP-MS-04A	1.5	2.0	SP	Rusty brown								47+00	112+30
TP-MS-05	0.0	0.1	OL									48+50	110+80
TP-MS-05	0.1	1.2	OL									48+50	110+80
TP-MS-05	1.2	1.5	OL		175	406	286	43223				48+50	110+80
TP-MS-05	1.5	1.8	OL									48+50	110+80
TP-MS-05	1.8	1.8	GP-GC									48+50	110+80
TP-MS-05	1.8	2.0	GP-GC		100	302	282	66859				48+50	110+80
TP-MS-05	2.0	2.3	GP-GC									48+50	110+80
TP-MS-05	2.3	3.0	GP-GC									48+50	110+80
TP-MS-05	3.0	3.3	GP-GC									48+50	110+80
TP-MS-05	3.3	3.5	GP-GC		138	324	273	61506				48+50	110+80
TP-MS-05	3.5	4.0	GP-GC									48+50	110+80
TP-MS-05	4.0	4.5	GP-GC		208	293	360	35429				48+50	110+80
TP-MS-05	4.5	6.0	GP-GC									48+50	110+80
TP-MS-05	6.0	6.5	GP-GC		195	325	255	49626				48+50	110+80
TP-MS-05	6.5	7.0	GP-GC						6.21	6.17	134.00	48+50	110+80
TP-MS-05	7.0	9.0	GP-GC									48+50	110+80
TP-MS-05	9.0	9.5	GP-GC		221	374	416	53532				48+50	110+80
TP-MS-06	0.0	0.3	SM									48+40	110+90
TP-MS-06	0.3	0.5	SM									48+40	110+90
TP-MS-06	0.5	1.0	SM		130	370	261	42817				48+40	110+90
TP-MS-06	1.0	1.5	ML		162	353	237	42193				48+40	110+90
TP-MS-06	1.5	1.6	ML									48+40	110+90

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-MS-06	1.6	2.0	ML	silt with gravel and peat	Undisturbed		with PEAT	Groundwater at 2;; 472.1 rmv; 103.5 µs/cm; pH start 5.90 pH end 5.67 (19 min)	Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-06	2.0	2.3	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic	2-8 trace organics; estiamted 15% Cobble; 25% Gravel; 30% Sand and 30% Clay; fine grain fraction has medium plasticity; approximate 6" maximum particle size		Saturated	Dark yellowish brown [10YR 4/6]
TP-MS-06	2.3	2.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic			Saturated	Dark yellowish brown [10YR 4/6]
TP-MS-06	2.5	2.7	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic			Saturated	Dark yellowish brown [10YR 4/6]
TP-MS-06	2.7	4.5	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic			Saturated	Dark yellowish brown [10YR 4/6]
TP-MS-06	4.5	5.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic			Saturated	Dark yellowish brown [10YR 4/6]
TP-MS-06	5.0	6.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic		Groundwater at 6;; 472.1 rmv; 103.5 µs/cm; pH start 5.90 pH end 5.67 (19 min)	Saturated	Dark yellowish brown [10YR 4/6]
TP-MS-06	6.0	8.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed	Organic		Installed 1.5" PVC to 7.7;	Saturated	Dark yellowish brown [10YR 4/6]
TP-MS-07	0.0	0.1	PT	peat with silt	Undisturbed	Black	trace fine sand	Lush vegetation at ground surface.	Saturated	Black [5Y 2.5/1]
TP-MS-07	0.1	0.5	PT	peat with silt	Undisturbed	Black	trace fine sand		Saturated	Black [5Y 2.5/1]
TP-MS-07	0.5	1.0	PT	peat with silt	Undisturbed	Black	trace fine sand	Groundwater at 1 ft.	Saturated	Black [5Y 2.5/1]
TP-MS-07	1.0	1.5	PT	peat with silt	Undisturbed	Black	trace fine sand		Saturated	Black [5Y 2.5/1]
TP-MS-07	1.5	2.0	PT	peat with silt	Undisturbed	Black	trace fine sand		Saturated	Black [5Y 2.5/1]
TP-MS-07	2.0	2.5	PT	peat with silt	Undisturbed	Black	trace fine sand	Groundwater at 1;; 273.9 rmv; 97.6 µs/cm pH start 4.78 end 5.35	Saturated	Black [5Y 2.5/1]
TP-MS-07	2.5	2.8	CL	clay with sand	Undisturbed		2.5-95 trace roots. Color transition to grayish black and increasing organic content at 4.5'			
TP-MS-07	2.8	3.5	CL	clay with sand	Undisturbed					
TP-MS-07	3.5	4.5	CL	clay with sand	Undisturbed					
TP-MS-07	4.5	5.5	CL	clay with sand	Undisturbed					
TP-MS-07	5.5	6.5	CL	clay with sand	Undisturbed					
TP-MS-07	6.5	7.5	CL	clay with sand	Undisturbed					
TP-MS-07	7.5	8.5	CL	clay with sand	Undisturbed					
TP-MS-07	8.5	9.5	CL	clay with sand	Undisturbed					
TP-MS-08	3.0	4.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed				Saturated	Very dark gray [10YR 3/1]
TP-MS-08	4.0	5.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed				Saturated	Very dark gray [10YR 3/1]
TP-MS-08	5.0	6.0	GP-GC	poorly graded gravel with clay and sand	Undisturbed				Saturated	Very dark gray [10YR 3/1]
TP-MS-09	4.0	5.0	CL	lean clay	Undisturbed				Saturated	Very dark brown [10YR 2/2]
TP-MS-09	5.0	6.0	CL	lean clay	Undisturbed				Saturated	Very dark brown [10YR 2/2]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-MS-06	1.6	2.0	ML		154	290	146	91967	5.9	5.67	472.10	48+40	110+90
TP-MS-06	2.0	2.3	GP-GC		154	290	146	91967				48+40	110+90
TP-MS-06	2.3	2.5	GP-GC									48+40	110+90
TP-MS-06	2.5	2.7	GP-GC		236	276	154	60496				48+40	110+90
TP-MS-06	2.7	4.5	GP-GC									48+40	110+90
TP-MS-06	4.5	5.0	GP-GC		318	181	355	79148				48+40	110+90
TP-MS-06	5.0	6.0	GP-GC						5.9	5.67		48+40	110+90
TP-MS-06	6.0	8.0	GP-GC									48+40	110+90
TP-MS-07	0.0	0.1	PT		52	19	1114	44395				27+20	132+10
TP-MS-07	0.1	0.5	PT		52	19	1114	44395				27+20	132+10
TP-MS-07	0.5	1.0	PT		28	14	1089	10570				27+20	132+10
TP-MS-07	1.0	1.5	PT		87	39	868	8647				27+20	132+10
TP-MS-07	1.5	2.0	PT		87	39	868	8647				27+20	132+10
TP-MS-07	2.0	2.5	PT						4.78	5.35	273.90	27+20	132+10
TP-MS-07	2.5	2.8	CL									27+20	132+10
TP-MS-07	2.8	3.5	CL		152	154	328	28121				27+20	132+10
TP-MS-07	3.5	4.5	CL		167	201	268	29061				27+20	132+10
TP-MS-07	4.5	5.5	CL		154	163	354	27277				27+20	132+10
TP-MS-07	5.5	6.5	CL		135	189	414	29270				27+20	132+10
TP-MS-07	6.5	7.5	CL									27+20	132+10
TP-MS-07	7.5	8.5	CL		137	216	687	46389				27+20	132+10
TP-MS-07	8.5	9.5	CL		169	186	459	61874				27+20	132+10
TP-MS-08	3.0	4.0	GP-GC									39+25	120+05
TP-MS-08	4.0	5.0	GP-GC		203	420	193	35665				39+25	120+05
TP-MS-08	5.0	6.0	GP-GC									39+25	120+05
TP-MS-09	4.0	5.0	CL									39+50	119+80
TP-MS-09	5.0	6.0	CL		202	316	239	36914				39+50	119+80

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-MS-09	6.0	7.0	CL	lean clay	Undisturbed			Installed 4-inch solid wall PVC with open bottom at 7;	Saturated	Very dark brown [10YR 2/2]
TP-MS-101	1.0	1.1	GC		Undisturbed					
TP-MS-103	0.5	1.0	OL	organic silty clay	Undisturbed		some subrounded fine gravel; trace pyrite		Saturated	Very dark gray [10YR 3/1]
TP-MS-103	1.0	1.5	OL	organic silty clay	Undisturbed					
TP-MS-104	2.5	2.6	GC		Undisturbed					
TP-MS-105	2.0	2.8	SM	silty sand with gravel	Undisturbed		some clay visible; fine to medium subangular gravel; no visible pyrite	Auger refusal at 3;; wet; well-graded; subangular to subrounded gravel; no visible pyrite encountered at BOH.	Wet to Saturated	Very dark brown [10YR 2/2]
TP-MS-105	2.8	3.0	SM	silty sand with gravel	Undisturbed		some clay visible; fine to medium subangular gravel; no visible pyrite		Wet to Saturated	Very dark brown [10YR 2/2]
TP-MS-105	3.0	3.1	GC		Undisturbed					
TP-MS-106	2.5	2.6	SM		TAILINGS					
TP-MS-107	0.0	0.3	OL	organic silt	TAILINGS		PEAT; no visible pyrite	Water at surface	Saturated	
TP-MS-107	0.3	2.3	OL	organic sandy silt	TAILINGS	Organic	abundant organics; PEAT; abundant very fine pyrite Becomes dark brown to black at 0.5'		Saturated	
TP-MS-107	2.3	2.5	OL	organic sandy silt	TAILINGS	Organic	fine sand with some organics; no visible pyrite		Saturated	
TP-MS-108	1.5	2.0	OL	organic sandy silt	TAILINGS		some fine sand; abundance of roots; PEAT and small trace of very fine pyrite.			
TP-MS-108	2.0	2.5	OL	organic sandy silt	Undisturbed		no visible pyrite		Saturated	Very dark brown [10YR 2/2]
TP-MS-109	1.5	1.9	OL	organic sandy silt	TAILINGS	Organic	abundant organics; PEAT; no visible pyrite		Wet	Very dark brown [7.5YR 2.5/2]
TP-MS-109	1.9	2.0	OL	organic sandy silt	TAILINGS	Organic	abundant organics; PEAT; no visible pyrite	Groundwater at 2ft	Wet	Very dark brown [7.5YR 2.5/2]
TP-MS-109	2.0	2.5	OL		Undisturbed					
TP-MS-10A	2.0	2.1	GW		Undisturbed					
TP-MS-10B	0.5	1.0	PT	peat with silt	TAILINGS	Black			Saturated	Black [10YR 2/1]
TP-MS-10C	3.8	3.8	GW		Undisturbed					
TP-MS-10D	3.5	3.6	GW		Undisturbed					
TP-MS-110	1.0	1.5	OL	organic silt	Undisturbed					
TP-MS-110	1.5	2.0	OL	organic silt	Undisturbed	Organic	PEAT; abundant organics; no visible pyrite		Saturated	Black [10YR 2/1]
TP-MS-111	0.8	0.8	GW		Undisturbed					
TP-MS-112	1.0	1.8	OL	organic sandy silt	TAILINGS		sand grains are rounded to subrounded; some organics and no visible pyrite.			
TP-MS-112	1.8	2.0	OL	organic sandy silt	Undisturbed		fine sand; no organics and no visible pyrite		Saturated	Very dark gray [7.5Y 3/1]
TP-MS-112	2.0	2.1	GW		Undisturbed					
TP-MS-114	0.0	0.3	OL	organic sandy silt	Undisturbed		0-0.5 sand grains are fine and subrounded; abundant roots with trace very fine pyrite		Moist	Dark reddish brown [5YR 3/2]
TP-MS-114	0.3	0.5	OL	organic sandy silt	Undisturbed				Moist	Dark reddish brown [5YR 3/2]
TP-MS-114	0.5	1.0	CL	lean clay	Undisturbed		0.5-1.5 no visible pyrite and abundant roots. Some fine; angular to subangular gravel at 0.5'. Becomes light brown to gray and saturated at 1'		Moist to wet	Dark reddish brown [5YR 2.5/2]
TP-MS-114	1.0	1.5	CL	lean clay	Undisturbed			Groundwater at 1.5ft	Moist to wet	Dark reddish brown [5YR 2.5/2]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-MS-09	6.0	7.0	CL		225	366	304	32693				39+50	119+80
TP-MS-101	1.0	1.1	GC									46+30	113+00
TP-MS-103	0.5	1.0	OL		211	473	200	31043				41+40	117+90
TP-MS-103	1.0	1.5	OL		199	329	254	32838				41+40	117+90
TP-MS-104	2.5	2.6	GC									39+20	120+10
TP-MS-105	2.0	2.8	SM		80	242	84	44444				35+10	124+20
TP-MS-105	2.8	3.0	SM		80	242	84	44444				35+10	124+20
TP-MS-105	3.0	3.1	GC									35+10	124+20
TP-MS-106	2.5	2.6	SM									35+85	123+45
TP-MS-107	0.0	0.3	OL	Black [10YR 2/1]	, but can't find data							33+25	126+05
TP-MS-107	0.3	2.3	OL	Very dark brown [10YR 2/2]	, but can't find data							33+25	126+05
TP-MS-107	2.3	2.5	OL	Very dark brown [10YR 2/2]	, but can't find data							33+25	126+05
TP-MS-108	1.5	2.0	OL									30+10	129+20
TP-MS-108	2.0	2.5	OL		183	191	113	28495				30+10	129+20
TP-MS-109	1.5	1.9	OL									30+75	128+55
TP-MS-109	1.9	2.0	OL									30+75	128+55
TP-MS-109	2.0	2.5	OL		183	191	113	28495				30+75	128+55
TP-MS-10A	2.0	2.1	GW									37+90	121+40
TP-MS-10B	0.5	1.0	PT	Very dark gray [10YR 3/1]								37+30	122+00
TP-MS-10C	3.8	3.8	GW									38+60	120+70
TP-MS-10D	3.5	3.6	GW									38+25	121+05
TP-MS-110	1.0	1.5	OL		144	466	254	36303.74				24+30	135+00
TP-MS-110	1.5	2.0	OL		169	428	245	44996.08				24+30	135+00
TP-MS-111	0.8	0.8	GW									40+50	118+80
TP-MS-112	1.0	1.8	OL									28+30	131+00
TP-MS-112	1.8	2.0	OL		220	383	238	32116				28+30	131+00
TP-MS-112	2.0	2.1	GW									28+30	131+00
TP-MS-114	0.0	0.3	OL		390	225	178	96587				21+80	137+50
TP-MS-114	0.3	0.5	OL		140	170	117	41488				21+80	137+50
TP-MS-114	0.5	1.0	CL									21+80	137+50
TP-MS-114	1.0	1.5	CL		191	215	182	74166				21+80	137+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-MS-114	1.5	2.0	CL	lean clay	Undisturbed		no visible pyrite and abundant roots. Some fine; angular to subangular gravel at 0.5'. Becomes light brown to gray and saturated at 1'		Moist to wet	Dark reddish brown [5YR 2.5/2]
TP-MS-115	1.0	1.3	PT	peat wtih silt	TAILINGS		no visible pyrite		Saturated	Very dusky red [2.5YR 2.5/2]
TP-MS-115	1.3	1.5	CL	lean clay	Undisturbed		organics and no visible pyrite		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-115	1.5	1.8	CL	lean clay	Undisturbed		organics and no visible pyrite		Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-115	1.8	2.0	CL	lean clay	Undisturbed		organics and no visible pyrite	Unable to retrieve significant sample below 2;.	Saturated	Very dark brown [7.5YR 2.5/2]
TP-MS-116	2.0	2.2	GM		Undisturbed					
TP-MS-117	2.5	2.6	GC		Undisturbed					
TP-MS-118	1.0	1.3	OL		TAILINGS					
TP-MS-118	1.3	1.5	OL	organic silt	TAILINGS	Black	abundant roots and no visible pyrite	Auger refusal at 1.5;; wet; subrounded to subangular gravel with sand encountered at BOH.	Saturated	Black [10YR 2/1]
TP-MS-119	1.5	1.6	Alluvium		Undisturbed					
TP-MS-11A	0.4	0.5	GP	gravel	Undisturbed		Crushed WASTE ROCK	TP-MS-11A located on drill road/pad. Crushed waste rock was encountered for approximately a 30 ft radius around TP-MS-11A. Depth to waste rock ranged between 2 and 6 inches.	Wet	
TP-MS-11B	0.5	1.0	PT	peat wtih silt	TAILINGS	Black		Surface water 386.7 rmV; 280 µs/cm; pH start 6.37 pH end 6.81 (17 minutes)	Saturated	Black [10YR 2/1]
TP-MS-11B	3.0	4.0	ML	silt	Undisturbed		with PEAT and TAILINGS;			
TP-MS-11B	4.0	5.0	ML	silt	Undisturbed		with PEAT and TAILINGS;			
TP-MS-11B	5.0	5.8	ML	silt	Undisturbed		with PEAT and TAILINGS;			
TP-MS-11C	0.5	1.0	PT	peat wtih silt	TAILINGS	Black		Surface water 327.3 rmV; 314 µs/cm; pH start 8.49 pH end 7.14 (19 minutes)	Wet	Black [10YR 2/1]
TP-MS-11C	3.0	4.0	ML	silt with sand	Undisturbed	Organic	with Organics; Trace flat; subangular gravels at 4 ft		Wet	Very dark brown [10YR 2/2]
TP-MS-11C	4.0	4.2	ML	silt with sand	Undisturbed	Organic	with Organics; Trace flat; subangular gravels at 4 ft		Wet	Very dark brown [10YR 2/2]
TP-MS-12	0.0	0.1	OL	organic silt	Undisturbed	Topsoil	with Organics; TOPSOIL	Wetland vegetation at ground surface.	Moist	Black [10YR 2/1]
TP-MS-12	0.1	0.5	OL	organic silt	Undisturbed	Topsoil	with Organics; TOPSOIL		Moist	Black [10YR 2/1]
TP-MS-12	0.5	1.0	OL	organic silt	Undisturbed	Topsoil	with Organics; TOPSOIL		Moist	Black [10YR 2/1]
TP-MS-12	1.0	1.3	OL	organic silt	Undisturbed	Topsoil	with Organics; TOPSOIL	Groundwater not observed	Moist	Black [10YR 2/1]
TP-MS-12	1.3	1.5	CL	lean clay	Undisturbed		1.3-3.4 rust color mottling observed from 1.3 to 1.7 ft. Trace sand and gravel from 2.0 to 2.5 ft. 1" minus angular gravels at 3.2 ft		Moist	Very dark brown [10YR 2/2]
TP-MS-12	1.5	2.0	CL	lean clay	Undisturbed				Moist	Very dark brown [10YR 2/2]
TP-MS-12	2.0	3.0	CL	lean clay	Undisturbed				Moist	Very dark brown [10YR 2/2]
TP-MS-121	1.8	1.8	GW		Undisturbed					
TP-MS-122	3.0	3.1	GW		Undisturbed					
TP-MS-13	1.9	2.0	GW		Undisturbed					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-MS-114	1.5	2.0	CL									21+80	137+50
TP-MS-115	1.0	1.3	PT									19+00	140+30
TP-MS-115	1.3	1.5	CL		169	338	171	80386				19+00	140+30
TP-MS-115	1.5	1.8	CL		186	265	156	69718				19+00	140+30
TP-MS-115	1.8	2.0	CL		186	265	156	69718				19+00	140+30
TP-MS-116	2.0	2.2	GM									17+80	141+50
TP-MS-117	2.5	2.6	GC									14+20	145+10
TP-MS-118	1.0	1.3	OL									10+80	148+50
TP-MS-118	1.3	1.5	OL	Sample is missing or mislabeled (2x 0.5 to 1)								10+80	148+50
TP-MS-119	1.5	1.6	Alluvium									16+00	143+30
TP-MS-11A	0.4	0.5	GP	Orangish brown								33+70	125+60
TP-MS-11B	0.5	1.0	PT	Very dark gray [2.5Y 3/1]					6.37	6.81	280.00	33+50	125+80
TP-MS-11B	3.0	4.0	ML		228	431	321	43203				33+50	125+80
TP-MS-11B	4.0	5.0	ML		225	284	348	32081				33+50	125+80
TP-MS-11B	5.0	5.8	ML		212	298	254	35673				33+50	125+80
TP-MS-11C	0.5	1.0	PT	Very dark gray [2.5Y 3/1]					8.49	7.14	314.00	34+13	125+17
TP-MS-11C	3.0	4.0	ML		201	324	221	43254				34+13	125+17
TP-MS-11C	4.0	4.2	ML									34+13	125+17
TP-MS-12	0.0	0.1	OL		267	440	616	43492				26+50	132+80
TP-MS-12	0.1	0.5	OL		267	440	616	43492				26+50	132+80
TP-MS-12	0.5	1.0	OL		132	243	963	26352				26+50	132+80
TP-MS-12	1.0	1.3	OL		190	279	869	30014				26+50	132+80
TP-MS-12	1.3	1.5	CL		190	279	869	30014				26+50	132+80
TP-MS-12	1.5	2.0	CL		184	319	473	35480				26+50	132+80
TP-MS-12	2.0	3.0	CL		142	414	311	34474				26+50	132+80
TP-MS-121	1.8	1.8	GW									41+15	118+15
TP-MS-122	3.0	3.1	GW									41+90	117+40
TP-MS-13	1.9	2.0	GW									26+40	132+90

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-MS-14	2.0	3.0	ML	sandy silt	Undisturbed				Moist to wet	Dark reddish brown [5YR 2.5/2]
TP-MS-14	3.0	3.4	ML	sandy silt	Undisturbed			Installed 4-inch solid wall PVC with open bottom at 3.5;. Auger refusal at 3.5; on gravels	Moist to wet	Dark reddish brown [5YR 2.5/2]
TP-MS-14	3.4	3.5	GM		Undisturbed					
TP-MS-15	1.0	2.0	PT	peat wtih silt	Undisturbed	Organic			Moist to wet	Very dark brown [10YR 2/2]
TP-MS-15	2.0	2.5	PT	peat wtih silt	Undisturbed	Organic			Moist to wet	Very dark brown [10YR 2/2]
TP-MS-15	2.5	3.0	ML	silt with sand	Undisturbed	Organic			Wet to Saturated	Very dark grayish brown [10YR 3/2]
TP-MS-15	3.0	3.2	ML	silt with sand	Undisturbed	Organic		Groundwater at 3.2 ft; @ 3.2; rmV 687 µs/cm pH start 6.63 pH end 6.55 (12 minutes)	Wet to Saturated	Very dark grayish brown [10YR 3/2]
TP-MS-15	3.2	3.5	ML	silt with sand	Undisturbed	Organic	with organics Flat; subrounded Gravels at 3.5 ft		Wet to Saturated	Very dark grayish brown [10YR 3/2]
TP-MS-15	3.5	3.6	GM		Undisturbed					
TP-MS-16	0.0	0.1	SM	silty sand	TAILINGS			Forest vegetation at ground surface.		
TP-MS-16	0.1	0.2	SM	silty sand	TAILINGS		TAILINGS		Moist	Dark reddish brown [5YR 3/3]
TP-MS-16	0.2	0.5	ML	sandy silt	TAILINGS		trace roots; trace rust colored mottling		Moist	Very dark brown [10YR 2/2]
TP-MS-16	0.5	1.0	ML	sandy silt	Undisturbed		trace roots; trace rust colored mottling		Moist	Very dark brown [10YR 2/2]
TP-MS-16	1.0	1.7	ML	sandy silt	Undisturbed		trace roots; trace rust colored mottling		Moist	Very dark brown [10YR 2/2]
TP-MS-16	1.7	2.5	ML	sandy silt	Undisturbed		1.7-4.6 trace rust colored mottling; occasional lenses of black organic silt; sand fine grained; abundant rust colored mottling			
TP-MS-16	2.5	3.0	ML	sandy silt	Undisturbed			Groundwater at 3.0 ft.		
TP-MS-16	3.0	3.5	ML	sandy silt	Undisturbed			Groundwater at 3.5; 647.1 rmV; 218.2 µs/cm; pH start 4.31 pH end 4.23 (15 minutes)		
TP-MS-16	3.5	4.5	ML	sandy silt	Undisturbed					
TP-MS-16	4.5	4.6	ML	sandy silt	Undisturbed			Installed 4-inch solid wall PVC with open bottom at 5.0;; auger refusal at 5.0; on gravels		
TP-MS-16	4.6	5.0	ML	sandy silt	Undisturbed		fine to coarse grain sands; Gravels encountered at 5.0 ft		Wet	Brown [7.5YR 4/4]
TP-MS-16	5.0	5.1	GM		Undisturbed					
TP-MS-17	0.0	0.1	CL	sandy clay	Undisturbed		Sandy Clay is intermixed with TAILING.	Groundwater not observed.		
TP-MS-17	0.1	0.5	CL	sandy clay	Undisturbed		Sandy Clay is intermixed with TAILING.			
TP-MS-17	0.5	0.8	CL	sandy clay	Undisturbed		Sandy Clay is intermixed with TAILING.			
TP-MS-17	0.8	1.0	CL	lean clay	Undisturbed		Cobble at 2.0 ft		Moist	Dark brown [7.5YR 3/2]
TP-MS-17	1.0	2.0	CL	lean clay	Undisturbed		Cobble at 2.0 ft	Installed 4-inch solid wall PVC with open bottom at 2.3;; slotted 1.75; to 2.25;	Moist	Dark brown [7.5YR 3/2]
TP-MS-17	2.0	2.3	CL	lean clay	Undisturbed		Cobble at 2.0 ft	Auger refusal at 2.3; on gravel	Moist	Dark brown [7.5YR 3/2]
TP-MS-17	2.3	2.4	GM		Undisturbed					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-MS-14	2.0	3.0	ML	Very dark brown [10YR 2/2]	155	404	384	36801				26+00	133+30
TP-MS-14	3.0	3.4	ML	Very dark brown [10YR 2/2]	155	404	384	36801				26+00	133+30
TP-MS-14	3.4	3.5	GM									26+00	133+30
TP-MS-15	1.0	2.0	PT	Black [10YR 2/1]	169	278	228	45058				27+10	132+20
TP-MS-15	2.0	2.5	PT	Black [10YR 2/1]	178	251	228	50730				27+10	132+20
TP-MS-15	2.5	3.0	ML	Very dark brown [10YR 2/2]	178	251	228	50730				27+10	132+20
TP-MS-15	3.0	3.2	ML	Very dark brown [10YR 2/2]	170	274	163	50080	6.63	6.55	687.00	27+10	132+20
TP-MS-15	3.2	3.5	ML	Very dark brown [10YR 2/2]	170	274	163	50080				27+10	132+20
TP-MS-15	3.5	3.6	GM									27+10	132+20
TP-MS-16	0.0	0.1	SM									19+20	140+10
TP-MS-16	0.1	0.2	SM		1043	368	598	75738				19+20	140+10
TP-MS-16	0.2	0.5	ML									19+20	140+10
TP-MS-16	0.5	1.0	ML		148	142	535	34211				19+20	140+10
TP-MS-16	1.0	1.7	ML									19+20	140+10
TP-MS-16	1.7	2.5	ML		135	125	406	36183				19+20	140+10
TP-MS-16	2.5	3.0	ML									19+20	140+10
TP-MS-16	3.0	3.5	ML		43	132	766	7793	4.31	4.23	218.20	19+20	140+10
TP-MS-16	3.5	4.5	ML		343	192	675	23895				19+20	140+10
TP-MS-16	4.5	4.6	ML		348	269	837	35465				19+20	140+10
TP-MS-16	4.6	5.0	ML		348	269	837	35465				19+20	140+10
TP-MS-16	5.0	5.1	GM									19+20	140+10
TP-MS-17	0.0	0.1	CL		328	242	371	51413				17+60	141+70
TP-MS-17	0.1	0.5	CL		328	242	371	51413				17+60	141+70
TP-MS-17	0.5	0.8	CL		152	165	181	31585				17+60	141+70
TP-MS-17	0.8	1.0	CL		152	165	181	31585				17+60	141+70
TP-MS-17	1.0	2.0	CL		109	209	516	18681				17+60	141+70
TP-MS-17	2.0	2.3	CL									17+60	141+70
TP-MS-17	2.3	2.4	GM									17+60	141+70

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-MS-19	1.0	1.3	PT	peat wtih silt	Undisturbed	Organic			Saturated	Black [10YR 2/1]
TP-MS-19	1.3	2.0	OL	organic silty clay	Undisturbed		with Silt		Saturated	Dark reddish brown [5YR 3/2]
TP-MS-19	2.0	3.0	OL	organic silty clay	Undisturbed		with Silt		Saturated	Dark reddish brown [5YR 3/2]
TP-MS-19	3.0	3.4	OL	organic silty clay	Undisturbed		with Silt	Installed 4-inch solid wall PVC with open bottom at 3.5;	Saturated	Dark reddish brown [5YR 3/2]
TP-MS-19	3.4	3.5	CL	clay with gravel	Undisturbed	Black	1.5" minus	Auger refusal at 3.5; on gravels	Saturated	Black [7.5YR 2.5/1]
TP-MS-19	3.5	3.6	GM		Undisturbed					
TP-MS-20	0.5	0.7	OL	organic silt with gravel	Undisturbed	Topsoil			Moist	Black [7.5YR 2.5/1]
TP-MS-20	0.7	1.0	OL	organic silt with gravel	Undisturbed	Topsoil			Moist	Black [7.5YR 2.5/1]
TP-MS-20	1.0	2.0	SC	clayey sand with gravel	Undisturbed			Auger refusal at 2.0; on gravel	Moist	Very dark brown [10YR 2/2]
TP-MS-20	2.0	2.1	GM		Undisturbed					
TP-MS-21	0.8	1.3	PT	peat wtih silt	TAILINGS				Wet	Very dark brown [10YR 2/2]
TP-MS-21	3.3	3.4	GM		Undisturbed					
TP-MS-22	1.0	1.5	PT	peat with sandy silt	Undisturbed	Black	@ 0.75' trace gravels and color transitions to grayish black		Wet to Saturated	Very dark brown [10YR 2/2]
TP-MS-22	1.5	1.8	GM	silty gravel with sand	Undisturbed		estimated 60% Gravel and 40% Sand/Silt			
TP-MS-22	1.8	1.9	GM		Undisturbed					
TP-MS-23	1.0	1.5	GP-GM	poorly graded gravel with silt and sand	Undisturbed			Installed 4-inch solid wall PVC with open bottom and slotted 1.5-2;	Saturated	Dark reddish brown [5YR 3/4]
TP-MS-23	1.5	2.0	GP-GM	poorly graded gravel with silt and sand	Undisturbed				Saturated	Dark reddish brown [5YR 3/4]
TP-MS-23	2.0	2.1	GM		Undisturbed					
TP-MS-24	1.0	2.0	ML	silt with gravel	Undisturbed	Organic			Moist	Very dark brown [7.5YR 2.5/2]
TP-MS-24	4.0	4.3	CL	clay with gravel	Undisturbed		rust colored mottling		Moist to wet	Very dark brown [7.5YR 2.5/3]
TP-MS-24	4.3	4.5	CL	sandy clay	Undisturbed		rust colored mottling; fine to coarse grained		Moist to wet	Brown [7.5YR 4/4]
TP-MS-24	5.8	5.9	GM		Undisturbed					
TP-MS-25	3.0	3.1	GM		Undisturbed					
TP-MS-26	2.5	2.6	GM		Undisturbed					
TP-MS-27	1.5	2.0	ML	silty sand	Undisturbed	Organic	organics to 1.0 ft	Solid wall piezometer with open bottom.	Moist	Very dark brown [7.5YR 2.5/2]
TP-MS-27	2.0	2.5	CL	clay with gravel	Undisturbed	Black	2.0-3.0 trace of gravels; occasional thin sand layers; rust colored mottling observed in sand layers; gravels have black spots		Moist	Very dark brown [7.5YR 2.5/3]
TP-MS-27	4.0	4.5	CL	gravelly clay	Undisturbed			Groundwater at 4.5 ft	Moist to wet	Dark brown [7.5YR 3/4]
TP-MS-27	4.5	5.2	CL	gravelly clay	Undisturbed				Moist to wet	Dark brown [7.5YR 3/4]
TP-MS-27	5.2	5.3	GM		Undisturbed					
TP-TS-01	0.0	0.5	ML	silt with gravel	Mine waste	Organic	DUFF; with organics		Dry	Dark reddish brown [5YR 3/3]
TP-TS-01	1.0	3.0	GC	clayey gravel with sand	Undisturbed		Weathered Argillitic estimated 80% Rock and 20% Soil matrix		Dry	Brown [10YR 5/3]
TP-TS-02	0.0	0.6	ML	sandy silt with gravel	Mine waste	Organic	0-1 DUFF; contains some pockets of rust staining with organics; subangular to subrounded gravels;		Dry	Dark reddish brown [5YR 3/4]
TP-TS-02	0.6	0.9	ML	sandy silt with gravel	Mine waste	Organic			Dry	Dark reddish brown [5YR 3/4]
TP-TS-02	0.9	1.0	ML	sandy silt with gravel	Undisturbed	Organic			Dry	Dark reddish brown [5YR 3/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-MS-19	1.0	1.3	PT		107	137	146	138133				17+75	141+55
TP-MS-19	1.3	2.0	OL	Black [5YR 2.5/1]	107	137	146	138133				17+75	141+55
TP-MS-19	2.0	3.0	OL	Black [5YR 2.5/1]	120	162	122	92318				17+75	141+55
TP-MS-19	3.0	3.4	OL	Black [5YR 2.5/1]	175	193	255	59904				17+75	141+55
TP-MS-19	3.4	3.5	CL		135	176	167	62781				17+75	141+55
TP-MS-19	3.5	3.6	GM									17+75	141+55
TP-MS-20	0.5	0.7	OL	Very dark brown [7.5YR 2.5/3]								13+10	146+20
TP-MS-20	0.7	1.0	OL	Very dark brown [7.5YR 2.5/3]	105	490	111	46215				13+10	146+20
TP-MS-20	1.0	2.0	SC		100	438	106	34166				13+10	146+20
TP-MS-20	2.0	2.1	GM									13+10	146+20
TP-MS-21	0.8	1.3	PT									11+20	148+10
TP-MS-21	3.3	3.4	GM									11+20	148+10
TP-MS-22	1.0	1.5	PT		141	292	175	67972				11+75	147+55
TP-MS-22	1.5	1.8	GM		141	292	175	67972				11+75	147+55
TP-MS-22	1.8	1.9	GM									11+75	147+55
TP-MS-23	1.0	1.5	GP-GM		92	253	168	169496				11+80	147+50
TP-MS-23	1.5	2.0	GP-GM		92	253	168	169496				11+80	147+50
TP-MS-23	2.0	2.1	GM									11+80	147+50
TP-MS-24	1.0	2.0	ML		169	410	190	35464				06+30	153+00
TP-MS-24	4.0	4.3	CL									06+30	153+00
TP-MS-24	4.3	4.5	CL									06+30	153+00
TP-MS-24	5.8	5.9	GM									06+30	153+00
TP-MS-25	3.0	3.1	GM									05+40	153+90
TP-MS-26	2.5	2.6	GM									04+75	154+55
TP-MS-27	1.5	2.0	ML		161	463	289	51237				03+50	155+80
TP-MS-27	2.0	2.5	CL		176	473	420	48985				03+50	155+80
TP-MS-27	4.0	4.5	CL									03+50	155+80
TP-MS-27	4.5	5.2	CL									03+50	155+80
TP-MS-27	5.2	5.3	GM									03+50	155+80
TP-TS-01	0.0	0.5	ML									140+60	18+70
TP-TS-01	1.0	3.0	GC									140+60	18+70
TP-TS-02	0.0	0.6	ML									140+15	19+15
TP-TS-02	0.6	0.9	ML		2806	464	293	117172				140+15	19+15
TP-TS-02	0.9	1.0	ML									140+15	19+15

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TP-TS-02	1.0	1.5	GM	silty gravel with sand	Undisturbed		0-3.5 Weathered Argillitic rock; estimated 50% Cobbles and Gravels; 50% Silty Sand		Dry	Brown [10YR 5/3]
TP-TS-02	1.5	2.0	GM	silty gravel with sand	Undisturbed				Dry	Brown [10YR 5/3]
TP-TS-02	2.0	3.5	GM	silty gravel with sand	Undisturbed				Dry	Brown [10YR 5/3]
TP-TS-03	0.0	0.1	ML	sandy silt with gravel	Mine waste	Organic	DUFF; some pockets of rust staining; organics		Dry	Dark brown [7.5YR 3/4]
TP-TS-03	0.1	0.2	ML	sandy silt with gravel	Mine waste	Organic	DUFF; some pockets of rust staining; organics		Dry	Dark brown [7.5YR 3/4]
TP-TS-03	0.2	0.8	ML	sandy silt with gravel	Undisturbed	Organic	DUFF; some pockets of rust staining; organics		Dry	Dark brown [7.5YR 3/4]
TP-TS-03	0.8	1.8	CL	clay with gravel	Undisturbed		0-3 Weathered Argillitic rock; pockets of higher clay content; 6-in. max particle size; estimated 50% Cobble and Gravel; 50% Sand; gravels subangular		Dry	Brown [7.5YR 4/3]
TP-TS-03	1.8	2.0	CL	clay with gravel	Undisturbed				Dry	Brown [7.5YR 4/3]
TP-TS-03	2.0	3.0	CL	clay with gravel	Undisturbed				Dry	Brown [7.5YR 4/3]
Anaconda-1	0.0	1.0	GM	Gravel	Undisturbed		gravel -2-inch. Grab from Anaconda Creek as background sample.			
BFR-TP-1	1.2	2.2	ML	Silty Clay	Undisturbed		Dark Brown silty clay with 75% CF angular cobbles gravels			
BFR-TP-10	0.0	0.7	SW	Tailings	TAILINGS					
BFR-TP-12	1.7	2.7	SL	Silty clay	Undisturbed		Dark brown silty clay; few CF gravels; saturated at 36"			
BFR-TP-3	0.0	2.0	Alluvium	tailings	TAILINGS		Silty sand; orange; slightly moist; PCF gravels. Lumber debris at bottom			
BTC-TP-1	0.0	0.7	Alluvium	tailings	TAILINGS					
BTC-TP-10	0.0	1.5	GC	Native	Undisturbed					
BTC-TP-10	1.5	2.5	GC	Native	Undisturbed					
BTC-TP-2	0.0	3.6	Alluvium	tailings	TAILINGS					
BTC-TP-3	0.0	1.5	Alluvium	tailings	TAILINGS					
BTC-TP-4	0.0	4.0	Alluvium	tailings	TAILINGS					
BTC-TP-5	0.0	2.0	SL	Native	TAILINGS					
BTC-TP-6	0.0	2.0	Alluvium	tailings	TAILINGS					
BTC-TP-7	0.0	2.3	SL	tailings	TAILINGS					
BTC-TP-9	0.0	2.5	Alluvium	tailings	TAILINGS					
LMH3-TP-1			GW	Native	TAILINGS					
LMH6-TP-1			SL	Waste Dump	WASTE_DUMP					
LMH6-TP-1			GW	Native	Undisturbed					
LMH6-TP-2			GW	Native	Undisturbed					
LMH7-TP-1			SL	Waste Dump	WASTE_DUMP					
UBDT-TP-03	0.0	0.2	GP	Tailings	TAILINGS					
UBDT-TP-03	1.0	2.0	GP	Tailings	TAILINGS					
BRSD-04	0.0	0.2	SM		Undisturbed					
BRSD-04	0.2	0.5	SM		Undisturbed					
BRSD-04	0.5	1.0	SM		Undisturbed					
BRSD-05	0.0	0.2	SM		Undisturbed					
BRSD-05	0.2	0.5	SM		Undisturbed					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TP-TS-02	1.0	1.5	GM	to purplish brown								140+15	19+15
TP-TS-02	1.5	2.0	GM	to purplish brown	186	204	108	35113				140+15	19+15
TP-TS-02	2.0	3.5	GM	to purplish brown								140+15	19+15
TP-TS-03	0.0	0.1	ML	to purplish brown								139+25	20+05
TP-TS-03	0.1	0.2	ML	to purplish brown	2272	460	323	108209				139+25	20+05
TP-TS-03	0.2	0.8	ML	to purplish brown								139+25	20+05
TP-TS-03	0.8	1.8	CL	Brown [7.5YR 4/4]								139+25	20+05
TP-TS-03	1.8	2.0	CL	Brown [7.5YR 4/4]	96	217	59	32174				139+25	20+05
TP-TS-03	2.0	3.0	CL	Brown [7.5YR 4/4]								139+25	20+05
Anaconda-1	0.0	1.0	GM		30	67	42	18300				120+75	38+55
BFR-TP-1	1.2	2.2	ML		164	317	146	50000				76+80	82+50
BFR-TP-10	0.0	0.7	SW									71+60	87+70
BFR-TP-12	1.7	2.7	SL		220	333	287	50000				71+55	87+75
BFR-TP-3	0.0	2.0	Alluvium		1273	439	133	50000				75+00	84+30
BTC-TP-1	0.0	0.7	Alluvium									114+25	45+05
BTC-TP-10	0.0	1.5	GC									134+35	24+95
BTC-TP-10	1.5	2.5	GC		101	387	65	50000				134+35	24+95
BTC-TP-2	0.0	3.6	Alluvium									116+95	42+35
BTC-TP-3	0.0	1.5	Alluvium									121+03	38+27
BTC-TP-4	0.0	4.0	Alluvium									122+15	37+15
BTC-TP-5	0.0	2.0	SL									124+30	35+00
BTC-TP-6	0.0	2.0	Alluvium									126+72	32+58
BTC-TP-7	0.0	2.3	SL									130+30	29+00
BTC-TP-9	0.0	2.5	Alluvium									133+90	25+40
LMH3-TP-1			GW		692	492	169	40000				141+00	18+30
LMH6-TP-1			SL		474	483	249	70000				141+00	18+30
LMH6-TP-1			GW		127	492	130	40000				141+00	18+30
LMH6-TP-2			GW		81	333	135	30000				141+00	18+30
LMH7-TP-1			SL		4272	492	258	50000				141+00	18+30
UBDT-TP-03	0.0	0.2	GP		1640	461	250					93+95	65+35
UBDT-TP-03	1.0	2.0	GP		964	264	217					93+95	65+35
BRSD-04	0.0	0.2	SM		111	181	62	13000				45+90	113+40
BRSD-04	0.2	0.5	SM		114	214	129	11700				45+90	113+40
BRSD-04	0.5	1.0	SM		212	318	93	14800				45+90	113+40
BRSD-05	0.0	0.2	SM		65	107	39	13600				35+80	123+50
BRSD-05	0.2	0.5	SM		62	100	42	12100				35+80	123+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
BRSD-05	0.5	1.0	SM		Undisturbed					
BRSD-06	0.0	0.2	SM		Undisturbed					
BRSD-06	0.2	0.5	SM		Undisturbed					
BRSD-06	0.5	1.0	SM		Undisturbed					
BRSD-07	0.2	0.5	SM		Undisturbed					
BRSD-07	0.5	1.0	SM		Undisturbed					
BRSD-09	0.2	0.5	SM		Undisturbed					
BRSD-09	0.5	1.0	SM		Undisturbed					
BRSD-11	0.0	0.2	SM		Undisturbed					
BRSD-11	0.2	0.5	SM		Undisturbed					
BRSD-11	0.5	1.0	SM		Undisturbed					
BRSD-15	0.0	0.2	SM		Undisturbed					
BRSD-15	0.2	0.5	SM		Undisturbed					
PGBG-1	0.0	0.2	SM		Undisturbed					
PGBG-1	0.2	0.5	SM		Undisturbed					
PGBG-1	0.5	1.0	SM		Undisturbed					
PGBG-2	0.0	0.2	SM		Undisturbed					
PGBG-2	0.2	0.5	SM		Undisturbed					
PGBG-2	0.5	1.0	SM		Undisturbed					
UM-0250N1750E	0.0	0.2	SM		Undisturbed					
UM-0250N1750E	0.2	0.5	SM		Undisturbed					
UM-0250N1750E	0.5	1.0	SM		Undisturbed					
UM-0250N2250E	0.5	1.0	SM		Undisturbed					
UM-0250S-1250E	0.0	0.2	SM		Undisturbed					
UM-0250S-1250E	0.2	0.5	SM		Undisturbed					
UM-0250S-1250E	0.5	1.0	SM		Undisturbed					
UM-0250S-2500E	0.2	1.0	SM		Undisturbed					
UM-0250S-250E	0.0	0.2	SM		Undisturbed					
UM-0250S-250E	0.2	0.5	SM		Undisturbed					
UM-0250S-250E	0.5	1.0	SM		Undisturbed					
UM-0250S-500E	0.0	0.2	SM		Undisturbed					
UM-0250S-500E	0.2	0.5	SM		Undisturbed					
UM-0250S-500E	0.5	1.0	SM		Undisturbed					
UM-0500N-2500E	0.0	0.2	SM		Undisturbed					
UM-0500N-2500E	0.2	0.5	SM		Undisturbed					
UM-0500N-2500E	0.5	1.0	SM		Undisturbed					
UM-0500S-2000E	0.0	0.2	SM		Undisturbed					
UM-0500S-2000E	0.2	0.5	SM		Undisturbed					
UM-0500S-2000E	0.5	1.0	SM		Undisturbed					
UM-0500S-2500E	0.0	0.2	SM		Undisturbed					
UM-0500S-2500E	0.2	0.5	SM		Undisturbed					
UM-0500S-2500E	0.5	1.0	SM		Undisturbed					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
BRSD-05	0.5	1.0	SM		79	98	45	14500				35+80	123+50
BRSD-06	0.0	0.2	SM		2	8	2	22600				21+00	138+30
BRSD-06	0.2	0.5	SM		7	22	16	20800				21+00	138+30
BRSD-06	0.5	1.0	SM		4	35	8	22900				21+00	138+30
BRSD-07	0.2	0.5	SM		62	148	57	28300				19+80	139+50
BRSD-07	0.5	1.0	SM		115	116	49	21800				19+80	139+50
BRSD-09	0.2	0.5	SM		59	300	53	16600				14+50	144+80
BRSD-09	0.5	1.0	SM		85	352	84	33400				14+50	144+80
BRSD-11	0.0	0.2	SM		92	456	133	16200				03+75	155+55
BRSD-11	0.2	0.5	SM		93	297	154	13200				03+75	155+55
BRSD-11	0.5	1.0	SM		104	301	148	15100				03+75	155+55
BRSD-15	0.0	0.2	SM		67	167	89	16800				48+20	111+10
BRSD-15	0.2	0.5	SM		112	243	97	21000				48+20	111+10
PGBG-1	0.0	0.2	SM		55	158	35					36+40	122+90
PGBG-1	0.2	0.5	SM		101	174	37					36+40	122+90
PGBG-1	0.5	1.0	SM		174	133	22					36+40	122+90
PGBG-2	0.0	0.2	SM		105	263	52					35+75	123+55
PGBG-2	0.2	0.5	SM		108	252	55					35+75	123+55
PGBG-2	0.5	1.0	SM		113	275	67					35+75	123+55
UM-0250N1750E	0.0	0.2	SM		96	126	153	15200				29+25	130+05
UM-0250N1750E	0.2	0.5	SM		94	286	108	12500				29+25	130+05
UM-0250N1750E	0.5	1.0	SM		99	100	143	14800				29+25	130+05
UM-0250N2250E	0.5	1.0	SM		194	390	180	14100				33+15	126+15
UM-0250S-1250E	0.0	0.2	SM		95	99	91	17800				25+25	134+05
UM-0250S-1250E	0.2	0.5	SM		93	140	79	32200				25+25	134+05
UM-0250S-1250E	0.5	1.0	SM		102	146	78	22600				25+25	134+05
UM-0250S-2500E	0.2	1.0	SM		85	253	147					35+20	124+10
UM-0250S-250E	0.0	0.2	SM		131	131	240					09+90	149+40
UM-0250S-250E	0.2	0.5	SM		121	172	208					09+90	149+40
UM-0250S-250E	0.5	1.0	SM		95	245	128					09+90	149+40
UM-0250S-500E	0.0	0.2	SM		70	148	81					14+00	145+30
UM-0250S-500E	0.2	0.5	SM		95	99	90					14+00	145+30
UM-0250S-500E	0.5	1.0	SM		98	112	114					14+00	145+30
UM-0500N-2500E	0.0	0.2	SM		91	270	59					34+75	124+55
UM-0500N-2500E	0.2	0.5	SM		89	272	74					34+75	124+55
UM-0500N-2500E	0.5	1.0	SM		76	176	33					34+75	124+55
UM-0500S-2000E	0.0	0.2	SM		34	41	183					27+25	132+05
UM-0500S-2000E	0.2	0.5	SM		92	111	237					27+25	132+05
UM-0500S-2000E	0.5	1.0	SM		94	86	232					27+25	132+05
UM-0500S-2500E	0.0	0.2	SM		40	222	373					34+80	124+50
UM-0500S-2500E	0.2	0.5	SM		44	220	355					34+80	124+50
UM-0500S-2500E	0.5	1.0	SM		122	188	364					34+80	124+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
UM-0500S-3000E	0.2	0.5	SM		Undisturbed					
UM-0500S-3000E	0.5	1.0	SM		Undisturbed					
UM-0500S-500E	0.0	0.2	SM		Undisturbed					
UM-0500S-500E	0.2	0.5	SM		Undisturbed					
UM-0500S-500E	0.5	1.0	SM		Undisturbed					
UM-1000S-3500E	0.2	0.5	SM		Undisturbed					
UM-1000S-3500E	0.5	1.0	SM		Undisturbed					
UM-ON-0500E	0.0	0.2	SM		Undisturbed					
UM-ON-0750E	0.0	0.2	SM		Undisturbed					
UM-ON-0750E	0.2	0.5	SM		Undisturbed					
UM-ON-0750E	0.5	1.0	SM		Undisturbed					
UM-ON-1000E	0.0	0.2	SM		Undisturbed					
UM-ON-1000E	0.2	0.5	SM		Undisturbed					
UM-ON-1000E	0.5	1.0	SM		Undisturbed					
UM-ON-1500E	0.0	0.2	SM		Undisturbed					
UM-ON-1500E	0.2	0.5	SM		Undisturbed					
SRB-01	0.0	23.0	GM	SILTY GRAVEL						
SRB-01	23.0	35.0	BEDROCK	BEDROCK						
SRB-02	0.0	4.5	GM	SILTY GRAVEL						
SRB-02	4.5	10.0	GP	GRAVEL with Sand						
SRB-02	10.0	18.5	GM	SILTY GRAVEL						
SRB-02	18.5	30.0	BEDROCK	BEDROCK						
SRB-03	0.0	7.0	GM	SILTY GRAVEL						
SRB-03	7.0	18.0	GM	SILTY GRAVEL						
SRB-03	18.0	26.0	BEDROCK	BEDROCK						
SRB-04	0.0	5.0	GM	SILTY GRAVEL						
SRB-04	5.0	21.0	GM	SILTY GRAVEL						
SRB-04	21.0	24.5	GC	CLAYEY GRAVEL						
SRB-04	24.5	40.0	GC	CLAYEY GRAVEL						
SRB-04	40.0	42.0	BEDROCK	BEDROCK						
SRB-05	0.0	0.5	OL	ORGANIC SILT						
SRB-05	0.5	5.0	GP	GRAVEL with Sand						
SRB-05	5.0	25.0	GP	GRAVEL with Sand						
SRB-05	25.0	32.0	GM	SILTY GRAVEL						
SRB-05	32.0	34.0	GC	CLAYEY GRAVEL						
SRB-05	34.0	40.0	CH	FAT CLAY						
SRB-05	40.0	49.0	CH	CLAY with Gravel						
SRB-05	49.0	50.0	BEDROCK	BEDROCK						
SRB-06	0.0	1.0	OL	ORGANIC SILT						
SRB-06	1.0	5.0	GM	SILTY GRAVEL						
SRB-06	5.0	22.0	GM	SILTY GRAVEL						
SRB-06	22.0	23.5	MH	ELASTIC SILT						

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
UM-0500S-3000E	0.2	0.5	SM		138	265	82					43+90	115+40
UM-0500S-3000E	0.5	1.0	SM		112	320	89					43+90	115+40
UM-0500S-500E	0.0	0.2	SM		66	188	96					13+50	145+80
UM-0500S-500E	0.2	0.5	SM		76	177	88					13+50	145+80
UM-0500S-500E	0.5	1.0	SM		73	175	82					13+50	145+80
UM-1000S-3500E	0.2	0.5	SM		320	396	106					50+75	108+55
UM-1000S-3500E	0.5	1.0	SM		82	182	87					50+75	108+55
UM-ON-0500E	0.0	0.2	SM		163	218	450					13+50	145+80
UM-ON-0750E	0.0	0.2	SM		2	2	2					18+00	141+30
UM-ON-0750E	0.2	0.5	SM		7	41	8					18+00	141+30
UM-ON-0750E	0.5	1.0	SM		6	42	5					18+00	141+30
UM-ON-1000E	0.0	0.2	SM		3	4	3					21+00	138+30
UM-ON-1000E	0.2	0.5	SM		5	6	5					21+00	138+30
UM-ON-1000E	0.5	1.0	SM		6	10	8					21+00	138+30
UM-ON-1500E	0.0	0.2	SM		102	286	91					25+90	133+40
UM-ON-1500E	0.2	0.5	SM		111	255	135					25+90	133+40
SRB-01	0.0	23.0	GM									137+87	21+43
SRB-01	23.0	35.0	BEDROCK									137+87	21+43
SRB-02	0.0	4.5	GM									121+95	37+35
SRB-02	4.5	10.0	GP									121+95	37+35
SRB-02	10.0	18.5	GM									121+95	37+35
SRB-02	18.5	30.0	BEDROCK									121+95	37+35
SRB-03	0.0	7.0	GM									90+37	68+93
SRB-03	7.0	18.0	GM									90+37	68+93
SRB-03	18.0	26.0	BEDROCK									90+37	68+93
SRB-04	0.0	5.0	GM									78+60	80+70
SRB-04	5.0	21.0	GM									78+60	80+70
SRB-04	21.0	24.5	GC									78+60	80+70
SRB-04	24.5	40.0	GC									78+60	80+70
SRB-04	40.0	42.0	BEDROCK									78+60	80+70
SRB-05	0.0	0.5	OL									64+10	95+20
SRB-05	0.5	5.0	GP									64+10	95+20
SRB-05	5.0	25.0	GP									64+10	95+20
SRB-05	25.0	32.0	GM									64+10	95+20
SRB-05	32.0	34.0	GC									64+10	95+20
SRB-05	34.0	40.0	CH									64+10	95+20
SRB-05	40.0	49.0	CH									64+10	95+20
SRB-05	49.0	50.0	BEDROCK									64+10	95+20
SRB-06	0.0	1.0	OL									44+25	115+05
SRB-06	1.0	5.0	GM									44+25	115+05
SRB-06	5.0	22.0	GM									44+25	115+05
SRB-06	22.0	23.5	MH									44+25	115+05

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
SRB-06	23.5	37.0	GM	SILTY GRAVEL						
SRB-06	37.0	45.0	BEDROCK	BEDROCK						
SRB-07	0.0	10.0	GM	SILTY GRAVEL						
SRB-07	10.0	22.0	GM	SILTY GRAVEL						
SRB-07	22.0	24.0	ML	SILT						
SRB-07	24.0	44.0	MH	ELASTIC SILT						
ANMW-3	0.0	6.9	TAILINGS	TAILINGS	TAILINGS		Sandy with medium find gravel			
ANMW-3	6.9	6.9	ATER TAB	WATER TABLE	TAILINGS		WATER_TABLE			
ANMW-3	6.9	8.0	GW	GRAVEL	Undisturbed		coarse sand with the coarse gravel			
ANMW-3	8.0	24.5	GW	GRAVEL	Undisturbed		mixed gravels: light brown			
ANMW-3	24.5	25.5	BEDROCK	BEDROCK	BEDROCK		bedrock			
ANMW-7	0.0	5.0	GM	SAND	TAILINGS		Sand with gravel: alluvium			
ANMW-7	5.0	8.0	GM	GRAVEL	Undisturbed		Gravel with sand and silt			
ANMW-7	8.0	8.0	GM	WATER TABLE	Undisturbed		WATER_TABLE			
ANMW-7	8.0	21.0	GM	GRAVEL	Undisturbed		Gravel with sand and silt			
ANMW-7	21.0	22.0	PORPHOR	PORPHORY	BEDROCK		Porphyry: hard weathered			
ANMW-9	0.0	2.0	GM	GRAVEL	Undisturbed		Sandy gravel with Clay			
ANMW-9	2.0	5.5	GM	GRAVEL	Undisturbed					
ANMW-9	5.5	5.5	GM	WATER TABLE	Undisturbed		WATER_TABLE			
ANWS-1	0.0	1.0	SOIL	SOIL	Undisturbed		topsoil Brown abundant organic matter Sandy silty clay loam			
ANWS-1	1.0	5.0	GW	GRAVEL	Undisturbed		sandy gravel red green can great find coarse-grained sand-water at 5 feet			
ANWS-1	5.0	5.0	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
ANWS-1	5.0	15.0	GW	GRAVEL	Undisturbed		gravel			
BCGW-115	0.0	2.0	GW	GRAVEL	Undisturbed		Angular gravel with silt			
BCGW-115	2.0	11.0	GW	GRAVEL	Undisturbed		Angular gravel tan purpleish fine grained quartzite			
BCGW-115	11.0	20.0	GW	GRAVEL	Undisturbed		Argillite boulders			
BCGW-115	20.0	65.0	GW	GRAVEL	Undisturbed					
BCGW-115	65.0	70.3	GW	GRAVEL	Undisturbed		fractured rock angular gravel			
BCGW-115	70.3	70.3	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
BCGW-115	70.3	85.0	GW	GRAVEL	Undisturbed		Brown silty angular gravel			
BCMW-10	0.0	1.0	GW	GRAVEL	TAILINGS		Sandy gravel with clay dark gray browon			
BCMW-10	1.0	7.0	GW	GRAVEL	TAILINGS		sandy gravel with clay dark yellow brown			
BCMW-10	7.0	7.0	e	e	TAILINGS		WATER_TABLE			
BCMW-10	7.0	15.0	GW	GRAVEL	Undisturbed		sandy gravel with clay dark yellow brown			
BCMW-10	15.0	15.1	BEDROCK	BEDROCK	BEDROCK		Hard drilling suspect bedrock no cuttings			
BRGW-101	0.0	6.0	GM	NATIVE	Undisturbed		red brown silt sand with some rounded black red green gravels			
BRGW-101	6.0	8.1	GM	NATIVE	Undisturbed		Black red green rounded glacial gravels and sand			
BRGW-101	8.1	8.1	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
BRGW-101	8.1	28.0	GW	NATIVE	Undisturbed		Black red green rounded glacial gravels and sand			
BRGW-101	28.0	30.0	ML	NATIVE	Undisturbed		reddish tan silts and clay			
BRGW-101	30.0	53.0	ML	NATIVE	Undisturbed		cobble and boulders			
BRGW-101	53.0	85.0	BEDROCK	BEDROCK	BEDROCK		fractured bedrock: diorite			

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
SRB-06	23.5	37.0	GM									44+25	115+05
SRB-06	37.0	45.0	BEDROCK									44+25	115+05
SRB-07	0.0	10.0	GM									01+20	158+10
SRB-07	10.0	22.0	GM									01+20	158+10
SRB-07	22.0	24.0	ML									01+20	158+10
SRB-07	24.0	44.0	MH									01+20	158+10
ANMW-3	0.0	6.9	TAILINGS									108+95	50+35
ANMW-3	6.9	6.9	ATER TAB									108+95	50+35
ANMW-3	6.9	8.0	GW									108+95	50+35
ANMW-3	8.0	24.5	GW									108+95	50+35
ANMW-3	24.5	25.5	BEDROCK									108+95	50+35
ANMW-7	0.0	5.0	GM									103+80	55+50
ANMW-7	5.0	8.0	GM									103+80	55+50
ANMW-7	8.0	8.0	GM									103+80	55+50
ANMW-7	8.0	21.0	GM									103+80	55+50
ANMW-7	21.0	22.0	PORPHORY									103+80	55+50
ANMW-9	0.0	2.0	GM									120+20	39+10
ANMW-9	2.0	5.5	GM									120+20	39+10
ANMW-9	5.5	5.5	GM									120+20	39+10
ANWS-1	0.0	1.0	SOIL									113+85	45+45
ANWS-1	1.0	5.0	GW									113+85	45+45
ANWS-1	5.0	5.0	ATER TAB									113+85	45+45
ANWS-1	5.0	15.0	GW									113+85	45+45
BCGW-115	0.0	2.0	GW									126+55	32+75
BCGW-115	2.0	11.0	GW									126+55	32+75
BCGW-115	11.0	20.0	GW									126+55	32+75
BCGW-115	20.0	65.0	GW									126+55	32+75
BCGW-115	65.0	70.3	GW									126+55	32+75
BCGW-115	70.3	70.3	ATER TAB									126+55	32+75
BCGW-115	70.3	85.0	GW									126+55	32+75
BCMW-10	0.0	1.0	GW									123+50	35+80
BCMW-10	1.0	7.0	GW									123+50	35+80
BCMW-10	7.0	7.0	e									123+50	35+80
BCMW-10	7.0	15.0	GW									123+50	35+80
BCMW-10	15.0	15.1	BEDROCK									123+50	35+80
BRGW-101	0.0	6.0	GM									00+25	159+05
BRGW-101	6.0	8.1	GM									00+25	159+05
BRGW-101	8.1	8.1	ATER TAB									00+25	159+05
BRGW-101	8.1	28.0	GW									00+25	159+05
BRGW-101	28.0	30.0	ML									00+25	159+05
BRGW-101	30.0	53.0	ML									00+25	159+05
BRGW-101	53.0	85.0	BEDROCK									00+25	159+05

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
BRGW-110	0.0	12.5	GW	GRAVEL	Undisturbed		red Greenblatt glacial gravel: cobbles: boulders with silt			
BRGW-110	12.5	12.5	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
BRGW-110	12.5	20.0	GW	GRAVEL	Undisturbed		red Greenblatt glacial gravel: cobbles: boulders with silt			
BRGW-110	20.0	43.0	BEDROCK	DIORITE	BEDROCK		diorite: pyrite in fractures: probable fault at bottom			
EDGW-105	0.0	7.1	GW	GRAVEL	Undisturbed		red Brown angular gravel: silts wett at 2 feet			
EDGW-105	7.1	7.1	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
EDGW-105	7.1	32.0	GW	GRAVEL	Undisturbed		red Brown angular gravel: silts wett at 2 feet			
EDGW-105	32.0	40.0	CL	CLAY	Undisturbed		tan brown Clay			
EDGW-105	40.0	48.0	GW	GRAVEL	Undisturbed		red green can sub rounded glacial gravels			
EDGW-105	48.0	90.0	BEDROCK	DIORITE	BEDROCK		decomposed granite with orange staining			
EDGW-105	90.0	90.0	BEDROCK	DIORITE	BEDROCK		decomposed granite			
GW-01A	0.0	10.0	TAILINGS	TAILINGS	TAILINGS					
GW-01A	10.0	30.0	GM	ALLUVIUM	Undisturbed					
GW-01A	30.0	35.0	GM	ALLUVIUM	Undisturbed					
GW-01A	35.0	50.0	BEDROCK	ARGILLITE	BEDROCK					
GW-01C	0.0	10.0	TAILINGS	TAILINGS	TAILINGS					
GW-01C	10.0	30.0	GM	ALLUVIUM	Undisturbed					
GW-01C	30.0	35.0	GM	ALLUVIUM	Undisturbed					
GW-01C	35.0	50.0	BEDROCK	BEDROCK	BEDROCK					
GW-01C	50.0	95.0	BEDROCK	BEDROCK	BEDROCK					
GW-02	0.0	3.0	FILL	ROAD FILL	FILL					
GW-02	3.0	30.0	TAILINGS	TAILINGS	TAILINGS					
GW-02	30.0	36.0	GM	ALLUVIUM	Undisturbed					
GW-02	36.0	50.0	BEDROCK	ARGILLITE	BEDROCK					
GW-02	50.0	57.0	BEDROCK	DIORITE/MAGNETITE	BEDROCK		DIORITE/MAGNETITE			
GW-02	57.0	69.0	BEDROCK	DIORITE/MAGNETITE	BEDROCK		DIORITE/MAGNETITE			
GW-02	69.0	80.0	BEDROCK	DIORITE/MAGNETITE	BEDROCK		DIORITE/MAGNETITE			
GW-02A	0.0	11.0	GM	ALLUVIUM	Undisturbed					
GW-02A	11.0	13.0	BEDROCK	ARGILLITE	BEDROCK					
GW-02A	13.0	23.0	BEDROCK	ARGILLITE	BEDROCK		ARGILLITE			
GW-02A	23.0	38.0	BEDROCK	BEDROCK	BEDROCK					
LCMW-1	0.0	3.0	GW	GRAVEL	Undisturbed		fine sand and gravel: reddish brown color			
LCMW-1	3.0	9.0	GW	GRAVEL	Undisturbed		coarse sand and gravel: moist			
LCMW-1	9.0	9.0	GW	GRAVEL	Undisturbed					
LCMW-1	9.0	22.0	GW	GRAVEL	Undisturbed		coarse sand and gravel: moist			
LCMW-1	22.0	26.0	ML	SILT	Undisturbed		silty and soft about 25 feet with some gravel			
LCMW-5	0.0	2.5	SOIL	SOIL	SOIL		Brown silty soil: moist: some brown-orange intervals			
LCMW-5	2.5	2.5	ATER TAB	WATER TABLE	SOIL		WATER_TABLE			
LCMW-5	2.5	9.0	SOIL	SOIL	Undisturbed		Brown silty soil with coarse gravel: moist			
LCMW-5	9.0	12.0	ML	SAND	Undisturbed		Brown sand: moist			
LCMW-5	12.0	13.5	ML	SILTY SAND	Undisturbed		Brown sand: silt: gravel			
LCMW-5	13.5	19.0	BEDROCK	BEDROCK	BEDROCK		Gray gravel and sand: dry: hard (bedrock)			

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
BRGW-110	0.0	12.5	GW									90+50	68+80
BRGW-110	12.5	12.5	ATER TAB									90+50	68+80
BRGW-110	12.5	20.0	GW									90+50	68+80
BRGW-110	20.0	43.0	BEDROCK									90+50	68+80
EDGW-105	0.0	7.1	GW									53+10	106+20
EDGW-105	7.1	7.1	ATER TAB									53+10	106+20
EDGW-105	7.1	32.0	GW									53+10	106+20
EDGW-105	32.0	40.0	CL									53+10	106+20
EDGW-105	40.0	48.0	GW									53+10	106+20
EDGW-105	48.0	90.0	BEDROCK									53+10	106+20
EDGW-105	90.0	90.0	BEDROCK									53+10	106+20
GW-01A	0.0	10.0	TAILINGS									145+00	14+30
GW-01A	10.0	30.0	GM									145+00	14+30
GW-01A	30.0	35.0	GM									145+00	14+30
GW-01A	35.0	50.0	BEDROCK									145+00	14+30
GW-01C	0.0	10.0	TAILINGS									146+10	13+20
GW-01C	10.0	30.0	GM									146+10	13+20
GW-01C	30.0	35.0	GM									146+10	13+20
GW-01C	35.0	50.0	BEDROCK									146+10	13+20
GW-01C	50.0	95.0	BEDROCK									146+10	13+20
GW-02	0.0	3.0	FILL									153+10	06+20
GW-02	3.0	30.0	TAILINGS									153+10	06+20
GW-02	30.0	36.0	GM									153+10	06+20
GW-02	36.0	50.0	BEDROCK									153+10	06+20
GW-02	50.0	57.0	BEDROCK									153+10	06+20
GW-02	57.0	69.0	BEDROCK									153+10	06+20
GW-02	69.0	80.0	BEDROCK									153+10	06+20
GW-02A	0.0	11.0	GM									154+58	04+72
GW-02A	11.0	13.0	BEDROCK									154+58	04+72
GW-02A	13.0	23.0	BEDROCK									154+58	04+72
GW-02A	23.0	38.0	BEDROCK									154+58	04+72
LCMW-1	0.0	3.0	GW									00+25	159+05
LCMW-1	3.0	9.0	GW									00+25	159+05
LCMW-1	9.0	9.0	GW									00+25	159+05
LCMW-1	9.0	22.0	GW									00+25	159+05
LCMW-1	22.0	26.0	ML									00+25	159+05
LCMW-5	0.0	2.5	SOIL									16+75	142+55
LCMW-5	2.5	2.5	ATER TAB									16+75	142+55
LCMW-5	2.5	9.0	SOIL									16+75	142+55
LCMW-5	9.0	12.0	ML									16+75	142+55
LCMW-5	12.0	13.5	ML									16+75	142+55
LCMW-5	13.5	19.0	BEDROCK									16+75	142+55

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
LMSD-202	0.0	0.2	SOIL	SOIL						
LMSD-202	0.2	0.5	SOIL	SOIL						
LMSD-202	0.5	1.0	SOIL	SOIL						
LMSD-203	0.0	0.2	SOIL	SOIL						
LMSD-203	0.2	0.5	SOIL	SOIL						
LMSD-203	0.5	1.0	SOIL	SOIL						
LMSD-204	0.0	0.2	SOIL	SOIL						
LMSD-204	0.2	0.5	SOIL	SOIL						
LMSD-204	0.5	1.0	SOIL	SOIL						
MHGW-109	0.0	8.8	GW	GRAVEL	Undisturbed		gravel with sand wet at 10 feet			
MHGW-109	8.8	8.8	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
MHGW-109	8.8	11.0	GW	GRAVEL	Undisturbed		gravel with sand wet at 10 feet			
MHGW-109	11.0	12.0	BEDROCK	ARGILLITE	BEDROCK		light blue gray fractured bedrock			
MHGW-112	0.0	1.9	GW	GRAVEL	Undisturbed		gravel/cobble in silty sand light brown			
MHGW-112	1.9	1.9	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
MHGW-112	1.9	10.0	GW	GRAVEL	Undisturbed		gravel/cobble in silty sand light brown			
MHGW-112	10.0	10.0	BEDROCK	ARGILLITE	BEDROCK		bedrock dark gray			
MHGW-113	0.0	1.9	GW	GRAVEL	FILL		silty gravel purple green blue cobble			
MHGW-113	1.9	1.9	ATER TAB	WATER TABLE	FILL		WATER_TABLE			
MHGW-113	1.9	9.0	GW	GRAVEL	FILL		silty gravel purple green blue cobble			
MHGW-113	9.0	38.0	BEDROCK	ARGILLITE	BEDROCK		bedrock-dark gray: wet at 18 feet			
MHMW-8	0.0	7.5	GW	GRAVEL	WASTE_DUMP		clayey gravel: olive Brown			
MHMW-8	7.5	7.5	ATER TAB	WATER TABLE	WASTE_DUMP		WATER_TABLE			
MHMW-8	7.5	8.0	ASTE DUN	WASTE DUMP	WASTE_DUMP					
MHMW-8	8.0	25.0	BEDROCK	BEDROCK	BEDROCK		silicified silt stone			
MHMW-115	0.0	4.0	GW	GRAVEL	FILL		Sandy gravelly silt with cobbles and boulders			
MHMW-115	4.0	7.0	BEDROCK	ARGILLITE	BEDROCK		light gray bedrock fractured			
MMSD-201	0.0	0.2	SOIL	SOIL	Unknown					
MMSD-201	0.2	0.5	SOIL	SOIL	Unknown					
MMSD-201	0.5	1.0	SOIL	SOIL	Unknown					
MMSD-202	0.0	0.2	SOIL	SOIL	Unknown					
MMSD-202	0.2	0.5	SOIL	SOIL	Unknown					
MMSD-202	0.5	1.0	SOIL	SOIL	Unknown					
PGBG-1	0.0	0.2	ML	MARSH	Unknown					
PGBG-1	0.2	0.5	ML	MARSH	Unknown					
PGBG-1	0.5	1.0	ML	MARSH	Unknown					
PGBG-2	0.0	0.2	ML	MARSH	Unknown					
PGBG-2	0.2	0.5	ML	MARSH	Unknown					
PGBG-2	0.5	1.0	ML	MARSH	Unknown					
PMGW-116	0.0	0.5	SOIL	SOIL	Undisturbed		organics			
PMGW-116	0.5	5.4	ML	SILT	Undisturbed		silt: clayey: Brown: moist			
PMGW-116	5.4	5.4	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
LMSD-202	0.0	0.2	SOIL									#N/A	#N/A
LMSD-202	0.2	0.5	SOIL									#N/A	#N/A
LMSD-202	0.5	1.0	SOIL									#N/A	#N/A
LMSD-203	0.0	0.2	SOIL									#N/A	#N/A
LMSD-203	0.2	0.5	SOIL									#N/A	#N/A
LMSD-203	0.5	1.0	SOIL									#N/A	#N/A
LMSD-204	0.0	0.2	SOIL									#N/A	#N/A
LMSD-204	0.2	0.5	SOIL									#N/A	#N/A
LMSD-204	0.5	1.0	SOIL									#N/A	#N/A
MHGW-109	0.0	8.8	GW									00+00	00+00
MHGW-109	8.8	8.8	ATER TAB									00+00	00+00
MHGW-109	8.8	11.0	GW									00+00	00+00
MHGW-109	11.0	12.0	BEDROCK									00+00	00+00
MHGW-112	0.0	1.9	GW									00+00	00+00
MHGW-112	1.9	1.9	ATER TAB									00+00	00+00
MHGW-112	1.9	10.0	GW									00+00	00+00
MHGW-112	10.0	10.0	BEDROCK									00+00	00+00
MHGW-113	0.0	1.9	GW									00+00	00+00
MHGW-113	1.9	1.9	ATER TAB									00+00	00+00
MHGW-113	1.9	9.0	GW									00+00	00+00
MHGW-113	9.0	38.0	BEDROCK									00+00	00+00
MHMW-8	0.0	7.5	GW									00+00	00+00
MHMW-8	7.5	7.5	ATER TAB									00+00	00+00
MHMW-8	7.5	8.0	ASTE DUN									00+00	00+00
MHMW-8	8.0	25.0	BEDROCK									00+00	00+00
MHMW-115	0.0	4.0	GW									00+00	00+00
MHMW-115	4.0	7.0	BEDROCK									00+00	00+00
MMSD-201	0.0	0.2	SOIL									00+00	00+00
MMSD-201	0.2	0.5	SOIL									00+00	00+00
MMSD-201	0.5	1.0	SOIL									00+00	00+00
MMSD-202	0.0	0.2	SOIL									00+00	00+00
MMSD-202	0.2	0.5	SOIL									00+00	00+00
MMSD-202	0.5	1.0	SOIL									00+00	00+00
PGBG-1	0.0	0.2	ML									36+40	122+90
PGBG-1	0.2	0.5	ML									36+40	122+90
PGBG-1	0.5	1.0	ML									36+40	122+90
PGBG-2	0.0	0.2	ML									35+75	123+55
PGBG-2	0.2	0.5	ML									35+75	123+55
PGBG-2	0.5	1.0	ML									35+75	123+55
PMGW-116	0.0	0.5	SOIL									20+50	138+80
PMGW-116	0.5	5.4	ML									20+50	138+80
PMGW-116	5.4	5.4	ATER TAB									20+50	138+80

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
PMGW-116	5.4	6.0	ML	SILT	Undisturbed		silt: clayey: Brown: moist			
PMGW-116	6.0	8.0	ML	SAND	Undisturbed		silty sand: light brown: minor Clay: moist			
PMGW-116	8.0	15.0	ML	SAND	Undisturbed		silty sand: minor angular gravel increasing with depth: dark brown			
PMGW-116	15.0	18.0	ML	SAND	Undisturbed		silty sand light brown very moist			
PMGW-117	0.0	0.5	SOIL	SOIL	Undisturbed		organics			
PMGW-117	0.5	11.2	GC	SILT	Undisturbed		silt: light brown minor gravels angular			
PMGW-117	11.2	11.2	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
PMGW-117	11.2	12.0	GC	SILT	Undisturbed		silt: light brown minor gravels angular			
PMGW-117	12.0	18.0	GC	SILT	Undisturbed		silt: light brown minor gravel with Clay			
PMGW-117	18.0	24.9	GW	GRAVEL	Undisturbed		gravel increasing very moist to wet in silty sand light brown			
PMGW-117	24.9	25.0	BEDROCK	BEDROCK	BEDROCK		hard drilling at 25: assume it is bedrock			
PMGW-118	0.0	0.0	ERRICRET	FERRICRETE	FERRICRETE		tan Brown silt?6 feet to 20 feet no cuttings			
PMGW-118	0.0	6.0	GC	SILT	Undisturbed		tan brown silt with some angular gravel			
PMGW-118	6.0	9.9	GC	SILT	Undisturbed		tan Brown silt?6 feet to 20 feet no cuttings			
PMGW-118	9.9	9.9	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
PMGW-118	9.9	30.0	ERRICRET	FERRICRETE	FERRICRETE		red brown angular gravel with silt: assumed ferricrete			
PMGW-119	0.0	6.0	GM	NATIVE	Undisturbed		tan silt with some anger gravel - 6 feet to 20 feet no cuttings			
PMGW-119	6.0	11.0	GM	NATIVE	Undisturbed		tan silt with some anger gravel - 6 feet to 20 feet no cuttings			
PMGW-119	11.0	11.0	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
PMGW-119	11.0	20.0	GM	NATIVE	Undisturbed		tan silt with some angular gravel - 6 feet to 20 feet no cuttings			
PMGW-119	20.0	45.0	ERRICRET	FERRICRETE	FERRICRETE		red brown white angular gravel: 35 feet making 100 GPM			
PMGW-119	45.0	53.0	ERRICRET	FERRICRETE	FERRICRETE		reddish-brown clayey silt with fine sand			
PMGW-119	53.0	70.0	ERRICRET	FERRICRETE	FERRICRETE		bluish gray soft siltstonewith pyrite cubes to 0.5 cm			
PMGW-119	70.0	80.0	BEDROCK	ARGILLITE	BEDROCK		purple black sandy siltstone abundant pyrite > 1 cm			
PMGW-119	80.0	90.0	BEDROCK	ARGILLITE	BEDROCK		light gray dolomite soft with pyrite less than .5 cm			
PMGW-120	0.0	14.6	GW	GRAVEL	Undisturbed		gravels sub rounded 200 mm: dark brown sand grading to light brown at 8 feet			
PMGW-120	14.6	14.6	ATER TAB	WATER TABLE	Undisturbed					
PMGW-120	14.6	20.0	GW	GRAVEL	Undisturbed		gravels sub rounded 200 mm: dark brown sand grading to light brown at 8 feet			
PMGW-120	20.0	35.0	BEDROCK	ARGILLITE	BEDROCK		bedrock cuttings angular less than 5 mm dark Brown to light			
PMGW-120	35.0	60.0	BEDROCK	ARGILLITE	BEDROCK		bedrock cuttings angular less than 5 mm dark gray with pyrite: 10 to 15 GPM			
PMMW-13	0.0	3.0	FILL	FILL	FILL		fill gravel cobbles Clay light brown light gray			
PMMW-13	3.0	8.0	GW	GRAVEL	Undisturbed					
PMMW-13	8.0	8.0	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
PMMW-13	8.0	15.0	GW	GRAVEL	Undisturbed		sand gravel Clay light gray light brown find coarse-grained sand			
PMMW-14	0.0	5.0	FILL	FILL	FILL					
PMMW-14	5.0	10.0	GW	GRAVEL	Undisturbed		sand clay and gravel Brown			
PMMW-14	10.0	10.7	GW	GRAVEL	Undisturbed					
PMMW-14	10.7	10.7	ATER TAB	WATER TABLE	Undisturbed		WATER_TABLE			
PMMW-14	10.7	22.4	GW	GRAVEL	Undisturbed		sand clay and gravel Brown			
PMMW-14	22.4	22.5	BEDROCK	BEDROCK	BEDROCK		bedrock at 22.5			
PMMW-15	0.0	5.5	FILL	FILL	FILL		Fill			
PMMW-15	5.5	5.5	ATER TAB	WATER TABLE	FILL		WATER_TABLE			

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
PMGW-116	5.4	6.0	ML									20+50	138+80
PMGW-116	6.0	8.0	ML									20+50	138+80
PMGW-116	8.0	15.0	ML									20+50	138+80
PMGW-116	15.0	18.0	ML									20+50	138+80
PMGW-117	0.0	0.5	SOIL									22+50	136+80
PMGW-117	0.5	11.2	GC									22+50	136+80
PMGW-117	11.2	11.2	ATER TAB									22+50	136+80
PMGW-117	11.2	12.0	GC									22+50	136+80
PMGW-117	12.0	18.0	GC									22+50	136+80
PMGW-117	18.0	24.9	GW									22+50	136+80
PMGW-117	24.9	25.0	BEDROCK									22+50	136+80
PMGW-118	0.0	0.0	ERRICRET									25+20	134+10
PMGW-118	0.0	6.0	GC									25+20	134+10
PMGW-118	6.0	9.9	GC									25+20	134+10
PMGW-118	9.9	9.9	ATER TAB									25+20	134+10
PMGW-118	9.9	30.0	ERRICRET									25+20	134+10
PMGW-119	0.0	6.0	GM									25+25	134+05
PMGW-119	6.0	11.0	GM									25+25	134+05
PMGW-119	11.0	11.0	ATER TAB									25+25	134+05
PMGW-119	11.0	20.0	GM									25+25	134+05
PMGW-119	20.0	45.0	ERRICRET									25+25	134+05
PMGW-119	45.0	53.0	ERRICRET									25+25	134+05
PMGW-119	53.0	70.0	ERRICRET									25+25	134+05
PMGW-119	70.0	80.0	BEDROCK									25+25	134+05
PMGW-119	80.0	90.0	BEDROCK									25+25	134+05
PMGW-120	0.0	14.6	GW									45+15	114+15
PMGW-120	14.6	14.6	ATER TAB									45+15	114+15
PMGW-120	14.6	20.0	GW									45+15	114+15
PMGW-120	20.0	35.0	BEDROCK									45+15	114+15
PMGW-120	35.0	60.0	BEDROCK									45+15	114+15
PMMW-13	0.0	3.0	FILL									47+80	111+50
PMMW-13	3.0	8.0	GW									47+80	111+50
PMMW-13	8.0	8.0	ATER TAB									47+80	111+50
PMMW-13	8.0	15.0	GW									47+80	111+50
PMMW-14	0.0	5.0	FILL									00+00	00+00
PMMW-14	5.0	10.0	GW									00+00	00+00
PMMW-14	10.0	10.7	GW									00+00	00+00
PMMW-14	10.7	10.7	ATER TAB									00+00	00+00
PMMW-14	10.7	22.4	GW									00+00	00+00
PMMW-14	22.4	22.5	BEDROCK									00+00	00+00
PMMW-15	0.0	5.5	FILL									44+50	114+80
PMMW-15	5.5	5.5	ATER TAB									44+50	114+80

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
PMMW-15	5.5	8.8	ERRICRET	FERRICRETE	FERRICRETE		Sandy gravelpartially cemented with tan to red iron oxides			
PMMW-15	8.8	11.0	ERRICRET	FERRICRETE	FERRICRETE		red massive fine-grained iron oxide material laminated amorphous containing organic clasts and pine needles			
SGGW-101	0.0	15.0	GW	GRAVEL	Undisturbed		gravels sub rounded in silty sand light brown wet at 15 feet			
SGGW-101	15.0	30.0	GW	GRAVEL	Undisturbed		gravel sub angular on silty sand light brown. Hard drilling and 30: drills like bedrock			
SGGW-101	30.0	30.0	ATER TAB	WATER TABLE	Undisturbed		Water Table			
SGGW-101	30.0	53.0	BEDROCK	ARGILLITE	BEDROCK		light brown gray: dolomite?			
SGGW-101	53.0	70.0	BEDROCK	ARGILLITE	BEDROCK					
SGGW-102	0.0	14.6	GW	GRAVEL	Undisturbed		gravelwith silty sand light brown			
SGGW-102	14.6	14.6	ATER TAB	WATER TABLE	Undisturbed		Water Table			
SGGW-102	14.6	21.0	GW	GRAVEL	Undisturbed		gravelwith silty sand light brown			
SGGW-102	21.0	25.0	GC	SILT	Undisturbed		silt light brown			
SGGW-102	25.0	31.0	GW	GRAVEL	Undisturbed		gravel sub rounded to 15 mm in silty sand light brown			
SGGW-102	31.0	31.0	BEDROCK	BEDROCK	BEDROCK		bedrock			
SUMP-N	0.0	11.0	GC	ALLUVIUM	Undisturbed					
SUMP-N	11.0	13.0	BEDROCK	ARGILLITE	BEDROCK					
SUMP-N	13.0	23.0	BEDROCK	ARGILLITE	BEDROCK					
SUMP-N	23.0	38.0	BEDROCK	DIORITE	BEDROCK					
SUMP-S ALLUVIUM	0.0	13.0	GC	ALLUVIUM	Undisturbed					
SUMP-S ALLUVIUM	13.0	45.0	BEDROCK	ARGILLITE	BEDROCK					
SUMP-S ALLUVIUM	45.0	90.0	BEDROCK	DIORITE	BEDROCK					
SUMP-S ALLUVIUM	90.0	95.0	BEDROCK	DIORITE	BEDROCK					
SWGW-101	0.0	7.0	GW	GRAVEL	Undisturbed		red brown silt with fractured gravels			
SWGW-101	7.0	7.0	BEDROCK	BEDROCK	BEDROCK		decomposed pyritic granite bedrock reddish: gray with white inclusions: dry			
SWGW-102	0.0	6.0	GW	GRAVEL	Undisturbed		gravelly cobbling Brown silt: road fill material			
SWGW-102	6.0	8.0	GW	GRAVEL	Undisturbed		gravelly cobbling can silt angular width cobbles			
SWGW-102	8.0	23.0	BEDROCK	DIORITE	BEDROCK		greenish silty sand (decomposed granite) darker green at 18 to 20: dry			
SWGW-103	0.0	8.3	GC	SILT	Undisturbed		Brown fine sandy silt: some small angular gravels			
SWGW-103	8.3	8.3	ATER TAB	WATER TABLE	Undisturbed					
SWGW-103	8.3	16.0	GC	SILT	Undisturbed		Brown fine sandy silt: some small angular gravels			
SWGW-103	16.0	20.0	BEDROCK	DIORITE	BEDROCK		dark Grey silty fine sand (decomposed diorite?)			
MH-B01A	0.0	3.5	MLS	SANDY SILT	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B01A	3.5	5.5	GP-GC	CLAYEY GRAVEL with Sand	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B01A	6.0	7.9	CH	FAT CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B01A	7.9	8.1	GP	GRAVEL	Undisturbed				0.000	Dark gray [2.5Y 4/1]
MH-B01A	8.1	12.0	GP	gap in sampling/logging	TAILINGS					
MH-B01A	12.0	13.0	SP-SM	SAND with Silt	TAILINGS				0.000	Dark grayish brown [2.5Y 4/2]
MH-B01A	13.0	14.0	MLS	SANDY SILT	TAILINGS				0.000	Olive brown [2.5Y 4/3]
MH-B01A	14.0	16.0	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/3]
MH-B01A	16.0	16.3	GC	CLAYEY GRAVEL with Sand	Undisturbed					Olive brown [2.5Y 4/3]
MH-B01A	16.3	17.8	GP-GC	GRAVEL with Clay and Sand	Undisturbed				0.000	Light olive brown [2.5Y 5/4]
MH-B01A	17.8	17.9	CL	LEAN CLAY	Undisturbed					Light olive brown [2.5Y 5/4]
MH-B01A	17.9	18.3	GP-GC	GRAVEL with Clay and Sand	Undisturbed				0.000	Light olive brown [2.5Y 5/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
PMMW-15	5.5	8.8	ERRICRET									44+50	114+80
PMMW-15	8.8	11.0	ERRICRET									44+50	114+80
SGGW-101	0.0	15.0	GW									82+25	77+05
SGGW-101	15.0	30.0	GW									82+25	77+05
SGGW-101	30.0	30.0	ATER TAB									82+25	77+05
SGGW-101	30.0	53.0	BEDROCK									82+25	77+05
SGGW-101	53.0	70.0	BEDROCK									82+25	77+05
SGGW-102	0.0	14.6	GW									84+10	75+20
SGGW-102	14.6	14.6	ATER TAB									84+10	75+20
SGGW-102	14.6	21.0	GW									84+10	75+20
SGGW-102	21.0	25.0	GC									84+10	75+20
SGGW-102	25.0	31.0	GW									84+10	75+20
SGGW-102	31.0	31.0	BEDROCK									84+10	75+20
SUMP-N	0.0	11.0	GC									158+70	00+60
SUMP-N	11.0	13.0	BEDROCK									158+70	00+60
SUMP-N	13.0	23.0	BEDROCK									158+70	00+60
SUMP-N	23.0	38.0	BEDROCK									158+70	00+60
SUMP-S ALLUVIUM	0.0	13.0	GC									159+75	-00+45
SUMP-S ALLUVIUM	13.0	45.0	BEDROCK									159+75	-00+45
SUMP-S ALLUVIUM	45.0	90.0	BEDROCK									159+75	-00+45
SUMP-S ALLUVIUM	90.0	95.0	BEDROCK									159+75	-00+45
SWGW-101	0.0	7.0	GW									17+20	142+10
SWGW-101	7.0	7.0	BEDROCK									17+20	142+10
SWGW-102	0.0	6.0	GW									09+30	150+00
SWGW-102	6.0	8.0	GW									09+30	150+00
SWGW-102	8.0	23.0	BEDROCK									09+30	150+00
SWGW-103	0.0	8.3	GC									21+00	138+30
SWGW-103	8.3	8.3	ATER TAB									21+00	138+30
SWGW-103	8.3	16.0	GC									21+00	138+30
SWGW-103	16.0	20.0	BEDROCK									21+00	138+30
MH-B01A	0.0	3.5	MLS									145+80	13+50
MH-B01A	3.5	5.5	GP-GC									145+80	13+50
MH-B01A	6.0	7.9	CH									145+80	13+50
MH-B01A	7.9	8.1	GP									145+80	13+50
MH-B01A	8.1	12.0	GP									145+80	13+50
MH-B01A	12.0	13.0	SP-SM									145+80	13+50
MH-B01A	13.0	14.0	MLS									145+80	13+50
MH-B01A	14.0	16.0	GC									145+80	13+50
MH-B01A	16.0	16.3	GC									145+80	13+50
MH-B01A	16.3	17.8	GP-GC									145+80	13+50
MH-B01A	17.8	17.9	CL									145+80	13+50
MH-B01A	17.9	18.3	GP-GC									145+80	13+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
MH-B01A	18.3	18.5	CL	LEAN CLAY	Undisturbed					Light olive brown [2.5Y 5/4]
MH-B01A	18.5	22.1	GP	GRAVEL	Undisturbed				0.000	Olive brown [2.5Y 4/3]
MH-B01A	22.1	27.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B01A	27.0	32.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B01A	32.0	37.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B01A	37.0	41.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B02A	0.0	3.5	CH	FAT CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B02A	3.5	6.0	CH	FAT CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B02A	6.0	8.5	MLS	SANDY SILT	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B02A	8.5	11.0	CH	FAT CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B02A	11.0	12.9	CH	FAT CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B02A	13.4	13.5	CH	FAT CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B02A	13.5	14.3	CH	FAT CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B02A	14.8	16.4	GP-GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Black [5Y 2.5/2]
MH-B02A	16.4	17.4	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B02A	17.4	19.4	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B02A	19.4	22.0	GC	CLAYEY GRAVEL	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B02A	22.0	24.5	GC	CLAYEY GRAVEL	Undisturbed				0.000	Dark olive brown [2.5Y 3/3]
MH-B02A	24.5	29.0	GC	CLAYEY GRAVEL	Undisturbed				0.000	Olive brown [2.5Y 4/3]
MH-B02A	29.0	30.3	GC	CLAYEY GRAVEL	Undisturbed				0.000	Light olive brown [2.5Y 5/4]
MH-B02A	30.3	34.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B02A	34.0	36.5	BEDROCK	ARGILLITE	BEDROCK					
MH-B02A	36.5	39.5	BEDROCK	ARGILLITE	BEDROCK					
MH-B02A	39.5	44.5	BEDROCK	ARGILLITE	BEDROCK					
MH-B03A	0.0	5.5	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	5.5	10.5	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	10.5	13.0	SM	SILTY SAND	TAILINGS					
MH-B03A	13.0	18.0	CL	LEAN CLAY	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	18.0	20.5	CL	LEAN CLAY	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	20.5	23.0	CL	LEAN CLAY	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	23.0	28.0	CH	SANDY FAT CLAY	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	28.0	31.0	ML	SANDY SILT	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	31.0	33.5	CH	FAT CLAY	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	33.5	35.2	CH	FAT CLAY	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B03A	35.2	35.7	CH	FAT CLAY	TAILINGS				19.400	Dark gray [5Y 4/1]
MH-B03A	35.7	36.3	OL	ORGANIC SILT	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B03A	36.3	37.0	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B03A	37.0	38.0	GW	GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B03A	38.0	40.5	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B03A	40.5	44.0	GP-GC	GRAVEL with Clay and Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B03A	44.0	49.0	GP-GC	GRAVEL with Clay and Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B03A	49.0	53.0	GP-GC	GRAVEL with Clay and Sand	Undisturbed				0.000	Light olive brown [2.5Y 5/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
MH-B01A	18.3	18.5	CL									145+80	13+50
MH-B01A	18.5	22.1	GP									145+80	13+50
MH-B01A	22.1	27.0	BEDROCK									145+80	13+50
MH-B01A	27.0	32.0	BEDROCK									145+80	13+50
MH-B01A	32.0	37.0	BEDROCK									145+80	13+50
MH-B01A	37.0	41.0	BEDROCK									145+80	13+50
MH-B02A	0.0	3.5	CH									152+65	06+65
MH-B02A	3.5	6.0	CH									152+65	06+65
MH-B02A	6.0	8.5	MLS									152+65	06+65
MH-B02A	8.5	11.0	CH									152+65	06+65
MH-B02A	11.0	12.9	CH									152+65	06+65
MH-B02A	13.4	13.5	CH									152+65	06+65
MH-B02A	13.5	14.3	CH									152+65	06+65
MH-B02A	14.8	16.4	GP-GM									152+65	06+65
MH-B02A	16.4	17.4	GM									152+65	06+65
MH-B02A	17.4	19.4	GM									152+65	06+65
MH-B02A	19.4	22.0	GC									152+65	06+65
MH-B02A	22.0	24.5	GC									152+65	06+65
MH-B02A	24.5	29.0	GC									152+65	06+65
MH-B02A	29.0	30.3	GC									152+65	06+65
MH-B02A	30.3	34.0	BEDROCK									152+65	06+65
MH-B02A	34.0	36.5	BEDROCK									152+65	06+65
MH-B02A	36.5	39.5	BEDROCK									152+65	06+65
MH-B02A	39.5	44.5	BEDROCK									152+65	06+65
MH-B03A	0.0	5.5	SM									147+80	11+50
MH-B03A	5.5	10.5	SM									147+80	11+50
MH-B03A	10.5	13.0	SM									147+80	11+50
MH-B03A	13.0	18.0	CL									147+80	11+50
MH-B03A	18.0	20.5	CL									147+80	11+50
MH-B03A	20.5	23.0	CL									147+80	11+50
MH-B03A	23.0	28.0	CH									147+80	11+50
MH-B03A	28.0	31.0	ML									147+80	11+50
MH-B03A	31.0	33.5	CH									147+80	11+50
MH-B03A	33.5	35.2	CH									147+80	11+50
MH-B03A	35.2	35.7	CH		37	106	39	18600				147+80	11+50
MH-B03A	35.7	36.3	OL									147+80	11+50
MH-B03A	36.3	37.0	GM									147+80	11+50
MH-B03A	37.0	38.0	GW									147+80	11+50
MH-B03A	38.0	40.5	GM									147+80	11+50
MH-B03A	40.5	44.0	GP-GC									147+80	11+50
MH-B03A	44.0	49.0	GP-GC									147+80	11+50
MH-B03A	49.0	53.0	GP-GC									147+80	11+50

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
MH-B03A	53.0	57.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B03A	57.0	60.5	BEDROCK	ARGILLITE	BEDROCK					
MH-B03A	60.5	63.5	BEDROCK	ARGILLITE	BEDROCK					
MH-B04	0.0	2.0	GP-GM	GRAVEL with Silt and Sand	TAILINGS	FILL			0.000	Olive brown [2.5Y 4/4]
MH-B04	2.0	5.0	SM	SILTY SAND	TAILINGS	FILL			0.000	Dark gray [2.5Y 4/1]
MH-B04	5.0	7.0	SM	SILTY SAND	TAILINGS	FILL			0.000	Olive [5Y 5/3]
MH-B04	7.0	12.0	SM	SILTY SAND	TAILINGS	FILL				
MH-B04	12.0	19.0	SM	SILTY SAND	TAILINGS	FILL			0.000	Olive gray [5Y 5/2]
MH-B04	19.0	20.0	SM	SILTY SAND	TAILINGS	FILL			0.000	Dark gray [N4]
MH-B04	20.5	24.5	SM	SILTY SAND	TAILINGS	FILL			0.000	Dark gray [N4]
MH-B04	24.5	32.0	ML	SANDY SILT	TAILINGS	FILL			0.000	Dark gray [N4]
MH-B04	32.0	33.0	CL	LEAN CLAY	TAILINGS	FILL			0.000	Dark gray [N4]
MH-B04	33.0	39.5	ML	SILTY SAND	TAILINGS	FILL			0.000	Dark gray [N4]
MH-B04	39.5	40.0	CH	FAT CLAY	TAILINGS	FILL			0.000	Very dark gray [2.5Y 3/1]
MH-B04	40.0	42.5	CL	LEAN CLAY	TAILINGS	FILL			0.000	Dark gray [2.5Y 4/1]
MH-B04	42.5	44.5	CL	LEAN CLAY	TAILINGS	FILL			0.000	Dark gray [2.5Y 4/1]
MH-B04	45.0	45.2	CL	LEAN CLAY	TAILINGS	FILL			0.000	Dark gray [2.5Y 4/1]
MH-B04	46.3	46.4	GP-GM	GRAVEL with Silt and Sand	ALLUVIUM	FILL			0.000	Dark gray [5Y 4/1]
MH-B04	46.9	47.0	GP-GM	GRAVEL with Silt and Sand	ALLUVIUM	FILL			0.000	Dark gray [5Y 4/1]
MH-B04	47.0	48.0	GP-GM	GRAVEL with Silt and Sand	ALLUVIUM	FILL			7.770	Dark yellowish brown [10YR 4/4]
MH-B04	48.0	50.0	GC	CLAYEY GRAVEL with Sand	ALLUVIUM	FILL			0.000	Brown [10YR 4/3]
MH-B04	50.0	52.0	GC	CLAYEY GRAVEL with Sand	ALLUVIUM	FILL			16.800	Brown [10YR 4/3]
MH-B04	52.0	61.0	GC	CLAYEY GRAVEL with Sand	ALLUVIUM	FILL			0.000	Yellowish brown [10YR 5/4]
MH-B04	61.0	62.5	BEDROCK	ARGILLITE	BEDROCK					
MH-B04	62.5	66.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B04	66.0	70.0	BEDROCK	ARGILLITE	BEDROCK					
MH-B04	70.0	70.8	BEDROCK	ARGILLITE	BEDROCK					
MH-B05	0.0	1.5	SM	SILTY SAND	TAILINGS					
MH-B05	1.5	4.0	SM	SILTY SAND	TAILINGS				0.000	Olive brown [2.5Y 4/4]
MH-B05	4.0	6.0	SM	SILTY SAND	TAILINGS				0.000	Olive brown [2.5Y 4/4]
MH-B05	6.0	8.5	SM	SILTY SAND	TAILINGS				0.000	Olive brown [2.5Y 4/4]
MH-B05	8.5	11.0	MLS	SANDY SILT	TAILINGS				0.000	Dark grayish brown [2.5Y 4/2]
MH-B05	11.0	13.5	MLS	SANDY SILT	TAILINGS				0.000	Dark grayish brown [2.5Y 4/2]
MH-B05	13.5	16.5	MLS	SANDY SILT	TAILINGS				0.000	Dark grayish brown [2.5Y 4/2]
MH-B05	16.5	18.5	SM	SILTY SAND	TAILINGS				0.000	Dark grayish brown [2.5Y 4/2]
MH-B05	18.5	21.0	SM	SILTY SAND	TAILINGS				0.000	Dark grayish brown [2.5Y 4/2]
MH-B05	21.0	23.5	SM	SILTY SAND	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B05	23.5	26.0	CL-ML	SILTY CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B05	26.0	27.5	CL-ML	SILTY CLAY	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B05	29.0	29.5	GC	CLAYEY GRAVEL with Sand	Undisturbed				13.600	Olive brown [2.5Y 4/4]
MH-B05	29.5	32.5	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
MH-B03A	53.0	57.0	BEDROCK									147+80	11+50
MH-B03A	57.0	60.5	BEDROCK									147+80	11+50
MH-B03A	60.5	63.5	BEDROCK									147+80	11+50
MH-B04	0.0	2.0	GP-GM									145+12	14+18
MH-B04	2.0	5.0	SM									145+12	14+18
MH-B04	5.0	7.0	SM									145+12	14+18
MH-B04	7.0	12.0	SM									145+12	14+18
MH-B04	12.0	19.0	SM									145+12	14+18
MH-B04	19.0	20.0	SM									145+12	14+18
MH-B04	20.5	24.5	SM									145+12	14+18
MH-B04	24.5	32.0	ML									145+12	14+18
MH-B04	32.0	33.0	CL									145+12	14+18
MH-B04	33.0	39.5	ML									145+12	14+18
MH-B04	39.5	40.0	CH									145+12	14+18
MH-B04	40.0	42.5	CL									145+12	14+18
MH-B04	42.5	44.5	CL									145+12	14+18
MH-B04	45.0	45.2	CL									145+12	14+18
MH-B04	46.3	46.4	GP-GM									145+12	14+18
MH-B04	46.9	47.0	GP-GM									145+12	14+18
MH-B04	47.0	48.0	GP-GM		209	196	65	13000				145+12	14+18
MH-B04	48.0	50.0	GC									145+12	14+18
MH-B04	50.0	52.0	GC		27	88	46	16400				145+12	14+18
MH-B04	52.0	61.0	GC									145+12	14+18
MH-B04	61.0	62.5	BEDROCK									145+12	14+18
MH-B04	62.5	66.0	BEDROCK									145+12	14+18
MH-B04	66.0	70.0	BEDROCK									145+12	14+18
MH-B04	70.0	70.8	BEDROCK									145+12	14+18
MH-B05	0.0	1.5	SM									145+26	14+04
MH-B05	1.5	4.0	SM									145+26	14+04
MH-B05	4.0	6.0	SM									145+26	14+04
MH-B05	6.0	8.5	SM									145+26	14+04
MH-B05	8.5	11.0	MLS									145+26	14+04
MH-B05	11.0	13.5	MLS									145+26	14+04
MH-B05	13.5	16.5	MLS									145+26	14+04
MH-B05	16.5	18.5	SM									145+26	14+04
MH-B05	18.5	21.0	SM									145+26	14+04
MH-B05	21.0	23.5	SM									145+26	14+04
MH-B05	23.5	26.0	CL-ML									145+26	14+04
MH-B05	26.0	27.5	CL-ML									145+26	14+04
MH-B05	29.0	29.5	GC		85	224	102	16300				145+26	14+04
MH-B05	29.5	32.5	GC									145+26	14+04

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
MH-B05	32.5	33.5	GC	CLAYEY GRAVEL with Sand	Undisturbed					Brown [10YR 4/3]
MH-B05	34.0	36.0	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Brown [10YR 4/3]
MH-B05	36.0	37.8	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Brown [10YR 4/3]
MH-B05	37.8	38.4	GP	GRAVEL	Undisturbed				0.000	Very dark brown [10YR 2/2]
MH-B05	38.4	39.4	BOULDER	BOULDER	Undisturbed					Very dark brown [10YR 2/2]
MH-B05	39.4	41.5	GC	BOULDER/COBBLE IN CLAY MATRIX	Undisturbed					Very dark brown [10YR 2/2]
MH-B05	41.5	42.3	BOULDER	BOULDER	Undisturbed					Very dark brown [10YR 2/2]
MH-B05	42.3	44.3	GC	BOULDER/COBBLE IN CLAY MATRIX	Undisturbed					Very dark brown [10YR 2/2]
MH-B05	44.3	45.0	CL	Clay	Undisturbed					Brown [10YR 4/3]
MH-B05	45.0	47.8	GC	BOULDER/COBBLE IN CLAY MATRIX	Undisturbed					Very dark grayish brown [10YR 3/2]
MH-B05	47.8	48.3	CL	Clay	Undisturbed					Very dark grayish brown [10YR 3/2]
MH-B05	48.3	50.3	GC	BOULDER/COBBLE IN CLAY MATRIX	Undisturbed					Very dark grayish brown [10YR 3/2]
MH-B05	50.3	51.0	CL	Clay	Undisturbed					Very dark grayish brown [10YR 3/2]
MH-B05	51.0	53.3	BEDROCK	ARGILLITE	BEDROCK					
MH-B05	53.3	55.3	BEDROCK	ARGILLITE	BEDROCK					
MH-B05	55.3	58.5	BEDROCK	ARGILLITE	BEDROCK					
MH-B05	58.5	63.6	BEDROCK	ARGILLITE	BEDROCK					
MH-B06	0.0	1.0	SM	SILTY SAND	TAILINGS					Olive brown [2.5Y 4/3]
MH-B06	1.0	1.8	SM	SILTY SAND	TAILINGS				0.000	Olive brown [2.5Y 4/3]
MH-B06	1.8	2.3	ML	SILT with Sand	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B06	2.3	3.0	ML	SILT with Sand	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B06	3.0	4.1	ML	SILT with Sand	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B06	4.1	5.5	ML	SILT with Sand	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B06	5.5	8.0	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	8.0	8.5	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	8.5	10.5	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	10.5	13.0	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	13.0	15.5	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	15.5	18.0	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	18.0	20.5	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	20.5	23.0	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	23.0	25.5	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	25.5	28.0	MLS	SANDY SILT	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	28.0	30.5	ML	SILT with Sand	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	30.5	33.0	ML	SILT with Sand	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	33.0	35.5	ML	SILT with Sand	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	35.5	38.0	ML	SILT with Sand	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	38.0	40.5	ML	SILT with Sand	TAILINGS				0.000	Gray [2.5Y 5/1]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
MH-B05	32.5	33.5	GC									145+26	14+04
MH-B05	34.0	36.0	GC									145+26	14+04
MH-B05	36.0	37.8	GC									145+26	14+04
MH-B05	37.8	38.4	GP									145+26	14+04
MH-B05	38.4	39.4	BOULDER									145+26	14+04
MH-B05	39.4	41.5	GC									145+26	14+04
MH-B05	41.5	42.3	BOULDER									145+26	14+04
MH-B05	42.3	44.3	GC									145+26	14+04
MH-B05	44.3	45.0	CL									145+26	14+04
MH-B05	45.0	47.8	GC									145+26	14+04
MH-B05	47.8	48.3	CL									145+26	14+04
MH-B05	48.3	50.3	GC									145+26	14+04
MH-B05	50.3	51.0	CL									145+26	14+04
MH-B05	51.0	53.3	BEDROCK									145+26	14+04
MH-B05	53.3	55.3	BEDROCK									145+26	14+04
MH-B05	55.3	58.5	BEDROCK									145+26	14+04
MH-B05	58.5	63.6	BEDROCK									145+26	14+04
MH-B06	0.0	1.0	SM									145+20	14+10
MH-B06	1.0	1.8	SM									145+20	14+10
MH-B06	1.8	2.3	ML									145+20	14+10
MH-B06	2.3	3.0	ML									145+20	14+10
MH-B06	3.0	4.1	ML									145+20	14+10
MH-B06	4.1	5.5	ML									145+20	14+10
MH-B06	5.5	8.0	MLS									145+20	14+10
MH-B06	8.0	8.5	MLS									145+20	14+10
MH-B06	8.5	10.5	MLS									145+20	14+10
MH-B06	10.5	13.0	MLS									145+20	14+10
MH-B06	13.0	15.5	MLS									145+20	14+10
MH-B06	15.5	18.0	MLS									145+20	14+10
MH-B06	18.0	20.5	MLS									145+20	14+10
MH-B06	20.5	23.0	MLS									145+20	14+10
MH-B06	23.0	25.5	MLS									145+20	14+10
MH-B06	25.5	28.0	MLS									145+20	14+10
MH-B06	28.0	30.5	ML									145+20	14+10
MH-B06	30.5	33.0	ML									145+20	14+10
MH-B06	33.0	35.5	ML									145+20	14+10
MH-B06	35.5	38.0	ML									145+20	14+10
MH-B06	38.0	40.5	ML									145+20	14+10

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
MH-B06	40.5	43.0	ML	SILT with Sand	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	43.0	45.5	ML	SILT with Sand	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B06	45.5	46.0	SM	SILTY SAND	TAILINGS				0.000	Dark brown [10YR 3/3]
MH-B06	46.0	48.0	GP	GRAVEL with Sand	Undisturbed				0.000	Brown [10YR 4/3]
MH-B06	48.0	54.0	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Brown [10YR 4/3]
MH-B06	54.0	58.0	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Dark yellowish brown [10YR 4/4]
MH-B06	58.0	63.0	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Brown [7.5YR 4/3]
MH-B06	63.0	67.3	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Olive brown [2.5Y 4/4]
MH-B06	67.3	68.3	BEDROCK	BEDROCK - no cuttings returned	BEDROCK					Olive brown [2.5Y 4/4]
MH-B07	0.0	2.0	ML	SANDY SILT	TAILINGS				0.000	Dark brown [10YR 3/3]
MH-B07	2.0	7.5	SM	SILTY SAND	TAILINGS				0.000	Olive brown [2.5Y 4/3]
MH-B07	7.5	11.5	ML	SANDY SILT	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B07	11.5	13.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B07	13.0	14.5	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Brown [7.5YR 4/3]
MH-B07	14.5	15.5	ML	SANDY SILT	Undisturbed				0.000	Dark gray [5Y 4/1]
MH-B07	15.5	17.3	SP-SM	SAND with Silt and Gravel	Undisturbed				0.000	Brown [7.5YR 4/3]
MH-B07	17.3	18.0	GM	SILTY GRAVEL with Sand	Undisturbed					
MH-B07	18.0	23.0	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Brown [7.5YR 4/3]
MH-B07	23.0	28.0	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Brown [7.5YR 4/3]
MH-B07	28.0	28.5	GM	SILTY GRAVEL with Sand	Undisturbed				0.000	Pale yellow [2.5Y 7/3]
MH-B07	28.5	29.0	BEDROCK	BEDROCK - no cuttings returned	BEDROCK					
MH-B08	0.0	2.5	SM	SILTY SAND	TAILINGS				0.000	
MH-B08	2.5	4.3	SM	SILTY SAND	TAILINGS				0.000	Olive [5Y 4/4]
MH-B08	4.3	6.3	SM	SILTY SAND	TAILINGS				0.000	Olive gray [5Y 4/2]
MH-B08	6.3	8.8	ML	SANDY SILT	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B08	8.8	11.3	SP-SM	SAND with Silt	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B08	11.3	16.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B08	16.0	17.5	ML	SILT with Sand	TAILINGS				0.000	Dark gray [N4]
MH-B08	17.5	22.5	MLS	SANDY SILT	TAILINGS				0.000	Dark gray [N4]
MH-B08	22.5	23.7	MLS	SANDY SILT	TAILINGS				0.000	Dark gray [N4]
MH-B08	23.7	23.9	OL	PEAT	Undisturbed					Wet
MH-B09	0.0	1.0	OL	ORGANIC SANDY SILT WITH GRAVEL	Undisturbed					
MH-B09	1.0	3.3	OL	ORGANIC SANDY SILT WITH GRAVEL	Undisturbed				0.000	Very dark gray [2.5Y 3/1]
MH-B09	3.3	5.3	GP-GC	GRAVEL with Clay and Sand	Undisturbed				0.000	Dark yellowish brown [10YR 4/4]
MH-B09	5.3	8.5	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Dark yellowish brown [10YR 4/4]
MH-B09	8.5	13.5	GC	CLAYEY GRAVEL with Sand	Undisturbed				0.000	Yellowish brown [10YR 5/4]
MH-B09	13.5	15.0	BEDROCK	ARGILLITE	BEDROCK					Saturated
MH-B10	0.0	1.0	GP	Gravel	FILL					
MH-B10	1.0	5.0	GC-GM	SILTY CLAYEY GRAVEL with SAND	FILL				0.000	Brown [10YR 4/3]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
MH-B06	40.5	43.0	ML									145+20	14+10
MH-B06	43.0	45.5	ML									145+20	14+10
MH-B06	45.5	46.0	SM									145+20	14+10
MH-B06	46.0	48.0	GP									145+20	14+10
MH-B06	48.0	54.0	GC									145+20	14+10
MH-B06	54.0	58.0	GC									145+20	14+10
MH-B06	58.0	63.0	GC									145+20	14+10
MH-B06	63.0	67.3	GC									145+20	14+10
MH-B06	67.3	68.3	BEDROCK									145+20	14+10
MH-B07	0.0	2.0	ML									145+20	14+10
MH-B07	2.0	7.5	SM									145+20	14+10
MH-B07	7.5	11.5	ML									145+20	14+10
MH-B07	11.5	13.0	SM									145+20	14+10
MH-B07	13.0	14.5	GM									145+20	14+10
MH-B07	14.5	15.5	ML									145+20	14+10
MH-B07	15.5	17.3	SP-SM									145+20	14+10
MH-B07	17.3	18.0	GM									145+20	14+10
MH-B07	18.0	23.0	GM									145+20	14+10
MH-B07	23.0	28.0	GM									145+20	14+10
MH-B07	28.0	28.5	GM									145+20	14+10
MH-B07	28.5	29.0	BEDROCK									145+20	14+10
MH-B08	0.0	2.5	SM									148+20	11+10
MH-B08	2.5	4.3	SM									148+20	11+10
MH-B08	4.3	6.3	SM									148+20	11+10
MH-B08	6.3	8.8	ML									148+20	11+10
MH-B08	8.8	11.3	SP-SM									148+20	11+10
MH-B08	11.3	16.0	SM									148+20	11+10
MH-B08	16.0	17.5	ML									148+20	11+10
MH-B08	17.5	22.5	MLS									148+20	11+10
MH-B08	22.5	23.7	MLS									148+20	11+10
MH-B08	23.7	23.9	OL									148+20	11+10
MH-B09	0.0	1.0	OL									156+95	02+35
MH-B09	1.0	3.3	OL									156+95	02+35
MH-B09	3.3	5.3	GP-GC									156+95	02+35
MH-B09	5.3	8.5	GC									156+95	02+35
MH-B09	8.5	13.5	GC									156+95	02+35
MH-B09	13.5	15.0	BEDROCK									156+95	02+35
MH-B10	0.0	1.0	GP									144+05	15+25
MH-B10	1.0	5.0	GC-GM									144+05	15+25

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
MH-B10	5.0	7.0	GC-GM	SILTY CLAYEY GRAVEL with SAND	FILL				8.680	Brown [10YR 4/3]
MH-B10	7.0	10.0	GC-GM	SILTY CLAYEY GRAVEL with SAND	FILL				0.000	Brown [10YR 4/3]
MH-B10	10.0	15.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B10	15.0	20.0	SM	SILTY SAND	TAILINGS				0.000	Gray [5Y 5/1]
MH-B10	20.0	25.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B10	25.0	30.0	SM	SILTY SAND	TAILINGS				0.000	Gray [2.5Y 5/1]
MH-B10	30.0	35.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B10	35.0	40.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [5Y 4/1]
MH-B10	42.0	45.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B10	45.0	50.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B10	50.0	55.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B10	55.0	56.0	SM	SILTY SAND	TAILINGS				0.000	Dark gray [2.5Y 4/1]
MH-B10	56.0	58.0	GC	SILTY CLAYEY GRAVEL with SAND	Undisturbed				0.000	Dark gray [2.5Y 4/1]
MH-B10	58.0	59.8	BEDROCK	ARGILLITE	BEDROCK					Moist
MH-B11	0.0	5.0	GM	silty to CLAYEY GRAVEL w/ sand	TAILINGS	FILL				
MH-B11	7.0	10.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Olive brown [2.5Y 4/3]
MH-B11	10.0	15.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 5/3]
MH-B11	15.0	20.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 4/3]
MH-B11	20.0	25.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 5/3]
MH-B11	25.0	27.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			7.220	Brown [10YR 5/3]
MH-B11	27.0	30.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 5/3]
MH-B11	30.0	35.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 5/3]
MH-B11	35.0	40.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 5/3]
MH-B11	40.0	42.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			8.240	Brown [10YR 5/3]
MH-B11	42.0	45.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 5/3]
MH-B11	45.0	50.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 4/3]
MH-B11	50.0	55.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 5/3]
MH-B11	55.0	57.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			14.100	Brown [10YR 5/3]
MH-B11	57.0	59.5	BEDROCK	Siltstone	BEDROCK					
MH-B12	0.0	1.0	GP-GM	GRAVEL with Silt and Sand	TAILINGS	FILL			0.000	Dark yellowish brown [10YR 3/4]
MH-B12	3.0	5.0	GP-GM	GRAVEL with Silt and Sand	TAILINGS	FILL			0.000	Dark brown [10YR 3/3]
MH-B12	5.0	10.0	GP-GM	GRAVEL with Silt and Sand	TAILINGS	FILL			0.000	Dark brown [10YR 3/3]
MH-B12	12.0	15.0	GP-GM	GRAVEL with Silt and Sand	TAILINGS	FILL			0.000	Dark brown [10YR 3/3]
MH-B12	15.0	20.0	GP-GM	GRAVEL with Silt and Sand	TAILINGS	FILL			0.000	Dark yellowish brown [10YR 4/4]
MH-B12	22.0	25.0	GP-GM	GRAVEL with Silt and Sand	TAILINGS	FILL			0.000	Dark yellowish brown [10YR 3/4]
MH-B12	25.0	30.0	GP	GRAVEL	TAILINGS	FILL			0.000	Brown [10YR 4/3]
MH-B12	30.0	35.0	GC-GM	SILTY CLAYEY GRAVEL with SAND	TAILINGS	FILL			0.000	Brown [10YR 4/3]
MH-B12	35.0	37.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			7.830	Brown [10YR 4/3]
MH-B12	37.0	40.0	GC	CLAYEY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 4/3]

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
MH-B10	5.0	7.0	GC-GM		156	263	41	18800				144+05	15+25
MH-B10	7.0	10.0	GC-GM									144+05	15+25
MH-B10	10.0	15.0	SM									144+05	15+25
MH-B10	15.0	20.0	SM									144+05	15+25
MH-B10	20.0	25.0	SM									144+05	15+25
MH-B10	25.0	30.0	SM									144+05	15+25
MH-B10	30.0	35.0	SM									144+05	15+25
MH-B10	35.0	40.0	SM									144+05	15+25
MH-B10	42.0	45.0	SM									144+05	15+25
MH-B10	45.0	50.0	SM									144+05	15+25
MH-B10	50.0	55.0	SM									144+05	15+25
MH-B10	55.0	56.0	SM									144+05	15+25
MH-B10	56.0	58.0	GC									144+05	15+25
MH-B10	58.0	59.8	BEDROCK									144+05	15+25
MH-B11	0.0	5.0	GM									144+10	15+20
MH-B11	7.0	10.0	GC									144+10	15+20
MH-B11	10.0	15.0	GC									144+10	15+20
MH-B11	15.0	20.0	GC									144+10	15+20
MH-B11	20.0	25.0	GC									144+10	15+20
MH-B11	25.0	27.0	GC		44	97	56	20100				144+10	15+20
MH-B11	27.0	30.0	GC									144+10	15+20
MH-B11	30.0	35.0	GC									144+10	15+20
MH-B11	35.0	40.0	GC									144+10	15+20
MH-B11	40.0	42.0	GC		35	92	32	21500				144+10	15+20
MH-B11	42.0	45.0	GC									144+10	15+20
MH-B11	45.0	50.0	GC									144+10	15+20
MH-B11	50.0	55.0	GC									144+10	15+20
MH-B11	55.0	57.0	GC		75	134	34	18600				144+10	15+20
MH-B11	57.0	59.5	BEDROCK									144+10	15+20
MH-B12	0.0	1.0	GP-GM									143+50	15+80
MH-B12	3.0	5.0	GP-GM									143+50	15+80
MH-B12	5.0	10.0	GP-GM									143+50	15+80
MH-B12	12.0	15.0	GP-GM									143+50	15+80
MH-B12	15.0	20.0	GP-GM									143+50	15+80
MH-B12	22.0	25.0	GP-GM									143+50	15+80
MH-B12	25.0	30.0	GP									143+50	15+80
MH-B12	30.0	35.0	GC-GM									143+50	15+80
MH-B12	35.0	37.0	GC		151	325	59	23600				143+50	15+80
MH-B12	37.0	40.0	GC									143+50	15+80

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
MH-B12	40.0	45.0	GM	SILTY GRAVEL with Sand	TAILINGS	FILL			0.000	Brown [10YR 4/3]
MH-B12	47.0	48.0	SM	SILTY SAND with Gravel	TAILINGS	FILL			0.000	Black [5Y 2.5/2]
MH-B12	48.0	53.0	GPS	GRAVEL with Sand	TAILINGS	FILL			0.000	Dark grayish brown [2.5Y 4/2]
MH-B12	53.0	54.4	BEDROCK	ARGILLITE	BEDROCK					Saturated
MH-B14	0.0	32.0	TAILINGS	Tailings	TAILINGS					
MH-B14	32.0	35.0	ALLUVIUM	Alluvium	Undisturbed					
MH-B15	0.0	23.0	TAILINGS	Tailings	TAILINGS					
MH-B15	23.0	27.0	ALLUVIUM	Alluvium	Undisturbed					
MH-B16	0.0	18.0	TAILINGS	Tailings	TAILINGS					
MH-B16	18.0	21.0	ALLUVIUM	Alluvium	Undisturbed					
MH-B17	0.0	16.0	TAILINGS	Tailings	TAILINGS					
MH-B17	16.0	20.0	ALLUVIUM	Alluvium	Undisturbed					
MH-B18	0.0	9.0	TAILINGS	Tailings	TAILINGS					
MH-B18	9.0	15.0	ALLUVIUM	Alluvium	Undisturbed					
MH-B19	0.0	9.0	TAILINGS	Tailings	TAILINGS					
MH-B19	9.0	15.0	ALLUVIUM	Alluvium	Undisturbed					
P-1	0.0	36.5	TAILINGS		TAILINGS					
P-1	36.5	41.5	TAILINGS		TAILINGS	PIEZO				
P-2	0.0	12.0	ZONE_2_FILL		TAILINGS					
P-2	12.0	36.5	ZONE_2_FILL		TAILINGS	PIEZO				
P-2	36.5	41.5	ZONE_1_FILL		TAILINGS					
P-3	0.0	3.0	ZONE_2_FILL		TAILINGS					
P-3	3.0	16.0	ZONE_2_FILL		TAILINGS					
P-3	16.0	21.5	TAILINGS		TAILINGS	PIEZO				
P-4	0.0	16.5	ZONE_2_FILL		TAILINGS					
P-4	16.5	21.5	ZONE_2_FILL		TAILINGS	PIEZO				
P-5	0.0	26.0	ZONE_1_FILL		TAILINGS					
P-5	26.0	45.5	TAILINGS		TAILINGS					
P-5	45.5	50.5	TAILINGS		TAILINGS	PIEZO				
P-5	50.5	62.0	TAILINGS		TAILINGS					
P-5	62.0	64.0	ALLUVIUM		Undisturbed					
P-6	0.0	44.5	ZONE_1_FILL		TAILINGS					
P-6	44.5	49.5	ZONE_1_FILL		TAILINGS	PIEZO				
P-6	49.5	57.0	ZONE_1_FILL		TAILINGS					
P-6	57.0	58.0	SHOTCRETE		SHOTCRETE					
P-7	0.0	25.0	TAILINGS	N/A - Pushed	TAILINGS					
P-7	25.0	30.0	TAILINGS		TAILINGS	PIEZO				
P-8	0.0	33.2	TAILINGS	N/A - Pushed	TAILINGS					
P-8	33.2	38.2	TAILINGS		TAILINGS	PIEZO				
P-8	38.2	38.7	TAILINGS		TAILINGS					
TDMW-2D	0.0	1.0	Topsoil		FILL					
TDMW-2D	1.0	9.0	GM	Silty sand and gravel	FILL					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
MH-B12	40.0	45.0	GM									143+50	15+80
MH-B12	47.0	48.0	SM									143+50	15+80
MH-B12	48.0	53.0	GPS									143+50	15+80
MH-B12	53.0	54.4	BEDROCK									143+50	15+80
MH-B14	0.0	32.0	TAILINGS									145+00	14+30
MH-B14	32.0	35.0	ALLUVIUM									145+00	14+30
MH-B15	0.0	23.0	TAILINGS									148+30	11+00
MH-B15	23.0	27.0	ALLUVIUM									148+30	11+00
MH-B16	0.0	18.0	TAILINGS									152+60	06+70
MH-B16	18.0	21.0	ALLUVIUM									152+60	06+70
MH-B17	0.0	16.0	TAILINGS									153+00	06+30
MH-B17	16.0	20.0	ALLUVIUM									153+00	06+30
MH-B18	0.0	9.0	TAILINGS									154+80	04+50
MH-B18	9.0	15.0	ALLUVIUM									154+80	04+50
MH-B19	0.0	9.0	TAILINGS									154+90	04+40
MH-B19	9.0	15.0	ALLUVIUM									154+90	04+40
P-1	0.0	36.5	TAILINGS									00+00	00+00
P-1	36.5	41.5	TAILINGS									00+00	00+00
P-2	0.0	12.0	ZONE_2_									00+00	00+00
P-2	12.0	36.5	ZONE_2_									00+00	00+00
P-2	36.5	41.5	ZONE_1_									00+00	00+00
P-3	0.0	3.0	ZONE_2_									142+61	16+69
P-3	3.0	16.0	ZONE_2_									142+61	16+69
P-3	16.0	21.5	TAILINGS									142+61	16+69
P-4	0.0	16.5	ZONE_2_									00+00	00+00
P-4	16.5	21.5	ZONE_2_									00+00	00+00
P-5	0.0	26.0	ZONE_1_									00+00	00+00
P-5	26.0	45.5	TAILINGS									00+00	00+00
P-5	45.5	50.5	TAILINGS									00+00	00+00
P-5	50.5	62.0	TAILINGS									00+00	00+00
P-5	62.0	64.0	ALLUVIUM									00+00	00+00
P-6	0.0	44.5	ZONE_1_									00+00	00+00
P-6	44.5	49.5	ZONE_1_									00+00	00+00
P-6	49.5	57.0	ZONE_1_									00+00	00+00
P-6	57.0	58.0	SHOTCRET									00+00	00+00
P-7	0.0	25.0	TAILINGS									00+00	00+00
P-7	25.0	30.0	TAILINGS									00+00	00+00
P-8	0.0	33.2	TAILINGS									00+00	00+00
P-8	33.2	38.2	TAILINGS									00+00	00+00
P-8	38.2	38.7	TAILINGS									00+00	00+00
TDMW-2D	0.0	1.0	Topsoil									141+51	17+79
TDMW-2D	1.0	9.0	GM									141+51	17+79

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
TDMW-2D	9.0	18.0	GM	Silty sand and gravel	FILL					
TDMW-2D	18.0	33.0	GM	Silty sand and gravel	Undisturbed					
TDMW-2D	33.0	37.0	Bedrock	Borken bedrock	BEDROCK					
TDMW-3D	0.0	18.0	COLLUVIUM		Undisturbed	OPEN				
TDMW-3D	18.0	24.0	BEDROCK	Broken argillite	BEDROCK	OPEN				
TDMW-3D	24.0	70.0	BEDROCK	Competent argillite	BEDROCK	OPEN				
TDMW-3S	0.0	15.0	COLLUVIUM		Undisturbed					
TDMW-3S	15.0	18.0	COLLUVIUM		Undisturbed	SCREEN				
TDMW-3S	18.0	24.0	BEDROCK	Broken argillite	BEDROCK	SCREEN				
TDMW-3S	24.0	30.0	BEDROCK	Competent argillite	BEDROCK	SCREEN				
TDMW-4D	0.0	20.0	COLLUVIUM		Undisturbed					
TDMW-4D	20.0	24.0	BEDROCK	Broken argillite	BEDROCK					
TDMW-4D	24.0	33.0	BEDROCK	argillite	BEDROCK	SCREEN				
TDMW-4D	33.0	60.0	BEDROCK	Competent argillite	BEDROCK	SCREEN				
TDMW-4S	0.0	7.0	COLLUVIUM		Undisturbed					
TDMW-4S	7.0	20.0	COLLUVIUM		Undisturbed	SCREEN				
TDMW-4S	20.0	22.0	BEDROCK	Broken argillite	BEDROCK	SCREEN				
09-MHTP-1	0.0	2.5	SP	tailings send with gravel and cobbles dark yellowish brown and dry	TAILINGS					
09-MHTP-1	2.5	4.0	ML	sandy silt with cobbles and gravel	TAILINGS					
09-MHTP-1	4.0	5.0	SW	sand with gravel and cobbles	TAILINGS					
09-MHTP-1	5.0	9.5	SW	sandy lean clay with gravel and boulders	TAILINGS					
09-MHTP-1	9.6	10.0	SW		TAILINGS					
09-MHTP-1	10.5	12.0	SW	tailings sand with gravel and cobbles	TAILINGS					
09-MHTP-1	12.0	16.0	CL	Fill sandy lean clay with gravel	TAILINGS					
09-MHTP-1	16.1	19.0	GC	sandy lean clay with gravel	Undisturbed					
09-MHTP-2	0.0	4.5	SP	sand with gravel and cobbles: acid generating	TAILINGS					
09-MHTP-2	4.5	5.0	SW	well graded sand with gravel	TAILINGS					
09-MHTP-2	5.0	5.5	SM	silty sand with gravel	TAILINGS					
09-MHTP-2	5.5	5.6	SM	silty sand with gravel	TAILINGS					
09-MHTP-2	5.6	6.0	SM	silty sand with gravel	TAILINGS					
09-MHTP-2	6.0	6.1	SM	silty sand with gravel	TAILINGS					
09-MHTP-2	6.1	9.0	SM	silty sand with gravel	TAILINGS					
09-MHTP-3	0.0	3.0	CL	sandy lean clay with gravel	TAILINGS					
09-MHTP-3	3.0	6.5	SM	silty fine sand with trace of lean clay	TAILINGS					
09-MHTP-3	6.5	6.6	SM	roots and fine pyrite sand	TAILINGS					
09-MHTP-3	6.6	7	SM	silty fine sand with trace of lean clay	TAILINGS					
09-MHTP-3	7.0	7.1	SM		TAILINGS					
09-MHTP-3	7.5	8.0	ML	fill: sandy silt was cobbles	TAILINGS					
09-MHTP-3	8.0	8.1	SM		TAILINGS					
09-MHTP-3	8.1	8.5	SM		TAILINGS					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
TDMW-2D	9.0	18.0	GM									141+51	17+79
TDMW-2D	18.0	33.0	GM									141+51	17+79
TDMW-2D	33.0	37.0	Bedrock									141+51	17+79
TDMW-3D	0.0	18.0	COLLUVIU									147+10	12+20
TDMW-3D	18.0	24.0	BEDROCK									147+10	12+20
TDMW-3D	24.0	70.0	BEDROCK									147+10	12+20
TDMW-3S	0.0	15.0	COLLUVIU									147+00	12+30
TDMW-3S	15.0	18.0	COLLUVIU									147+00	12+30
TDMW-3S	18.0	24.0	BEDROCK									147+00	12+30
TDMW-3S	24.0	30.0	BEDROCK									147+00	12+30
TDMW-4D	0.0	20.0	COLLUVIU									153+10	06+20
TDMW-4D	20.0	24.0	BEDROCK									153+10	06+20
TDMW-4D	24.0	33.0	BEDROCK									153+10	06+20
TDMW-4D	33.0	60.0	BEDROCK									153+10	06+20
TDMW-4S	0.0	7.0	COLLUVIU									153+15	06+15
TDMW-4S	7.0	20.0	COLLUVIU									153+15	06+15
TDMW-4S	20.0	22.0	BEDROCK									153+15	06+15
09-MHTP-1	0.0	2.5	SP									142+40	16+90
09-MHTP-1	2.5	4.0	ML									142+40	16+90
09-MHTP-1	4.0	5.0	SW									142+40	16+90
09-MHTP-1	5.0	9.5	SW									142+40	16+90
09-MHTP-1	9.6	10.0	SW									142+40	16+90
09-MHTP-1	10.5	12.0	SW									142+40	16+90
09-MHTP-1	12.0	16.0	CL									142+40	16+90
09-MHTP-1	16.1	19.0	GC									142+40	16+90
09-MHTP-2	0.0	4.5	SP									142+60	16+70
09-MHTP-2	4.5	5.0	SW		57	346	70	22300				142+60	16+70
09-MHTP-2	5.0	5.5	SM									142+60	16+70
09-MHTP-2	5.5	5.6	SM		49	312	48	20700				142+60	16+70
09-MHTP-2	5.6	6.0	SM									142+60	16+70
09-MHTP-2	6.0	6.1	SM		34	300	58	17400				142+60	16+70
09-MHTP-2	6.1	9.0	SM									142+60	16+70
09-MHTP-3	0.0	3.0	CL									142+20	17+10
09-MHTP-3	3.0	6.5	SM									142+20	17+10
09-MHTP-3	6.5	6.6	SM									142+20	17+10
09-MHTP-3	6.6	7	SM									142+20	17+10
09-MHTP-3	7.0	7.1	SM									142+20	17+10
09-MHTP-3	7.5	8.0	ML									142+20	17+10
09-MHTP-3	8.0	8.1	SM		159	322	53	29600				142+20	17+10
09-MHTP-3	8.1	8.5	SM									142+20	17+10

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
09-MHTP-3	8.5	8.6	SM		TAILINGS					
09-MHTP-3	8.6	10.0	BEDROCK	weathered shale	BEDROCK					
09-MHTP-4	0.0	2.5	CL	sandy lean clay with gravel	TAILINGS					
09-MHTP-4	2.5	7.0	SM	silty sand with gravel and wood fragments	TAILINGS					
09-MHTP-4	7.0	7.3	SM	manganese stain	TAILINGS					
09-MHTP-4	7.6	8.5	SM		TAILINGS					
09-MHTP-4	8.6	9.0	SM		TAILINGS					
09-MHTP-4	9.1	9.5	GC		Undisturbed					
09-MHTP-4	9.5	10.0	GC	shaly gravel with silt and lean clay	Undisturbed					
09-MHTP-5	0.0	3.3	SP	tailings: sand with gravel	tailings					
09-MHTP-5	3.3	5.5	CL	sandy lean clay with gravel	tailings					
09-MHTP-5	5.8	6.5	OL	topsoil-lean clay with gravel	Undisturbed					
09-MHTP-5	6.6	7	GM		Undisturbed					
09-MHTP-5	7.1	12.5	GM		Undisturbed					
09-MHTP-5	12.5	13.0	BEDROCK	Refusal	BEDROCK					
09-MHTP-6	0.0	2.5	SP	sand and gravel with lean clay	tailings					
09-MHTP-6	2.5	5.3	SP	fill: find sand trace organics	tailings					
09-MHTP-6	5.5	6	ML	fill sandy silt with gravel?	tailings					
09-MHTP-6	6.1	6.5	ML		Undisturbed					
09-MHTP-6	6.6	7.5	ML		Undisturbed					
09-MHTP-6	7.6	10.0	ML		Undisturbed					
09-MHTP-6	10.0	10.5	Bedrock	base of impacted soils/refusal	BEDROCK					
09-MHTP-7	0.0	6.0	SM	fine sand with silt gravel and cobbles	Tailings		oxidized tailing			
09-MHTP-7	6.0	7.5	GW		Undisturbed					
09-MHTP-7	7.5	8.5	GW	Weathered shale	Undisturbed		highly weathered shale gravel with sand iron staining			
09-MHTP-7	8.5	8.6	GW		Undisturbed					
09-MHTP-7	8.6	9.0	GW		Undisturbed					
09-MHTP-7	9.0	9.1	GW		Undisturbed					
09-MHTP-7	9.1	10.0	BEDROCK	Weathered shale/refusal	BEDROCK					
09-MHTP-8	0.0	2.5	SW	sanding gravel	tailings		oxidized tailings			
09-MHTP-8	2.5	4.0	SP	fine sand	tailings		Tailings:fine sand trace of roots: white salts			
09-MHTP-8	4.0	8.0	ML	sandy silt with gravel	tailings		tailings			
09-MHTP-8	9.0	9.5	SM		Undisturbed					
09-MHTP-8	9.6	10.0	SM		Undisturbed					
09-MHTP-8	10.0	10.1	GM		Undisturbed					
09-MHTP-8	10.1	11.0	GW	highly weathered Shale	Undisturbed					
09-MHTP-9	0.0	1.0	PT	Peat	tailings					
09-MHTP-9	1.0	10	ML	find sandy silt with gravel and boulders and tailings	tailings					
09-MHTP-9	10.1	11.0	ML		tailings					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
09-MHTP-3	8.5	8.6	SM		144	277	55	27300				142+20	17+10
09-MHTP-3	8.6	10.0	BEDROCK									142+20	17+10
09-MHTP-4	0.0	2.5	CL									142+42	16+88
09-MHTP-4	2.5	7.0	SM									142+42	16+88
09-MHTP-4	7.0	7.3	SM									142+42	16+88
09-MHTP-4	7.6	8.5	SM									142+42	16+88
09-MHTP-4	8.6	9.0	SM									142+42	16+88
09-MHTP-4	9.1	9.5	GC									142+42	16+88
09-MHTP-4	9.5	10.0	GC		56	131	32	19200				142+42	16+88
09-MHTP-5	0.0	3.3	SP									141+95	17+35
09-MHTP-5	3.3	5.5	CL									141+95	17+35
09-MHTP-5	5.8	6.5	OL									141+95	17+35
09-MHTP-5	6.6	7	GM									141+95	17+35
09-MHTP-5	7.1	12.5	GM									141+95	17+35
09-MHTP-5	12.5	13.0	BEDROCK									141+95	17+35
09-MHTP-6	0.0	2.5	SP									141+90	17+40
09-MHTP-6	2.5	5.3	SP									141+90	17+40
09-MHTP-6	5.5	6	ML									141+90	17+40
09-MHTP-6	6.1	6.5	ML									141+90	17+40
09-MHTP-6	6.6	7.5	ML									141+90	17+40
09-MHTP-6	7.6	10.0	ML									141+90	17+40
09-MHTP-6	10.0	10.5	Bedrock									141+90	17+40
09-MHTP-7	0.0	6.0	SM									141+60	17+70
09-MHTP-7	6.0	7.5	GW		348	463	131	26800				141+60	17+70
09-MHTP-7	7.5	8.5	GW									141+60	17+70
09-MHTP-7	8.5	8.6	GW		244	351	99	24500				141+60	17+70
09-MHTP-7	8.6	9.0	GW									141+60	17+70
09-MHTP-7	9.0	9.1	GW		31	192	42	18200				141+60	17+70
09-MHTP-7	9.1	10.0	BEDROCK									141+60	17+70
09-MHTP-8	0.0	2.5	SW									141+60	17+70
09-MHTP-8	2.5	4.0	SP									141+60	17+70
09-MHTP-8	4.0	8.0	ML									141+60	17+70
09-MHTP-8	9.0	9.5	SM									141+60	17+70
09-MHTP-8	9.6	10.0	SM									141+60	17+70
09-MHTP-8	10.0	10.1	GM		290	369	86	21800				141+60	17+70
09-MHTP-8	10.1	11.0	GW									141+60	17+70
09-MHTP-9	0.0	1.0	PT									141+12	18+18
09-MHTP-9	1.0	10	ML									141+12	18+18
09-MHTP-9	10.1	11.0	ML									141+12	18+18

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	USCS_Name	Bed	Black Bed	Notes	Remarks	Moisture	Color1
09-MHTP-9	11.0	11.5	GM	gravel with silt	tailings					
09-MHTP-9	11.5	13.0	GW	sandy gravel fill	tailings					
09-MHTP-9	13.0	13.5	GW		tailings					
09-MHTP-9	13.5	16.0	GW		tailings					
09-MHTP-9	16.1	19.0	GW	sandy gravel with boulders	Undisturbed		alluvium: tree debris at 17 feet			
09-MHTP-10	0.0	0.5	PT	peat	tailings					
09-MHTP-10	0.5	8	ML	find sandy silt with pyrite flotation tailings	tailings					
09-MHTP-10	8.1	10.0	GM	gravel with silt and trace of sand	tailings					
09-MHTP-10	10.0	16	GW		tailings					
09-MHTP-10	16.1	19.0	GW	alluvium: sandy gravel with boulders flotation tailings roots	tailings					

2012 UBMC Floodplain Sampling Logs and XRF results

Name	Top	Bottom	USCS	Color2	Pb	Zn	Cu	Fe	pHstart	pH end	Conductivity	Valley CL Station from Meadow Creek Bridge	Station from upstream end of Impoundment
09-MHTP-9	11.0	11.5	GM									141+12	18+18
09-MHTP-9	11.5	13.0	GW									141+12	18+18
09-MHTP-9	13.0	13.5	GW									141+12	18+18
09-MHTP-9	13.5	16.0	GW									141+12	18+18
09-MHTP-9	16.1	19.0	GW									141+12	18+18
09-MHTP-10	0.0	0.5	PT									140+51	18+79
09-MHTP-10	0.5	8	ML									140+51	18+79
09-MHTP-10	8.1	10.0	GM									140+51	18+79
09-MHTP-10	10.0	16	GW									140+51	18+79
09-MHTP-10	16.1	19.0	GW									140+51	18+79

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$

$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin.} \frac{1}{2} D}$

$\text{Sin.} \frac{1}{2} D = \frac{50}{R}$

$\text{Sin.} \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$

$R = T \cot. \frac{1}{2} I$

$R = \frac{50}{\text{Sin.} \frac{1}{2} D}$

$E = R \text{ ex. sec } \frac{1}{2} I$

$E = T \tan \frac{1}{4} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{I}{D}$

$\text{Tan. def.} = \frac{1}{2} \text{ chord def.}$

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

Right Angle Triangles. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$; $100 - 3.125 = 96.875$ = Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

Leveling. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574 d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3} d^2$. The combined correction is negative.

Probable Error. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean = $\pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1'	.0167	11'	.1833	21'	.3500	31'	.5167	41'	.6833	51'	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	⅛	3-16	¼	5-16	⅜	½	⅝	¾	⅞	1⅛
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729	
1	2	3	4	5	6	7	8	9	10	11	
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167	

7/23/12 UTM UPS NAD83

DEQ - Shelly
PTS - L Duensing, M Browne, Pat Redmond

1130 PTS arrived to perform sampling + conduct safety meeting

1400 Mobilize to TP-FP-01

1500 collect TP-FP-01 bulk sample

GPS = 12T 0397052, 5209273

1515 closed TP-FP-01 (0-2)

1535 done

1540 move to TP-FP-02

GPS = 12T 0397061, 5209319

1609 collect bulk TP-FP-02 (8.5-9.5)

1620 collect TP-FP-02 (3-8.5')

1800 leave site

7/24/12

830 PTS arrive onsite - L Duensing
M Browne P Redmond

meter calibration
pH 7.02 → 7.00
10.07 → 10.01
4.00 → 4.01
RMV 426.5 → 427.0 @ 16°
ORP 1418 → 1413

915 start digging TP-FP-06
GPS: 12T 0397063, 5209330
940 - collect sample (soil)

* @ gw level	water sample	10:18	(7.5')	
	597 µs/cm	6.58 pH	1021	
	485.3 RMV	6.50	1022	
	479.7 1023	6.46	1023	
	476.7 1024	6.42	1024	
	~~67~~ 474.7 1024	6.41	1025	
	471.2 1026	6.40	1026	
	464.3 1026	6.36	1028	
	457.2 1030	6.36	1030	
	443.4	6.36	1033	

7/24/12

water sample 1044 (≈1.5' below gw level)

6.94	438.8	576	1044
6.45	436.9	580	1046
6.38	437.9	580	1049
6.35	439.6	580	1052

1052 install perzo in TP-FP-03

1057 measure stream water

RMV	372.2	7.60	2294 µs	1057
	366.2	7.72	2294 µs	1059
	356.8	7.86	2294	1101
	352.0	7.94	"	1102
	350.1	7.98	"	1103
	348.4	8.01	"	1104
	346.0	8.02	"	1105
	341.6	8.09	"	1109
	340.9	8.10	"	1110

1115 - close TP-FP-03
1120 dig TP-FP-04
1127 gw sample

476.7	7.86	608	1127
475.7	7.10	594	1129
471.5	6.87	"	1131

7/24/12

Time	RmV	pH	uS/cm
1131	464.0	6.70	594
1144	449.4	6.56	"

GPS = 12T 0397078, 5209332

1146 collect bulk sample for gradation

1240 collect soil sample

collect water @ 7.5'

1241	403.0	6.63	581
1243	398.7	6.68	581
1245	397.3	6.70	"
1246	397.0	6.70	"
1247	396.7	6.70	"

1250 Install peizo

1320 dig TP-FP-05

1333 collect gw sample

1334	401.0	7.23	701
1335	405.0	6.62	701
1336	404.4	6.31	"
1337	401.0	6.06	"
1339	397.5	5.94	"
1346	387.1	5.85	"

7/24/12

TP-FP-05 GPS

12T 0397089, 5209329

TP-FP-05 (1-3)	1340
Dup 1	1600
↳ TP-FP-05 (1-3)	
~~(4-5.5)~~ (7)	~~940~~
TP-FP-03 (9-9.5)	1020
TP-FP-03 (11.5-12.5)	1048
TP-FP-03 (7.6-8.6)	940
TP-FP-03 (6-7)	940
TP-FP-03 (2-3.5)	940
TP-FP-04 (3-4)	1155
TP-FP-04 (7-8)	1220
TP-FP-04 (9-10)	1240
TP-FP-04 (1.5-2)	1140
TP-FP-04 (5.5-6.5)	1208
TP-FP-03 (4-5.5)	940
TP-FP-05 (3.8-4.8)	1358
TP-FP-05 (1-3)	1345
TP-FP-05 (6-7)	1407
TP-FP-05 (7.5-8)	1422
TP-FP-05 (8.5-9.5)	1430

7/24/12

1432 Water Sample (8.5')

1433	476.3	5.75	683
1434	471.2	5.31	"
1436	469.9	5.23	"
438	468.2	5.20	"
441	467.4	5.19	"
442	467.5	5.18	"
~~install pz~~ 444	467.5	5.17	"
145	467.5	5.17	"

1435 install Peizo

1450 dig TP-FP-06

TP-FP-06 (1.3-2) 1506

TP-FP-06 (4.5-5.5) 1520

GPS: 12T 0397104, 5209331

gw sample @ 1530

1533	424.6	6.05	680
1538	396.2	6.11	"
1542	386.3	6.17	"
1550	389	6.15	"

TP-FP-06 (7-8) 1550

TP-FP-06 (8.5-9) 1600

7/24/12

1607 gw Sample @ 8.5

			us/cm
1607	345.9	7.19	602
1608	350.6	7.03	602
1609	354.1	6.93	606
1610	357.9	6.83	606
1612	361.4	6.75	606
1613	363.6	6.71	605
1614	364.9	6.68	605
1617	368.7	6.62	605
1619	369.9	6.60	603
1621	371.3	6.59	603
1623	372.6	6.57	603

1630 Install peizo

1640 start digging TP-bulk-01

1650 Sample TP-Bulk-01

8 buckets

GPS: 12T 0397093, 5209364

1815 Leave site

7/25/12

PTS: P Redmond, L Duensing
M Browne

830 Arrive on site

Water Meter Calibration
pH: 7.02 → 7.00
4.00 → 4.01
10.08 → 10.01 slp = 96.0
ORP: 424.7 @ 18.6°
Cond: 1413 → 1413

950 TP-FP-6A - dig
GPS: 12T 0397078, 5209405

10:05 TP-FP-6A (5.5-6.5)
2 buckets
10:10 TP-FP-6A (2-3)
2 buckets
10:40 TP-FP-6A (16-16.5)
2 buckets
10:57 Install Peizo
1130 dig TP-FP-6B
GPS: 12T 0397067, 5209458

7/25/12

1150 TP-FP-6B (2.5-3.5)
2 buckets
1220 TP-FP-6B (12-13)
2 buckets
1250 Install Peizo
1330 Start digging TP-FP-07
1337 water sample @ gw level 5'
1339 462.4 R mv 5.83 (pH)* 481 us
1340 465.3 5.84 493
1341 468.1 6.07 495
1342 469.1 6.25 497
1343 469.5 6.40 496
1347 466.5 6.82 495
1349 464.2 6.93 492
1352 461.5 6.96 492
1354 460.3 6.96 491
1355 459.8 6.96 490
1344 TP-FP-07 (2.5-3.5) 2 buckets
1400 TP-FP-07 (5-5.5) 2 buckets
GPS TP-FP-07: 12T 0397041, 5209[illegible]
1411: TP-FP-07 (7-8) 2 buckets
1430: TP-FP-07 (11-12) 2 buckets
1440: Install peizo
1450: TP-FP-07 (0.5-1) 2 buckets (tailing)

* pH probe not working (left cap on probe)

7/25/12

1424	water sample	ORP	pH	Cond
	1446	481.8	8.34	473 µS
	1447	482.0	8.06	484
	1448	482.3	7.68	486
	1449	482.0	7.47	486
	1450	481.8	7.38	486
	1453	479.6	6.99	474
	1444	476.6	6.84	477
	1446	474.3	6.79	476
	1447	472.8	6.80	474
	1448	472.6	6.78	474
	1449	472.3	6.79	474
	1450	472.8	6.77	473

1453 soil sample TP-FP-07 (0-1.5) ziploc)

~~1555~~ 1500 install peizo

1530 start digging TP-FP-08

1540	water sample @ 2'		
	ORP	pH	Spec. Cond
1541	424.1	6.64	350
1542	449.4	5.93	354
1550	477.1	4.88	358
1553	477.5	4.84	357
1554	476.0	4.84	356
1555	475.7	4.83	357

*located ≈ 20 yds downstream from waste dump (mine)

7/25/12

1543	soil sample (ziploc)			TP-FP-08 (0
1558	"	"	"	TP-FP-08 (3
1607	"	"	"	TP-FP-08 (2.9-2.9)
1620	"	"	"	TP-FP-08 (4.5-5)
1625	"	"	"	TP-FP-08 (4-4.3)
1630	"	"	"	TP-FP-08 (6-6.5)

Field gradation (2 buckets)

1630 gw sample @ 6'

1632	508.2 ORP	5.62 pH	941 µS/cm
1635	486.8	5.74	962
1637	473.9	5.77	964
1640	461.7	5.78	967
1644	452.2	5.79	966

1642 soil sample (ziploc) TP-FP-08 (8-8.5)

1645 install peizo

GPS: 12T 0397039, 5209545

1700 start digging TP-FP-09

1708 water sample @ 2.5'

1710	552.2 ORP	3.03 pH	1773 µS
1719	587.1	3.02	1755
1721	612.0	3.02	1749
1722	617.7	3.02	1749
1723	620.3	3.02	1744

7/25/12

1708 soil Sample (ziploc) TP-FP-08 (1.5-2)
GPS 12T 0397042 5209543
1710 soil sample ziploc TP-FP-08 (2.7-3)
1715 " " TP-FP-09 (3.2-3.3)
1735 " " TP-FP-09 (4.5-5)
1740 " " TP-FP-09 (7.5-8)

1746 water sample @ 7.5'

	ORP	pH	SC
1746	463.0	5.48	289.9
1747	427.8	5.75	290.2
1751	365.0	6.02	294.6
1754	346.9	6.10	294.5
1755	341.9	6.10	293.8
1756	337.9	6.14	292.1
1757	334.9	6.16	292.1

1755 install peizo

1758	332.6	6.17	292.2
1759	331.9	6.18	292.0

1845 Leave site

7/25/12

7/26/12

830 Arrive onsite: P Redmond, L Duensing, M Browne
Water meter calibration
pH 7.02 → 7.00
4.00 → 4.01
10.09 → 10.01 slp = 96.7
ORP 426.4 @ 16.5 → 426.0
SC 1413 → 1413 acc 0.477
900 Start digging TP-FP-10
GPS 12T 0397054, 5209552

922 Water sample @ 6.4'

	ORP	pH	SC
924	562.7	7.92	200.2
926	570.9	7.30	202.1
927	573.3	7.16	203.1
929	572.4	7.04	202.2
931	571.7	6.99	202.5
933	569.7	6.94	201.9

water coming out of hillside.
922 soil sample (ziploc) TP-FP-10 (2-2.4)
930 " " " TP-FP-10 (4-4.5)

937	566.3	6.85	201.7
940	564.9	6.81	203.6
941	563.9	6.80	203.4
942	563.3	6.80	203.6

11/26/12

945 soil sample (ziploc) TP-FP-10 (5.5-6)
1003 " " " TP-FP-10 (8-8.5)
1018 water sample @ 8.5'

1020	546.6	7.78	199.2
1021	556.1	7.46	203.6
1023	582.2	7.26	205.0
1025	565.9	7.13	204.4
1037	559.7	7.01	202.3
1038	558.9	7.01	201.8
1040	558.0	7.00	201.5
1043	554.9	6.99	200.7

1028 soil sample (ziploc) TP-FP-10A (.75-1) tailings
1030 " " " TP-FP-10A (1.1-1.3)
1050 " " " TP-FP-10A (2.1-2.6)
1104 " " " TP-FP-10A (3.5-4)

1115 Install peizo
1145 Patty Navarro arrive onsite (PTS H+S) - review daily toolbox meeting
1235 Start digging TP-FP-11
GPS 12T 0396960 5209682
1250 watersample @ 2'

11/26/12

	ORP	pH	SC
1252	538.1	7.36	491
1300	545.6	6.32	492
1310	530.9	6.19	488
1311	529.2	6.19	489
1312	527.4	6.18	488
1314	525.6	6.18	488

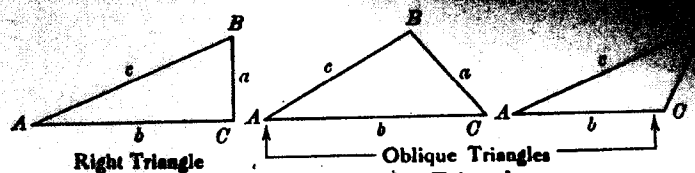
1300 soil sample (ziploc) TP-FP-11 (1.5-2)
1303 " " " TP-FP-11 (.01-.3)
1306 " " " TP-FP-11 (1-1.2)
1323 " " " TP-FP-11 (3.7-4)
1333 " " " TP-FP-11 (6.5-7)
1600 " " " TP-FP-11A (dup)
1340 water sample @ 9'

	ORP	pH	SC
1341	491.9	7.59	459
1343	502.2	7.33	464
1345	505.3	7.22	465
1347	505.2	7.17	467
1349	504.8	7.16	469
1350	504.3	7.13	468
1351	503.1	7.13	458
1353	502.3	7.10	459
1355	501.3	7.09	458
1356	499.3	7.08	456

7/26/12

1404	506.2	6.98	454	
1406	504.2	7.00	457	
1409	507.2	6.92	457	
1412	507.4	6.91	455	
1357	soil sample (ziploc)			TP-FP-11 (8.5-9)
1402	"	"	"	TP-FP-11 (27-3)
1420	Start digging			TP-FP-12
	ORP	pH	SC	(water sample @ 1425 @ 2')
1427	705.8	3.23	1689	
1428	713.9	3.26	1720	
1429	714.9	3.29	1716	
1431	714.1	3.31	1715	
1433	710.6	3.32	1717	
1437	706.8	3.26	1718	
1439	704.5	3.27	1721	
1444	701.8	3.27	1732	
1447	701.2	3.27	1733	
1434	soil sample (ziploc)			TP-FP-12 (0.9-1.3)
1444	"	"	"	TP-FP-12 (1.6-2.0)
1450	"	"	"	TP-FP-12 (1.6-1.8)
1456	"	"	"	TP-FP-12 (2-2.3)
1500	rain - lightening / thunder			
1615	leave site			

TRIGONOMETRIC FORMULAS



Solution of Right Triangles

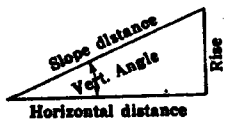
For Angle A. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\operatorname{cosec} = \frac{c}{a}$

Given	Required	
a, b	A, B, c	$\tan A = \frac{a}{b} = \cot B,\ c = \sqrt{a^2+b^2} = a\sqrt{1+\frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B,\ b = \sqrt{(c+a)(c-a)} = c\sqrt{1-\frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90° - A,\ b = a \cot A,\ c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90° - A,\ a = b \tan A,\ c = \frac{b}{\cos A}$
A, c	B, a, b	$B = 90° - A,\ a = c \sin A,\ b = c \cos A$

Solution of Oblique Triangles

Given	Required	
A, B, a	b, c, C	$b = \frac{a \sin B}{\sin A},\ C = 180° - (A+B),\ c = \frac{a \sin C}{\sin A}$
A, a, b	B, c, C	$\sin B = \frac{b \sin A}{a},\ C = 180° - (A+B),\ c = \frac{a \sin C}{\sin A}$
a, b, C	A, B, c	$A + B = 180° - C,\ \tan \frac{1}{2}(A-B) = \frac{(a-b)\tan\frac{1}{2}(A+B)}{a+b},\ c = \frac{a \sin C}{\sin A}$.
a, b, c	A, B, C	$s = \frac{a+b+c}{2},\ \sin\frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}},\ \sin\frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{ac}},\ C = 180° - (A+B)$
a, b, c	Area	$s = \frac{a+b+c}{2},\ \text{area} = \sqrt{s(s-a)(s-b)(s-c)}$
A, b, c	Area	$\text{area} = \frac{bc \sin A}{2}$
A, B, C, a	Area	$\text{area} = \frac{a^2 \sin B \sin C}{2 \sin A}$

REDUCTION TO HORIZONTAL



Horizontal distance = Slope distance multiplied by the cosine of the vertical angle. Thus: slope distance = 319.4 ft. Vert. angle = 5° 10′. Since cos 5° 10′ = .9959, horizontal distance = 319.4 × .9959 = 318.09 ft.

Horizontal distance also = Slope distance minus slope distance times (1 − cosine of vertical angle). With the same figures as in the preceding example, the following result is obtained. Cosine 5° 10′ = .9959. 1 − .9959 = .0041. 319.4 × .0041 = 1.31. 319.4 − 1.31 = 318.09 ft.

When the rise is known, the horizontal distance is approximately the slope distance less the square of the rise divided by twice the slope distance. Thus: rise = 14 ft., slope distance = 302.6 ft. Horizontal distance = $302.6 - \frac{14 \times 14}{2 \times 302.6} = 302.6 - 0.32 = 302.28$ ft.

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$

$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin.} \frac{1}{2} D}$

$\text{Sin.} \frac{1}{2} D = \frac{50}{R}$

$\text{Sin.} \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$

$R = T \cot. \frac{1}{2} I$

$R = \frac{50}{\text{Sin.} \frac{1}{2} D}$

$E = R \text{ ex. sec } \frac{1}{2} I$

$E = T \tan \frac{1}{2} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{I}{D}$

Tan. def. = ½ chord def.

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve. very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) .nd divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

Right Angle Triangles. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$; $100 - 3.125 = 96.875$ = Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

Leveling. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574\,d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3}d^2$. The combined correction is negative.

Probable Error. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean = $\pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1'	.0167	11'	.1833	21'	.3500	31'	.5167	41'	.6833	51'	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	⅛	3-16	¼	5-16	⅜	½	⅝	¾	⅞
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

7/30/12

830 PTS arrive onsite: L Duensing
M Bowman

Meter Calibration
US 14.13 → 14.13
pH 4.01 → 4.01
10.03 → 10.01
7.00 → 7.00 95.2 slp

10:00 Start on TP-FP-12
1015 soil sample ziploc TP-FP-12 (3-3.3)
1025 soil sample ziploc TP-FP-12 (6-6.8)
1035 " " " TP-FP-12 (8-8.5)
1040 " " " TP-FP-12 (9.5-10)
1045 Install peizo
1100 Start digging TP-FP-13
1115 Soil sample (zip) TP-FP-13 (1-1.3)
1125 " " " TP-FP-13 (1.5-1.8)
1135 " " " TP-FP-13 (2.4-2.7)
1140 " " " TP-FP-13 (3.1-3.4)
1155 " " " TP-FP-13 (3.5-3.5)
1200 " " " TP-FP-13 (4-4.3)

1225 Install Peizo.

7/30/12

1133 Water sample TP-FP-13 @ 2'

	ORP	pH	spec cond.
1134	490.5	6.87	281.2
1135	492.3	6.32	284.3
1138	487.2	5.64	285.4
1140	480.2	5.56	286.9
1142	474.6	5.55	286.6
1144	470.0	5.53	286.0
1146	467.2	5.52	285.9
1147	466.1	5.49	287.3
1148	461.6	5.50	286.9
1154	451.4	5.55	287.9
1156	449.2	5.52	~~[illegible]~~ 288.3
1158	448.4	5.52	288.1
1200	447.8	5.51	288.5

1218 Water sample @ 5' TP-FP-13

1220	451.8	5.73	321
1222	460.6	5.62	322
1224	461.6	5.60	320
1227	460.3	5.66	320
1228	460.6	5.59	320
1231	460.2	5.66	321
1234	457.9	5.69	323
1235	457.7	5.63	324
1237	457.9	5.67	324
1241	458.0	5.66	326
1242	456.8	5.65	326

7/30/12

time	ORP	pH	SC
1243	456.7	5.64	327
1244	456.5	5.61	326
1245	456.9	5.63	326

1230 Start digging TP-FP-14

1258 soil sample ziploc TP-FP-14 (1-1.3)
1300 " " " TP-FP-14 (1.4-1.9)
1315 " " " TP-FP-14 (3.2-3.5)
1326 " " " TP-FP-14 (4-4.6)
1347 " " " TP-FP-14 (6-6.5)
1358 " " " TP-FP-14 (10-10.5)

1305 water sample @ 2' TP-FP-14

	ORP	pH	SC
1307	683.3	3.42	1066
1308	686.5	3.43	1078
1310	697.5	3.48	1078
1312	698.9	3.49	1072
1314	699.6	3.54	1072
1315	701.1	3.51	1069
1316	705.4	3.52	1067
1318	702.0	3.51	1074

1405 Install peizo @ TP-FP-14

1403 Water sample @ 8' TP-FP-14

	ORP	pH	SC
1406	578.8	5.03	792
1408	563.2	5.55	824
1409	561.0	5.63	824
1410	559.7	5.64	821

1443 Arrive @ TP-Bulk-02
1515 Collect bulk sample TP-Bulk-02 (8 buckets)
1530 Stop work - thunder/lightening
1600 back @ TP-Bulk-02
1620 Install Peizo

1640 Start digging TP-FP-15
1645 soil sample (Ziplock) TP-FP-15 (0-0.2)
1652 " " " TP-FP-15 (1.7-1.9)
1701 " " " TP-FP-15 (0-0.3)
1702 " " " TP-FP-15 (0-0.4)
1655 " " " TP-FP-15A (0.5-1.5)
1700 " " " TP-FP-15A (dup @ 0.5-1.5)
1700 rain storm - thunder/lightening stop work
1750 leave site

7/31/12

815 PTS onsite: L Duensing M Browne
Calibrate meters
pH 4.00 → 4.01
10.07 → 10.01
7.02 → 7.00 slp = 95.9
ORP @ 19.3° 424.1 → 424.0
SC 1413 → 1413
900 Start on TP-FP-15
925 TP-FP-15A (2.7-3) soil ziplock
927 TP-FP-15 (6.5-7) " "
935 TP-FP-15A (3.1-3.6) " "
940 TP-FP-15A (5-5.2) " "
1026 TP-FP-15A (5.5-5.7) " "
1038 TP-FP-15A (6-6.5) " "
1050 TP-FP-15A (8.5-9) " "
928 water sample @ 8' (TP-FP-15)

931	742.2	3.03	2231
933	743.1	3.01	2222
935	743.7	3.06	2216
939	745.1	3.14	2212
944	746.6	3.18	2219
948	747.2	3.16	2247
950	747.9	3.14	2257
955	748.4	3.15	2255
956	748.4	3.12	2254

1055 water sample @ 9.5' (TP-FP-15)

	ORP	pH	
1050	624.9	4.43*	675
1101	626.0	4.58*	839
1102	627.0	4.60*	837
1107	629.0	4.60*	832
1120	631.8	—	820

pH meter not working properly
reset meter - log full

1120 Start digging TP-FP-16
1128 TP-FP-16 (1.1-1.5) soil ziploc
1130 TP-FP-16 (3.0-3.4) soil ziploc
1134 TP-FP-16A (dup 3-3.4) " "
1150 TP-FP-16 (4.8-5.0) " "
1157 TP-FP-16 (4.2-4.3) " "
collect 2 buckets for grad. (3-4')
1210 TP-FP-16 (6.2-7.4) soil ziploc
1220 TP-FP-16 (5.5-6.3) " "
1230 TP-FP-16 (9-9.4) " "
1240 TP-FP-16 (11.5-12) ✓ " "
→ 2 bucket soil sample

1250 Install Peizo

1249 water sample @ 11'

	ORP	pH	
1250	756.3	3.59	1907
1253	768.0	3.60	1929
1258	766.8	3.67	1961
1259	765.1	3.68	1953
1301	767.8	3.69	1965
1302	766.8	3.70	1956
1309	752.5	3.76	1942
1312	750.8	3.79	1941

1300 Dig TP-FP-17
1317 TP-FP-~~16~~17 (1-1.5) soil ziploc
1332 TP-FP-~~16~~17 (2.6-3.0) " "
1335 TP-FP-~~16~~17 (3-3.2) " "
1357 TP-FP-~~16~~17 (4.6-5) " "
1400 TP-FP-~~16~~17 (6.3-6.5) " "
1408 TP-FP-~~16~~17 (9-9.5) " "
1413 TP-FP-17 (5-6) " "
1430 TP-FP-17 (11.5-12) " "

1438 water sample @ 12'

	ORP	pH	
1438	548.1	4.60	938
1439	559.3	4.72	947
1441	569.2	4.86	966
1443	572.5	4.90	965
1445	575.9	4.93	967
1448	580.9	4.95	962
1450	582.8	4.91	940

1440 Install peizo

Water sample (con't) 12' TP-FP-17

1459	5853	4.91	937
1500	5867	4.90	935
1501	5877	4.90	935
1502	5884	4.90	933

1520 Start dig TP-FP-18

1530 TP-FP-18 (0-.3) soil ziplac
1533 TP-FP-18 (.6-.8) " "
1537 TP-FP-18 (2-2.3) " "
1550 TP-FP-18 (4-4.5) " "
1600 TP-FP-18A (Dup 4-4.5) " "
1630 TP-FP-18 (9-9.5) " "
1642 TP-FP-18 (12-12.5) " "

1650 Install Peizo

~~16~~ 17-00 start dig TP-FP-19
1720 TP-FP-19 (0.5-0.9) soil ziplac
1726 TP-FP-19 (18-24) " "
1725 TP-FP-19 (39-46) " "

1650 Water sample (TP-FP-18) @ 12'

	ORP	pH	SC
1651	402.6	5.70	345
1652	425.2	5.88	358
1658	460.1	6.21	355
1701	472.8	6.43	348
1702	474.7	6.44	348
1703	475.7	6.47	347
1704	476.5	6.48	347
1705	477.1	6.48	348
1706	477.9	6.48	347

1815 Leave site

LMD 7/31/12

8/1/12 * sample from exc. bucket

800 PTS arrive onsite:
M Browne, L Duensing

Meter calibration
pH 4.01 → 4.01
10.05 → 10.01
7.01 → 7.00 slp = 94.7
ORP 421.9 → 423
SC 1413 → 1413

900 Starton TP-FP-19
920 TP-FP-19 (5-5.5) soil ziploc
933 TP-FP-19 (4.9') " "
1027 TP-FP-19 (8-8.5) " " *
1035 Install peizo

1052 dig TP-FP-19A

1115 dig TP-FP-21
1145 water sample @ 3.5'

	ORP	pH	SC
1147	552.5	4.54	320
1148	571.4	5.14	323
1150	594.1	5.60	325
1152	608.7	5.81	322
1202	576.1	6.12	323
1204	566.2	6.14	322
1206	563.0	6.15	323
1210	542.2	6.19	323
1211	537.0	6.19	324

1158 TP-FP-21 (3-3.2) soil ziploc
1201 TP-FP-21 (1-1.3) " "
1207 TP-FP-21 (6.5-7) " "
1249 TP-FP-21 (10-10.5) " "
243 water sample @

	ORP	pH	SC
1244	543.7	6.08	489
1245	549.8	5.94	500
1250	556.8	5.74	486
1252	557.8	5.71	482
1255	560.8	5.68	477
1256	561.3	5.67	477
1258	562.0	5.65	476
1300	562.9	5.63	475
1304	565.0	5.57	475

320 TP-FP-21A (3.4-3.7) soil ziploc
315 " " " (2.8-3) " "
330 Dig TP-FP-20
340 TP-FP-20 (0.3-0.5) soil ziploc
350 TP-FP-20 (2.1-2.4) " "
400 TP-FP-20A (dup 2.1-2.4) " "
350 TP-FP-20 (2.1-2.4) soil bucket
05 TP-FP-20 (3.1-3.6) soil ziploc
1210 TP-FP-20 (6-6.5) " "
130 TP-FP-20 (6.5) 2 buckets
140 TP-FP-20 (8-8.5) soil ziploc

1426 water sample @ 6.5'

1427	548.6	5.57	330
1428	531.2	5.49	343
1430	511.9	5.46	345
1435	493.6	5.52	347
1436	491.1	5.53	348
1437	493.1	5.56	349
1438	489.3	5.57	348
1444	480.5	5.61	347
1445	480.5	5.61	348
1447	479.0	5.61	348

1450 TP-FP-20 (9.5-10) soil ziploc
- front of bucket sample

1450 TP-FP-20 (9.5-10) soil ziploc
- back of bucket sample

1458 water sample @ 10'

1458	561.0	5.57	600
1500	563.0	5.43	604
1504	546.4	5.39	591
1507	538.9	5.36	589
1509	535.5	5.35	589
1512	532.9	5.36	590

1505 Install piezo

1545 dig TP-FP-22

1600 TP-FP-22 (0.1-0.3) soil ziploc

1615 TP-FP-22 (2.0-2.3) " "

1625 TP-FP-22 (3.7-3.9) " "

1630 TP-FP-22 (0.4-1.2) " "

1640 TP-FP-22 (5.5-6) " "

1650 TP-FP-22 (7.5-8) " "

1700 TP-FP-22 (9-9.5) " "

1715 Install piezo

water sample @ 6'

1645	528.2	5.70	205.8
1705	516.6	5.70	202.3
1707	514.1	5.69	201.9
1713	509.7	5.69	201.1

710 water sample @ 9.5'

714	470.8	5.79	235.3
715	472.0	5.82	235.9
717	478.0	5.87	234.0
719	482.0	5.89	233.1
720	483.1	5.90	233.2
721	484.1	5.90	232.7

1800 Leave site

LAD

8/2/12 *bucket sample

810 PTS arrive on site MBrowne
2 Dwensing
900 Start digging TP-FP-25
meter calibration
pH 4.00 → 4.01
10.08 → 10.08 ±1 (us)
7.02 → 7.00 slp = 96.0
ORP ~~10.08~~ 425 @ 18.2°
SC 1413 → 1413
933 TP-FP-25A (1.3-1.8) soil zip loc
1600 TP-FP-25A (Dup 1.3-1.8) " "
935 TP-FP-25 (0.4-0.9) " "
937 TP-FP-25 (1.1-1.2) " "
939 TP-FP-25 (1.7-2.1) " "
950 TP-FP-25 (4.3-4.5) " "
1000 TP-FP-25 (6-6.2) " "
*1015 TP-FP-25 (7.5-8) " "
*1045 TP-FP-25 (10) " "

1050 Install piezo

Rite in the Rain

8/2/12

		ORP	pH	SC
1011	Water sample @ 7.5' (TP-FP-25)			
1012		697.4	6.27	371
1014		681.1	5.56	372
1016		666.2	5.36	386
1018		658.3	5.32	389
1021		646.2	5.32	392
1022		643.1	5.32	394
1024		639.7	5.34	396
1027		634.2	5.36	397
1041		605.2	5.39	401
1042	Water sample @ 10' (TP-FP-25)			
1042		615.7	5.05	505
1043		617.1	5.04	506
1050		621.7	5.05	511
1052		623.6	5.05	511
1054		625.4	5.05	510
1115	Dig TP-FP-26			
1122	Water @ 2' (orange + cloudy)			
1123		526.1	6.05	209.7
1125		517.0	6.29	209.8
1132		515.1	6.53	208.8
1135		516.7	6.50	208.9
1142		517.8	6.50	208.2
1146		518.0	6.52	208.2

8/2/12

1126	TP-FP-26 (0.7-1)	soil	ziploc
1130	TP-FP-26 (1.8-2)	"	"
1143	TP-FP-26 (4-4.5)	—	—
	2 buckets		
1146	TP-FP-26 (4-4.5)	soil	ziploc
* 1200	TP-FP-26 (6-6.5)	"	"
* 1215	TP-FP-26 (9-9.5)	"	"
1220	Install Peizo		

		ORP	pH	SC
1210	Water sample @ 9'			
1211		553.0	5.06	773
1212		551.7	5.04	764
1218		549.3	5.16	788
1220		549.5	5.18	793
1222		549.7	5.20	799
1227		550.9	5.22	803
1229		551.2	5.23	803
1232		552.0	5.23	806
1235		552.4	5.23	805

1245	Start digging TP-FP-27		
1320	TP-FP-27 (1.3-1.9)	soil	ziploc
1318	TP-FP-27 (0.9-1.2)	"	"
1330	TP-FP-27 (3.8-4.2)	"	"
1326	TP-FP-27 (2-2.4)	"	"

Rite in the Rain

8/2/12

1312 TP-FP-27 (0-0.4) soil ziploc
1313 TP-FP-27 (0.5-0.8) "
1700 TP-FP-27A (0.5-0.8 dup)
1344 TP-FP-27 (5-5.5) soil ziploc
1340 Water sample @ 7.5

	ORP	pH	SC
1340	483.9	5.80	357
1342	480.7	5.90	359
1346	480.7	6.03	359
1349	481.7	6.04	358
1354	484.8	6.06	356
1355	485.7	6.06	356
1357	486.9	6.05	357

1408 Install piezo

1350 TP-FP-27 (6.5-7) soil ziploc *
1400 TP-FP-27 (9.5-10) " " *
1356 Water sample @ 9.5'

	ORP	pH	SC
1358	505.3	5.63	656
1359	506.3	5.59	662
1401	507.3	5.55	667
1403	507.9	5.53	670
1404	509.1	5.51	678
1409	512.6	5.47	695
1410	514.0	5.46	700
1414	517.3	5.44	707

8/2/12

water (cont)

	ORP	pH	SC
1416	518.8	5.43	709
1417	519.8	5.42	710
1418	520.8	5.42	711
1420	522.9	5.41	713
1421	524.3	5.40	713
1422	525.6	5.40	714
1424	526.6	5.40	715

1535 leave site

LAB 8/2/12

Rite in the Rain

8/~~12~~6/12

910 PTS onsite: L Duensing, M Browne

1015 Meet Don onsite @ TP-FP-28

pH calibration:

pH 7.01 → 7.00

4.01 → 4.01

10.05 → 10.01 slp = 959

ORP 420.5 → 420 @ 24°

SC 1413 → 1413

1100 Start digging TP-FP-28

1127 water sample @ 6'

time	ORP	pH	SC
1130	457.1	6.21	219.4
1132	440.9	6.45	230.4
1138	435.8	6.52	230.0
1149	429.0	6.56	225.7
1151	425.7	6.59	226.1
1153	424.3	6.60	225.8
1202	421.9	6.62	226.4
1203	421.5	6.63	226.4
1204	421.2	6.64	226.4
1205	420.8	6.64	226.9
1206	420.5	6.65	226.7

8/6/12

1140 TP-FP-28 (1-1.5) soil ziploc

1142 TP-FP-28 (1.5-2) " "

1145 TP-FP-28A (1.5-2) " "

1153 TP-FP-28 (3-3.5) " "

1155 TP-FP-28 (4.6-5) " "

1159 TP-FP-28 (5.5-7) " "

1211 TP-FP-28 (8-8.5) " "

1230 TP-FP-28 (9-9.5) " "

1235 Install piezo

1223 Water sample @ 9'

time	ORP	pH	SC
1227	409.5	5.84	376
1229	426.7	5.81	378
1230	432.7	5.80	378
1231	437.2	5.80	379
1232	442.8	5.82	378
1239	458.0	5.80	376
1245	467.9	5.78	375
1248	473.3	5.74	375
1300	485.5	5.69	374

1400 Move to TP-~~FP-28A~~ TS-01 (JM)

Mike Horse Mine townsite

1440 TP-~~FP-28A~~ (JM) TS-01 soil ziploc (0.5-1)

8/6/12

TP-TS-01

GPS: 12T 0397046, 5209322

1515 dig TP-TS-02

GPS 12T 0397046, 5209315

1518 TP-TS-02 (1.5-2) soil ziploc

1512 TP-TS-02 (0.6-0.9) " "

1520 backfill

1535 dig TP-TS-03

1539 TP-TS-03 (0.1-0.2) soil zip

1540 TP-TS-03 (1.8-2) " "

1600 TP-TS-03A (Dup - 1.8-2) " "

GPS: 12T

1605 Move to TP-Bulk-03

1615 Start digging

1620 water sample @ 2'

1622	479.4	6.55	249.2
1629	452.9	6.50	247.5
1642	434.7	6.51	248.7
1643	433.8	6.50	249.0
1656	432.2	6.57	249.5
1657	432.6	6.56	249.8
1659	431.9	6.57	250.2

8/6/12

1630 Collect bulk sample @ 5.55'

TP-Bulk-03 (8 buckets)

1645 backfill

1700 site cleanup

1740 leave site

MAP

8/7/12 * bucket sample
800 PTS onsite: MBraune, C Dunsing
Calibrate meters
pH 7.03 → 7.00
10.12 → 10.01
4.00 → 4.01 96.6 slp
ORP 427.2 → 427.7 @ 15.4°
SC 1413 → 1413
840 Dig TP-FP-30
844 TP-FP-30 (.5-.8) soil ziploc
1600 TP-FP-30A " "
(dup (0.5-0.8)
846 TP-FP-30 (0.8-1) soil ziploc
848 TP-FP-30 (1.6-2) " "
850 TP-FP-30 (3.5-4) " "
901 TP-FP-30 (4.8-5) " "
* 914 TP-FP-30 (7.5-8) " "
* 915 TP-FP-30A (2.3-3.3) " "
* 930 TP-FP-30 (10-10.5) " "
* 945 Install peizometer
Shelly (DEQ) onsite

1005 Dig TP-FP-31

8/7
859 Water sample @ 5' (TP-FP-30)

	ORP	pH	SC
900	704.6	4.91	1290
903	678.9	4.93	1313
906	662.3	4.95	1313
909	652.1	4.95	1306
916	636.4	4.95	1292
917	634.6	4.95	1291
921	624.9	4.95	1280
922	623.5	4.95	1278
926	620.1	4.95	1275

938 Water sample @ 10' (TP-FP-30)

940	692.5	4.99	939
942	687.1	4.68	961
944	673.4	4.54	965
946	656.7	4.41	957
958	596.4	4.23	939
1001	602.3	4.54	944
1003	603.8	4.60	942
1005	603.7	4.60	940
1007	602.6	4.60	940
1009	603.5	4.61	941

8/7/12

1030 Water sample @ 4.5'

	ORP	pH	SC
1032	665.5	3.41	1100
1034	671.8	3.44	1091
1037	677.4	3.49	1080
1039	678.0	3.51	1076
1041	678.7	3.52	1072
1058	677.3	3.48	1081
1103	673.3	3.49	1084
1105	671.6	3.49	1084
1107	670.0	3.49	1085
1109	667.1	3.51	1089

1046 TP-FP-31 (0.1-0.4) soil ziploc
1049 TP-FP-31 (1-1.8) " "
1052 TP-FP-31 (2-2.75) " "
1055 TP-FP-31 (3-3.5) " "
1057 TP-FP-3 (4.5-5) " "
1105 TP-FP-31 (6.5-7) soil, 2 buck, zip
1110 TP-FP-31 (7-7.5) soil ziploc
1128 TP-FP-31 (9-9.5) " "

1140 install peizometer

8/7/12

1118 Water sample @ 9'

	ORP	pH	SC
1121	572.4	4.66	520
1123	580.6	4.53	536
1125	587.0	4.49	538
1132	602.6	4.48	546
1143	619.1	4.32	560
1146	625.4	4.13	564
1149	628.0	4.04	567
1153	631.6	3.97	572
1159	636.9	3.96	579

1230 Dig TP-FP-33

1249 TP-FP-33 (0-0.5) soil zip
1251 TP-FP-33 (2.3-2.6) " "
1254 TP-FP-33 (3.5-4) " "
1300 TP-FP-33 (5.9-6.2) " "
1315 TP-FP-33 (8-8.5) " "

1332 Install Peizo + backfill

8/7/12

1256 water sample @ 5.3 (TP-FP-33)

1259	525.6	5.78	353
1302	503.5	6.16	383
1304	497.8	6.31	395
1306	495.2	6.43	403
1310	494.6	6.53	413
1312	495.6	6.55	416
1318	499.2	6.51	420

1335 dig TP-FP-32

1350 water sample @ 4'

1351	600.1	6.10	364
1353	606.6	5.23	361
1356	606.6	5.13	362
1419	563.2	5.21	380
1422	566.1	5.25	384
1426	564.5	5.25	384

1400 TP-FP-32 (0-.4) soil bag

1404 TP-FP-32 (0.7-1.2) " "

1600 TP-FP-32A " "

dup 0.7-1.2

1410 TP-FP-32 (1.3-1.4) soil bag

1417 TP-FP-32 (1.4-1.5) " "

1415 TP-FP-32 (2.4-2.7) " "

1435 TP-FP-32 (7-7.5) " "

1501 TP-FP-32 (10.5-11) soil bag

1450 TP-FP-32 (8.5-9) soil ziploc

1450 Install peizo + backfill

1440 Water sample @ 9' (TP-FP-32)

	ORP	pH	SC
1442	583.8	5.07	759
1445	583.8	5.00	796
1451	585.2	4.95	846
1456	584.4	4.94	866
1457	584.2	4.94	868
1501	583.3	4.94	879
1503	583.7	4.94	885
1507	584.5	4.93	894
1508	584.9	4.93	895
1511	586.0	4.92	901

1530 Move to TP-FP-34

1550 start digging

1612 TP-FP-34 (0-.6) soil ziploc

1614 TP-FP-34 (1.2-1.7) " "

1618 TP-FP-34 (3.5-4) " "

1631 TP-FP-34 (7.5-8) " "

1633 TP-FP-34 (8.5-9) " "

1635 TP-FP-34 (6-6.3) " "

1656 TP-FP-34 (10-10.5) " "

1710 TP-FP-34 (12.5-13) " "

Rite in the Rain

8/7/12

GPS TP-FP-34

12T 0396197, ~~5210~~ 5210160

1720 Install peizo + backfill

1800 Leave site

8/7/12

8/8/12

800 PTS onsite M Browne, L Dunning

900 Start on TP-FP-35

pH calibration (meter)

7.02 → 7.00

4.00 → 4.01

10.08 → 10.01 slp = 96.0

ORP = 426.0 → 426.0 @ 17°C

SC = 1413 → 1413

919 Water sample @

	ORP	pH	SC
919	719.3	5.22	1581
941	679.3	4.72	1659
947	680.0	4.71	161.7
949	679.1	4.71	160.7
950	679.0	4.70	159.7
951	678.4	4.71	159.6
953	677.0	4.71	159.2
955	675.9	4.72	158.6

955	TP-FP-35 (.5-.7)	soil	ziploc
1000	TP-FP-35 (2.3-2.8)	"	"
1005	TP-FP-35 (~~5.5-6~~ 6-6.4)	"	"
1003	TP-FP-35 (4-4.3)	"	"
1600	TP-FP-35A (dup 4-4.3)	"	"

Rite in the Rain

8/8/12

1010 TP-FP-35 (8.5-9) soil ziploc
1030 TP-FP-35A (8.5-8.9) " "
1035 TP-FP-35 (9-9.5) " "
1050 TP-FP-35 (12.5-13) " "
1100 Install ~~track~~ peizo + back fill
1050 water sample @ 12.5
1101 624.7 4.30 863
1108 652.8 4.28 892
1117 667.8 4.23 919
1126 669.3 4.20 951
1129 673.2 4.19 963
1134 677.7 4.15 978

1140 Move to TP-FP-40
GPS:
moved ≈ 300' downstream @
Shelly's request + approved
by Don (Spectrum Engineer)

TP-FP-~~45~~ 40 12T 0396023, 5210371

1210 Start dig TP-FP-40
GPS 12T 0396003, 5210306

8/8/12

1236 TP-FP-40 (0-.5) soil ziploc
1238 TP-FP-40 (1.5-2) " "
1241 TP-FP-40 (3.5-3.6) " "
1245 TP-FP-40 (6-6.2) " "
1250 TP-FP-40 (6.5-6.8) " "
1300 TP-FP-40 (8.5-9) " "
1600 TP-FP-40 A " "
(dup 8.5-9)
1320 TP-FP-40 (14.5-15) " "
1325 water sample @ 15'
1327 534.5 6.24 344
1329 528.9 6.23 343
1331 524.2 6.29 345
1334 520.4 6.32 354
1337 520.4 6.29 360
1340 518.3 6.23 362
1342 516.5 6.21 365
1346 515.1 6.18 371
1348 514.6 6.17 373
1351 514.4 6.16 374
1330 TP-FP-40 (13-13.5) soil ziploc
1335 install peizo + backfill
1400 Start on TP-FP-41
GPS: 12T 0396000, 5210327

Rite in the Rain

8/8/12

1440	TP-FP-41 (4-4.5)	soil	ziplock
1444	TP-FP-41 (.5-8)	"	"
1445	TP-FP-41 (2-2.5)	"	"
1448	TP-FP-41 (3-7)	"	"
1500	TP-FP-41 (5.5-6)	"	"
1510	TP-FP-41 (8.5-9)	"	"
1531	TP-FP-41 (10.5-11)	"	"

1540 Install peizo + backfill

1610	Dig TP-FP-42	soil	bag
1625	TP-FP-42 (.5-1)	"	"
1628	TP-FP-42A (.5-8)	"	"
1632	TP-FP-42 (2-2.6)	"	"
1635	TP-FP-42 (4.8-5.2)	"	"
1640	TP-FP-42 (4.2-4.8)	"	"
1655	TP-FP-42 (6-6.1)	"	"
1657	TP-FP-42 (6.6-7)	"	"
1710	TP-FP-42 (10-10.5)	"	"
1720	TP-FP-42 (12-12.5)	"	"
1735	TP-FP-42 (15.5-16)	"	"

1740 Install peizo + backfill

TP-FP-42 GPS: 12T 0391604, 5210349

8/8/12

1738 Water @ 16'

1740	493.1	6.92	357
1744	505.5	6.26	360
1748	503.5	6.18	362
1750	503.8	6.16	364
1752	504.6	6.19	362
1754	503.5	6.20	363
1755	503.1	6.21	363
1756	502.8	6.22	363
1757	502.6	6.22	364
1758	502.6	6.21	365

1820 Leave site

LAO

Rite in the Rain

8/9/12

810 PTS onsite M Browne, L Dwensky
Meter Calibration
pH 7.02 → 7.00
4.01 → 4.01
10.07 → 10.01 SP = 94.9
ORP = 424.0 → 424.0 @ 19.6°
SC = 1413 → 1413
840 Start digging TP-FP-43
GPS: 12T 0396018, 5210356

905 TP-FP-43 (1.2-1.4) soil bag
910 TP-FP-43 (4-4.3) " "
922 TP-FP-43 (6-6.5) " "
924 TP-FP-43 (4-4.5) " 2 buck
935 TP-FP-43 (9-9.5) " bag
943 TP-FP-43 (11-11.5) " "
948 Install peizo + backfill
950 Shelly (DEQ) onsite
1005 Start dig TP-FP-44
1034 TP-FP-44 (0-.7) soil bag
~~1039~~ 1035 TP-FP-44A (dup 0-.7) " "
1039 TP-FP-44 (.7-1) " "
1041 TP-FP-44 (2-2.5) " "
1045 TP-FP-44 (4-4.5) " "

8/9/12
935 Water sample @ 9.5' TP-FP-43

936	639.0	7.13	359
938	641.0	6.83	359
940	642.0	6.73	359
945	639.8	6.66	353
949	637.5	6.66	353
952	637.0	6.65	351
957	636.5	6.65	351
958	636.4	6.66	350

TP-FP-44 (cont.)
1110 TP-FP-44A (2.5-3) soil bag
1115 TP-FP-44 (6-6.5) " "
1133 TP-FP-44 (13) " "
1135 Water sample @ 13'

1138	646.2	6.93	426
1140	644.8	6.85	429
1141	642.7	6.81	431
1142	641.1	6.78	431
1145	638.8	6.70	433
1149	635.6	6.65	435
1151	638.5	6.62	436
1230	693.0	6.34	459

Rite in the Rain

8/9/12

1120 TP-FP-44A (8-8.5) soil bag
1125 TP-FP-44 (11.5-12) " "
1145 install peizo + back fill

1230 Tara + Erin onsite (Pioneer H+S)
1245 Dig TP-FP-45
GPS:
1250 TP-FP-45 (.5-1) soil bag
1605 TP-FP-45A (.5-1 Dup) " "
1254 TP-FP-45 (1.6-1.8) " "
1257 TP-FP-45 (1.8-2) " "
1300 TP-FP-45 (2-2.3) " "
1304 TP-FP-45 (3.5-4) " "
1305 TP-FP-45 (1.2-1.6) " "
1325 TP-FP-45 (7.5-8) " "
1350 TP-FP-45 (10.5-11) " "
1408 Install peizo + back fill
1400 TP-FP-45 (13.5-4) soil bag

1405 water sample @ 13'

1408	521.8	6.47	356
1414	524.9	6.38	361
1420	526.1	6.39	360
1422	526.9	6.39	359
1424	528.5	6.39	358

1500 Leave site

Rite in the Rain

Project and Name: Mike Horse

Results Needed by:

Location: Lincoln MT

Project Manager: Pat Redmond

Contact Phone #:

Date Sampled	Date Received	Photo	Borehole # or Location	Depth	Sample Type	Moisture Content	Gradation	Hydrometer	Atterberg Limits	Proctor (Method)	CBR	Consol.	Unconfined Compr.	Corrosivity					Sample #
8/15	8/16		TP-Bulk-05	5-6			/												13042 *
↓	↓		TP-FP-48	1-2			/												13043 *

Comments:

* Run grad. on entire sample

8/13/12

9:00 PTS onsite: M Burns, L Dunsing
pH meter calibration
pH 4.00 → 4.01
10.01 → 10.01
7.02 → 7.00 slp = 97.0
SC = 1413 → 1413
ORP 426.1 → 427.0 @ 16.8°
935 Dig TP-FP-45A
GPS = 12T 0396044, 5210394

958 TP-FP-45A (5-5.6) soil bag
1002 TP-FP-45A (3-3.5) " "
1005 TP-FP-45A (8-1.2) " "
1015 TP-FP-45A (9-9.5) " "
1019 TP-FP-45A (5-6A) " "
1030 TP-FP-45A (11-11.5) " "
1034 TP-FP-45A (13.5-14) " "
1040 Install peizo + backfill
1100 Move to TP-FP-39
1130 Dig TP-FP-39
GPS: 12T 0396198, 5210273
1200 TP-FP-39 (9-1.6) soil bag
1000 TP-FP-39 A " "
(dup 9-1.6)

8/13/12

1206 TP-FP-39 (3.5-4.2) soil bag
1212 TP-FP-39 (6-6.5A) " "
1227 TP-FP-~~95~~ 39 (9.5-10A) " "
+2 buckets
1245 TP-FP-39 (12.5-13) soil bag
1255 install peizo + backfill

1350 Dig TP-FP-35
1350 TP-FP-36 (1-1.5) soil bag
1356 TP-FP-36 (3.5-4) " "
1400 TP-FP-36 (6.5-7) " "
1446 TP-FP-36 (9.5-10) " "
1410 Water sample @ 7

1413	4240	6.23	326
1414	604.0	5.99	334
1416	6202	5.93	335
1418	5986	5.88	333
1420	5846	5.88	332
1429	5553	5.93	332
1431	5519	5.93	333
1434	5461	5.93	334
1437	5389	5.93	336

1440 TP-FP-36 (10-10.5) soil bag

Rite in the Rain

8/13/12

1440 water sample @ 13.5'

	ORP	pH	SC
1450	506.4	6.56	344
1454	494.4	6.67	340
1456	491.4	6.72	340
1502	489.8	6.72	343

1500 Install peizo + backfill

1540 Leave site

(leave early to get parts for machinery)

8/14/12

900 PTS on site M Browne, L Duensing

meter calibration

pH = 4.00 → 4.01

10.06 → 10.01

7.02 → 7.00 95.1 slp

SC = 1413 → 1413

ORP = 424.3 → 424.0 @ 19.2°

915 Dig TP-FP-37

9495	TP-FP-37 (5-1)	soil	bag
949	TP-FP-37 (2.5-3)	"	"
953	TP-FP-37 (4.5-5)	"	"
1006	TP-FP-37 (7.5-8)	"	"/2 bac
1015	TP-FP-37 (9.5-10)	"	bag
1024	TP-FP-37 (11.5-12)	"	"
1034	TP-FP-37 (14.5-15)	"	"

1040 Install peizo + backfill

1055 Dig TP-FP-38

1130	TP-FP-38A (2.5-3)	soil	bag
1143	TP-FP-38 (5-5.4)	"	"
[illegible]	TP-FP-38A (5-1)	"	"
[illegible]	TP-FP-38A (Dup 0.5-1)	"	"

8/14/12

1126 TP-FP-38A (1.-1.5) soil bag
1117 TP-FP-38B (.5-1) " "
1138 TP-FP-38 (2-2.5) " "
1134 TP-FP-38A (4.5-5) " "
1153 TP-FP-38 (7.5-8) " "
1215 TP-FP-38 (9.5-10) " "
1225 TP-FP-38 (11.5-12) " "
1255 TP-FP-38 (14.5-15) " "
1300 Install peizo + backfill

1330 dig TP-Bulk-04
1336 water sample @ 2.5'

	ORP	pH	SC
1339	622.9	6.60	396
1341	629.6	6.17	399
1343	626.3	6.08	399
1345	612.7	6.04	400
1347	606.0	6.04	400
1352	581.2	6.09	401
1355	571.7	6.11	403
1412	516.8	6.21	404
1417	511.2	6.21	404
1419	509.0	6.22	405

1400 ~~Collect bulk sample (8 buckets)~~
~~TP-Bulk-04 ( )~~ (10)

8/14/12

1402 TP-Bulk-04 (0-3.5) soil bag
1404 TP-Bulk-04 (3.5-3.9) " "
1406 TP-Bulk-04 (3.9-4.5) " "
1408 TP-Bulk-04 (4.5-4.7) " "
1415 TP-Bulk-04 (2.5-3.5) soil bucket
1430 Water sample @ 4'

1431	492.7	6.47	374
1435	480.4	6.47	379
1438	478.6	6.45	379
~~1424~~ 1424	475.4	6.41	378
1446	472.6	6.40	380
1448	471.4	6.41	381

GPS: 12T 0396218, 5210208
(TP-Bulk-04)
1450 Install peizo + backfill
Water (cont)

1455	465.4	6.41	386
1458	463.3	6.42	387
1500	461.9	6.44	387
1514	453.1	6.47	389

1510 dig TP-Bulk-4A
GPS: 12T 0396224 5210218
1523: TP-Bulk-4A (7-7.5) soil & buck.
1550 backfill TP-Bulk-4A

Rite in the Rain

8/14/12

1640 Dig TP-FP-49

GPS: 12T 0395742, 5210590

1655 TP-FP-49(0.7-1.2) soil bag

1700 ~~1800~~ TP-FP-49(1.7-2.4) " "

*1800 TP-FP-49A " "

1702 TP-FP-49(3.3-4) " "

1704 TP-FP-49A(2.8-3.2) " "

*dup TP-FP-49(0.7-1.2) " "

1715 water sample @ 6.5'

1716	550.5	6.77	296.4
1718	550.3	6.50	300
1720	549.6	6.32	300
1721	548.7	6.26	300
1722	546.8	6.24	300
1723	544.1	6.20	299
1724	542.1	6.19	299
1725	540.2	6.18	300

1718 TP-FP-49(5-5.5) soil bag

1745 leave site

JAD

8/15/12

800 PTS on site: MBrowne, L Duenzing

830 Start dig TP-FP-49

meter calibration

pH = 4.00 → 4.01

7.04 → 7.00

10.14 → 10.01 956 slp

ORP = 429.0 → 429.0 @ 13°

SC pH = 1413 → 1413

910 water sample @ 11'

916	705.8	6.60	415
918	739.1	6.16	440
921	752.1	5.98	442
925	735.6	5.94	419
938	716.8	5.93	425
939	715.3	5.94	425
940	714.1	5.94	425

930 Install peizo + backfill

JAD

8/15/12

835 TP-FP-49 (6.5-7) soil bag
850 TP-FP-49 (8.5-9) " "

9 840 start TP-FP-50 — GPS 12T 0395768 5210635

952 TP-FP-50 (1.6-2.2) soil bag
950 TP-FP-50 (.8-1.2) soil bag
1600 TP-FP-50A " "
*Dup 1.6-2.2
955 TP-FP-50 (3.5-4) soil bag
1000 TP-FP-50 (5.5-6) " "

1012 Water sample @ 6'

	ORP	pH	SC
1012	560.9	6.77	407
1015	531.7	6.77	407
1018	528.6	6.77	408
1021	513.5	6.77	407
1023	503.0	6.77	408

1018 TP-FP-50 (7.5-8) soil bag
1027 TP-FP-50 (9-10) " "
1040 TP-FP-50 (11.5-12) " "
1040 water sample @ 12'

1041	468.7	6.77	376
1043	478.1	6.77	376
1047	483.5	6.77	377
1049	488.1	6.77	377

8/15/12

	ORP	pH	SC
1052	491.9	7.25	377
1054	494.0	6.69	378
1056	495.1	6.45	378
1059	497.5	6.25	377
1102	499.5	6.08	378
1104	501.2	5.97	378
1106	502.5	5.89	378

1056 Install peizo + backfill

1115 Dig TP-FP ~~50A~~ 51
GPS 12T 0395777 5210658

~~12~~ 1148 water @ 5' — pH meter not working right

1151	545.6	6.77	189.4
1153	574.4	6.77	188.8
1158	583.4	6.77	188.0
1202	585.9	6.77	187.6
1215	590.8	7.31	187.4
1225	592.9	5.01	187.2
1232	594.7	4.77	187.3

1240 Water sample @ 12'

1241	514.8	6.77	190.4
1244	533.6	—*	190.6

*pH meter not working

Rite in the Rain

8/15/12 [illegible]

1148 TP-FP-51A (4.5-5) soil bag
1140 TP-FP-51A (2.5-3) " "
1135 TP-FP-51 (5.5-6) " "
1132 TP-FP-51 (3.5-4) " "
1129 TP-FP-51 (1.5-2) " "
1217 TP-FP-51 (10-10.5) " "
1203 TP-FP-51 (7.5-8) " "
1154 TP-FP-51A (6-6.2) " "
1200 TP-FP-51 (11-11.5) " "
1240 TP-FP-51 (12-12.5) " "

1400 Dig tp-fp-50 A
GPS: 12T 0395771, 5210655
1414 TP-FP-50A (0.5-1) soil bag
1417 TP-FP-50A (2.3-2.5) soil bag
1419 TP-FP-50A (3.5-4) " "
1800 TP-FP-50A " "
(Dup 3.5-4)
1438 TP-FP-50A (1-1.5A) " "
1446 TP-FP-50A (5-5.5) " "
1440 TP-FP-50A (2.2-2.5A) " "
1500 TP-FP-50A (8.5-9) " "

8/15/12 use backup pH meter

1440 Water @ 5.5'

	ORP	SC	pH
1445	339.4	209.7	5.98
1447	399.7	221.4	5.13
1449	432.9	224.4	4.99
1451	450.0	228.6	4.95
1457	474.8	242.7	4.93
1502	483.6	248.2	4.91

1500 Backfill TP-FP-50A

1520 Dig TP-FP-48 GPS: 12T 0395749 5210562
1537 TP-FP-48 (1.5-2) soil bag
1536 TP-FP-48 (0-.4) " "
1540 TP-FP-48 (2.5-3) " "
1543 TP-FP-48 (3-3.5) " "
1543 TP-FP-48 (1-1.5) " "
TP-FP-48 (1-2) " 2 buck
1605 Water @ 4

1610	474.6	329	5.66
1612	475.3	311	5.62
1614	475.6	301	5.62
1616	475.8	299	5.64
1620	477.5	288.6	5.64
1625	479.4	290.7	5.64

Rite in the Rain

8/15/12

1610 TP-FP-48 (6-6.5) soil bag
1616 TP-FP-48 (8-8.5) " "
1630 TP-FP-48 (10-10.5) " "
1642 TP-FP-48 (13.5-14) " "
1650 Install peizo + backfill
1648 Water sample @ 13

1651	452.8	376	641
1653	447.0	378	641
1656	443.5	377	642
1659	442.2	379	644
1702	441.8	375	645
1704	441.7	378	646
1706	441.8	380	646
1708	442.1	380	647
1717	446.8	374	648
1720	445.0	374	648
1739	439.2	373	648

1710 Dig TP-Bulk-05
GPS: 12T 0395726, 5210563
1730 TP-Bulk-05 (5-6) soil & back
1735 backfill
1800 Leave site

?

Rite in the Rain

~~2/27/1~~ 8/27/12

1145 PTS arrive onsite
L Duensing, M Browne
mobe to TP-FP-55
1215 Dig TP-FP-55
Meter calibration
pH 7.00 → 7.00
10.01 → 10.01
4.01 → 4.01 slp = 95.3
SC 1413 → 1413
ORP 417.6 → 418.0 @ 27°

1304 TP-FP-52 (1-1.5) bag soil
pH meter won't turn on
1314 water sample at 3'

1317	501.4 (ORP)	191.3 (SC)	—
1319	482.2	184.6	—
1322	479.3	184.6	—
1327	413.3	185.9	6.75 pH*
1330	403.6	185.4	5.26
1332	404.9	185.6	5.24

* calibrate backup pH meter
6.96 → 7.00
10.00 → 10.01
3.79 → 4.01

GPS: 12T 0395143 5210549

Rite in the Rain

8/2[illegible]/12

1315 TP-FP-52 (2.7-3.0) bag soil
1330 TP-FP-52 (5-5.5) " "
1340 TP-FP-52 (7.5-8) " "
1355 TP-FP-52 (9.5-10) " "
1359 Water sample @ 12'
1401 446.6 273.8 4.68 pH
1403 445.6 274.6 4.35
1405 444.9 272.9 4.33
1408 444.6 271.8 4.33
1410 444.4 270.5 4.33
1408 Install Peizo and backfill
1420 Walk next line of test pits
1515 Dig TP-FP-53
GPS: 12T 0398745, 5210565
1528 TP-FP-53 (3-3.6) bag soil
1528 water sample @ 4'
1533 3.95 pH 504.8 ORP 352 SC
1534 3.95 503.8 352
1536 3.95 503.3 351
1539 3.95 504.1 350
1541 3.95 504.8 349
1544 3.95 505.2 349
1546 3.95 505.6 348

8/27/12

1530 TP-FP-53 (1.8-2.4) soil bag
1550 TP-FP-53 (5-5.5) " "
1600 TP-FP-53 (7.5-8) " "
1610 TP-FP-53 (9.5-10) " "
1620 TP-FP-53 (12-12.5) " "
1618 water @ 12'
1619 4.65 pH 425.1 ORP 302 SC
1623 4.66 403.5 300
1625 4.64 401.3 299
1627 4.64 400.3 297
1631 4.64 400.4 295
1633 4.64 400.2 293.9
1635 4.64 400.1 292.8
1625 Install Peizo + backfill

1640 Dig TP-FP-54
1655 water sample @ 4'
1657 2.94 pH 644.3 ORP 1283 SC
1700 2.94 645.5 1290
1702 2.94 646.0 1284
1704 2.92 646.6 1280
1707 2.92 646.9 1275

solvent odor observed in test pit

Rite in the Rain

8/27/12

1648 TP FP-54(0.6-1) soil bag
1900 TP FP-54(A) " "
dup (0.6-1)
1650 TP FP-54(12-14) soil bag
1654 TP FP-54 (18-24) " "
1658 TP FP-54 (34-38) " "
GPS: 12T 0375457 5210569
1730 leave site

SAB
8/27/12

8/28/12
800 PTS onsite: L Duensing M Browne
meter calibration
pH 3.93 → 4.01
7.11 → 7.00
9.99 → 10.01
SC 1413 → 1413
ORP 427.5 → 428.0 @ 14.5°
845 Start on TP-FP-54
850 TP-FP-54(5-5.5) bag soil
850 " " " " 2 pack soil
905 TP-FP-54(7-7.5) bag soil
915 TP-FP-54 (9-9.5) bag soil
914 water sample @ 10'

	pH	ORP	SC
914	4.88	520.5	511
917	4.86	599.9	505
919	4.86	597.2	499
921	4.88	597.7	496
923	4.88	596.3	510
925	4.88	596.5	507
927	4.88	596.6	504
929	4.88	597.5	501

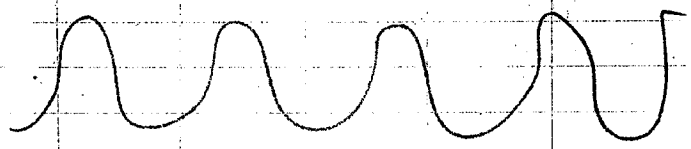
925 Install piezo + backfill

Rite in the Rain

8/28 GPS: 12T 0395411
5210595

940 Dig TP-FP-55
948 Water sample @ 3'

949	6.15 pH	410.1 ORP	177.6 SC
950	5.93	400.5	178.4
952	5.89	392.8	178.5
954	5.87	386.2	178.1
956	5.87	383.7	177.7
958	5.87	381.1	177.1
1000	5.87	379.7	177.0
1002	5.90	380.8	176.5
1004	5.90	378.0	176.1
1006	5.87	375.1	176.1
1008	5.87	373.1	176.4
1018	5.88	371.6	175.2



1015 TP-FP-55 (.6-1) bag soil
1014 TP-FP-55 (2-2.3) " "
1012 TP-FP-55 (2.5-3) " "
1010 TP-FP-55 (3.8-4.2) " " *
1028 TP-FP-55 (5-5.5) " " *
1035 Install peizo + backfill
hole caving in extremely

8/28/12

1035 Water sample @ 5'

1036	5.25 pH	414.9 ORP	263.7 SC
1038	5.14	418.9	263.8
1040	5.14	417.4	263.6
1043	5.12	416.5	264.1
1045	5.12	416.2	263.5
1047	5.12	416.0	263.8
1049	5.10	415.2	264.7
1052	5.08	414.0	266.4
1054	5.08	413.4	267.6

1045 Install peizo + backfill
1110 Mobe to next test pit
1130 Start digging TP-FP-60

1205	TP-FP-60 (3.6-4)	bag	soil
1209	TP-FP-60 (2-2.2)	"	"
1210	TP-FP-60 (2.2-.5)	"	"
1212	TP-FP-60 (4.5-5)	2 buck	soil
1217	TP-FP-60 (5.8-6)	bag	soil
1225	TP-FP-60 (8-8.5)	"	"
1234	TP-FP-60 (9.5-10)	"	"
1240	TP-FP-60 (8')	"	"

1245 Install peizo + backfill
GPS: 12T 0395274, 5210612

Rite in the Rain

8/1[illegible]

1218 Water @ 6'

1220	5.52 pH	496.6 ORP	66.8 SC
1222	5.23	516.1	68.7
1226	5.21	524.2	69.6
1228	5.21	526.8	70.1
1230	5.19	529.3	69.0
1234	5.17	533.8	68.8
1236	5.16	535.6	~~[illegible]~~ 68.6
1241	5.13	539.7	69.5
1243	5.11	541.1	69.7
1246	5.10	544.2	69.2
1249	5.08	545.9	69.5
1251	5.06	548.0	69.6

1300 Dig TP.FP.59
GPS 12T 0395265, 5210548

1342 TP.FP.60 (.2-.4) bag soil
1340 TP.FP.60 (1.5-1.8) " "
1337 TP.FP.60 (1.8-2) " "
1336 TP.FP.60 (2.5-3) " "
1333 TP.FP.60 (3.5-4) " "

WATER SAMPLE @ 6'

	pH	ORP	SC
13:56	6.16	526.7	230.1
13:58	6.22	524.4	233.9
1400	6.24	521.2	234.1
140[illegible]	6.24	518.3	235.6

8/2[illegible]7

water cont.

1404	6.22	515.7	234.6
1406	6.22	514.8	234.1
1408	6.23	512.2	234.0
1413	6.23	506.1	232.7
1415	6.23	503.7	231.9
1418	6.22	499.9	231.6
1421	6.23	497.7	231.6

1357 TP.FP.59 (6.5-7) soil bag
1409 TP.FP.59 (8.5-9) " "

water sample @ 12'

	pH	ORP	SC
1423	5.36	453.8	212.3
1424	5.32	422.0	212.2
1426	5.30	416.6	213.1
1428	5.28	414.7	212.3
1430	5.28	411.2	211.1
1432	5.26	408.3	210.0
1434	5.26	408.8	208.8
1437	5.26	404.7	207.7

1440 TP.FP.59 (12-12.5) soil bag
1430 Install piezo & backfill

1455 TP.FP.58 - start digging
GPS: 12T 0395259, 5210537

Rite in the Rain

8/28/12

1458 Water sample @ 4'

	pH	ORP	SC
1459	6.55	474.8	246.2
1501	6.37	454.1	253.4
1503	6.33	442.5	254.4
1507	6.33	434.5	253.7
1509	6.33	433.5	253.5
1511	6.33	433.1	252.9
1513	6.33	433.2	252.5
1515	6.33	434.1	252.3
1531	6.31	441.6	250.8

1518 TP FP 58 (.1-3) bag soil
1900 TP FP 58 (A) " "
dup (.1-.3)
1526 TP FP 58 (1.3-1.6) bag soil
1523 TP FP 58 (2.3-2.8) " "
1520 TP FP 58 (3.6-4) " "
1535 TP FP 58 (4.1-4.7) " "
1905 TP FP 58 B " "
dup 4.1-4.7
1537 TP FP 58 (6-6.5) bag soil
1547 TP FP 58 (8.5-9) " "
1604 TP FP 58 (9.5-10) " "
1605 Install peizo + backfill

8/28/12

1557 Water sample @ 10'

	pH	ORP	SC
1559	6.07	341.2	216.1
1601	6.07	322.6	216.5
1605	6.07	305.8	214.9
1607	6.05	301.6	214.4
1609	6.05	294.5	214.1
1614	6.05	283.4	212.8
1616	6.05	277.5	212.4
1623	6.03	260.0	211.2

1615 TP-Bulk-06 GPS: 12T 0395288 5210536
1624 water sample @ 25

1627	6.54	475.2	257.2
1629	6.56	469.1	256.9
1631	6.58	481.6	257.4
1633	6.58	474.1	256.7
1635	6.58	468.4	256.1
1637	6.50	467.1	255.6
1639	6.54	460.6	253.3
1645	6.54	459.2	252.9

1646 backfill

1640 TP-Bulk-06 (3-4) & buck soils

1735 leave site

Rite in the Rain

8/29/12

840 PTS onsite: M Browne, L Dunsing
Mobe to TP MS 05
Meter calibration
ORP 4259 → 426.0 @ 17
SC 1413 → 1413
pH 4.25 → 4.01
7.07 → 7.00
10.16 → 10.01

930 Water sample @ 2'

	pH	ORP	SC
932	7.24	652.0	133.7
934	6.38	656.8	134.5
936	6.16	657.0	137.2
938	6.14	649.0	136.1
942	6.12	640.6	136.4
946	6.12	630.0	136.2
949	6.11	625.5	136.2
954	6.16	611.3	137.0

TP MS 05 GPS 12T 0395053, 5210732

943 TP MS 05 (1.2-1.5) bag soil
1600 TP MS 05 (A) " "
dup 1.2-1.5
948 TP MS 05 (1.8-2) bag soil
953 TP MS 05 (3.3-3.5) " "
~~1000 TP MS 05 (4.5-5)~~ " "

8/29/12

1011 TP MS 05 (4-4.5) bag soil
1018 TP MS 05 (6-6.5) " "
1028 TP MS 05 (9-9.5) " "
1033 water @ 9.5'

	pH	ORP	SC
1034	6.21	409.0	135.5
1035	6.18	389.1	135.7
1037	6.17	372.5	135.7
1039	6.17	364.7	135.5
1044	6.17	352.8	135.0
1046	6.17	349.1	134.9
1048	6.17	346.1	134.9
~~1050~~ 1052	6.17	339.7	134.5
1054	6.17	336.7	134.0
1056			

1035 Install perzo + backfill
1048 Dig TP Bulk 07
right next to TP MS 05
1053 TP Bulk 07 (0.5-1) 1 bucket soil
1057 TP Bulk 07 (2-3) 8 buckets soil
1115 Backfill
1135 Move to TP MS 06
GPS: 12T 0395058, 5210748

Rite in the Rain

8/29/12

1137 TP-MS-06 (0.5-1) bag soil
1140 TP-MS-06 (1-1.5) " "
1145 TP-MS-06 (1.6-2.3 A) " "
1152 Water sample @ 2'

	pH	ORP	SC
1153	5.80	420.9	104.6
1159	5.68	453.9	103.7
1207	5.67	466.2	103.5
1212	5.67	472.1	103.5

1155 TP-MS-06 (2.5-2.7) bag soil
1205 TP-MS-06 (4.5-5) " "
1212 Water sample @ 6'

	pH	ORP	SC
1214	5.71	457.3	121.9
1216	5.78	441.3	122.4
1218	5.70	434.2	124.0
1220	5.68	430.5	124.9
1222	5.68	427.4	125.8
1226	5.66	420.1	126.5
1228	5.64	417.5	126.0
1230	5.64	409.6	125.9
1232	5.64	403.7	126.1
1234	5.64	395.4	126.1

8/29/12

1220 Install peizo + backfill
1430 Site cleanup + peizometer additions as needed
1520 Leave site

TP-FP-31
stickup = 5.0
TP-FP-33
stickup = 5.2

Rite in the Rain

TC1 BS@2 : HI = 5.25 ϕ = 5.56'

STORE 3001 & 3002	= 31 ft
3003 & 3004	= 25.6'
3005 & 3006	= 34.6'
3007 & 3008	= 34.3'
3009 & 3010	= 51
3011 & 3012	= 45.5'

TC1	47°00'46.758"N	112°27'06.246"W
TC2	47°00'44.028"N	112°27'04.332"W
TC3	47°00'40.914"N	112°27'01.194"W
TC4	47°00'39.726"N	112°26'58.872"W
TC5	47°00'38.874"N	112°26'55.332"W
TC6	47°00'38.292"N	112°26'48.594"W

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$

$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin. } \frac{1}{2} D}$

$\text{Sin. } \frac{1}{2} D = \frac{50}{R}$

$\text{Sin. } \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$

$R = T \cot. \frac{1}{2} I$

$R = \frac{50}{\text{Sin. } \frac{1}{2} D}$

$E = R \text{ ex. sec } \frac{1}{2} I$

$E = T \tan \frac{1}{4} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{I}{D}$

$\text{Tan. def.} = \frac{1}{2} \text{ chord def.}$

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

Right Angle Triangles. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$; $100 - 3.125 = 96.875$ = Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

Leveling. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574 d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3} d^2$. The combined correction is negative.

Probable Error. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean = $\pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1′	.0167	11′	.1833	21′	.3500	31′	.5167	41′	.6833	51′	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	⅛	3-16	¼	5-16	⅜	½	⅝	¾	⅞
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

7/23/12 UTM UPS NAD83

D&Q - Shelly

PTS - L. Duensing, M Browne, Pat Redmond

1130 PTS arrived to perform sampling + conduct safety meeting

1400 Mobilize to TP-FP-01

1500 collect TP-FP-01 bulk sample

GPS = 12T 0397052, 5209275

1515 closed TP-FP-01 (0-2)

1535 done

1540 move to TP-FP-02

GPS = 12T 0397061, 5209319

1609 collect bulk TP-FP-02 (85-95)

1620 collect TP-FP-02 (3-8.5')

1800 leave site

7/24/12

830 PTS arrive onsite - L Duensing
M Browne P Redmond

meter calibration
pH 7.02 → 7.00
10.07 → 10.01
4.00 → 4.01
RMV 426.5 → 427.0 @ 16°
ORP 141B → 1413

915 start digging TP-FP-06
GPS: 12T 0397063, 5209330
940 - collect sample (Soil)

* @ gw level	water sample		10:18	(7.5')
	597 µs/cm		6.58 pH	1021
	485.3	RMV	6.50	1022
	479.7	1023	6.46	1023
	476.7	1024	6.42	1024
	~~6.7~~ 474.7	1024	6.41	1025
	471.2	1026	6.40	1026
	464.3	1026	6.36	1028
	457.2	1030	6.36	1030
	443.4		6.36	1033

7/24/12

water sample 1044 (≈1.5' below gw level)

6.94	438.8	576	1044
6.45	436.9	580	1046
6.38	437.9	580	1049
6.35	439.6	580	1052

1052 install peizo in TP-FP-03

1057 measure stream water

RMV	372.2	7.60	229.4 µs	1057
	366.2	7.72	229.4 µs	1059
	356.8	7.86	229.4	1101
	352.0	7.94	"	1102
	350.1	7.98	"	1103
	348.4	8.01	"	1104
	346.0	8.02	"	1105
	341.6	8.09	"	1109
	340.9	8.10	"	1110

1115 - close TP-FP-03
1120 dig TP-FP-04
1127 gw sample

476.7	7.86	608	1127
475.7	7.10	594	1129
471.5	6.87	"	1131

7/24/12

Time	RmV	pH	uS/cm
1134	464.0	6.70	594
1144	449.4	6.56	"

GPS = 12T 0397078, 5209332

1146 collect bulk sample for gradation

1240 collect soil sample

collect o water @ 7.5'

1241	403.0	6.63	581
1243	398.7	6.68	581
1245	397.3	6.70	"
1246	397.0	6.70	"
1247	396.7	6.70	"

1250 Install peizo

1320 dig TP-FP-05

1333 collect gw sample

1334	401.0	7.23	701
1335	405.0	6.62	701
1336	404.4	6.31	"
1337	401.0	6.06	"
1339	397.5	5.94	"
1346	387.1	5.85	"

7/24/12

TP-FP-05 GPS

12T 0397089, 5209329

TP-FP-05(1-3)	1340
Dup 1	1600
↳ TP-FP-05(1-3)	
~~(4-5.5)~~ (Dup)	~~940~~
TP-FP-03(9-9.5)	1020
TP-FP-03 (11.5-12.5)	1048
TP-FP-03 (7.6-8.6)	940
TP-FP-03 (6-7)	940
TP-FP-03 (2-3.5)	940
TP-FP-04 (3-4)	1155
TP-FP-04 (7-8)	1220
TP-FP-04 (9-10)	1240
TP-FP-04 (1.5-2)	1140
TP-FP-04 (5.5-6.5)	1208
TP-FP-03 (4-5.5)	940
TP-FP-05 (3.8-4.8)	1358
TP-FP-05 (1-3)	1345
TP-FP-05 (6-7)	1407
TP-FP-05 (7.5-8)	1422
TP-FP-05 (8.5-9.5)	1430

7/24/12

1432 Water sample (8.5')

1433	476.3	5.75	683
1434	471.2	531	"
1436	469.9	5.23	"
438	468.2	5.20	"
441	467.4	5.19	"
442	467.5	518	"
~~install pd~~ 444	467.5	5.17	"
145	467.5	5.17	"

1435 install Perzo

1450 dig TP-FP-06

TP-FP-06 (1.3-2) 1506

TP-FP-06 (4.5-5.5) 1520

GPS: 12T 0397104; 5209331

gw sample @ 1530

1533	424.6	6.05	680
1538	396.2	6.11	"
1542 ~~1535~~	386.3	6.17	"
1550	389	6.15	"

TP-FP-06 (7-8) 1550

TP-FP-06 (8.5-9) 1600

7/24/12

1607 gw sample @ 8.5

			uS/cm
1607	345.9	7.19	602
1608	350.6	7.03	602
1609	354.1	6.93	606
1610	357.9	6.83	606
1612	361.4	6.75	606
1613	363.6	6.71	605
1614	364.9	6.68	605
1617	368.7	6.62	605
1619	369.9	6.60	603
1621	371.3	6.59	603
1623	372.6	6.57	603

1630 install perzo

1640 start digging TP-bulk-01

1650 Sample TP-Bulk-01
8 buckets
GPS: 12T 0397093, 5209364

1815 Leave site

7/25/12

PTS: P Redmond, L Duensing
M Browne

830 Arrive on site

Water Meter Calibration

pH: 7.02 → 7.00
4.00 → 4.01
10.08 → 10.01

SIP = 96.0
@ 18.6°

ORP: 424.7
Cond: 1413 → 1413

950 TP-FP-6A - dig
GPS: 12T 0397078, 5209405

10:05 TP-FP-6A (5.5-6.5)
2 buckets
10:10 TP-FP-6A (2-3)
2 buckets
10:40 TP-FP-6A (16-16.5)
2 buckets
10:57 Install peizo
1130 dig TP-FP-6B
GPS: 12T 0397067, 5209458

7/25/12

1150 TP-FP-6B (2.5-3.5)
2 buckets
1220 TP-FP-6B (12-13)
2 buckets
1250 Install Peizo
1330 Start digging TP-FP-07
1337 water sample @ gw level 5'

1339	462.4 mv	5.83 (pH)*	481 us
1340	465.3	5.84	493
1341	468.1	6.07	495
1342	469.1	6.25	497
1343	469.5	6.40	496
1347	466.5	6.82	495
1349	464.2	6.93	492
1352	461.5	6.96	492
1354	460.3	6.96	491
1355	459.8	6.96	490

1344 TP-FP-07 (2.5-3.5) ziploc
1400 TP-FP-07 (5-5.5) ziploc
GPS TP-FP-07: 12T 0397024, 5209500
1411: TP-FP-07 (7-8) ziploc
1430: TP-FP-07 (11-12) ziploc
1440: Install peizo
1450: TP-FP-07 (0.5-1) ziploc (tailing)

* pH probe not working (left cap on probe)

7/25/12

1424 water sample

	ORP Raw	pH	Cond
1446	481.8	8.34	473 uS
1447	482.0	8.06	484
1448	482.3	7.60	486
1449	482.0	7.47	486
1430	481.8	7.38	486
1437	479.6	6.99	474
1444	476.6	6.84	477
1446	474.3	6.79	476
1447	472.8	6.80	474
1448	472.6	6.78	474
1449	472.3	6.79	474
1450	472.8	6.77	473

1453 soil sample TP-FP-07 (0-15) ziploc)

~~1555~~ 1500 install peizo

1530 Start digging TP-FP-08

1540 water sample @ 2'

	ORP	pH	Spec. Cond
1541	424.1	6.64	350
1542	449.4	5.93	354
1550	477.1	4.88	358
1553	477.5	4.84	357
1559	476.0	4.84	356
1555	475.7	4.83	357

*located ≈ 20 yds downstream from waste dump (mine)

7/25/12

1543 soil sample (ziploc) TP-FP-08 (13-2)
1558 " " " TP-FP-08 (3-3.8)
1607 " " " TP-FP-08 (2.4-2.9)
1620 " " " TP-FP-08 (4.5-5)
1625 " " " TP-FP-08 (4-4.3)
1630 " " " TP-FP-08 (6-6.5)

Field gradation (2 buckets)

1630 gw sample @ 6'

	ORP	pH	uS/cm
1632	508.2	5.62	941
1635	486.8	5.74	962
1637	473.9	5.77	964
1640	461.7	5.78	967
1644	452.2	5.79	966

1642 soil sample (ziploc) TP-FP-08 (8-8.5)
1645 install peizo
GPS: 12T 0397039, 5209545

1700 Start digging TP-FP-09
1708 water sample @ 2.5'

	ORP	pH	uS
1710	552.2	3.03	1773
1719	587.1	3.02	1755
1721	612.0	3.02	1749
1722	617.7	3.02	1749
1723	620.3	3.02	1744

7/25/12

1708 Soil Sample (ziploc) TP-FP-08 (1.5-2)
GPS 12T 0397042 5209543
1710 soil sample ziploc TP-FP-08 (2.7-3)
1715 " " TP-FP-09 (3.2-3.3)
1735 " " TP-FP-09 (4.5-5)
1740 " " TP-FP-09 (7.5-8)

1746 Water Sample @ 7.5'

1746	463.0 ORP	5.48 pH	289.9 SC
1747	427.8	5.75	290.2
1751	365.0	6.02	294.6
1754	346.9	6.10	294.5
1755	341.9	6.10	293.8
1756	337.9	6.14	292.1
1757	334.9	6.16	292.1

1755 install peizo

1758	332.6	6.17	292.2
1759	331.9	6.18	292.0

1845 Leave site

7/25/12

7/26/12

830 Arrive onsite: P Redmond, L Duensing, M Browne
Water meter calibration
pH 7.02 → 7.00
4.00 → 4.01
10.09 → 10.01 slp = 96.7
ORP 426.4 @ 16.5 → 426.0
SC 1413 → 1413 acc 0477
900 Start digging TP-FP-10
GPS 12T 0397054, 5209552

922 Water sample @ 2.4'

924	562.7 ORP	7.92 pH	200.2 SC
926	570.9	7.30	202.1
927	573.3	7.16	203.1
929	572.4	7.04	202.2
931	571.7	6.99	202.5
933	569.7	6.94	201.9

water coming out of hillside
922 soil sample (ziploc) TP-FP-10 (2-2.4)
930 " " " TP-FP-10 (4-4.5)

937	566.3	6.85	201.7
940	564.9	6.81	203.6
941	563.9	6.80	203.4
942	563.3	6.80	203.6

7/26/12

945 soil sample (ziploc) TP-FP-10 (5.5-6)
1003 " " " TP-FP-10 (8-8.5)
1018 water sample @ 8.5'

1020	546.6	7.78	199.2
1021	556.1	7.46	203.6
1023	582.2	7.26	205.0
1025	565.9	7.13	204.4
1037	559.7	7.01	202.3
1038	558.9	7.01	201.8
1040	558.0	7.00	201.5
1043	554.9	6.99	200.7

1028 soil sample (ziploc) TP-FP-10A (.25-1) tailings
1030 " " " TP-FP-10A (1.1-1.3)
1050 " " " TP-FP-10A (2.1-2.6)
1104 " " " TP-FP-10A (3.5-4)

1115 Install peizo
1145 Patty Navarro arrive onsite (PTS H+S) - review daily toolbox meeting
1235 Start digging TP-FP-11
GPS 12T 0396960 5209682
1250 watersample @ 2'

7/26/12

	ORP	pH	SC
1252	538.1	7.36	491
1300	545.6	6.32	492
1310	530.9	6.19	488
1311	529.2	6.19	489
1312	527.4	6.18	488
1314	525.6	6.18	488

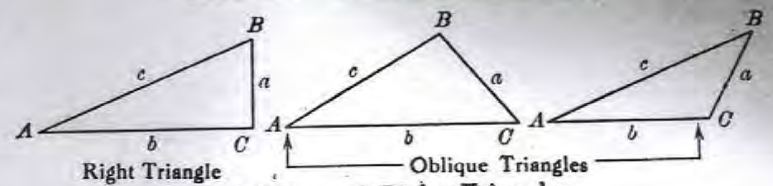
1300 soil sample (ziploc) TP-FP-11 (1.5-2)
1303 " " " TP-FP-11 (1.01-3)
1306 " " " TP-FP-11 (1-1.2)
1323 " " " TP-FP-11 (3.7-4)
1333 " " " TP-FP-11 (6.5-7)
1600 " " " TP-FP-11A (dup)
1340 water sample @ 9'

	ORP	pH	SC
1341	491.9	7.59	459
1343	502.2	7.33	464
1345	505.3	7.22	465
1347	505.2	7.17	467
1349	504.8	7.16	469
1350	504.3	7.13	468
1351	503.1	7.13	458
1353	502.3	7.10	459
1355	501.3	7.09	458
1356	499.3	7.08	456

7/26/12

1404	506.2	6.98	454	
1406	504.2	7.00	457	
1409	507.2	6.92	457	
1412	507.4	6.91	455	
1357	Soil sample (ziploc)			TP-FP-11 (8.5-9)
1402	"	"	"	TP-FP-11 (2.7-3)
1420	Start digging			TP-FP-12
	ORP	pH	SC	(water sample @ 1425 @ 2')
1427	705.8	3.23	1689	
1428	713.9	3.26	1720	
1429	714.9	3.29	1716	
1431	714.1	3.31	1715	
1433	710.6	3.32	1717	
1437	706.8	3.26	1718	
1439	704.5	3.27	1721	
1444	701.8	3.27	1732	
1447	701.2	3.27	1733	
1434	Soil sample (ziploc)			TP-FP-12 (0.9-1.3)
1444	"	"	"	TP-FP-12 (1.6-2.0)
1450	"	"		TP-FP-12 (1.6-1.8)
1456	"	"		TP-FP-12 (2-2.3)
1500	rain - lightening / thunder			
1615	leave site			

TRIGONOMETRIC FORMULAS



Solution of Right Triangles

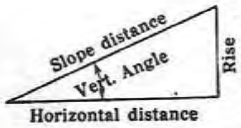
For Angle A. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\operatorname{cosec} = \frac{c}{a}$

Given	Required	
a, b	A, B, c	$\tan A = \frac{a}{b} = \cot B,\ c = \sqrt{a^2+b^2} = a\sqrt{1+\frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B,\ b = \sqrt{(c+a)(c-a)} = c\sqrt{1-\frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90° - A,\ b = a \cot A,\ c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90° - A,\ a = b \tan A,\ c = \frac{b}{\cos A}$
A, c	B, a, b	$B = 90° - A,\ a = c \sin A,\ b = c \cos A$

Solution of Oblique Triangles

Given	Required	
A, B, a	b, c, C	$b = \frac{a \sin B}{\sin A},\ C = 180° - (A+B),\ c = \frac{a \sin C}{\sin A}$
A, a, b	B, c, C	$\sin B = \frac{b \sin A}{a},\ C = 180° - (A+B),\ c = \frac{a \sin C}{\sin A}$
a, b, C	A, B, c	$A+B = 180° - C,\ \tan \frac{1}{2}(A-B) = \frac{(a-b)\tan\frac{1}{2}(A+B)}{a+b},\ c = \frac{a \sin C}{\sin A}$.
a, b, c	A, B, C	$s = \frac{a+b+c}{2},\ \sin\frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}},\ \sin\frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{ac}},\ C = 180° - (A+B)$
a, b, c	Area	$s = \frac{a+b+c}{2}$, area $= \sqrt{s(s-a)(s-b)(s-c)}$
A, b, c	Area	area $= \frac{bc \sin A}{2}$
A, B, C, a	Area	area $= \frac{a^2 \sin B \sin C}{2 \sin A}$

REDUCTION TO HORIZONTAL



Horizontal distance = Slope distance multiplied by the cosine of the vertical angle. Thus: slope distance = 319.4 ft. Vert. angle = 5° 10′. Since cos 5° 10′ = .9959, horizontal distance = 319.4 × .9959 = 318.09 ft.

Horizontal distance also = Slope distance minus slope distance times (1 − cosine of vertical angle). With the same figures as in the preceding example, the following result is obtained. Cosine 5° 10′ = .9959. 1 − .9959 = .0041. 319.4 × .0041 = 1.31. 319.4 − 1.31 = 318.09 ft.

When the rise is known, the horizontal distance is approximately the slope distance less the square of the rise divided by twice the slope distance. Thus: rise = 14 ft., slope distance = 302.6 ft. Horizontal distance $= 302.6 - \frac{14 \times 14}{2 \times 302.6} = 302.6 - 0.32 = 302.28$ ft.

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$

$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin.} \frac{1}{2} D}$

$\text{Sin.} \frac{1}{2} D = \frac{50}{R}$

$\text{Sin.} \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$

$R = T \cot. \frac{1}{2} I$

$R = \frac{50}{\text{Sin.} \frac{1}{2} D}$

$E = R \text{ ex. sec } \frac{1}{2} I$

$E = T \tan \frac{1}{4} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{I}{D}$

$\text{Tan. def.} = \frac{1}{2} \text{ chord def.}$

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

Right Angle Triangles. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$. $100 - 3.125 = 96.875 =$ Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

Leveling. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574 d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3} d^2$. The combined correction is negative.

Probable Error. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean $= \pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1′	.0167	11′	.1833	21′	.3500	31′	.5167	41′	.6833	51′	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	⅛	3-16	¼	5-16	⅜	½	⅝	¾	⅞
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

7/30/12

830 PTS arrive onsite: L Duensing, M Browne

Meter Calibration

US 14.13 → 14.13

pH 4.01 → 4.01

10.03 → 10.01

7.00 → 7.00 95.2 slp

10:00 start on TP-FP-12

1015 soil sample ziploc TP-FP-12 (3-3.3)

1025 soil sample ziploc TP-FP-12 (6-6.8)

1035 " " " TP-FP-12 (8-8.5)

1040 " " " TP-FP-12 (9.5-10)

1045 Install peizo

1100 Start digging TP-FP-13

1115 soil sample (zip) TP-FP-13 (1-1.3)

1125 " " " TP-FP-13 (1.5-1.8)

1135 " " " TP-FP-13 (2.4-2.7)

1140 " " " TP-FP-13 (3.1-3.4)

1155 " " " TP-FP-13 (3.5-3.7)

1200 " " " TP-FP-13 (4-4.3)

1225 Install Peizo.

7/30/12

1133 Water sample TP-FP-13 @ 2'

	ORP	pH	spec cond.
1134	490.5	6.87	281.2
1135	492.3	6.32	284.3
1138	487.2	5.64	285.4
1140	480.2	5.56	286.9
1142	474.6	5.55	286.6
1144	470.0	5.53	286.0
1146	467.2	5.52	285.9
1147	466.1	5.49	287.3
1148	461.6	5.50	286.9
1154	451.4	5.55	287.9
1156	449.2	5.52	~~820~~ → 288.3
1158	448.4	5.52	288.1
1200	447.8	5.51	288.5

1218 Water sample @ 5' TP-FP-13

1220	451.8	5.73	321
1222	460.6	5.62	322
1224	461.6	5.60	320
1227	460.3	5.66	320
1228	460.6	5.59	320
1231	460.2	5.66	321
1234	457.9	5.69	323
1235	457.7	5.63	324
1237	457.9	5.67	324
1241	458.0	5.66	326
1242	456.8	5.65	326

7/30/12

time	ORP	pH	SC
1243	456.7	5.64	327
1244	456.5	5.61	326
1245	456.9	5.63	326

1230 Start digging TP-FP-14

1258 soil sample ziploc TP-FP-14 (1-1.3)
1300 " " " TP-FP-14 (1.4-1.9)
1315 " " " TP-FP-14 (3.2-3.5)
1326 " " " TP-FP-14 (4-4.6)
1347 " " " TP-FP-14 (6-6.5)
1358 " " " TP-FP-14 (10-10.5)

1305 water sample @ 2' TP-FP-14

	ORP	pH	SC
1307	683.3	3.42	1066
1308	686.5	3.43	1078
1310	697.5	3.48	1078
1312	698.9	3.49	1072
1314	699.6	3.54	1072
1315	701.1	3.51	1069
1316	705.4	3.52	1067
1318	702.0	3.51	1074

1405 Install peizo @ TP-FP-14

1403 Water sample @ 8' TP-FP-14

	ORP	pH	SC
1406	578.8	5.03	792
1408	563.2	5.55	824
1409	561.0	5.63	824
1410	559.7	5.64	821

1443 Arrive @ TP-Bulk-02
1515 Collect bulk sample TP-Bulk-02 (8 buckets)
1530 Stop work - thunder/lightening
1600 back @ TP-Bulk-02
1620 Install Peizo

1640 Start digging TP-FP-15
1645 soil sample (ziplock) TP-FP-15 (0-0.2)
1652 " " " TP-FP-15 (1.7-1.9)
1701 " " " TP-FP-15 (0-0.3)
1702 " " " TP-FP-15 (0-0.4)
1655 " " " TP-FP-15A (0.5-1.5)
1700 " " " TP-FP-15A (dup @ 0.5-1.5)
1700 rain storm - thunder/lightening stop work
1750 leave site

7/31/12
815 PTS onsite: LDuensing M Browne
Calibrate meters
pH 4.00 → 4.01
10.07 → 10.01
7.02 → 7.00 slp = 95.9
ORP @ 19.3° 424.1 → 424.0
SC 1413 → 1413
900 Start on TP-FP-15
925 TP-FP-15A (2.7-3) soil ziplock
927 TP-FP-15 (6.5-7) " "
935 TP-FP-15A (3.1-3.6) " "
940 TP-FP-15A (5-5.2) " "
1026 TP-FP-15A (5.5-5.7) " "
1038 TP-FP-15A (6-6.5) " "
1050 TP-FP-15A (8.5-9) " "
928 water sample @ 8' (TP-FP-15)

931	742.2	3.03	2231
933	743.1	3.01	2222
935	743.7	3.06	2216
939	745.1	3.14	2212
944	746.6	3.18	2219
948	747.2	3.16	2247
950	747.9	3.14	2257
955	748.4	3.15	2255
956	748.4	3.12	2254

1055 water sample @ 9.5' (TP-FP-15)

	ORP	pH	
1056	624.9	4.43*	675
1101	626.0	4.58*	839
1102	627.0	4.60*	837
1107	629.0	4.60*	832
1120	631.8	—	820

pH meter not working properly
reset meter - log full

1120 Start digging TP-FP-16
1128 TP-FP-16 (1.1-1.5) soil ziploc
1130 TP-FP-16 (3.0-3.4) soil ziploc
1134 TP-FP-16A (dup 3-3.4) " "
1150 TP-FP-16 (4.8-5.0) " "
1157 TP-FP-16 (4.2-4.3) " "
collect 2 buckets for grad. (3-4')
1210 TP-FP-16 (6.2-7.4) soil ziploc
1220 TP-FP-16 (5.5-6.3) " "
1230 TP-FP-16 (9-9.4) " "
1240 TP-FP-16 (11.5-12) " "
2 bucket soil sample

1250 Install Peizo

1249 water sample @ 11'

	ORP	pH	SC
1250	756.3	3.59	1907
1253	768.0	3.60	1929
1258	766.8	3.67	1961
1259	765.1	3.68	1953
1301	767.8	3.69	1965
1302	766.8	3.70	1956
1309	752.5	3.76	1942
1312	750.8	3.79	1941

1300 Dig TP-FP-17
1317 TP-FP-16A (1-1.5) soil ziploc
1322 TP-FP-16A (2.6-3.0) " "
1325 TP-FP-16A (3-3.2) " "
1357 TP-FP-16A (4.6-5) " "
1400 TP-FP-16A (6.3-6.5) " "
1408 TP-FP-16A (9-9.5) " "
1413 TP-FP-17 (5-6) " "
1430 TP-FP-17 (11.5-12) " "

1438 water sample @ 12'

	ORP	pH	SC
1438	548.1	4.60	938
1439	559.3	4.72	947
1441	569.2	4.86	966
1443	572.5	4.90	965
1445	575.9	4.93	967
1448	580.9	4.95	962
1458	582.8	4.91	940

1440 Install peizo

Water sample (con't) 12' TP-FP-17

1459	586.3	4.91	937
1500	586.7	4.90	935
1501	587.7	4.90	935
1502	588.4	4.90	933

1520 Start dig TP-FP-18

1530 TP-FP-18 (0-.3) soil ziplock
1533 TP-FP-18 (.6-.8) " "
1537 TP-FP-18 (2-2.3) " "
1550 TP-FP-18 (4-4.5) " "
1600 TP-FP-18A (Dup 4-4.5) " "
1630 TP-FP-18 (9-9.5) " "
1642 TP-FP-18 (12-12.5) " "

1650 Install Peizo

1700 Start dig TP-FP-19

1726 TP-FP-19 (0.5-0.9) soil ziplock
1726 TP-FP-19 (18-24) " "
1725 TP-FP-19 (39-46) " "

1650 Water sample @ 12' (TP-FP-18)

	ORP	pH	SC
1651	402.6	5.70	345
1652	425.2	5.88	358
1656	460.1	6.21	355
1701	472.8	6.43	348
1702	474.7	6.44	348
1703	475.7	6.47	347
1704	476.5	6.48	347
1705	477.1	6.48	348
1706	477.9	6.48	347

1815 Leave site

LMO 7/31/12

8/1/12 * sample from exc. bucket

800 PTS arrive onsite:
M Browne, L Duensing

Meter calibration
pH 4.01 → 4.01
10.05 → 10.01
7.01 → 7.00 slp = 94.7
ORP 421.9 → 423
SC 1413 → 1413

900 Starton TP-FP-19
920 TP-FP-19 (5-5.5) soil ziploc
933 TP-FP-19 (4.9') " "
1027 TP-FP-19 (8-8.5) " " *
1035 Install peizo

1052 dig TP-FP-19A

1115 dig TP-FP-21
1145 water sample @ 3.5'

	ORP	pH	SC
1147	552.5	4.34	320
1148	571.4	5.14	323
1150	594.1	5.60	325
1152	608.7	5.81	322
1202	576.1	6.13	323
1204	566.2	6.14	322
1206	563.0	6.15	323
1210	542.2	6.19	323
1211	537.0	6.19	324

1158 TP-FP-21 (3-3.2) soil ziploc
1201 TP-FP-21 (1-1.3) " "
* 1227 TP-FP-21 (6.5-7) " "
* 1249 TP-FP-21 (10-10.5) " "
1243 water sample @

	ORP	pH	SC
1244	543.7	6.08	489
1245	549.8	5.94	500
1250	556.8	5.74	486
1252	557.8	5.71	482
1255	560.8	5.68	477
1256	561.3	5.67	477
1258	562.0	5.65	476
1300	562.9	5.63	475
1304	565.0	5.57	475

1320 TP-FP-21A (3.4-3.7) soil ziploc
1315 " " " (2.8-3) " "
1330 Dig TP-FP-20
1340 TP-FP-20 (0.3-0.5) soil ziploc
1350 TP-FP-20 (2.1-2.4) " "
1600 TP-FP-20A (dup 2.1-2.4) " "
1350 TP-FP-20 (2.1-2.4) soil bucket
1405 TP-FP-20 (3.1-3.6) soil ziploc
* 1420 TP-FP-20 (6-6.5) " "
* 1430 TP-FP-20 (6.5) 2 buckets
* 1440 TP-FP-20 (8-8.5) soil ziploc

1426 water sample @ 6.5'

1427	548.6	5.57	330
1428	531.2	5.49	343
1430	511.9	5.46	345
1435	493.6	5.52	347
1436	491.1	5.53	348
1437	493.1	5.56	349
1438	489.3	5.57	348
1444	480.5	5.61	347
1445	480.5	5.61	348
1447	479.0	5.61	348

1450 *TP-FP-20 (9.5-10) soil ziploc *
- front of bucket (sample
1450 *TP-FP-20 (9.5-10) soil ziploc *
- back of bucket (sample)

1458 water sample @ 10'

1458	581.0	5.57	600
1500	563.0	5.43	604
1504	546.4	5.39	591
1507	538.9	5.36	589
1509	535.5	5.35	589
1512	532.9	5.36	590

1505 install piezo

1545 dig TP-FP-22
1610 TP-FP-22 (0.1-0.3) soil ziploc
1615 TP-FP-22 (2.0-2.3) " "
1618 TP-FP-22 (3.7-3.9) " "
1630 TP-FP-22 (0.4-1.2) " "
*1640 TP-FP-22 (5.5-6) " "
*1650 TP-FP-22 (7.5-8) " "
*1700 TP-FP-22 (9-9.5) " "
1715 install piezo

10 water sample @ 6'

1645	528.2	5.70	205.8
1705	516.6	5.70	202.3
1707	514.1	5.69	201.9
1713	509.7	5.69	201.1

1710 water sample @ 9.5'

1714	470.8	5.79	235.3
1715	472.0	5.82	235.9
1717	478.0	5.87	234.0
1719	482.0	5.89	233.1
1720	483.1	5.90	233.2
1721	484.1	5.90	232.7

1800 Leave site

LMP

8/2/12 *bucket sample

810 PTS arrive on site MBraone
↳ Drensing
900 Start digging TP-FP-25
meter calibration
pH 4.00 → 4.01
10.08 → 10.01 (us)
7.02 → 7.00 sip = 960
ORP ~~10.08~~ (16) 425.1 @ 18.2°
SC 1413 → 1413
933 TP-FP-25A (1.3-1.8) soil ziploc
1600 TP-FP-25A (Dup 1.3-1.8) " "
935 TP-FP-25 (0.4-0.9) " "
937 TP-FP-25 (1.1-1.2) " "
939 TP-FP-25 (1.7-2.1) " "
950 TP-FP-25 (4.3-4.5) " "
1000 TP-FP-25 (6-6.2) " "
*1015 TP-FP-25 (7.5-8) " "
*1045 TP-FP-25 (10) " "

1050 Install peizo

Rite in the Rain

8/2/12

		ORP	pH	SC
1011	Water sample @ 7.5' (TP-FP-25)			
1012		697.4	6.27	371
1014		681.1	5.56	372
1016		666.2	5.36	386
1018		658.3	5.32	389
1021		646.2	5.32	392
1022		643.1	5.32	394
1024		639.7	5.34	396
1027		634.2	5.36	397
1041		605.2	5.39	401
1042	Water sample @ 10' (TP-FP-25)			
1042		615.7	5.05	505
1043		617.1	5.04	506
1050		621.7	5.05	511
1052		623.6	5.05	511
1054		625.4	5.05	510
1115	Dig TP-FP-26			
1122	Water @ 2' (orange + cloudy)			
1123		526.1	6.05	209.7
1125		517.0	6.29	209.8
1132		515.1	6.53	208.8
1135		516.7	6.50	208.9
1142		517.8	6.50	208.2
1146		518.0	6.52	208.2

8/2/12

1126	TP-FP-26 (0.7-1)	soil ziploc
1130	TP-FP-26 (1.8-2)	" "
1143	TP-FP-26 (4-4.5)	——
	2 buckets	
1146	TP-FP-26 (4-4.5)	soil ziploc
* 1200	TP-FP-26 (6-6.5)	" "
* 1215	TP-FP-26 (9-9.5)	" "
1220	Install Peizo	

		ORP	pH	SC
1210	Water sample @ 9'			
1211		553.0	5.06	773
1212		551.7	5.04	764
1218		549.3	5.16	768
1220		549.5	5.18	793
1222		549.7	5.20	799
1227		550.9	5.22	803
1229		551.2	5.23	803
1232		552.0	5.23	806
1235		552.4	5.23	805

1245 Start digging TP-FP-27

1320	TP-FP-27 (1.3-1.9)	soil ziploc
1318	TP-FP-27 (0.9-1.2)	" "
1330	TP-FP-27 (3.8-4.2)	" "
1326	TP-FP-27 (2-2.4)	" "

Rite in the Rain

8/2/12

1312 TP-FP-27 (0-0.4) soil ziploc
1313 TP-FP-27 (0.5-0.8) " "
1700 TP-FP-27A (0.5-0.8 dup)
1344 TP-FP-27 (5-5.5) soil ziploc
1340 Water sample @ 7.5'

	ORP	pH	SC
1340	483.9	5.80	357
1342	480.7	5.90	359
1346	480.7	6.03	359
1349	481.7	6.04	358
1354	484.8	6.06	356
1355	485.7	6.06	356
1357	486.9	6.05	357

1408 Install piezo

1350 TP-FP-27 (6.5-7) soil ziploc *
1400 TP-FP-27 (9.5-10) " " *
1356 Water sample @ 9.5'

	ORP	pH	SC
1358	505.3	5.63	656
1359	506.3	5.59	662
1401	507.3	5.55	667
1403	507.9	5.53	670
1404	509.1	5.51	678
1409	512.6	5.47	695
1410	514.0	5.46	700
1414	517.3	5.44	707

8/2/12

water (cont)

	ORP	pH	SC
1416	518.8	5.43	709
1417	519.8	5.42	710
1418	520.8	5.42	711
1420	522.9	5.41	713
1421	524.3	5.40	713
1422	525.6	5.40	714
1424	526.6	5.40	715

1535 leave site

LAD 8/2/12

Rite in the Rain

8/~~12~~6/12

910 PTS onsite: L Duensing, M Browne

1015 Meet Don onsite @ TP-FP-28

pH calibration:

pH 7.01 → 7.00

4.01 → 4.01

10.05 → 10.01 slp = 959

ORP 420.5 → 420 @ 24°

SC 1413 → 1413

1100 Start digging TP-FP-28

1127 water sample @ 6'

time	ORP	pH	SC
1130	457.1	6.21	219.4
1132	440.9	6.45	230.4
1138	435.8	6.52	230.0
1149	429.0	6.56	225.7
1151	425.7	6.59	226.1
1153	424.3	6.60	225.8
1202	421.9	6.62	226.4
1203	421.5	6.63	226.4
1204	421.2	6.64	226.4
1205	420.8	6.64	226.9
1206	420.5	6.65	226.7

8/6/12

1140 TP-FP-28 (1-1.5) soil ziploc

1142 TP-FP-28 (1.5-2) " "

1145 TP-FP-28A (1.5-2) " "

1153 TP-FP-28 (3-3.5) " "

1155 TP-FP-28 (4.6-5) " "

1159 TP-FP-28 (5.5-7) " "

1211 TP-FP-28 (8-8.5) " "

1230 TP-FP-28 (9-9.5) " "

1235 Install piezo

1223 Water sample @ 9'

	ORP	pH	SC
1227	409.5	5.84	376
1229	426.7	5.81	378
1230	432.7	5.80	378
1231	437.2	5.80	379
1232	442.8	5.82	378
1239	458.0	5.80	376
1245	467.9	5.78	375
1248	473.3	5.74	375
1300	485.5	5.69	374

1400 Move to TP-~~FP-28A~~ TS-01 (JM)

Mike Horse Mine townsite

1440 TP-~~FP-28A~~ (JM) TS-01 soil ziploc (0.5-1)

8/6/12

TP-TS-01

GPS: 12T 0397046, 5209322

1505 dig TP-TS-02

GPS 12T 0397046, 5209315

1518 TP-TS-02 (1.5-2) soil ziploc

1512 TP-TS-02 (0.6-0.9) " "

1520 backfill

1535 dig TP-TS-03

1539 TP-TS-03 (0.1-0.2) soil zip

1540 TP-TS-03 (1.8-2) " "

1600 TP-TS-03A (Dup - 1.8-2) " "

GPS: 12T

1605 Move to TP-Bulk-03

1615 Start digging

1620 water sample @ 2'

1622	479.4	6.55	249.2
1629	452.9	6.50	247.5
1642	434.7	6.51	248.7
1643	433.8	6.50	249.0
1656	432.2	6.57	249.5
1657	432.6	6.56	249.8
1659	431.9	6.57	250.2

8/6/12

1630 Collect bulk sample @ 5.55'

TP-Bulk-03 (8 buckets)

1645 backfill

1700 site cleanup

1740 leave site

8/7/12 * bucket sample
800 PTS onsite: MBraune, C Duensing
Calibrate meters
pH 7.03 → 7.00
10.12 → 10.01
4.00 → 4.01 96.6 slp
ORP 427.2 → 427.7 @ 15.4°
SC 1413 → 1413
840 Dig TP-FP-30
844 TP-FP-30 (.5-.8) soil ziploc
1600 TP-FP-30A " "
(dup (0.5-0.8)
846 TP-FP-30 (.08-1) soil ziploc
848 TP-FP-30 (1.6-2) " "
850 TP-FP-30 (3.5-4) " "
901 TP-FP-30 (4.8-5) " "
* 914 TP-FP-30 (7.5-8) " "
* 915 TP-FP-30A (2.3-3.3) " "
* 930 TP-FP-30 (10-10.5) " "
* 945 Install peizometer
Shelly (DEQ) onsite

1005 Dig TP-FP-31

8/7
859 Water sample @ 5' (TP-FP-30)

	ORP	pH	SC
900	704.6	4.91	1290
903	678.9	4.93	1313
906	662.3	4.95	1313
909	652.1	4.95	1306
916	636.4	4.95	1292
917	634.6	4.95	1291
921	624.9	4.95	1280
922	623.5	4.95	1278
926	620.1	4.95	1275

938 Water sample @ 10' (TP-FP-30)

940	692.5	4.99	939
942	687.1	4.68	961
944	673.4	4.54	965
946	656.7	4.41	957
958	596.4	4.23	939
1001	602.3	4.54	944
1003	603.8	4.60	942
1005	603.7	4.60	940
1007	602.6	4.60	940
1009	603.5	4.61	941

8/7/12

1030 Water sample @ 4.5'

	ORP	pH	SC
1032	665.5	3.41	1100
1034	671.8	3.44	1091
1037	677.4	3.49	1080
1039	678.0	3.51	1076
1041	678.7	3.52	1072
1058	677.3	3.48	1081
1103	673.3	3.49	1084
1105	671.6	3.49	1084
1107	670.0	3.49	1085
1109	667.1	3.51	1089

1046 TP-FP-31 (0.1-0.4) soil ziploc
1049 TP-FP-31 (1-1.8) " "
1052 TP-FP-31 (2-2.75) " "
1055 TP-FP-31 (3-3.5) " "
1057 TP-FP-3 (4.5-5) " "
1105 TP-FP-31 (6.5-7) soil, 2 buck, zip.
1110 TP-FP-31 (7-7.5) soil ziploc
1128 TP-FP-31 (9-9.5) " "

1140 install peizometer

8/7/12

1118 Water sample @ 9'

	ORP	pH	SC
1121	572.4	4.66	520
1123	580.6	4.53	536
1125	587.0	4.49	538
1132	602.6	4.48	546
1143	619.1	4.32	560
1146	625.4	4.13	564
1149	628.0	4.04	567
1153	631.6	3.97	572
1159	636.9	3.96	579

1230 Dig TP-FP-33

1249 TP-FP-33 (0-0.5) soil zip
1251 TP-FP-33 (2.3-2.6) " "
1254 TP-FP-33 (3.5-4) " "
1300 TP-FP-33 (5.9-6.2) " "
1315 TP-FP-33 (8-8.5) " "

1332 Install Peizo + backfill

8/7/12

1256 water sample @ 5.3 (TP-FP-33)

1259	525.6	5.78	353
1302	503.5	6.16	383
1304	497.8	6.31	395
1306	495.2	6.43	403
1310	494.6	6.53	413
1312	495.6	6.55	416
1318	499.2	6.51	420

1335 dig TP-FP-32

1350 water sample @ 4'

1351	600.1	6.10	364
1353	606.6	5.23	361
1356	606.6	5.13	362
1419	563.2	5.21	380
1422	566.1	5.25	384
1426	564.5	5.25	384

1400 TP-FP-32 (0-.4) soil bag

1404 TP-FP-32 (0.7-1.2) " "

1600 TP-FP-32A " "

Rep 0.7-1.2

1416 TP-FP-32 (1.3-1.4) soil bag

1417 TP-FP-32 (1.4-1.5) " "

1415 TP-FP-32 (2.4-2.7) " "

1435 TP-FB-32 (7-7.5) " "

1501 TP-FP-32 (10.5-11) soil bag

1450 TP-FP-32 (8.5-9) soil ziploc

1450 Install peizo + backfill

1440 Water sample @ 9' (TP-FP-32)

	ORP	pH	SC
1442	583.8	5.07	759
1445	583.8	5.00	796
1451	585.2	4.95	846
1456	584.4	4.94	866
1457	584.2	4.94	868
1501	583.3	4.94	879
1503	583.7	4.94	885
1507	584.5	4.93	894
1508	584.9	4.93	895
1511	586.0	4.92	901

1530 Move to TP-FP-34

1550 start digging

1612 TP-FP-34 (0-.6) soil ziploc

1614 TP-FP-34 (1.2-1.7) " "

1618 TP-FP-34 (3.5-4) " "

1631 TP-FP-34 (7.5-8) " "

1633 TP-FP-34 (8.5-9) " "

1635 TP-FP-34 (6-6.3) " "

1656 TP-FP-34 (10-10.5) " "

1710 TP-FP-34 (12.5-13) " "

Rite in the Rain

8/7/12

GPS TP-FP-34

12T 0396197, ~~5210~~ 5210160

1720 Install peizo + backfill

1800 Leave site

8/7/12

8/8/12

800 PTS onsite M Browne, L Dunsing

900 Start on TP-FP-35

pH calibration (meter)

7.02 → 7.00

4.00 → 4.01

10.08 → 10.01 slp = 96.0

ORP = 426.0 → 426.0 @ 17°C

SC = 1413 → 1413

919 Water sample @

	ORP	pH	SC
919	714.3	5.22	158.1
941	679.3	4.72	165.9
947	680.0	4.71	161.7
949	679.1	4.71	160.7
950	679.0	4.70	159.7
951	678.4	4.71	159.6
953	677.0	4.71	159.2
955	675.9	4.72	158.6

955	TP-FP-35 (.5-.7)	soil	ziploc
1000	TP-FP-35 (2.3-2.8)	"	"
1005	TP-FP-35 (~~5.5-6~~ 6-6.4)	"	"
1003	TP-FP-35 (4-4.3)	"	"
1600	TP-FP-35A (dup 4-4.3)	"	"

Rite in the Rain

8/8/12

1010 TP-FP-35 (8.5-9) soil ziploc
1030 TP-FP-35 (8.5-8.9) " "
1035 TP-FP-35 (9-9.5) " "
1050 TP-FP-35 (12.5-13) " "
1100 Install ~~back~~ peizo + back fill
1050 water sample @ 12.5
1101 624.7 4.30 863
1108 652.8 4.28 892
1117 667.8 4.23 919
1126 669.3 4.20 951
1129 673.2 4.19 963
1134 677.7 4.15 978

1140 Move to TP-FP-40
GPS:
moved ≈ 300' downstream @
Shelly's request + approved
by Don (Spectrum Engineer)

TP-FP-454 (40) 12T 0396023, 5210371

1210 Start dig TP-FP-40
GPS 12T 0396003, 5210306

8/8/12

1236 TP-FP-40 (0-.5) soil ziploc
1238 TP-FP-40 (1.5-2) " "
1241 TP-FP-40 (3.5-3.8) " "
1245 TP-FP-40 (6-6.2) " "
1250 TP-FP-40 (6.5-6.8) " "
1300 TP-FP-40 (8.5-9) " "
1600 TP-FP-40 A " "
(dup 8.5-9)
1320 TP-FP-40 (14.5-15) " "
1325 water sample @ 15'
1327 534.5 6.24 344
1329 528.9 6.23 343
1331 524.2 6.29 345
1334 520.4 6.32 354
1337 520.4 6.29 360
1340 518.3 6.23 362
1342 516.5 6.21 365
1346 515.1 6.18 371
1348 514.6 6.17 373
1351 514.4 6.16 374
1330 TP-FP-40 (13-13.5) soil ziploc
1335 install peizo + backfill
1400 Start on TP-FP-41
GPS: 12T 0396000, 5210327

Rite in the Rain

8/8/12

1440	TP-FP-41 (4-4.5)	soil	ziplox
1444	TP-FP-41 (.5-8)	"	"
1445	TP-FP-41 (2-2.5)	"	"
1448	TP-FP-41 (3-.7)	"	"
1500	TP-FP-41 (5.5-6)	"	"
1510	TP-FP-41 (8.5-9)	"	"
1531	TP-FP-41 (10.5-11)	"	"

1540 Install peizo + backfill

1610	Dig TP-FP-42	soil	bag
1625	TP-FP-42 (.5-1)	"	"
1628	TP-FP-42A (.5-8)	"	"
1632	TP-FP-42 (2-2.6)	"	"
1635	TP-FP-42 (4.8-5.2)	"	"
1640	TP-FP-42 (4.2-4.8)	"	"
1655	TP-FP-42 (6-6.1)	"	"
1657	TP-FP-42 (6.6-7)	"	"
1710	TP-FP-42 (10-10.5)	"	"
1720	TP-FP-42 (12-12.5)	"	"
1735	TP-FP-42 (15.5-16)	"	"

1740 Install peizo + backfill

TP-FP-42 GPS: 12T 0396014, 5210349

8/8/12

1738 Water @ 16'

1740	493.1	6.92	357
1744	505.5	6.26	360
1748	503.5	6.18	362
1750	503.8	6.16	364
1752	504.6	6.19	362
1754	503.5	6.20	363
1755	503.1	6.21	363
1756	502.8	6.22	363
1757	502.6	6.22	364
1758	502.6	6.21	365

1820 Leave site

LAO

Rite in the Rain

8/9/12

810 PTS onsite M Browne, L Dauensby
Meter Calibration
pH 7.02 → 7.00
4.01 → 4.01
10.07 → 10.01 S/P = 94.9
ORP = 424.0 → 424.0 @ 19.6°
SC = 1413 → 1413
840 Start digging TP-FP-43
GPS: 12T 0396018, 5210356

905 TP-FP-43 (1.2-1.4) soil bag
910 TP-FP-43 (4-4.3) " "
922 TP-FP-43 (6-6.5) " "
924 TP-FP-43 (4-4.5) " 2 buck.
935 TP-FP-43 (9-9.5) " bag
943 TP-FP-43 (11-11.5) " "
948 Install peizo + backfill
950 Shelly (DEQ) onsite
1005 Start dig TP-FP-44
1034 TP-FP-44 (0-.7) soil bag
~~1039~~ 1038 TP-FP-44A (dup 0-.7) " "
1039 TP-FP-44 (.7-1) " "
1041 TP-FP-44 (2-2.5) " "
1045 TP-FP-44 (4-4.5) " "

8/9/12
935 Water sample @ 9.5' TP-FP-43

936	639.0	7.13	359
938	641.0	6.83	359
940	642.0	6.73	359
945	639.8	6.66	353
949	637.5	6.66	353
952	637.0	6.65	351
957	636.5	6.65	351
958	636.4	6.66	350

TP-FP-44 (cont.)
1110 TP-FP-44A (2.5-3) soil bag
1115 TP-FP-44 (6-6.5) " "
1133 TP-FP-44 (13) " "
1135 Water sample @ 13'

1138	646.2	6.93	426
1140	644.8	6.85	429
1141	642.7	6.81	431
1142	641.1	6.78	431
1145	638.8	6.70	433
1149	635.6	6.65	435
1151	638.5	6.62	436
1230	593.5	6.31	459

Rite in the Rain

8/9/12

1120 TP-FP-44A (8-8.5) soil bag
1125 TP-FP-44 (11.5-12) " "
1145 install peizo + back fill

1230 Tara + Erin onsite (Pioneer H+S)
1245 Dig TP-FP-45
GPS:
1250 TP-FP-45 (.5-1) soil bag
1605 TP-FP-45A (.5-1 Dup) " "
1254 TP-FP-45 (1.6-1.8) " "
1257 TP-FP-45 (1.8-2) " "
1300 TP-FP-45 (2-2.3) " "
1304 TP-FP-45 (3.5-4) " "
1305 TP-FP-45 (1.2-1.6) " "
1325 TP-FP-45 (7.5-8) " "
1350 TP-FP-45 (10.5-11) " "
1408 Install peizo + back fill
1400 TP-FP-45 (13.5-4) soil bag

1405 water sample @ 13'

1408	521.8	6.47	356
1414	524.9	6.38	361
1420	526.1	6.39	360
1422	526.9	6.39	359
1424	528.5	6.39	358

1500 Leave site

Rite in the Rain

Project # and Name: Mike Horse

Results Needed By:

Location: Lincoln MT

Project Manager: Pat Redmond

Contact Phone #:

Date Sampled	Date Received	Photo	Borehole # or Location	Depth	Sample Type	Moisture Content	Gradation	Hydrometer	Atterberg Limits	Proctor (Method)	CBR	Consol.	Unconfined Compr.	Corrosivity					Sample #
8/15	8/16		TP-Bulk-05	5-6			/												13042 *
↓	↓		TP-FP-48	1-2			/												13043 *

Comments:

* Run grad. on entire sample

8/13/12

9:00 PTS onsite: M Burns, L Dunsing

pH meter calibration

pH 4.00 → 4.01

10.01 → 10.01

7.02 → 7.00 slp = 97.0

SC = 1413 → 1413

ORP 426.1 → 427.0 @ 16.8°

935 Dig TP-FP-45A

GPS = 12T 0396044, 5210394

958 TP-FP-45A (5.5-6) soil bag

1002 TP-FP-45A (3-3.5) " "

1005 TP-FP-45A (.8-1.2) " "

1015 TP-FP-45A (9-9.5) " "

1019 TP-FP-45A (5-6A) " "

1030 TP-FP-45A (11-11.5) " "

1034 TP-FP-45A (13.5-14) " "

1040 Install peizo + backfill

1100 Move to TP-FP-39

1130 Dig TP-FP-39

GPS: 12T 0396198, 5210273

1200 TP-FP-39 (9-1.6) soil bag

1600 TP-FP-39A " "

(dup 9-1.6)

8/13/12

1206 TP-FP-39 (3.5-4.2) soil bag

1212 TP-FP-39 (6-6.5A) " "

1227 TP-FP-~~9.5~~ 39 (9.5-10A) " "

+2 buckets

1245 TP-FP-39 (12.5-13) soil bag

1255 install peizo + backfill

1330 Dig TP-FP-35

1350 TP-FP-36 (1-1.5) soil bag

1356 TP-FP-36 (3.5-4) " "

1400 TP-FP-36 (6.5-7) " "

1446 TP-FP-36 (9.5-10) " "

1410 Water sample @ 7'

1413	424.0	6.23	326
1414	604.0	5.99	334
1416	620.2	5.93	335
1418	598.6	5.88	333
1420	584.6	5.88	332
1429	555.3	5.93	332
1431	551.4	5.93	333
1434	546.1	5.93	334
1437	538.9	5.93	336

1440 TP-FP-36 (10-10.5) soil bag

Rite in the Rain

8/13/12

1440 water sample @ 13.5'

	ORP	pH	SC
1450	506.4	6.56	344
1454	494.4	6.67	340
1456	491.4	6.72	340
1502	489.8	6.72	343

1500 Install peizo + backfill

1540 Leave site

(leave early to get parts for machinery)

8/14/12

900 PTS onsite M Browne, L Duensing

meter calibration

pH = 4.00 → 4.01

10.06 → 10.01

7.02 → 7.00 95.1 slp

SC = 1413 → 1413

ORP = 424.3 → 424.0 @ 19.2°

915 Dig TP-FP-37

9495	TP-FP-37 (5-1)	soil	bag
949	TP-FP-37 (2.5-3)	"	"
953	TP-FP-37 (4.5-5)	"	"
1006	TP-FP-37 (7.5-8)	"	" /2 bag
1015	TP-FP-37 (9.5-10)	"	bag
1024	TP-FP-37 (11.5-12)	"	"
1034	TP-FP-37 (14.5-15)	"	"

1040 Install peizo + backfill

1055 Dig TP-FP-38

1130	TP-FP-38A (2.5-3)	soil	bag
1143	TP-FP-38 (5-5.4)	"	"
1120	TP-FP-38A (.5-1)	"	"
1600	TP-FP-38A (Dup 0.5-1)	"	"

Rite in the Rain

8/14/12

1126 TP-FP-38A (1.-1.5) soil bag
1117 TP-FP-38B (.5-1) " "
1138 TP-FP-38 (2-2.5) " "
1134 TP-FP-38A (4.5-5) " "
1153 TP-FP-38 (7.5-8) " "
1215 TP-FP-38 (9.5-10) " "
1225 TP-FP-38 (11.5-12) " "
1255 TP-FP-38 (14.5-15) " "
1300 Install peizo + backfill

1330 dig TP-Bulk-04
1336 water sample @ 2.5'

	ORP	pH	SC
1339	622.9	6.60	396
1341	629.6	6.17	399
1343	626.3	6.08	399
1345	612.7	6.04	400
1347	606.0	6.04	400
1352	581.2	6.09	401
1355	571.7	6.11	403
1412	516.8	6.21	404
1417	511.2	6.21	404
1419	509.0	6.22	405

1400 ~~Collect bulk sample (8 buckets)~~
~~TP-FP-Bulk-04 ( )~~ (no)

8/14/12

1402 TP-Bulk-04 (0-3.5) soil bag
1404 TP-Bulk-04 (3.5-3.9) " "
1406 TP-Bulk-04 (3.9-4.5) " "
1408 TP-Bulk-04 (4.5-4.7) " "
1415 TP-Bulk-04 (2.5-3.5) soil bucket
1430 Water sample @ 4'

1431	492.7	6.47	374
1435	480.4	6.47	379
1438	478.6	6.45	379
~~1424~~ 1424	475.4	6.41	377
1446	472.6	6.40	380
1448	471.4	6.41	381

GPS: 12T 0396218, 5210208
(TP-Bulk-04)
1450 Install peizo + backfill
Water (cont)

1455	465.4	6.41	386
1458	463.3	6.42	387
1500	461.9	6.44	387
1504	453.4	6.47	389

1510 dig TP-Bulk-4A
GPS: 12T 0396224 5210218
1523: TP-Bulk-4A (7-7.5) soil & buck.
1550 backfill TP-Bulk-4A

Rite in the Rain

8/14/12

1640 Dig TP-FP-49

GPS: 12T 0395742, 5210590

1655 TP-FP-49(0.7-1.2) soil bag

1700 ~~1800~~ TP-FP-49(1.7-2.4) " "

*1800 TP-FP-49A " "

1702 TP-FP-49(3-3.4) " "

1704 TP-FP-49A(2.8-3.2) " "

*dup TP-FP-49(0.7-1.2) " "

1715 water sample @ 6.5'

1716	550.5	6.77	296.4
1718	550.3	6.50	300
1720	549.6	6.32	300
1721	548.7	6.26	300
1722	546.8	6.24	300
1723	544.1	6.20	299
1724	542.1	6.19	299
1725	540.2	6.18	300

1718 TP-FP-49(5-5.5) soil bag

1745 leave site

JAD

8/15/12

800 PTS onsite: MBrowne, L Duenzing

830 Start dig TP-FP-49

meter calibration

pH = 4.00 → 4.01

7.01 → 7.00

10.14 → 10.01 956 SIP

ORP = 429.0 → 429.0 @ 13°

Sc pH = 1413 → 1413

910 water sample @ 11'

	ORP	pH	Sc
916	705.8	6.60	415
918	739.1	6.16	440
921	752.1	5.98	442
925	735.6	5.94	419
938	716.8	5.93	425
939	715.3	5.94	425
940	714.1	5.94	425

930 Install peizo + backfill

JAD

Rite in the Rain

8/15/12

835 TP-FP-49 (6.5-7) soil bag
850 TP-FP-49 (8.5-9) " "

9 ~~8~~40 start TP-FP-50 — GPS 12T 0395768 5210632

952 TP-FP-50 (1.6-2.2) soil bag
950 TP-FP-50 (.8-1.2) soil bag
1600 TP-FP-50A " "
*Dup 1.6-2.2
955 TP-FP-50 (3.5-4) soil bag
1000 TP-FP-50 (5.5-6) " "

1012 Water sample @ 6'

	ORP	pH	SC
1012	560.9	6.77	407
1015	537.7	6.77	407
1018	528.6	6.77	408
1021	513.5	6.77	407
1023	503.0	6.77	408

1018 TP-FP-50 (7.5-8) soil bag
1027 TP-FP-50 (9-10) " "
1040 TP-FP-50 (11.5-12) " "
1040 water sample @ 12'

1041	468.7	6.77	376
1043	478.1	6.77	376
1047	483.5	6.77	377
1049	488.1	6.77	377

8/15/12

	ORP	pH	SC
1052	491.9	7.25	377
1054	494.0	6.69	378
1056	495.1	6.45	378
1059	497.5	6.25	377
1102	499.5	6.08	378
1104	501.2	5.97	378
1106	502.5	5.89	378

1056 Install peizo + backfill

1115 Dig TP-FP-~~50A~~ 51
GPS 12T 0395777 5210658

~~12~~ 1148 water @ 5' — pH meter not working right

1151	545.8	6.77	189.4
1153	574.4	6.77	188.8
1158	583.4	6.77	188.0
1202	585.9	6.77	187.6
1215	590.8	7.31	187.4
1225	592.9	5.01	187.2
1232	594.7	4.77	187.3

1240 water sample @ 12'

1241	514.8	6.77	190.4
1244	533.6	—*	190.6

*pH meter not working

Rite in the Rain

8/15/12 [illegible]

1148 TP-FP-51A (4.5-5) soil bag
1140 TP-FP-51A (2.5-3) " "
1135 TP-FP-51 (5.5-6) " "
1132 TP-FP-51 (3.5-4) " "
1129 TP-FP-51 (1.5-2) " "
1217 TP-FP-51 (10-10.5) " "
1203 TP-FP-51 (7.5-8) " "
1154 TP-FP-51A (6-6.2) " "
1220 TP-FP-51 (11-11.5) " "
1240 TP-FP-51 (12-12.5) " "

1400 Dig tp-fp-50 A
GPS: 12T 0395771, 5210655
1414 TP-FP-50A (0.5-1) soil bag
1417 TP-FP-50A (2.3-2.5) soil bag
1419 TP-FP-50A (3.5-4) " "
1800 TP-FP-50A " "
(Dup 3.5-4)
1438 TP-FP-50A (1-1.5A) " "
1446 TP-FP-50A (5-5.5) " "
1440 TP-FP-50A (2.2-2.5A) " "
1500 TP-FP-50A (8.5-9) " "

8/15/12 use backup pH meter

1440	Water @ 5.5'		
		SC	pH
1445	399.4	209.1	5.78
1447	399.7	221.4	5.13
1449	432.9	224.4	4.99
1451	450.0	228.6	4.95
1457	474.8	242.7	4.93
1502	483.6	244.2	4.91

1500 Backfill TP-FP-50A

1520 Dig TP-FP-48 GPS: 12T 0395729 5210569
1537 TP-FP-48 (1.5-2) soil bag
1536 TP-FP-48 (0-.4) " "
1540 TP-FP-48 (2.5-3) " "
1543 TP-FP-48 (3-3.5) " "
1543 TP-FP-48 (1-1.5) " "
TP-FP-48 (1-2) " 2 buck
1605 Water @ 4

1610	474.6	329	5.66
1612	475.3	311	5.62
1614	475.6	301	5.62
1616	475.8	299	5.64
1620	477.5	288.6	5.64
1625	479.4	290.7	5.64

Rite in the Rain

8/15/12

1610 TP-FP-48 (6-6.5) soil bag
1616 TP-FP-48 (8-8.5) " "
1630 TP-FP-48 (10-10.5) " "
1642 TP-FP-48 (13.5-14) " "
1650 Install pezo + backfill
1648 Water sample @ 13

1651	452.8	376	6.41
1653	447.0	378	6.41
1656	443.5	377	6.42
1659	442.2	379	6.44
1702	441.8	375	6.45
1704	441.7	378	6.46
1706	441.8	380	6.46
1708	442.1	380	6.47
1717	446.8	374	6.48
1720	445.0	374	6.48
1739	439.2	373	6.48

1710 Dig TP-Bulk-05
GPS: 12T 0395726, 5210563
1730: TP-Bulk-05 (5-6) soil & back
1735 backfill
1800 Leave site

?

Rite in the Rain

~~8/27/1~~ 8/27/12

1145 PTS arrive onsite
L Duensing, M Browne
mobe to TP-FP-55
1215 Dig TP-FP-55
Meter calibration
pH 7.00 → 7.00
10.01 → 10.01
4.01 → 4.01 slp = 95.3
SC 1413 → 1413
ORP 417.6 → 418.0 @ 27°

1304 TP-FP-52 (1-1.5) bag soil
pH meter won't turn on
1314 water sample at 3'

1317	501.4 (ORP)	191.3 (SC)	—
1319	482.2	184.6	—
1322	479.3	184.6	—
1327	413.3	185.9	6.75 pH*
1330	403.6	185.4	5.26
1332	404.9	185.6	5.24

* calibrate backup pH meter
6.96 → 7.00
10.00 → 10.01
3.79 → 4.01

GPS: 12T 0395443 5210549

Rite in the Rain

8/27/12

1315 TP-FP-52 (2.7-3.0) bag soil
1330 TP-FP-52 (5-5.5) " "
1340 TP-FP-52 (7.5-8) " "
1355 TP-FP-52 (9.5-10) " "
1359 Water sample @ 12'
1401 446.0 273.8 4.68 pH
1403 445.6 274.6 4.35
1405 444.9 272.9 4.33
1408 444.6 271.8 4.33
1410 444.4 270.5 4.33
1408 Install peizo and backfill
1420 Walk next line of test pits
1515 Dig TP-FP-53
GPS: 12T 0398445, 5210565
1528 TP-FP-53 (3-3.6) bag soil
1528 water sample @ 4'
1533 3.95 pH 504.8 ORP 352 SC
1534 3.95 503.8 352
1536 3.95 503.3 351
1539 3.95 504.1 350
1541 3.95 504.8 349
1544 3.95 505.2 349
1546 3.95 505.6 348

8/27/12

1530 TP-FP-53 (1.8-2.4) soil bag
1550 TP-FP-53 (5-5.5) " "
1600 TP-FP-53 (7.5-8) " "
1610 TP-FP-53 (9.5-10) " "
1620 TP-FP53 (12-12.5) " "
1618 water @ 12'
1619 4.65 (pH) 425.1 (ORP) 302 (SC)
1623 4.66 403.5 300
1625 4.64 401.3 299
1627 4.64 400.3 297
1631 4.64 400.4 295
1633 4.64 400.2 293.9
1635 4.64 400.1 292.8
1625 Install Peizo + backfill

1640 Dig TP-FP-54
1655 water sample @ 4'
1657 2.94 pH 644.3 (ORP) 1283 (SC)
1700 2.94 645.5 1290
1702 2.94 646.0 1284
1704 2.92 646.6 1280
1707 2.92 646.9 1275

solvent odor observed in test pit

Rite in the Rain

8/27/12

1648 TP.FP.54(0.6-1) soil bag
1900 TP.FP-54(A) " " "
dup (0.6-1)
1650 TP.FP.54(12-14) soil bag
1654 TP.FP.54 (18-24) " "
1658 TP.FP.54 (34-38) " "
GPS: 12T 0395457 5210569
1730 Leave site

SAB
8/27/12

8/28/12
800 PTS onsite: L Duensing M Browne
meter calibration
pH 3.93 → 4.01
7.11 → 7.00
9.99 → 10.01
SC 1413 → 1413
ORP 427.5 → 428.0 @ 14.5°
845 Start on TP-FP.54
850 TP.FP.54(5-5.5) bag soil
850 " " " " 2 pack soil
905 TP.FP.54(7-7.5) bag soil
915 TP.FP.54 (9-9.5), bag soil
914 water sample @ 10'

914	4.88 pH	590.5 ORP	511 SC
917	4.86	599.9	505
919	4.86	597.2	499
921	4.88	597.7	496
923	4.88	596.3	510
925	4.88	596.5	507
927	4.88	596.6	504
929	4.88	597.5	501

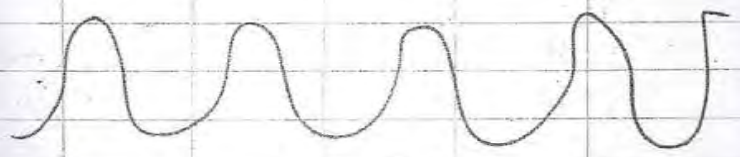
925 Install perzo + backfill

Rite in the Rain

8/28/12 GPS: 12T 0315411
5210595

940 Dig TP-FP-55
948 Water sample @ 3'

949	6.15 pH	410.1 ORP	177.6 SC
950	5.93	400.5	178.4
952	5.89	392.8	178.5
954	5.87	386.2	178.1
956	5.87	383.7	177.7
958	5.87	381.1	177.1
1000	5.87	379.7	177.0
1002	5.90	380.8	176.5
1004	5.90	378.0	176.1
1006	5.87	375.1	176.1
1008	5.87	373.1	176.4
1018	5.88	371.6	175.2



1015 TP-FP-55 (1.6-1) bag soil
1014 TP-FP-55 (2-2.3) " "
1012 TP-FP-55 (2.5-3) " "
1010 TP-FP-55 (3.8-4.2) " " *
1028 TP-FP-55 (5-5.5) " " *
1035 install peizo + backfill
hole caving in extremely

8/28/12

1035 Water sample @ 5'

1036	5.25 pH	414.9 ORP	263.7 SC
1038	5.14	418.9	263.8
1040	5.14	417.4	263.6
1043	5.12	416.5	264.1
1045	5.12	416.2	263.5
1047	5.12	416.0	263.8
1049	5.10	415.2	264.7
~~10~~ 1052	5.08	414.0	266.4
1 1054	5.08	413.4	267.6

1045 Install peizo + backfill
1110 Mobe to next test pit
1130 Start digging TP-FP-60

1205 TP-FP-60 (3.6-4) bag soil
1209 TP-FP-60 (2-2.2) " "
1210 TP-FP-60 (2.2-.5) " "
1212 TP-FP-60 (4.5-5) 2 buck soil
1217 TP-FP-60 (5.8-6) bag soil
1225 TP-FP-60 (8-8.5) " "
1234 TP-FP-60 (9.5-10) " "
1240 TP-FP-60 (8') " "
1245 Install peizo + backfill
GPS: 12T 0315274, 5210612

Rite in the Rain

8/28/12

1218 Water @ 6'

1220	5.52 pH	496.6 ORP	66.8 SC
1222	5.23	516.1	68.7
1226	5.21	524.2	69.6
1228	5.21	526.8	70.1
1230	5.19	529.3	69.0
1234	5.17	533.8	68.8
1236	5.16	535.6	68.6
1241	5.13	539.7	69.5
1243	5.11	541.1	69.7
1246	5.10	544.2	69.2
1249	5.08	545.9	69.5
1251	5.06	548.0	69.6

1300 Dig TP.FP.59
GPS 12T 0395265, 5210548

1342 TP.FP.60 (.2-.4) bag soil
1340 TP.FP.60 (1.5-1.8) " "
1337 TP.FP.60 (1.8-2) " "
1336 TP.FP.60 (2.5-3) " "
1333 TP.FP.60 (3.5-4) " "

WATER SAMPLE @ 6'

	pH	ORP	SC
13:56	6.16	526.7	230.1
13:58	6.22	524.4	233.9
14:00	6.24	521.2	234.1
1402 @	6.24	518.3	235.6

8/28/12
water cont.

1404	6.22	515.7	234.6
1406	6.22	514.8	234.1
1408	6.23	512.2	234.0
1413	6.23	506.1	232.7
1415	6.23	503.7	231.9
1418	6.22	499.9	231.6
1421	6.23	497.7	231.6

1357 TP.FP.59 (6.5-7) soil bag
1409 TP.FP.59 (8.5-9) " "

water sample @ 12'

	pH	ORP	SC
1423	5.36	433.8	212.3
1424	5.32	422.0	212.2
1426	5.30	416.6	213.1
1428	5.28	414.7	212.3
1430	5.28	411.2	211.1
1432	5.28	408.3	210.0
1434	5.26	408.8	208.8
1437	5.26	404.7	207.7

1440 TP.FP.59 (12-12.5) soil bag
1430 Install peizo & backfill

1455 TP.FP.58 - start digging
GPS: 12T 0395259, 5210537

Rite in the Rain

8/28/12

1458 Water sample @ 4'

	pH	ORP	SC
1459	6.55	474.8	246.2
1501	6.37	454.1	253.4
1503	6.33	442.5	254.4
1507	6.33	434.5	253.7
1509	6.33	433.5	253.5
1511	6.33	433.1	252.9
1513	6.33	433.2	252.5
1515	6.33	434.1	252.3
1331	6.31	441.6	250.8

1518 TP FP 58 (.1-.3) bag soil
1900 TP FP 58 (A) " "
dup (.1-.3)
1526 TP FP 58 (1.3-1.6) bag soil
1523 TP FP 58 (2.3-2.8) " "
1520 TP FP 58 (3.6-4) " "
1535 TP FP 58 (4.1-4.7) " "
1905 TP FP 58 B " "
dup 4.1-4.7
1537 TP FP 58 (6-6.5) bag soil
1547 TP FP 58 (8.5-9) " "
1604 TP FP 58 (9.5-10) " "
1605 Install peizo + backfill

8/28/12

1557 Water sample @ 10'

	pH	ORP	SC
1559	6.07	341.2	216.1
1601	6.07	322.6	216.5
1605	6.07	~~60~~ 305.8	214.9
1607	6.05	301.6	214.4
1609	6.05	294.5	214.1
1614	6.05	283.4	212.8
1616	6.05	277.5	212.4
1623	6.03	260.0	211.2

1615 TP-Bulk-06 GPS: 12T 0395288 5210536

1624 water sample @ 2.5

1627	6.54	475.2	257.2
1629	6.56	469.1	256.9
1631	6.58	481.6	257.4
1633	6.58	474.1	256.7
1635	6.58	468.4	256.1
1637	6.50	467.1	255.6
1639 13	6.54	460.6	253.3
1645	6.54	459.2	252.9

1646 backfill

1640 TP-Bulk-06 (3-4) & buck soil

1735 Leave site

Rite in the Rain

8/29/12

840 PTS onsite: M Browne, L Duensing
Mobe to TP MS.05
Meter calibration
ORP 4259 → 4260 @ 17°
SC 1413 → 1413
ph 4.25 → 4.01
7.07 → 7.00
10.16 → 10.01

930 Water sample @ 2'

	pH	ORP	SC
932	7.24	652.0	133.7
934	6.38	656.8	134.5
936	6.16	657.0	137.2
938	6.14	649.0	136.1
942	6.12	640.6	136.4
946	6.12	630.0	136.2
949	6.11	625.5	136.2
954	6.16	611.3	137.0

TP MS.05 GPS 12T 0395053, 5210732

943 TP MS.05 (1.2-1.5) bag soil
1600 TP MS.05 (A) " "
dup 1.2-1.5
948 TP MS.05 (1.8-2) bag soil
953 TP MS.05 (3.3-3.5) " "
~~1000 TP MS.05 (4.5-5)~~ " " (10)

8/29/12

1011 TP MS.05 (4-4.5) bag soil
1018 TP MS.05 (6-6.5) " "
1028 TP MS.05 (9-9.5) " "
1033 water @ 9.5'

	pH	ORP	SC
1034	6.21	409.0	135.5
1035	6.18	389.1	135.7
1037	6.17	372.5	135.7
1039	6.17	364.7	135.5
1044	6.17	352.8	135.0
1046	6.17	349.1	134.9
1048	6.17	346.1	134.9
~~1050~~ 1052	6.17	339.7	134.5
1054	6.17	336.7	134.0
1056			

1035 Install perzo + backfill
1048 Dig TP Bulk.07
right next to TP MS.05
1053 TP Bulk.07 (0.5-1) 1 bucket soil
1057 TP Bulk.07 (2-3) 8 buckets soil
1115 Backfill
1135 Move to TP MS.06
GPS: 12T 0395058, 5210748

Rite in the Rain

8/29/12

1137 TP-MS-06 (0.5-1) bag soil
1140 TP-MS-06 (1-1.5) " "
1145 TP-MS-06 (1.6-2.3 A) " "
1152 Water sample @ 2'

	pH	ORP	SC
1153	5.80	450.9	104.6
1159	5.68	453.9	103.7
1207	5.67	466.2	103.5
1212	5.67	472.1	103.5

1155 TP-MS-06 (2.5-2.7) bag soil
1205 TP-MS-06 (4.5-5) " "
1212 Water sample @ 6'

	pH	ORP	SC
1214	5.71	457.3	121.9
1216	5.78	441.3	122.4
1218	5.70	434.2	124.0
1220	5.68	430.5	124.9
1222	5.68	427.4	125.8
1226	5.66	420.1	126.5
1228	5.64	417.5	126.0
1230	5.64	409.6	125.9
1232	5.64	403.7	126.1
1234	5.64	395.4	126.1

1220 Install perizo + backfill
1430 Site cleanup + perizometer additions as needed
1520 Leave site

TP-FP-31
stickup = 5.0
TP-FP-33
stickup = 5.2

Rite in the Rain

T@1 BS@2 HI = 5.25 ϕ = 5.56'

STORE 3001 & 3002	= 31 ft
3003 & 3004	= 25.6'
3005 & 3006	= 34.6'
3007 & 3008	= 34.3'
3009 & 3010	= 51
3011 & 3012	= 45.5'

TC1	47°00'46.758"N	112°27'06.246"W
TC2	47°00'44.028"N	112°27'04.332"W
TC3	47°00'40.914"N	112°27'01.194"W
TC4	47°00'39.726"N	112°26'58.872"W
TC5	47°00'38.874"N	112°26'55.332"W
TC6	47°00'38.292"N	112°26'48.594"W

FINAL

DEQ CONTRACT NO. 407040
TASK ORDER 13

UBMC FLOODPLAIN INVESTIGATION SAMPLING AND ANALYSIS PLAN

PREPARED FOR

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

Prepared by:

Spectrum Engineering
1413 4th Ave. North
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July 12, 2012

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1 INTRODUCTION

This site-specific Sampling and Analysis Plan (SAP) has been prepared for the Montana Department of Environmental Quality Remediation Division pursuant to Task Order Number 13, Contract No. 407040, issued by DEQ. This site-specific SAP has been designed to guide aspects of environmental field sampling, data collection, and laboratory analytical activities for the floodplain investigation at the Upper Blackfoot Mining Complex (UBMC). Anticipated duties under this investigation include, but are not necessarily limited to:

- Soils Investigation - test pitting and/or soil boring investigations to define the nature and extent of mine wastes deposited in the Upper Blackfoot River floodplain from the tailings impoundment through the upper marsh (wetlands) areas.
- Alluvium Gradation Sampling - collect bulk samples of the floodplain materials for geotechnical analysis to define typical material gradations in the floodplain.
- Groundwater Investigation - install piezometers in the test pits (or soil borings) to measure the groundwater elevation and collect stream flow data to better define floodplain hydrology and seasonal groundwater elevations.
- Bedrock Investigation - complete a drilling and geophysical investigation of several floodplain transects to better define the depth to bedrock beneath the floodplain alluvium.

All work identified in this Sampling and Analysis Plan (SAP) will be completed by Spectrum Engineering (Spectrum) and Pioneer Technical Services, Inc. (Pioneer) with Montana Department of Environmental Quality (DEQ or Agency) oversight. This SAP presents the sampling approach for the UBMC Floodplain Investigation and includes the following appendices:

- Sample Plan Maps (Appendix A)
- Field Forms (Appendix B)
- Site-Specific Health and Safety Plan (SSHSP) (Appendix C)
- Quality Assurance Project Plan (QAPP) (Appendix D)

The QAPP is a stand-alone document to be used for all future design-level investigations. It is included in this SAP as Appendix D.

1.1 Project Location

The UBMC is located approximately 15 miles east of Lincoln, Montana, in the headwaters area of the upper Blackfoot River (Figure 1).The UBMC includes numerous abandoned or inactive mine sites located on a mixture of National Forest and private lands within a portion of the historic Heddleston Mining District and surrounding lands in the Rocky Mountains of Lewis and Clark County, Montana.

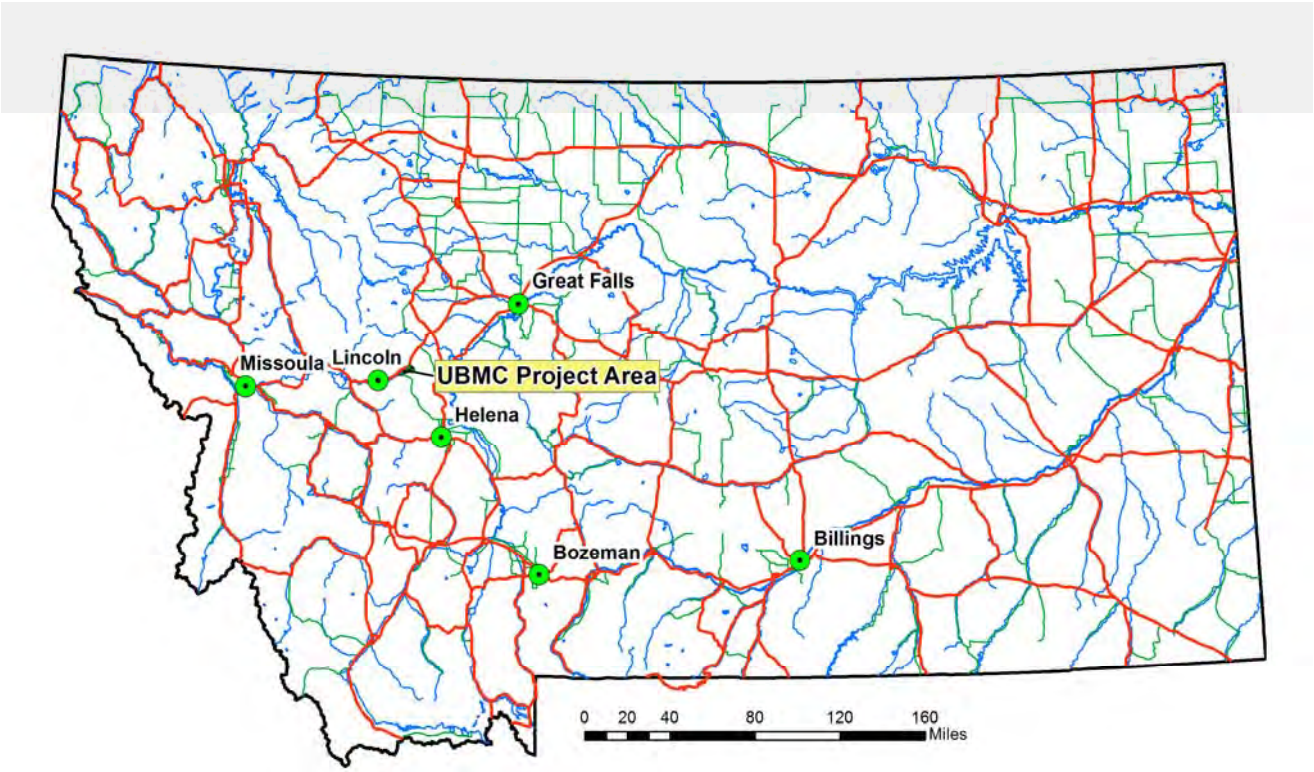

Figure 1 - Project Location Map

1.2 Site Description

The UBMC includes a number of individual underground mines that developed deposits occurring principally as narrow, fault-controlled, base-metal (lead- zinc) veins. The Mike Horse Mine, the largest producing mine within the UBMC, occurs at latitude 47º01'31.87" North, and longitude 112º21'41.48" West.

Historic mining activity at the UBMC generated hard-rock mining wastes (e.g. waste rock and tailings materials, etc.) and acidic water discharges (e.g. adit discharges and seeps, waste pile seeps, etc.) that impact the environment. Human health and environmental concerns at the site are related to elevated concentrations of heavy metals present in mine waste rock piles and impounded tailings; metal-bearing surface water, groundwater, sediments, and water discharging from mine adits; and tailings redeposited as stream sediments. Numerous investigations have been conducted over the last 20 years to characterize contamination in mine wastes and have identified arsenic, cadmium, copper, lead, iron, manganese and zinc as the primary Contaminants of Concern (CoC's) at the site.

1.3 Background and Site History

Alluvial sediments and soils in the floodplain below the Mike Horse Dam have been contaminated by past mining and milling activities in the basin and from a catastrophic failure of the Mike Horse Dam in 1975. The breach of the dam was caused by heavy precipitation and blockage of the diversion ditch by a debris flow that diverted water directly into the tailings pond. The original drain system that protected the dam was also plugged during this event, which allowed the flood flows to fill the impoundment completely and discharge over the top of the earthen dam. The flows over the top of the dam eroded more than 100,000 cubic yards of tailings and several thousand yards of hillside colluvium from the east

end of the dam. These eroded materials washed downstream and were deposited along approximately 2.5 miles of Blackfoot River floodplain.

The materials eroded by the flood included materials scoured to an undetermined depth from the native floodplain. Some of these scoured materials were transported downstream by the violent flood flows and re-deposited in the floodplain. These existing floodplain materials were mixed with tailings eroded from the tailings dam and the impoundment, including the debris flow deposits immediately below the dam. The data collection efforts to date have focused on identifying the lateral extent of the contamination. Very little information has been collected concerning the depth of the contamination or how the contaminants can be identified, quantified, and remediated. The depth of the mixed scour, deposition, and debris flow deposits is not well known.

Based on numerous geology and geochemistry maps and reports that DEQ has obtained from the Anaconda Collection at the American Heritage Center, of the University of Wyoming, the entire area is heavily mineralized with vein deposits of lead and zinc, and large disseminated deposits of copper and iron sulfides. Spectrum Engineering has geo-referenced the geology and geochemistry maps into an ArcMap® database which shows that these deposits cross the valley and sub-crop beneath the alluvium intermittently for approximately 3 miles between upper Mike Horse Creek to Meadow Creek. The primary CoCs within the mining area are also found in the native material.

Previous test pitting and sampling completed by Spectrum Engineering (Spectrum 2009), Hydrometrics (multiple reports 1988 through 2005) and TetraTech (TetraTech 2001) indicate that the metals concentrations in the minus 10 mesh fraction in the undisturbed alluvium (natural metals-laden materials) are similar to the concentrations in the mining-related metals-laden materials visible on the ground surface. Based on these findings, metals concentration alone cannot be used to distinguish native sediments from mine waste. In these previous sampling events, the principal differences observed between the disturbed and undisturbed sediments are the color, texture, and whether the sediments were jumbled and mixed or well sorted. The platy argillite gravel observed beneath the jumbled and mixed alluvium is well organized with the plates lying horizontally or stacked in an imbricate structure, whereas the plates are disorganized and mixed with random coarse rock and tailings near the surface. Many of the test pits excavated previously by Spectrum (Spectrum 2009) and Hydrometrics (multiple reports 1988 to 2005) also showed a layer of black sooty textured stained gravel (iron and manganese oxides and hydroxides) at the low water table interface. Sulfide minerals (especially pyrite) were observed in the sediments above and below the low water table elevation. The sulfide minerals above the water table typically appeared dull, indicating that they had oxidized, whereas the sulfides below the water table appeared shiny and bright, indicating that they were in a reducing environment.

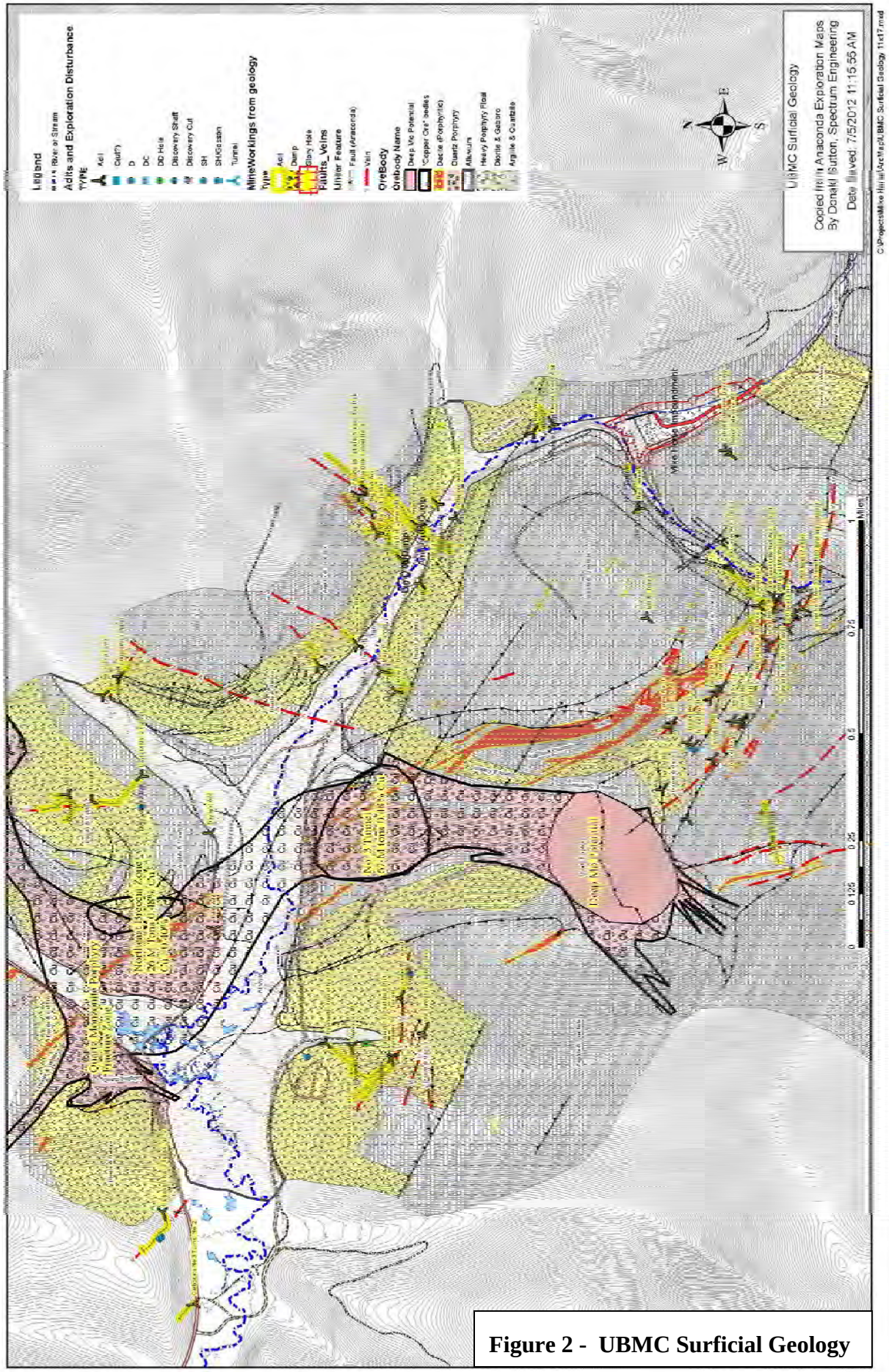

Figure 2 - UBMC Surficial Geology

2 SCOPE OF PROJECT

The Montana Department of Environmental Quality (DEQ) is proceeding with removal actions per the Forest Service's 2007 EE/CA and Action Memorandum, and the 2012 Amendment to the Action Memorandum at the UBMC. DEQ is also continuing with its remedial investigation and feasibility study for lands not held by the Forest Service. Spectrum has been contracted by DEQ to complete an investigation to collect data to better define the nature and extent of contamination in the floodplain of the Blackfoot River at the UBMC and will complete all field sampling work described in this SAP, with Pioneer Technical Services providing additional field personnel and resource expertise.

The scope of the sampling effort described in this SAP is to collect the data and information necessary to determine the vertical extent of mine waste materials in the Blackfoot River floodplain within the UBMC. The data and information collected under this SAP will be used to discern mine waste from native materials, to quantify the potential volume of materials to be removed, define water table elevations, define the depth to bedrock, and gather other site information as appropriate. These data can then be used to analyze the effectiveness and feasibility of various remediation and stream restoration options, as well as delineate native material from mine waste for purposes of removal.

2.1 DESCRIPTION OF ACTIVITIES

Eighteen transects that cross the valley will be established, test pitted and sampled. The transect locations are between the toe of the dam and the Meadow Creek bridge, with four (4) to six (6) test pits on each transect (**See Sample Plan Maps, Appendix A)** The alluvium will be sampled from the surface to approximately 10 to 15 feet deep depending on the ground stability and the reach of the excavator. Samples will be collected and analyzed to determine the metals concentrations in each type/color/texture of sediment above and below the water table, to define the metal concentration as a function of depth, and to determine if there is a reliable method to discern the tailings/mine waste contaminated alluvium from the native undisturbed alluvium.

The groundwater investigation includes installing piezometers in most test pits (or bore holes) to collect the groundwater elevation data needed to identify the low water table surface. Depth to water in the piezometers will be measured at the time of installation and seasonally to monitor seasonal water table fluctuations. Transducers will be installed in at least two (2) transects of piezometers. Staff gages or stream elevation measuring points will also be established at each transect to measure the surface water elevation at each transect.

The thickness of the alluvium (depth to the bedrock) is unknown or poorly defined in most areas of the floodplain. A combination of bore holes and seismic refraction lines will be used to estimate depth to bedrock.

The data and information to be collected under this SAP includes:

- Sampling approximately 87 test pit/drill hole locations along 18 transects across the Beartrap and Upper Blackfoot river valleys (60 test pits above the marsh, 27 test pits or drill holes in the marsh) to determine the distribution of metals as a function of depth and lithology in the alluvium.
- Collecting and analyzing the alluvium samples to determine chemical and physical characteristics of the tailings, mixed materials, and native (undisturbed) alluvium.

- Field testing the groundwater seeping from test pit walls for field pH, specific conductance (SC) and, oxidation/reduction potential (Eh).
- Installing piezometers in approximately 87 test pits/bore hole locations (where the water table is below the surface of the floodplain) to define the low groundwater surface and to help define gaining or losing stream reaches. Transducers will be installed in at least two (2) transects of piezometers. The transducers will be installed and monitored by Portage, Inc.
- Installing staff gages or stream elevation measuring points at each transect.
- Collecting nine (9) large bulk samples of the stream alluvium for stream design purposes.
- Completing a seismic survey along eight (8) lines across the valley (about 2400 feet total length along the seismic lines) to estimate the depth to bedrock.
- Completing eight (8) seismic calibration borings to bedrock to calibrate the seismic lines.

Samples will be collected, handled and analyzed as described below and according to the standard operating procedures (SOPs) provided in the Appendix B of the QAPP (Appendix D). Quality assurance (QA) and data validation procedures are described in the QAPP (Appendix D).

2.2 SOILS INVESTIGATION

This section describes the soils investigation to characterize the mine waste in the floodplain, and collection of bulk samples of the alluvium to assist with stream channel design. Samples will be obtained from test pits dug with a track-mounted excavator wherever feasible. Samples may be collected manually with a shovel, or using a small drill rig in saturated areas where test pitting is not feasible. The primary activities associated with the sampling and analysis will include:

- Identify, locate, and clearly mark test pit locations.
- Excavate test pits.
- Document the depth-to-groundwater in each test pit.
- Dewater the test pit, if required.
- Collect and analyze samples
- Install a 1” diameter PVC piezometer in each test pit, and then backfill around the piezometer.
- Split and screen samples to minus 10 mesh in Pioneer’s laboratory.
- Analyze samples with the portable XRF unit and submit selected samples to the analytical laboratory.
- Archive the remaining samples for further analysis, if required.
- Survey the test pit and piezometer locations and elevations.

2.2.1 Test Pit or Borehole Location and Identification

The sampling plan maps (**Appendix A)** show the approximate locations of the proposed test pits or soil borings. Each test pit or borehole has a pre-assigned unique identification. The approximate test pit coordinates in Montana State Plane NAD83 International feet are provided in **Table 1, Table 2**, and

Table 3**.** The coordinates will be uploaded to a recreational or resource grade GPS unit to help the sampling team locate each proposed test pit in the field. The actual locations will later be surveyed using survey grade techniques.

The sampling team may adjust the exact test pit location or add additional test pits in the field as needed to better identify the horizontal extent of impacted soils, to reflect field observations, or because of access constraints. All modified or additional test pit locations will be identified and documented during

the site investigation. The approximate location will be determined by the field crew by measuring from the nearest staked location or using the resource-grade GPS unit. These measurements will be documented in the field logbook and clearly staked and flagged for surveying. Borings will be identified with a metal identification tag placed on the piezometer standpipe (if applicable) or on a wooden stake.

Table 1- Proposed Test Pit Locations Above the Marsh

Name	Northing	Easting	Type		Name	Northing	Easting	Type
TP-FP-01 & 02 are bulk samples					TP-FP-31	1,255,625	1,028,497	Test Pit/Piezometer
TP-FP-03	1,257,149	1,026,273	Test Pit/Piezometer		TP-FP-32	1,255,653	1,028,535	Test Pit/Piezometer
TP-FP-04	1,257,196	1,026,258	Test Pit/Piezometer		TP-FP-33	1,255,681	1,028,573	Test Pit/Piezometer
TP-FP-05	1,257,227	1,026,248	Test Pit/Piezometer		TP-FP-34	1,254,277	1,029,108	Test Pit/Piezometer
TP-FP-06	1,257,278	1,026,232	Test Pit/Piezometer		TP-FP-35	1,254,310	1,029,153	Test Pit/Piezometer
TP-FP-07	1,257,015	1,026,948	Test Pit/Piezometer		TP-FP-36	1,254,344	1,029,200	Test Pit/Piezometer
TP-FP-08	1,257,047	1,026,961	Test Pit/Piezometer		TP-FP-37	1,254,387	1,029,257	Test Pit/Piezometer
TP-FP-09	1,257,091	1,026,978	Test Pit/Piezometer		TP-FP-38	1,254,426	1,029,311	Test Pit/Piezometer
TP-FP-10	1,257,142	1,026,999	Test Pit/Piezometer		TP-FP-39	1,254,488	1,029,395	Test Pit/Piezometer
TP-FP-11	1,256,829	1,027,412	Test Pit/Piezometer		TP-FP-40	1,253,466	1,029,688	Test Pit/Piezometer
TP-FP-12	1,256,868	1,027,428	Test Pit/Piezometer		TP-FP-41	1,253,523	1,029,747	Test Pit/Piezometer
TP-FP-13	1,256,907	1,027,445	Test Pit/Piezometer		TP-FP-42	1,253,592	1,029,823	Test Pit/Piezometer
TP-FP-14	1,256,938	1,027,457	Test Pit/Piezometer		TP-FP-43	1,253,635	1,029,869	Test Pit/Piezometer
TP-FP-15	1,256,604	1,027,800	Test Pit/Piezometer		TP-FP-44	1,253,692	1,029,927	Test Pit/Piezometer
TP-FP-16	1,256,670	1,027,824	Test Pit/Piezometer		TP-FP-45	1,253,760	1,029,996	Test Pit/Piezometer
TP-FP-17	1,256,727	1,027,846	Test Pit/Piezometer		TP-FP-46	1,252,846	1,030,231	Test Pit/Piezometer
TP-FP-18	1,256,789	1,027,871	Test Pit/Piezometer		TP-FP-47	1,252,852	1,030,306	Test Pit/Piezometer
TP-FP-19	1,256,848	1,027,889	Test Pit/Piezometer		TP-FP-48	1,252,862	1,030,432	Test Pit/Piezometer
TP-FP-20	1,256,532	1,027,968	Test Pit/Piezometer		TP-FP-49	1,252,874	1,030,588	Test Pit/Piezometer
TP-FP-21	1,256,568	1,028,009	Test Pit/Piezometer		TP-FP-50	1,252,885	1,030,715	Test Pit/Piezometer
TP-FP-22	1,256,598	1,028,052	Test Pit/Piezometer		TP-FP-51	1,252,899	1,030,839	Test Pit/Piezometer
TP-FP-23	1,256,634	1,028,100	Test Pit/Piezometer		TP-FP-52	1,252,156	1,030,066	Test Pit/Piezometer
TP-FP-24	1,256,686	1,028,172	Test Pit/Piezometer		TP-FP-54	1,252,167	1,030,226	Test Pit/Piezometer
TP-FP-25	1,256,289	1,028,071	Test Pit/Piezometer		TP-FP-55	1,252,177	1,030,404	Test Pit/Piezometer
TP-FP-26	1,256,308	1,028,124	Test Pit/Piezometer		TP-FP-56	1,252,190	1,030,619	Test Pit/Piezometer
TP-FP-27	1,256,328	1,028,183	Test Pit/Piezometer		TP-FP-57	1,251,358	1,030,122	Test Pit/Piezometer
TP-FP-28	1,256,348	1,028,236	Test Pit/Piezometer		TP-FP-58	1,251,349	1,030,301	Test Pit/Piezometer
TP-FP-29	1,256,369	1,028,291	Test Pit/Piezometer		TP-FP-59	1,251,336	1,030,444	Test Pit/Piezometer
TP-FP-30	1,255,583	1,028,440	Test Pit/Piezometer		TP-FP-60	1,251,334	1,030,626	Test Pit/Piezometer

Table 2 - Proposed Test Pits (or or Soil Borings) Locations in the Marsh

Name	Northing	Easting	Type	Name	Northing	Easting	Type
TP-MS-01	1,250,080	1,030,408	Test Pit/Piezometer	TP-MS-12	1,248,815	1,031,083	Test Pit/Piezometer
TP-MS-02	1,250,080	1,030,408	Test Pit/Piezometer	TP-MS-13	1,248,744	1,031,224	Test Pit/Piezometer
TP-MS-03	1,250,220	1,030,564	Test Pit/Piezometer	TP-MS-14	1,248,665	1,031,379	Test Pit/Piezometer
TP-MS-04	1,250,338	1,030,716	Test Pit/Piezometer	TP-MS-15	1,248,613	1,031,505	Test Pit/Piezometer
TP-MS-05	1,250,444	1,030,842	Test Pit/Piezometer	TP-MS-16	1,248,098	1,030,796	Test Pit/Piezometer
TP-MS-06	1,250,584	1,031,014	Test Pit/Piezometer	TP-MS-17	1,247,884	1,030,921	Test Pit/Piezometer
TP-MS-07	1,249,184	1,030,786	Test Pit/Piezometer	TP-MS-19	1,247,758	1,031,243	Test Pit/Piezometer
TP-MS-08	1,249,536	1,031,226	Test Pit/Piezometer	TP-MS-20	1,247,466	1,030,542	Test Pit/Piezometer
TP-MS-09	1,249,586	1,031,259	Test Pit/Piezometer	TP-MS-21	1,247,449	1,030,766	Test Pit/Piezometer
TP-MS-10a	1,249,733	1,031,482	Test Pit/Piezometer	TP-MS-22	1,247,460	1,030,909	Test Pit/Piezometer
TP-MS-10b	1,249,702	1,031,554	Test Pit/Piezometer	TP-MS-23	1,247,409	1,031,050	Test Pit/Piezometer
TP-MS-10c	1,249,923	1,031,561	Test Pit/Piezometer	TP-MS-24	1,246,795	1,030,818	Test Pit/Piezometer
TP-MS-10d	1,249,893	1,031,635	Test Pit/Piezometer	TP-MS-25	1,246,707	1,030,956	Test Pit/Piezometer
TP-MS-11a	1,249,350	1,031,606	Test Pit/Piezometer	TP-MS-26	1,246,628	1,031,045	Test Pit/Piezometer
MS11b	1,249,294	1,031,557	Test Pit/Piezometer	TP-MS-27	1,246,552	1,031,148	Test Pit/Piezometer

Table 3 - Proposed Floodplain Bulk Sample Locations

Name	Northing	Easting	Type
TP-FP-01[(1)]	1,257,032	1,026,043	Floodplain Bulk Sample
TP-FP-02[(1)]	1,257,105	1,026,138	Floodplain Bulk Sample
TP-Bulk-01	1,257,250	1,026,334	Floodplain Bulk Sample
TP-Bulk-02	1,256,813	1,027,609	Floodplain Bulk Sample
TP-Bulk-03	1,255,735	1,028,461	Floodplain Bulk Sample
TP-Bulk-04	1,254,377	1,029,141	Floodplain Bulk Sample
TP-Bulk-05	1,252,934	1,030,376	Floodplain Bulk Sample
TP-Bulk-06	1,251,371	1,030,245	Floodplain Bulk Sample
TP-Bulk-07	1,250,412	1,030,706	Floodplain Bulk Sample

[(1)] TP-FP-01 and 02 are samples of the townsite fill that was pushed into the creek, apparently covering old jig tailings or mine waste. The fill will be sampled for particle size distribution and metals, the jig tailings will be sampled separately for particle size distribution and metals.

2.2.2 Test Pitting Using an Excavator or Backhoe

Samples will be collected using an excavator that can allow sampling to at least 15 feet deep where feasible. Previous backhoe test pits showed a high degree of variability within each test pit and demonstrated that test pitting provides superior information to a drill hole, therefore test pits will be dug wherever feasible.

One wall of the test pit will be prepared for evaluation and sampling. Excavated materials will be stockpiled a minimum of three (3) feet from the edge of the excavation. Side slopes of the three walls not logged and sampled will be sloped at an angle of 1.5 horizontal (H):1 vertical (V) to minimize the possibility of sloughing or cave-ins. A competent person or licensed Professional Engineer will assess the stability and sloping requirement(s) for each test pit before sampling. If a specific area is presenting excavation or sampling problems and it is necessary to sample deeper, then a drill (as described below) will be used.

Dewatering of the test pits may be required to provide safe access for lithologic logging and sampling. If necessary, a trash pump will be used to dewater the pit. Water will be discharged into a nearby test pit that is still open or to an area on the floodplain that will not erode and will allow infiltration before the water can enter the stream channel.

The textural classification and lithology of the test pit sidewalls will be logged and photographed/videoed. This will include a soil log of the test pit sidewall, including texture, rock content estimate, color, depth to top and bottom of each stratigraphic unit, visual interpretation of the depth of tailings, and depth-to-groundwater. All relevant observations will be recorded in a bound field logbook on the form provided in **Appendix B**. Each test pit will be photographed or videoed to document existing conditions.

2.2.3 Test Pit Sampling Equipment

Test pits will be excavated using a track-mounted or rubber-tired excavator to provide access for sampling soils at depth. Equipment utilized to collect soil samples will include:

- Sharpshooter shovels and spoons or disposable sampling scoops;
- Field logbook and data log;
- Measuring tape;
- Munsell color chart;
- Sample containers and labels;
- Chain of custody forms;
- Decontamination supplies (tap water, dilute nitric acid, liquinox soap, decontamination containers, paper towels, scrub brushes, and spray bottles);
- Camera and film, digital camera, or digital video camera;
- Portable pump;
- Personal Protective Equipment (PPE); and,
- Field pH, EC, and SC meters.

2.2.4 Test Pit Sampling

The sampling team will describe and sample each stratigraphic layer, including the black colored redox zone (if present in sufficient thickness to sample), to the maximum depth of the test pit or bore hole. The sample interval will be no more than 2.0 feet thick, but a separate sample will be taken for each change in the texture/color/lithology based on the judgment of the sampler. If there is doubt regarding whether an interval should be split, it will be split into at least two samples. The sample intervals will be logged by the Sampling Team to visually assess, if feasible, whether the sample is mine tailings, disturbed by flood events, or native, undisturbed material. The alluvium texture and color will be described and recorded using the universal soil classification nomenclature. Anticipated typical test pit sampling intervals and guidelines are illustrated on Figure 3 - 3.

Test pits will be excavated to below groundwater elevation, if feasible. If the amount of groundwater entering the test pit causes sidewall instability, sampling will begin as close to the base of the test pit as is practical and safe. In these cases, if it is visually evident that impacted material extends below the depth at which the sloughing occurs, sampling in larger intervals may be performed with the excavator bucket to estimate the maximum depth of impacted soils. Samples collected in this manner will be flagged for special consideration in the data validation process. Field parameters and visual observations will be recorded and these samples will be analyzed with the XRF unit to provide at least Level III data for design purposes. Anticipated typical test pit sampling intervals and guidelines are illustrated on 3.

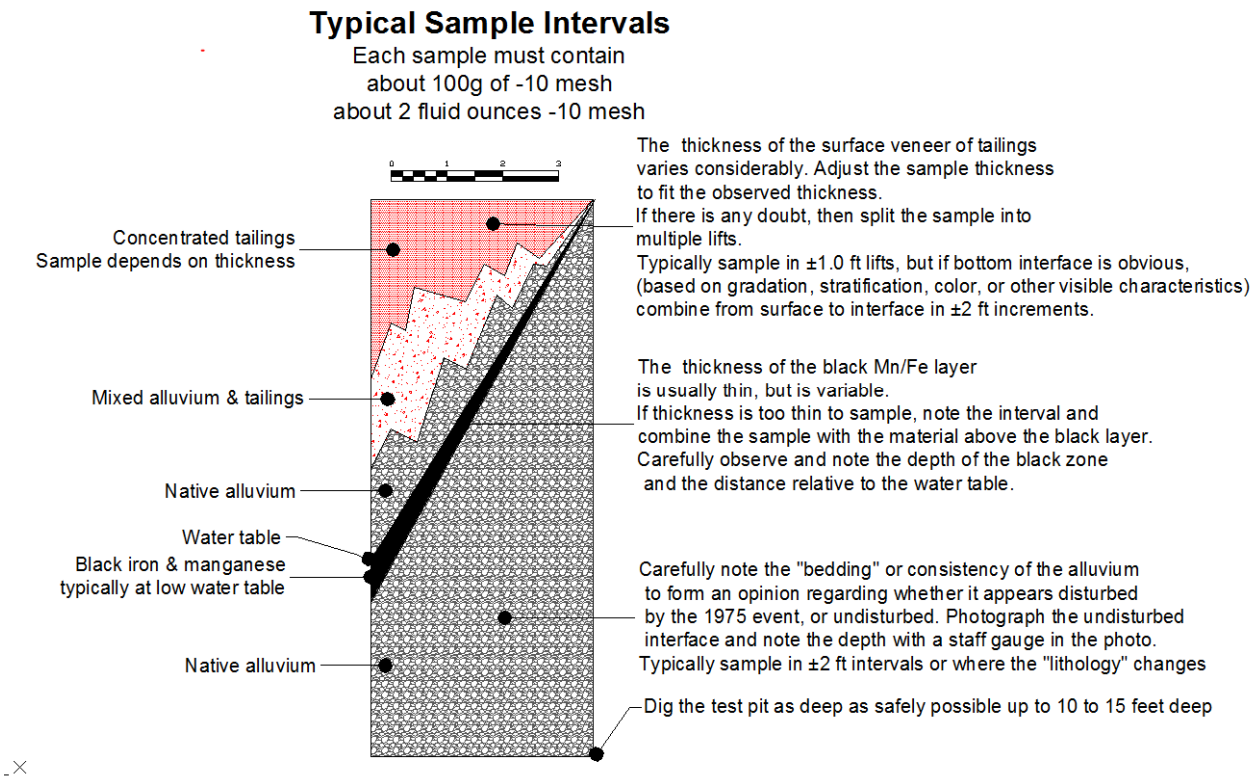

Figure 3 - Typical Test Pit Sampling Intervals

Samples will be obtained using a disposable hand scoops or decontaminated shovel by scraping samples from the sidewall into a sample container. The Field Team Leader will determine if a larger sample is appropriate and if it is safe to enter the pit to collect samples. If it is unsafe, then the excavator will obtain the sample, and the sample will be collected from the excavator bucket. Samples collected in this manner will flagged for special consideration in the data validation process. Field parameters and visual observations will be recorded and these samples will be analyzed with the XRF unit to provide at least Level III data for design purposes.

Gallon-sized samples will be collected in order to obtain at least 50 grams of minus-10 mesh material in each sample. If the material is very rocky with only a small fine fraction, samples may be collected in decontaminated five-gallon buckets or proctor bags. Gravel samples will include field sieving air dried samples on the #4, 3/8, 3/4, and 3” sizes, for textural classification only. 6” and 12” sizes will be estimated by use of photographs with a survey rod placed on the soil in the photo. The samples will be

taken to Pioneer's lab where they will be further described, screened to obtain samples of the minus 10 mesh material for metals analysis, and repackaged for XRF and/or laboratory analysis.

No water samples will be collected for laboratory analysis, but the pH, SC and Eh of ground water that enters the pit will be tested, if feasible. All water sampling results will be recorded in the field logbook.

2.2.5 Test Pit Surveying

Each site will be surveyed by a qualified Land Surveyor. The surveyor will locate the coordinates, ground surface elevation, and the top of the piezometer elevation (measuring point or MP). The accuracy will be to within 1-foot horizontally and 0.1-foot vertically. Survey data will be collected using the Montana State Plane (NAD 83) coordinate system and North American Vertical Datum (NAVD) 1988. Surveying will be completed by the state-contracted surveyor.

2.2.6 Soil Boring Methods

It may not be feasible to sample the marsh or other areas using a small excavator, because many of the sample sites may be inundated (submerged below the water surface elevation). The existing old drill roads in the marsh will be used (where available) to access the wettest portion of the marsh. If representative samples cannot be obtained using a small excavator, soil borings will be employed to collect soil samples using a small drill rig and split spoon samples.

The primary activities associated with the sampling and analysis will include:

- Drill borings using auger and/or ODEX drilling techniques.
- Document the depth-to-groundwater in each of the borings.
- Collect and analyze split-spoon samples of both impacted and non-impacted soils.
- Split and screen samples in the geotechnical laboratory and submit samples to the analytical laboratory.
- Archive the remaining samples for further analysis, or geotechnical testing if required.
- Survey the boring locations and elevations.
- Decontaminate equipment between borings.

Auger drilling may be used for up to twenty seven (27) locations in the marsh area if the use of a mini-excavator and test pits in these same locations is not feasible. Auger drilling in the marsh area will use a low ground pressure tracked drill rig or a skid mounted hydraulically powered ODEX drill. Drilling on the project will be completed by Earth Stabilization and Drilling, LLC or Axis Drilling.

The auger drill will use a hollow exterior casing that can be linked in 5-foot increments as the boring depth is increased. The interior of the auger casing is filled with drill rods and a pilot bit while drilling. The pilot bit extends out of the bottom of the auger casing slightly to prevent intrusion of soils into the hollow casing while drilling. The hollow casing prevents cave-in above the sampling depth and allow undisturbed samples to be obtained at any sampling depth below the auger.

Auger and ODEX drills both use rotary motion to advance either a hollow series of connected augers or hollow threaded drill casing to maintain a continuously open hole to the new sampling depth. Both methods employ an internal drill string to plug the open end of the casing while the drill bit is advanced. Auger drills use rotary motion only and the cuttings are removed by auger flights on the outside of the casing. The ODEX drill uses rotary motion coupled with a percussive drill bit to advance the hole.

The percussive bit on the ODEX rig creates a slightly oversize hole that the casing, which is attached to the bit, follows at approximately the same depth as the bit. The bit is typically a "button style" bit that both rotates and hammers. Cuttings are removed by a pressurized air supply. The air supply also

powers an impact hammer which gives the ODEX rig sufficient power to drill through rock using percussive energy. The ODEX method maintains a cased hole for undisturbed sampling of soils below the bottom of the bit. If soil conditions are soft the percussive action is not activated.

The ODEX drilling method could be used if deeper borings that require environmental sampling are deemed necessary for any reason in the marsh area. In this case the drilling would advance to the proposed depth of sampling and the percussive drill bit and drill rod is removed. If this sample depth is substantially below the groundwater elevation, local site water will be used to flood the boring and prevent heaving of materials into the casing. At present, deeper boring samples using the ODEX method are not anticipated for this sampling event and the ODEX descriptions are included only in case site conditions prohibit use of the auger equipment.

2.2.7 Drill and Sampling Equipment

The borings will be completed with either a skid mounted auger drill rig or a track mounted ODEX unit. The skid mounted auger drill has a weight of approximately 3,000 pounds and requires a small portable diesel powered hydraulic power pack that is also skid mounted. The track mounted ODEX drill has a weight of approximately 10,000 to 20,000 pounds depending on the rig and requires a tow behind air compressor. These criteria limit the ability to use this equipment in some areas and these drills will be used to sample the marsh only if test pitting is not at all feasible. The Sampling Team will consult with DEQ to determine if drilling is needed to sample the marsh area.

Equipment utilized to collect soil samples from the soil borings will include:

- Drill rig with or without split spoon samplers depending on the method;
- Split spoon samplers;
- Field logbook, pens, and measuring tape;
- Sample containers and labels;
- Chain of custody forms;
- Coolers;
- Decontamination equipment (pressure washer, tap water, dilute HNO_3, liquinox soap, decontamination containers, paper towels, scrub brushes, and spray bottles);
- Camera and film or digital camera;
- Portable pump; and,
- Personal Protective Equipment (PPE).

2.2.8 Soil Boring Sampling Procedure

When a sampling depth is reached the drill rods and the pilot bit will be removed and a split spoon sampler will be attached to the bottom of the drill rods and inserted into the center of the augers or casing. The sampling spoon will be lowered to the bottom of the hole and a 140-lb hammer attached to the drill rods at the surface. The hammer will drive the sampler into the undisturbed soils below the cased hole. The hammer will be rhythmically raised and allowed to drop 30-inches (one blow). The number of blows required to drive the sampler each 6-inch increment will be recorded and the sampler will be driven 18 to 24 inches depending on the sample recovery. The blow count or standard penetration value (SPT) is described as the number of blows to drive a 2-inch diameter sampler the second and third 6-inch increments below the initial sample depth. This information is useful for engineering purposes and will be recorded. Oversized 2.5 to 3 inches samplers will be used to maximize the sample recovery and volume. The SPT values will be corrected for the larger sampler.

Each boring will be logged in the field. Additional information will be appended to the log in the office as needed to reflect observation of soil cores and to attach testing results as the laboratory data is received. There will be one driller and at least one drilling helper on-site at all times.

Each sample will be labeled with the job name and sample ID number, the drill hole number, and sealed in zip log bags. A tag with the sample information will be placed between the inner plastic bag and an outer protective bag to ensure the sample does not become separated from the sampling label. Each sample will be photographed in the field and in the laboratory when the cores are exposed and a photo log will be prepared. Soil texture will be assessed when a change in lithology that may affect removal techniques or restoration parameters is noted.

2.2.9 Selection of Soil Boring Samples for Laboratory Analyses

All samples collected from the soil borings will be transported to the laboratory for observation, sample selection, collection and analysis. The cores will be examined in sequence within each boring to define discreet samples of each lithology and to select the appropriate sample interval to be analyzed. All samples will be sealed in a plastic bag as described in Section 3.1.7, Table 6, and labeled and analyzed as described in Section 2.6 and Section 3.

2.2.10 Field Duplicates

Field duplicates of the samples from the test pits will be collected during the test pitting operation. A duplicate sample will be taken from the test pit wall directly adjacent to the original sample at the same interval. Field duplicates of the samples from the soil borings (if applicable) will be collected when the sample cores are examined in the laboratory. The interval requiring a duplicate will be sampled twice. Additional information on field duplicate sampling is described in Section 3.1.6.

2.3 ALLUVIUM GRADATION SAMPLING

Up to 9 large bulk samples consisting of 8 to 10 5-gallon buckets or approximately 500 to 700 pounds (40-50 gallons per sample) of alluvial material will be collected from below the bottom of the impacted soil. These samples will be tested at Pioneer's accredited geotechnical laboratory to determine bulk gradations to assist in evaluation of stream restoration alternatives. These samples will be collected by scraping a vertical column in the test pit wall and testing the entire sample.

2.4 GROUNDWATER INVESTIGATION

The groundwater elevation within the investigation area is variable and depends on seasonal water level fluctuations and proximity to the hillsides. These fluctuations may significantly affect the relative mobility of metals within the system. Groundwater elevations are expected to be a key design constraint. Groundwater parameters including pH, Eh and SC are useful in determining the oxidation/reduction potential and will assist in assessing the mobility of metals in the groundwater. Piezometers will be installed in all test pits (or soil borings) unless the ground surface is below the water surface. The following sections discuss the installation of the piezometers and staff gages.

2.4.1 Piezometer Location and Identification

Approximately 87 piezometers will be installed in test pit excavations or soil borings. Piezometers will be identified with the same number as the test pit ID with the prefix "PZ". For example, a piezometer

identified as PZ-TP-14 indicates this is the piezometer installed in test pit TP-14. Transducers will be installed and monitored by Portage Inc. in at least two (2) transects of piezometers.

2.4.2 Piezometer Installation

This section details the installation process of the piezometers to be installed during the floodplain investigation. Test pits will be excavated with a track-mounted or rubber-tired excavator. Equipment, materials, and supplies utilized to install the piezometer will include:

- One 1-inch by 5 or 10-foot Schedule 80 PVC (flush-threaded) casing per piezometer;
- One 1-inch by 5-foot Schedule 80 PVC screen 0.010 slot (flush-threaded) per piezometer;
- One 1-inch PVC bottom cap;
- One 1-inch slip cap;
- One 40- to 50-foot rope;
- Field logbook and measuring tape;
- Sharpie marker;
- Water level probe;
- Metal Tag with the test pit identification
- Camera; and
- PPE.

Piezometers will be installed in test pits as follows:

1. Excavate and log test pit.
2. Assemble 1-inch diameter schedule 80 PVC piezometer with bottom cap, top cap and sufficient riser pipe to place the top of the screen approximately 1 foot above the water table. More than 10 feet of blank riser pipe may be needed at some locations.
3. Place 1-inch PVC casing string into the corner of the test pit selected for the piezometer installation.
4. Hold the 1-inch PVC casing vertical while the test pit is slowly backfilled to existing ground surface. Caution must be taken to ensure that ground personnel are a safe distance from heavy equipment. A rope tied around the casing can be used by one or two ground personnel to keep the casing vertical while staying clear of the equipment. Equipment operator should be careful not to place large cobbles near the PVC casing.
5. After the test pit is backfilled to the original grade, cut the 1-inch PVC piezometer riser 4 feet (or the desired stick-up height) above the existing ground surface.
6. Using a permanent marker, mark a measuring point on the north side of the piezometer riser pipe and write the piezometer identification on side of riser and inside the slip cap. Attach a metal label to each standpipe with wire. The metal label will be stamped with the test pit identification.

2.4.3 Piezometer Surveying

The piezometer location and elevation will be surveyed as described in the test pit surveying section. Data collected will include piezometer designation, northing, easting, measuring point (MP) elevation, and stickup. The accuracy of the survey will be to within one-foot horizontal (H) and 0.1-foot vertical (V). Survey data will be collected and presented in the Montana State Plane (NAD 83) coordinate

system and elevations will be based on NAVD 1988. Surveying will be completed by a DEQ-contracted surveyor.

2.4.4 Stream Gage Location

A ±6 ft tall metal fence post (or rebar equivalent) will be installed adjacent to the stream channel so that the distance from the top of the post to the water surface can be measured by hammering the post at least one to two feet deep into the floodplain. (The post should be cemented with one bag of pre-mix concrete to maintain a solid post, if the post cannot be driven deep enough.) The measurement will be recorded. The gage identifier (ID) will be written on the gage with permanent marker, and a metal tag with the ID will be affixed with wire or tape. The identifier will be similar to the piezometers and will reflect the ID of the piezometer on either side. If the gage is between PZ-TP-10 and PZ-TP-11, the ID will be PZ-TP-10/11

The gage location and elevation will be surveyed using methods described in the test pit surveying section. Data collected will include piezometer designation, northing, easting, elevation, and stickup above the ground. The accuracy of the survey will be to within one-foot horizontal (H) and 0.1-foot vertical (V). Survey data will be collected and presented in the Montana State Plane (NAD 83) coordinate system and elevations will be based on NAVD 1988. Surveying will be completed by a DEQ-contracted surveyor.

2.4.5 Staff Gage Installation

Equipment and supplies used to install staff gages include the following:

- Field logbook and measuring tape;
- One standard steel T-type fence post;
- Post driver or sledge hammer;
- One standard commercially available graduated staff gage or 2.5 foot long section of ½ diameter rebar;
- Mounting hardware;
- Permanent marker;
- Metal tag
- Camera;
- Waders and wading shoes; and,
- PPE, including life vests.

The staff gages will be installed as follows:

1. Select a stable and safe location in the stream channel, protected from ice jams or floes.
2. Drive the steel T-type fence post into the channel bottom at least 1-2 feet as described in 2.4.4.
3. If using a rebar monument, drive into ground as far as feasible at a location on the back as close to the stream channel as feasible.
4. Attach the staff gage to the T-type post per manufacturer's instructions.
5. Ensure base of the staff gage rests on stream channel bottom.
6. Ensure gage can be read safely from the streambank.
7. Label staff gage face with identification number using a permanent marker. Record the distance from the top of the post to the water surface.

8. Photograph location and record the information in the field logbook.
9. Survey the elevation of the top of the post during field survey.

2.4.6 Groundwater Sampling and Field Testing

Groundwater sampling will be limited to measuring field parameters on water seeping in to the test pits. Field testing will include pH, Eh, and SC. Sampling and analysis will be completed as described in the SOPs provided in Appendix B to the QAPP (**Appendix D**).

2.4.7 Surface Water Flow Measurements

Surface water flow will be measured at each transect after piezometers are installed whenever the piezometers are measured. The surface water flow at these locations will be measured using a Marsh-McBirney flow meter or the bucket and stopwatch method for measuring flow depending on the amount of flow present. Flow measurements will be completed as described in the SOPs provided in Appendix B to the QAPP (**Appendix D**).

2.5 BEDROCK INVESTIGATION (SEISMIC SURVEY)

A seismic refraction survey will be completed to estimate the depth to bedrock beneath the alluvium, i.e. the thickness of the alluvium. Eight (8) seismic refraction lines will be selected based on the results of the test pitting investigation. The seismic refraction lines will be completed along eight (8) selected test pit transects. The seismic lines will produce an estimated bedrock elevation across the entire valley width for each seismic line completed instead of a single depth to bedrock at a single boring location, which may or may not be representative of other locations in the valley cross-section. Because the geophones used to detect the source energy must have a direct connection to the soil, the bedrock investigation will be completed when the ground surface is free of snow and not frozen.

A seismic calibration boring will be completed at each refraction line using the ODEX method. Each boring will be logged by the Sampling Team. The boring will be advanced at least 10 feet into bedrock to ensure that the actual bedrock interface is reached. Once the depth to bedrock is known, the seismic velocity profile will be correlated to known bedrock elevation in the boring. A lithology log describing the color and texture and rock types will be recorded. The cuttings will not be sampled and will be replaced in the boring when the boring is completed.

Eight seismic refraction lines will be completed to correlate the velocity profile with each drilled borehole. Additional seismic lines can then be completed between boreholes at a future date to define depth to bedrock at other locations, if necessary, without the need for additional expensive boreholes.

The seismic refraction surveys will be conducted using either a Seistronix RAS-24 or a Mark Products refraction apparatus depending on which is available at the time. Both systems are 24-channel seismographs with stacking capabilities. The ground array will include geophones set on 5-meter spacing and the excitation source will be placed on 2.5- and 12.5-meter spacing on the ends of each line and at 15-meter spacing in the central portion of each array. The seismograph will be positioned in the center of two 12-channel arrays. If the width of the valley is less than the length of the two 12-channel arrays, the spacing will be reduced to take advantage of all geophones. If the line is longer than can be covered by the 24 geophones at 5-meter spacing, the seismograph will be “leapfrogged” by first disconnecting the first 12-channel array, moving the seismograph, and then utilizing the second array as the first array. The original 12-channel array will then be “leapfrogged” over the second array and be

used as a third 12-channel array. This can be continued in sequence to complete as long of a line as necessary.

The energy source will be a heavy sledge hammer based on the expected depth of bedrock in most areas. Multiple hammer blows can be stacked to mimic a larger energy source. However, other heavier energy sources such as a large dead-drop could be employed for lines in the marsh area if they are needed.

The data will be uploaded into data processing software which creates an image file showing the material velocity vs. depth and location along the survey line. This data will be used to show the velocity distribution cross-section for each seismic line that will be included in the data summary report. The estimated bedrock elevation data will be converted to a digital format that will show the interpreted depth to bedrock along each seismic survey line.

2.5.1 Seismic Calibration Borings

One bore hole will be drilled to bedrock on each seismic line to calibrate the seismic depths to bedrock. No samples will be collected but the drill cuttings will be logged to define the general lithology and correlate to the seismic survey. Locations of the borings are shown on the maps in Appendix A and the coordinates are provide in Table 4.

The ODEX method will be used to complete a total of eight (8) borings. This drilling method is rapid and the holes will be advanced 10 feet into bedrock to be certain the hole is not terminated on a large boulder. Boulders and cobbles are present in the alluvium in the middle and upper reaches and the ODEX method was selected because auger drill rigs may meet refusal on large boulders and cannot penetrate bedrock.

Table 4 - Location of Seismic Refraction Calibration Bore Holes

Name	Northing	Easting	Type
SRB-01	1257210	1026313	Seismic Refraction Calibration Bore Hole to Bedrock
SRB-02	1256734	1027785	Seismic Refraction Calibration Bore Hole to Bedrock
SRB-03	1254079	1029458	Seismic Refraction Calibration Bore Hole to Bedrock
SRB-04	1253243	1030282	Seismic Refraction Calibration Bore Hole to Bedrock
SRB-05	1251774	1030490	Seismic Refraction Calibration Bore Hole to Bedrock
SRB-06	1250330	1031269	Seismic Refraction Calibration Bore Hole to Bedrock
SRB-07	1246193	1031057	Seismic Refraction Calibration Bore Hole to Bedrock

A stake will be driven into the ground at the location of each borehole and the location of each end of the seismic line and clearly identified with a permanent ink marker. As soon as the seismic survey is complete, the surveyors will be notified so the locations can be accurately located. The surveyors will survey the ground profile along each seismic line.

2.6 SAMPLE ANALYSIS

This section describes the sample analysis procedures for the project. The following samples will analyzed for metals by XRF; 10% of the samples will be sent to an analytical laboratory:

- Four (4) to six (6) samples per test pit for the 60 test pits above the marsh,
- Four (4) to six (6) samples per test pit or drill hole for the 27 test pits or drill holes in the marsh.

The following samples will analyzed in the geotechnical laboratory for physical properties:

- Nine (9) large bulk samples (7 stream alluvium samples and 2 samples from the Mike Horse town site fill) ,
- One (1) sample per bulk sample pit for TP-Bulk-01 through 7 and up to two (2) samples from each of TP-FP-1 and TP-FP-2.

The analytical sample analysis parameters and the respective method of analysis are listed in Table 5.

Table 5 - Analytical Sample Target Analyte List (TAL)

PARAMETER	LOCATION	ANALYSIS METHOD
TAL Metals: Aluminum, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Zinc	Analytical Lab/Field Lab	QAPP Table 1
Soil Texture	Geotechnical Lab	QAPP Table 1
Proctor	Geotechnical Lab	QAPP Table 1
Particle Size	Geotechnical Lab	QAPP Table 1

2.6.1 XRF Analysis

The minus 10 portion of the 4-6 soil samples collected from each test pit or soil boring will be analyzed in Pioneer's laboratory using a multi-source or X-Ray Tube XRF instrument according to EPA Method 6200 (Appendix C of the QAPP provided in Appendix D). The XRF unit will be properly calibrated with standards and operated as described in the method. Ten percent (10%) of the samples analyzed by XRF will be submitted to Energy Laboratories for metals testing and the results will be used to verify XRF results and to develop a statistical relationship to the XRF results.

Samples collected in the field will be brought back to the lab, air dried and weighed, screened to separate the minus 10 mesh fraction, and weighed again to estimate the percentage of the minus-10 mesh material in the sample. All sample drying and screening equipment will be properly decontaminated as described in Section 3.1.1. The minus 10 mesh material will be bagged as described in Section 3.1.7, Table 6.

The XRF unit to be used will include a sample stand which allows the samples to be analyzed in the plastic bags. Prior to XRF analysis, samples will be homogenized to reduce the variability within the sample. Duplicate XRF analyses will be carried out on at least five percent (5%) of the samples analyzed in the XRF unit.

All paired duplicate analyses (XRF vs XRF and XRF vs laboratory analysis) will be compared to develop the relative percent difference (RPD) for the XRF vs XRF analysis as well as the RPD for the XRF vs laboratory analysis. Accuracy for the XRF will be assessed by reporting the percent recovery (%R) for analysis of the standard samples with known concentrations and by comparing the RPD for the XRF vs Laboratory analyses. The precision, accuracy, representativeness, completeness, and comparability (PARCC) statement for the project will address the XRF data as described in Section 5.0 of the QAPP (Appendix D).

2.6.2 Sample Labeling

All test pit samples will be collected and sealed in plastic bags. Geotechnical samples and materials with significant coarse materials will be sealed in proctor bags or decontaminated 5 gallon buckets with lids. The floodplain bulk samples will be collected and sealed in multiple proctor bags or five-gallon buckets with lids. The sample ID, date, and depth interval of the sample will be written on the sample container with an indelible marker. If the sample is collected from a soil boring, the core will be sealed in a plastic bag and then that bag and an adhesive sample tag with the number will be placed inside a second bag to ensure the sample does not become separated from the tag.

The samples will be taken to Pioneer's lab to be screened and weighed. The minus10 mesh fraction will be re-bagged with the identical sample number in a suitable zip lock bag for the XRF analyzer and for delivery to Energy labs, if appropriate. Samples will be stored, handled, and packaged as described in Section 3.1.6, Table 6.

A copy of the chain of custody record will accompany the samples during shipment and will serve as laboratory request forms. The chain of custody form will specify the type of analysis requested for each individual sample. The original form will be maintained with the field notes and in the project records.

2.6.3 Sample Disposal and Archiving

All samples not submitted to the laboratory will be archived. When it is determined that the samples are no longer needed, they will be disposed at the site in an area approved by DEQ.

2.6.4 Test Pit Field Parameters

The following field measurement will be made during the test pitting as described above. All field measurements will be completed according to the SOPs provided in the QAPP (Appendix D).

FIELD PARAMETER	OBJECTIVE	WHEN COLLECTED
Eh	Determine if groundwater is oxidized or reduced, general assessment of stability during aquifer test	As soon as feasible when water first seeps into the test pit
pH	Assess state of dissolved metals according to general Eh-pH diagrams, general assessment of stability during aquifer test	As soon as feasible when water first seeps into the test pit
SC	Relative estimate of dissolved metals concentration, general assessment of stability during aquifer test	As soon as feasible when water first seeps into the test pit
Temperature	General information, needed for calibration of field instruments.	As soon as feasible when water first seeps into the test pit

3 SAMPLING PROTOCOL

3.1 FIELD PROCEDURES

All field activities including sampling and analytical methods, quality assurance/quality control (QA/QC) procedures, equipment and personnel decontamination, sample designation and handling, and documentation will follow Pioneer's SOPs presented in Appendix B of the QAPP (Appendix D).

3.1.1 Equipment Decontamination

Gallon-sized or larger samples for metals analysis will be collected using a disposable scoop. If disposable scoops are not available, a trowel or small shovel will be used then cleaned for each sample collected. If necessary, the sampling tool decontamination procedure is:

1. Mechanical removal of gross debris by brushing or other means.
2. Tap water rinse to loosen and remove debris.
3. Soap (liquinox/Simple Green) and water wash.
4. Dilute nitric acid rinse.
5. Deionized water rinse.

The sampling may be performed when the temperatures may be below freezing, so it may not always be possible to follow all four decontamination steps. If it is below freezing, and proper decontamination is not possible, only disposable tools will be used.

The drill rigs and excavators will arrive at the site decontaminated. The drill rigs will provide their own decontamination equipment and will be decontaminated between sample locations. The drill rigs will be decontaminated prior to leaving the Site. Decontamination fluids will be disposed of to the ground surface. Gross contamination will be removed from the excavator with a shovel prior to leaving the site and from bucket between test pits. If the equipment encounters materials that cannot be adequately removed manually, power-washing or other methods will be employed.

Disposable equipment intended for one-time use and personal protective equipment (PPE) materials will not be decontaminated but will be packaged for appropriate disposal as a solid waste in the local landfill. Any other equipment used will also be decontaminated before leaving the site to prevent off-site transport of contaminants. All personnel must undergo decontamination procedures when leaving a contaminated area, for their own protection. Personnel decontamination includes routine practices as well as emergency decontamination; all procedures will follow EPA protocols. All measures will be taken to prevent the spread of potentially contaminated materials to clean areas.

3.1.2 Sample Designation and Labeling

A sample number system will be used to uniquely identify the project site, the sample medium, and the specific sample location and depth interval. The following is an example of the sample numbering system:

Sample Number:	**TP-02(1.6-3.1)-082812**
Media:	TP – Test Pit, SB – Soil Boring
Location:	TP-15 - Sample Location (corresponds with Test Pit ID No.).
	All sample locations are plotted on the sampling maps.

Depth Interval:	(Upper limit-Lower limit), e.g. (1.6-3.1). If sample is a duplicate, label the interval "A." Do not use specific intervals. Intervals and duplicates will be recorded on the field log or logbook.
Date:	082812 - sample collected on August 28, 2012

The sample identification number will be derived from the test pit or boring number with the Site Name followed by the sample interval enclosed in parentheses. For example, a sample designated SB-02(1.6-3.1), describes a sample from borehole SB-02 taken from a depth of 1.6-3.1 feet below existing grade. All measurements will be decimal feet. There will be no blank spaces permitted in the identification.

All subsample locations and depths will be described in the data log. The field logbook will include the subsample locations plotted on the site sketch. All samples will be labeled in the field with documentation of the date and time of sample collection, the sample number, analyses requested, and the sampler's initials. A permanent marker will be used for labeling.

3.1.3 Quality Assurance/Quality Control Sampling

The field investigation includes collection of soil samples only. Equipment blanks and field blanks are not needed. Field duplicates will be collected and analyzed to assess overall sampling error.

3.1.4 Equipment Contamination Blank

Equipment contamination blanks will not be collected for this soil sampling effort. The drilling augers, casing, drill rods, and samplers will be properly decontaminated between boreholes, and the excavator bucket will have gross contamination removed with a shovel between test pits, while disposable sampling trowels will be used to collect the samples to be analyzed.

3.1.5 Field Blanks

Field blanks will not be collected for this soil sampling effort.

3.1.6 Field Duplicate Samples

A field duplicate is defined as two or more samples collected independently at the same sampling location during a single act of sampling. Field duplicates will be indistinguishable from other samples by the laboratory. Each of the field duplicates will be uniquely identified with a coded identifier. Duplicate sample results are used to assess the precision of the sample collection process. A field duplicate will be collected for five percent (1 for every 20 samples) of all field samples collected. For test pit samples, a duplicate sample of the same interval will be collected adjacent to the original sample. Field duplicates of the samples from the soil borings (if applicable) will be collected when the sample cores are examined in the laboratory. Two samples will be collected over the same interval within the soil boring.

3.1.7 Sample Handling

Sample containers, and holding times are listed in Table 6. All procedures will strictly follow appropriate protocols and SOP's (Appendix B). Chain of custody records will be kept with the samples and custody seals will be placed on the sample storage containers (coolers).

Table 6 - Laboratory Sample Collection, Preservation And Holding Times

MEDIA	PARAMETER	ANALYTICAL METHOD	PRESERVATION	HOLDING TIME	SAMPLE SIZE	SAMPLE CONTAINER
Solid	Total Metals (TAL)	CLP SOW 3/92	Ice to 4ºC	180 days; Hg 28 days	8 oz.	8 oz. plastic bag
Solid	Soil Texture	USDA Handbook #18	N/A	N/A	N/A	N/A
Solid	pH	S-2.10 WSLPTP	N/A	N/A	4 oz.	1 qt. ziploc storage bags
Solid	Conductivity	S-1.20 WSLPTP	N/A	N/A	4 oz.	1 qt. ziploc storage bags
Solid	Atterberg Limits	Method D4318 ASTM	N/A	N/A	4 oz.	1 qt. ziploc storage bags
Solid	Moisture Content	CLP SOW 3/92	N/A	N/A	4 oz.	1 qt. ziploc storage bags
Solid	Standard Proctor	Methods D698 ASTM	N/A	N/A	25 lbs.	5 gal. bucket or Proctor Bag
Solid	Particle size	Method D422 ASTM	N/A	N/A	varies	Multiple 5 Gal Buckets or Proctor Bags

TAL - Target Analyte List; from the EPA Contract Laboratory Program (CLP) SOW (EPA, 1990);

CAWW - Methods for Chemical Analysis of Water and Wastes (EPA, 1984).

SW-846 - Test Methods for Evaluating Solid Waste-Physical/Chemical Methods, SW-846 (EPA, 1986).

OAMS - Field and Laboratory Methods Applicable to Overburden and Mine Soils (EPA, 1978).

SWQ - Mine Spoils Potentials for Soil and Water Quality (EPA, 1974).

MSA - Methods of Soil Analysis Part 2: Chemical and Microbiological Properties (SSSA, 1982).

ASTM - American Society for Testing and Materials (ASTM, 1985).

DISAS - Diagnosis and Improvement of Saline and Alkali Soils.

MDMES - Methods for the Determination of Metals in Environmental Samples (MDMES, 1991).

ASA #9 - American Society of Agronomy, Methods of Soil Analysis (ASA, 1965).

WSLPTP - Western States Laboratory Proficiency Testing Program

3.1.8 Documentation

All field sampling activities and non-sampling data collection will be recorded in a bound field logbook. The field team leader is responsible for recording information including weather conditions, field crew members, visitors to the site, samples collected, date and time of sample collection, procedures used, any field data collected, and any deviations from this SAP, per EPA guidance (EPA, 1974 and 1978). Individual field team members may be responsible for required documentation based upon specific tasks assigned by the field project manager in the field.

An example of the data log format is provided in Appendix B. The information will be transcribed into gINT® geotechnical software and exported to a spreadsheet or database that can be merged with the analytical and survey data.

All significant observations, measurements, relevant data, and results will be clearly documented in the data log or the field logbook. The following will be recorded:

- The date.
- A lithologic log of the test pit indicating material types, from and to depths, rock content, color, presence of water, etc.
- Presence of visually discernible tailings impacted alluvium.
- For each interval note whether the alluvium appears disturbed or native. Identify and separately sample the discernible tailings layer.
- Specify whether the tailings are continuous within the pit or if it appears to be a stringer deposit.
- Consider and note how the disturbed interval could be identified during remediation (removal).
- Depth intervals from the ground surface for each soil horizon and total depth of the test pit.
- Depth-to-groundwater, identifying the depth at which water is seen initially flowing into the pit.
- Record water pH, SC, and Eh when it begins flowing into pit and after the water level in the pit stabilizes.
- After a piezometer is installed (if applicable), record the height of stickup and the distance from the top of the piezometer (MP) to the water.
- Sample location descriptions and designations, soil type and texture (e.g., sand, silt, etc.), grain-size, and color will be noted in the field and further described by the lab.
- Photograph or video of each test pit or trench with a staff gage or tape measure for scale to document existing conditions. Include site name ID in photo using a white board or note pad.
- Abnormal occurrences, deviations from the SAP, or other relevant observations.

3.1.9 Photographs and Video

Field sampling activities will be documented with photographs and/or video. The following information will be documented in the field logbook for each photograph or video taken:

- Time, date, and location;
- Photo or video number from the camera or video recorder;
- The identity of the person taking the photograph/video; and,
- Direction that the photograph was taken and description of the subject photographed.

3.1.10 Field Activities Oversight

The DEQ oversight personnel will have the ability to inspect each test pit and determine the appropriateness of the recorded data and ensure that the appropriate samples are collected. Copies of field logbook pages will be provided to the DEQ as part of the data summary report.

Any deviations from this SAP will be brought to the attention of DEQ oversight personnel, or if first determined by oversight personnel, Spectrum will be immediately notified. Reasons for such deviations will be recorded in the field logbook, along with corrective actions to be implemented, if required. If DEQ oversight personnel request a deviation from the SAP, the deviation, and the reasons for the deviation will be noted and then signed by the agency personnel.

3.1.11 Post-Sampling Activities

As applicable, samples will be either hand-delivered to Pioneer's lab or hand-delivered or shipped via Federal Express to Energy Laboratories under strict EPA chain of custody procedures. Samples will be shipped in appropriate containers that will prevent detrimental effects to the sample.

4 PROJECT ORGANIZATION AND RESPONSIBILITIES

The roles, duties and responsibilities of personnel assigned to this project are provided below.

4.1 DEQ Project Officer – Shellie Haaland

The DEQ Project Officer will oversee the field activities are provide input regarding field decisions. DEQ will notify the Forest Service and the Montana Environmental Trust Group prior to field activities.

4.2 Project Manager/Coordinator – Donald Sutton (Spectrum Engineering)

The responsibilities of the Project Manager are project coordination and liaison with DEQ, assisting in field planning, problem solving and decision making, quality assurance, and preparing and reviewing project documents. The project manager/coordinator will also review and check all chain-of-custody forms and assist with data validation and reporting.

4.3 Field Project Manager – Pat Redmond (Pioneer)

The Field Project Manager is responsible for implementing and maintaining the integrity of the SAP. This includes communicating the SAP requirements to all personnel, supervising fieldwork, and making appropriate changes to the SAP, if necessary.

4.4 Health and Safety Officer – Tara Schleeman (Pioneer)

The Health and Safety Officer will ensure that work crews comply with all site health and safety requirements and will coordinate with the Sampling Leader/Field Health and Safety Officer to revise the SAP and HASP, if necessary.

4.5 Sampling Leader/Field Health and Safety Officer – Niki Griffis (Pioneer)

The Sampling Leader/Field Health and Safety Officer will ensure that the SAP is followed for all required field activities. The Sampling Leader/Field Health and Safety Officer will lead all field activities, document activities in the logbook, oversee equipment calibration and maintenance, solve problems, and make decisions affecting the SAP and safety in the field. The Sampling Leader/Field Health and Safety Officer will ensure that work crews comply with all site health and safety

requirements and will coordinate with the Health and Safety Officer to revise the HASP (Appendix C) if necessary. The sampling leader will also review and check all chain-of-custody forms and assist with data validation and reporting.

4.6 Field Samplers – Patrick Redmond, Jeffrey Riedel, Niki Griffis, others (Pioneer)

The Field Samplers assist in all required field activities as directed by the Sampling Leader/Field Health and Safety Officer including sampling, monitoring and decontamination procedures according to the SAP, HASP, and this QAPP. All Field Samplers will participate in all required safety meetings and assist with hazard analyses to identify safety hazards, concerns, and specify appropriate safety measures for the field work.

5 HEALTH AND SAFETY

A site -specific Health and Safety Plan (HASP) has been prepared (Appendix C) for this SAP. Potential hazards associated with this work include:

- Collection of samples within test pits;
- Heavy equipment hazards; and,
- Exposure to heavy metals from impacted soils and groundwater.

The potential hazards listed above are addressed in the site-specific Health and Safety Plan including the safety precautions that will be taken to ensure site safety.

6 SCHEDULE

Fieldwork is scheduled to begin in the summer of 2012 and will proceed until completed (approximately 6-8 weeks). The logistics include one field sampling team consisting of four people: Field Project Manager, Field Health and Safety Officer, and two field samplers. Subcontractors will also be on the site during the investigation.

7 DATA ANALYSIS AND REPORTING

This section describes data analysis methods for determining the elevation of the base of impacted soils. All laboratory data will be validated as described in the QAPP (Appendix D).

7.1 Data Analysis

Laboratory data generated by Pioneer and Energy Labs will be conveyed to Spectrum Engineering in a pre-approved Excel format. The data will include the geotechnical data from gINT® exported to Excel, the particle size analysis data, the field measurements and data, and the metals concentrations. These data will be converted to the Carlson Geology® format so that the data can be presented in “three-dimensional” (3D) cross sections compatible with AutoCAD® and ArcMap®. The groundwater elevation data will be merged into the existing piezometer database and plotted on the same cross sections as the test pit lithology and analytical data.

Data validation and the PARCC statement will be prepared as described in Section 5.0 of the QAPP. The PARCC statement will evaluate all data to determine if data quality objectives for the project are met.

7.2 Reporting

A data summary report (DSR) will be prepared to summarize the activities carried out under this SAP. Data will be presented in table format and all data will be validated using a DEQ-approved data validation checklist and all validation reports will be included in the DSR. The report will be prepared in draft form for submittal to DEQ. After receipt of comments, the final version will be distributed. A key portion of this report will be the database with all the sample data and the elevation of the base of impacted soil for each test pit. The report will include discussion of any deviations from the approved SAP, an estimate of the volume of impacted soil, and a site map showing test pit locations, sample locations, piezometer locations, and estimated extent of the impacted soil. The DSR will include hard and electronic copies (on compact disc) of all laboratory reports, maps, copies of field notes and other field forms, and photographs/videos will be attached to the DSR.

The seismic data will be reported on cross sections that also show the test pit data and the bore holes. The bedrock interface will be shown as a line on each cross section. Copies of the raw seismic data cross sections will be included as an appendix to the DSR.

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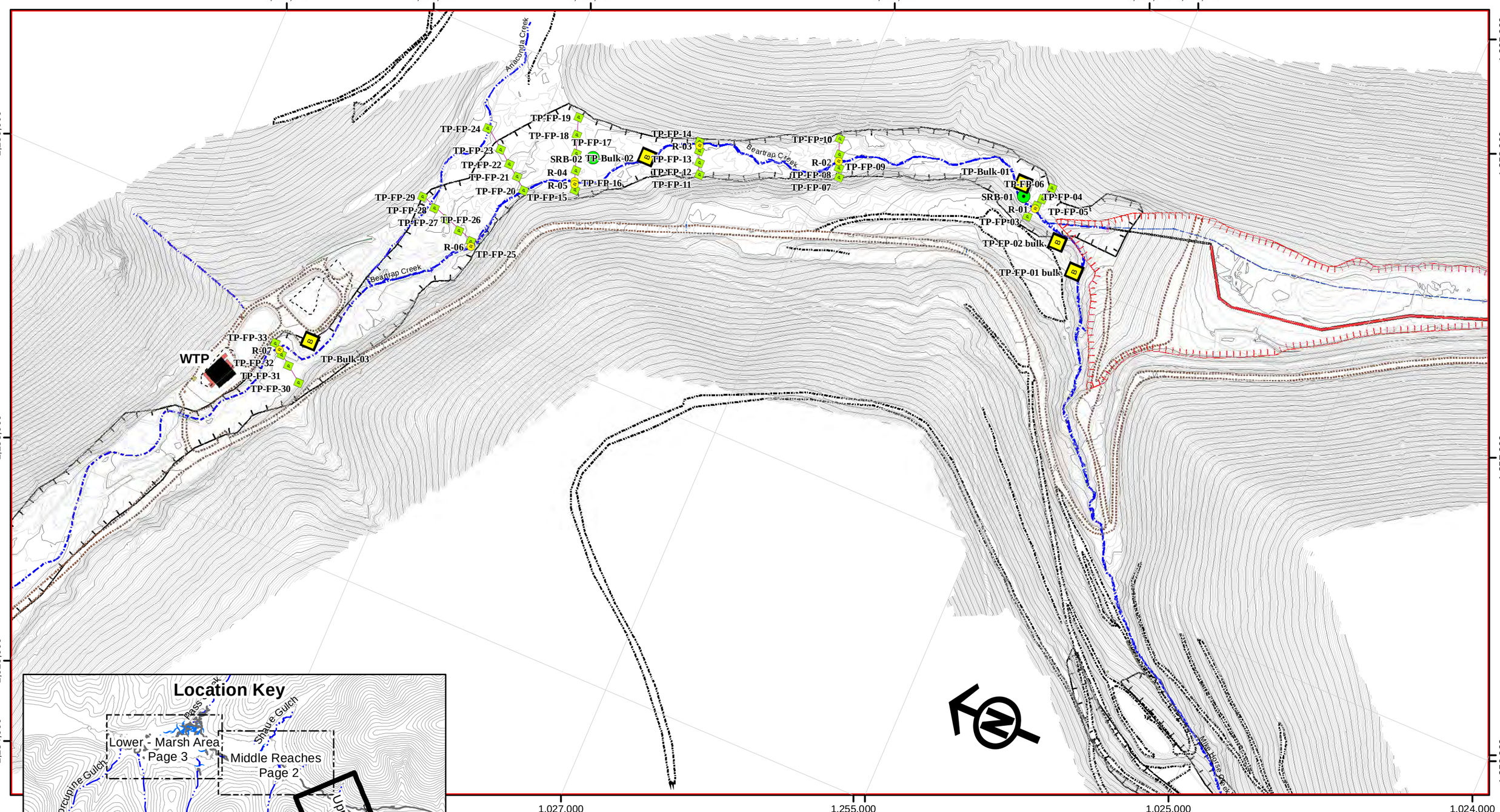
APPENDIX A: SAMPLE PLAN MAPS



B Bulk Sample

M Marsh Test Pit with piezo

R Rebar surface water gage

Seismic Bore Hole to bedrock

P Test Pit with piezo

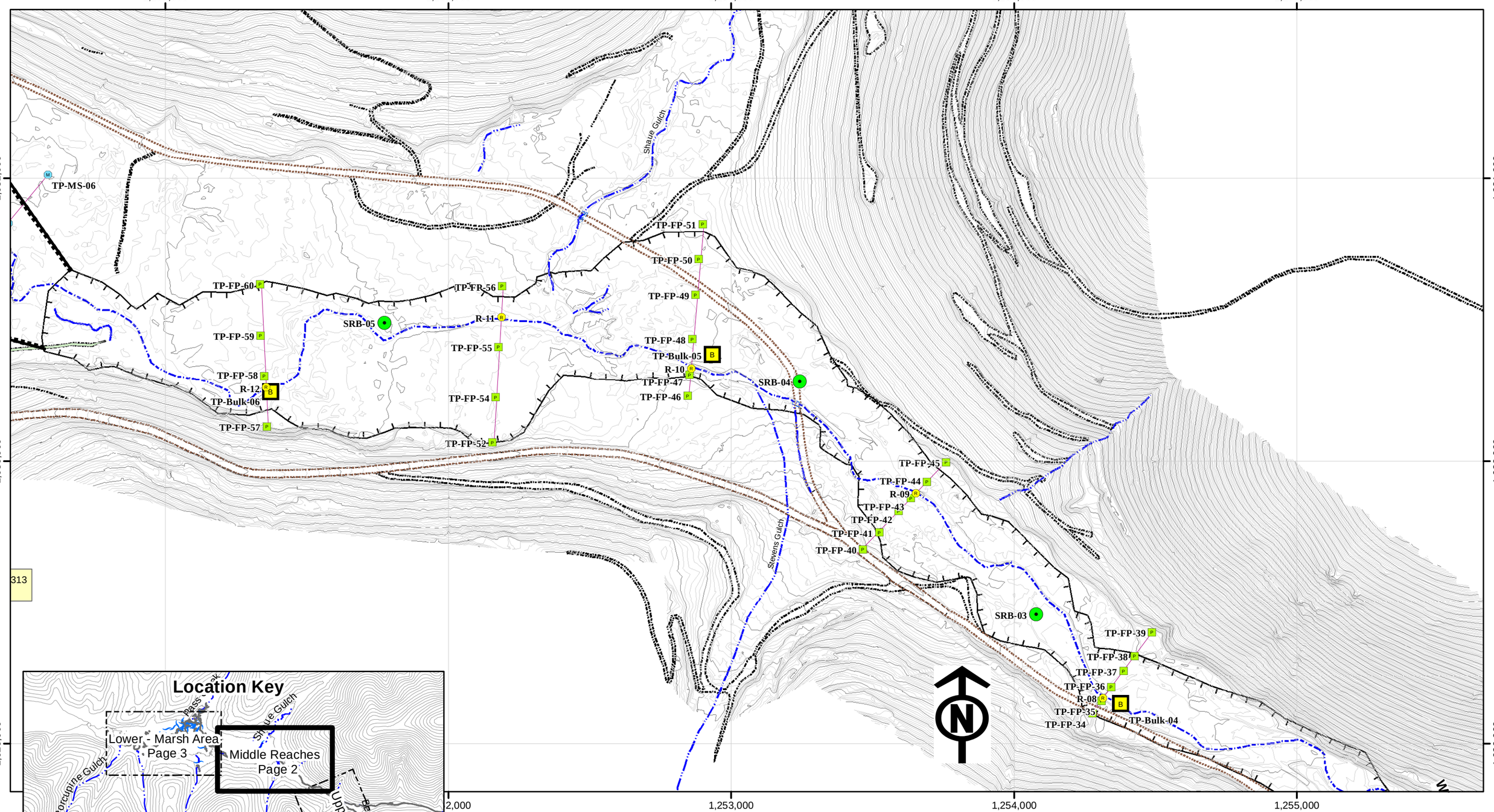
UBMC 2012 Data Gap Sampling Plan

Upper Reaches

2012 Sampling Plan for UBMC Removals.mxd

Date: 7/4/2012 Page 1

Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl



Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl

UBMC 2012 Data Gap Sampling Plan

Middle Reaches

2012 Sampling Plan for UBMC Removals.mxd

Date: 7/4/2012

1,246,000 1,247,000 1,248,000 1,249,000 1,250,000

1,032,000 1,031,000 1,030,000

Page Creek

TP-MS-11a
TP-MS-11b
TP-MS-10d
TP-MS-10b
R-14
1960's drill road road slightly higher than swamp
TP-MS-15
TP-MS-14
R-15
TP-MS-13
TP-MS-19
4' nick point
4' nick point Paymaster
TP-MS-09
TP-MS-08
SRB-06
Beaver dam on Paymaster drainage
TP-MS-27
SRB-07
TP-MS-26
TP-MS-25
TP-MS-23
R-16
4' nick point
TP-MS-22
TP-MS-17
R-18
TP-MS-24
TP-MS-16
R-17
TP-MS-21
TP-MS-07
TP-MS-06
TP-MS-05
R-13
Trail or drainage
TP-MS-04
TP-Bulk-07
B
BFR incised 4 to 6 ft
TP-MS-03
TP-MS-20
TP-MS-02
TP-MS-01
Porcupine Gulch
Meadow Creek
N
-112.3838562, 47.03769313
Jumbo Mine (TetraTech)

1,248,000 1,249,000 1,250,000

Location Key

Lower - Marsh Area
Page 3

Middle Reaches
Page 2

Upper Reaches
Page 1

Porcupine Gulch
Shaute Gulch
Meadow Creek
Paymaster Gulch
Beartrap Creek
Beartrap Cr.

B Bulk Sample

M Marsh Test Pit with piezo

R Rebar surface water gage

Seismic Bore Hole to bedrock

P Test Pit with piezo

0 250 500 1,000 Feet

UBMC 2012 Data Gap Sampling Plan

Lower - Marsh Area

Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 Feet Intl

2012 Sampling Plan for UBMC Removals.mxd

Date: 7/4/2012

APPENDIX B: FIELD FORMS

Field Note Form for UBMC Floodplain Sampling

Type	
CT	Concentrated Tailings
MT	Mixed Tailings/alluvium
NA	Native, undisturbed above water table
NB	Native, undisturbed below water table
BLK	Black Mn/Fe coated
?	Unknown
W	Water starts flowing into pit

Classification USC	
GW	well graded gravel, fine to coarse gravel
GP	poorly graded gravel
GM	silty gravel
GC	clayey gravel
SW	well graded sand, fine to coarse sand
SP	poorly-graded sand
SM	silty sand
SC	clayey sand
ML	silt
CL	clay
OL	organic silt, organic clay
MH	silt of high plasticity, elastic silt
CH	clay of high plasticity, fat clay
OH	organic clay, organic silt
Pt	peat

Test Pit ID: _____

Location: _____

Date: _____

Personnel: _____

Weather: _____

Piezo Stickup: _____

MP to water: _____

pH at start _____

pH after stabilization _____

From	To	Sample ID	Type	USC	Color	Comment	Photo ID

- Note the depth water is first encountered in the TO column From and To will be same value.
- A sample can span several lithology intervals, but the From and To should agree with the top and bottom. Note the interval water begins to enter the pit and the interval where the water stabilizes.

APPENDIX C: HEALTH AND SAFETY PLAN

Mike Horse Dam
Lincoln, MT

Site Specific Health and Safety Plan for:

UBMC FLOOD PLAIN SAMPLING

July 2012

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1.0 PURPOSE

The purpose of this Site Specific Health and Safety Plan is to address the hazards and risks associated with geotechnical investigation activities at the Mike Horse Dam site. In addition, this document will identify the appropriate mitigation and controls to eliminate or reduce identified hazards and/or risks.

2.0 SCOPE OF WORK

Work being conducted under this Health and Safety Plan consists of the following:

Test pitting;

Soil sample collection;

Drilling with augers or ODEX and spoon sampling;

Seismic refraction.

3.0 SITE LOCATION AND CHARACTERIZATION

The site is located in the headwaters of the Blackfoot River, 16 miles east of Lincoln, Montana in Lewis and Clark County. Alluvial soils located in the floodplain below the Mike Horse Dam have been impacted by past mining activities in the basin and from a catastrophic breach of the Mike Horse Mine tailings dam in 1975. The breach of the dam was caused by heavy precipitation and blockage of the diversion ditch by a debris flow that diverted water directly into the tailings pond. The dam overtopped causing rapid dam erosion.

This erosion released metal laden tailings into the flood waters which were then deposited downstream within depositional areas impacted by flood waters. Immediately downstream of the tailings dam the floodplain was severely impacted by the floodwaters resulting from the breach. Flood deposits below the dam include considerable scour to an undetermined depth, deposition of remobilized existing floodplain deposits and eroded soils from the tailings dam and tailings pond, and potential debris flow deposits immediately below the dam. The depth of the scour, deposition, and debris flow deposits is not known and little information is available concerning the depth of impacted soils in the floodplain below the dam. In addition, the entire area consists of developed and undeveloped areas of mineralization which may affect the interpretation of metal concentration data both spatially and with depth.

3.1 Regulatory Requirements

All personnel must comply with applicable regulations at all times. Occupational health and safety regulations require that all project personnel:

1. Eliminate risks to health & safety so far as reasonably practicable; and If it is not reasonably practicable to eliminate risks to health & safety, to reduce those risks so far as is reasonably practicable.

Relevant regulations that will apply to this project include but are not limited to the following:

- OSHA 29 CFR 1926 (Construction)
- OSHA 29 CFR 1910 (General Industry)

3.2 Site Work Zones

The ASARCO Water Treatment Plant building will be the support zone for work activities. This area will also be the check in point for crews or subcontractors coming on site

3.21 Security

There are no fences or gates around the site. There are limited access roads. If members of the public enter the work area, work will be stopped and they will be asked to leave before work will start again.

4.0 SITE ROLES AND RESPONSIBILITIES

4.1 Person in Charge (PIC)

The site PIC is responsible for coordinating among multiple workers/contractors working at one site/location to confirm safe, responsible and reliable delivery of all work activities. The PIC is an onsite individual who has working knowledge of all work activities being performed by all members of the workforce.

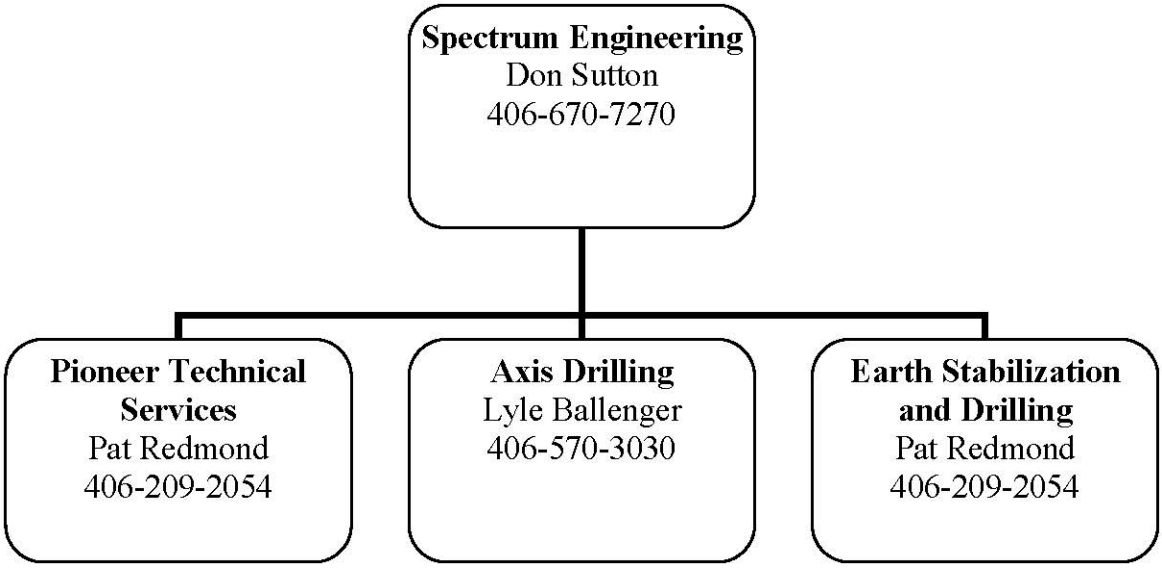
The PIC for this work will be Don Sutton of Spectrum Engineering.

4.2 Workforce

Workforce will be responsible for carrying out the duties given by an authority to proper specifications. Workforce will STOP WORK if it appears potentially unsafe. Field members will conduct a work area inspection prior to commencing work and actively monitor the site and its surroundings for changes that might affect the performance of the task. Also, the workforce will report all allegations or occurrences of unsafe work, near misses, and opportunities.

4.3 Site Organization

Spectrum Engineering is the prime contractor for this project. Pioneer Technical, Earth Stabilization and Drilling and Axis Drilling will be performing work as subcontractors to Spectrum Engineering.



5.0 HAZARD ASSESSMENT AND CONTROL

The following paragraphs discuss the primary site specific hazards and mitigations measures associated with Mike Horse Dam drilling and soil sample collection activities. This Health and Safety plan includes site specific hazard evaluation on a job and task specific basis by the employees performing the work.

5.1 Biological Hazards

Biological hazards include insects, animals, and human behavior. All personnel working on site will be trained and competent on the tasks they will perform in the field. In addition, all personnel will understand the scope of work and tasks to be performed. If workers are unclear on the scope of work or new tasks arise, work will stop until all members of the workforce can verify that they understand the task. A WRA is completed if necessary.

Personnel working onsite may come in contact with various species of plants and animals such as wildlife, livestock, insects, snakes, rodents, etc. Workers will avoid contact with animals if possible. Workers are aware of the signs and symptoms of exposure to plants or insect bites. First aid kits are available at the site to treat minor bites and stings. Personnel with allergies will notify their supervisor/project manager to ensure proper treatment in the event of a bite, sting, or exposure to plants/weeds. Workers will follow defensive driving procedures if animals are encountered on the roadways.

5.2 Chemical Hazards

Personnel working on site maybe exposed to heavy metals such as arsenic, cadmium, copper, silver, and zinc via contaminated soil and/or water. Potential exposure pathways for these metals include inhalation and ingestion. Workers will practice proper personal hygiene techniques (i.e. wash hands before eating/drinking, eating in designated areas) while on site. Work will be suspended during

high wind conditions that produce large amounts of visible dust.

Carbon Monoxide (CO) exposure is a colorless, tasteless, and odorless gas that mixes evenly with air. It is produced any time a carbon-based fuel such as gasoline, propane, or oil burns. CO can build up in enclosed and semi-enclosed enclosures. Heavy equipment, vehicles, and generators can produce CO. Early signs and symptoms of exposure include irritated eyes, headache, nausea, weakness, and dizziness. If the symptoms are experienced move to fresh air and notify the appropriate emergency personnel.

Exposure to gasoline/diesel can occur while refueling vehicles and equipment. Minimize splash hazards so skin contact does not occur. If skin contact does occur, flush affected area with water.

Exposure to hydraulic fluid can occur when working around equipment. Contact with hydraulic fluids and fuels can cause injury to eyes and skin. Hydraulic fluids and fuels can penetrate the skin and may require immediate medical attention. In the event of a spill personnel will contain the fluid or fuels using the spill cleanup materials (i.e., pads and/or loose sorbent) available at the site. Cleanup materials will be disposed of according to the appropriate regulations

Hazard communication will be followed at all times. Material Safety Data Sheets are located onsite at all times.

5.3 Electrical Hazards

Overhead utilities are located within the work area. The drill rig will not travel with mast in the air and will avoid contact with overhead power lines. Underground utilities also exist and will be located prior to starting work.

Generators pose a risk of shock and electrocution, especially if they are operated in wet conditions. If you must use a generator when it is wet outside, protect the generator from moisture to help avoid the shock/electrocution hazard, but do so without operating the generator indoors or near openings to any building that can be occupied in order to help avoid the CO hazard. Operate the generator under an open, canopy-like structure on a dry surface where water cannot reach it or puddle or drain under it. Dry your hands, if wet, before touching the generator. Connect appliances to the generator using heavy-duty extension cords that are specifically designed for outdoor use. Make sure the wattage rating for each cord exceeds the total wattage of all appliances connected to it. Use extension cords that are long enough to allow the generator to be placed outdoors and far away from windows, doors and vents or to other structures that could be occupied. Check that the entire length of each cord is free of cuts or tears and that the plug has all three prongs. Protect the cord from getting pinched or crushed if it passes through a window or doorway.

Employees will not be permitted to work near any part of an electrical power circuit that the employee could contact, unless the employee is protected against shock by de-energizing the circuit and grounding it or by guarding it effectively using insulation or other means.

Exposure to lightning can be common at the site during the summer and fall months. Workers shall following the existing lightning procedures to minimize risk of shock/electrocution, as outlined in the Pioneer Technical Services Corporate HASP.

5.4 Gravitational Hazards

Personnel will be required to walk on uneven and slippery walking and working surfaces. As a result, slips, trips and falls could occur. Workers will wear boots with good traction and appropriate for the weather conditions. In addition, personnel will plan their path and if possible avoid steep, rugged terrain.

Personnel will also be required to walk and work on soft saturated soil and sediment while collecting samples. Saturated soils could result in sloughing of test pit walls. Personnel will not enter the test pits for any reason to collect samples. Samples will be collected either out of the excavator bucket or the spoil pile.

Personnel could fall into open test pits. Personnel will stay at least 6 ft away from the edge of any open test pits.

Objects could fall off of the equipment resulting in injury or equipment damage. The equipment will be inspected prior to coming onsite to assure it is in good working order.

If new or unforeseen workings from heights situations/issues are encountered, STOP WORK procedures will be implemented and the hazards will be assessed.

5.5 Motion Hazards

There are three primary motion hazards that will exist for operations and maintenance personnel at the site, as identified below:

Driving – Operators will interact with public traffic when entering and exiting the site, In addition, workers will be required to drive to various locations on site. Personnel will practice defensive driving at all times. Vehicles will be in good working order.

Drill Rig – Personnel will maintain the 10 foot buffer area around the rig

Muscle/Back Strains - Personnel will be required to handle and lift equipment/tools which could result in muscle and back strains. Personnel will follow established OSHA/Industry recommendations for lifting to avoid potential back/muscle injuries.

Working Around Heavy Equipment - Workers will be working around heavy equipment on a day-to-day basis when approaching operators to communicate/ask questions and standing or walking near working equipment to observe operations and perform QA/QC activities. Ground personnel will maintain a 10ft buffer around equipment when equipment is being operated.

Specific company procedures exist to help mitigate and address the motion related activities listed above.

5.6 Pressure Hazards

Personnel may be exposed to pressurized hydraulic hoses when working around heavy equipment. Equipment will be inspected to assure that it is in good working order. Additional pressure hazards may exist on the site via excessive noise levels from heavy duty and light duty equipment in employee work areas. Hearing protection shall be administered and used in accordance with the hearing protection policies and procedures.

5.7 Radiological Hazards

Personnel may be exposed to ultraviolet radiation from the sun most frequently in the summer months. The hazards associated with UV radiation are burns and eye and skin damage. All personnel should use sun-screen with high sun-protection factor (SPF) >15.

5.8 Thermal Hazards

Personnel could be exposed to cold windy climates. Personnel will dress in layers when working in cold temperatures and will stop work when conditions warrant. For cold stresses, personnel shall be required to wear appropriate PPE along with any appropriate clothing to ensure the body is protected from frostbite and/or hypothermia. Personnel should be aware of the signs and symptoms of cold stress.

6.0 SITE SPECIFIC REQUIRMENTS/PROCEDURES

6.1 Daily Toolbox Meeting

Workforce shall participate in the Daily Toolbox Meeting to coordinate activities and site operations. Toolbox meetings shall be held with all members involved in the given activity and documented.

6.2 Permits

No permits are anticipated for this project. In the event that there is a task change that requires a permit, work will stop, hazards associated with the work will be assessed, and a permit will be issued

6.3 Communication

No conditions are expected that would render verbal communications difficult or impossible. The use of two-way radios will be the primary method of communication for site construction operations. There is now cell reception at the water treatment plant, though nowhere else on the site. A land-line telephone is located at the water treatment plant. Access to the telephone is not always available as the plant is not manned continually. The telephone number at the water treatment plant is (406) 362-4667. Employees shall not use two-way radios or cell phones while driving and must ensure they are stopped prior to using them.

6.4 Personal Protective Equipment

Personal Protective Equipment for the sites shall be Level D unless otherwise noted on project risk assessments or other subsequent site documentation. Level D includes high visibility vest/clothing, safety glasses with side shields, hard hat, long pants, work shirt, gloves, and steel-toed boots or shoes.

6.5 Subcontractors

Subcontractors shall conform to all of the policies, procedures, and programs included in this SSHSP.

Subcontractors for this project include the following:

Pioneer Technical Services
Axis Drilling
Earth Stabilization and Drilling

7.0 SITE SPECIFIC EMERGENCY RESPONSE PLAN

In order to address the most likely emergency response situations at the site, personnel shall be knowledgeable of the primary contractor's Emergency Response Plan and be able to carry-out support activities outlined therein.

7.1 Emergency Procedure for Accident/Injury

In case of a serious accident or emergency situation involving activities addressed under this SSHSP, the following procedure should be followed:

1. **Cease Work in the Vicinity-**

2. **Assess the Situation**- make sure scene is safe to enter before further assessing the accident, if conditions are unsafe to enter do not put yourself or others in danger. Do not move the injured person(s). This can lead to more severe injuries.

3. **Call 911**- Information to give dispatcher includes the following:
   - Explain the nature of the emergency
   - Give accurate information on the severity and urgency of the situation
   - Give clear information on where the accident occurred and the quickest route to get there.
   - If hazardous materials or substances are involved, inform dispatcher of them
   - When necessary, make follow-up contact with emergency services personnel to provide added information, coordinate response to any injuries of care or service providers

4. **Escort**- Assign someone to escort emergency personnel to the scene of the accident.

5. **Make Additional Emergency Contacts -** Continue calling in the order listed below until you obtain direct voice contact:

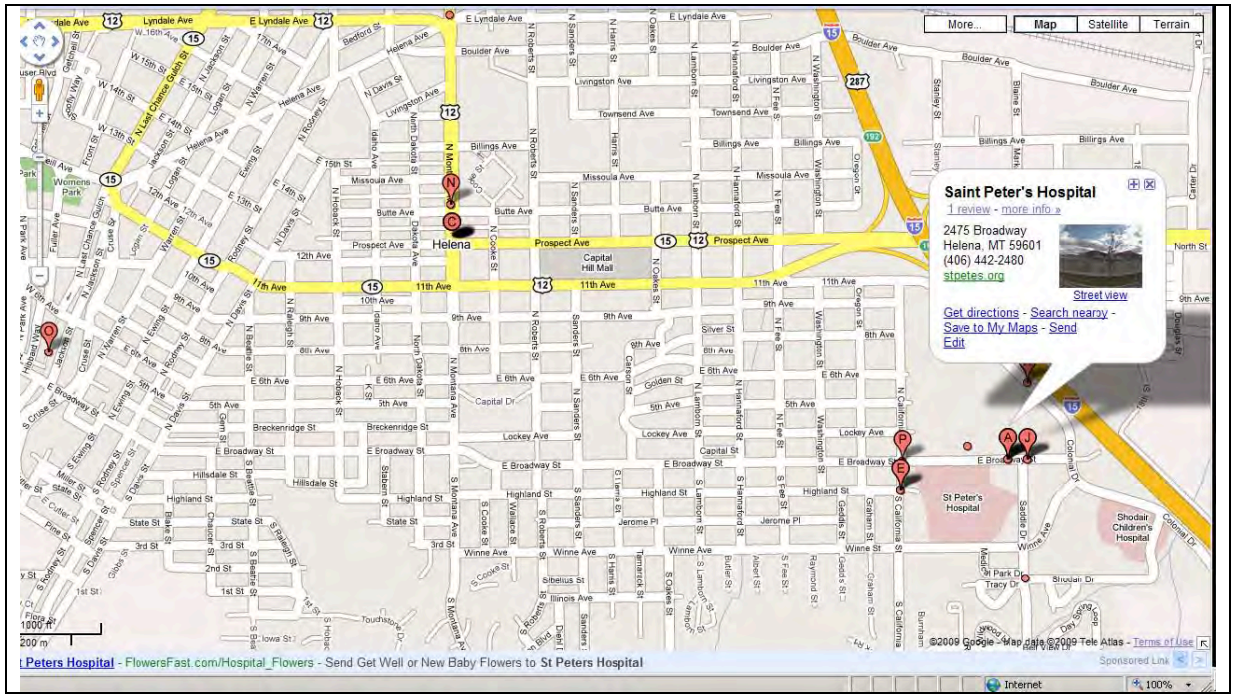
Spectrum Engineering
Don Sutton 406-670-7270

Pioneer Technical Services
Patrick Redmond 406-388- 2622

Axis Drilling
Lyle Ballenger 406-570-3030

Earth Stabilization and Drilling
Patrick Redmond 406-388- 2622

7.2 Emergency Hospital Routes



The closest hospital is in Helena, 55 miles and about one hour away.
The Parker Medical Center in Lincoln, is approximately 16 miles (20 minutes), has 2 doctors. Their regular hours are Mon-Friday, Mon – Fri 8-12pm and 1-5pm.

Note that there is cell reception only at the water treatment plant. There is no cell service anywhere else at the site or immediate vicinity. A land-line telephone is located at the water treatment plant. Access to the telephone is not always available as the plant is not manned continually. The telephone number at the water treatment plant is (406) 362-4667.

Call emergency agencies for assistance. If Life Flight, or other emergency medical care giver, is required the following decimal latitude and longitude coordinates may be required for a meeting place:

Helicopter Landing Site	Longitude	Latitude
Mike Horse Town Site	-112.35537163000	47.02922158120
Water Treatment Plant	-112.362187	47.096141
Highway 200 Wetlands	-112.38570399500	47.04458189120

Directions to St. Peter's Hospital in Helena

From the intersection of Meadow Creek Road and Highway 200, turn right (east) onto Highway 200 and follow for 13.4 miles. Turn right onto State Hwy 434 (Little Wolf Creek Road) for 17.6 miles, then merge onto I-15 heading south to Helena for 33.9 miles. Take exit 192 (Townsend Exit) & turn right onto Prospect Avenue for 0.2 miles. Turn left on N. Fee Street. After 0.3 miles, Fee Street becomes 11th Avenue. Turn right onto N. California Street for 0.4 miles then turn left onto E. Broadway Street. Turn right after 0.1 miles into the St. Peter's Hospital at 2475 E. Broadway St.

Alternate Route with little to no cell phone coverage: From the intersection of Meadow Creek Road and Highway 200, turn left (west) onto Highway 200 and follow for approximately 4.5 miles. Turn left (south) onto Highway 279 to Flesher Pass. Follow Highway 279 for 38.9 miles to Interstate 15 and merge onto I-15. Follow I-15 south for 7.7 miles to exit 192 onto Prospect Avenue for 0.2 miles. Turn left on N. Fee Street. After 0.3 miles, Fee Street becomes 11th Avenue. Turn right onto N. California Street for 0.4 miles then turn left onto E. Broadway Street. Turn right after 0.1 miles into the St. Peter's Hospital at 2475 E. Broadway St.

7.3 Evacuation Procedures

Evacuations, if needed, will take place from the operations center. The **Water Treatment Plant** will be the emergency assembly point and operations center for activities addressed in this SSHSP. The **intersection of MT Highway 200 and Meadow Creek Road** will be the secondary assembly area.

APPENDIX D: UBMC FLOODPLAIN INVESTIGATION QAPP

FINAL

QUALITY ASSURANCE PROJECT PLAN

FOR THE

UPPER BLACKFOOT MINING COMPLEX DESIGN INVESTIGATIONS

Prepared for:

Montana Department of Environmental Quality
Remediation Division
P.O. Box 200901
Helena, Montana 59620

Prepared by:

Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, Montana 59702

July 13, 2012

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1.0 INTRODUCTION

This site-specific Quality Assurance Project Plan (QAPP) has been prepared for the Montana Department of Environmental Quality Remediation Division pursuant to Task Order Number 13, Contract No. 407040, issued by DEQ. This site-specific plan QAPP has been designed to guide aspects of environmental field sampling, data collection, and laboratory analytical activities for environmental-cleanup-related actions at the Upper Blackfoot Mining Complex (UBMC). Anticipated future investigations include, but are not necessarily limited to:

- Test pitting and/or soil boring investigations to define the nature and extent of mine wastes as the site including waste piles, tailing impoundments, and materials deposited in the floodplain and wetlands (marsh) areas.
- Geotechnical investigations to collect design data for roads, pipelines, repository construction, borrow areas, and other facilities as needed.
- Hydrogeologic investigations to evaluate waste and groundwater interactions, potential repository sites, and stream/groundwater interaction.

Quality assurance (QA) is defined as the integrated program for ensuring reliability of monitoring and measuring data. The QA program for this project requires the generation of a site or project-specific Quality Assurance Project Plan QAPP.

This QAPP describes quality assurance (QA) measures for the various investigations necessary characterize existing site conditions and to collect engineering design data for Upper Blackfoot Mining Complex (UBMC) cleanup. These data can then be used to analyze the effectiveness and feasibility of various remediation/restoration options as well as to complete engineering design of the Remedial Actions (RAs). This QAPP is a supporting document for the various Sampling and Analysis Plans (SAPs) or Field Work Plans (FWPs) that will be prepared for various sampling efforts and investigations.

2.0 PROJECT LOCATION

The UBMC is an abandoned hard rock mine site that includes numerous abandoned or inactive mine sites located on a mixture of National Forest and private lands within a portion of the historic Heddleston Metal Mining District in the Rocky Mountains of Lewis and Clark County, Montana. The UBMC is located approximately 15 miles east of Lincoln, Montana, in the headwaters area of the upper Blackfoot River.

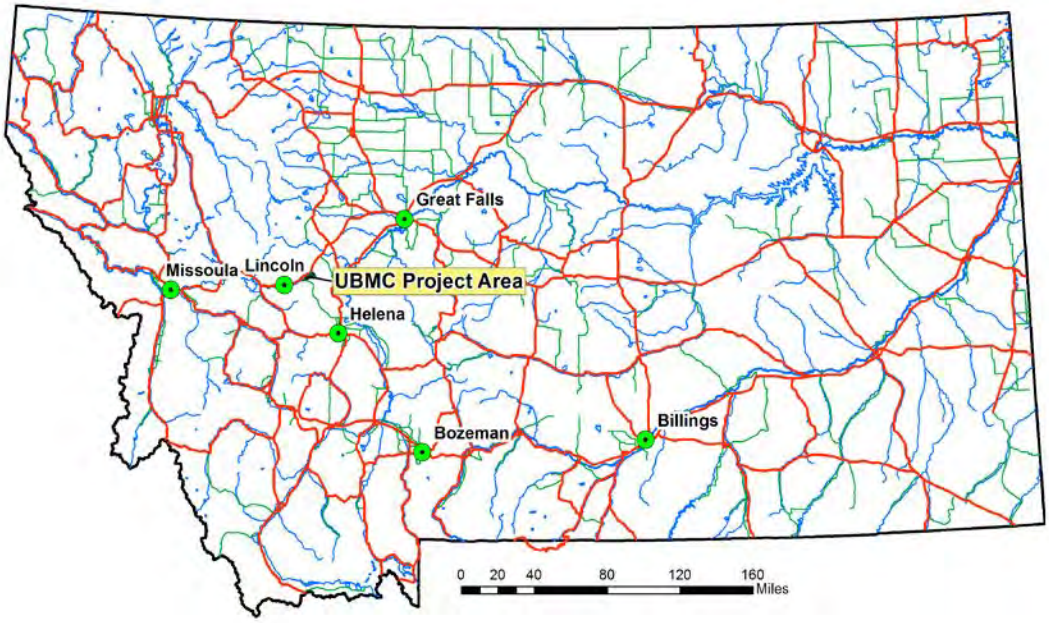


Figure 1 - Project Location Map

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

DEQ Project Officer– Shellie Haaland

The DEQ Project Officer will oversee the field activities are provide input regarding field decisions. DEQ will notify the Forest Service and the Montana Environmental Trust Group prior to field activities.

Project Manager/Coordinator –Contractor Employee

The responsibilities of the Project Manager are project coordination and liaison with DEQ, assisting in field planning, problem solving and decision making, quality assurance, and preparing and reviewing project documents. The project manager/coordinator will also review and check all chain-of-custody forms and assist with data validation and reporting.

Field Project Manager –Contractor Employee(s)

The Field Project Manager is responsible for implementing and maintaining the integrity of the SAP. This includes communicating the SAP requirements to all personnel, supervising fieldwork, and making appropriate changes to the SAP, if necessary.

Health and Safety Officer –Contractor Employee(s)

The Health and Safety Officer will ensure that work crews comply with all site health and safety requirements and will coordinate with the Sampling Leader/Field Health and Safety Officer to revise the SAP and HASP, if necessary.

Sampling Leader/Field Health and Safety Officer –Contractor Employee(s)

The Sampling Leader/Field Health and Safety Officer will ensure that the SAP is followed for all required field activities. The Sampling Leader/Field Health and Safety Officer will lead all field activities, document activities in the logbook, oversee equipment calibration and maintenance, solve problems, and make decisions affecting the SAP and safety in the field. The Sampling Leader/Field Health and Safety Officer will ensure that work crews comply with all site health and safety requirements and will coordinate with the Health and Safety Officer to revise the HASP (Appendix C) if necessary. The sampling leader will also review and check all chain-of-custody forms and assist with data validation and reporting.

Field Samplers –Contractor Employee(s)

The Field Samplers assist in all required field activities as directed by the Sampling Leader/Field Health and Safety Officer including sampling, monitoring and decontamination procedures according to the SAP, HASP, and this QAPP. All Field Samplers will participate in all required safety meetings and assist with hazard analyses to identify safety hazards, concerns, and specify appropriate safety measures for the field work.

4.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data necessary to support decision making, design and remediation activities. The DQOs for the UBMC investigations were developed using the process outlined in *Data Quality Objectives for Remedial Response Activities, Development Process* (EPA, 1987).

Table 1 and Table 2 present the DQOs for the project. Included in Table 1 and 2 is the measurement, the location of that measurement, analysis method, sample media, and analytical support level.

Table 1 - Data Quality Objectives (Soils)

MEASUREMENT	LOCATION	ANALYSIS METHOD	ANALYTICAL SUPPORT LEVEL	MEDIA	DATA USE
TAL Metals (see SAP)	Lab/Field Lab	CLP SOW, EPA METHOD 6200 (Field XRF)	II/III/IV	SS, SD	SC, ED, EA, RA
Sulfur fractions and Neutralization Potential	Lab	Modified EPA 600/2-78-054 and EPA-670/2-74-070 OAMS and SWQ	III	SS	SC, ED
SPLP	Lab	EPA 1312	III/IV	SS,SD	SC, ED, EA, RA
SMP Buffer	Lab	12-3.4.4.1 MSA	III	SS	SC, EA, ED
TCLP	Lab	EPA 1311	III/IV	SS,SD	SC, ED, EA, RA
Exchangeable Acidity	Lab	9-4.1 MSA	III	SS	SC, EA, ED
Fertilizer Recommendation Analysis (N,K,P)	Lab	N-ASA #9 (84-2); K-ASA #9 (71-3); P-(73-4.1)	III	SS	SC, EA, ED
Soil Texture	Lab	USDA Handbook #18	N/A	SS	SC
Field Water Capacity	Lab	DISAS (31) pgs. 109-110	III	SS	SC
Wilting Point	Lab	DISAS (30) pg. 109	III	SS	SC
Specific Gravity	Lab	ASTM D854	III	SS	SC, ED
Hydraulic Conductivity	Lab	Method D5084 ASTM, Vol. 4.08	III	SS	SC
Organic Matter Content	Lab	ASA #9, Part 2 (90) pgs. 1371-1372	III	SS	SC, ED
Proctor	Lab	Methods D698 ASTM	III	SS	SC, ED
Particle Size	Lab	Method D422 ASTM	III	SS	SC, ED
Atterberg Limits	Lab	Method D4318 ASTM	III	SS	SC, ED
Bulk Density (In-Place)	Lab	ASTM D420	III	SS	SC, ED
Cation Exchange Capacity	Lab	Method 9081 SW-846	III	SS	SC

Analysis Method

ASA #9 - American Society of Agronomy, Methods of Soil Analysis (ASA, 1965)
ASTM - American Society for Testing and Materials (ASTM, 1985)
CAWW - Methods for Chemical Analysis of Water and Wastes (EPA, 1984)
CLP - Contract Laboratory Program
DISAS - Diagnosis and Improvement of Saline and Alkali Soils
EPA - Environmental Protection Agency
USDA - United States Department of Agriculture

Data Use

EA - Evaluation of Alternatives
ED - Engineering Design
RA - Risk Assessment
SC - Site Characterization
D - Disposal

Analysis/Measurement

SPLP – Synthetic Precipitation Leaching Procedure
TDS - Total Dissolved Solids
N – Nitrogen
P – Phosphorus
K – Potassium

Media Type

SD - Sediment
SS - Soil
SW - Surface Water
GW – Groundwater

Anticipated TAL Metals (may be modified in SAP) – Aluminum, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Zinc

Table 2 - Data Quality Objectives (Surface And Groundwater)

ANALYSIS/ MEASUREMENT	LOCATION	ANALYSIS METHOD	ANALYTICAL SUPPORT LEVEL	MEDIA	DATA USE
TAL Metals - Total Recoverable and Dissolved Metals	Lab	EPA 6010, 6020	IV	SW, GW*	SC, RA
TDS	Lab	Method 160.1 CAWW	III	SW, GW	SC, RA, EA, ED
Hardness	Lab	Method 130.2 CAWW	III	SW, GW	SC, RA, EA, ED
Alkalinity	Lab	EPA E310.1/A 2320B	III	SW, GW	SC, RA
Nitrate/nitrite	Lab	EPA 353.2	III	SW, GW	SC, RA
Nitrate/nitrite	Lab	EPA 353.2	III	SW, GW	SC, RA
Specific Conductance	Field	Manufacturer's Instructions	II	SW, GW	SC, RA
Dissolved Oxygen	Field	Manufacturer's Instructions	II	SW, GW	SC, RA
pH	Field/Lab	Manufacturer's Instructions/EPA 150.1	II/III	SW, GW	SC, RA

Analysis Method

CAWW - Methods for Chemical Analysis of Water and Wastes (EPA, 1984)

CLP - Contract Laboratory Program

EPA - Environmental Protection Agency

Data Use

EA - Evaluation of Alternatives

ED - Engineering Design

RA - Risk Assessment

SC - Site Characterization

Analysis/Measurement

TDS - Total Dissolved Solids

Media Type

SW - Surface Water

GW – Groundwater

Anticipated TAL Metals (may be modified in SAP) – Aluminum, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Zinc

*Groundwater will only be sampled for total dissolved metals

The analytical support levels are the analytical options available to support data collection activities. There are five general levels that are distinguished by the types of technology, documentation use, and degree of sophistication. The five general levels are as follows:

- Level I - Field Screening. Level I includes data from portable instruments that can provide real-time data to help optimize sampling point locations and for health and safety support.

- Level II - Field Analysis. Level II includes data from portable analytical instruments used on-site or in mobile laboratories stationed near the site.

- Level III – Level III includes laboratory sample analyses by methods other than U. S. Environmental Protection Agency (EPA) Contract Laboratory Program (CLP) Routine Analytical Service (RAS) methods. Level III is used primarily to support engineering studies using standard EPA approved procedures. Some procedures may be equivalent to CLP RAS methods without the CLP documentation requirements.

- Level IV - EPA CLP RAS. Level IV includes provides full qualitative and quantitative laboratory analytical data supported by all rigorous field and laboratory QA protocols, procedures, and documentation.

- Level V – Non-Standard Methods. Level V includes analyses that may require method modification and/or development. Analyses performed by the EPA CLP under a Unique Laboratory Services Analysis (ULSA) request are considered Level V.

5.0 QUALITY ASSURANCE OBJECTIVES

The ability of data to meet DQOs will be evaluated with a precision, accuracy, representativeness, completeness, and comparability (PARCC) statement. A PARCC statement will be generated for all Level IV data during data evaluation (after data have been validated). A PARCC statement will not be prepared for Level II and III data used only for engineering design or used as supporting data for evaluation of alternatives.

5.1 PRECISION

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Acceptance or rejection of precision measurements is based on the relative percent difference (RPD) of the laboratory and field duplicates. For example, perfect precision would be a 0% RPD between duplicate samples (both samples have the same analytical result). For total metals, acceptable precision would be a RPD of plus or minus 35% in solid samples. Precision requirements are derived from the CLP Statement of Work (SOW) (EPA, 1992). For these investigations, precision will only be assessed for the laboratory analysis of certain metals on the TAL. The procedures used to assess precision will follow the DEQ guidance provided in Appendix A. The ranges of acceptable RPDs for precision for the UBMC investigations are presented in Table 3.

Table 3 - Precision, Accuracy And Completeness Requirements

PRECISION (RPD)			ACCURACY (%R)		COMPLETENESS
Media	Solid	Water	Solid	Water	All
Metals	35%	20%	75-125%	75-125%	90%

5.2 ACCURACY

Accuracy is the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. The standard deviation (SD) of the laboratory matrix spike will be used to measure accuracy statements for inorganic data. Accuracy acceptance or rejection

will be based on the percent recovery (% R) of the laboratory matrix spike. For example, perfect recovery would be 100% (the analysis result is exactly the known concentration of the matrix spike) and an acceptable range for total metals would be 75% to 125% in solids. Accuracy requirements for this project are derived from the CLP SOW (EPA, 1992). Accuracy will only be assessed for the laboratory analysis of metals in the TAL. The procedures used to calculate accuracy will follow the DEQ guidance provided in Appendix A. The range of acceptable %R's for accuracy is presented in Table 3.

5.3 REPRESENTATIVENESS

Representativeness is a qualitative parameter that is addressed through proper design of the sampling program. The sampling program described in each individual SAP will be designed to obtain a sufficient number of samples that adequately represent the range of conditions present in the medium being sampled and will specify suitable sampling methods and procedures.

The Project Officer and Project Manager/Coordinator will review each SAP to ensure that it is designed to collect the data and information necessary to meet the purpose of the investigation. The review will consider the volume, variability, and intended use of the data to ensure proper sampling methods and adequate spatial distribution of samples.

After the data have been collected and analyzed, the Project Officer and Project Manager/ Coordinator will review the data and qualitatively assess if the data adequately represent the site conditions and intended purpose of the investigation. Sample representativeness may also be evaluated using the RPD's for field duplicate sample results, if applicable. The representativeness will be addressed in the PARCC.

5.4 COMPLETENESS

Completeness is assessed to determine if enough valid data have been collected (see Section 10.0) to meet the investigation needs. Completeness is assessed by comparing the number of valid sample results to the number of samples planned for the investigation. The completeness targets for these investigations are presented in Table 3.

5.5 COMPARABILITY

Comparability is assessed to determine if one set of data can be compared to another set of data. Comparability is assessed by determining if an EPA-approved analysis method was used, if values and units are sufficient for the database, if specific sampling points can be established and documented, and if field collection methods were similar. Analysis methods and SOP's for these investigations are included in this QAPP and sampling locations will be documented in each SAP and the associated data summary reports which together will provide all necessary information for comparability assessments.

6.0 SAMPLING PROCEDURES

Detailed procedures for sample collection and handling are specified and documented in each individual SAP and in the corresponding SOPs. All anticipated SOPs for these investigations are provided in Appendix B. Specific SOPs needed for an individual SAP or FWP will be listed in the plan and may be included in an appendix to the SAP or FWP as needed. If the SOPs are not included the SAP or FWP, the field team will maintain a copy of this QAPP on site for reference. All procedures presented in the SAPs will meet EPA-accepted procedures. Specialized requirements and procedures not included in the SOP's will be provided in the individual SAPs or FWPs, as needed.

6.1 FIELD LOGBOOK

The field logbook is the written record of all data, observations, field equipment calibrations, samples, and chain of custody. All entries will be in waterproof ink, and any mistakes will be lined out with a single line and initialed by the person making the correction. At a minimum the entry will include the following:

- Purpose of sampling;
- Location and description of sampling point;
- Identification of sampling crew;
- Type, number, and volume of sample;
- Date and time of sampling; date and time of shipping;
- Weather;
- Field measurements; and
- Deviations from SOPs.

6.2 SAMPLE CONTROL, DOCUMENTATION, AND SHIPPING

The SOPs for sample handling, shipping, and related matters are provided in Appendix B. Samples will be packaged and shipped according to the SOPs and all U.S. Department of Transportation (DOT) and EPA regulations. The purpose of these procedures is to maintain the integrity of all samples during collection, transportation, analysis, and reporting.

7.0 SAMPLE CUSTODY

7.1 CHAIN OF CUSTODY

Maintaining the integrity of the sample from collection through data reporting is critical to the sampling and analytical program. This process includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. This documentation of the sample's history is referred to as chain of custody. A sample is considered to be under a person's custody if it is in a person's physical possession, in view of the person after taking possession, or secured by that person so that no one can tamper with the sample.

The components of the field chain of custody (chain of custody form, labels, and custody seals) and laboratory chain of custody (chain of custody record, sample log-in/log-out, sample storage records, and disposal records) are described in this section.

7.2 CHAIN OF CUSTODY FORM

A chain of custody form will be completed and accompany every sample. A standard form will be provided in the field forms with each SAP. The form will include the following information:

- Project code;
- Project name;
- Samplers signature;
- Sample identification;
- Date sampled;
- Time sampled;
- Analysis requested;
- Remarks;
- Relinquishing signature, data, and time; and
- Receiving signature, date, and time.

7.3 SAMPLE LABELS

Sample labels are necessary to ensure proper identification of samples. Sample containers with pre-printed labels or self-adhesive will be used. Sample labels will include the following information:

- Sample identification;
- Sampler's initials;
- Analysis requested;
- Sampling date; and
- Sampling time.

7.4 CUSTODY SEALS

Custody will be used to detect unauthorized tampering with samples following sample collection up to the time of analysis. Custody seals will be applied to the shipping containers when the samples are not in the sampler's custody.

7.5 LABORATORY CUSTODY

Laboratory custody will conform to procedures established for the CLP. These procedures include the following:

- Designation of sample custodian;
- Correct completion of the chain of custody form, recording of sample identification numbers,

and documentation of sample condition upon receipt;
- Laboratory sample tracking and documentation procedures; and
- Secure sample storage.

The samples will be delivered to the laboratory for analysis in a timely manner to ensure the requested analyses can be performed within the specified allowable holding times. The sample will be hand delivered or addressed to a person in the laboratory who is authorized to receive samples (laboratory sample custodian).

8.0 EQUIPMENT OPERATION, MAINTENANCE, CALIBRATION, AND STANDARDIZATION

All field and laboratory equipment will be operated, maintained, calibrated, and standardized in accordance with all EPA and manufacturer's recommended procedures. The SOPs for the field equipment are provided in Appendix B. The XRF operation, maintenance, calibration, and standardization procedures and analytical procedure (EPA Method 6200) is provided in Appendix C. The contract laboratory SOPs are provided in Appendix D. The referenced standard analytical methods and the laboratory SOPs contain the laboratory equipment operation, maintenance, calibration, and standardization procedures.

9.0 ANALYTICAL LABORATORY PROCEDURES

The anticipated laboratory analytical methods to be used are presented in Table 2. Laboratory analysis of samples collected during the course of this study will be performed by laboratories that have established protocols and QA procedures that meet or exceed EPA guidelines. EPA-approved methods will be used for all applicable parameters. Analytical requirements for Marsh Sediments are provide in
Table 4. Analytical requirements for Mine waste are provide in Table 5.

Table 4 - Marsh Sediments Analytical Requirements

Parameter	Method(1)	PQL(2)
General**		
Saturated Paste pH (s.u.) and Electrical Conductivity (mmhos/cm)	ASAM10-3	--
TAL Metals**		
Total Aluminum	SW-846 – 6020 / 6010B	1
Total Arsenic (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Cadmium (mg/Kg)	SW-846 – 6020 / 6010B	0.15
Total Copper (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Iron (mg/kg)	SW-846 – 6020 / 6010B	5
Total Lead (mg/Kg)	SW-846 – 6020 / 6010B	0.2
Total Manganese (mg/Kg)	SW-846 – 6020 / 6010B	10
Total Zinc (mg/Kg)	SW-846 – 6020 / 6010B	2
Acid-Base Accounting** *(As required in the SAP or FWP)*		
Acid-Base Accounting	Modified Sobek	--

Parameter	Method(1)	PQL(2)
Synthetic Precipitation Leaching Procedure** *(As required in the SAP or FWP)*		
Synthetic Precipitation Leaching Procedure	EPA 1312	--
Total Aluminum	200.8/200.7	0.03*
Total Arsenic (mg/L)	200.8/200.7	0.003*
Total Cadmium (mg/L)	200.8/200.7	0.00008*
Total Copper (mg/L)	200.8/200.7	0.001*
Total Iron (mg/L)	200.8/200.7	0.05*
Total Lead (mg/L)	200.8/200.7	0.0005*
Total Manganese (mg/L)	200.8/200.7	0.005*
Total Zinc (mg/L)	200.8/200.7	0.01*

Note: XRF Screening will compare results to most stringent Ecological Risk Soil Screening Levels (EcoSSLs)

1. USDA Handbook 60 - Diagnosis and Improvement of Saline and Alkali Soils (USDA, 1954)
   Sobek - Field and Laboratory Methods Applicable to Overburdens and Minesoils (EPA, 1978)
   Methods of Soil Analysis - American Society of Agronomy, Parts I and II. Monograph No. 9 (1982)
   SW-846 - Test Methods for Evaluating Solid Waste-Physical Chemical Methods (EPA, 1986)

PQL = Practical quantitation limit.

* Montana RRV – Required Reporting Value Montana Circular DEQ-7, August 2010, or latest version)

**If required in the SAP or FWP, ½ of all marsh sediment samples collected will be analyzed by the laboratory for ABA and SPLP in addition to the parameters listed under General and TAL Metals. The other ½ of the samples will only require laboratory analysis for the parameters under General and TAL Metals.

Table 5 - Mine Waste Analytical Requirements

Parameter**	Method(1)	PQL(2)
General**		
Saturated Paste pH (s.u.) and Electrical Conductivity (mmhos/cm)	ASAM10-3	--
TAL Metals**		
Total Aluminum	SW-846 – 6020 / 6010B	1
Total Arsenic (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Cadmium (mg/kg)	SW-846 – 6020 / 6010B	0.15
Total Copper (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Iron	SW-846 – 6020 / 6010B	5
Total Lead (mg/kg)	SW-846 – 6020 / 6010B	0.2
Total Manganese (mg/kg)	SW-846 – 6020 / 6010B	10
Total Zinc (mg/kg)	SW-846 – 6020 / 6010B	2
Acid-Base Accounting** *(If required in the SAP or FWP)*		
Acid-Base Accounting	Modified Sobek	--
Synthetic Precipitation Leaching Procedure** *(If required in the SAP or FWP)*		
Synthetic Precipitation Leaching Procedure	EPA 1312	--
Total Aluminum	200.8/200.7	0.03*
Total Arsenic (mg/L)	200.8/200.7	0.003*
Total Cadmium (mg/L)	200.8/200.7	0.00008*
Total Copper (mg/L)	200.8/200.7	0.001*
Total Iron (mg/L)	200.8/200.7	0.05*
Total Lead (mg/L)	200.8/200.7	0.0005*
Total Manganese (mg/L)	200.8/200.7	0.005*
Total Zinc (mg/L)	200.8/200.7	0.01*

Parameter**	Method[1]	PQL[2]

Note: XRF Screening will compare results to most stringent Ecological Risk Soil Screening Levels (EcoSSLs)

1. USDA Handbook 60 - Diagnosis and Improvement of Saline and Alkali Soils (USDA, 1954)
   Sobeck - Field and Laboratory Methods Applicable to Overburdens and Minesoils (EPA, 1978)
   Methods of Soil Analysis - American Society of Agronomy, Parts I and II. Monograph No. 9 (1982)
   SW-846 - Test Methods for Evaluating Solid Waste-Physical Chemical Methods (EPA, 1986)
2. PQL = Practical quantitation limit

* -Montana RRV – Required Reporting Value – Montana Circular DEQ-7, August 2010, or latest version

****If required in the SAP or FWP, 10% of mine waste samples will be submitted for laboratory analysis for the above parameters following XRF analysis. Samples will be selected for Laboratory Analysis as described in the SAP**

9.1 XRF ANALYTICAL PROCECDURES

If specified in the SAP or FWP, soil or sediment samples may be analyzed for TAL metals using a field-portable XRF. All XRF samples will be analyzed according to EPA Method 6200 (Appendix C). The anticipated size of the data set will be considered in the sampling plan design and XRF will only be used for sampling efforts with large numbers of samples (generally greater than 100 samples). At least 10% of all samples analyzed using an XRF will also be analyzed in the contracted laboratory according to standard methods to verify the quality and reliability of the XRF data.

The project-specific SAP or FWP will address specific XRF data collection, XRF and lab quality control requirements (including XRF calibration), collection of laboratory samples, comparison of XRF to laboratory data, and a detailed description of the XRF/laboratory data correlation, as described above. The XRF/laboratory data comparison and correlation will be discussed as part of the overall data quality for the investigation.

The XRF data collected during the design investigations will be considered Level II or III data and will be used only for engineering design or evaluation of alternatives, unless the data validation process shows that the XRF data meet the precision and accuracy requirements specified in Table 3. The XRF data may be considered Level IV data if all appropriate data quality objectives are met and documented in the PARCC.

The PARCC statement for the XRF data will include a discussion of the factors that may affect the strength of the correlation and why it does or does not indicate a strong relationship between the two data sets. The relative percent difference (RPD) of each XRF/laboratory sample pair will be calculated and presented in the PARCC. The average RPD of the XRF/laboratory sample pairs should not exceed 35% (per EPA National Functional Guidelines for Inorganic Data Review, October 2004). A graph showing the correlation between the XRF and laboratory results will be provided in the and the correlation coefficient for the results should be 0.7 or greater for the XRF data to be considered screening level data (per EPA Method 6200 [XRF], Appendix C). The results discussion in the PARCC will also include discussion of false negatives or positives, outliers, correlated residuals, XRF sample interference, elevated detection limits, bias, and site conditions, if necessary.

10.0 DATA REDUCTION, VALIDATION, DATA EVALUATION, AND REPORTING

10.1 DATA REDUCTION

Data reduction will be performed in the laboratory on the data by grouping similar Quality Control (QC) samples and calculating and reporting their recoveries, RPD's, flags, and qualifiers. Data reduction will be performed using applicable EPA procedures, guidelines and methods.

10.2 DATA VALIDATION

Data validation will be performed on the laboratory data in the laboratory and in the office after data reduction is complete. The laboratory validates data by reporting concentrations with "result qualifiers" (inorganics), if necessary. Table 6 presents result qualifiers derived from the CLP SOW (EPA, 1992) that may be used for the investigations.

Table 6 - Result Qualifiers

1)	C (Concentration) qualifier -- Enter "B" if the reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL). If the analyte was analyzed for but not detected, enter a "U".
2)	Q (Qualifier) E - The reported value is estimated because of the presence of interference. S - The reported value was determined by the Method of Standard Additions (MSA). W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance. * - Duplicate analysis not within control limits. + - Correlation coefficient for the MSA is less than 0.995.
Entering "S" "W" or "+" is mutually exclusive. No combination of these qualifiers can appear in the same field for an analyte.	
3)	M (Method) qualifier -- Enter: - "AA" for Atomic Adsorption "P" for Inductive Coupled Plasma. - "A" for Flame AA. - "F" for Furnace AA. - "CV" for Manual Cold Vapor AA. - "AV" for Automated Cold Vapor AA. - "AS" for Semi-Automated Spectrophotometric. - "C" for Manual Spectrophotometric. - "T" for Titrimetric. - "X" for Field Portable XRF. - "NR" if the analyte is not required to be analyzed.

Data will be validated by the field sampling team in the office by reporting concentrations with data or results qualifiers (inorganics). Table 7 presents the anticipated data qualifiers that may be used; data qualifiers are derived from the *Functional Guidelines for Evaluating Inorganics Analysis* (EPA, 1994). Additional data qualifiers may be generated by the sampling team following a review of the laboratory data package and field quality control samples. If a problem is identified through the review of the field QC data, all related field samples will be identified and qualified.

Table 7 - Data Qualifiers

U -	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
J -	The associated value is an estimated quantity.
R -	The data are unusable. (Note: Analyte may or may not be present.)
UJ -	The material was analyzed for, but not detected. The associated value is an estimate and may not be accurate or precise.

Knowing the limitations of the data assists the data users when interpreting or using the data. Data with limitations are usable for evaluation as long as the limitations are considered. Data are divided into three levels after data validation has been completed. The three levels include: enforcement quality (unrestricted use), screening quality (restricted use), and unusable. These data levels are related to the analytical support levels described in Section 4.0.

10.3 DATA EVALUATION

Data evaluation is performed in the office after data validation is complete. Data evaluation will be performed by completing the PARCC statement (see Section 5.0) to assess which data meet the DQOs.

10.4 DATA REPORTING

Data reporting begins with transferring the validated analytical results and field measurements to the computerized database. All data will be entered into a Microsoft Access or Microsoft Excel database for transferring data to DEQ. Data reporting continues with a printout of the analytical results and field measurements database and the validation of the analytical results and field measurements.

A data summary report (DSR) will be prepared for work completed under each SAP or FWP. The DSR's will include descriptions of all sampling activities, problems, difficulties, deviations, summary results, data validation summaries, the PARCC, and electronic database.

11.0 CORRECTIVE ACTION PROCEDURES

Field equipment malfunctions will be identified immediately and corrected by the Field Team Leader. Field QC samples outside of the control limits will be addressed in the data validation process by assigning data or result qualifiers. Laboratory equipment malfunctions will be addressed by the laboratory according to the EPA standard analytical method specifications. Laboratory QC samples (calibration samples, method blanks, matrix spike samples, laboratory control samples, and laboratory duplicates) will be addressed according to the EPA standard analytical method specifications.

12.0 AUDIT PROCEDURES

An internal audit of all field procedures will be performed by the Project Manager/Coordinator and the Field Sampling Team Leader (the QA Team) prior to any fieldwork. The internal audit will include a review of procedures selected for the sampling program, a review of the QA/QC samples required, and a review of training requirements. The laboratory is required to have written procedures addressing internal QA/QC and will follow their written procedures.

An external audit of all field procedures may be performed at the discretion of the DEQ Project Officer. External audit reports with recommended corrective action will be submitted by the DEQ Project Officer to the QA Team.

13.0 REFERENCES

ASA, 1965. Methods of Soil Analysis. American Society of Agronomy.

ASTM, 1985. American Society of Testing Materials.

EPA, 1974. Mine Spoils Potentials for Soil and Water Quality. EPA-670/2-74-070. U.S. Environmental Protection Agency.

EPA, 1978. Field and Laboratory Methods Applicable to Overburden and Minesoils. U.S. Environmental Protection Agency.

EPA, 1984. Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency.

EPA, 1986. Test methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846. U.S. Environmental Protection Agency.

EPA, 1987. Data Quality Objectives for Remedial Response Activities. Volume 1 - Development Process. U.S. Environmental Protection Agency, March 1987.

EPA, 1994. Laboratory Data Validation, Functional Guidelines for Evaluating Inorganics Analysis. U.S. Environmental Protection Agency, December 1994.

EPA, 1992. Contract Laboratory Program, Statement of Work. Inorganic Analysis, Multi-Media, Multi-Concentration. U.S. Environmental Protection Agency, March 1992.

MDMES, 1991. Methods for the Determination of Metals in Environmental Samples

SSSA, 1982. Methods of Soil Analysis. Part 2: Chemical and Microbiological Properties. Soil Science Society of America

Western States Laboratory Proficiency Testing Program, “Soil and Plant Analysis Methods” Version 4.00, 1997.

APPENDIX A: MONTANA DEQ DATA VALIDATION GUIDELINES FOR EVALUATING ANALYTICAL DATA

Montana Department of Environmental Quality
Data Validation Guidelines for Evaluating Analytical Data
(updated August 5, 2010)

This document was assembled by the Montana Department of Environmental Quality Site Response Section (DEQ) to formalize technical direction for conducting data validation. Data validation is a standardized review process for judging the analytical quality and usefulness of a discrete set of chemical data and is necessary to ensure that data of known and documented quality are used in making environmental decisions.

While these guidelines are generally used by DEQ, there may be circumstances that warrant a higher level of data validation review and DEQ reserves the right to require additional validation. For investigations where XRF or other field screening equipment is used, an evaluation including the comparison and correlation of field screening data to laboratory confirmation data must be also be included in the data validation discussion (please see DEQ's frequently asked questions at http://deq.mt.gov/StateSuperfund/FrequentlyAskedQuestions.mcpx for specifics associated with the use of XRF equipment and data collection/evaluation).

A separate data validation report must be completed for each sample batch/group. A brief summary of this validation report and the usability of the data should be included in the text of the project report with the validation report included as an appendix. The data validation should include an assessment of data using the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters:

Precision: The degree of mutual agreement between individual measurements of the same property under similar conditions.

- Combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD). Laboratory analytical precision is evaluated by analyzing matrix spike/matrix spike duplicate (MS/MSD) samples and using the results to calculate an RPD.

Accuracy: The degree of agreement between an analytical measurement and a reference accepted as a true value.

- The accuracy of a measurement system can be affected by errors introduced by field contamination, sample preservation, sample handling, sample preparation, and analytical techniques. Analysis of MS/MSD samples, laboratory control spikes (LCS) or blank spikes, surrogate standards, and method blanks are typically used to calculate the percent recovery (%R) for evaluating accuracy.

Representativeness: The degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent.

- Typically, representative data will be obtained through careful selection of sampling locations and analytical parameters; proper collection and handling of samples; and through use and consistent application of established field and laboratory procedures. Evaluation of field and laboratory blank samples for presence of contaminants can be useful in evaluating representativeness of sample results.

Completeness: A measure of the percentage of project-specific data that is valid.

- Valid data are obtained when samples are collected and analyzed in accordance with quality control (QC) procedures outlined in the SAP, and when none of the QC criteria that affect data usability are exceeded. Once data validation is complete, the number of useable sample results is divided by the total number of sample results planned for the investigation to determine the percent completeness. A completeness goal should be developed for each project (i.e., 100% completeness for residential samples to ensure that all properties requiring sampling are sampled).

Comparability: Expression of the confidence with which one data set can be compared with another.

- Comparability of data is achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data.

DATA VALIDATION REPORT

1. Please provide the following information at the beginning of the data validation report:
   - Project name
   - Name and Date of approved Quality Assurance Project Plan (QAPP), Sampling and Analysis Plan (SAP), or other applicable document
   - Laboratory Name
   - Laboratory Project ID
   - Sample Matrix
   - Sample Start and End Dates
   - Parameters Included (e.g., volatile organic compounds using EPA Method 8260)
   - Date Validated
   - Name of Validator

2. Please include a description of the data validation criteria used. These data validation criteria should be outlined in the appropriate QAPP, SAP, or other applicable document. ***For example:***

   - *USEPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG) for Superfund Organic Methods Data Review, USEPA-540-R-08-01, June 2008; with additional reference to USEPA CLP NFGs for Organic Data Review, EPA 540/R-99-008, October 1999*
   - *USEPA CLP NFGs for Inorganic Superfund Data Review, EPA 540R-10-011, January 2010.*
   - *USEPA Region 1 Laboratory Data Validation Function Guidelines for Evaluation of Organic Analysis, December 1996.*

3. Please include a table or list identifying all samples evaluated in this validation report. Please provide the associated laboratory sample identification numbers if different than the project sample ID/name.

4. Please include a description of the acceptability and usability of the data, including any qualified data Please explain data qualification flags or any other notes used by the laboratory. Please identify and explain any exceptions (i.e., rejected data) to the acceptability and usability of the data. Also include a cross reference where data qualified by the laboratory is discussed. ***For example:*** *Based on a data validation review, the data are acceptable as delivered with the exceptions noted below as rejected data. Data qualified by the laboratory are discussed in Section #2 [of the project report].*

5. Please include a description of the data qualifiers used during this validation. ***For example***: *J - estimated concentration; UJ – estimated reporting limit (for non-detect results); or R - rejected, data not usable.*

6. Does the laboratory case narrative note any nonconformance issues with the analytical data? Please identify the nonconformance issues.

7. Were sample chain-of-custody (CoC) forms complete? Please describe. ***For example:*** *The CoC records from field to laboratory were complete, and custody was maintained as evidenced by field and laboratory personnel signatures, dates, and times of receipt.*

8. Were detection limits in accordance with the project requirements? If applicable, discuss how this relates to method selection, screening levels, and matrix interference. Please explain, and include discussion of how this affects the data.

9. Were the requested analytical methods in compliance with project requirements (i.e., QAPP, SAP)? If not, please explain, and include discussion of how this affects the data.

10. Were samples received in good condition within method specified requirements? Please explain any exceptions, and how sample condition may affect the results. ***For example:*** *Sample collected and listed on CoC; however, lab noted sample not received in shipment. No qualification necessary.*

11. Were samples analyzed within method specified or technical holding times? Please explain any exceptions, and how this may affect the results.

12. Were reported units appropriate for the associated sample matrix/matrices and method(s) of analyses? Please explain.

13. Do the laboratory reports include all constituents requested to be analyzed on the CoC or under the QAPP, SAP, or other applicable document? Please explain.

14. Was there indication from the laboratory that the initial or continuing calibration verification results were within acceptable limits? Please explain. ***For example:*** *Initial and continuing calibration data were not included as part of this data set; however, these data are assumed to be acceptable as the laboratory did not note any calibration results that were outside of QC limits.*

15. Was the total number of method blank samples prepared equal to at least 5% (1 in 20) of the total number of samples, or analyzed as required by the method? Please explain.

16. Were laboratory blank samples free of analyte contamination? Please explain, and include discussion of how this affects the data. ***For example:*** *The method blank samples were reported to be free of analyte contamination with the following exceptions: MADEP VPH - the analyte naphthalene was detected at 0.0256 mg/Kg in the method blank prepared for batch X. As naphthalene was not detected in the associated samples, no qualification of data was required.*

17. Was the total number of matrix spike samples prepared equal to at least 5% of the total number of samples, or analyzed as required by the method? Please include a discussion of the project samples used to prepare the MS and MSD samples, if applicable. Please explain, and include discussion of how this affects the data. ***For example:*** *The total number of MS/MSD samples was equal to at least 5% of the total number of samples for each analysis and batch, with the exception of pesticides by Method 8081A batch X, where the laboratory indicated with a MNR1 qualifier that sufficient sample volume was not available to perform matrix spikes. These data were evaluated using other laboratory QC data. Additionally, no matrix spike samples were analyzed for percent dry solids as it is not required by the method.*

18. Please include a discussion of the project samples used to prepare the MS and MSD samples, if applicable.

19. Were MS/MSD percent recoveries and MS/MSD relative percent difference (RPDs) within data validation or laboratory QC limits? Please explain, and include discussion of how this affects the data.

20. Was the reference material used for the laboratory control standard (LCSs) the correct matrix and concentration? Please explain, and include discussion of how this affects the data.

21. Was the total number of LCSs samples analyzed equal to at least 5% (1 in 20) of the total number of samples, or analyzed as required by the method? ***For example:*** *The frequency requirements for laboratory quality control samples (1/20) were met.*

22. Were LCSs prepared in the same way as the associated samples? Please explain, and include discussion of how this affects the data.

23. Were LCS/LCSD percent recoveries and LCS/LCSD RPDs within laboratory QC limits? Please explain, and include discussion of how this affects the data.

24. Were surrogate recoveries within laboratory QC limits? Please explain and include a discussion of how this affects the data. ***For example:*** *In sample A, the surrogates 2-fluorobiphenyl and 2-bromonaphthalene were recovered outside the laboratory QC limits of 40-140% at 143% and 151%, respectively. As a result, the detection for the analyte C19-C36 aliphatic hydrocarbons was qualified as J in this sample due to possible high bias.*

25. Were the number of equipment, trip, or field blanks collected equal to at least 10% of the total number of samples, or as required by the project requirements, QAPP, or SAP? Please explain, and include discussion of how this affects the data.

26. Were the trip blank, field blank, and/or equipment blank samples free of analyte contamination? Please explain, and include discussion of how this affects the data.

27. Were the field duplicates collected as required by the project requirements, QAPP or SAP? Please explain, and include discussion of how this affects the data. Also, please provide a summary or a table identifying primary and duplicate sample pairs.

28. Were field duplicate RPD values within data validation QC limits (generally soil 0-50%, water 0-30%, or air 0-25%, or otherwise specified in the QAPP/SAP)? Please explain, and include discussion of how this affects the data.

29. Were laboratory duplicate RPD values within laboratory-specified limits? Please explain, and include discussion of how this affects the data.

30. If any data was qualified, please provide a data qualification summary or table that includes the analyte, sample ID, laboratory ID, laboratory result, validator qualifier, and reason for qualification (and include how data is affected/biased). ***For example:***

Analyte	***Sample ID***	***Laboratory ID***	***Laboratory Result***	***Validator Qualifier***	***Reason for Qualification***
C5-C8 Aliphatic Hydrocarbons	*All Samples*	*Lab-01 through Lab-14*	*Detects and Non-Detects*	*J for detections or UJ for non-detections*	*The RPD for the MS/MSD or LCS/LCSD was greater than the acceptable difference indicating poor repeatability. The MS and/or MSD recovery(ies) were below the acceptable limits indicating possible matrix interference.*
Benzene	*All Samples*	*Lab-01 through Lab-14*	*Detects and Non-Detects*	*J for detections or UJ for non-detections*	*The RPD for the MS/MSD or LCS/LCSD was greater than the acceptable difference indicating poor repeatability. The MS and/or MSD recovery(ies) were below the acceptable limits indicating possible matrix interference.*

31. If DEQ collected split samples, explain how those results compare to the natural sample.

32. Please provide any other general comments or other observations.

APPENDIX B: INVESTIGATION SOPS

PIONEER TECHNICAL SERVICES, INC.
STANDARD OPERATING PROCEDURES LIST

NUMBER	TITLE
PTS-SOP-DE-01	PERSONNEL DECONTAMINATION PROCEDURES
PTS-SOP-DE-02	EQUIPMENT DECONTAMINATION
PTS-SOP-DE-03	DERIVED WASTE
PTS-SOP-SA-01	SOIL AND WATER SAMPLE PACKAGING AND SHIPPING
PTS-SOP-SA-02	SAMPLE PRESERVATION, AND CONTAINERIZATION FOR AQUEOUS SAMPLES
PTS-SOP-SA-03	FIELD QUALITY CONTROL SAMPLES
PTS-SOP-SA-04	CHAIN OF CUSTODY FORMS FOR ENVIRONMENTAL SAMPLES
PTS-SOP-SA-05	PROJECT DOCUMENTATION
PTS-SOP-WFM-01	FIELD MEASUREMENT OF pH IN WATER
PTS-SOP-WFM-02	FIELD MEASUREMENT OF E_H IN WATER
PTS-SOP-WFM-03	FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE
PTS-SOP-WFM-04	FIELD MEASUREMENT OF WATER TEMPERATURE
PTS-SOP-WFM-05	STREAMFLOW MEASUREMENT WITH PORTABLE METER
PTS-SOP-WFM-06	FIELD MEASUREMENT OF ALKALINITY
PTS-SOP-WFM-07	FIELD MEASUREMENT OF DISSOLVED OXYGEN
PTS-SOP-SFM-01	FIELD MEASUREMENT OF pH IN SOIL
PTS-SOP-SFM-02	XRF ANALYSIS
PTS-SOP-SW-01	STREAM SAMPLING
PTS-SOP-GW-01	ELEVATION SURVEY FOR MONITOR WELLS
PTS-SOP-GW-03	DEPTH TO WATER LEVEL MEASUREMENTS
PTS-SOP-GW-04	MULTIPLE WELL PUMP TEST
PTS-SOP-GW-05	PNEUMATIC/VACUUM RESPONSE (SLUG) TEST
PTS-SOP-GW-06	RESPONSE TEST

PTS-SOP-GW-07	DISCRETE INTERVAL VERTICAL PROFILING
PTS-SOP-GW-08	SAMPLING SEEPS AND SPRINGS
PTS-SOP-GW-09	PORTABLE BOREHOLE GAMMA LOGGER
PTS-SOP-GW-10	PURGING AND SAMPLING WITH A SUBMERSIBLE PUMP
PTS-SOP-GW-11	PURGING WITH A PERISTALTIC PUMP
PTS-SOP-GW-12	MONITOR WELL DESIGN AND CONSTRUCTION
PTS-SOP-S-01	SURFACE SOIL SAMPLING
PTS-SOP-S-02	SUBSURFACE SOIL SAMPLING
PTS-SOP-S-03	SEDIMENT SAMPLING FROM STREAMS, PONDS, AND LAKES
PTS-SOP-S-04	SPLIT SPOON SAMPLING
PTS-SOP-S-06	TEST PIT SAMPLING

PTS-SOP-DE-01

STANDARD OPERATING PROCEDURE
PERSONNEL DECONTAMINATION PROCEDURES

All personnel must go through decontamination procedures whenever leaving a contaminated area. Decontamination procedures should be used in conjunction with methods to prevent contamination including minimizing contact with wastes and maximizing worker protection.

PROTECTION:

1. Follow personal protective measures outlined in the site-specific Health and Safety Plan.

2. In the event that personnel decontamination becomes necessary, the outer more heavily contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.

3. Next, the inner, less contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.

4. Store the items separately so they are used in contaminated areas only.

5. For contaminants other than those found typically at uncontrolled hazardous waste sites, see the Health and Safety Officer.

EMERGENCY DECONTAMINATION:

1. If the decontamination procedure is essential to the life-saving process, decontamination must be performed immediately.

2. If heat related illness develops, protective clothing should be removed as soon as possible.

WASH, RINSE AND/OR CUT OFF PROTECTIVE CLOTHING/EQUIPMENT

3. If medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. Wrap the victim to reduce contamination of others.

4. Alert medical personnel to the emergency and instruct them about potential contamination. Instruct medical personnel about specific decontamination procedures.

5. Dispose contaminated clothing and equipment properly.

PTS-SOP-DE-02

STANDARD OPERATING PROCEDURE
EQUIPMENT DECONTAMINATION

All equipment leaving the contaminated area of a site must be decontaminated. Decontamination methods include physical removal, chemical removal or a combination of both. Decontamination procedures, in some cases, are to be performed in the same level of protection used in the contaminated area of a site. However, decontamination personnel may be sufficiently protected by wearing one level lower protection. The following decontamination procedures are for typical uncontrolled hazardous waste sites. For a more specific or unusual contaminant such as dioxins, see the site-specific Health and Safety Plan. Decontamination procedures should be used in conjunction with methods to prevent contamination of sampling and monitoring equipment.

INORGANIC CONTAMINANTS - HEAVY METALS:

1. Remove gross contamination with a water rinse using pressurized or gravity flow tap water.

2. Wash equipment in a solution of soap (non-phosphate) and tap water with a stiff brush.

3. Rinse the equipment with tap water.

4. Rinse the equipment with distilled water.

5. Rinse the equipment with a mixture of 10:1 nitric acid in distilled water (10 parts water to 1 part nitric acid).

6. Rinse the equipment again with distilled water.

ORGANIC CONTAMINANTS:

1. Remove gross contamination physically with a disposable paper towel or with a water rinse using pressurized or gravity flow.

2. Wash equipment in a solution of soap (non-phosphate) and tap water with a stiff brush.

3. Rinse the equipment in tap water.

4. Rinse the equipment with deionized water.

5. Rinse the equipment with methanol.

EQUIPMENT USED FOR DECONTAMINATION:

1. Rinse equipment (brushes, buckets, tubs) used in the decontamination process with water, preferably pressurized.

2. Agitate the equipment used in the decontamination process in the soap/tap water solution. (The tub which holds the solution will only have the water rinse.)

3. Rinse equipment with tap water.

4. Place equipment in appropriate areas, so they are used only for decontamination purposes (label if necessary).

DISPOSAL OF DECONTAMINATION SOLUTIONS:

1. Proper disposal of the soap/tap water solution, the tap water rinse, and the deionized water rinse is to a proper waste water container.

2. Proper disposal of the solvent rinse is to a proper organic solvent waste container.

3. When contaminants have been identified, either in the solutions or elsewhere on the site, solutions should be disposed of appropriately. If they are hazardous (characteristic, listed, etc.) dispose of them as such.

4. WHEN USING OTHER THAN THE ABOVE MENTIONED SOLUTIONS, BE SURE TO CHECK WITH THE HEALTH AND SAFETY OFFICER AND THE PROJECT MANAGER. SOME SOLVENTS MUST BE EVAPORATED.

EFFECTIVENESS OF DECONTAMINATION:

1. Effectiveness of the decontamination procedures will be measured using field equipment rinsate blanks (see the site-specific Quality Assurance Project Plan).

PTS-SOP-DE-03

STANDARD OPERATING PROCEDURE
INVESTIGATION DERIVED WASTE HANDLING

During a Site Assessment (SA), Site Investigation (SI), or Remedial Investigation (RI) process investigation derived wastes may be generated. The following is the method for handling investigation-derived waste in accordance with EPA protocols and DEQ guidance:

1. Decontamination fluids will be collected and then disposed of by either sending to a TSD, evaporated, treated using an activated carbon or air sparging unit, or temporarily stored until determined if it is contaminated. Decontamination fluids generated from cleaning equipment used in background sampling or for sampling in areas where past results indicate that contaminants are below standards, will be disposed of to the ground surface.

2. Groundwater generated from developing and purging monitoring wells will be discharged to the ground surface if past monitoring results indicated that all contaminants were below groundwater standards. If past monitoring results indicated that one or more contaminants were above groundwater standards, the purged water and potentially contaminated water will be collected. If the water is determined to be below standards by laboratory analysis it will be discharged to the ground surface. There may be instances (i.e. inclement weather) where purge water and/or decon water will be temporarily stored in drums or tanks to be treated on-site with granulated activated carbon or air sparging. If the water is determined by laboratory analysis to contain contaminants above groundwater standards and can not be treated on-site it, it will be stored on-site until shipping/disposal arrangements can be made. If the water is visibly contaminated it will be drummed, labeled, and stored on-site until shipping/disposal arrangements are made. All containers stored on-site will be labeled with the date, time, contents, any corresponding analytical data, collection location, contact person, contact agency, etc.

3. Soil and or cuttings from monitoring well installation will be placed back in the borehole unless it is visibly contaminated. If the soil is visibly contaminated the soil/cuttings will be drummed, labeled, and stored on-site until shipping/disposal arrangements are made. Soils from borings/well installations located in previously sampled areas that are known to be contaminated will be drummed, labeled, and left on-site until shipping/disposal arrangements are made.

4. Disposable equipment intended for one-time use and personal protective equipment (PPE) materials will be packaged for appropriate disposal. The disposable equipment and PPE utilized for sampling will be double bagged and disposed of as a solid waste in the local landfill. Disposable equipment and PPE utilized for sampling visibly contaminated sites or sites known to be contaminated from previous monitoring will

be packaged, drummed, labeled and left on-site until shipping/disposal arrangements are made.

5. Laboratories will dispose of the portions of the samples not used for analysis.

Personnel will decontaminate all equipment prior to sampling and before leaving the site, to prevent off-site contamination, in accordance with PTS-SOP-DE-02. Equipment decontamination will consist of a tap water rinse, soap and water wash, distilled water rinse, and air drying. If appropriate, additional rinses may be needed in association with decontamination procedures for specific contaminants (i.e., dilute nitric rinse for equipment used in sampling for metals, a methanol rinse for equipment used in sampling for certain organics).

All personnel must go through decontamination procedures whenever leaving a contaminated area. Decontamination procedures should be used in conjunction with methods to prevent contamination including minimizing contact with wastes and maximizing worker protection. Personnel must follow the Personnel Decontamination Procedure PTS-SOP-DE-01.

PTS-SOP-SA-01

STANDARD OPERATING PROCEDURE
SOIL AND WATER SAMPLE PACKAGING AND SHIPPING

1. WATER SAMPLE PRESERVATION precedes if the sample to be packed is water and preservation is required.

2. Each of the filled sample containers will be placed in separate ziplock bags to keep it clean, dry, isolated, and to protect the sample label. Samples will then be placed in a cooler which has been lined with a plastic bag. The samples will be surrounded with vermiculite to reduce movement and absorb any leakage. The garbage bag will then be tied to contain the vermiculite.

3. The Project Manager will double check the paper work (chain-of-custody form, etc.) to assure those samples recorded on the associated paper work are in the cooler. The Project Manager and the sampler will then sign the chain-of-custody form to relinquish custody.

4. The paper work will then be placed in a sealed ziplock bag and taped to the inside of the cooler lid.

5. The cooler will be labeled with the appropriate shipping labels (NOS, flammable liquids, flammable solids, this side up, fragile, etc.).

6. The cooler will then be closed and an address label will be affixed to the lid (a Federal Express label will also be affixed, if used, at this time).

7. The cooler will then be closed and chain-of-custody seals will be placed over the opening.

8. Tape will then be placed over the custody seals and around the cooler.

9. The cooler(s) will then be transported to a secure storage, to the shipping agent, or directly to the laboratory.

Note: Bagging of samples and lining of coolers will not be necessary if samplers transport samples directly to the laboratory.

PTS-SOP-SA-02

STANDARD OPERATING PROCEDURE
SAMPLE PRESERVATION AND CONTAINERIZATION FOR AQUEOUS SAMPLES

This SOP describes the techniques and quality control measures used to sample, prepare, and handle water containing the analytes listed below:

- Target Analyte List;
- Total Recoverable Metals;
- Cyanide;
- Sulfate;
- Nitrate/Nitrite;
- Chloride;
- Hardness;
- Pentachlorophenol;
-Dioxins/Furans; and
-Extractable Petroleum Hydrocarbons.

TARGET ANALYTE LIST:

1. One liter polyethylene or glass bottles will be required from the contract laboratory.

2. Upon sample collection, the sample is to be acidified with dilute nitric acid (1 to 1) to a pH of 2 or less. Normally, 3 milliliters (ml) of dilute nitric acid per liter should be sufficient to preserve the samples. This will keep the metals in solution and minimize their absorption on the container wall.

3. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

4. All samples should be analyzed within six months of collection. An exception is mercury (Hg) analysis, which must be completed in 28 days.

5. Serious errors may result during sampling and storage by failure to follow these guidelines.

TOTAL RECOVERABLE METALS

1. Follow the procedure outlined for the Target Analyte List.

CYANIDE

1. One liter polyethylene or glass bottles will be required from the contract laboratory.

2. Upon sample collection, the sample is to be preserved with dilute sodium hydroxide (NaOH) to a pH of greater than 12 or higher.

3. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

4. All samples should be analyzed within 12 days of collection.

SULFATE, CHLORIDE, HARDNESS

1. Because these four parameters can be analyzed together, one 1-Liter polyethylene or glass bottle will be required from the contract laboratory.

2. Upon sample collection and sample labeling and storing (as per PTS-SOP-SA-01), the sample should be stored at 4°C until analysis.

3. All samples must be analyzed within 28 days of collection.

4. In the presence of organic matter, certain bacteria may reduce sulfate to sulfide. To avoid this, samples will be stored at or below 4°C.

NITRATE/NITRITE

1. A 250 ml polyethylene bottle is required for this analysis.

2. Upon sample collection, the sample should be acidified with sulfuric acid (H_2SO_4) to a pH of 2 or less and promptly stored at 4°C until analysis.

3. All samples must be analyzed within 28 days of collection.

PENTACHLOROPHENOL

1. A 2,360 ml amber glass jug is required for this analysis.

2. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4 ºC until analysis.

3. All samples must be analyzed within 14 days of collection.

DIOXIN/FURANS

1. A 1,000 ml amber glass bottle will be required for this analysis.

2. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4 ºC until analysis.

3. Samples must be extracted within 10 days of collection.

EXTRACTABLE PETROLEUM HYDROCARBONS (EPH)

1. Two 1,000 ml glass bottles are required for this analysis.

2. Upon sample collection, each bottle should be acidified with hydrochloric acid (HCL) to a pH of 2 or less and promptly stored at 4 ºC until analysis.

3. All samples must be analyzed within 14 days of collection.

PTS-SOP-SA-03

STANDARD OPERATING PROCEDURE
FIELD QUALITY CONTROL SAMPLES

Field quality control (QC) is a part of the Project Quality Assurance/Quality Control (QA/QC) program and is described in detail in the site-specific Quality Assurance Project Plan. This SOP describes the preparation and collection frequency of field QC blanks and duplicate samples from water media.

At least one set of field QC samples will be prepared for each sampling event. QA/QC samples will be collected at a frequency of 1:20. If the number of field QC samples taken is not equal to an integer multiple of the interval, then the next higher multiple will be used. For example, if a frequency of 1:20 is indicated and 28 samples are taken, then two QC samples will be prepared.

All field QC samples shall be shipped with field samples to the contract laboratory as per PTS-SOP-SA-01.

One field bottle blank will be required at 1:20 and as follows:

> A bottle blank is a sample bottle containing DS/DI water and preservatives and is prepared in the field. It is contained in a sample bottle randomly chosen from each lot of bottles received by the contract laboratory or supplier. A bottle blank is prepared by the same protocols as a normal sample, but is not exposed to any "field conditions" or sampling equipment. The appropriate sample number shall be placed on the bottle.

One field duplicate will be taken 1:20 and as follows:

> A field duplicate consists of two samples taken at the same location and time, but placed in different bottles for separate analysis. Each duplicate shall be analyzed for identical chemical parameters.

1. Collect an adequate volume of sample to accommodate two sample bottles.

2. Process the samples (as per SOPs) for each duplicate.

3. Label the two sample bottles with appropriate sample numbers.

4. Record duplicate number, sample number, and sample location in the field log book.

PTS-SOP-SA-04

STANDARD OPERATING PROCEDURE
CHAIN OF CUSTODY FORMS FOR ENVIRONMENTAL SAMPLES

This SOP establishes the requirements for documenting and maintaining environmental sample chain of custody from point of origin to receipt of sample at the analytical laboratory. This procedure shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigations by Pioneer Technical Services, Inc. (Pioneer). It is applicable from the time of sample acquisition until custody of the sample is transferred to an analytical laboratory.

Chain of custody is an unbroken trail of accountability that ensures the physical security of samples, data and records. Custody refers to the physical responsibility for sample integrity, handling, and/or transportation. Custody responsibilities are effectively met if the samples are:

- in the responsible individual's physical possession;
- in the responsible individual's visual range after having taken possession;
- secured by the responsible individual so that no tampering can occur; or
- secured or locked by the responsible individual in an area in which access is restricted to authorized personnel.

RESPONSIBILITIES

PROJECT MANAGER:

1. The Project Manager is responsible for overall management of environmental sampling activities, designating sampling responsibilities to qualified personnel, and reviewing any changes to the sampling plan.

FIELD TEAM LEADER:

1. The Project Manager may act as the Field Team Leader or may choose to appoint a Field Team Leader.
2. The Field Team Leader is responsible for general supervision of field sampling activities and ensuring proper storage/transportation of samples from the field to the analytical laboratory. Chain of Custody forms will be reviewed for accuracy and completeness to preserve sample integrity from collection to receipt by an analytical lab. Review of Chain of Custody forms may be delegated to qualified personnel. The Field Team Leader is responsible for sample custody until the sample has been properly relinquished as documented on the chain of custody form.

FIELD SAMPLER

1. The Field Sampler is responsible for sample acquisition in compliance with technical procedures, initiating the Chain of Custody, and checking sample integrity and documentation prior to transfer.

2. Field samplers are also responsible for initial transfer of samples consisting of physical transfer of samples directly to the internal laboratory or transferred to a shipping carrier, (i.e., United Parcel Service or Federal Express) for delivery.

LABORATORY TECHNICIAN

1. The receiving Laboratory Technician is responsible for inspection of transferred samples to ensure proper labeling and satisfactory sample condition.
2. Unacceptable samples will be identified and segregated. The Environmental Manager will be notified.
3. The Laboratory Technician will review the Chain of Custody for completeness and file as part of the project's permanent record.

EQUIPMENT AND MATERIALS

- Seals and Labels;
- Chain of Custody forms (provided by contracted laboratory); and
- Packing and shipping materials as necessary.

1. All samples shall be collected and handled in accordance with PTS-SOP-SA-01 and PTS-SOP-SA-02, or other methods, if appropriate. Samples will be transported in insulated coolers with ice ('blue ice' is acceptable) as necessary to maintain temperature at 4° C+/- 2°C until receipt by the analytical laboratory.

2. The Field Team Leader or designated Field Sampler shall initiate the Chain of Custody form for the initial transfer of samples.

3. A Chain of Custody form will be completed and accompany every sample. The form includes the following information:

- Project code;
- Project name;
- Samplers signature;
- Sample identification;
- Date sampled;
- Time sampled;
- Analysis requested;
- Remarks;
- Relinquishing signature, data, and time; and
- Receiving signature, date, and time.

4. The Field Sampler relinquishing custody and the responsible individual accepting custody shall sign, date, and note the time of transfer on the Chain of Custody form. (If the transporter is not an employee of Pioneer, the Field Sampler may identify the carrier and reference the bill of lading number in lieu of the transporter's signature.)

5. One copy of the Chain of Custody form shall be filed as a temporary record of sample transfer by the Field Sampler. The original form shall accompany the samples and

shall be returned to Pioneer as part of the contracted laboratory Quality Assurance/Quality Control (QA/QC) requirements. The original form will be filed as part of the project's permanent records.

6. The Project Manager (or designee) shall track the Chain of Custody to ensure timely receipt of samples by an analytical laboratory.

PTS-SOP-SA-05

STANDARD OPERATING PROCEDURE
PROJECT DOCUMENTATION

This SOP establishes the requirements for documenting and maintaining field logbooks and photographs. These procedures shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigation by Pioneer Technical Services, Inc. (Pioneer). These procedures apply from the time field work begins until site activities are completed.

RESPONSIBILITIES

A separate field logbook will be used for each field task. Each logbook shall have a unique document control number. The logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written ink. The author will initial and date entries at the end of each day. All corrections will consist of a single line-out deletion in ink, followed by the author's initials and the date. No bound field logbooks will be destroyed or thrown away even if they are illegible or contain inaccuracies that require a replacement document. These bound logbooks shall include the following entries:

1. A description of the field task.
2. Time and date fieldwork started.
3. Location and description of the work areas, including sketches if possible, map references and photographs, and sketches of well construction details.
4. Names and titles of field personnel.
5. Name, address, and phone number of any field contacts or site visitors
6. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions.
7. Details of the fieldwork performed and field data sheets used with special attention to any deviation from the task-specific Sampling and Analysis Plan (SAP) or Standard Operating Procedures.
8. All field measurements made.
9. Any field laboratory analytical results.
10. Personnel and equipment decontamination procedures.

For any field sampling work the following entries should be made:

1. Sample location and number.
2. Sample type and amount collected.
3. Date and time of sample collection.
4. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of person, person's company, and any other pertinent information.
5. Sampling method, particularly any deviations from the SOP.
6. Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample.

7. Sample preservation, handling, packaging, labeling, and the laboratory where the samples will be sent.

Photographs will be taken of field activities using a camera-lens system or a digital camera system. Photographs should include a scale in the picture when practical. Telephoto or wide-angle shots will not be used, since they cannot be used in enforcement meetings. The following items shall be recorded in the bound field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced.
2. A brief description of the subject and the fieldwork portrayed in the picture.
3. Sequential number of the photograph and the roll number on which it is contained.

The slides or prints and associated negatives shall be placed in task files in the field office after the film is developed. Any supporting documentation from the bound field logbooks shall be photocopied and placed in the task files to accompany the particular slides or prints.

PTS-SOP-WFM-01

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH IN WATER

INSTRUMENT CALIBRATION:

Calibrate pH meter in the field at the beginning of each day of field work and when the standard check is out of calibration. Recheck calibration at end of day.

1. Rinse pH and temperature probes in deionized water.

2. Turn on meter and immerse pH and temperature probe in a pH 7 buffer solution. Calibrate meter to pH 7 allowing enough time for meter to stabilize.

3. Rinse pH and temperature probe with deionized water.

4. Immerse pH and temperature probe in either a pH 4 or a pH 10 buffer solution depending on whether expected pH of samples is above or below pH 7. If expected sample pH is above pH 7, use pH 10 solution for the second calibration. If expected sample pH is below pH 7, use pH 4 for the second calibration. Calibrate meter to second pH solution allowing enough time for meter to stabilize.

5. Rinse pH and temperature probe with deionized water.

6. Recheck meter calibration to a pH 7 calibration solution. Repeat the calibration process (Steps 2-4) if value for final pH check is more than 0.1 units from pH 7.0.

FIELD PROCEDURES:

1. Rinse beaker with sample water three times.

2. Rinse pH and temperature probes with deionized water.

3. Fill beaker with sample water.

4. Turn on meter and immerse pH probe and temperature electrodes in sample water. Stir sample for thorough mixing. Read and record pH to nearest 0.01 unit once pH reading has stabilized.

5. Rinse electrodes with deionized water and store in carrying case.

Note: pH may also be measured by placing the probe directly into the water body being tested. The probe must be moved slowly in a circular motion when measuring stagnant water.

PTS-SOP-WFM-02

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF E_H IN WATER

Redox-Potential (E_H) measurements are performed using ORION model 96-78 redox electrode and ORION SA-210 or 250A portable meter set to the millivolt (mV) mode.

FILLING ELECTRODE:

The electrode shall be filled with one of the two solutions selected to best match the ionic strength of the sample solution to minimize junction potentials. The following solutions shall be used:

1. Dilute solution (total ionic strength less than 0.2 molar [M]). Use ORION dilute filling solution (Cat. No. 900001), which will match the potential of a conventional calomel electrode.

2. Concentrated solution (total ionic strength greater than 0.2M). Use ORION concentrated filling solution (Cat. No. 900011), which is 4M KCl saturated with Ag/AgCl.

Filling solution level in the electrode should always be at least one inch above the level of the solution being measured.

CONNECTING THE ELECTRODE TO THE METER:

Insert the platinum redox connector (large diameter) in the pH or sensing electrode input jack on the ORION SA-210 meter and the reference electrode connector (small diameter) into the reference electrode input jack.

CALIBRATION PROCEDURE:

The meter shall be calibrated daily using a two stage process that checks the operation and accuracy of the meter. To check the operation of the meter:

1. Connect the electrodes to the meter, place the electrodes in a beaker of tap water, and turn on the meter.

2. Add a drop of dilute NaOH to the beaker and mix it with tap water.

3. If the reading on the meter decreases sharply, then the electrodes are sensitive and operating properly.

4. If little or no change in the reading is observed, then the electrodes are not functioning properly and must be cleaned. The following summarizes the electrode cleaning procedures:

   - Drain filling solution from outer portion of electrode body and refill with fresh solution (see Filling Electrode).

   - If the electrode still does not function properly, remove sleeve from the inner electrode, rinse all the parts of the electrode with DS/DI water, and allow to air dry.

   - Reassemble electrode and refill with filling solution.

To check the accuracy of the meter and E_H electrode:

5. Use a standard solution consisting of Zobell's ferrous/ferric solution.

6. Rinse electrodes with DS/DI water.

7. Pour the standard solution into a small beaker and place electrodes into the beaker. The redox potential of the standard solution should read 439 +/- 30 mV. If the reading deviates from this range, then the electrodes must be cleaned (see Step 4).

MEASUREMENT PROCEDURE:

1. Set the mode switch to the mV position, and place the electrode in the sample solution. When the reading stabilizes, record the potential.

2. For some applications, redox-potential readings are reported relative to the normal hydrogen electrode (NHE). To do this, select the electrode potential (C) value in Table FM-01-1 that corresponds to the filling solution used and the temperature of the solution measured. Substitute the table value for C in the following equation and solve for E.

   $E = Eo + C$ where:

   E - Oxidation reduction potential of the sample relative to the NHE.

   Eo - Potential developed by the platinum redox electrode.

   C - Potential developed by the reference electrode relative to the NHE (see Table WFM-02-1).

TABLE WFM-02-1

POTENTIALS ("C") DEVELOPED BY THE REFERENCE ELECTRODE PORTION RELATIVE TO THE NORMAL ELECTRODE AT VARIOUS TEMPERATURES

	"C" electrode Potential in mV	
Temperature EC	900001 Solution	900011 Solution
10	251	214
20	244	204
25	241	199
30	238	194

PTS-SOP-WFM-03

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE

FIELD PROCEDURES:

1. Calibrate instrument as described in instruction manual. Usually the lowest concentration standard is appropriate. Recalibrate at the end of the day and note any drift. Replace batteries and try fresh calibration solutions if meter does not calibrate properly.

2. Rinse decontaminated beaker with sample water three times.

3. Fill beaker with water sample.

4. Rinse conductivity probe with deionized water and place probe in sample water.

5. Submerge conductivity probe in sample so that flow cell holes are immersed, stir to remove any air bubbles from within flow cell. Turn instrument on to appropriate scale for sample analysis. Read specific conductance and record to the nearest one Seimen (same as micromhos/centimeter). Measure sample temperature to the nearest 0.1EC from conductivity meter after temperature has equilibrated.

6. Remove probe from sample and rinse with deionized water.

7. Correct conductivity reading to specific conductance (corrected to 25EC) by multiplying the conductivity value by the temperature correction factor and then by the probe correction factor (<u>unless SC unit has an automatic temperature correction</u>).

MAINTENANCE:

1. Store meter in case during transport.

2. Check batteries before taking meter into the field. Carry spare batteries and deionized water for rinsing probe.

3. Inspect probe for damage or dirt.

4. If meter readings are erratic, return meter and probe to factory for repair.

PTS-SOP-WFM-04

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF WATER TEMPERATURE

NOTE: Often, temperature is measured with a pH meter or the specific conductance meter. If included as part of those instruments, use SOP for that instrument. Otherwise:

1. Provide two calibrated thermometers inside protective cases for field measurements.

2. Check thermometer for cracks or gaps in the mercury. If cracks or gaps are visible, thermometer will not be used.

3. When possible, measure temperature of surface water at midstream, submersing the thermometer for approximately one minute or until temperature stabilizes.

4. When in situ temperature measurements are not possible, draw sample of at least 200 milliliters into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about one minute).

6. Record temperature to nearest 0.5EC in field log book or on field data sheet.

7. On a quarterly basis, check field thermometers against NBS-calibrated laboratory thermometer. Agreement should be within 0.5EC.

PTS-SOP-WFM-05

STANDARD OPERATING PROCEDURE
STREAMFLOW MEASUREMENT WITH PORTABLE METER

Measurement of discharge will be accomplished by the velocity - area method utilizing a current meter. Locations for the discharge gaging stations will be based on the physical characteristics of the stream reach. Discharge measurement requires a stream section with consistently uniform flow and a static stream bed where dimensions are unlikely to change over the monitoring period. A static stream section is usually found on a straight stream reach at the downstream end of a riffle. For shallow streams with depths less than 2.5 feet the best velocity - area method is the six-tenths' method. This method measures current velocity at a depth six-tenths of the total depth below the water surface. The procedure is as follows:

1. Assemble the equipment as per the manufacturer's instructions.

2. Select a stream section where flows are mostly parallel to the banks, there are no sharp turns in the flow direction, and the bottom is reasonably smooth. The section can be smoothed by reshaping the edges, removing rocks from the bottom, and removing branches, weeds, or grasses.

3. Set a tag line or cloth tape across the section, perpendicular to the flow. Anchor both ends securely to stakes or other fixed objects.

4. Determine the measurement interval size necessary so that no interval has greater than 10% of the flow. Generally 20 to 25 intervals are adequate depending on the variability and complexity of the stream channel.

5. Turn on the flowmeter and begin measurements at either the left or right bank. The initial point is generally the tape reading at the water line and has no depth or velocity to measure. Measurement points are best set at whole or half-foot intervals.

6. Water depth is determined by reading the calibrations on the wading rod; read depths while ignoring the "pile-up" effect on the upstream portion of the wading rod.

7. Velocity is measured by vertically integrating the water column. This is accomplished by slowly lowering the probe to the bottom of the stream and then raising it at the same speed. The resulting reading is the average velocity for the water column at that station. Care must be taken to keep the meter pointed directly into the flow and to keep the rod in a vertical position. It is important to raise and lower the probe at the same slow speed. Repeat each station three times and use the average of the three readings for the flow velocity at the station.

8. Record station, depth and average velocity on the streamflow field data sheet and calculate the approximate stream flow. Attach the data sheet to the inventory form package.

Note: Very small flows (not exceeding 50 gpm) may be measured using the bucket and stopwatch or float and stopwatch methods.

PTS-SOP-WFM-06

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF ALKALINITY

Alkalinity is determined by titrating a water sample with a standard solution of sulfuric acid. The end point is selected as pH 4.5.

1. Fill a 25 milliliter (mL) buret with 0.01639 Normal (N) or a known normality sulfuric acid solution.

2. Pipet 50 mL of filtered sample into a clean dry 100 mL beaker. The sample volume may be increased for low ionic strength solution or decreased for solutions of high ionic strength. Filtering is recommended for turbid samples.

3. Rinse pH electrode three times with an aliquot of the sample.

4. Insert pH electrode and a clean dry stirring bar into the sample.

5. Place beaker containing sample on the titration assembly and record the pH.

6. Adjust the stirrer speed to slow, titrate immediately to pH 4.5, and record the titrant volume on the field note sheet.

The calculation for total alkalinity (TA) as $CaCO_3$ in milligrams per liter is (titrant normality = 0.06139):

TA = 1000) mL Sample x 0.8202 x mL titrate

<u>Caution</u>

If the volume of titrant used in determination exceeds 25 mL (size of buret from step 1), DO NOT refill buret and continue the titration. Select a smaller sample and repeat the procedure from Step 3.

Note: The appropriate Hach reagents may be used instead of the pH meter for colorometric determination of pH endpoints.

PTS-SOP-WFM-07

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF DISSOLVED OXYGEN

1. Inspect dissolved oxygen meter for damage. Inspect probe for sufficient electrolyte and to determine if oxygen sensor membrane is in good condition. Replace membrane if torn or wrinkled. Inspect for air bubbles beneath the membrane. If bubbles are present, remove membrane and add electrolyte solution. Replace membrane so that air bubbles are absent.

2. Rinse probe and cable with deionized water.

3. Calibrate probe and meter according to manufacturer's instructions.

4. Place probe in water body to be sampled. Raise and lower probe through water sample at a rate of about one foot per second. Allow probe sufficient time to stabilize to temperature and dissolved oxygen concentration.

5. Read and record dissolved oxygen concentration.

PTS-SOP-SFM-01

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH IN SOIL

METHOD 1 - MATERIALS REQUIRED:

1. ORION pH meter (refer to PTS-SOP-WFM-01 for calibration and operating procedures).

2. pH probes and pH-4, pH-7, and pH-10 buffer solutions.

3. Hard plastic spoons (teaspoon size, two minimum).

4. Glass stirring rods (two minimum).

5. 50-milliliter (ml) sample beaker (or disposable cup) with lid. Quantity depends on number of samples.

6. Deionized (DI) water (two liters minimum).

7. 0.01 M $CaCl_2$ (1.47 grams $CaCl_2$ x 2 H_2O/liter = 2 liters minimum).

8. Paper towels.

FIELD LABORATORY PROCEDURES:

1. Place approximately 1 teaspoon (about 10 grams) of soil sample in sample beaker.

2. Add about 20 ml of 0.01 M $CaCl_2$ into beaker.

3. Stir with glass rod to make slurry. (Clean glass rod with DI water prior to preparing another soil sample.)

4. Attach lid to beaker and shake vigorously.

5. Let beaker stand until sediment has settled. (This will take about 5 minutes for sandy samples to 30 minutes for clayey samples.)

6. Calibrate pH meter according to procedures outlined in PTS-SOP-WFM-01.

7. Immerse clean pH probe in the supernatant. Gently move the probe up and down without disturbing the sediment.

8. Record pH value of solution in the field log book when stabilized.

9. Decontaminate pH probe and continue on to next sample.

METHOD 2 - MATERIALS REQUIRED:

1. Soiltest direct reading soil pH meter

2. Deionized (DI) water

3. Paper towels

FIELD LABORATORY PROCEDURES:

1. Place decontaminated pH tester into soil, assuring maximum contact of metal side plates in finer grained soil. Note that soil must be damp for this procedure to give proper results.

2. Read pH from face of meter after equilibration for approximately 10 seconds. (If dial does not move, soil is not damp enough for testing. Use another, wetter aliquot, add a small amount of tap water to the soil, or use METHOD 1 [$CaCl_2$].)

3. Record pH value of soil in the field log book.

4. Decontaminate pH probe and continue on to next sample.

PTS-SOP-SFM-02

STANDARD OPERATING PROCEDURE
XRF ANALYSIS

The chemical characterization of solid samples (soil, tailings, waste rock, etc.) in the field will be determined by the field portable X-ray fluorescence (XRF) spectrometer 9000 instrument manufactured by Spectrace Instruments, Inc., Fort Collins, Colorado. The XRF will be used in a prepared application meaning the solid sample will be sieved or ground to minimize void space and the sample will be cupped for measurement on the instrument probe. This is opposed to an in-situ application where the solid sample has no preparation and the reading is on the ground surface.

OBJECTIVES:

1. To screen on-site solids for selecting biased (high concentration) sample locations for laboratory analysis; and

2. To characterize (obtain numerous data points) on-site solids.

SOURCE:

The instrument has a mercuric iodide (HgI2) conductor and three shielded radioactive sources (Fe-55, Cd-109, and Am-241) that produce spectral peaks. The manufacturer states that no personal dosimetry is required for the radioactive source because of the high quality aluminum shielding. The position (energy level) of the spectral peaks is specific to an individual element and the peak height is indicative of the concentration of that element within the area exposed to the source. The sources will allow determination of the following compounds:

Source	Element Range
Fe-55	S to Cr
	Mo to Ba
Cd-109	Ca to Rh
	Ta to Pb
	Ba to U
Am-241	Cu to Tm
	W to U

DETECTION LIMIT:

The detection limit is a function of source strength, particle size, counting time, and the concentration of other elements.

1. The source strength is constant.

2. Particle size will be standardized at those fractions less than 2mm by using a sieve of 10 mesh screen.

3. Counting time can range from 100 to 400 seconds. The counting time to be used on-site will be determined during the two day XRF training that will be held in the office and in the field. The counting time needs to be selected based on the concentration of elements that is expected.

Controlling the above mentioned variables will allow a detection of 50 to 100 ppm for most analytes.

CALIBRATION/STANDARDIZATION:

Calibration of the instrument is performed using the factory installed fundamental parameters algorithm is used for standardization and is derived from theoretical considerations for calculations of the element concentrations.

COMPUTER INTERFACE:

The XRF operator will download concentration and standard deviation data from the XRF to the on-site portable IBM compatible lap-top computer on a daily basis. Down-loaded data will be backed up on 3 1/2 inch disks immediately after down-loading is complete.

FIELD PROCEDURES:

1. The Project Manager and XRF operator will select sample locations of solid source samples as instructed in the site-specific Sampling and Analysis Plan.

2. The Project Manager will select sample locations in migration pathways (solid matrix only) that originate from a source. If a drainage pathway is evident, the sample locations will typically be 500 and 1000 feet from the source. Samples will be collected from surface to six inches depth at each station.

3. Split samples will be collected and analyzed from every sample collected for CLP laboratory analysis in order to establish a correlation between the field analyses and laboratory analyses.

4. The field personnel will collect the XRF solid samples in a clean ziplock plastic bag from the specified location and depth.

5. The XRF operator will sieve the sample to remove any fraction greater than 2 mm by using a stainless steel sieve. If the moisture content of the sample is too great for sieving, the sample will be ground in a mortar and pestle to a comparable size.

6. Sample analysis will strictly follow manufacturer's instructions.

7. Samples that are analyzed will be archived in plastic ziplock bags for later analyses if accuracy problems become apparent during QA/QC evaluation of data.

8. The data from the XRF will be transferred to a hard copy form as sample runs are completed. The XRF has the capability to magnetically store up to 300 sets of analysis and up to 120 spectra. The XRF results will be downloaded to the computer as discussed previously.

PTS-SOP-SW-01

STANDARD OPERATING PROCEDURE
SURFACE WATER/STREAM SAMPLING

Note: This sampling procedure shall be utilized to collect aqueous samples from stream channels and drainage ditches. The samples collected will be composite or grab samples depending upon the sample site. Always sample from downstream to upstream locations and stand downstream of the sample bottles to avoid stream bed solids. If it is determined that sampling water is highly polluted, an alternative method using a dipper or pump will be chosen. Gloves will be worn for all surface water sampling.

1. Rinse a set of clean sample bottles (for unfiltered samples and inorganic analyses) <u>three</u> times with the water to be sampled. If collecting a composite sample from multiple stream segments, also rinse a deconned sampling bucket three times.

2. If the channel width is less than 5 feet across, collect grab samples from the center of the channel. If the channel width is greater than 5 feet, divide the channel into 5-foot sections and collect a composite sample at the center of each section to obtain a channel-integrated sample.

3. Submerse the sampling containers in the water, mouth pointing upstream and below the water surface. If necessary to stand in the stream, always collect sample upstream from samplers location, facing upstream. Samples shall be collected from the approximate midpoint between the stream bed and the stream surface. Take care not to collect any stream bed solids. If collecting a grab sample, fill the sample bottle, and add required preservatives according to PTS-SOP-SA-02. Secure the bottle cap tightly then proceed to Step No. 5.

4. If collecting a composite sample, pour full container into the bucket and then take the additional grabs in each of the remaining channel sections. Collect an adequate volume of water to fill all of the required bottles. Stir or swirl the contents of the bucket gently and fill each of the sample bottles for that particular sample set and add required preservatives according to PTS-SOP-SA-02.

5. Label the sample bottles with the appropriate sample tag, carefully and clearly addressing all the required categories and parameters. Record sampling information in the Inventory form and on the chain-of-custody form.

PTS-SOP-GW-01

STANDARD OPERATING PROCEDURES
ELEVATION SURVEY FOR MONITOR WELLS

1. Arrive at the site with appropriate equipment in good working condition.

2. Begin survey using a U.S. Geological Survey (USGS) elevation reference mark as a reference point. If none are available, establish an arbitrary reference point. The arbitrary reference point must be a solid fixed point that will not change throughout the project.

3. Record survey instrument readings in field note book using proper notation.

4. Survey all monitor well locations with an accuracy of ∀0.01 foot.

5. Measure three elevations for each well including:

   a. top of the inner well casing (TOC);
   b. top of the outer protective casing (on the lip, not the cap); and
   c. finished concrete pad adjacent to the outer well casing.

6. Mark TOC for future water level measurements.

7. Return survey circuit to point of origin to complete the loop and determine if the survey "closed" to allowable limits of precision.

PTS-SOP-GW-03

STANDARD OPERATING PROCEDURE
DEPTH TO WATER LEVEL MEASUREMENTS

Electrical Depth to Water Indicator

1) Arrive at site with proper equipment fully decontaminated and in working order.

2) Inspect well and casing for a marked measuring point. If no measuring point is marked locate the north side of the well and determine a new marking point, choose the point for ease of accurately reading the measuring tape.

3) Test that the water level indicator is on and working by pushing the test button on the indicator and checking the buzzer sound level and/or checking for the light.

4) Lower the sensor probe slowly into the well to minimized disturbance of water when it is encountered.

5) As the sensor is lowered down the well, the buzzer and/or flashing light will indicate contact with water. Be aware that sensor may indicate water prior to actual water level if the probe contacts condensation on the well casing.

6) Once the buzzer has sounded, align the marked probe cable with the designated marking point and gently raise and lower the probe until the exact mark on the probe cable when water is encountered is identified.

7) Record this information in the project logbook as the depth to water (DTW). In addition, record where the marking point was located (e.g. TOC (top of casing), TOPVC (top of PVC), IPVC (inner PVC) to help maintain continuity if subsequent DTW readings are needed from this well.

8) Reel in sensor probe.

9) Decontaminate all equipment prior to re-use.

Chalked Measuring Tape Depth to Water Measurements

1. Arrive at site with proper equipment, fully decontaminated and in working order.

2. Coat the lower three to five feet of tape with chalk and lower into well. Listen for weight to contact water and lower tape an additional 0.5 foot. Record measure point and pull tape carefully from well. Read the wetted chalk mark and record. Subtract the wetted chalk mark from the measure point for true depth to water.

3. Decontaminate all equipment before re-use.

PTS-SOP-GW-04

STANDARD OPERATING PROCEDURE
MULTIPLE WELL PUMP TEST

1. Monitor water levels in well to be pumped and all observation wells to establish groundwater level trends or fluctuations.

2. Secure all permits needed for water discharge or other operations.

3. Deliver all equipment needed at the site in working condition and free of contamination.

4. Install necessary equipment for the pump test. Route discharge line to a containment area, infiltration gallery, or injection ell so that no recharge to the aquifer being tested will occur, adversely affecting pump test results.

5. Record static water levels in pumping well and corresponding observation wells on standardized pump test data forms.

6. Begin step-draw down test at a constant discharge. Record water levels in pumping wells and observation wells. After a pre-determined amount of time, increase discharge. Continue recording water levels in wells. After pumping for the set time period, discharge will be increased for two more time periods. After four equal time periods of pumping, the test will be terminated and data will be analyzed to determine optimum pump rates.

7. Allow water levels to recover to prepumping elevations.

8. Assemble all personnel and coordinate pump test activities. Install data logging system with pressure transducers in appropriate wells. Begin constant discharge pump test. Collect water level data as follows:

   PUMPING WELL

Time Since Pump Started (Minutes)	Measurement Interval (Minutes)
0-10	as frequent as possible
10-15	1.0
15-60	5.0
16-300	30.0
300-termination of test	60.0

OBSERVATION WELL

Time Since Pump Started (Minutes)	Measurement Interval (Minutes)
0-10	as frequent as possible
10-30	1.0
30-60	2.0
6-120	5.0
120-240	10.0
240-360	30.0
360-termination of test	60.0

9. Obtain discharge measurements throughout the test and adjust discharge to maintain a constant flow. Field parameters including pH, SC, and temperature will be measured at time of discharge measurements.

10. Immediately upon termination of pump test, water level recovery data will be collected using the same intervals shown in item #8.

11. Record all data on Standard Field Forms, noting any problems or irregularities.

12. Plot drawdown and recovery curves in the field using appropriate methods and graph paper for aquifer analysis.

13. Disassemble pump test equipment and decontaminate before exiting project area.

References:

Driscoll, F. G., 1986. Groundwater and Wells. Johnson Division, St. Paul, Minnesota.

Lohman, S. W., 1972. Groundwater Hydraulics. U.S. Geological Survey Professional Paper 708. Washington.

PTS-SOP-GW-05

STANDARD OPERATING PROCEDURE
PNEUMATIC/VACUUM RESPONSE (SLUG) TEST

1. Arrive on-site with all equipment decontaminated and in working order, and a plan to test wells having the least amount of contamination first, then proceeding to wells having the highest amounts of contamination.

2. Place well head fixture on tested well and secure.

3. Place a pressure transducer down tested well and in each observation well used. Secure each transducer cable to the well casing and allow each to stabilize.

4. Measure and record static water levels prior to conducting a test.

5. Ready the data logger by programming an appropriate sample rate (at least one sample per second for fast recovering wells).

6. Perform test by either pressurizing the well head fixture with air or by evacuating well chamber with a vacuum pump. Displacements are measured using either a manometer for pressure tests, or an electrical water level indicator for vacuum tests. Once the desired displacement is obtained, air pressure, or vacuum is maintained to hold the displacement constant, allowing for aquifer-well system to re-equilibrate. Once equilibrium is achieved, pressure or vacuum is released through a two-inch ball valve on the well head fixture. Recoveries and/or effects seem in the tested well and observation wells are recorded by the data logger.

7. Data from the tested well is plotted on graph paper and analyzed using the appropriate slug test analysis technique. Effects recorded from observation wells will be plotted on a time verses water displacement plot to identify the degree of communication between the test well and observation well(s).

8. Decontaminate all equipment between wells and prior to leaving site.

References:

Prosser, D. W., A method of performing response tests on highly permeable aquifers, Groundwater, Vol. 19 (6), 588-592, 1981.

PTS-SOP-GW-06

STANDARD OPERATING PROCEDURES
RESPONSE TEST

1. Arrive on-site with proper, functioning equipment that has been thoroughly decontaminated and a testing plan that tests least contaminated to most contaminated wells in that order.

2. Electric tapes or pressure transducer(s) will be used to measure water levels.

3. If pressure transducer(s) are used, they will be placed down the well, securely fastened to well casing, and allowable to stabilize.

4. Measure and record static water level from a fixed reference point prior to conducting the test.

5. Perform test by either withdrawing a known volume of water, inserting a bomb of known volume, or removing a bomb of known volume after equilibration of static water level. Water levels will be measured as rapid as conditions permit up to 15 minutes and every five minutes thereafter. For wells recovering rapidly, a data logging device will be used to record output of pressure transducers. Water levels will be recorded until 95 percent recovery is attained.

6. Field data will be plotted on appropriate graph paper or entered on a computer for appropriate analysis. Unconfined aquifers will be analyzed using the Bouwer-Rice Method (1976) and confined aquifers will utilize methods developed by Cooper, Bredehoeft, and Papadopulos (1967).

7. Decontaminate all field equipment between well testing and prior to leaving site.

References:

Bouwer, H. and R. C. Rice. A slug test for determining hydraulic conductivity of unconfirmed aquifers with completely or partially penetrating wells, Water Resources Research, Vol. 12(3), 423-428, 1976.

Cooper, H. H., Jr., J. D. Bredehoeft, and J. S. Papadopulos. Response of a finite diameter well to an instantaneous charge of water, Water Resources Research, 3, 263-269, 1967.

PTS-SOP-GW-07

STANDARD OPERATING PROCEDURE
DISCRETE INTERVAL VERTICAL PROFILING

Discrete Interval Vertical Profiling (DIVP) is a method to vertically characterize an aquifer in terms of groundwater contamination. By collecting and analyzing water samples from discrete intervals within the aquifer, contaminant concentrations can be determined to vertically profile the aquifer. Well screen interval(s) can then be picked using the data. This method is performed easiest with screened augers but can be done using other drilling methods such as air rotary with casing advance. The procedure is as follows:

1. Arrive on-site with appropriate drilling and sampling equipment, fully decontaminated and ready to drill.

2. Begin drilling operations using the drilling method best suited for subsurface conditions.

3. Drill to saturation and advance special sample equipment into aquifer. If using screened auger drilling, the screened portion of the auger is advanced into the upper portion of the aquifer. If air rotary with casing advance is used, a temporary well is installed by first advancing the casing to the tape of the sampling interval, drilling down an additional few feet, pulling out drill string, and plowing the temporary well screen and riser down the casing into the sample zone. An alternative method for air rotary would be to slot the first three-feet to five-feet of the casing lead to be used as a form of screen. The casing would be advanced to the appropriate depth to be sampled.

4. Once the "screened" section is in place, it will be developed by pumping, surging, and/or bailing. Once development water has cleared, sampling can proceed. All development water will be placed in appropriate containers.

5. Before sampling, three-casing to five-casing volumes will be evacuated and pH, SC, and temperature will be allowed to stabilize. Samples will be collected in appropriate containers using sampling protocols. All sampling equipment will be decontaminated before and after sampling.

6. Continue drilling to next sample interval and repeat the sample collection procedure outlined in Item No. 3.

7. Deliver samples as they are collected to a portable gas chromatograph or laboratory for field screening of samples.

8. Continued drilling until the target depth is reached or two consecutive sample intervals show undetectable amounts of contamination.

9. Set screen interval of well at the depth indicated to have the highest levels of contamination. Construction of the well will be to monitor well specifications.

PTS-SOP-GW-08

STANDARD OPERATING PROCEDURE
SAMPLING SEEPS AND SPRINGS

1. Arrive at site with proper, decontaminated sampling equipment in working order.

2. Determine sampling point from which sample is to be collected. This point must be as close to the actual seep as possible to reduce contact time with the atmosphere and potential for surface contamination.

3. Use stainless steel scoop to collect sample by pressing the flat bottom against bank, allowing very little water flow disturbance.

4. Slowly transfer water to appropriate sample container.

PTS-SOP-GW-09

STANDARD OPERATING PROCEDURE
PORTABLE BOREHOLE GAMMA LOGGER

NATURAL GAMMA LOGGING:

1. Arrive on-site with necessary equipment, fully decontaminated and in good working condition.

2. Determine the order in which wells are to be gamma logged starting with least contaminated and ending with the most contaminated.

3. Lower probe to the bottom of the well and attach to control box. Begin log by hitting start button and record the number of seconds needed to count a known number of scintillations.

4. Raise probe to next desired interval, usually one-foot intervals, and push start button on control panel to begin the test again. Record the seconds for each interval.

5. Once probe is at the surface, terminate the test and decontaminate the equipment, before moving to the next well or before moving off site.

6. Plot counts per minute verses depth to produce a natural gamma log of each well.

PTS-SOP-GW-10

STANDARD OPERATING PROCEDURE
PURGING AND SAMPLING WITH A SUBMERSIBLE PUMP

1. Using clean, noncontaminating equipment, e.g., an electronic level indicator (avoid indicating paste or chalk), determine the water level in the well, then calculate the fluid volume in the casing.

2. Lower the precleaned pump to just below the water level and begin pumping. Collect or dispose of purged water in an acceptable manner. Lower the pump, keeping submerged.

3. Frequently measure rate of discharge. A bucket and stopwatch are commonly used.

4. Purge a minimum of three casing volumes or until discharge pH, conductivity, or temperature stabilize. (Note: If the pump is constructed of materials compatible with the required sample analysis and if the well has recovered sufficiently (re-found water level) sample acquisition can proceed. Note also that all down-hole and potentially wetted surfaces must also be noncontaminating/noncontributing. This includes power and suspension cables and compressed gas or sample tubing).

5. Fill necessary bottles by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. Cap each bottle as filled.

6. Select appropriate sample bottles and preserve the sample if necessary.

7. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.

8. Label the sample bottle with an appropriate tag. Be sure to complete the tag with all necessary information. Complete chain-of-custody documents and field logbook.

PTS-SOP-GW-11

STANDARD OPERATING PROCEDURE
PURGING WITH A PERISTALTIC PUMP

The use of a peristaltic pump for well purging is particularly advantageous since the same system can later be utilized for sample collection. The application, however, is limited to wells with a depth of less than approximately 8 m, due to the limited lift capabilities of peristaltic action.

PROCEDURE:

1. Using clean equipment, sound well for total depth and water level, then calculate the fluid volume in the case ("casing volume").

2. Determine depth from casing top to mid-point of screen or well section open to aquifer. (Consult Drillers log or sound for bottom).

3. If depth to mid-point of screen is over 8 m, choose alternative system.

4. Lower pump intake into the well to a short distance below the water level and begin water removal. Collect or dispose of purged water in an acceptable manner. Lower intake, as required, to maintain submergence.

5. Measure rate of discharge frequently. A bucket and stopwatch are most commonly used.

6. Purge a minimum of three casing volumes or until discharge, pH, temperature, or conductivity stabilizes.

7. After pumping, monitor water level recovery. Recovery rate may be useful in determining sample rate.

8. Sampling may be conducted from the peristaltic pump at low pumping rates in accordance with the requirements of the site-specific SAP and PTS-SOP-GW-02.

PTS-SOP-GW-12

STANDARD OPERATING PROCEDURE
MONITOR WELL DESIGN AND CONSTRUCTION

A set procedure for designing and constructing monitoring wells cannot be listed. Every location within a site may vary depending on contamination encountered, lithology of the subsurface, and depth to groundwater. A technique that may work at one location may be inappropriate at the next. The following section discusses general guidelines for well design and construction, but actual well designs will depend on site conditions.

Wells drilled for a CERCLA investigation will be designed to specifications suggested by the site being investigated, provided such design presents no conflict with investigation sampling objectives. This policy will permit the site to incorporate any new wells into ongoing monitoring programs by ensuring that new wells are constructed in the same manner as existing wells. Conflicts may result when existing well construction is not suitable for the proposed sampling. For example, polyvinyl chloride (PVC) casing will not be used if the well samples are to be analyzed for organics, even though existing wells contain PVC casings. Such conflicts will be resolved on a site specific, case-by-case basis. The method of well construction and the materials used in the casing and screen affect the quality of the well, and its utility for groundwater monitoring, throughout its lifetime. The elements of proper monitoring well construction presented serve as guides for any wells constructed for the groundwater investigation. In addition, these guidelines can be applied to evaluate the adequacy of existing wells when sampling will be conducted from available wells.

WELL DIAMETER:

The diameter of the well casing will be the minimum that allows the sampling tool to be lowered to the desired depth. The diameter of the borehole into which the casing is placed must be large enough for the casing to fit. (An extra 5 cm, is necessary, if grout seals are necessary.)

WELL DEPTH:

Wells will be constructed to be depth discrete and to be sampled from one aquifer zone without interference from other zones. This requires provisions for grouting above, and if necessary, below the well screen on the outside of the casing. The location of the screen will be important for sampling, since it has an impact on sampling of immiscible organics. Sampling of less dense or more dense organics, which float or sink, will require the screen to be placed at the appropriate depth.

WELL CASINGS/SCREENS:

Well casings and screens will be constructed of materials with the least potential for affecting the water quality parameters of the sample. Guidance regarding casing and screen material selection criteria is presented in various USEPA guidance documents. Well casings will be cleaned and protected from contamination prior to their installation.

WELL DRILLING:

Drilling method selection will be based on minimizing both the disturbance of the geologic materials penetrated, and the introduction of air, fluids, and muds. Organic drilling muds or additives will be avoided. Advantages and disadvantages of various drilling methods are also discussed in USEPA guidance documents.

MONITORING WELL FILTER PACK AND ANNULAR SEALANT:

The materials used to construct the filter pack should be chemically inert (e.g., clean quartz sand, silica, or glass beads), well rounded, and dimensionally stable. Fabric filters souls not be used as filter pack materials. Natural gravel packs are acceptable, provided that a sieve analysis is performed to establish the appropriate well screen slot size and determine chemical inertness of the filter pack materials in anticipated environments.

The materials used to seal the annular space must prevent the migration of contaminants to the sampling zone from the surface or intermediate zones and prevent cross contamination between strata. The materials should be chemically compatible with the anticipated contaminants to ensure seal integrity during the life of the monitoring well and chemically inert so they do not affect the quality of the groundwater samples. The permeability of the sealants should be one to two orders of magnitude less than the surrounding formation. An example of an appropriate use of annular sealant material is using a minimum of two feet of certified sodium bentonite pellets immediately over the filter pack when in a saturated zone. The pellets are most appropriate in a saturated zone because they will be within the column of water and create an effective seal. Coarse grit sodium bentonite is likely to hydrate and bridge before reaching the filter pack. A cement and bentonite mixture, bentonite chips, or antishrink cement mixtures should be used as the annular sealant in the unsaturated zone above the certified-bentonite pellet seal and below the frost line. Again, the appropriate clay must be selected on the basis of the environment in which it is to be used. In most cases, sodium bentonite is appropriate. The addition of bentonite to the cement admixture should generally be in the amount of 2 to 5 percent by weight of cement content. This will aid in reducing shrinkage and control time of setting. Calcium bentonite may be more appropriate in calcic sediments/soils due to reduced cation exchange potential. Clays should be pure, i.e., free of additives that may affect groundwater quality. From below the frost line, the cap should be composed of concrete blending into a four-inch thick apron extending three feet or more from the outer edge of the borehole.

The untreated sodium bentonite seal should be placed around the casing either by dropping it

directly down the borehole or, if a hollow-stem auger is used, putting the bentonite between the casing and the inside of the auger stem. Both of these methods present a potential for bridging. In shallow monitoring wells, a tamping device should be used to reduce this potential. In deeper wells, it may be necessary to pour a small amount of formation water down the casing to wash the bentonite down the hole. In either case, a spacing differential of 3 to 5 inches should exist between the outer diameter of the casing and the inner diameter of the auger or the surface of the borehole to facilitate emplacement of filter pack and annular sealant required should be calculated to establish their correct subsurface distribution. The actual volume of materials used should be determined during well construction. Discrepancies between calculated volumes and volumes used require explanation.

The cement-bentonite mixture should be prepared using clean water and placed in the borehole using a tremie pipe. The tremie method ensures good sealing of the borehole from the bottom.

The remaining annular space should be sealed with expanding cement to provide for security and an adequate surface seal. Locating the interface between the cement and bentonite-cement mixture below the frost line serves to protect the well from damage due to frost heaving. The cement should be placed in the borehole using the tremie method.

Upon completion of the well, installation of a suitable threaded or flanged cap or compression seal should be placed or locked in properly to prevent either tampering with the well or the entrance of foreign material into it. A one-quarter inch vent hole pipe provides an avenue for the escape of gas. Placement of concrete or steel bumper guards around the well will prevent external damage by a vehicular collision with the exposed casing.

WELL INTAKE DESIGN:

The intake of the monitor well should be designed and constructed to: 1) allow sufficient groundwater flow into the well for sampling; 2) minimize the passage of formation materials (turbidity) into the well; and 3) ensure sufficient structural integrity to prevent the collapse of the intake structure.

For wells completed in unconsolidated materials, the intake of a monitoring well should consist of a screen or slotted casing with openings sized to ensure that formational material is prohibited from passing through the well during development. Extraneous fine-grained material (clays and silts) that has been dislodged during drilling may be left on the screen and the water in the well. These fines should be removed from the screen and filter pack during development of the well. Commercially manufactured screens or slotted casings should be used; field slotting of screens is not acceptable.

The annular space between the face of the formation and the screen or slotted casing should be filled to minimize passage of formation materials into the well. The driller should, therefore, install a filter pack in each monitoring well that is constructed on-site. Furthermore, in order to ensure discrete sample horizons, the filter pack should extend no more than two feet above the

well screen.

WELL DEVELOPMENT:

After monitor well installation, natural hydraulic conductivity of the formation should have been restored and all foreign sediment removed to ensure turbid-free groundwater samples.

A variety of techniques are available for developing a well. To be effective, they require reversals or surges in flow to avoid bridging by particles, which is common when flow is continuous in one direction. These reversals or surges can be created by using surge blocks, bailers, or pumps. Formation water should be used for surging the well. Any contaminated waters produced during development will be containerized for proper disposal. In low-yielding water-bearing formations, an outside source of water may sometimes be introduced into the well to facilitate development. In these cases, this water should be chemically analyzed to evaluate its potential impact on in-situ water quality. The driller should not have used air to develop the wells. All developing equipment should have been decontaminated prior to use as should have the materials used for well construction.

DOCUMENTATION OF WELL DESIGN AND CONSTRUCTION:

Information on the design and construction of wells will be documented and may include:

- Date/time of construction;
- Drilling method and drilling fluid used;
- Well location (0.5 feet);
- Bore hole diameter and well casing diameter;
- Well depth (0.1 feet);
- Drilling and lithologic logs;
- Casing materials;
- Screen materials and design;
- Casing and screen joint type;
- Screen slot size/length;
- Filter pack material/size, grain analysis (D10);
- Filter pack volume calculations;
- Filter pack placement method;
- Sealant materials (percent bentonite);
- Sealant placement method;
- Surface seal design/construction;
- Well development procedure;
- Type of protective well cap;
- Ground surface elevation (∀ 0.01 ft.);
- Surveyor's pin elevation (∀ 0.01 ft.) on concrete apron;
- Top of monitoring well casing elevation (∀ 0.01 ft.);
- Top of protective steel casing elevation (∀ 0.01 ft.); and

- Detailed drawing of well (include dimensions).

SPECIALIZED WELL DESIGNS:

There are two cases where special monitoring well design will be used:

- Where it has been decided to use dedicated pumps to draw groundwater samples; and

- Where light and/or dense immiscible phases may be present.

If it is elected to use a dedicated system, it should be a fluorocarbon resin or stainless steel bailer, or a dedicated positive gas displacement bladder pump composed of the same two materials. As other sampling devices that can perform at least equivalently become available, they may be employed as well.

The introduction of this pump, however, necessitates certain changes in the well. The principal change is the addition of a two-inch diameter pump with fluorocarbon resin outlet tubing to the well. A four-inch interior diameter outer well casing should easily accommodate this additional equipment. However, should a larger pump (e.g., three inches in diameter) be required because of greater well depth or yield, a larger outer casing may prove necessary (six-inch inside diameter). The pump should be positioned midway along the screened interval, and the top of its outlet pipe should extend into the well cap.

If light and dense-phase immiscible layers are presumed to be present, discrete samples must be obtained. The well system should have been designed to allow sampling of both light and dense phases by using a well screen that extends from above the potentiometric surface to the lower confining layer. Where well clusters are employed, one well in the cluster may be screened at horizons where floaters are expected, another at horizons where dense phases are expected, and others within other portions of the uppermost aquifer.

A periodic check of the dedicated sampling system should be exercised to prevent damage and maximize efficiency. This inspection should include removal of samples for verification of proper function. The design of the dedicated sampling system should also allow access for regular testing of aquifer characteristics. It is also recommended that the well be periodically resurveyed using the protective casing and apron as points of reference. An option that can be exercised in constructing a monitoring well (e.g., dedicated sampler) is the use of fine sand at the top of the filter pack to reduce or minimize invasion.

PTS-SOP-S-01

STANDARD OPERATING PROCEDURE
SURFACE SOIL SAMPLING

Surface sampling under biased conditions may be selected after considering factors such as type of contaminant, length of time the area has been contaminated, the type of soil and the past use of the area. Surface soil sampling usually includes the upper six inches of soil.

GRAB SAMPLE:

The most desirable sample collection device would be the soil probe (oakfield tube, king tube). This device allows uniform depth. Alternative sample collection devices include stainless steel scoops or trowels and disposable Teflon trowels. These devices often produce inconsistent depths. The following procedure is designed to be used to collect a surface soil sample from the 0-2 inch horizon. These procedures may be modified in the field based on field and site conditions after appropriate annotations have been made in the field log book. These procedures are not to be used when sampling for volatile organic compounds.

1. Locate the site as directed in the appropriate sampling and analysis plan.

2. Dig a 12-inch square pit to a depth of approximately 8 inches. If an organic layer is present, this layer will be peeled back.

3. Place a stainless steel bowl in the pit and collect a sample by scraping the face of the pit from the mineral soil (0-2 inch interval) with a stainless steel spoon.

4. Remove all coarse fragments greater than 0.5 inches from the bowl. Mix the remaining sample in the bowl with a stainless steel spoon.

5. Transfer the soil sample directly into the appropriate sample container according to PTS-SOP-SA-01 and store in a cooler at 4EC or less.

6. Record appropriate information about the sample collection in the field logbook.

7. Decontaminate sampling tools according to procedures outlined in PTS-SOP-DE-02.

COMPOSITE SAMPLING:

1. The most desirable method of compositing soil subsamples is with a large plastic or canvas sheet. The subsamples are mixed in the center of the sheet. Each corner is pulled up and toward the diagonally opposite corner. This process is done from each corner. After the soil is mixed, it is again spread out on the cloth into a relatively flat pile. The pile is quartered. A small scoop is used to collect small samples from each quarter until the desired amount of soil is acquired. Note: High concentrations of organic chemicals in soils can react with the plastic sheet.

2. Subsamples are often collected in a five-point (star) pattern. At each point, a subsample of a predetermined depth is collected. The diagonal distance between points is commonly ten feet depending on the area of soil homogeneity.

3. Subsamples can also be collected in a three-point (triangular) pattern. At each point, a subsample of predetermined depth is collected. The diagonal distance between the points is commonly ten feet depending on the area of soil homogeneity.

PTS-SOP-S-02

STANDARD OPERATING PROCEDURE
SUBSURFACE SOIL SAMPLING

The need for biased sampling of subsurface soils should be evaluated by considering factors such as the precipitation, the type of soil and the length of time the site has been contaminated. If precipitation has moved contaminants into lower soil horizons, subsurface sampling may be appropriate. Subsurface sampling includes soil depths from 1 foot to 25 feet.

Subsurface sampling can also be composite or grab sampling similar to surface sampling techniques.

SHALLOW SUBSURFACE SAMPLING:

1. The hand auger may be used to collect subsurface samples up to four or five feet in depth. The auger is twisted into the soil. The auger destroys the soil's cohesive structure and stratigraphic character.

2. The in situ soil recovery auger may be used to collect subsurface samples up to five feet. The auger accommodates a liner and provides fast cutting of the soil with very little soil disturbance.

DEEP SUBSURFACE SAMPLING:

1. A power auger mounted on a truck or trailer, a well drilling rig, or a backhoe can be used for sampling up to 25 feet or more in depth.

PTS-SOP-S-03

STANDARD OPERATING PROCEDURE
SEDIMENT SAMPLING FROM STREAMS, PONDS, AND LAKES

Very simple techniques can usually be employed for sediment sampling. Most samples will be grab samples, although sometimes sediment taken from various locations may be combined into one sample to reduce the amount of laboratory support required. Suggested techniques include the following:

1. In small, low flowing streams or near the shore of a pond or lake, a sample container may be used to scrape up the sediments.

2. To obtain sediments from larger streams or farther from the shore of a pond or lake, a Teflon beaker attached to a telescoping pole by means of a clamp may be used to dredge sediments. In most cases, a number of sediment samples should be collected along a cross-section of a river or stream in order to characterize the bed material adequately. A common practice is to sample at quarter points along the cross-section of the site selected. When the sampling technique or equipment requires that the samples be extruded or transferred at the site, they can be combined into a single composite sample. However, samples of dissimilar composition should not be combined, but should be stored for separate analysis.

3. To obtain sediments from rivers or in deeper lakes and ponds, a spring loaded sediment dredge or benthic sampler may be used by lowering the sampler to the appropriate depth with a rope. The sediments thus obtained are placed into the sample container. When collecting sediment samples in lakes, ponds, and streams the site should be approximately at the center of the water mass. This is particularly true for reservoirs that are formed by the impoundment of rivers or streams. Generally, the coarser-grained sediments are deposited near the headwaters of the reservoirs, and the bed sediments near the center of the water mass will be composed of fine-grained materials. The shape, inflow pattern, bathymetry, and circulation must all be considered when selecting sediment sampling sites in lakes or reservoirs. In rivers or streams, fine-grained sediments are deposited on the outside of bends and downstream from islands or obstructions.

4. The sampling device should be decontaminated between locations as per PTS-SOP-DE-02.

PTS-SOP-S-04

STANDARD OPERATING PROCEDURE
SPLIT SPOON SAMPLING

Split Spoon Sampling allows for the taking of relatively undisturbed subsurface soil samples. Best sample results occur when sampling finer grained material. Coarser gravels and cobbles cause the spoon to become plugged or prevent spoon advancement. The split spoon can be either pounded in the ground using a standard 140-pound hammer to determine blow counts or can be hydraulically pressed into the sample interval using drill rig equipment. The procedure is as follows:

1. Arrive on-site with proper decontaminated sampling equipment.

2. Set up all equipment and begin drilling. Drilling will proceed to the top of the first sampling interval.

3. Thoroughly decontaminate sampling equipment and assemble.

4. Place assembled split spoon sampler down the casing or hollow stem augers. Collect sample by using a 140-pound hammer or by pressing the sampling equipment with drill rig hydraulics. If using a 140-pound hammer, mark three eight-inch intervals on sample rod with chalk and note number of blows for each of the eight-inch intervals.

5. Retrieve sampling equipment and take split spoon off sample rod. Open split spoon and log the lithology, keeping the proper orientation (top to bottom). Place sample in proper sample container.

6. Decontaminate sampler as per decontamination SOP, PTS-SOP-DE-02.

PTS-SOP-S-06

STANDARD OPERATING PROCEDURE
TEST PIT SAMPLING

1. Stake the locations for the test pits.

2. The decontaminated backhoe will excavate the test pit to the desired depth. If the total depth is less than four feet, the test pit should have one vertical smooth wall for sample collection and one sloping wall for entrance into the test pit. The Project Leader should enter the test pit to make the required observations and/or collect sample. The project leader will scrape the pit wall with a decontaminated stainless steel trowel to collect a sample.

3. The excavated material should be layered adjacent to the test pit in the sequence in which it is removed.

4. If the total depth is greater than four feet, samples will be collected from the backhoe bucket. Or, a trench box will be used to shore the pit sides and allow entrance into the test pit.

5. Sample collection will take place in the test pit at intervals specified in the site-specific Sampling and Analysis Plan.

6. The backhoe should fill in the test pit with the excavated material in the geologic sequence in which it was removed. The backfilled test pit should attempt to achieve a surface flush with surrounding terrain.

6. The backhoe and other sampling equipment should undergo decontamination as outlined in PTS-SOP-DE-02.

APPENDIX C: EPA METHOD 6200

METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to the in situ and intrusive analysis of the 26 analytes listed below for soil and sediment samples. Some common elements are not listed in this method because they are considered "light" elements that cannot be detected by field portable x-ray fluorescence (FPXRF). These light elements are: lithium, beryllium, sodium, magnesium, aluminum, silicon, and phosphorus. Most of the analytes listed below are of environmental concern, while a few others have interference effects or change the elemental composition of the matrix, affecting quantitation of the analytes of interest. Generally elements of atomic number 16 or greater can be detected and quantitated by FPXRF. The following RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Antimony (Sb)	7440-36-0
Arsenic (As)	7440-38-0
Barium (Ba)	7440-39-3
Cadmium (Cd)	7440-43-9
Chromium (Cr)	7440-47-3
Cobalt (Co)	7440-48-4
Copper (Cu)	7440-50-8
Lead (Pb)	7439-92-1
Mercury (Hg)	7439-97-6
Nickel (Ni)	7440-02-0
Selenium (Se)	7782-49-2
Silver (Ag)	7440-22-4
Thallium (Tl)	7440-28-0
Tin (Sn)	7440-31-5

Analytes	CAS Registry No.
Vanadium (V)	7440-62-2
Zinc (Zn)	7440-66-6

In addition, the following non-RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Calcium (Ca)	7440-70-2
Iron (Fe)	7439-89-6
Manganese (Mn)	7439-96-5
Molybdenum (Mo)	7439-93-7
Potassium (K)	7440-09-7
Rubidium (Rb)	7440-17-7
Strontium (Sr)	7440-24-6
Thorium (Th)	7440-29-1
Titanium (Ti)	7440-32-6
Zirconium (Zr)	7440-67-7

1.2 This method is a screening method to be used with confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnance atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)). This method's main strength is that it is a rapid field screening procedure. The method's lower limits of detection are typically above the toxicity characteristic regulatory level for most RCRA analytes. However, when the obtainable values for precision, accuracy, and laboratory-established sensitivity of this method meet project-specific data quality objectives (DQOs), FPXRF is a fast, powerful, cost effective technology for site characterization.

1.3 The method sensitivity or lower limit of detection depends on several factors, including the analyte of interest, the type of detector used, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. Example lower limits of detection for analytes of interest in environmental applications are shown in Table 1. These limits apply to a clean spiked matrix of quartz sand (silicon dioxide) free of interelement spectral interferences using long (100 -600 second) count times. These sensitivity values are given for guidance only and may not always be achievable, since they will vary depending on the sample matrix, which instrument is used, and operating conditions. A discussion of performance-based sensitivity is presented in Sec. 9.6.

1.4 Analysts should consult the disclaimer statement at the front of the manual and the information in Chapter Two for guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and on the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to Federal testing requirements. The information contained in this method is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.5 Use of this method is restricted to use by, or under supervision of, personnel appropriately experienced and trained in the use and operation of an XRF instrument. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

2.1 The FPXRF technologies described in this method use either sealed radioisotope sources or x-ray tubes to irradiate samples with x-rays. When a sample is irradiated with x-rays, the source x-rays may undergo either scattering or absorption by sample atoms. This latter process is known as the photoelectric effect. When an atom absorbs the source x-rays, the incident radiation dislodges electrons from the innermost shells of the atom, creating vacancies. The electron vacancies are filled by electrons cascading in from outer electron shells. Electrons in outer shells have higher energy states than inner shell electrons, and the outer shell electrons give off energy as they cascade down into the inner shell vacancies. This rearrangement of electrons results in emission of x-rays characteristic of the given atom. The emission of x-rays, in this manner, is termed x-ray fluorescence.

Three electron shells are generally involved in emission of x-rays during FPXRF analysis of environmental samples. The three electron shells include the K, L, and M shells. A typical emission pattern, also called an emission spectrum, for a given metal has multiple intensity peaks generated from the emission of K, L, or M shell electrons. The most commonly measured x-ray emissions are from the K and L shells; only metals with an atomic number greater than 57 have measurable M shell emissions.

Each characteristic x-ray line is defined with the letter K, L, or M, which signifies which shell had the original vacancy and by a subscript alpha (α), beta (β), or gamma (γ) etc., which indicates the higher shell from which electrons fell to fill the vacancy and produce the x-ray. For example, a K_α line is produced by a vacancy in the K shell filled by an L shell electron, whereas a K_β line is produced by a vacancy in the K shell filled by an M shell electron. The K_α transition is on average 6 to 7 times more probable than the K_β transition; therefore, the K_α line is approximately 7 times more intense than the K_β line for a given element, making the K_α line the choice for quantitation purposes.

The K lines for a given element are the most energetic lines and are the preferred lines for analysis. For a given atom, the x-rays emitted from L transitions are always less energetic than those emitted from K transitions. Unlike the K lines, the main L emission lines (L_α and L_β) for an element are of nearly equal intensity. The choice of one or the other depends on what interfering element lines might be present. The L emission lines are useful for analyses involving elements of atomic number (Z) 58 (cerium) through 92 (uranium).

An x-ray source can excite characteristic x-rays from an element only if the source energy is greater than the absorption edge energy for the particular line group of the element, that is, the K absorption edge, L absorption edge, or M absorption edge energy. The absorption edge energy is somewhat greater than the corresponding line energy. Actually, the K absorption edge energy is approximately the sum of the K, L, and M line energies of the particular element, and the L absorption edge energy is approximately the sum of the L and M line energies. FPXRF is more sensitive to an element with an absorption edge energy close to but less than

the excitation energy of the source. For example, when using a cadmium-109 source, which has an excitation energy of 22.1 kiloelectron volts (keV), FPXRF would exhibit better sensitivity for zirconium which has a K line energy of 15.77 keV than to chromium, which has a K line energy of 5.41 keV.

2.2 Under this method, inorganic analytes of interest are identified and quantitated using a field portable energy-dispersive x-ray fluorescence spectrometer. Radiation from one or more radioisotope sources or an electrically excited x-ray tube is used to generate characteristic x-ray emissions from elements in a sample. Up to three sources may be used to irradiate a sample. Each source emits a specific set of primary x-rays that excite a corresponding range of elements in a sample. When more than one source can excite the element of interest, the source is selected according to its excitation efficiency for the element of interest.

For measurement, the sample is positioned in front of the probe window. This can be done in two manners using FPXRF instruments, specifically, in situ or intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. The sample cup is then placed on top of the window inside a protective cover for analysis.

Sample analysis is then initiated by exposing the sample to primary radiation from the source. Fluorescent and backscattered x-rays from the sample enter through the detector window and are converted into electric pulses in the detector. The detector in FPXRF instruments is usually either a solid-state detector or a gas-filled proportional counter. Within the detector, energies of the characteristic x-rays are converted into a train of electric pulses, the amplitudes of which are linearly proportional to the energy of the x-rays. An electronic multichannel analyzer (MCA) measures the pulse amplitudes, which is the basis of qualitative x-ray analysis. The number of counts at a given energy per unit of time is representative of the element concentration in a sample and is the basis for quantitative analysis. Most FPXRF instruments are menu-driven from software built into the units or from personal computers (PC).

The measurement time of each source is user-selectable. Shorter source measurement times (30 seconds) are generally used for initial screening and hot spot delineation, and longer measurement times (up to 300 seconds) are typically used to meet higher precision and accuracy requirements.

FPXRF instruments can be calibrated using the following methods: internally using fundamental parameters determined by the manufacturer, empirically based on site-specific calibration standards (SSCS), or based on Compton peak ratios. The Compton peak is produced by backscattering of the source radiation. Some FPXRF instruments can be calibrated using multiple methods.

3.0 DEFINITIONS

3.1 FPXRF -- Field portable x-ray fluorescence.

3.2 MCA -- Multichannel analyzer for measuring pulse amplitude.

3.3 SSCS -- Site-specific calibration standards.

3.4 FP -- Fundamental parameter.

3.5 ROI -- Region of interest.

3.6 SRM -- Standard reference material; a standard containing certified amounts of metals in soil or sediment.

3.7 eV -- Electron volt; a unit of energy equivalent to the amount of energy gained by an electron passing through a potential difference of one volt.

3.8 Refer to Chapter One, Chapter Three, and the manufacturer's instructions for other definitions that may be relevant to this procedure.

4.0 INTERFERENCES

4.1 The total method error for FPXRF analysis is defined as the square root of the sum of squares of both instrument precision and user- or application-related error. Generally, instrument precision is the least significant source of error in FPXRF analysis. User- or application-related error is generally more significant and varies with each site and method used. Some sources of interference can be minimized or controlled by the instrument operator, but others cannot. Common sources of user- or application-related error are discussed below.

4.2 Physical matrix effects result from variations in the physical character of the sample. These variations may include such parameters as particle size, uniformity, homogeneity, and surface condition. For example, if any analyte exists in the form of very fine particles in a coarser-grained matrix, the analyte's concentration measured by the FPXRF will vary depending on how fine particles are distributed within the coarser-grained matrix. If the fine particles "settle" to the bottom of the sample cup (i.e., against the cup window), the analyte concentration measurement will be higher than if the fine particles are not mixed in well and stay on top of the coarser-grained particles in the sample cup. One way to reduce such error is to grind and sieve all soil samples to a uniform particle size thus reducing sample-to-sample particle size variability. Homogeneity is always a concern when dealing with soil samples. Every effort should be made to thoroughly mix and homogenize soil samples before analysis. Field studies have shown heterogeneity of the sample generally has the largest impact on comparability with confirmatory samples.

4.3 Moisture content may affect the accuracy of analysis of soil and sediment sample analyses. When the moisture content is between 5 and 20 percent, the overall error from moisture may be minimal. However, moisture content may be a major source of error when analyzing samples of surface soil or sediment that are saturated with water. This error can be minimized by drying the samples in a convection or toaster oven. Microwave drying is not recommended because field studies have shown that microwave drying can increase variability between FPXRF data and confirmatory analysis and because metal fragments in the sample can cause arcing to occur in a microwave.

4.4 Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample should be flat and smooth to provide a good contact surface.

4.5 Chemical matrix effects result from differences in the concentrations of interfering elements. These effects occur as either spectral interferences (peak overlaps) or as x-ray absorption and enhancement phenomena. Both effects are common in soils contaminated with heavy metals. As examples of absorption and enhancement effects; iron (Fe) tends to absorb copper (Cu) x-rays, reducing the intensity of the Cu measured by the detector, while chromium (Cr) will be enhanced at the expense of Fe because the absorption edge of Cr is slightly lower in energy than the fluorescent peak of iron. The effects can be corrected mathematically through the use of fundamental parameter (FP) coefficients. The effects also can be compensated for using SSCS, which contain all the elements present on site that can interfere with one another.

4.6 When present in a sample, certain x-ray lines from different elements can be very close in energy and, therefore, can cause interference by producing a severely overlapped spectrum. The degree to which a detector can resolve the two different peaks depends on the energy resolution of the detector. If the energy difference between the two peaks in electron volts is less than the resolution of the detector in electron volts, then the detector will not be able to fully resolve the peaks.

The most common spectrum overlaps involve the K_β line of element Z-1 with the K_α line of element Z. This is called the K_α/K_β interference. Because the K_α:K_β intensity ratio for a given element usually is about 7:1, the interfering element, Z-1, must be present at large concentrations to cause a problem. Two examples of this type of spectral interference involve the presence of large concentrations of vanadium (V) when attempting to measure Cr or the presence of large concentrations of Fe when attempting to measure cobalt (Co). The V K_α and K_β energies are 4.95 and 5.43 keV, respectively, and the Cr K_α energy is 5.41 keV. The Fe K_α and K_β energies are 6.40 and 7.06 keV, respectively, and the Co K_α energy is 6.92 keV. The difference between the V K_β and Cr K_α energies is 20 eV, and the difference between the Fe K_β and the Co K_α energies is 140 eV. The resolution of the highest-resolution detectors in FPXRF instruments is 170 eV. Therefore, large amounts of V and Fe will interfere with quantitation of Cr or Co, respectively. The presence of Fe is a frequent problem because it is often found in soils at tens of thousands of parts per million (ppm).

4.7 Other interferences can arise from K/L, K/M, and L/M line overlaps, although these overlaps are less common. Examples of such overlap involve arsenic (As) K_α/lead (Pb) L_α and sulfur (S) K_α/Pb M_α. In the As/Pb case, Pb can be measured from the Pb L_β line, and As can be measured from either the As K_α or the As K_β line; in this way the interference can be corrected. If the As K_β line is used, sensitivity will be decreased by a factor of two to five times because it is a less intense line than the As K_α line. If the As K_α line is used in the presence of Pb, mathematical corrections within the instrument software can be used to subtract out the Pb interference. However, because of the limits of mathematical corrections, As concentrations cannot be efficiently calculated for samples with Pb:As ratios of 10:1 or more. This high ratio of Pb to As may result in reporting of a "nondetect" or a "less than" value (e.g., <300 ppm) for As, regardless of the actual concentration present.

No instrument can fully compensate for this interference. It is important for an operator to understand this limitation of FPXRF instruments and consult with the manufacturer of the FPXRF instrument to evaluate options to minimize this limitation. The operator's decision will be based on action levels for metals in soil established for the site, matrix effects, capabilities of the instrument, data quality objectives, and the ratio of lead to arsenic known to be present at the site. If a site is encountered that contains lead at concentrations greater than ten times the concentration of arsenic it is advisable that all critical soil samples be sent off site for confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnance atomic absorption spectrometry (GFAA), inductively coupled plasma-

atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)).

4.8 If SSCS are used to calibrate an FPXRF instrument, the samples collected must be representative of the site under investigation. Representative soil sampling ensures that a sample or group of samples accurately reflects the concentrations of the contaminants of concern at a given time and location. Analytical results for representative samples reflect variations in the presence and concentration ranges of contaminants throughout a site. Variables affecting sample representativeness include differences in soil type, contaminant concentration variability, sample collection and preparation variability, and analytical variability, all of which should be minimized as much as possible.

4.9 Soil physical and chemical effects may be corrected using SSCS that have been analyzed by inductively coupled plasma (ICP) or atomic absorption (AA) methods. However, a major source of error can be introduced if these samples are not representative of the site or if the analytical error is large. Another concern is the type of digestion procedure used to prepare the soil samples for the reference analysis. Analytical results for the confirmatory method will vary depending on whether a partial digestion procedure, such as Method 3050, or a total digestion procedure, such as Method 3052, is used. It is known that depending on the nature of the soil or sediment, Method 3050 will achieve differing extraction efficiencies for different analytes of interest. The confirmatory method should meet the project-specific data quality objectives (DQOs).

XRF measures the total concentration of an element; therefore, to achieve the greatest comparability of this method with the reference method (reduced bias), a total digestion procedure should be used for sample preparation. However, in the study used to generate the performance data for this method (see Table 8), the confirmatory method used was Method 3050, and the FPXRF data compared very well with regression correlation coefficients (r often exceeding 0.95, except for barium and chromium). The critical factor is that the digestion procedure and analytical reference method used should meet the DQOs of the project and match the method used for confirmation analysis.

4.10 Ambient temperature changes can affect the gain of the amplifiers producing instrument drift. Gain or drift is primarily a function of the electronics (amplifier or preamplifier) and not the detector as most instrument detectors are cooled to a constant temperature. Most FPXRF instruments have a built-in automatic gain control. If the automatic gain control is allowed to make periodic adjustments, the instrument will compensate for the influence of temperature changes on its energy scale. If the FPXRF instrument has an automatic gain control function, the operator will not have to adjust the instrument's gain unless an error message appears. If an error message appears, the operator should follow the manufacturer's procedures for troubleshooting the problem. Often, this involves performing a new energy calibration. The performance of an energy calibration check to assess drift is a quality control measure discussed in Sec. 9.2.

If the operator is instructed by the manufacturer to manually conduct a gain check because of increasing or decreasing ambient temperature, it is standard to perform a gain check after every 10 to 20 sample measurements or once an hour whichever is more frequent. It is also suggested that a gain check be performed if the temperature fluctuates more than 10° F. The operator should follow the manufacturer's recommendations for gain check frequency.

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The user is responsible for maintaining a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals listed in this method. A reference file of material safety data sheets (MSDSs) should be available to all personnel involved in these analyses.

NOTE: No MSDS applies directly to the radiation-producing instrument because that is covered under the Nuclear Regulatory Commission (NRC) or applicable state regulations.

5.2 Proper training for the safe operation of the instrument and radiation training should be completed by the analyst prior to analysis. Radiation safety for each specific instrument can be found in the operator's manual. Protective shielding should never be removed by the analyst or any personnel other than the manufacturer. The analyst should be aware of the local state and national regulations that pertain to the use of radiation-producing equipment and radioactive materials with which compliance is required. There should be a person appointed within the organization that is solely responsible for properly instructing all personnel, maintaining inspection records, and monitoring x-ray equipment at regular intervals.

Licenses for radioactive materials are of two types, specifically: (1) a general license which is usually initiated by the manufacturer for receiving, acquiring, owning, possessing, using, and transferring radioactive material incorporated in a device or equipment, and (2) a specific license which is issued to named persons for the operation of radioactive instruments as required by local, state, or federal agencies. A copy of the radioactive material license (for specific licenses only) and leak tests should be present with the instrument at all times and available to local and national authorities upon request.

X-ray tubes do not require radioactive material licenses or leak tests, but do require approvals and licenses which vary from state to state. In addition, fail-safe x-ray warning lights should be illuminated whenever an x-ray tube is energized. Provisions listed above concerning radiation safety regulations, shielding, training, and responsible personnel apply to x-ray tubes just as to radioactive sources. In addition, a log of the times and operating conditions should be kept whenever an x-ray tube is energized. An additional hazard present with x-ray tubes is the danger of electric shock from the high voltage supply, however, if the tube is properly positioned within the instrument, this is only a negligible risk. Any instrument (x-ray tube or radioisotope based) is capable of delivering an electric shock from the basic circuitry when the system is inappropriately opened.

5.3 Radiation monitoring equipment should be used with the handling and operation of the instrument. The operator and the surrounding environment should be monitored continually for analyst exposure to radiation. Thermal luminescent detectors (TLD) in the form of badges and rings are used to monitor operator radiation exposure. The TLDs or badges should be worn in the area of maximum exposure. The maximum permissible whole-body dose from occupational exposure is 5 Roentgen Equivalent Man (REM) per year. Possible exposure pathways for radiation to enter the body are ingestion, inhaling, and absorption. The best precaution to prevent radiation exposure is distance and shielding.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for

use. The products and instrument settings cited in SW-846 methods represent those products and settings used during method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

6.1 FPXRF spectrometer -- An FPXRF spectrometer consists of four major components: (1) a source that provides x-rays; (2) a sample presentation device; (3) a detector that converts x-ray-generated photons emitted from the sample into measurable electronic signals; and (4) a data processing unit that contains an emission or fluorescence energy analyzer, such as an MCA, that processes the signals into an x-ray energy spectrum from which elemental concentrations in the sample may be calculated, and a data display and storage system. These components and additional, optional items, are discussed below.

6.1.1 Excitation sources -- FPXRF instruments use either a sealed radioisotope source or an x-ray tube to provide the excitation source. Many FPXRF instruments use sealed radioisotope sources to produce x-rays in order to irradiate samples. The FPXRF instrument may contain between one and three radioisotope sources. Common radioisotope sources used for analysis for metals in soils are iron Fe-55 (^{55}Fe), cadmium Cd-109 (^{109}Cd), americium Am-241 (^{241}Am), and curium Cm-244 (^{244}Cm). These sources may be contained in a probe along with a window and the detector; the probe may be connected to a data reduction and handling system by means of a flexible cable. Alternatively, the sources, window, and detector may be included in the same unit as the data reduction and handling system.

The relative strength of the radioisotope sources is measured in units of millicuries (mCi). All other components of the FPXRF system being equal, the stronger the source, the greater the sensitivity and precision of a given instrument. Radioisotope sources undergo constant decay. In fact, it is this decay process that emits the primary x-rays used to excite samples for FPXRF analysis. The decay of radioisotopes is measured in "half-lives." The half-life of a radioisotope is defined as the length of time required to reduce the radioisotopes strength or activity by half. Developers of FPXRF technologies recommend source replacement at regular intervals based on the source's half-life. This is due to the ever increasing time required for the analysis rather than a decrease in instrument performance. The characteristic x-rays emitted from each of the different sources have energies capable of exciting a certain range of analytes in a sample. Table 2 summarizes the characteristics of four common radioisotope sources.

X-ray tubes have higher radiation output, no intrinsic lifetime limit, produce constant output over their lifetime, and do not have the disposal problems of radioactive sources but are just now appearing in FPXRF instruments. An electrically-excited x-ray tube operates by bombarding an anode with electrons accelerated by a high voltage. The electrons gain an energy in electron volts equal to the accelerating voltage and can excite atomic transitions in the anode, which then produces characteristic x-rays. These characteristic x-rays are emitted through a window which contains the vacuum necessary for the electron acceleration. An important difference between x-ray tubes and radioactive sources is that the electrons which bombard the anode also produce a continuum of x-rays across a broad range of energies in addition to the characteristic x-rays. This continuum is weak compared to the characteristic x-rays but can provide substantial excitation since it covers a broad energy range. It has the undesired property of producing background in the spectrum near the analyte x-ray lines when it is scattered by the sample. For this reason a filter is often used between the x-ray tube and the sample to suppress the continuum radiation while passing the characteristic x-rays from the anode. This filter is sometimes incorporated into the window of the x-ray tube. The choice of

accelerating voltage is governed both by the anode material, since the electrons must have sufficient energy to excite the anode, which requires a voltage greater than the absorption edge of the anode material and by the instrument's ability to cool the x-ray tube. The anode is most efficiently excited by voltages 2 to 2.5 times the edge energy (most x-rays per unit power to the tube), although voltages as low as 1.5 times the absorption edge energy will work. The characteristic x-rays emitted by the anode are capable of exciting a range of elements in the sample just as with a radioactive source. Table 3 gives the recommended operating voltages and the sample elements excited for some common anodes.

6.1.2 Sample presentation device -- FPXRF instruments can be operated in two modes: in situ and intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. For FPXRF instruments operated in the intrusive mode, the probe may be rotated so that the window faces either upward or downward. A protective sample cover is placed over the window, and the sample cup is placed on top of the window inside the protective sample cover for analysis.

6.1.3 Detectors -- The detectors in the FPXRF instruments can be either solid-state detectors or gas-filled, proportional counter detectors. Common solid-state detectors include mercuric iodide (HgI_2), silicon pin diode and lithium-drifted silicon Si(Li). The HgI_2 detector is operated at a moderately subambient temperature controlled by a low power thermoelectric cooler. The silicon pin diode detector also is cooled via the thermoelectric Peltier effect. The Si(Li) detector must be cooled to at least -90 °C either with liquid nitrogen or by thermoelectric cooling via the Peltier effect. Instruments with a Si(Li) detector have an internal liquid nitrogen dewar with a capacity of 0.5 to 1.0 L. Proportional counter detectors are rugged and lightweight, which are important features of a field portable detector. However, the resolution of a proportional counter detector is not as good as that of a solid-state detector. The energy resolution of a detector for characteristic x-rays is usually expressed in terms of full width at half-maximum (FWHM) height of the manganese K_α peak at 5.89 keV. The typical resolutions of the above mentioned detectors are as follows: HgI_2-270 eV; silicon pin diode-250 eV; Si(Li)–170 eV; and gas-filled, proportional counter-750 eV.

During operation of a solid-state detector, an x-ray photon strikes a biased, solid-state crystal and loses energy in the crystal by producing electron-hole pairs. The electric charge produced is collected and provides a current pulse that is directly proportional to the energy of the x-ray photon absorbed by the crystal of the detector. A gas-filled, proportional counter detector is an ionization chamber filled with a mixture of noble and other gases. An x-ray photon entering the chamber ionizes the gas atoms. The electric charge produced is collected and provides an electric signal that is directly proportional to the energy of the x-ray photon absorbed by the gas in the detector.

6.1.4 Data processing units -- The key component in the data processing unit of an FPXRF instrument is the MCA. The MCA receives pulses from the detector and sorts them by their amplitudes (energy level). The MCA counts pulses per second to determine the height of the peak in a spectrum, which is indicative of the target analyte's concentration. The spectrum of element peaks are built on the MCA. The MCAs in FPXRF instruments have from 256 to 2,048 channels. The concentrations of target analytes are usually shown in ppm on a liquid crystal display (LCD) in the instrument. FPXRF instruments can store both spectra and from 3,000 to 5,000 sets of numerical analytical results. Most FPXRF instruments are menu-driven from software built into the

units or from PCs. Once the data–storage memory of an FPXRF unit is full or at any other time, data can be downloaded by means of an RS-232 port and cable to a PC.

6.2 Spare battery and battery charger.

6.3 Polyethylene sample cups -- 31 to 40 mm in diameter with collar, or equivalent (appropriate for FPXRF instrument).

6.4 X-ray window film -- Mylar™, Kapton™, Spectrolene™, polypropylene, or equivalent; 2.5 to 6.0 µm thick.

6.5 Mortar and pestle -- Glass, agate, or aluminum oxide; for grinding soil and sediment samples.

6.6 Containers -- Glass or plastic to store samples.

6.7 Sieves -- 60-mesh (0.25 mm), stainless-steel, Nylon, or equivalent for preparing soil and sediment samples.

6.8 Trowels -- For smoothing soil surfaces and collecting soil samples.

6.9 Plastic bags -- Used for collection and homogenization of soil samples.

6.10 Drying oven -- Standard convection or toaster oven, for soil and sediment samples that require drying.

7.0 REAGENTS AND STANDARDS

7.1 Reagent grade chemicals must be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Pure element standards -- Each pure, single-element standard is intended to produce strong characteristic x-ray peaks of the element of interest only. Other elements present must not contribute to the fluorescence spectrum. A set of pure element standards for commonly sought analytes is supplied by the instrument manufacturer, if designated for the instrument; not all instruments require the pure element standards. The standards are used to set the region of interest (ROI) for each element. They also can be used as energy calibration and resolution check samples.

7.3 Site-specific calibration standards -- Instruments that employ fundamental parameters (FP) or similar mathematical models in minimizing matrix effects may not require SSCS. If the FP calibration model is to be optimized or if empirical calibration is necessary, then SSCSs must be collected, prepared, and analyzed.

7.3.1 The SSCS must be representative of the matrix to be analyzed by FPXRF. These samples must be well homogenized. A minimum of 10 samples spanning the concentration ranges of the analytes of interest and of the interfering elements must be obtained from the site. A sample size of 4 to 8 ounces is recommended, and standard glass sampling jars should be used.

7.3.2 Each sample should be oven-dried for 2 to 4 hr at a temperature of less than 150 °C. If mercury is to be analyzed, a separate sample portion should be dried at ambient temperature as heating may volatilize the mercury. When the sample is dry, all large, organic debris and nonrepresentative material, such as twigs, leaves, roots, insects, asphalt, and rock should be removed. The sample should be homogenized (see Sec. 7.3.3) and then a representative portion ground with a mortar and pestle or other mechanical means, prior to passing through a 60-mesh sieve. Only the coarse rock fraction should remain on the screen.

7.3.3 The sample should be homogenized by using a riffle splitter or by placing 150 to 200 g of the dried, sieved sample on a piece of kraft or butcher paper about 1.5 by 1.5 feet in size. Each corner of the paper should be lifted alternately, rolling the soil over on itself and toward the opposite corner. The soil should be rolled on itself 20 times. Approximately 5 g of the sample should then be removed and placed in a sample cup for FPXRF analysis. The rest of the prepared sample should be sent off site for ICP or AA analysis. The method use for confirmatory analysis should meet the data quality objectives of the project.

7.4 Blank samples -- The blank samples should be from a "clean" quartz or silicon dioxide matrix that is free of any analytes at concentrations above the established lower limit of detection. These samples are used to monitor for cross-contamination and laboratory-induced contaminants or interferences.

7.5 Standard reference materials -- Standard reference materials (SRMs) are standards containing certified amounts of metals in soil or sediment. These standards are used for accuracy and performance checks of FPXRF analyses. SRMs can be obtained from the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), the Canadian National Research Council, and the national bureau of standards in foreign nations. Pertinent NIST SRMs for FPXRF analysis include 2704, Buffalo River Sediment; 2709, San Joaquin Soil; and 2710 and 2711, Montana Soil. These SRMs contain soil or sediment from actual sites that has been analyzed using independent inorganic analytical methods by many different laboratories. When these SRMs are unavailable, alternate standards may be used (e.g., NIST 2702).

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

Sample handling and preservation procedures used in FPXRF analyses should follow the guidelines in Chapter Three, "Inorganic Analytes."

9.0 QUALITY CONTROL

9.1 Follow the manufacturer’s instructions for the quality control procedures specific to use of the testing product. Refer to Chapter One for additional guidance on quality assurance (QA) and quality control (QC) protocols. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a Quality Assurance Project Plan (QAPP) or a Sampling and Analysis Plan (SAP), which translates project objectives and specifications into directions for those that will implement the project and assess the results.

9.2 Energy calibration check -- To determine whether an FPXRF instrument is operating within resolution and stability tolerances, an energy calibration check should be run. The energy calibration check determines whether the characteristic x-ray lines are shifting,

which would indicate drift within the instrument. As discussed in Sec. 4.10, this check also serves as a gain check in the event that ambient temperatures are fluctuating greatly (more than 10 °F).

9.2.1 The energy calibration check should be run at a frequency consistent with manufacturer's recommendations. Generally, this would be at the beginning of each working day, after the batteries are changed or the instrument is shut off, at the end of each working day, and at any other time when the instrument operator believes that drift is occurring during analysis. A pure element such as iron, manganese, copper, or lead is often used for the energy calibration check. A manufacturer-recommended count time per source should be used for the check.

9.2.2 The instrument manufacturer's manual specifies the channel or kiloelectron volt level at which a pure element peak should appear and the expected intensity of the peak. The intensity and channel number of the pure element as measured using the source should be checked and compared to the manufacturer's recommendation. If the energy calibration check does not meet the manufacturer's criteria, then the pure element sample should be repositioned and reanalyzed. If the criteria are still not met, then an energy calibration should be performed as described in the manufacturer's manual. With some FPXRF instruments, once a spectrum is acquired from the energy calibration check, the peak can be optimized and realigned to the manufacturer's specifications using their software.

9.3 Blank samples -- Two types of blank samples should be analyzed for FPXRF analysis, specifically, instrument blanks and method blanks.

9.3.1 An instrument blank is used to verify that no contamination exists in the spectrometer or on the probe window. The instrument blank can be silicon dioxide, a polytetraflurorethylene (PTFE) block, a quartz block, "clean" sand, or lithium carbonate. This instrument blank should be analyzed on each working day before and after analyses are conducted and once per every twenty samples. An instrument blank should also be analyzed whenever contamination is suspected by the analyst. The frequency of analysis will vary with the data quality objectives of the project. A manufacturer-recommended count time per source should be used for the blank analysis. No element concentrations above the established lower limit of detection should be found in the instrument blank. If concentrations exceed these limits, then the probe window and the check sample should be checked for contamination. If contamination is not a problem, then the instrument must be "zeroed" by following the manufacturer's instructions.

9.3.2 A method blank is used to monitor for laboratory-induced contaminants or interferences. The method blank can be "clean" silica sand or lithium carbonate that undergoes the same preparation procedure as the samples. A method blank must be analyzed at least daily. The frequency of analysis will depend on the data quality objectives of the project. If the method blank does not contain the target analyte at a level that interferes with the project-specific data quality objectives then the method blank would be considered acceptable. In the absence of project-specific data quality objectives, if the blank is less than the lowest level of detection or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the method blank would be considered acceptable. If the method blank cannot be considered acceptable, the cause of the problem must be identified, and all samples analyzed with the method blank must be reanalyzed.

9.4 Calibration verification checks -- A calibration verification check sample is used to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest. A check sample should be analyzed at the beginning of each working day, during active sample analyses, and at the end of each working day. The frequency of calibration checks during active analysis will depend on the data quality objectives of the project. The check sample should be a well characterized soil sample from the site that is representative of site samples in terms of particle size and degree of homogeneity and that contains contaminants at concentrations near the action levels. If a site-specific sample is not available, then an NIST or other SRM that contains the analytes of interest can be used to verify the accuracy of the instrument. The measured value for each target analyte should be within ±20 percent (%D) of the true value for the calibration verification check to be acceptable. If a measured value falls outside this range, then the check sample should be reanalyzed. If the value continues to fall outside the acceptance range, the instrument should be recalibrated, and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

9.5 Precision measurements -- The precision of the method is monitored by analyzing a sample with low, moderate, or high concentrations of target analytes. The frequency of precision measurements will depend on the data quality objectives for the data. A minimum of one precision sample should be run per day. Each precision sample should be analyzed 7 times in replicate. It is recommended that precision measurements be obtained for samples with varying concentration ranges to assess the effect of concentration on method precision. Determining method precision for analytes at concentrations near the site action levels can be extremely important if the FPXRF results are to be used in an enforcement action; therefore, selection of at least one sample with target analyte concentrations at or near the site action levels or levels of concern is recommended. A precision sample is analyzed by the instrument for the same field analysis time as used for other project samples. The relative standard deviation (RSD) of the sample mean is used to assess method precision. For FPXRF data to be considered adequately precise, the RSD should not be greater than 20 percent with the exception of chromium. RSD values for chromium should not be greater than 30 percent. If both in situ and intrusive analytical techniques are used during the course of one day, it is recommended that separate precision calculations be performed for each analysis type.

The equation for calculating RSD is as follows:

$$RSD = (SD/\text{Mean Concentration}) \times 100$$

where:

RSD	=	Relative standard deviation for the precision measurement for the analyte
SD	=	Standard deviation of the concentration for the analyte
Mean concentration	=	Mean concentration for the analyte

The precision or reproducibility of a measurement will improve with increasing count time, however, increasing the count time by a factor of 4 will provide only 2 times better precision, so there is a point of diminishing return. Increasing the count time also improves the sensitivity, but decreases sample throughput.

9.6 The lower limits of detection should be established from actual measured performance based on spike recoveries in the matrix of concern or from acceptable method performance on a certified reference material of the appropriate matrix and within the appropriate calibration range for the application. This is considered the best estimate of the true method sensitivity as opposed to a statistical determination based on the standard deviation of

replicate analyses of a low-concentration sample. While the statistical approach demonstrates the potential data variability for a given sample matrix at one point in time, it does not represent what can be detected or most importantly the lowest concentration that can be calibrated. For this reason the sensitivity should be established as the lowest point of detection based on acceptable target analyte recovery in the desired sample matrix.

9.7 Confirmatory samples -- The comparability of the FPXRF analysis is determined by submitting FPXRF-analyzed samples for analysis at a laboratory. The method of confirmatory analysis must meet the project and XRF measurement data quality objectives. The confirmatory samples must be splits of the well homogenized sample material. In some cases the prepared sample cups can be submitted. A minimum of 1 sample for each 20 FPXRF-analyzed samples should be submitted for confirmatory analysis. This frequency will depend on project-specific data quality objectives. The confirmatory analyses can also be used to verify the quality of the FPXRF data. The confirmatory samples should be selected from the lower, middle, and upper range of concentrations measured by the FPXRF. They should also include samples with analyte concentrations at or near the site action levels. The results of the confirmatory analysis and FPXRF analyses should be evaluated with a least squares linear regression analysis. If the measured concentrations span more than one order of magnitude, the data should be log-transformed to standardize variance which is proportional to the magnitude of measurement. The correlation coefficient (r) for the results should be 0.7 or greater for the FPXRF data to be considered screening level data. If the r is 0.9 or greater and inferential statistics indicate the FPXRF data and the confirmatory data are statistically equivalent at a 99 percent confidence level, the data could potentially meet definitive level data criteria.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Instrument calibration -- Instrument calibration procedures vary among FPXRF instruments. Users of this method should follow the calibration procedures outlined in the operator's manual for each specific FPXRF instrument. Generally, however, three types of calibration procedures exist for FPXRF instruments, namely: FP calibration, empirical calibration, and the Compton peak ratio or normalization method. These three types of calibration are discussed below.

10.2 Fundamental parameters calibration -- FP calibration procedures are extremely variable. An FP calibration provides the analyst with a "standardless" calibration. The advantages of FP calibrations over empirical calibrations include the following:

- No previously collected site-specific samples are necessary, although site-specific samples with confirmed and validated analytical results for all elements present could be used.

- Cost is reduced because fewer confirmatory laboratory results or calibration standards are necessary.

However, the analyst should be aware of the limitations imposed on FP calibration by particle size and matrix effects. These limitations can be minimized by adhering to the preparation procedure described in Sec. 7.3. The two FP calibration processes discussed below are based on an effective energy FP routine and a back scatter with FP (BFP) routine. Each FPXRF FP calibration process is based on a different iterative algorithmic method. The calibration procedure for each routine is explained in detail in the manufacturer's user manual for each FPXRF instrument; in addition, training courses are offered for each instrument.

10.2.1 Effective energy FP calibration -- The effective energy FP calibration is performed by the manufacturer before an instrument is sent to the analyst. Although SSCS can be used, the calibration relies on pure element standards or SRMs such as those obtained from NIST for the FP calibration. The effective energy routine relies on the spectrometer response to pure elements and FP iterative algorithms to compensate for various matrix effects.

Alpha coefficients are calculated using a variation of the Sherman equation, which calculates theoretical intensities from the measurement of pure element samples. These coefficients indicate the quantitative effect of each matrix element on an analyte's measured x-ray intensity. Next, the Lachance Traill algorithm is solved as a set of simultaneous equations based on the theoretical intensities. The alpha coefficients are then downloaded into the specific instrument.

The working effective energy FP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of sampling. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. A manufacturer-recommended count time per source should be used for the calibration check. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A percent difference (%D) is then calculated for each target analyte. The %D should be within ±20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line or the y-intercept value for the analyte. The SRM or SSCS is reanalyzed until the %D falls within ±20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

The equation to calibrate %D is as follows:

$$\%D = ((C_s - C_k) / C_k) \times 100$$

where:

%D = Percent difference
C_k = Certified concentration of standard sample
C_s = Measured concentration of standard sample

10.2.2 BFP calibration -- BFP calibration relies on the ability of the liquid nitrogen-cooled, Si(Li) solid-state detector to separate the coherent (Compton) and incoherent (Rayleigh) backscatter peaks of primary radiation. These peak intensities are known to be a function of sample composition, and the ratio of the Compton to Rayleigh peak is a function of the mass absorption of the sample. The calibration procedure is explained in detail in the instrument manufacturer's manual. Following is a general description of the BFP calibration procedure.

The concentrations of all detected and quantified elements are entered into the computer software system. Certified element results for an NIST SRM or confirmed and validated results for an SSCS can be used. In addition, the concentrations of oxygen and silicon must be entered; these two concentrations are not found in standard metals analyses. The manufacturer provides silicon and oxygen concentrations for typical soil types. Pure element standards are then analyzed using a manufacturer-recommended

count time per source. The results are used to calculate correction factors in order to adjust for spectrum overlap of elements.

The working BFP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of the analysis. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. The standard sample is analyzed using a manufacturer-recommended count time per source to check the calibration curve. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A %D is then calculated for each target analyte. The %D should fall within ±20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line the y-intercept value for the analyte. The standard sample is reanalyzed until the %D falls within ±20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

10.3 Empirical calibration -- An empirical calibration can be performed with SSCS, site-typical standards, or standards prepared from metal oxides. A discussion of SSCS is included in Sec. 7.3; if no previously characterized samples exist for a specific site, site-typical standards can be used. Site-typical standards may be selected from commercially available characterized soils or from SSCS prepared for another site. The site-typical standards should closely approximate the site's soil matrix with respect to particle size distribution, mineralogy, and contaminant analytes. If neither SSCS nor site-typical standards are available, it is possible to make gravimetric standards by adding metal oxides to a "clean" sand or silicon dioxide matrix that simulates soil. Metal oxides can be purchased from various chemical vendors. If standards are made on site, a balance capable of weighing items to at least two decimal places is necessary. Concentrated ICP or AA standard solutions can also be used to make standards. These solutions are available in concentrations of 10,000 parts per million, thus only small volumes have to be added to the soil.

An empirical calibration using SSCS involves analysis of SSCS by the FPXRF instrument and by a conventional analytical method such as ICP or AA. A total acid digestion procedure should be used by the laboratory for sample preparation. Generally, a minimum of 10 and a maximum of 30 well characterized SSCS, site-typical standards, or prepared metal oxide standards are necessary to perform an adequate empirical calibration. The exact number of standards depends on the number of analytes of interest and interfering elements. Theoretically, an empirical calibration with SSCS should provide the most accurate data for a site because the calibration compensates for site-specific matrix effects.

The first step in an empirical calibration is to analyze the pure element standards for the elements of interest. This enables the instrument to set channel limits for each element for spectral deconvolution. Next the SSCS, site-typical standards, or prepared metal oxide standards are analyzed using a count time of 200 seconds per source or a count time recommended by the manufacturer. This will produce a spectrum and net intensity of each analyte in each standard. The analyte concentrations for each standard are then entered into the instrument software; these concentrations are those obtained from the laboratory, the certified results, or the gravimetrically determined concentrations of the prepared standards. This gives the instrument analyte values to regress against corresponding intensities during the modeling stage. The regression equation correlates the concentrations of an analyte with its net intensity.

The calibration equation is developed using a least squares fit regression analysis. After the regression terms to be used in the equation are defined, a mathematical equation can be developed to calculate the analyte concentration in an unknown sample. In some FPXRF instruments, the software of the instrument calculates the regression equation. The software uses calculated intercept and slope values to form a multiterm equation. In conjunction with the software in the instrument, the operator can adjust the multiterm equation to minimize interelement interferences and optimize the intensity calibration curve.

It is possible to define up to six linear or nonlinear terms in the regression equation. Terms can be added and deleted to optimize the equation. The goal is to produce an equation with the smallest regression error and the highest correlation coefficient. These values are automatically computed by the software as the regression terms are added, deleted, or modified. It is also possible to delete data points from the regression line if these points are significant outliers or if they are heavily weighing the data. Once the regression equation has been selected for an analyte, the equation can be entered into the software for quantitation of analytes in subsequent samples. For an empirical calibration to be acceptable, the regression equation for a specific analyte should have a correlation coefficient of 0.98 or greater or meet the DQOs of the project.

In an empirical calibration, one must apply the DQOs of the project and ascertain critical or action levels for the analytes of interest. It is within these concentration ranges or around these action levels that the FPXRF instrument should be calibrated most accurately. It may not be possible to develop a good regression equation over several orders of analyte concentration.

10.4 Compton normalization method -- The Compton normalization method is based on analysis of a single, certified standard and normalization for the Compton peak. The Compton peak is produced from incoherent backscattering of x-ray radiation from the excitation source and is present in the spectrum of every sample. The Compton peak intensity changes with differing matrices. Generally, matrices dominated by lighter elements produce a larger Compton peak, and those dominated by heavier elements produce a smaller Compton peak. Normalizing to the Compton peak can reduce problems with varying matrix effects among samples. Compton normalization is similar to the use of internal standards in organics analysis. The Compton normalization method may not be effective when analyte concentrations exceed a few percent.

The certified standard used for this type of calibration could be an NIST SRM such as 2710 or 2711. The SRM must be a matrix similar to the samples and must contain the analytes of interests at concentrations near those expected in the samples. First, a response factor has to be determined for each analyte. This factor is calculated by dividing the net peak intensity by the analyte concentration. The net peak intensity is gross intensity corrected for baseline reading. Concentrations of analytes in samples are then determined by multiplying the baseline corrected analyte signal intensity by the normalization factor and by the response factor. The normalization factor is the quotient of the baseline corrected Compton K_α peak intensity of the SRM divided by that of the samples. Depending on the FPXRF instrument used, these calculations may be done manually or by the instrument software.

11.0 PROCEDURE

11.1 Operation of the various FPXRF instruments will vary according to the manufacturers' protocols. Before operating any FPXRF instrument, one should consult the manufacturer's manual. Most manufacturers recommend that their instruments be allowed to warm up for 15 to 30 minutes before analysis of samples. This will help alleviate drift or energy calibration problems later during analysis.

11.2 Each FPXRF instrument should be operated according to the manufacturer's recommendations. There are two modes in which FPXRF instruments can be operated: in situ and intrusive. The in situ mode involves analysis of an undisturbed soil sediment or sample. Intrusive analysis involves collection and preparation of a soil or sediment sample before analysis. Some FPXRF instruments can operate in both modes of analysis, while others are designed to operate in only one mode. The two modes of analysis are discussed below.

11.3 For in situ analysis, remove any large or nonrepresentative debris from the soil surface before analysis. This debris includes rocks, pebbles, leaves, vegetation, roots, and concrete. Also, the soil surface must be as smooth as possible so that the probe window will have good contact with the surface. This may require some leveling of the surface with a stainless-steel trowel. During the study conducted to provide example performance data for this method, this modest amount of sample preparation was found to take less than 5 min per sample location. The last requirement is that the soil or sediment not be saturated with water. Manufacturers state that their FPXRF instruments will perform adequately for soils with moisture contents of 5 to 20 percent but will not perform well for saturated soils, especially if ponded water exists on the surface. Another recommended technique for in situ analysis is to tamp the soil to increase soil density and compactness for better repeatability and representativeness. This condition is especially important for heavy element analysis, such as barium. Source count times for in situ analysis usually range from 30 to 120 seconds, but source count times will vary among instruments and depending on the desired method sensitivity. Due to the heterogeneous nature of the soil sample, in situ analysis can provide only “screening” type data.

11.4 For intrusive analysis of surface or sediment, it is recommended that a sample be collected from a 4- by 4-inch square that is 1 inch deep. This will produce a soil sample of approximately 375 g or 250 cm^3, which is enough soil to fill an 8-ounce jar. However, the exact dimensions and sample depth should take into consideration the heterogeneous deposition of contaminants and will ultimately depend on the desired project-specific data quality objectives. The sample should be homogenized, dried, and ground before analysis. The sample can be homogenized before or after drying. The homogenization technique to be used after drying is discussed in Sec. 4.2. If the sample is homogenized before drying, it should be thoroughly mixed in a beaker or similar container, or if the sample is moist and has a high clay content, it can be kneaded in a plastic bag. One way to monitor homogenization when the sample is kneaded in a plastic bag is to add sodium fluorescein dye to the sample. After the moist sample has been homogenized, it is examined under an ultraviolet light to assess the distribution of sodium fluorescein throughout the sample. If the fluorescent dye is evenly distributed in the sample, homogenization is considered complete; if the dye is not evenly distributed, mixing should continue until the sample has been thoroughly homogenized. During the study conducted to provide data for this method, the time necessary for homogenization procedure using the fluorescein dye ranged from 3 to 5 min per sample. As demonstrated in Secs. 13.5 and 13.7, homogenization has the greatest impact on the reduction of sampling variability. It produces little or no contamination. Often, the direct analysis through the plastic bag is possible without the more labor intensive steps of drying, grinding, and sieving given in Secs. 11.5 and 11.6. Of course, to achieve the best data quality possible all four steps should be followed.

11.5 Once the soil or sediment sample has been homogenized, it should be dried. This can be accomplished with a toaster oven or convection oven. A small aliquot of the sample (20 to 50 g) is placed in a suitable container for drying. The sample should be dried for 2 to 4 hr in the convection or toaster oven at a temperature not greater than 150 °C. Samples may also be air dried under ambient temperature conditions using a 10- to 20-g portion. Regardless of what drying mechanism is used, the drying process is considered complete when a constant sample weight can be obtained. Care should be taken to avoid sample cross-contamination and these measures can be evaluated by including an appropriate method blank sample along with any sample preparation process.

CAUTION: Microwave drying is not a recommended procedure. Field studies have shown that microwave drying can increase variability between the FPXRF data and confirmatory analysis. High levels of metals in a sample can cause arcing in the microwave oven, and sometimes slag forms in the sample. Microwave oven drying can also melt plastic containers used to hold the sample.

11.6 The homogenized dried sample material should be ground with a mortar and pestle and passed through a 60-mesh sieve to achieve a uniform particle size. Sample grinding should continue until at least 90 percent of the original sample passes through the sieve. The grinding step normally takes an average of 10 min per sample. An aliquot of the sieved sample should then be placed in a 31.0-mm polyethylene sample cup (or equivalent) for analysis. The sample cup should be one-half to three-quarters full at a minimum. The sample cup should be covered with a 2.5 µm Mylar (or equivalent) film for analysis. The rest of the soil sample should be placed in a jar, labeled, and archived for possible confirmation analysis. All equipment including the mortar, pestle, and sieves must be thoroughly cleaned so that any cross-contamination is below the established lower limit of detection of the procedure or DQOs of the analysis. If all recommended sample preparation steps are followed, there is a high probability the desired laboratory data quality may be obtained.

12.0 DATA ANALYSIS AND CALCULATIONS

Most FPXRF instruments have software capable of storing all analytical results and spectra. The results are displayed in ppm and can be downloaded to a personal computer, which can be used to provide a hard copy printout. Individual measurements that are smaller than three times their associated SD should not be used for quantitation. See the manufacturer's instructions regarding data analysis and calculations.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. These performance data are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

13.2 The sections to follow discuss three performance evaluation factors; namely, precision, accuracy, and comparability. The example data presented in Tables 4 through 8 were generated from results obtained from six FPXRF instruments (see Sec. 13.3). The soil samples analyzed by the six FPXRF instruments were collected from two sites in the United States. The soil samples contained several of the target analytes at concentrations ranging from "nondetect" to tens of thousands of mg/kg. These data are provided for guidance purposes only.

13.3 The six FPXRF instruments included the TN 9000 and TN Lead Analyzer manufactured by TN Spectrace; the X-MET 920 with a SiLi detector and X-MET 920 with a gas-filled proportional detector manufactured by Metorex, Inc.; the XL Spectrum Analyzer manufactured by Niton; and the MAP Spectrum Analyzer manufactured by Scitec. The TN 9000 and TN Lead Analyzer both have a HgI_2 detector. The TN 9000 utilized an Fe-55, Cd-109, and Am-241 source. The TN Lead Analyzer had only a Cd-109 source. The X-Met 920 with the SiLi detector had a Cd-109 and Am-241 source. The X-MET 920 with the gas-filled proportional detector had only a Cd-109 source. The XL Spectrum Analyzer utilized a silicon pin-diode

detector and a Cd-109 source. The MAP Spectrum Analyzer utilized a solid-state silicon detector and a Cd-109 source.

13.4 All example data presented in Tables 4 through 8 were generated using the following calibrations and source count times. The TN 9000 and TN Lead Analyzer were calibrated using fundamental parameters using NIST SRM 2710 as a calibration check sample. The TN 9000 was operated using 100, 60, and 60 second count times for the Cd-109, Fe-55, and Am-241 sources, respectively. The TN Lead analyzer was operated using a 60 second count time for the Cd-109 source. The X-MET 920 with the Si(Li) detector was calibrated using fundamental parameters and one well characterized site-specific soil standard as a calibration check. It used 140 and 100 second count times for the Cd-109 and Am-241 sources, respectively. The X-MET 920 with the gas-filled proportional detector was calibrated empirically using between 10 and 20 well characterized site-specific soil standards. It used 120 second times for the Cd-109 source. The XL Spectrum Analyzer utilized NIST SRM 2710 for calibration and the Compton peak normalization procedure for quantitation based on 60 second count times for the Cd-109 source. The MAP Spectrum Analyzer was internally calibrated by the manufacturer. The calibration was checked using a well-characterized site-specific soil standard. It used 240 second times for the Cd-109 source.

13.5 Precision measurements -- The example precision data are presented in Table 4. These data are provided for guidance purposes only. Each of the six FPXRF instruments performed 10 replicate measurements on 12 soil samples that had analyte concentrations ranging from "nondetects" to thousands of mg/kg. Each of the 12 soil samples underwent 4 different preparation techniques from in situ (no preparation) to dried and ground in a sample cup. Therefore, there were 48 precision data points for five of the instruments and 24 precision points for the MAP Spectrum Analyzer. The replicate measurements were taken using the source count times discussed at the beginning of this section.

For each detectable analyte in each precision sample a mean concentration, standard deviation, and RSD was calculated for each analyte. The data presented in Table 4 is an average RSD for the precision samples that had analyte concentrations at 5 to 10 times the lower limit of detection for that analyte for each instrument. Some analytes such as mercury, selenium, silver, and thorium were not detected in any of the precision samples so these analytes are not listed in Table 4. Some analytes such as cadmium, nickel, and tin were only detected at concentrations near the lower limit of detection so that an RSD value calculated at 5 to 10 times this limit was not possible.

One FPXRF instrument collected replicate measurements on an additional nine soil samples to provide a better assessment of the effect of sample preparation on precision. Table 5 shows these results. These data are provided for guidance purposes only. The additional nine soil samples were comprised of three from each texture and had analyte concentrations ranging from near the lower limit of detection for the FPXRF analyzer to thousands of mg/kg. The FPXRF analyzer only collected replicate measurements from three of the preparation methods; no measurements were collected from the in situ homogenized samples. The FPXRF analyzer conducted five replicate measurements of the in situ field samples by taking measurements at five different points within the 4-inch by 4-inch sample square. Ten replicate measurements were collected for both the intrusive undried and unground and intrusive dried and ground samples contained in cups. The cups were shaken between each replicate measurement.

Table 5 shows that the precision dramatically improved from the in situ to the intrusive measurements. In general there was a slight improvement in precision when the sample was dried and ground. Two factors caused the precision for the in situ measurements to be poorer. The major factor is soil heterogeneity. By moving the probe within the 4-inch by 4-inch square,

measurements of different soil samples were actually taking place within the square. Table 5 illustrates the dominant effect of soil heterogeneity. It overwhelmed instrument precision when the FPXRF analyzer was used in this mode. The second factor that caused the RSD values to be higher for the in situ measurements is the fact that only five instead of ten replicates were taken. A lesser number of measurements caused the standard deviation to be larger which in turn elevated the RSD values.

13.6 Accuracy measurements -- Five of the FPXRF instruments (not including the MAP Spectrum Analyzer) analyzed 18 SRMs using the source count times and calibration methods given at the beginning of this section. The 18 SRMs included 9 soil SRMs, 4 stream or river sediment SRMs, 2 sludge SRMs, and 3 ash SRMs. Each of the SRMs contained known concentrations of certain target analytes. A percent recovery was calculated for each analyte in each SRM for each FPXRF instrument. Table 6 presents a summary of this data. With the exception of cadmium, chromium, and nickel, the values presented in Table 6 were generated from the 13 soil and sediment SRMs only. The 2 sludge and 3 ash SRMs were included for cadmium, chromium, and nickel because of the low or nondetectable concentrations of these three analytes in the soil and sediment SRMs.

Only 12 analytes are presented in Table 6. These are the analytes that are of environmental concern and provided a significant number of detections in the SRMs for an accuracy assessment. No data is presented for the X-MET 920 with the gas-filled proportional detector. This FPXRF instrument was calibrated empirically using site-specific soil samples. The percent recovery values from this instrument were very sporadic and the data did not lend itself to presentation in Table 6.

Table 7 provides a more detailed summary of accuracy data for one particular FPXRF instrument (TN 9000) for the 9 soil SRMs and 4 sediment SRMs. These data are provided for guidance purposes only. Table 7 shows the certified value, measured value, and percent recovery for five analytes. These analytes were chosen because they are of environmental concern and were most prevalently certified for in the SRM and detected by the FPXRF instrument. The first nine SRMs are soil and the last 4 SRMs are sediment. Percent recoveries for the four NIST SRMs were often between 90 and 110 percent for all analytes.

13.7 Comparability -- Comparability refers to the confidence with which one data set can be compared to another. In this case, FPXRF data generated from a large study of six FPXRF instruments was compared to SW-846 Methods 3050 and 6010 which are the standard soil extraction for metals and analysis by inductively coupled plasma. An evaluation of comparability was conducted by using linear regression analysis. Three factors were determined using the linear regression. These factors were the y-intercept, the slope of the line, and the coefficient of determination (r^2).

As part of the comparability assessment, the effects of soil type and preparation methods were studied. Three soil types (textures) and four preparation methods were examined during the study. The preparation methods evaluated the cumulative effect of particle size, moisture, and homogenization on comparability. Due to the large volume of data produced during this study, linear regression data for six analytes from only one FPXRF instrument is presented in Table 8. Similar trends in the data were seen for all instruments. These data are provided for guidance purposes only.

Table 8 shows the regression parameters for the whole data set, broken out by soil type, and by preparation method. These data are provided for guidance purposes only. The soil types are as follows: soil 1--sand; soil 2--loam; and soil 3--silty clay. The preparation methods are as follows: preparation 1--in situ in the field; preparation 2--intrusive, sample collected and homogenized; preparation 3--intrusive, with sample in a sample cup but sample still wet and not

ground; and preparation 4–intrusive, with sample dried, ground, passed through a 40-mesh sieve, and placed in sample cup.

For arsenic, copper, lead, and zinc, the comparability to the confirmatory laboratory was excellent with r^2 values ranging from 0.80 to 0.99 for all six FPXRF instruments. The slopes of the regression lines for arsenic, copper, lead, and zinc, were generally between 0.90 and 1.00 indicating the data would need to be corrected very little or not at all to match the confirmatory laboratory data. The r^2 values and slopes of the regression lines for barium and chromium were not as good as for the other for analytes, indicating the data would have to be corrected to match the confirmatory laboratory.

Table 8 demonstrates that there was little effect of soil type on the regression parameters for any of the six analytes. The only exceptions were for barium in soil 1 and copper in soil 3. In both of these cases, however, it is actually a concentration effect and not a soil effect causing the poorer comparability. All barium and copper concentrations in soil 1 and 3, respectively, were less than 350 mg/kg.

Table 8 shows there was a preparation effect on the regression parameters for all six analytes. With the exception of chromium, the regression parameters were primarily improved going from preparation 1 to preparation 2. In this step, the sample was removed from the soil surface, all large debris was removed, and the sample was thoroughly homogenized. The additional two preparation methods did little to improve the regression parameters. This data indicates that homogenization is the most critical factor when comparing the results. It is essential that the sample sent to the confirmatory laboratory match the FPXRF sample as closely as possible.

Sec. 11.0 of this method discusses the time necessary for each of the sample preparation techniques. Based on the data quality objectives for the project, an analyst must decide if it is worth the extra time necessary to dry and grind the sample for small improvements in comparability. Homogenization requires 3 to 5 min. Drying the sample requires one to two hours. Grinding and sieving requires another 10 to 15 min per sample. Lastly, when grinding and sieving is conducted, time has to be allotted to decontaminate the mortars, pestles, and sieves. Drying and grinding the samples and decontamination procedures will often dictate that an extra person be on site so that the analyst can keep up with the sample collection crew. The cost of requiring an extra person on site to prepare samples must be balanced with the gain in data quality and sample throughput.

13.8 The following documents may provide additional guidance and insight on this method and technique:

13.8.1 A. D. Hewitt, "Screening for Metals by X-ray Fluorescence Spectrometry/Response Factor/Compton K_α Peak Normalization Analysis," American Environmental Laboratory, pp 24-32, 1994.

13.8.2 S. Piorek and J. R. Pasmore, "Standardless, In Situ Analysis of Metallic Contaminants in the Natural Environment With a PC-Based, High Resolution Portable X-Ray Analyzer," Third International Symposium on Field Screening Methods for Hazardous Waste and Toxic Chemicals, Las Vegas, Nevada, February 24-26, 1993, Vol 2, pp 1135-1151, 1993.

13.8.3 S. Shefsky, "Sample Handling Strategies for Accurate Lead-in-soil Measurements in the Field and Laboratory," *International Symposium of Field Screening Methods for Hazardous Waste and Toxic Chemicals*, Las Vegas, NV, January 29-31, 1997.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction* available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th St., N.W. Washington, D.C. 20036, http://www.acs.org.

15.0 WASTE MANAGEMENT

The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available from the American Chemical Society at the address listed in Sec. 14.2.

16.0 REFERENCES

1. Metorex, X-MET 920 User's Manual.

2. Spectrace Instruments, "Energy Dispersive X-ray Fluorescence Spectrometry: An Introduction," 1994.

3. TN Spectrace, Spectrace 9000 Field Portable/Benchtop XRF Training and Applications Manual.

4. Unpublished SITE data, received from PRC Environment Management, Inc.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables referenced by this method. A flow diagram of the procedure follows the tables.

TABLE 1

EXAMPLE INTERFERENCE FREE LOWER LIMITS OF DETECTION

Analyte	Chemical Abstract Series Number	Lower Limit of Detection in Quartz Sand (milligrams per kilogram)
Antimony (Sb)	7440-36-0	40
Arsenic (As)	7440-38-0	40
Barium (Ba)	7440-39-3	20
Cadmium (Cd)	7440-43-9	100
Calcium (Ca)	7440-70-2	70
Chromium (Cr)	7440-47-3	150
Cobalt (Co)	7440-48-4	60
Copper (Cu)	7440-50-8	50
Iron (Fe)	7439-89-6	60
Lead (Pb)	7439-92-1	20
Manganese (Mn)	7439-96-5	70
Mercury (Hg)	7439-97-6	30
Molybdenum (Mo)	7439-93-7	10
Nickel (Ni)	7440-02-0	50
Potassium (K)	7440-09-7	200
Rubidium (Rb)	7440-17-7	10
Selenium (Se)	7782-49-2	40
Silver (Ag)	7440-22-4	70
Strontium (Sr)	7440-24-6	10
Thallium (Tl)	7440-28-0	20
Thorium (Th)	7440-29-1	10
Tin (Sn)	7440-31-5	60
Titanium (Ti)	7440-32-6	50
Vanadium (V)	7440-62-2	50
Zinc (Zn)	7440-66-6	50
Zirconium (Zr)	7440-67-7	10

Source: Refs. 1, 2, and 3
These data are provided for guidance purposes only.

TABLE 2

SUMMARY OF RADIOISOTOPE SOURCE CHARACTERISTICS

Source	Activity (mCi)	Half-Life (Years)	Excitation Energy (keV)	Elemental Analysis Range	
Fe-55	20-50	2.7	5.9	Sulfur to Chromium Molybdenum to Barium	K Lines L Lines
Cd-109	5-30	1.3	22.1 and 87.9	Calcium to Rhodium Tantalum to Lead Barium to Uranium	K Lines K Lines L Lines
Am-241	5-30	432	26.4 and 59.6	Copper to Thulium Tungsten to Uranium	K Lines L Lines
Cm-244	60-100	17.8	14.2	Titanium to Selenium Lanthanum to Lead	K Lines L Lines

Source: Refs. 1, 2, and 3

TABLE 3

SUMMARY OF X-RAY TUBE SOURCE CHARACTERISTICS

Anode Material	Recommended Voltage Range (kV)	K-alpha Emission (keV)	Elemental Analysis Range	
Cu	18-22	8.04	Potassium to Cobalt Silver to Gadolinium	K Lines L Lines
Mo	40-50	17.4	Cobalt to Yttrium Europium to Radon	K Lines L Lines
Ag	50-65	22.1	Zinc to Technicium Ytterbium to Neptunium	K Lines L Lines

Source: Ref. 4

Notes: The sample elements excited are chosen by taking as the lower limit the same ratio of excitation line energy to element absorption edge as in Table 2 (approximately 0.45) and the requirement that the excitation line energy be above the element absorption edge as the upper limit (L2 edges used for L lines). K-beta excitation lines were ignored.

TABLE 4

EXAMPLE PRECISION VALUES

Analyte	Average Relative Standard Deviation for Each Instrument at 5 to 10 Times the Lower Limit of Detection					
	TN 9000	TN Lead Analyzer	X-MET 920 (SiLi Detector)	X-MET 920 (Gas-Filled Detector)	XL Spectrum Analyzer	MAP Spectrum Analyzer
Antimony	6.54	NR	NR	NR	NR	NR
Arsenic	5.33	4.11	3.23	1.91	12.47	6.68
Barium	4.02	NR	3.31	5.91	NR	NR
Cadmium	29.84[a]	NR	24.80[a]	NR	NR	NR
Calcium	2.16	NR	NR	NR	NR	NR
Chromium	22.25	25.78	22.72	3.91	30.25	NR
Cobalt	33.90	NR	NR	NR	NR	NR
Copper	7.03	9.11	8.49	9.12	12.77	14.86
Iron	1.78	1.67	1.55	NR	2.30	NR
Lead	6.45	5.93	5.05	7.56	6.97	12.16
Manganese	27.04	24.75	NR	NR	NR	NR
Molybdenum	6.95	NR	NR	NR	12.60	NR
Nickel	30.85[a]	NR	24.92[a]	20.92[a]	NA	NR
Potassium	3.90	NR	NR	NR	NR	NR
Rubidium	13.06	NR	NR	NR	32.69[a]	NR
Strontium	4.28	NR	NR	NR	8.86	NR
Tin	24.32[a]	NR	NR	NR	NR	NR
Titanium	4.87	NR	NR	NR	NR	NR
Zinc	7.27	7.48	4.26	2.28	10.95	0.83
Zirconium	3.58	NR	NR	NR	6.49	NR

These data are provided for guidance purposes only.
Source: Ref. 4

[a] These values are biased high because the concentration of these analytes in the soil samples was near the lower limit of detection for that particular FPXRF instrument.

NR Not reported.

NA Not applicable; analyte was reported but was below the established lower limit detection.

TABLE 5

EXAMPLES OF PRECISION AS AFFECTED BY SAMPLE PREPARATION

Analyte	Average Relative Standard Deviation for Each Preparation Method		
	In Situ-Field	Intrusive-Undried and Unground	Intrusive-Dried and Ground
Antimony	30.1	15.0	14.4
Arsenic	22.5	5.36	3.76
Barium	17.3	3.38	2.90
Cadmium[a]	41.2	30.8	28.3
Calcium	17.5	1.68	1.24
Chromium	17.6	28.5	21.9
Cobalt	28.4	31.1	28.4
Copper	26.4	10.2	7.90
Iron	10.3	1.67	1.57
Lead	25.1	8.55	6.03
Manganese	40.5	12.3	13.0
Mercury	ND	ND	ND
Molybdenum	21.6	20.1	19.2
Nickel[a]	29.8	20.4	18.2
Potassium	18.6	3.04	2.57
Rubidium	29.8	16.2	18.9
Selenium	ND	20.2	19.5
Silver[a]	31.9	31.0	29.2
Strontium	15.2	3.38	3.98
Thallium	39.0	16.0	19.5
Thorium	NR	NR	NR
Tin	ND	14.1	15.3
Titanium	13.3	4.15	3.74
Vanadium	NR	NR	NR
Zinc	26.6	13.3	11.1
Zirconium	20.2	5.63	5.18

These data are provided for guidance purposes only.
Source: Ref. 4

[a] These values may be biased high because the concentration of these analytes in the soil samples was near the lower limit of detection.

ND Not detected.

NR Not reported.

TABLE 6

EXAMPLE ACCURACY VALUES

Analyte	Instrument															
	TN 9000				TN Lead Analyzer				X-MET 920 (SiLi Detector)				XL Spectrum Analyzer			
	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec	SD	n	Range of % Rec.	Mean % Rec.	SD
Sb	2	100-149	124.3	NA	--	--	--	--	--	--	--	--	--	--	--	--
As	5	68-115	92.8	17.3	5	44-105	83.4	23.2	4	9.7-91	47.7	39.7	5	38-535	189.8	206
Ba	9	98-198	135.3	36.9	--	--	--	--	9	18-848	168.2	262	--	--	--	--
Cd	2	99-129	114.3	NA	--	--	--	--	6	81-202	110.5	45.7	--	--	--	--
Cr	2	99-178	138.4	NA	--	--	--	--	7	22-273	143.1	93.8	3	98-625	279.2	300
Cu	8	61-140	95.0	28.8	6	38-107	79.1	27.0	11	10-210	111.8	72.1	8	95-480	203.0	147
Fe	6	78-155	103.7	26.1	6	89-159	102.3	28.6	6	48-94	80.4	16.2	6	26-187	108.6	52.9
Pb	11	66-138	98.9	19.2	11	68-131	97.4	18.4	12	23-94	72.7	20.9	13	80-234	107.3	39.9
Mn	4	81-104	93.1	9.70	3	92-152	113.1	33.8	--	--	--	--	--	--	--	--
Ni	3	99-122	109.8	12.0	--	--	--	--	--	--	--	--	3	57-123	87.5	33.5
Sr	8	110-178	132.6	23.8	--	--	--	--	--	--	--	--	7	86-209	125.1	39.5
Zn	11	41-130	94.3	24.0	10	81-133	100.0	19.7	12	46-181	106.6	34.7	11	31-199	94.6	42.5

Source: Ref. 4. These data are provided for guidance purposes only.
n: Number of samples that contained a certified value for the analyte and produced a detectable concentration from the FPXRF instrument.
SD: Standard deviation; NA: Not applicable; only two data points, therefore, a SD was not calculated.
%Rec.: Percent recovery.
-- No data.

TABLE 7

EXAMPLE ACCURACY FOR TN 9000[a]

Standard Reference Material	Arsenic			Barium			Copper			Lead			Zinc		
	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.
RTC CRM-021	24.8	ND	NA	586	1135	193.5	4792	2908	60.7	144742	149947	103.6	546	224	40.9
RTC CRM-020	397	429	92.5	22.3	ND	NA	753	583	77.4	5195	3444	66.3	3022	3916	129.6
BCR CRM 143R	--	--	--	--	--	--	131	105	80.5	180	206	114.8	1055	1043	99.0
BCR CRM 141	--	--	--	--	--	--	32.6	ND	NA	29.4	ND	NA	81.3	ND	NA
USGS GXR-2	25.0	ND	NA	2240	2946	131.5	76.0	106	140.2	690	742	107.6	530	596	112.4
USGS GXR-6	330	294	88.9	1300	2581	198.5	66.0	ND	NA	101	80.9	80.1	118	ND	NA
NIST 2711	105	104	99.3	726	801	110.3	114	ND	NA	1162	1172	100.9	350	333	94.9
NIST 2710	626	722	115.4	707	782	110.6	2950	2834	96.1	5532	5420	98.0	6952	6476	93.2
NIST 2709	17.7	ND	NA	968	950	98.1	34.6	ND	NA	18.9	ND	NA	106	98.5	93.0
NIST 2704	23.4	ND	NA	414	443	107.0	98.6	105	106.2	161	167	103.5	438	427	97.4
CNRC PACS-1	211	143	67.7	--	772	NA	452	302	66.9	404	332	82.3	824	611	74.2
SARM-51	--	--	--	335	466	139.1	268	373	139.2	5200	7199	138.4	2200	2676	121.6
SARM-52	--	--	--	410	527	128.5	219	193	88.1	1200	1107	92.2	264	215	81.4

Source: Ref. 4. These data are provided for guidance purposes only.
[a] All concentrations in milligrams per kilogram.
%Rec.: Percent recovery; ND: Not detected; NA: Not applicable.
-- No data.

TABLE 8

EXAMPLE REGRESSION PARAMETERS FOR COMPARABILITY[1]

	Arsenic				Barium				Copper			
	n	r^2	Int.	Slope	n	r^2	Int.	Slope	n	r^2	Int.	Slope
All Data	824	0.94	1.62	0.94	1255	0.71	60.3	0.54	984	0.93	2.19	0.93
Soil 1	368	0.96	1.41	0.95	393	0.05	42.6	0.11	385	0.94	1.26	0.99
Soil 2	453	0.94	1.51	0.96	462	0.56	30.2	0.66	463	0.92	2.09	0.95
Soil 3	—	—	—	—	400	0.85	44.7	0.59	136	0.46	16.60	0.57
Prep 1	207	0.87	2.69	0.85	312	0.64	53.7	0.55	256	0.87	3.89	0.87
Prep 2	208	0.97	1.38	0.95	315	0.67	64.6	0.52	246	0.96	2.04	0.93
Prep 3	204	0.96	1.20	0.99	315	0.78	64.6	0.53	236	0.97	1.45	0.99
Prep 4	205	0.96	1.45	0.98	313	0.81	58.9	0.55	246	0.96	1.99	0.96

	Lead				Zinc				Chromium			
	n	r^2	Int.	Slope	n	r^2	Int.	Slope	n	r^2	Int.	Slope
All Data	1205	0.92	1.66	0.95	1103	0.89	1.86	0.95	280	0.70	64.6	0.42
Soil 1	357	0.94	1.41	0.96	329	0.93	1.78	0.93	—	—	—	—
Soil 2	451	0.93	1.62	0.97	423	0.85	2.57	0.90	—	—	—	—
Soil 3	397	0.90	2.40	0.90	351	0.90	1.70	0.98	186	0.66	38.9	0.50
Prep 1	305	0.80	2.88	0.86	286	0.79	3.16	0.87	105	0.80	66.1	0.43
Prep 2	298	0.97	1.41	0.96	272	0.95	1.86	0.93	77	0.51	81.3	0.36
Prep 3	302	0.98	1.26	0.99	274	0.93	1.32	1.00	49	0.73	53.7	0.45
Prep 4	300	0.96	1.38	1.00	271	0.94	1.41	1.01	49	0.75	31.6	0.56

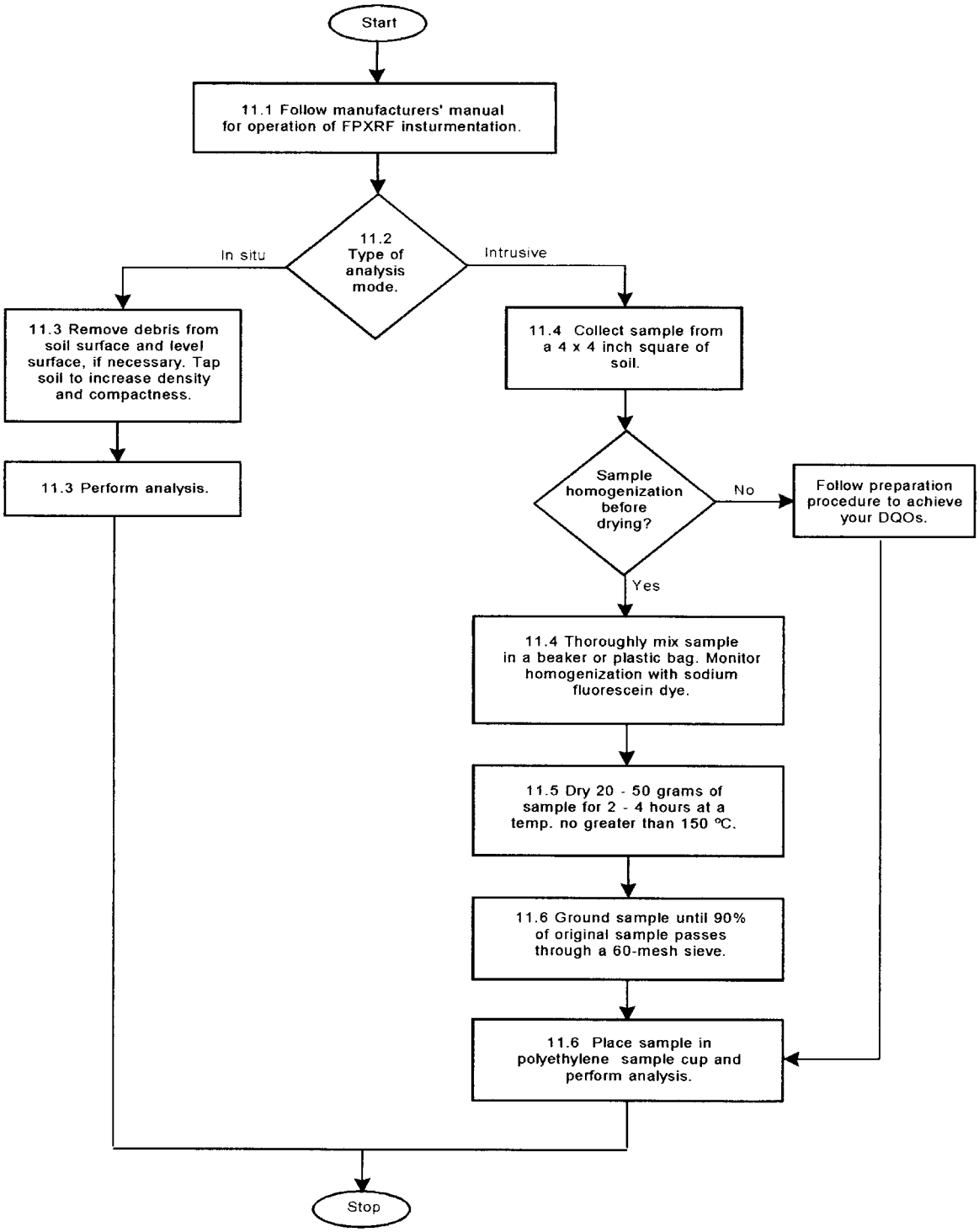
Source: Ref. 4. These data are provided for guidance purposes only.

[1] Log-transformed data

n: Number of data points; r^2: Coefficient of determination; Int.: Y-intercept

— No applicable data

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT



APPENDIX D: LABORATORY SOPS

ENERGY LABORATORIES, INC.

Helena, Montana

Quality Assurance Manual

Revision 2.16.2012

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ELI COMMITMENT

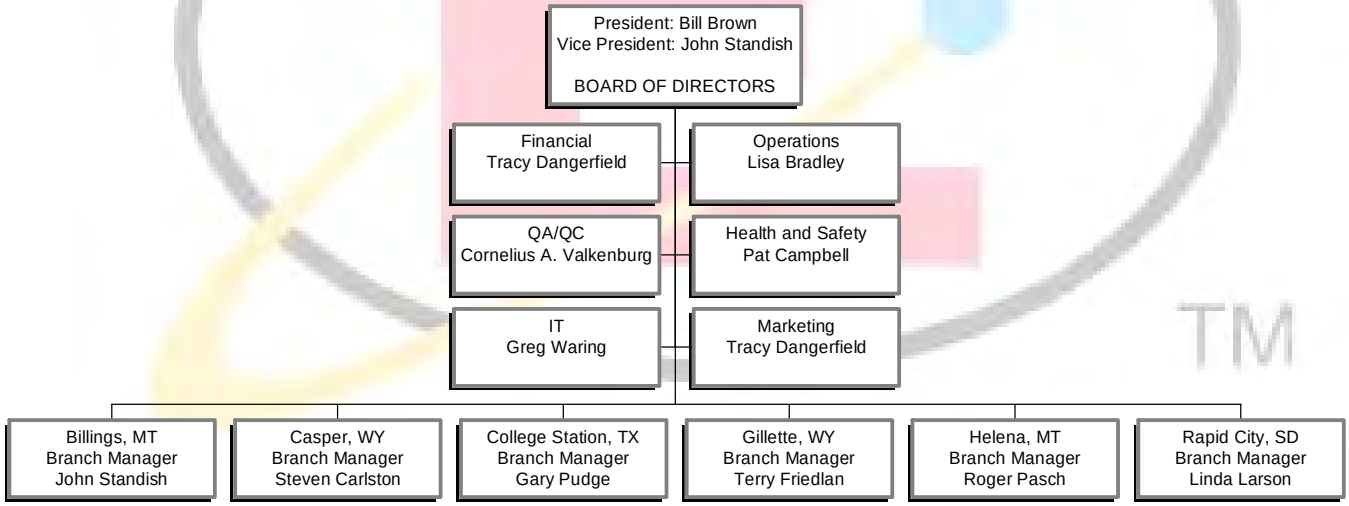
Energy Laboratories, Inc. Strives Toward:

1. Being highly skilled in the field of analytical chemistry.
2. Delivering quality and service with integrity.
3. Encouraging the professional development of our staff.
4. Offering our employees a safe and positive work environment.
5. Being profitable and using resources wisely for a sustainable future.

INTRODUCTION

Energy Laboratories, Inc. provides chemical, industrial hygiene, and environmental analytical services to private industry, agricultural industry, engineering consultants, government agencies, and private individuals. Analytical services include: analysis of waters and soils for inorganic and organic constituents, aquatic toxicity testing, hazardous waste analysis, radiochemistry, industrial hygiene, microbiology, soils and water physical parameters, and petroleum analysis. Founded in 1952, Energy Laboratories currently incorporates six separate testing laboratories. The main headquarters are located in Billings, MT, with branch laboratories located in Casper, WY; College Station, TX; Gillette, WY; Helena, MT; and Rapid City, SD.

ENERGY LABORATORIES, INC.
ORGANIZATION



ELI, as a coordinated company of six participating branches, has developed a QA program that takes into account the various method types and EPA programs, while also considering sample matrices, to develop a single comprehensive set of QA guidance. We use scientific approaches, Good Laboratory Practices, EPA Methods and Guidance documents, and accreditation audit guidance to develop our overall QA Program.

The Quality Assurance Program establishes acceptable performance criteria for all routine analytical procedures being performed by laboratory personnel. The Quality Assurance Assessment Program provides a formal system for evaluating the quality of data being generated and reported. The ELI Laboratory Safety Manual & Chemical Hygiene Plan insures the safety of all laboratory personnel and monitors the safety of all laboratory operations. These, in addition to the experience and expertise of

our analysts, provide a comprehensive Quality Assurance Program. Energy Laboratories, Inc., is certified under the Safe Drinking Water Act by Region VIII EPA for Wyoming, and the States of Montana, Idaho, Colorado, Nevada, North Dakota, and South Dakota. ELI also holds accreditation for Clean Water Act, Safe Drinking Water Act and Resource Conservation Recovery Act (RCRA) parameters through the National Environmental Laboratory Accreditation Program (NELAP), which is supported by the EPA. This certification is maintained through the state of Florida and is carried in the states of Nevada, Colorado, and North Dakota. ELI obtains these certifications either through reciprocal recognition of ELI's primary EPA or NELAP certification. ELI is also certified under the National Radon Proficiency Program administered by the National Environmental Health Association. Branch laboratories of ELI are certified in their own state and in neighboring states. Details on certification parameters for all laboratories are given in ELI's Qualifications Manual and maintained on ELI's website: www.energylab.com.

The ELI Quality Assurance Manual, the ELI Qualifications Manual, the ELI Technical Analytical Services and fee schedule are used together to outline the ELI Quality Assurance/Quality Control Program. This Quality Assurance Manual is appropriate to all departments of Energy Laboratories-Helena. The procedures discussed or referenced in this manual describe our day-to-day laboratory practices and adhere to USEPA Safe Drinking Water Act and TNI (The NELAC Institute) requirements as well as Good Laboratory Practices (GLPs). Information on ELI-Helena accreditations and certifications can be found in Appendix A of this plan. Where possible, ELI uses EPA, AOAC, ASTM, APHA, NIOSH, OSHA, or published analytical methods and follows the procedures with strict adherence to described protocol and recommended QA/QC parameters. Actual method operating procedures are described in the Standard Operating Procedures, and are available for review at the laboratory. Vital parts of our Quality Assurance Program, Quality Control and Quality Assessment programs, are outlined in Chapters One and Two of this manual.

To generate data that will meet project specific requirements, it is necessary to define the type of decisions that will be made and identify the intended use of the data. Data Quality Objectives (DQOs) are an integrated set of specifications that define data quality requirements and the intended use of the data. Project-specific DQOs must be established for both field and laboratory operations. Through the DQO process, appropriate reporting limits, extraction/digestion methods, clean-up methods, analyses methods, target analytes, method quality control samples, sample security requirements, quality control acceptance ranges, corrective action procedures, reporting formats and reporting limits can be specified. Professional laboratory project managers are available to assist clients in specifying appropriate laboratory analyses and reporting procedures necessary to meet project requirements. Client-specific DQOs can be coordinated with the laboratory through our Project Managers via in quotations or contracts, or with relevant documentation provided to the laboratory prior to (or at time of) sample receipt. Client-specific requirements are communicated to analysts and final report validators through the laboratory LIMS system. By default, our methods, analytes, and QC parameters are set up to meet the DQOs specified in federal and/or state regulations. ELI encourages clients to provide ELI documentation of any client-specific permit monitoring requirements.

Certain types of analysis requests may not be suitable to standardized analytical methods. These custom requests are handled individually with laboratory management and staff scientists. Project-specific methods and reporting packages are available upon request. Attention to documentation of the analytical procedure and use of suitable QC parameters is maintained according to good scientific discipline and Good Laboratory Practice guidelines.

The ELI-Helena laboratory managers, or their designees, will evaluate all new requests, tenders, and contracts to determine that the laboratory is capable of performing the requested work. This process includes ensuring that the laboratory maintains the required accreditation, equipment and resources. In the event that ELI is dependent on the service of an outside laboratory for analyses not available

through our facility or our branch laboratories, clients will be notified that the work will be subcontracted to a qualified outside laboratory (See Subcontracting Policy-Chapter 6 and ELI SOP, *Laboratory Policies*, which addresses Contract Reviews).

The general process for evaluation of new work includes:

- Determination of what area the work would fall under
    - Chemistry
    - Radiochemistry
    - Microbiology
- What certification is required
    - State certification
    - NELAP certification
    - EPA certification
- Is the required instrumentation available
- The time frame required
- Evaluation of current and future work load
- Fee negotiation

This Quality Manual and related quality documentation meet requirements of the National Environmental Laboratory Accreditation Program (NELAP), which is an EPA approved accreditation program.

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CHAPTER 1: QUALITY CONTROL PROGRAM

Quality Policy Statement

Energy Laboratories, Inc. is committed to produce laboratory data of known and documented quality that is scientifically valid, meets method specifications, satisfies regulatory requirements, and accomplishes the data quality objectives of the client and project. Management ensures that the laboratory maintains current certifications and is in compliance with accreditations through USEPA, State Agencies, and NELAP. Those method, regulatory, and client requirements are incorporated into our Quality Assurance Program, which is outlined within this Quality Assurance Manual. Our Quality Systems are designed to comply with the standards as defined by the most current versions of the USEPA, the NELAP accreditation standard and ISO 17025 standards. ELI is dedicated to providing appropriate corporate resources to set objectives, offering training opportunities, and monitoring the quality performance of our staff. ELI also provides facilities and equipment adequate and appropriate to those objectives.

Quality Assurance Program

The purpose of the Quality Assurance Program is to ensure that the analytical services provided by Energy Laboratories are of the highest quality, data is within established accuracy and precision limits (required by the referenced method or Standard Operating Procedure), and each analytical result produced meets or exceeds a client's requirements. Management ensures that the integrity of the management system is maintained. The Laboratory Manager, or designee, ensures that changes to the management system are planned, implemented and documented.

Management establishes and maintains data integrity by providing the following to ELI's data integrity system:

1) Data Integrity Training (Including the highest standards of ethical behavior)
2) Periodic review of data integrity procedural documentation
3) Annual Review of data integrity procedures with updates as needed
4) Periodic, in-depth monitoring of data integrity
5) Maintenance of signed data integrity documentation for all laboratory employees

All employees are expected to implement and follow the policies contained within the Quality Assurance Program. Internal documents, controlled and associated with the Quality Assurance Program are listed in Appendix B.

The quality systems in the program consist of the policies and procedures, and all referenced documents, described in this Quality Assurance Manual. The Quality Control Program also functions to maintain the laboratory's compliance with accreditations through USEPA, State Agencies, and NELAP. The Quality Control Program insures that results of analyses are within established accuracy and precision limits required by the referenced method or Standard Operating Procedure (SOP).

The Quality Control Program requires that the following points be met for each applicable analytical method:

- Performance of any analytical method requires that the proper equipment and instrumentation are available. A list of major equipment is listed in Chapter 12 and a company-wide list is available in the ELI-Qualifications Manual. The procedure for operation of an analytical

instrument is described in the equipment manufacturers operating manual, and may also be supplemented with a specific Standard Operating Procedure (SOP) for the instrument and/or the method.

- Each SOP covers operation of the instrument including the sequence of operations involved in instrument start-up, calibrating, analyzing, and shutting down. Chapter 13 of this manual includes recommended preventative maintenance, and/or a list of parameters used to identify other types of maintenance. The SOP outlines any special safety precautions for operation of the instrument.

- SOPs of well-detailed EPA, ASTM, NIOSH, APHA, OSHA, or published procedures include, as appropriate, a list of any method specific items or variances, a list of QC parameters and their recommended performance ranges, recommended or example analytical sequences, specific or unique safety information, method performance requirements, method references, and a signed signature page. SOPs' details and format of method follow NELAP requirements. Detailed SOPs are prepared for those procedures that do not have published methods. Further details of SOP format and information required in method SOPs can be found in the ELI SOP, *Preparation, Numbering, Use, and revision of Standard Operating Procedures.* Written Standard Operating Procedures referenced within this manual are available at the laboratory for review. (ELI SOPs are considered confidential proprietary information and ELI does not provide copies of SOPs off ELI premises).

- The initial test method evaluation for chemical analyses involves Method Detection Limit (MDL) studies (refer to ELI SOP, "*Determination of Method Detection Limits (MDL) and Quantitation Limits"*), verification of the Limit of Detection (LOD) and/or Practical Quantitation Limit (PQL), an evaluation of method performance (using four or more replicates of reference quality control reference samples), evaluation of the selectivity of the method, and any additional method-specific requirements.

- For radiochemical analyses, each method undergoes Method Validation as outlined in EPA's specific method and the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP), Chapter 6.

- The required detection level (RDL) for radiochemical analyses of drinking water samples is calculated based on the requirements in 40 CFR 141.25(c), which is a sample specific determination. The equation is specific for each method and noted in the method-specific SOP.

- ELI demonstrates that laboratory staff is qualified and capable of performing the method. Analysts are assigned duties based on their skills and experience. Training records are maintained for all analysts. Curricula vitae of supervisory and senior analysts are described in Appendix E and the ELI Qualification Manual.

- It is the responsibility of the analyst to become thoroughly familiar with the methodology and instrument operation before performing the analysis. It is the responsibility of the person providing training to monitor all laboratory results generated for a reasonable time. The amount of time necessary may vary depending on the method and the experience of the analyst. At a minimum, the analyst's performance is monitored until the analyst demonstrates the ability to generate results of acceptable accuracy and precision, according to the method.

- All analysts are required to demonstrate and maintain a record of proof of competency by routinely analyzing quality control samples appropriate to the analytical procedures they perform. Competency in analyzing these control samples is documented in analysts' training

files per NELAP requirements (for more information, see ELI SOP, *Personnel Training and Training Records*). For those analyses where external performance evaluation samples are not routinely analyzed, competency is documented by including the results of routine analyses of method specific quality control samples (prepared by laboratory staff) and/or a verifying statement of procedural review by a supervisor.

- Each analytical method is subjected to quality control monitoring. The purpose is to demonstrate that results generated meet acceptable accuracy and precision criteria for the method. Precision and bias are determined for standard and non-standard methods. Precision and bias are determined for standard methods through control charting of quality control data from quality control samples. Precision and bias using non-standard, modified standard or laboratory-developed methods are compared to the criteria established by the client (when requested), the method, or the laboratory.

Quality control requirements are outlined in the methods and ELI, at a minimum, follows the guidelines specified in the methods used. Additional QC requirements are also added as appropriate. Statistical method performance is periodically evaluated against method requirements using control charts.

- Quality control monitoring to measure accuracy for each method generally requires that five to ten percent of all samples analyzed be fortified (spiked) with a known concentration of target analytes tested by the method. The percent recovery is then calculated. This provides a means for monitoring method accuracy and evaluating sample matrix effects. Where appropriate, surrogates are included in the method to monitor method performance on each individual sample. Blank spike samples replace matrix spike samples for certain methods, or when there is insufficient sample for a matrix spike analyses. Historical, routine, batch QC sample performance can be used to estimate the precision and accuracy of the method.

- Quality control monitoring to measure precision for each method requires replicate samples be prepared and analyzed when appropriate. Actual requirements are outlined in the specific SOP. When replicate samples or matrix spike duplicates are analyzed, relative percent difference is calculated and used to monitor precision of the method. In instances where there are no specific method requirements, it is the policy of this laboratory to analyze five to ten percent of all samples in duplicate. Duplicate test results must be within the control limits established for each analysis type. Acceptance limits generally follow specifications listed in the method. Matrix spike duplicates replace sample duplicates for most methods.

- When not defined in the method, and as appropriate, method blanks and/or instrument blanks are analyzed one in every 20 samples at a minimum. Method blanks are used to verify that contamination from laboratory reagents and glassware is not present in the analytical sample process. The method blank should be less than the reporting limit, or 10 times less than the concentration amount in the sample, for the analytical parameter being tested, whichever is greater.

- When not defined in the method, and as appropriate, method spikes (blank spikes) are analyzed one in every 20 samples at a minimum.

- Calibration standards are analyzed and calibration curves are developed for all applicable methods. For additional information on instrument calibration, see Chapter Seven of this QA manual.

- The initial calibration is continuously monitored by analyzing a continuing calibration standard every 10 to 20 samples, or within a specified time frequency, and at the end of each new set of

samples; depending on the method and instrumentation. Results must be within an established range as described by the method SOP. Initial calibrations are verified against a standard from a second source.

- Performance evaluation samples and further quality control check samples may be required for various methods. Refer to Chapter Two of this QA manual for further details.

Estimation of Uncertainty

The estimation of uncertainty consists of the sum of the uncertainties of the individual measurements of an analytical procedure. The variability of the sampling plan, sample heterogeneity, extraction procedure, instrument calibration, systematic bias, and many other factors all contribute to the uncertainty of a measurement or result.

ELI estimates uncertainty utilizing Confidence Intervals defined as ±2σ (95%) and ±3σ (99%) where σ is the standard deviation of the recovery of quality control samples. When estimating the uncertainty of the measurement, all uncertainty components, which are of importance in the given situation, shall be taken into account using accepted methods of analysis. Sources contributing to the uncertainty include, but are not necessarily limited to, the reference standards and reference materials used, the environmental conditions, the condition of the item being tested or calibrated and the operator. The predicted long-term behavior of the tested and/or calibrated item is normally not taken into account when estimating the measurement uncertainty.

Energy Laboratories, Inc. uses the procedures outlined in ELI SOP, *Control Chart Generation and Maintenance,* for the purpose of evaluating estimation of uncertainty for chemical analyses and uses the determination of uncertainty on a sample-specific basis for all radiochemistry measurements. These estimates of uncertainty have formulas documented in the individual SOP.

Maintenance of Performance Records

All quality control monitoring is recorded and documented. Quality control data is recorded in laboratory notebooks, electronic summary files, and/or analyses sheets. QC data can also be maintained in quality control forms, graphs, or charts. QC data management and control chart generation, maintenance, and usage are described in ELI SOP, *Control Chart Generation and Maintenance*. It is the responsibility of the analyst to see that all results are recorded in a timely manner.

All quality control data are filed and available for inspection and assessment by analysts, supervisors, management, and quality control personnel.

Method Quality Control Specifications

Summaries of Quality Assurance/Quality Control specifications for a selected subset of procedures offered by ELI are outlined in Appendix C. These tables are recommended for our clients to use in the preparation of Quality Assurance Project Plans (QAPPs). Exact details of method QC can be found in the applicable method SOPs.

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CHAPTER 2 – QUALITY ASSESSMENT PROGRAM

The function of the Quality Assessment Program is to provide formal evaluation of the quality of data being generated and reported by the laboratory. External and internal quality control measures are used in this assessment. These measures include performance evaluation samples, laboratory quality control check samples, and routine internal and external audits on methodology and documentation procedures.

Performance Evaluation (PE) Samples

PE samples are supplied by an outside entity and contain known amounts of constituents. The laboratory does not have access to the known values of the samples. Only the PE provider has knowledge of constituent levels prior to the formal publishing of the test results.

These samples are received on a routine basis, with results sent to the providing entity for evaluation. Acceptable results are those that fall within a defined range as determined by the supplier.

Performance Evaluation (PE) Samples for USEPA, NELAP, and various State certifications are Water Pollution Study Samples (WP or DMRQA), Water Supply Study samples (WS), and Soil PE samples provided by either Resource Technology Corporation (RTC) and/or Environmental Resource Associates (ERA); vendors are accredited by the American Association for Laboratory Accreditation (A2LA) or the National Voluntary Laboratory Accreditation Program (NVLAP). Routine participation in NELAP, WS and WP PE sample studies is used to maintain certifications for Drinking Water, NPDES permit monitoring analyses, and projects requiring NELAP certification. These types of external PE samples are received on a semi-annual basis, with results sent to the reference supplier for evaluation. The samples are analyzed the same as routine samples in the laboratory. Acceptable results are those that fall within a defined range as determined by the vendor/EPA/NELAP; based on multi-laboratory study results. The provider sends these results to USEPA and other certifying agencies as requested by ELI-Helena. Current study results are available on request. A current copy of the certificate to perform drinking water analysis issued by the State of Montana is provided in Appendix A. Reciprocal certifications to perform drinking water analysis in USEPA Region VIII and Idaho are based on the Montana certification. Updated certificates are posted on the ELI Corporate Website (www.energylab.com.)

Performance evaluation samples for Radon Proficiency testing certification are from the National Environmental Health Association (NEHA), an EPA approved commercial Radon testing certification association. Our own radon sampling canisters are submitted to NEHA for known levels of radon exposure. Acceptable results are those that fall within a defined ranged based on multi-laboratory study results.

Blind Quality Control Check Samples are samples submitted as regular lab samples and are processed through the system in the same manner as any other sample. The analysts do not know the true value of these samples when performing the analyses. Method performance reports are returned to the analysts and maintained in method performance files. Clients occasionally submit these types of samples for their QAPP.

Inter- Laboratory comparison Samples are samples containing known/unknown quantities of analytes that are split and analyzed by more than one laboratory. These samples are routinely analyzed and results are kept on file.

Quality Control Check Samples

Quality Control Check Samples are performance evaluation samples used for routine method performance monitoring. As appropriate, analytical procedures include the analysis of a quality control sample with every sample batch analyzed. The materials are obtained from a commercial source, when available, or they may be prepared in-house. Acceptable results are within a defined range based on certified ranges, or against statistically determined control limits, method-defined criteria, or client-defined Data Quality Objectives. Routinely used methods not subjected to PE sample monitoring are evaluated with Quality Control Check Samples as appropriate.

QC samples are processed through the system in the same manner as any other sample; except the analyst is aware of the source, concentration, and acceptance ranges of target analytes and calculates analyte recoveries to evaluate method performance in real time.

Quality Assurance Audits

Quality Assurance Audits consist of internal and external laboratory analyses inspections designed to monitor adherence to quality systems and quality control requirements. These audits check general laboratory operations, overall Quality Systems, adherence to QA program requirements, sample tracking procedures, sample holding times, storage requirements, adherence to procedures during analysis, calculations, completion of required quality control samples within the group surrounding the sample, and proper record-keeping.

Internal quality assurance audits are conducted or coordinated by the Quality Assurance Manager at least annually. See ELI SOP, "*Internal Quality Assurance Audits*", for further information. ELI conducts internal inspections on a regular basis to monitor adherence to quality control requirements. Results of formal audits are given to management with possible recommendations for corrective action in the event any discrepancies are found. As necessary, a follow-up review is conducted to determine that identified problems have been addressed. Annually, the overall quality systems of the laboratory are reviewed and a summary report is prepared.

Per the NELAP and ISO 17025-2005 requirements, the management of the laboratory will conduct an annual review of the quality system, including policies, procedures and environmental testing activities. This is done to ensure the QA systems continuing suitability and effectiveness, as well as provide the opportunity to introduce necessary changes or improvements. The review shall take into account at a minimum the following:

- The suitability of policies and procedures;
- Reports from managerial and supervisory personnel;
- The outcome of recent internal audits;
- Corrective and preventative actions;
- Assessments by external bodies;
- The results of inter-laboratory comparisons or proficiency tests;
- Changes in the volume and type of work;
- Client feedback;
- Complaints;
- Recommendations for improvement, and
- Other relevant factors, such as quality control activities, resources and staff training.

The findings from management reviews and the corrective actions that arise from these findings shall be recorded. The management shall ensure that those actions are carried out within an appropriate, pre-determined timescale.

ELI also conducts Peer Audits as part of an internal auditing program established within the company. At least annually, analysts and supervisors from other branch laboratories evaluate a designated ELI branch lab. The Peer Audits serve to not only address conformance issues, but also provide ELI with a tool to continuously improve process and consistency throughout the company. The goals of the Peer Audits are to:

- Encourage relationships between analysts;
- Transfer technical knowledge between peers;
- Establish consistency of analytical process/method between branch laboratories;
- Identify the depth of analysts' knowledge at each position by observing what analysts are doing at the bench;
- Determine training needs of personnel;
- Document process/method and verify that issues are being corrected when found; and,
- Work with, and in support of, QA department efforts.

Depending on the size of the laboratory, a large number of methods and processes are examined during a Peer Audit. Results from these audits are provided to the branch management, as well as Corporate Management. Corrective Action Plans of a Peer Audit are initiated with the assistance of the Corporate Quality Assurance Officer for resolution of any findings.

ELI welcomes external Quality Assurance Audits, by qualified outside auditors, for review and comment on the overall QA program. To maintain certifications, accrediting authorities from the State of Montana conduct periodic comprehensive external audits. External audits by private clients to meet Quality Assurance Project Plans (QAPPs), as applicable to environmental remediation projects or for major industries, are also conducted as requested by clientele. See ELI SOP, *External Quality Assurance Audits*.

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CHAPTER 3 – LABORATORY FACILITIES

The Energy Laboratories, Inc. – Helena, MT facilities consists of three buildings all located at 3161 East Lyndale, Helena, MT 59601. The phone number for Helena's Energy Laboratories, Inc. is (406) 442-0711, the fax number is (406) 442-0712, the toll free number is (877)472-0711, and the email address is helena@energylab.com.

Laboratory space includes adequate bench top and floor space to accommodate periods of peak workloads. Working space includes sufficient bench top area for processing samples; storage space for reagents, chemicals, glassware, bench and portable equipment items; floor space for stationary equipment; and adequate associated area for cleaning glassware. The laboratory contains at least 15 linear feet of usable bench space per analyst and at least 150 to 200 square feet per person. Laboratory departments are organized and the facilities are designed for specific laboratory operations in order to protect the safety of analysts and to minimize potential sources of contamination between and within department areas (for more information see ELI SOP, *Facility Description, Access, and Security*).

The laboratory is appropriately ventilated and illuminated, relatively free of dust and drafts, and is not subject to excessive temperature changes. As required, laboratory areas are temperature and humidity controlled. A light intensity of 100-foot candles is present at all working surfaces. Ample cabinets, drawers and shelves are available for storage and protection of glassware. Exhaust and particulate filtering hoods are available as needed for use during preparation, extraction, and analysis of samples. Air quality monitoring is conducted to ensure a safe working environment.

To maintain security, all non-ELI laboratory personnel and visitors must sign an ELI guest book and be escorted by a staff member of ELI when present in laboratory working areas. A secure, sample login area restricts the access of unauthorized personnel to other parts of the laboratory.

The laboratory has provisions for the disposal of chemical, microbiological and radioactive wastes. These provisions are described in Standard Operating Procedures as well as outlined in the Laboratory Safety Manual & Chemical Hygiene Plan along with other safety and health guidelines. For more information, see ELI SOP, *General Laboratory Waste Disposal*.

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CHAPTER 4 – PERSONNEL REQUIREMENTS AND LABORATORY ORGANIZATION

Relationship Between Management, Technical Operations, Support Services and the Quality System

Laboratory Organization

The corporate organization of the six ELI laboratories located in Montana (2), Wyoming (2), South Dakota, and Texas is shown in the Corporate Organizational Chart presented in the Introduction and given in Appendix D. The Billings laboratory is the center for all corporate functions. Each laboratory is managed and operated individually under the supervision of a Branch Manager. Branch laboratories have fiscal and QA/QC responsibilities to Corporate, as well as general operating policies and goals. Quality Assurance Manuals are prepared individually for each branch and follow the QA/QC program outlined in the ELI-Billings QA manual.

The ELI-Helena Organizational Chart is also included in Appendix D, with curricula vitae of key ELI-Helena laboratory personnel maintained in Appendix E of this manual. A Personnel Summary for all ELI employees listing title, academic background, and years of relevant experience is also maintained in the Corporate Qualifications Manual. Job descriptions can be found in the ELI SOP, *Roles and Responsibilities.*

Quality Assurance receives direct support from senior management. Branch Quality Assurance Managers report directly to the Corporate Quality Assurance Officer as well as the Branch Manager. Quality Assurance Managers provide independent oversight of Quality Systems within the overall Energy Laboratories structure. When Quality Assurance Managers fill more than one role within the organization, they operate independently of direct environmental data generation while fulfilling quality assurance responsibilities. Quality Assurance Managers facilitate development and maintain the branch Quality Assurance Manual, provide assistance to personnel on quality assurance / quality control issues, maintain a quality assurance training program, and reviews quality documentation including SOPs. For more information, see ELI SOP, *Roles and Responsibilities*.

Management ensures the development and implementation of programs and policies to continuously improve the effectiveness of ELI's QA Program and Management Systems. Management performs an annual review of the laboratory's Quality System (policies, procedures, work instructions) to assure their continuing suitability and effectiveness (See ELI SOP, *Management Review*, for detailed procedures). As appropriate, management identifies and implements any necessary changes or improvements. Corrective and preventive actions are detailed in a Corrective Action Report and filed with the QA Department. (Refer to ELI SOP, *Nonconformance Procedures and Corrective Action Reports*, for detailed procedures.) In addition, management performs meetings with supervisory and key staff members throughout the year. Supervisors and QA personnel provide input on their specific areas of responsibility and evaluate the following:

1) Client-Related Items
2) Internal and External Audit Reports
3) Proficiency Testing Results
4) Review of Performance by Department
5) Corrective and Preventive Actions
6) Personnel Training Needs
7) Quality System Policies and Procedures

8) Resources including Personnel, Equipment and Facilities

Laboratory Management Review findings are compiled into a summary report. The report includes deficiencies identified and areas for improvement. The QA department ensures items from the Management Review are tracked, including actions that must be addressed, assignment of parties responsible for the actions to be taken, and recommendations on improvements to the Quality System.

The Technical Director, Laboratory Manager, QA Manager or designee, shall assign specific persons to address management review findings and establish deadlines for their completion. The Technical Director, Laboratory Manager, QA Manager or designee, reviews and approves all documents issued to personnel in the laboratory as part of the management system. The Laboratory Manager, or designee, has overall responsibility for the technical operations of the laboratory. Work is stopped when identification of any of the following is made: unapproved departures from the management system, unauthorized deviations from the procedures for performing tests and/or calibrations, and data quality or data integrity issues. If changes are determined to be necessary, refer to SOP "Method Deviations." The Technical Director, Laboratory Manager, QA Manager, or designee, is responsible for providing authorization for the work to resume once the identified issue has been addressed.

Personnel Requirements

ELI maintains experienced staff and management. Below is a summary of the primary roles, responsibilities and qualifications for designated positions. Laboratory experience can be substituted for academic requirements. Detailed job descriptions can be found in ELI SOP, *Roles and Responsibilities.* Specific titles of employees are at the discretion of the Branch Manager.

Branch Manager

The Branch Manager is required to have education or experience equivalent to a Bachelor of Science degree in Chemistry or a related science. Five years of relevant laboratory experience is required.

The Branch Manager is responsible for all operations, client management, analysis scheduling, equipment acquisition, as well as compliance with all employment, safety, environmental, and NELAP/ISO 17025 regulations. The Branch Manager may delegate daily activities of these work aspects to appropriate personnel. The Branch Manager reports directly to the Corporate Operations Manager~~s~~. All Branch managers have both technical and management responsibilities.

Quality Assurance Manager

The Quality Assurance Manager is required to have education or experience equivalent to a Bachelor of Science degree in chemistry or a related science. Five years of relevant laboratory experience is required.

The Quality Assurance Manager is responsible for quality systems development, implementation, and management. The Quality Assurance Manager is also responsible for maintaining and improving compliance with all applicable state and federal regulations as well as maintaining compliance with NELAP/ISO 17025 regulations regarding Quality Systems. The QA program is implemented in cooperation with all levels of management and staff. Quality Assurance Managers report directly to the Corporate Quality Assurance Officer. The Branch Manager will direct daily laboratory-specific QA/QC requirements.

Technical Director

The Technical Director is required to have education or experience equivalent to a Bachelor of Science degree in chemistry or a related science. Five years of relevant laboratory experience is required.

The Technical Director is responsible for ensuring compliance with all laboratory policies and ensures that the analyses conducted under their supervision are compliant with all state, EPA, and NELAP/ISO17026 standards. The Technical Director reports directly to the Branch Manager.

Laboratory Supervisor

A Laboratory Supervisor is required to have education or experience equivalent to a Bachelor of Science degree in chemistry or related science. Two years of relevant laboratory experience is required.

Supervisors are responsible for ensuring compliance with all laboratory policies and ensure that the analyses conducted under their supervision are compliant with all state, EPA, and NELAP/ISO 17025 standards. They report directly to the Branch Manager.

Analysts

Laboratory Analysts are required to have a High School Diploma or equivalent and laboratory experience/training appropriate to the procedures they are performing. New analysts require a minimum of six months of on-the-job training, under direct supervision of a qualified analyst, in the measurements being considered for certification. After the initial training period, and on a continuing basis thereafter, the analyst must demonstrate acceptable skills through the successful participation in the analysis of applicable performance evaluation and quality control samples.

Laboratory Analysts perform the following duties: preparation of samples and reagents, analysis and preliminary data input, as well as various other tests. Laboratory Analysts are responsible for ensuring compliance with all laboratory policies and ensure that the analyses conducted under their work scope are compliant with all state, EPA and NELAP/ISO 17025 standards.

Laboratory Technicians

Laboratory Technicians are required to have a High School Diploma or equivalent. Laboratory Technicians work under the supervision of the primary analyst performing general laboratory tests.

Under the supervision of a primary analyst, Laboratory Technicians perform the following duties: preparation of samples and reagents, analysis, and preliminary data input, as well as various other tests.

Laboratory Technicians are responsible for ensuring compliance with all laboratory policies and ensure that the analyses conducted under their work scope are compliant with all state, EPA, and NELAP/ISO 17025 standards.

Approved Signatories

The following lists, by title, those individuals that are approved signatories for all laboratory policies and controlled documents at the Helena Branch of Energy Laboratories, Inc:

- Branch Manager

- Technical Director
- Quality Assurance Manager
- Corporate Quality Assurance Officer

A master list including signatures and initials for all employees is maintained for reference and signature verification.

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CHAPTER 5 – SAMPLING PROCEDURES

Private individuals or companies, who are responsible for using proper collection procedures, collect most of the samples processed in this laboratory. Members of the staff are acquainted with proper sample collection and handling procedures and will advise those who need help in this area. Instructions and forms for initiating the Chain-of-Custody are available from ELI. Laboratory procedures for logging in samples for analyses and maintaining Chain-of-Custody are described in ELI SOP, *Sample Receipt, Login, and Labeling*.

When the laboratory has been assigned the responsibility of sample collection, there is strict adherence to correct sampling protocols, initiation of chain-of-custody, sampling documentation, complete sample identification, and prompt transfer of sample(s) to the laboratory.

The laboratory provides proper sample containers and preservatives as specified for the procedure. Certified sample bottles may be ordered upon request. Sample containers, preservatives, coolers for shipping, resealable plastic bags for ice containment, trip blanks for monitoring contamination during shipping, chain-of-custody forms, chain-of-custody seals, sample bottle labels, instructions for sampling, sample labeling, sample preservation, and sample packaging/shipping are also provided upon request. Sample container type, sample volume, preservation requirements, and maximum holding times, are detailed for each analyte in the ELI Analytical Services and Fee Schedule. See ELI website, www.energylab.com for the current Technical Analytical Services and fee Schedule.

For metals analysis, polyethylene plastic with a polypropylene cap liner is preferred. Glass containers with Teflon-lined caps are required for most organic analysis. The client is immediately notified (if possible) upon sample receipt if there is any doubt concerning the sample's suitability for testing, including, but not limited to, when:

- Samples are received in unacceptable containers,
- Samples have not been properly preserved,
- Samples have labels or chain-of-custody procedures that are incomplete, or
- Samples cannot be analyzed within method recommended holding time,
- The custody seal has been broken.

Samples not collected or documented properly can be rejected for any regulatory-based analyses with re-sampling recommended. If re-sampling is not possible, or the client cannot be contacted, the sample is analyzed, and the documentation concerning the non-compliance is included in the data package.

The laboratory will preserve samples at the time of sample login if samples are unpreserved and preservation is required by the methodology. Aqueous samples for volatile analyses are checked for preservation at the time of analyses. Samples for microbiological analysis are collected in pre-sterilized 120 mL plastic bottles containing sodium thiosulfate.

Sample preservation needs to be performed immediately upon sample collection. For composite samples, each aliquot is preserved at collection. When use of an automated sampler makes it impossible to preserve each aliquot, sample integrity is maintained by preserving all samples to a $\leq$ 6°C temperature until compositing and sample splitting can be performed.

The laboratory initiates a sample condition report at the time of sample receipt. The sample condition report evaluates Chain-of-Custody procedures, sample preservation status, carrier used for sample shipment, sample receipt temperature, and provides general comments concerning sample condition.

The sample condition report is provided with the analytical data report package. For more information, see ELI SOP, *Sample Receipt, Login, and Labeling*.

When any sample is shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements as described in the ELI Analytical Services and Fee Schedule, the Office of Hazardous Materials, Material Transportation Bureau, and Department of Transportation has determined the Federal Hazardous Materials Regulations do not apply to the following:

A) Hydrochloric Acid - (HCl) in water solutions of 0.04 % by weight or less (pH of 1.96 or greater).
B) Nitric Acid - (HNO_3) in water solutions of 0.15 % by weight or less (pH of 1.62 or greater).
C) Sulfuric Acid - (H_2SO_4) in water solutions of 0.35% by weight or less (pH of 1.15 or greater).
D) Sodium Hydroxide - (NaOH) in water solutions of 0.080% by weight or less (pH of 12.30 or less).

It is required that all samples be analyzed within the prescribed holding times. Holding times are the maximum times allowed between sampling and analysis for results to still be considered valid. Samples should be delivered to the laboratory as soon as possible following collection to assure that holding times can be met. Samples are analyzed as soon as possible after sample receipt. When maximum holding times cannot be met, re-sampling is requested. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time or if a variance is allowed. Some samples may not be stable for the maximum time period as given in the ELI Analytical Services and Fee Schedule. A permittee or monitoring laboratory is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.

To ensure that drinking water analysis for radiochemistry are met, the requirements for sample handling, preservation, and instrumentation for radiochemical analysis are included in ELI SOP, “Sample Receipt, Log-In and Labeling”. (For additional information, refer to “Manual for the Certification of Laboratories Analyzing Drinking Water”, Table VI-2: Sample Handling, Preservation, and Instrumentation, EPA 5th Edition, January 2005).

CHAPTER 6 – SAMPLE HANDLING

The ELI Helena laboratory utilizes a sample tracking policy that includes client-initiated chain of custody. Upon receipt, the security of the samples is maintained by the implementation of the laboratory access and security policies. See ELI SOP, *Facility Description, Access and Security*.

Sample Receipt

All samples arriving at the laboratory are logged into the Laboratory Information Management System (LIMS). Each sample container is given a unique laboratory sample number. The sample receipt checklist evaluates Chain-of-Custody procedures, sample preservation status, carrier used for sample shipment, cooler temperature, and provides general comments concerning sample condition. The completed checklist is provided with the sample analyses results data package. Chain-of-Custody forms are checked for pertinent information. If necessary information has been omitted, the collector is notified, if possible, and the missing information is requested.

Samples requiring preservation are checked to determine if the client performed preservation. If requested, ELI staff will preserve or filter samples as appropriate. Samples that degrade quickly or cannot be opened (such as aqueous samples for volatiles) are not preserved at the time of sample login. If samples are improperly preserved, or the maximum holding times are exceeded upon arrival at the laboratory, the collector is notified and re-sampling is requested.

Samples are stored in accordance with method specifications in designated laboratory areas.

During sample login, all sample information such as sample description, client name and address, analyses requested, special requirements, etc. are entered into the computer database of the Laboratory Information Management System (LIMS). Requested analyses parameters and special requirements are communicated to the analysts via their LIMS work lists. Project-specific requirements are maintained in the LIMS for any samples received from a special project. This process ensures that individual requirements are maintained.

For more information, see ELI SOPs, *Sample Receipt, Login, and Labeling*, and *Shipping, Receiving, Storage*, and *Decontamination of Foreign and Regulated Domestic Soils*.

Chain-of-Custody

Evidence level internal chain-of-custody (COC) procedures are available on a project-specific basis. For these procedures, internal COC sample custody is maintained down to the individual analyst level. When transferring the possession of the samples, the transferee must sign and record the date and time on the chain-of-custody record. Every person who takes custody must fill in the appropriate section of the chain-of-custody record. When received by ELI, sample identification information on the sample containers is compared to the custody report form. The sample is inspected and information regarding the condition of the sample and seal (if used) is recorded on a report form; the method of shipping is also documented on the report form. A copy of the report form is kept with the sample data file and a copy is sent to the client with the analysis report. Internal chain-of-custody forms are used to document the progress of the sample through the laboratory. For details on ELI's chain of custody policy information, see ELI SOP, *Chain-of-Custody Samples*.

ELI's routine COC policy is maintained at the laboratory level through our laboratory access and security policies. See ELI SOP, *Facility Description, Access, and Security*.

Sample Tracking

Samples are tracked through the analytical process by the LIMS. Completed analyses, which have been approved by the appropriate data validator as valid data, are noted in the LIMS. When all analyses are completed, the data is reviewed as a whole to ensure results pass data checks and match with historical data if available. The completed report is then reviewed again and signed by an approved signatory. The signed report is sent to the client via requested delivery format. Electronic results are sent via email, EDD generator, and/or fax when requested by the client. Generation of the invoice automatically completes the work order in the LIMS and removes the samples and removes the samples from the status report printed by the LIMS. For more information, see ELI SOP, *Document and Record Management, Control and Archiving*.

Sample Disposal

It is preferred that excess hazardous sample material be returned to the originator (client) for disposal by the originator. When this is not possible or reasonable, ELI will dispose of excess hazardous sample materials with a waste disposal surcharge added to the cost of the analysis.

The disposal of all laboratory wastes will be performed in accordance with all local, state, and federal regulations that apply to such activities. Each method SOP addresses waste minimization and management specific to the method procedure. See ELI SOP, *General Laboratory Waste Disposal* for more information.

Subcontracting Policy

The ELI Helena laboratory utilizes the expanded branch laboratory capability and expertise to provide comprehensive analytical services. This occurs when the Helena laboratory is requested to perform an analysis outside of the laboratory's capabilities, (for example: during the peak season when sample overload is experienced, or when equipment is out of service). Upon completion of the analyses, the branch laboratories report the sample results, and their quality control package, to the primary laboratory. The results are reviewed before being reported to the clients.

Branch laboratories are certified to perform drinking water analyses in their individual and neighboring states. Samples are forwarded to our branch laboratories only if the laboratory is certified in the state from which the sample originated. Individual branch laboratory Quality Assurance Programs are consistent with the Corporate Quality Assurance Program and are monitored through internal laboratory audits.

To support Energy Laboratories, Inc. Helena's analytical services, ELI branch laboratories (which maintain specific instrumentation for specialized analysis) are utilized to provide complete analytical services. Refer to Appendix A for ELI's certificates detailing routine analyses that ELI performs.

In the event that ELI is dependent on the service of an outside laboratory for analyses not available through our facility or our branch laboratories, the client will be notified in advance that their samples are being subcontracted to an outside laboratory. The outside laboratory reports the results to ELI and these results become part of the final report. Any external or internal subcontracted analyses that require NELAP accreditation will be performed by a laboratory accredited for those parameters. All final reports indicate where the analyses were performed.

CHAPTER 7 – INSTRUMENT OPERATION AND CALIBRATION

Laboratory instruments and equipment are operated and calibrated according to the manufacturer's instructions and according to the requirements of the method being used. Exact calibration procedures are outlined in the appropriate SOP. For most instruments, a calibration curve composed of three to five standards covering the concentration range of the samples is prepared. The acceptance criteria for the calibration curves are listed in the individual methods. Unless otherwise specified in the method, at least one of the standards is at or below the practical quantitation limit (PQL) of the method. Routine PQLs for each method are given in the ELI Analytical Services and Fee Schedule. Calibration standards are routinely compared against second source calibration standards to verify accuracy. These second source standard results must fall within an established range, as described by the SOP, to be accepted. Whenever possible, the laboratory uses calibration standards prepared from certified stock standards. Initial instrument calibration curves are verified and routinely monitored by running a continuing calibration standard every 10 to 20 samples, and at the end of every analytical sequence, depending on the analysis method and instrumentation. High-level samples, which produce an analytical response outside the calibrated range of the instrument, are diluted or reduced in mass and re-analyzed until a response within the calibrated range is obtained and/or the result is appropriately qualified.

System cleanliness is verified through the analysis of reagent/instrument blanks prior to analysis, between highly contaminated samples, and at regular intervals during the analysis. Samples are only quantitated within the limits of the response of the standards.

Use of measuring equipment and reagents (glassware, water, chemical reagents, and industrial gases) conform to Good Laboratory Practice guidelines. Good Laboratory Practices (GLPs) are laboratory guidelines which were established by the Food and Drug Administration and published in the Federal Register (21 CFR, part 58). The GLP guidelines were adopted by the Environmental Protection Agency. ELI SOPs are developed in accordance with GLP and NELAP guidelines. Laboratory volumetric glassware conforms to American Society for Testing and Materials (ASTM) Class A standards. All mechanical pipettors are calibrated at least quarterly. Laboratory balances are serviced annually and calibrated by certified technicians. Routine calibration checks of all balances are performed using NIST traceable ASTM Type I weights. Laboratory thermometers are annually calibrated against an NIST traceable thermometer and routinely checked for accuracy. Laboratory drying ovens, incubators, freezers, refrigerators, and water bath temperatures are recorded each working day, or at frequencies as described in the specific SOP. Laboratory pure water is generated by commercial water purification systems, to specifications needed for applicable methods, and is monitored and documented each working day. The routine analyses of laboratory blanks are used to verify laboratory water quality and the suitability of sampling containers. Chemical reagents and gases exceed purity requirements for their intended uses. Laboratory stock and working standards are derived from ISO 17025 and/or 9001 (or equivalent-certified), commercially available primary standards whenever possible. Standard preparation notebooks document the source, purity, content, concentration, preparation date, and analyst. All calibration standards are documented in the analytical sequence such that they are uniquely identifiable and traceable to stock standards and their source.

Standard Operating Procedures (SOPs) detail the sequence of operations involved in instrument start-up, calibration, analyzing, shutting down, and routine maintenance. Suggestions for corrective action are included with the SOPs and parameters are identified which dictate certain types of maintenance. Instrument and method detection limits are performed at the method-required frequency or whenever there is a significant change in instrumentation. Method detection limits are determined according to EPA guidelines found in 40 CFR, part 136, Appendix B. 40 CFR, Part 141.25 (c) is utilized to calculate the Minimum Detectable Concentration (MDC) for radiochemistry samples (except for the few methods that are not amenable to MDLs). Refer to ELI's Analytical Services and Fee Schedule for practical

quantitation limits. Acceptable instrument response/performance criteria are based upon the manufacturers or the analytical method specifications. SOPs exist for all major pieces of analytical equipment/methods.

Instrument logbooks are used to document instrument maintenance and repairs. Instruments that are no longer being utilized are documented in the applicable instrument maintenance logbook as “out-of-service” with the date the instrument was taken out of use noted. All out-of-service instruments are labeled with an out-of-service tag that identifies the effective date the instrument was retired and put out of use.

All instrumental run sequences are documented. Laboratory analysts record and document all instrumental runs in Laboratory Instrument Logbooks or computer files. Instrument Logbooks and/or dated computer files record instrument performance data, analytical sequences, instrument maintenance, calibration standards data, and any other additional information pertinent to operation of the instrument.

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CHAPTER 8 – RECORDS AND REPORTING

Document Management

Energy Laboratories Inc. manages three types of documents: 1) controlled, 2) approved, and 3) obsolete.

A CONTROLLED document is one that is uniquely identified, issued, tracked, and kept current as part of the Quality System. Controlled documents may be internal documents or external documents. A list of ELI's controlled documents is listed in Appendix B. All ELI controlled documents are written and reviewed by personnel technically competent to perform that procedure and approved for use by the Branch Manager as well as the Quality Assurance Manager.

APPROVED documents have been reviewed, signed and dated by the technical reviewer, the Quality Assurance Manager and the Branch Manager.

OBSOLETE documents are documents that have been superseded by more recent versions. Obsolete documents are retained for legal use or historical knowledge preservation. Old or archived SOPs are available for review using the laboratory's electronic document system. ELI's OBSOLETE document records are maintained for at least ten years.

Documents are reviewed on an annual basis to ensure their contents are suitable and in compliance with the current quality systems requirements, and accurately describe current operations. SOPs include a Record of Review/Revision page, which details revisions or reviews. The branch Quality Assurance Manager maintains a master list of controlled documents (which include title, author, revision number, and date of issue).

Procedures for identification, collection, access, filing, storage, and disposal of records are found in ELI SOP, *Document and Record Management Control and Archiving*.

Laboratory Notebooks

Several different types of laboratory notebooks are maintained at the ELI Laboratory. These include, but are not limited to, the following:

- Method/Parameter Notebooks
- Project Notebooks
- Instrument/Equipment Use and Maintenance Notebooks
- Standard Preparation Logbooks
- Balance Calibration Logbooks
- Pipette Calibration Logbooks
- General Logbooks

The general purpose of maintaining each of these Laboratory Notebooks is to record the details that may be important in repeating a procedure, interpreting data, or documenting certain operations. Entries in the notebook may include data such as standard and sample weights, pH measurements, instrument operating parameters, preparation of calibration curves, analytical run sequences, calculations, recording of instrument operating parameters, sample condition, etc. The analyst's notebook is particularly important in documenting analyses that deviate in any way from routine or standard practices. It can also be an important training record. All pertinent data is to be recorded directly in the notebook. Some notebooks or data records are maintained in electronic files (LIMS,

spreadsheets, or databases). Electronic data records are duplicated using hardcopy and/or alternate electronic backup techniques such as magnetic tape.

It is the responsibility of each analyst to maintain a laboratory notebook according to Good Laboratory Practices (GLP) Guidelines. All laboratory notebooks are assigned a unique logbook control # and are assigned to an analyst or supervisor. Laboratory notebooks will remain the responsibility of the ELI staff member to whom they are assigned until, or unless, they are formally transferred to another staff member, until they are completely filled and returned to the ELI Quality Assurance Department for archiving, or until the staff member resigns and returns them as a part of the check-out process. ELI staff members, other than the individual to whom the laboratory notebook is issued to, may make entries in the notebook as long as those entries are consistent with the intended use of the notebook, and such entries are initialed. Supervisors review and approve all Laboratory notebook formats. Procedures for use and maintenance of laboratory notebooks are detailed in ELI SOP, *Procurement, Usage and Archiving of Laboratory Notebooks*.

Records

The laboratory keeps records of chemical analyses, including all quality control records, for a minimum of ten years. In the event that Energy Laboratories, Inc, or any individual laboratory transfers ownership or goes out of business, the records will be transferred to the new owners. If a branch laboratory is closed, records will be maintained by Energy Laboratories, Inc. corporate office in Billings, Montana. Energy Laboratories, Inc. reserves the right to offer the records to the client in the event of complete closure. Details are described in ELI SOP, *Document and Record Management, Control and Archiving*.

Data Reduction

Data reduction refers to the process of converting raw data to reportable units. The reporting units used and analytical methods performed are described in the ELI Analytical Services and Fee Schedule.

Wherever possible, the instrument is calibrated to read out directly in the units reported. In this case, the value is recorded directly into a laboratory notebook, logbook, bench sheet, or electronic file and presented for review by supervision.

In cases such as titration, gravimetric measurements, or other techniques that require calculation prior to reporting, raw data is recorded in the appropriate laboratory notebook or electronic file, or on the appropriate laboratory form. The calculations specified in the EPA method are used to determine the reported value. That value is also entered into the laboratory notebook or bench sheet, and on the draft of the client report. Most of the calculations are computerized to reduce the chance of arithmetic or transcription errors.

Wherever possible, electronic data results are transmitted throughout the laboratory via the LIMS computer network. This process is intended to minimize manual data transcriptions within the laboratory. Additional advantages include the opportunity for rapid comprehensive data validation by supervisors, and more rapid data reporting.

Validation

Data validation includes the procedures used to ensure that the reported values are consistent with the raw data, calculated values, sample type, sample history, and other analyses parameters requested.

The data recorded on the draft report is validated with several steps. The analyst who submits the analytical results checks all the values reported for omissions and accuracy. Elements of this review

also evaluate all instrument and method QC results. Automated data management programs are designed with an interactive step allowing data review by the analyst. Results to be reported are approved by the analyst.

The reported result and associated QC data is reviewed by the supervisor, data validator, project managers or designated reporting staff. The report is reviewed for the suitability of the data according to project and method performance specifications. Analytical results for each requested parameter are evaluated against other requested parameters, project specifications, other samples within the set, historical files associated with the project/client, and any other information provided with the sample. The review is completed and documented by approved data validators.

The reports are generated, proofread, and reviewed by designated reporting staff.

The laboratory manager, project managers, supervisors, or their designee, also examine the validity of the data when reviewing the final report.

Internal and external laboratory audits review selected sets of data to ensure that the analysis results are correct and accurate, analytical methods are appropriate, documentation and record keeping procedures complete, and that overall objectives of the Quality Assurance Program are adhered to. At least annually, an in-depth monitoring of data integrity is performed per analytical method.

All automated programs used to process and report data are verified using hand-calculated results. Whenever a modification is performed to a program, re-verification of overall software function is performed.

During each of the above-mentioned review steps, the data is examined for outliers; data that falls outside of established limits. If an outlier is observed at any point in the review process, the analyst/reviewer must take action to investigate and/or correct the cause. Actions to correct these causes may include, but are not limited to, inspection of the instrumentation, checking calibrations, checking sample numbers or dilutions, rerunning samples or calibrations. When it is determined that the sample may need to be reported as analyzed, LIMS flags any QC data that is outside of the established limits for a given parameter. The flags as well as any other accompanying comments are considered the qualifiers for the data that falls outside expected or reasonable limits.

Reporting

One copy of the report is distributed to the client via requested delivery format after the report is validated and signed. A standardized report format is used unless otherwise specified. Client-specified report formats are available upon request. Electronic results are sent via diskette, email, EDD generator, website FTP, and/or fax when requested by the client. Electronic reporting is followed with a hardcopy of final results when requested by the client, with the exception of Level IV reporting, which is typically sent on a disk due to volume. Energy Laboratories, Inc. offers its clients a paperless tracking system.

Various levels of data reporting are available. All analytical results, regardless of the level of reporting used, have record keeping procedures which allow a complete "data validation package" to be produced. Note that a comprehensive "data validation package" is most easily generated at the time of sample analysis. Example data packages are available upon request.

Safe Drinking Water Act (SDWA) compliance monitoring samples for microbiological and chemistry samples that exceed the SDWA maximum contaminant level (MCL) may require notification to the appropriate state agencies. This process is detailed in the laboratory reporting section of ELI SOP,

Report Generation and Review. Generally, notification to the client, and to the state, of any SDWA MCL exceedance must be made immediately on the same day of analyses, or by noon the next business day. If requested by the client, additional copies of the report will be sent to a specified address or person.

The final copy of a completed report is maintained in an electronic format. An electronic copy of this file is available upon request. Energy Source is a client resource of ELI that provides secure online access for clients to view their data and documents. Clients are able to access their electronic files through ELI's secure website at https://energysource.energylab.com/. For more information, see ELI SOP, *Document and Record Management, Control and Archiving*.

In addition to traditional ink signatures, Energy Laboratories has approved the use of electronic signatures within our company-produced PDF documents. When an individual within Energy Laboratories electronically signs a document:

- The identity of the signer is encoded into the document by means of an encrypted electronic "certificate" immediately attached by Energy Laboratories' computer system. The certificate provides a guarantee that the specified Energy Laboratories employee produced the signature.

- The individual's electronic signature is password protected by that person within Energy Laboratories' computer system and can therefore only be produced by that person.

- The date and time of the signature is encoded into the document at the time of its signing by means of another electronic certificate produced by an independent third party organization sponsored by SecureSoft. This time stamp certificate ensures that the date and time associated with the signature are accurate and defensible.

- An electronic "fingerprint" of the document is automatically imbedded within it, which thereby thwarts any future attempts to make unauthorized changes.

- All aspects of the individual's electronic signature are encrypted to prevent unauthorized tampering.

Electronic signatures verify that the document has not changed after it was produced. Upon opening the document, notifications automatically display to inform the recipient of the validity of the sender's electronic signature and all included certificates. Should any changes be detected, an alert message is automatically displayed, noting that the signatures cannot be validated due to changes made to the document.

Detailed instructions on how to view or validate electronic signatures are available to our clients on the ELI website at: http://www.energylab.com/DigitalSignature.aspx.

CHAPTER 9 – GENERAL LABORATORY PRACTICES

Chemicals and Reagents

When available and appropriate, chemicals used in the laboratory are analytical reagent grade (AR) chemicals purchased from reliable suppliers. Reagents are prepared, standardized, and made fresh as mandated by the method, their stability, and according to Good Laboratory Practices. Procedures for purchasing of materials may be found in ELI SOP, *Property Procurement, Inventory, and Control*.

Normalized standards are checked regularly against independently prepared reference materials.

All standards and reagents are dated when received, opened, or prepared, and each are labeled with expiration dates when applicable.

Standards and reagents are checked for discoloration or signs of degradation and are discarded if these are observed.

Certified primary standards are obtained from commercial sources when available. Standards used for calibration are verified against second source standards. Secondary and working standards are accurately prepared in volumetric flasks, or other calibrated glassware, from primary standards and stored in appropriate containers.

ELI Helena has determined 5 years to be a reasonable expiration date for stable salts where the manufacturer does not supply such information.

Titrants, standards, and other solutions used for analytical purposes frequently must be standardized upon preparation with certified or traceable standards. Method SOPs specify if standardization is necessary. The date and analyst's initials must be recorded on the container whenever re-standardized and records are maintained in a laboratory notebook or in the LIMS.

Individual SOPs may also provide additional details for reagent requirements.

Reagent Interference

To determine the extent of reagent interference, method blanks are analyzed prior to sample analysis whenever appropriate.

If any interference cannot be eliminated, the magnitude of the interference is considered when calculating the concentration of the specific constituent in the sample, but only when permitted within the method being used.

If reagents, materials, or solvents contain substances that interfere with a particular determination, they are replaced.

Individual method SOPs may also provide additional requirements for handling reagent interferences.

Glassware Preparation

All glassware used for inorganic and radiochemical analyses is washed in warm detergent solution and thoroughly rinsed in tap water. Glassware is then rinsed well three times with laboratory-purified water. This cleaning procedure is sufficient for many analytical needs, but individual SOPs detail additional

procedures when necessary. Glassware washing procedures for inorganic analysis are described in ELI SOP, *Cleaning of Glassware Used in Inorganic Analyte Sample Preparation and Analysis*.

All glassware used for organic analyses is washed in warm synthetic detergent solution and thoroughly rinsed in tap water. The glassware is then rinsed well with laboratory-purified water, followed by rinses with acetone to remove any residual organics. Prior to use, the glassware is rinsed three times with the organic solvent to be used with the glassware. Glassware washing procedures for cleaning glassware for organic analysis are described in ELI SOP, Cleaning of Glassware Used in Volatile and Semivolatile Analyte Sample Preparation and Analysis.

All glassware used for microbiological analyses is washed in warm detergent solution. The detergent must be proven to contain no bacteriostatic or inhibiting substances. The glassware is rinsed thoroughly with laboratory-purified water. Specific details are described in SOPs.

Disposable, sterilized glassware/plasticware is preferred for many procedures in the laboratory. The cleanliness, and suitability of disposable glassware/plasticware is continuously evaluated for each test with the routine analyses of method blanks.

All volumetric glassware used in precise measurements of volume is class A or laboratory calibrated.

Laboratory Pure Water

Laboratory-purified water is used in the laboratory for dilution, preparation of reagent solutions and final rinsing of glassware. For organic analyses, organic-free water is prepared and used. Energy Laboratories, Inc. uses water purification systems that are designed to produce deionized water that meets the requirements of the methods.

Water quality is monitored for acceptability in the procedure in which it is used. Specific details are listed in the appropriate SOPs.

Employee Training

All new ELI employees and contract personnel are given an initial general orientation and tour of the laboratory facilities. Personnel are shown the locations of safety equipment such as safety showers, eye wash fountains, fire extinguishers, and first aid supplies. Personal protective equipment such as lab coats, disposable gloves, and safety glasses (if applicable) are issued at this time.

Safety considerations are a vital part of the training process. All hazards associated with the performance of a procedure or with the operation of an instrument are to be understood by the trainee before training can be considered complete. General laboratory safety procedures are a part of the new and current employee training. Specific safety procedures are outlined in SOPs and in instrument Operator's Manuals. Training in use of protective clothing, eye protection, ventilation, and general safety are provided to each employee. Each employee is required to read the Laboratory Safety Manual & Chemical Hygiene Plan.

All new and existing employees must demonstrate capability prior to performing an analytical procedure independently (See Chapter 1). Method performance on Quality Control Samples is used to document employee training and work quality. Employees are required to read the Quality Assurance Manual and all appropriate SOPs. Employees also are required to sign a Quality Assurance Manual Acknowledgement form, kept with the Quality Assurance Manual, which states that they have read, understood, and will comply with the requirements of the Quality Assurance Manual. Employees also are required to sign, for all applicable SOPs, a Record of Acknowledgement Form that states they have

read and understood and agree to follow the SOP. In the case of method SOPs, the employees sign a Record of Acknowledgment form that states that they have read, understand, and will follow the SOP using the latest method technology. All Record of Acknowledgement forms for all SOPs are kept with the current SOP as an attachment.

Employees also receive training on general laboratory policies including ethics and conflict of interest. Data integrity training is provided for all employees initially upon hire and annually thereafter. All employees are required to read, understand and comply with ELI's Corporate "Compliance & Ethics Manual." In addition to the Corporate Compliance & Ethics Manual, the ELI Quality Assurance department maintains a Laboratory Ethics & Data Integrity Manual, which supplements the corporate manual and provides specific training on data integrity. An annual Ethics training course is given to all laboratory employees. Attendance is required and is recorded with a signature attendance sheet or other form of documentation that demonstrates all staff has participated and understands their obligations related to data integrity and ethical policies. For details pertaining to ethics training and additional ethical procedures and policies refer to ELI SOPs, *Ethical Policy Statements* and *Personnel Training and Training Records*.

ELI encourages attendance at courses, workshops and other forms of continuing education available from on-site seminars, private institutions, local schools, and State and Federal regulatory agencies. Staff and department meetings are held routinely to communicate company policies and procedures. All training on procedures and policies is documented per NELAP guidelines in employee training files. For more information see ELI SOP, *Personnel Training and Training Records*.

Data Integrity

In order to ensure data integrity, the laboratory performs in-depth periodic monitoring of data integrity through internal and external audits, which are documented and maintained by the QA Department.

For all data involving the LIMS network,

- All employees are given unique username and password combinations to access the LIMS network
- Passwords are required to be changed on a regular basis.
- All data are electronically tracked to indicate any changes to the data.
- All data are backed up on magnetic tape per ELI SOP, *Computer Security, Backup & Storage*.
- Prior to releasing the data to the client, all data may be reviewed by any or all of the following:
    - The analyst,
    - The section supervisor,
    - The data validators,
    - The technical review staff,
    - The project managers,
    - The laboratory manager, or his designee.

Standard Operating Procedures

All routine laboratory operations and procedures are documented in Standard Operating Procedures (SOPs). SOPs are written to provide a reference that specifically defines requirements for routine procedures to ensure consistent, safe, and efficient laboratory operations are possible. For analytical methods, SOPs provide information on the details of the analyses that are not specified in a published analytical method. For routine procedures other than analytical methods, SOPs define the steps required in accomplishing a given task. All SOPs are reviewed periodically to assure that they reflect any changes in laboratory operations. Method SOPs follow NELAP requirements. For more

information on generation and distribution of SOPs, see ELI SOP, *Preparation, Numbering, Use, and Revision of Standard Operating Procedures*.

Client Confidentiality

Each employee has the responsibility to maintain confidentiality in all matters pertaining to our clients, samples submitted, and Energy Laboratories, Inc. Information obtained during employment with this laboratory regarding the specific business of this laboratory or its clients shall at no time be revealed to any outside sources without permission from the owner of the data.

Sample submittal, analysis and the report contents are considered confidential information of the client. When requested to provide results (either in person, via telephone or email), the employees shall verify that the requestor is either the person associated with the project, on the COC, or on a list provided by the client who are authorized to receive data. If a person who is not associated with the project personnel (or is not on the approved list), the base client will be contacted to inquire about authorization to release data. This contact will be documented in the work order comments section of the LIMS system to provide archival proof of authorization to release data. If the client does not authorize a release of data, the requestor will be contacted and told of this decision.

Client confidentiality is maintained electronically through the use of password-protected logins on all laboratory computer systems. Additionally, the laboratory maintains network security such as anti-virus programs and firewalls that prevent any unauthorized outside access. All copies of the original report are stored on the laboratory's optical scan system, which is also protected from unauthorized use by the network security systems. Backup media of all raw data, reports, and LIMS records are kept in an environmentally appropriate case (i.e. – fireproof) at a secure location of the laboratory. For more information, see ELI SOP, *Laboratory Policies*.

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CHAPTER 10 – QUALITY CONTROL MONITORING

Routine Monitoring

Temperatures of incubators, water baths, refrigerators, ovens and the DAC View are checked and recorded according to a prescribed schedule.

All pH meters are calibrated against reference standards. Calibrations are noted in laboratory notebooks.

Conductivity of the laboratory-purified water is monitored daily.

Reagents are dated and initialed at the time of receipt. Expirations dates are assigned as a fundamental component of their receipt and/or preparation. Reagents are not used after recommended shelf life is exceeded.

Balances are checked daily against NIST traceable Class I weights and are calibrated and serviced by certified technicians annually.

SOPs are reviewed annually for accuracy.

Laboratory Notebooks are reviewed periodically for correctness and accuracy by supervisors.

Performance Evaluation Samples are analyzed as required (See Chapter Two of this QA Manual).

Quality Control Check Samples are analyzed with each analytical batch.

Internal and External audits are performed as specified or requested (See Chapter Two of this QA Manual for additional discussion).

Additional monitoring requirements may also be specified in individual SOPs.

The Laboratory maintains an active fraud protection program that is implemented through the laboratory ethics policy. Additionally, the potential of fraud is monitored through analyst supervision, management supervision, regular internal audits, PT study participation, and an active quality assurance program.

Instruments/Method

Calibration is performed as required by the analytical method or SOP (See Chapter Seven of this QA Manual).

Depending on method requirements, the standard curve is verified with a known second source reference sample. The reference sample results must fall within the appropriate target range for the calibration to be accepted.

In most cases, the calibration is checked by running a continuing calibration standard every 10 to 20 samples, depending on the analysis and instrumentation. The verification standard results must fall within an established range as described by the SOP.

All laboratory instruments are subjected to preventive maintenance schedules. Preventive maintenance schedules are specified in instrument maintenance logbooks.

As appropriate, instrument and/or method detection limits are determined annually, or more frequently if changes in instrument performance are noted or per method requirements. Procedures for the determination of instrument detection and method detection limits are described in ELI SOP, *Determination of Method Detection Limits (MDL) and Quantitation Limits*.

Precision and accuracy requirements for each method are specified in the SOPs. General guidelines are given below.

- Each analytical batch will contain QC samples to measure the accuracy of the method. Each QC sample result is monitored to be within QC specifications of the method. Results of blank spiked sample analysis must be within the established control limits. Quality Control Limits are specified in the SOPs and meet recommended QC limits as described in the referenced method.

- Each sample analyses batch will contain QC samples to measure the precision of the method. (See Chapter One for discussion on duplicate sample analyses.) Criteria for duplicate sample acceptance are found in the SOP and are generally taken from the referenced method.

- Each sample analyses batch will contain QC samples to measure the performance of the method on the sample matrix. These are typically identified as a matrix spike analyses and are often done in duplicate to assess method precision. Typically the sample is fortified with a known amount of target analyte and spike recoveries are calculated. Results outside of method QC guidance are flagged. Quality control limits and appropriate corrective actions steps are specified in the method SOP.

- Several methods are considered to be concurrent methods in that they are either nearly identical or are identical to a method with a different citation. For example, even if two methodologies are identical in procedure, there might be slight differences in the QC requirements. These types of methods may also be considered "concurrent" if the procedures are identical and the more stringent of the two method criteria are used. During data reduction and reporting, the referenced method specifications and criteria will always take priority. The following methodology sets are considered concurrent methodologies: Methods 245.1, 7470A and SM3112B; Methods 200.7 and 6010B; Methods 200.8 and 6020; Methods 415.1 and SM5310B; Methods 415.2 and SM5310C. Other procedurally equivalent methods may be combined into a common single analytical procedure as well.

As appropriate, the performances of QC sample results are evaluated with Quality Control Charts. Suitability of existing QC limits is evaluated and possibly adjusted, but not to exceed method specification.

CHAPTER 11 – CORRECTIVE ACTION

When quality control checks indicate that an analysis is not within the established control limits, corrective action is needed. This section gives general guidelines for corrective action. Corrective actions for each method or instrument are detailed in individual SOPs. Records are maintained of non-conformances requiring corrective action to show that the root cause(s) was investigated, and includes the results of the investigation. The QA Manager monitors implementation and documentation of the corrective action to assure that the corrective actions were effective.

Method QC samples that fail to fall within QC control limits may be analyzed again to verify if a problem exists. However, matrix spike or matrix spike duplicate QC samples may not be re-analyzed if the performance can be attributed to matrix effects; data results are then reported and flagged. If the repeat analysis is not within control limits, the particular instrument or procedure is checked according to the specific protocols outlined in the method or according to the instrument manufacturer's guidelines. Once results are within control limits, analysis of all samples that were analyzed while the procedure was out of control are repeated, i.e., all analyses are repeated back to the previous acceptable control sample. In the case of radiochemical analyses, the term “analyze again” means to recount the final, prepared sample again. If the analyst is unable to achieve acceptable results after following the corrective action guidelines detailed in the SOP, supervision is consulted. If necessary, the appropriate service personnel are contacted if the problem is determined to be due to instrument error, and cannot be resolved. It is also possible that the result is due to statistical variation of the results based on the tolerable error rate that has been determined for the analysis (usually 0.05). In certain cases, where control limits are exceeded, it is possible that problems cannot be corrected to satisfy QC criteria. This could be due to problems such as matrix interference, instrument problems, lack of sufficient sample, missed holding times, high blank contamination, etc. If all possible solutions available to correct the problem are examined and the sample results are still considered valid, qualifying comments are attached to the sample report describing the non-compliance to QC and probable cause.

In the case of a single radiochemistry detector being returned to service, this refers only to the samples counted on that detector. For example, an individual gas proportional counter instrument may have up to 16 detectors; if only one does not pass the QC check the others are still valid and sample analyses performed on the others do NOT need to be repeated.

In the event that a QC audit or other informational review shows an analysis report to be incorrect, incomplete, or adversely compromised, a written corrected report and explanation is submitted to the client within ten business days. The report will clearly be identified as a revised report. As appropriate, an explanation submitted to the client should give a detailed review of the problem and document any unapproved deviations from the regulations, standard operating procedures, or project specific scope of work that may have caused it. The explanation to the client shall include, but not be limited to, the following components:

What actions have been taken regarding the affected data set(s),
Identification of the cause, and
Corrective action(s) taken to prevent future occurrence.

In the event that a QC check fails, the analyst will follow the procedures outlined in the QA/QC summary of the SOP. The analyst will document the steps taken to resolve the QC problem in the logbook for the instrument or method were the QC check failed.

Quality Control Checks for each method or instrument may vary. Energy Laboratories Inc. follows the QC checks set by each governing method. Due to the wide variations between methods, specifics are

listed within each SOP for the given method. Please reference the SOP for specific QC checks for the given method. The QC checks may include: ICV, MB, CCV, CCB, LCS, LCDS, LOD, MS, MSD or others specific to that method.

The following table lists the minimum actions to be taken upon discovery of a QC sample failure. The purpose of this table is not to supersede the actions stipulated in the method SOP or the Method criteria. This table provides general guidance as to what the minimum action is required for each QC type.

QA Indicator	Frequency	Acceptance Criteria	Corrective Action For Failure	Comments
ICV	At the beginning of the run, immediately after the ICAL.	Usually ± 10%. Method Dependent. Some methods have more stringent criteria.	**Option 1** – Re-analyze the ICV. **Option 2** – Stop run and re-calibrate the instrument.	Evaluates calibration accuracy and method performance. Must be prepared from Second source standard. Know and follow any method specifications regarding the ICV.
CCV	At the beginning of run, and every ten samples. Must have a closing CCV at the end of the run.	Typically ± 10% recovery. Very method dependent. See SOP & Method.	**Option 1** – Immediately re-run CCV upon failure. **Option 2** –Invalidate all samples not bracketed by passing CCVs, recalibrate, and re-analyze all invalidated samples.	Evaluates instrument drift throughout analytical sequence. Typically uses midpoint calibration standard or ICV. Know and follow any method specifications regarding the CCV.
CCB	Every ten samples after CCV.	CCB< PQL	**Option 1** – Stop run, invalidate all samples not bracketed by passing CCBs. Re-calibrate and re-analyze samples.	Evaluates baseline drift, contamination in the analytical system, and analyte carryover. Know and follow any method specifications regarding the CCB.
LCS	One per sample batch of 20, or less if tighter criteria specified in the published method.	Typically ± 10% recovery. Very method dependent.	**Option 1** – Re-analyze LCS for recovery. **Option 2** – Stop run, recalibrate, re-extract and re-analyze all samples.	Evaluates overall method accuracy/bias for the Preparatory Batch. Know and follow any method specifications regarding the LCS.
MS	One per sample batch of 20, or less if tighter criteria specified in the published method	Typically ± 30% recovery. Very method dependent.	**Option 1** - Report Spike as Analyzed. LCS/LFB must be passing. Flag sample for possible matrix effects. **Option 2** – Re-analyze MS/MSD, only if there was an error making the MS, for either recovery or RPD failure.	Evaluates effect of matrix on method performance. Know and follow any method specifications regarding the MS.
MSD	One per sample batch of 20, or less if tighter criteria specified in the published method.	Typically ± 30% Recovery. Very method dependent. 10-30% RPD –Check method for exact specifications.	Same as for MS.	MSD also evaluates method precision. Know and follow any method specifications regarding the MSD.
MBLK	One per sample batch of 20, or less if tighter criteria specified in the	MBLK<PQL	**Option 1** – Re-analyze the entire run. All organic runs with blank detections	Evaluates overall method including possible contamination in reagents and

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	published method.		must be re-analyzed. **Option 2** – Flag data on report as having compound in blank.	glassware utilized in preparatory batch. Know and follow any method specifications regarding the MBLK.
DUP	One per sample batch of 20, or less if tighter criteria specified in the published method. (The DUP can be satisfied by a MS/MSD)	10-30% RPD –Check method for exact specifications.	**Option 1** – Re-analyze sample. **Option 2** – Flag analysis as having a failing DUP RPD for reporting.	Evaluates method precision. MSD duplicate analyses preferred on some methods.

Essential Quality Control Elements for Radiochemistry			
Item	**Frequency**	**Acceptance Criteria**	**Corrective action**
Negative Control (Method Blank)	1/batch	Based on control chart	Qualify data and take corrective action
Positive Control (Laboratory Control Sample)	1/batch	Method specific or based on EPA Certification Manual	Reprocess, re-analyze, or qualify data.
Matrix Spike; Matrix Spike Duplicates	Per method requirement	Based on control chart	Corrective action and qualify data.
Negative Control (Instrument Background)	Daily	Based on control chart	Qualify data and take corrective action
Positive Control (Detector Efficiency)	Daily	Based on control chart	Qualify data and take corrective action
Continuing Calibration Verification	Per method requirement	Method specific or Based on control chart	Re-analyze standard immediately; and take corrective action

Deviation from any of the method or general criteria shall be thoroughly documented in all appropriate notebooks, run logs and particularly, the case narrative. Deviations from these acceptance criteria must have the approval of the Quality Assurance Manager/Officer, the area supervisor and the laboratory manager.

Procedure for Dealing with Complaints

DEFINITIONS

Complaint: For the purposes of this procedure, a complaint comes from a client, a user of our data, or employee. The complaint might cover issues about the quality of our data, sample turnaround time, method used, pricing, or other expectations.

Client: The client is the person or company that ordered and paid for the services. This is the person that a sample is logged in or filed under.

Procedure: The staff person receiving the complaint exercises judgment in deciding the severity and disposition of every complaint. The judgment must be used to decide whom, if anyone, is alerted to the complaint and what actions are appropriate. The complaint issued should be handled with a high degree of discretion and tact by the supervisor or manager involved. The individual handling the complaint is instructed to follow ELI's guidelines provided in this section on how to handle the complaint. This involves listening to the client and getting adequate information so the complaint can be investigated and resolved. The appropriate laboratory staff is notified and a solution to the problem, as well as a timeline for action, is given.

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After the complaint is investigated or resolved, as necessary, the client is made aware of the results and determination is made as to what further actions are needed. Complaints and investigations may result in the need to submit a revised report or invoice. Complaints that are straightforward and can be resolved using the resources available to the person handling the complaint should be resolved there. These include such things as minor revisions of reports or invoices. If other decisions need to be made, the appropriate person should be contacted.

It may be appropriate to initiate or prepare a non-compliance report. This report should be completed with the intention of informing the affected staff about the problem so that we can all learn from it, change our procedures and improve our service. A procedure to document non-compliance reports is documented in ELI SOP, *Nonconformance Procedures And Corrective/Preventive Action Reports*.

If the complaint is generated from a former or current employee, the matter should first be brought to the attention of their department supervisor. The supervisor shall document the complaint in memo form, determine if immediate participation of higher management is necessary and resolve to the best of their ability the issue that generated the complaint. Employees are encouraged to issue complaints regarding Quality Systems, unethical behavior, and/or financial mismanagement. If the employee is uncomfortable with approaching their supervisor with the complaint or feel that the issue was not properly dealt with by their supervisor, the employee may approach higher levels of management with their complaint issue.

Energy Laboratories, Inc., has also implemented a program to facilitate confidential reporting to upper management. This tool allows employees, customers, vendors, auditors and other interested parties to report situations or behaviors that they consider to be unethical, immoral, or improper. It also allows the reporting of suggestions or comments. The program has been implemented at ELI so that anyone reporting a situation can be assured that there will not be retaliation for reporting. It is meant to encourage parties to communicate with upper management when there appears to be no alternative for resolving the types of issues already described. There are currently four different options to utilize the program. Accessing the program is available via the ELI's company website (www.energylab.com using the "Contact ELI" ALERT ELI tab), the public website (energylaboratories.alertline.com) as well as a 24-hour telephone hotline number (877-874-8416).

Penalty for Improper, Unethical or Illegal Actions

Energy Laboratories, Inc. employees are expected to work in an ethical, proper, and legal manner. They are expected to perform laboratory analyses according to the cited method(s) and in conjunction with the SOP and the Quality Assurance Plan. Employees are expected and required to report any violations of this policy. All employees are mandated to participate in a written ethics-training program as part of their orientation upon hire.

Improper, unethical, or illegal activities by an employee will be addressed on a case-by-case basis as determined by the seriousness of the offense. Corrective actions may include disciplinary action up to and including discharge.

CHAPTER 12 – MAJOR EQUIPMENT AND METHODS

The table below is a summarized listing of major instrumentation utilized in the laboratory. See attached State of Montana certificate in Appendix A for a complete list of accredited methods and analytes that ELI-Helena performs to support SDWA, RCRA and CWA regulated methods. Refer to the ELI Analytical Services Pricing Guide, located on the ELI website www.energylab.com, for a list of all methods and analyte parameters that Energy Laboratories, Inc. performs.

Energy Laboratories, Inc-Helena, MT

Equipment	Quantity	Methods
Gas Chromatograph-FID with auto sampler	2	DRO, EPH (Mass. Method), TPH as Diesel
Gas Chromatograph-PID/FID with purge and trap and auto sampler	2	GRO, VPH (Mass. Method), TPH as Gasoline, 602, 8020
Gas Chromatograph-Mass Spectrometer with purge and trap and auto sampler	1	524, 624, 8260
Gas Chromatograph-Mass Spectrometer with DANI Thermal Desorber	1	TO-17
Inductively Coupled Argon Plasma Spectrophotometer	2	200.7, 6010
ICP-MS Collision Cell	1	200.7.8, 6010.20
Microscope, PCM, PLM	1	EPA 600/M4-82-020, RTI 600/R-93/116, NIOSH 7400, NIOSH 7402
Leco Sulfur Analyzer	1	ASA29-3, E3.2.3
Technicon AutoAnalyzer II	1	E350.1, E353.2, ASA38-3, ASA10-3, E365.1
Fisher Distillation Unit 100	1	ASA31-3, E351.2
Incubator	1	A9223
TDS/TSS Oven	2	A2540 C, E160.2
Metrohm Robotic Titrasampler	1	SM2510B, SM4500HB
UV-Visual Spectrophotometer	1	A10200 H, E410.4
Dionex Ion Chromatograph with autosampler	2	300.0
CVAA PSA with Autosampler	1	CVAA 3114
CeTac with Autosampler	1	CVAA-Hg 7470, 3112
ManTech Autotitrator	1	A2320B, A4500-H B, A2510 B, USDA23c
Hach 2100N Turbidimeter	1	SM2130B
HPLC	1	As Speciation
Quanti-Tray Sealer	1	A9223 B
Digestion Blocks	3	3050, 3010, 200.2
SampleTek Extractor	1	Various
3-bar, 15 bar	1	

(Serial numbers and associated support equipment are located in the ELI's LIMS database).

CHAPTER 13 – PREVENTIVE MAINTENANCE

Preventive maintenance is performed on laboratory equipment according to the manufacturer's guidelines and our experience in its operation. Repairs and maintenance are accomplished in-house by experienced laboratory personnel whenever possible. Other than consumable equipment items, an inventory of spare parts is not maintained. Spare parts are available from outside vendors on an as needed basis. (To ensure method capability, some methods have more than one instrument available). An outline of the maintenance on our major equipment follows:

Instrument	Maintenance	Frequency
Balances	Check with Class I weights	Daily
	Independent Service	Annually
Pipettes	Check volume	Monthly/Daily
ICP-Atomic Emission	Check Pump Tubing	Daily
	Check Coolant Levels	Daily
	Lubricate Autosampler	Quarterly
	Air Filter	Quarterly
	Optics Servicing	Annually, as needed
ICP-Mass Spectrometry	Check Pump Tubing	Daily
	Check Coolant Levels	Daily
	Check Electron Multiplier	Monthly
	Lubricate Autosampler	Quarterly
	Air Filter	Quarterly
	Same as other Mass spectrometers	
Gas Chromatograph	Change Septum	As needed
	Check Injection Liner	Daily
	Clean Detector	As needed
	Change Gas Cylinders	At 200 psi
	Change Column	As needed
Auto Analyzers	Check Bath Temperature	Daily
	Check For Leaks	Daily
	Change Tubing	When wear is visible
	Align Flow Cell	Quarterly
	Lubricate Pumps	Annually
	Lubricate Sampler	Annually
Mass Spectrometers	Monitor Vacuum Pressures	Daily
	Monitor Background Levels	Daily
	Monitor Electron Multiplier	Daily
	Change Pump Oil	Annually
Microbiology	Monitor Room Temperature	Twice daily
	Monitor Incubator Temperature	Twice daily
	Autoclave Maintenance	Annually
	Monitor Water Bath Temperature	Twice daily
Reagent Water Systems	Change/Check Cartridges	Quarterly, or as needed
Compressed Gases	Change Gas Cylinders	At 50 psi, monitor daily
Liquid Chromatograph	Flush System	Daily
	Change Filters	As needed
	Change Lamps	As needed
	Replace Seals	As needed
DAC System	Check Temperatures	Daily, calibrated annually

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CHAPTER 14 - REFERENCES

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Technical Notes on Drinking Water Methods, EPA/600/R-94/173, October 1994.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW846), Environmental Protection Agency, Final Update III and IIIB, 1997 and 2005.

TNI Standard, Volume 1 (EL-V1-2009), The NELAC Institute.

CHAPTER 15 – GLOSSARY OF TERMS

Accuracy - The degree of agreement between an observed value and an accepted reference value.

Analyst - The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Sample - Any solution or media introduced into an instrument on which an analysis is performed, excluding instrument calibration, initial calibration verification, initial calibration blank, continuing calibration verification, and continuing calibration blank.

Audit or Assessment- A systematic evaluation to determine the conformance to quantitative specifications of some operational function or activity.

Batch - Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to twenty environmental samples of the same matrix, meeting the criteria above. An analytical batch is composed of prepared environmental samples, extracts, digestates, or concentrates, which are analyzed together as a group and in a similar time frame.

Blank (BLK) - A sample of clean water that accompanies the samples through different aspects of sample and/or sample preparation. It is used to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value. There are various types of blanks: equipment blank, field blank, instrument blank, method blank, and reagent blank.

Blank Spike - See Laboratory Fortified Blank.

Blind QC Check Samples - Samples whose analyte concentrations are not known to the analyst. That the sample is a QC check sample may or may not be known to the analyst.

Calibration - The set of operations which establish, under specified conditions, the relationship between values indicated by the measuring instrument and the corresponding known value of the property being measured.

Calibration Blank - A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analytes.

Calibration Check Standard - See Check Standard.

Calibration Curve - The graphical relationship between the known values and the instrument responses for a series of calibration standards.

Calibration Standard - A solution of known concentration used in the calibration of an analytical instrument.

Chain of Custody Form- A record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; collector; time of collection; preservation; and required analyses.

Check Standard - A material of known composition that is analyzed concurrently with test samples to evaluate a measurement process.

Clean Water Act - Public Law PL 92-500. Found at 40 CFR 100-140 and 400-470. The act regulates the discharge of pollutants into surface waters.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - The enabling legislation (42 USC 9601 - 9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC 9601 et seq.), to eliminate the health and environmental threats posed by hazardous waste sites.

Continuing Calibration Blank (CCB) – See Check Standard.

Continuing Calibration Standard - See Check Standard.

Continuing Calibration Verification (CCV) - See Check Standard.

Control Limits - A range within which specified measurement results must fall to be compliant.

Control Standard - See Check Standard.

Corrective Action - An action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

Data Quality Objectives (DQO) - An integrated set of specifications that define data quality requirements and the intended use of the data.

Demonstration of Capability (DOC) - A procedure to establish the ability of the analyst to generate acceptable and accurate data.

Detectability – For radiochemical analyses, detectability as a Lower Limit Detection (LLD) or Minimum Detection Concentration (MDC), is assessed based on the requirements of 40 CFR 141.27 and is a sample-specific determination. The equation is specific for each method and noted in the method SOP.

Detection Limit - See Practical Quantitation Limit and Method Detection Limit. Reporting of detection in radiochemistry is based on specific formulas identified in individual procedures. Single activity point standards are used for efficiency calibration. When required, multiple energy emitters are used for energy calibration.

Document Control - The act of ensuring that documents and revisions are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct document version at the location where the prescribed activity is performed.

Duplicate (DUP) - A second aliquot of a sample that is treated the same as the original sample to determine the precision of the method.

Duplicate Sample - See Duplicate.

Fortified Sample - See Sample Matrix Spike.

Holding Times (Maximum Allowable Holding Times) - The maximum time that samples may be held prior to analysis and still be considered valid or not comprised.

Initial Calibration Verification (ICV) - A sample of known concentration, from a source other than that of the calibration standards, analyzed following calibration to demonstrate validity of the calibration.

Instrument Blank - See Calibration Blank.

Internal Standard – A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (LCS) – A sample with a known concentration prepared and/or analyzed as a measure of accuracy for the method.

Laboratory Fortified Blank (LFB) – An aliquot of reagent water to which known quantities of specific compounds are added and which is analyzed as a measure of method recovery.

Limit of Detection (LOD) - For chemical analyses, the LOD is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent.

Limit of Quantitation (LOQ) – For chemical analyses, the LOQ is an estimate of the minimum amount of a substance that can be reported with a specified degree of confidence. An LOQ is an evaluation of precision and bias.

LIMS - Laboratory Information Management System.

Laboratory Inter-comparison Sample - A performance evaluation sample analyzed by numerous laboratories. Acceptance criteria are often based statistically on the analysis results.

Matrix – The substrate of a test sample.

Matrix Spike - (MS) – An aliquot of a sample to which known quantities of specific compounds are added, and which is carried through the entire analytical process to determine the effect of the matrix on the method's recovery efficiency.

Matrix Spike Duplicate (MSD) – A second aliquot of a sample to which known quantities of specific compounds are added, and which is carried through the entire analytical process to determine the effect of the matrix on the method's recovery efficiency.

Maximum Contaminant Level (MCL) – Regulatory action levels for a contaminant of concern.

Method Blank (MBLK) - A clean sample processed simultaneously with, and under the same conditions as, samples containing an analyte of interest through all steps of the analytical procedure.

Method Validation - The confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled (NELAC 2003) (MARLAP 2004 for radiochemical methods).

Method Detection Limit (MDL) - A measure of the precision of an analytical method determined according to the procedure given in 40 CFR Part 136 Appendix B.

NELAC - National Environmental Laboratory Accreditation Conference.

NELAP - National Environmental Laboratory Accreditation Program.

NPDES - National Pollutant Discharge Elimination System - A discharge permit system authorized under the Clean Water Act.

Performance Evaluation (PE) Sample - A sample with a composition unknown to the analyst that is provided to test whether the analyst/laboratory can produce analytical results with specified limits.

Practical Quantitation Limit (PQL) – The lowest concentration or amount of the target analyte that can be identified, measured and reported with confidence that the analyte concentration is not a false positive value.

Precision - The degree to which a set of observations or measurements of the same property conform to themselves.

Preservation - Refrigeration and/or reagents added at the time of sample collection to maintain the chemical and/or biological integrity of the sample.

Proficiency Testing (PT) Sample - A sample with a composition unknown to the analyst that is provided to test whether the analyst/laboratory can produce analytical results with specified limits.

Quality Assurance – An integrated system of activities planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Assurance Project Plan (QAPP) - A formal document describing the detailed quality control procedures pertaining to a specific project. For environmental clean-up projects, this is typically produced by an engineering firm with references to include a laboratory's Quality Assurance Program Manual.

Quality Control – The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

Quality Control Sample – A sample used to assess the performance of all, or a portion, of the measurement system.

Replicate - An additional aliquot of a sample that is treated the same as the original sample to determine the precision of the method.

Reporting Limit (RL) – Also known as the Practical Quantitation Limit (PQL). The lowest level of reportable concentration for the method and the analyte.

Resource Conservation and Recovery Act (RCRA) - The enabling legislation under 42 USC 321 et seq. (1976) that gives EPA the authority to control hazardous waste.

Safe Drinking Water Act (SDWA) - The enabling legislation, 42 USC 300f et seq. (1974), which requires the USEPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations.

Sample (SAMP) - A portion of material to be analyzed.

Spiked Sample - See Matrix Spike.

Standardization - See Calibration.

Standard Operating Procedure - A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

TNI – The NELAC Institute

Traceability – The property of a result of a measurement whereby it can be related to appropriate standards.

Trip Blank - One type of Field Blank. An aliquot of analyte-free water or solvent transported to the field in a sealed container and returned to the laboratory with the sample containers.

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Acronyms and Abbreviations

AA	-	Accrediting Authority
AB	-	Accrediting Body
ANSI	-	American National Standards Institute
AOAC	-	The Scientific Association Dedicated to Analytical Excellence
APHA	-	American Public Health Association
ASQC	-	American Society for Quality Control
ASTM	-	American Society for Testing and Materials
Bq	-	Becquerel
BLK	-	Blank
Bg	-	Background
ºC	-	Degrees Celsius
Cal	-	Calibration
CAS	-	Chemical Abstract Service
CCB	-	Continuing Calibration Blank
CCV	-	Continuing Calibration Verification
COC	-	Chain of Custody
DOC	-	Demonstration of Capability
DO	-	Dissolved Oxygen
DQO	-	Data Quality Objectives
DRMQA	-	NPDES Discharge Monitoring Report Quality Assurance
DUP	-	Duplicate
ELI	-	Energy Laboratories, Inc.
EPA	-	Environmental Protection Agency
FDA	-	Food and Drug Administration
g/L	-	Grams per liter
GC	-	Gas Chromatography
GC-MS	-	Gas Chromatography/Mass Spectrometry
ICP (ICAP)	-	Inductively Coupled Plasma
ICP-MS	-	Inductively Coupled Plasma-Mass Spectrometry
ICV	-	Initial Calibration Verification
ISO	-	International Organization for Standardization
LCS	-	Laboratory Control Sample
LFB	-	Laboratory Fortified Blank
LIMS	-	Laboratory Information Management System
LLD	-	Low Limit Detection
LOD	-	Limit of Detection
LOQ	-	Limit of Quantitation
MDC	-	Minimum Detection Concentration
MDL	-	Method Detection Limit
MBLK	-	Method Blank
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NEHA	-	National Environmental Health Association
NELAC	-	National Environmental Laboratory Accreditation Council
NELAP	-	National Environmental Laboratory Accreditation Program
NIOSH	-	National Institute for Occupational Safety and Health
NIST	-	National Institute of Standards and Technology
OSHA	-	Occupational Safety and Health Administration
pCi/L	-	Picocuries per Liter
PT	-	Proficiency Testing
QA/QC	-	Quality Assurance / Quality Control
QS	-	Quality Systems
QAM	-	Quality Assurance Manual
RDL	-	Required Detection Level
RL	-	Reporting Level
RPD	-	Relative Percent Difference

RSD	-	Relative Standard Deviation
SOPs	-	Standard Operating Procedures
SPK	-	Spike
Std	-	Standard
SVOC	-	Semi-Volatile Organic Compound
TNI	-	The NELAC Institute
ug/L	-	Micrograms per Liter
UV/VIS	-	Ultraviolet/ Visible Spectroscopy
VOC	-	Volatile Organic Compound
WET	-	Whole Effluent Toxicity

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APPENDIX A

Laboratory Certifications

State of Montana Drinking Water Certificate

Additional Certifications available @ www.energylab.com

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DEPARTMENT OF
PUBLIC HEALTH AND HUMAN SERVICES
STATE OF MONTANA

ENVIRONMENTAL LABORATORY

CERTIFIED DRINKING WATER PARAMETERS

ENERGY LABORATORY, INC.
3161 East Lyndale
Helena, MT 59604
CERT0079
Chemistry Expiration 12/31/2012
Microbiology Expiration 12/31/2012

MICROBIOLOGY PARAMETERS

PARAMETER	METHOD
Total Coliforms	SM 9223 B
E. coli	SM 9223 B

ENUMERATION	METHOD
Total Coliforms	SM 9223 B
E. coli	SM 9223 B

INORGANIC PARAMETERS

PARAMETER	METHOD 1	METHOD 2
Aluminum	EPA 200.7	EPA 200.8
Arsenic	EPA 200.8	
Antimony	EPA 200.8	
Barium	EPA 200.7	EPA 200.8
Beryllium	EPA 200.7	EPA 200.8
Cadmium	EPA 200.7	EPA 200.8
Chromium	EPA 200.7	EPA 200.8
Copper	EPA 200.7	EPA 200.8
Nickel	EPA 200.7	EPA 200.8
Lead	EPA 200.8	
Selenium	EPA 200.8	
Thallium	EPA 200.8	
Uranium	EPA 200.8	
Mercury	EPA 200.8	EPA 245.1
Iron	EPA 200.7	EPA 200.8
Manganese	EPA 200.7	EPA 200.8
Silver	EPA 200.7	EPA 200.8
Zinc	EPA 200.7	EPA 200.8
Fluoride	SM 4500-F-C	EPA 300.0
Nitrate	EPA 353.2	EPA 300.0
Nitrite	EPA 353.2	EPA 300.0
Total Dissolved Solids	SM 2540 C	
Turbidity	SM2130B	
Conductivity	SM 2510 B	
Ortho-Phosphate	EPA 365.1	EPA 300.0
pH	SM4500-HB	
Sulfate	EPA 300.0	EPA 300.0
Alkalinity	SM 2320 B	
Chlorate	EPA 300.0	

Chlorite	EPA 300.0
Chloride	EPA 300.0
Bromide	EPA 300.0
Bromate	EPA 300.0

VOLATILE ORGANIC COMPOUNDS

PARAMETER	METHOD
Bromodicloromethane	EPA 524.2
Bromoform	EPA 524.2
Chlorodibromethane	EPA 524.2
Chloroform	EPA 524.2
Total Trihalomethanes	EPA 524.2
1,1,1-Trichloroethane	EPA 524.2
1,1,2-Trichloroethane	EPA 524.2
1,1-Dichloroethylene	EPA 524.2
1,2 Dichlorobenzene	EPA 524.2
1,2,4-Trichlorobenzene	EPA 524.2
1,2-Dichloroethane	EPA 524.2
1,2-Dichloropropane	EPA 524.2
1,4-Dichlorobenzene	EPA 524.2
Benzene	EPA 524.2
Carbon Tetrachloride	EPA 524.2
Chlorobenzene	EPA 524.2
cis-1,2-Dichloroethylene	EPA 524.2
Dichloromethane	EPA 524.2
Ethylbenzene	EPA 524.2
Styrene	EPA 524.2
Tetrachloroethylene	EPA 524.2
Toluene	EPA 524.2
trans-1,2-Dichloroethylene	EPA 524.2
Trichloroethylene	EPA 524.2
Vinyl Chloride	EPA 524.2
Xylenes	EPA 524.2
1,1,1,2-Tetrachloroethane	EPA 524.2
1,1,2,2-Tetrachloroethane	EPA 524.2
1,1-Dichloroethane	EPA 524.2
1,1-Dichloropropane	EPA 524.2
1,1-Dichloropropene	EPA 524.2
1,2-Dibromoethane	EPA 524.2
1,2-Dibromo-3-Chloropropane	EPA 524.2
1,2,3-Trichlorobenzene	EPA 524.2
1,2,3-Trichloropane	EPA 524.2
1,2,4-Trimethylbenzene	EPA 524.2
1,3,5-Trimethylbenzene	EPA 524.2
1,3-Dichlorobenzene	EPA 524.2
1,3-Dichloropropane	EPA 524.2
2,2-Dichlorobenzene	EPA 524.2
2,2-Dichloropropane	EPA 524.2
Bromobenzene	EPA 524.2
Bromochloromethane	EPA 524.2
Bromomethane	EPA 524.2
Chloroethane	EPA 524.2
Chloromethane	EPA 524.2
Cis-1,3-Dichloropropene	EPA 524.2
Dibromomethane	EPA 524.2
Dichlorodifluoromethane	EPA 524.2

Fluorotrichloromethane	EPA 524.2
Hexachlorobutadiene	EPA 524.2
Isopropylbenzene	EPA 524.2
Methyl tert Butyl ether (MTBE)	EPA 524.2
Naphthalene	EPA 524.2
n-Butylbenzene	EPA 524.2
n-Propylbenzene	EPA 524.2
o-Chlorotoluene	EPA 524.2
p-Chlorotoluene	EPA 524.2
p-Isopropyltoluene	EPA 524.2
sec-Butylbenzene	EPA 524.2
tert-Butylbenzene	EPA 524.2
trans-1,3-Dichloropropene	EPA 524.2

Appendix B

Quality Systems Controlled Documents

Quality Assurance Manual

Branch Laboratory SOPs

- Organization and Personnel (10-Series)
- General Facility Operations (20-Series)
- General Laboratory Procedures (30-Series)
- Equipment Use and Maintenance (40-Series)
- Analytical Methods (50-Series)

Employee Training Records (Quality Assurance Department and Human Resources)

Laboratory Notebooks (Quality Assurance Department)

Qualifications Manual (Corporate Document)

Energy Laboratories Analytical Services and Fee Schedule (Controlled by Corporate Marketing Department)

Employee Policies and Procedures Package (Controlled by Corporate Human Resource Department)

- Benefits
- 401-K
- Employee Leave Time, Work Week and Pay Period Procedures
- Computer Software Policy
- Work Ethic Policy
- Drug and Alcohol
- Firearms/Weapons Policy
- Non-Discrimination and Harassment in the Workplace Policy
- Confidentiality Agreement
- Electronic Access Policy
- Compliance & Ethics Manual
- Ethics and Data Integrity Manual (with input from Quality Assurance)

Corporate Safety Policies and Programs (Controlled by Corporate Safety Officer)

- Bloodborne Pathogens Exposure Control Plan
- Laboratory Safety Manual & Chemical Hygiene Plan
- Emergency Action Plan
- Hazards of Respirable Silica Manual
- Hearing Conservation Program
- Respiratory Protection Program

APPENDIX C

Quality Assurance / Quality Control Specifications

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Appendix A - Table 1 - QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SPECIFICATIONS - ENERGY LABORATORIES, Inc.

PARAMETER	METHOD REF.	HOLDING TIME**	INITIAL CALIBRATION	CONTINUING CALIBRATION	EXTERNAL CHECK SAMPLE	METHOD BLANK	SURROGATE Recovery	MATRIX SPK Frequency Recovery	DUPLICATE or Matrix Spk Dup	CALIBRATION STANDARDS VERIFICATION	OTHER
BTEX	8021/602 MDHES	14 Days	5 Point 20% RSD 20% RSD of MnRF	Every 12 Hours 85-115% of Initial	Every 48 Hrs 70-130	Every 12 Hrs <PQL	Trifluorotoluene 80-120% Rec.	10% of Smpls 70-130% Rec.	MSD <20% RPD	48 Hrs Check Smpl	PER METHOD SOP Instrument Blk as needed
GRO	MDHES	14 Days	5 Point 25% RSD OF RF 25% RSD of MnRF	Every 12 Hours 75-125% of Initial	Every 12 Hrs 50-150%	Every 12 Hrs <PQL	Trifluorotoluene 50-150% Rec.	10% of Smpls 60-120% Rec	MSD <20% RPD	48 Hrs Check Smpl	PER METHOD SOP Instrument Blk as needed
DRO	MDHES	Water Extr 7 Days Soil Extr 14 Days Analyze 40 Days	5 Point 25% RSD of MnRF 25% RSD of MnRF	Every 12 Hours 75-125% of Initial	Daily/Batch 60-120%	Every 12 Hrs <PQL	O-terphenyl 50-150% Rec.	10% of Smpls 60-120% Rec	MSD & BLKSPK <20% RPD	Each Lot of Stds	PER METHOD SOP Instrument Blk as needed
TPH as Diesel	8015 mod	Water Extr 7 Days Soil Extr 14 Days Analyze 40 Days	5 Point 25% RSD of MnRF 25% RSD of MnRF	Every 12 Hours 85-115% of Initial	Daily/Batch 60-140%	Every 12 Hrs <PQL	O-terphenyl 50-150% Rec.	10% of Smpls 60-120% Rec	MSD & BLKSPK <20% RPD	Each Lot of Stds	PER METHOD SOP Instrument Blk as needed
TPH by Infrared Spectroscopy	418.1	28 Days	4 Point Linear Regression r>.995	Daily 90-110%	Daily/batch 90-110%	10% of Smpls <PQL	NA NA	10% of Smpls 90-110%	MSD <20% RPD	Each Lot of Stds	Calibrate IR wavelength
Purgeable Organics	8260 624*	14 Days	5 Point* <30%RSD Min. RRF 0.25	Every 12 Hrs +/- 25% for CCC +/- 30%*	5% of Smpls QC Limits	10% of Smpls <PQL	3 Surrogates Statistical	10% of Smpls	MSD Statistical Limits	Each Lot of Stds	Tuning every 12 Hrs I.S. areas 50-150% of I.C. Analyte ID RRT +/- .06 Major Ions +/- 20% CLP Guidelines
Regulated and Unregulated Volatile Organic Compounds	524.2	14 Days	5 Point* <30%RSD or Linear Regression Min. RRF 0.25	Every 8 Hrs +/- 30%*	5% of Smpls QC Limits	10% of Smpls <PQL	3 Surrogates 80-120%	N/A	N/A	Each Lot of Stds	Tuning every 8 Hrs I.S. areas 50-150% of I.C. Analyte ID RT +/- 30 sec Major Ions +/- 20% CLP Guidelines
Ignitability	1010	NS	Six Months	NA	5% of Smpls	NA	NA	NA	5% of Smpls	Check Smpl	AS PER METHOD SOP
Corrosivity, pH	9040/9045	Immediately	2 Point bracket sample pH	Every 10thSample +/- 0.1 pH units	per Sequence +/- 0.1 pH units	NA	NA	NA	5% of Smpls	Each lot of Stds	AS PER METHOD SOP
Cyanide Reactivity	9012/9013	14 Days	3 Point Linear Regression r>.995	Every 10 Smpls 85-115% of Initial	NA	5% of Smpls <PQL	NA	NA NA	10% of Smpls 3xLLD or 10%RPD	Check Smpl Instrument	AS PER METHOD SOP
Sulfide Reactivity	9030/9031	7 Days	3 Point Linear Regression r>.995	Every 10 Smpls 85-115% of Initial	NA	5% of Smpls <PQL	NA	NA	10% of Smpls 3xLLD or 10%RPD	Check Smpl Instrument	AS PER METHOD SOP
Specific Gravity	NS	NS	NA	NA	NA	NA	NA	NA	10% of Smpls	NA	
Paint Filter Test	9095	NS	NA	NA	NA	NA	NA	NA	10% of Smpls	NA	
Total Halogens	D808	NS	NA	NA	NA	Batch <0.03 %	NA	NA	10% of Smpls per method	NA	ASTM method

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Appendix A - Table 1 - QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SPECIFICATIONS - ENERGY LABORATORIES, Inc.

PARAMETER	METHOD REF.	HOLDING TIME**	INITIAL CALIBRATION	CONTINUING CALIBRATION	EXTERNAL CHECK SAMPLE	METHOD BLANK	SURROGATE Recovery	MATRIX SPK Frequency Recovery	DUPLICATE or Matrix Spk Dup	CALIBRATION STANDARDS VERIFICATION	OTHER
Acid Digestion	3050		NA	NA	Daily/Batch	Daily/Batch	NA	10% of Smpls	5% of Smpls	NA	AS PER METHOD SOP
Metals, except mercury	ICP/ICPMS	6 Months	2 Point Blank and Std	Every 10 Samples 90-110% of Value	5% of Smpls 90-110% 95-105% for 1st CCV	Daily/Batch <2.2*MDL or 1/10 sample	NA	10% of Smpls 70-130% (200.7) 75-125% (6010)	5% of Smpls 3xLLD or 10%RPD	Check Smpl	AS PER METHOD SOP Instrument Blk as needed Intensity of I.C. Std area Interference Check Std
Mercury	AA	28 days	same as other metals								
TCLP	1311		NA	NA	NA	10% of Smpls	NA	EVERY MATRIX	NA	NA	NA
mercury		28 days to extract									
other metals		180 days to extract									
organics		14 days to extract									
Biochemical Oxygen Demand	405.1	48 hours	Daily, saturated air	NA	Daily 85-115%	Daily <0.2 mg/l	NA	NA	3 replicates/sample		
Chemical Oxygen Demand	410.1	28 days	3 point Linear Regression r>0.995	Every 10 Smpls 85-115% of Initial	10% of Smpls QC Range	Daily/Batch <PQL	NA	10% of Smpls 85-115% Rec.	5% of Smpls 3xLLD or 10%RPD	Check Smpl	AS PER METHOD SOP Instrument Blk as needed
Total Suspended Solids	160.2	7 days	Daily balance calibration	NA	NA	5% of Smpls	NA	NA	5% of Smpls 3xLLD or 10%RPD	NA	
Total Kjeldahl Nitrogen	351.3	28 days	5 pt Linear Regression r>0.995	NA	Daily 90-110%	Daily	NA	10% of Smpls 85-115% Rec.	5% of Smpls 3xLLD or 10%RPD	NA	
Nitrate+Nitrite as N	353.2	28 days	5 point Linear Regression r>0.995	Every 10 Smpls 90-110% of Initial	10% of Smpls 90-110%	10% of Smpls <MDL	NA	10% of Smpls 90-110% Rec.	5% of Smpls 3xLLD or 10%RPD	Check Smpl	AS PER METHOD SOP Instrument Blk as needed
Total Phosphorus as P	365.1	28 days	5 point Linear Regression r>0.995	Every 10 Smpls 90-110% of Initial	10% of Smpls 90-110%	10% of Smpls <MDL	NA	10% of Smpls 90-110% Rec.	5% of Smpls 3xLLD or 10%RPD	Check Smpl	AS PER METHOD SOP Instrument Blk as needed

*QA/QC criteria similar to method shown.

**Holding Times do not reflect actual sample turnaround times.

NS=Not Specified, NA=Not Applicable, Smpl=Sample, IC=Initial Calibration, CC=Continuing Calibration, I.S.=Internal Std, Std=Standard, Blk=Blank, MSD=Matrix Spike Duplicate, MDL=Method Detection Limit,Extr=Extract, RF=Response Factor,MnRF=Mean Response Factor,RRF=Relative Response Factor,RSD=Relative Standard Deviation,RRT=Relative Retention Time,LLD=Lower Limit of Detection. CLP=Contract Laboratory Program SOW 1988

Method Detection Limits are determined annually for chromatographic systems, QA/QC charts as needed. Chain-of-Custody records maintained, sample condition reports for every sample.

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METHOD QA/QC PARAMETERS
ELEMENTAL ANALYSES BY ICP by EPA Method 200.7/6010B
For Water, Waste, and Soil Analyses

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
Sample Preparation	Soils: 3050 Digestion Waters: Turbidity <1 Analyze direct , >1 digest using 200.2 Total metals are all digested	Meet method QC criteria for the matrix.	1) Reanalyze sample	Reporting: Audit review, "Digestion batch ID for each sample and Date extracted available in Dates Report".
Instrument Initial Calibration (IC)	Daily, or when needed. 1 point calibration and blank	None	None	Calibration of instrument. Calibration validity Tested by ICV and ICB. Reporting: In data QC report
Initial Calibration Verification (ICV)/Instrument Performance Check (IPC)	Immediately follows calibration. Use second source standard.	6010B: R% =90-110 200.7: %R=95-105 immediately after IC,	1) Recalibrate and rerun 2) Prepare fresh standards or/ ICV.	Evaluates accuracy/bias in calibration standards. Reporting: In data QC report
Initial Calibration Blank (ICB)	Immediately follows ICV	<2.2xMDL, or <10% of reporting limit, whichever is greatest.	1) Repour Blanks, recalibrate and rerun. 2) Prepare fresh blank	Evaluates reagent contamination and instrument carryover and background.. Reporting: In data QC report. Blanks values reported down to criteria used.
Low Level Calibration Verification (CRI)	Reporting limit standard analyzed at beginning and end of run.	R%= 50-150	1) None	Verifies instrument ability to quantitate analytes at the reporting limit. Reporting: In data QC report
Interference Check Sample "A" (ICSA)	Run daily	R%=80-120 for interferents +/- 2* reporting limit for analytes	1) Evaluate sample data. Results near reporting limit suspect if failing ICSA. 2) Rerun sample as indicated.	Reporting: In data QC report
Interference Check Sample "AB" (ICSAB)	Run daily	R%=80-120 for interferents	1) Evaluate sample data. Results near reporting limit suspect if failing ICSB. 2) Rerun sample as indicated.	Reporting: In data QC report
Continuing Calibration Verification (CCV)	Run every 10 samples and at end of run.	R% =90-110 as continuing calibration check 200.7: %R=95-105 immediately after IC, 90-110 following CCV's	1) Recalibrate and rerun all samples since last valid CCV 2) Check for sample matrix problems.	Evaluates instrument calibration drift. Reporting: Prior CCV In data QC report, ending CCV = audit review.
Continuing Calibration Blank (CCB)	Run with every CCV and after high level samples as needed.	<2.2xMDL, or <10% of reporting limit, whichever is greatest.	1) Check for high concentration sample 2) Reanalyze CCB. 3) Reanalyze affected samples	Measures analyte carryover in instrument and also evaluates possible contamination in reagents and glassware. Reporting: In data QC report, Blanks values reported down to criteria used.
Instrument Matrix Spike Sample (MS)	6010: Minimum 1/20 samples . 200.7: Minimum 1/10 samples and for each batch. Not performed on digested samples See MS	6010B: %R =75-125 200.7 %R-70-130	1) Rerun spike 2) Evaluate LCS performance.	Evaluates affect of matrix on method performance. Results not evaluated when sample analyte concentration greater than 4X spike level. Reporting: In data QC report.
Instrument Duplicate Sample or Matrix Spike duplicate.	Minimum 1/20 Samples in instrument sequence. Not performed on digested samples	Either 3* PQL or <10%RPD, whichever is greatest. %R= See MS	1) Rerun duplicate/spike 2) Evaluate LCS	Measures method precision. MSD may be used instead of duplicate. Reporting: In data QC report.
Method Blank Also see ICB and	Digested Samples, Minimum 1/20 samples or for each batch	< 10% of sample concentration,	1) Re-digest samples from batch which fail acceptance criteria.	Evaluates possible contamination in reagents and glassware. Reporting:

METHOD QA/QC PARAMETERS
ELEMENTAL ANALYSES BY ICP by EPA Method 200.7/6010B
For Water, Waste, and Soil Analyses

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
CCB for direct analyses	whichever is more frequent Direct analyses: Daily and each sequence	<2.2xMDL, or <10% of reporting limit, whichever is greatest.		Reporting: In data QC report, Blank values reported down to criteria used.
Laboratory Control Sample = LFB for direct instrument analyses (undigested).	Digested Samples, Minimum 1/20 samples or for each batch whichever is more frequent Direct analyses: Daily and each sequence.	6010B: %R= 75-125 200.7 %R=85-115 Soils: Within established acceptance ranges for certified material.	1) Repeat LCS analyses 2) Prepare new standards 3) Recalibrate 4) Re-extract and re-analyze samples associated with LFB. 5) Flag data or re-digest batch	Evaluates method precision and accuracy. Reporting: In data QC report
Matrix Spike (MS) (Laboratory Fortified Sample Matrix (LFM)) Pre-digestion for digested samples.	6010: 1/20 samples or 1/Digestion Batch whichever is more frequent. 200.7: 1/10 samples or per batch whichever is more frequent.	6010B: %R= 75-125 200.7: %R=70-130	1) See LCS 2) Flag data or re-digest batch 3) Repeat analyses Note MS recovery performance in soils varies considerably with matrix.	Evaluates digestion extraction efficiency and sample matrix effects on analyses. Reporting: In data QC report.
Matrix Spike Duplicate (MSD) or digestion duplicate Pre-digestion for digested samples	1/20 samples or 1/Digestion Batch whichever is more frequent	Either +/- 3*LLD or 10% RPD %R=See MS	1) See LCS 2) Flag data or re-digest batch 3) Repeat analyses.	Measures method precision. MSD may be used instead of duplicate. Reporting: In data QC report.
Serial Dilution Sample	when new matrix is encountered	%R=90-110 for analytes >50*PQL	1) Rerun samples 2) Run samples on dilution	Used for screening analyses and for evaluating new matrices.
Inter-element correction Factor Studies	Annually, or whenever instrument changes might affect inter-element corrections.	Comparison to historical data	1) Repeat 2) Correct problem	Correction factors to account for spectral overlap between differing elements.
Upper Linear Range Studies	Annually, or whenever instrument changes might affect sensitivity.	Comparison to historical data	1) Repeat 2) Correct problem 3) Adjust upper calibration limit	Used to determine the upper linear calibration range for the instrument.
MDL/IDL Studies	Annually or whenever instrument changes, which might affect sensitivity.	<2.2 X reporting limit and comparisons to prior studies.	1) Repeat 2) Correct problem 3) Adjust reporting limit to >MDL	Evaluates overall method detection limits in clean sample matrix. Actual samples may have higher MDL. Reporting: Audit review
External PE Samples	Semi-annually, WS and WP study samples and internal double blind samples.	Within EPA specified interlaboratory control limits	1) Repeat 2) Correct problem	External review of analytical method accuracy. Historically, excellent performance. Reporting: Current study results available on www. energylab.com website.
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. or as needed	Data statistically within control limits.	1) Correct method problem 2) Adjust control limits	For statistical process control. Reporting: Audit review

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METHOD QA/QC PARAMETERS
ELEMENTAL ANALYSES BY ICP-MS by EPA Method 200.8/6020
for Water, Waste, and Soil Analyses

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
Sample Preparation	Soils: 3050 Digestion Waters: Turbidity <1 Analyze direct , >1 digest using 200.2 Total metals are all digested	Meet method QC criteria for the matrix.	1) Reanalyze sample	Reporting: Audit review, "Digestion batch ID for each sample and Date extracted available in Dates Report".
Instrument Tuning	Daily – before calibration, analyze tuning solution; conduct mass calibration, and mass resolution check. Per method requirements	Per individual method requirements:	1) Rerun tuning solutions 2) Adjust instrument parameters and retune 3) Correct Problems	Set instrument parameters for accurate qualitative elemental identification. Tuning solution varies according to matrix and targeted analytes. Reporting: Audit review
Instrument Initial Calibration (IC)	Daily, or when needed. 2 point calibration and blank	None	None	Calibration of instrument. Calibration validity Tested by ICV and ICB. Reporting: In data QC report
(ICV) Initial Calibration Verification	Immediately follows calibration. Use second source standard.	R% =90-110	1) Recalibrate and rerun 2) Prepare fresh standards or/ ICV.	Evaluates accuracy/bias in calibration standards. Reporting: In data QC report
Initial Calibration Blank (ICB)	Immediately follows ICV	<2.2xMDL, or <10% of reporting limit, whichever is greatest.	1) Repour Blanks, recalibrate and rerun. 2) Prepare fresh blank	Evaluates reagent contamination and instrument carryover and background.. Reporting: In data QC report. Blanks values reported down to criteria used.
Low Level Calibration Verification (CRI)	Reporting limit standard analyzed at beginning and end of run.	R%= 50-150	1) None	Verifies instrument ability to quantitate analytes at the reporting limit. Reporting: In data QC report
Interference Check Sample "A" (ICSA)	Run daily per 6020B requirements	R%=80-120 for interferents +/- 2* reporting limit for analytes	1) Evaluate sample data. Results near reporting limit suspect if failing ICSA. 2) Rerun sample as indicated.	Reporting: In data QC report
Interference Check Sample "AB" (ICSAB)	Run daily for 6020B per 6020B requirements	R%=80-120 for interferents	1) Evaluate sample data. Results near reporting limit suspect if failing ICSB. 2) Rerun sample as indicated.	Reporting: In data QC report
Continuing Calibration Verification (CCV)	Run every 10 samples and at end of run.	R%= 90-110	1) Recalibrate and rerun all samples since last valid CCV 2) Check for sample matrix problems.	Evaluates instrument calibration drift. Reporting: Prior CCV In data QC report, ending CCV = audit review.
Continuing Calibration Blank (CCB)	Run with every CCV and after high level samples as needed.	<2.2xMDL, or <10% of reporting limit, whichever is greatest.	1) Check for high concentration sample 2) Reanalyze CCB. 3) Reanalyze affected samples	Measures analyte carryover in instrument and also evaluates possible contamination in reagents and glassware. Reporting: In data QC report, Blanks values reported down to criteria used.
Instrument Matrix Spike Sample (MS)	6020: Minimum 1/20 samples . 200.8: Minimum 1/10 samples and for each batch. Not performed on digested samples	6020B: %R =75-125 200.8 %R-70-130	1) Rerun spike 2) Evaluate LCS performance.	Evaluates affect of matrix on method performance. Results not evaluated when sample analyte concentration greater than 4X spike level. Reporting: In data QC report.
Instrument Duplicate Sample or Matrix Spike duplicate.	Minimum 1/20 Samples in instrument sequence. Not performed on digested samples	Either 3* PQL or <10%RPD, whichever is greatest. %R= See MS	1) Rerun duplicate/spike 2) Evaluate LCS	Measures method precision. MSD may be used instead of duplicate. Reporting: In data QC report.
Method Blank or	Digested Samples: Minimum 1/20	< 10% of sample	1) Re-digest samples from batch	Evaluates possible contamination in

METHOD QA/QC PARAMETERS
ELEMENTAL ANALYSES BY ICP-MS by EPA Method 200.8/6020
for Water, Waste, and Soil Analyses

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
LRB) (Digested samples only) Also See ICB and CCB for direct analyses	samples or for each batch whichever is more frequent. Direct analyses: Daily and each sequence.	concentration, <2.2xMDL, or <10% of reporting limit, whichever is greatest.	which fail acceptance criteria.	reagents and glassware. Reporting: Reporting: In data QC report, Blank values reported down to criteria used.
Laboratory Control Sample = LFB for direct instrument analyses (undigested).	Digested Samples: Minimum 1/20 samples or for each batch whichever is more frequent. Direct analyses: Daily and each sequence.	6020B: %R= 75-125 200.8 %R=85-115 Soils: Within established acceptance ranges for certified material.	1) Repeat LCS analyses 2) Prepare new standards 3) Recalibrate 4) Re-extract and re-analyze samples associated with LFB. 5) Flag data or re-digest batch	Evaluates method precision and accuracy. Reporting: In data QC report
Matrix Spike (MS) (Laboratory Fortified Sample Matrix (LFM)) Pre-digestion for digested samples.	6010: 1/20 samples or 1/Digestion Batch whichever is more frequent. 200.8: 1/10 samples or per batch whichever is more frequent.	6020B: %R= 75-125 200.8: %R=70-130	1) See LCS 2) Flag data or re-digest batch 3) Repeat analyses Note MS recovery performance in soils varies considerably with matrix.	Evaluates digestion extraction efficiency and sample matrix effects on analyses. Reporting: In data QC report.
Matrix Spike or Digestion duplicate sample	1/20 samples or 1/Digestion Batch whichever is more frequent	Either +/- 3*LLD or 10% RPD %R=See MS	1) See LCS 2) Flag data or re-digest batch 3) Repeat analyses.	Measures method precision. MSD may be used instead of duplicate. Reporting: In data QC report.
Internal Standards	Monitor in all standards, samples, and QC samples.	6010B: 30-140% of IC for all standards, blanks, and samples. 200.7: 60-125% of IC for all analyses.	1) Reanalyze sample 2) Dilute sample and reanalyze. 3) Evaluate associated QC samples in sequence. 4) Reanalyze sequence	Internal standards compensate for instrument drift and sample matrix affects. Internal standards used depend on parameters and sample matrix. Reporting: Audit review
MDL/IDL Studies	IDL's Quarterly, MDL's semiannually, or both whenever instrument changes which might affect sensitivity.	<2.2 X reporting limit and comparisons to prior studies.	1) Repeat 2) Correct problem 3) Adjust reporting limit to >MDL	Evaluates overall method detection limits in clean sample matrix. Actual samples may have higher MDL. Reporting: Audit review
Upper Linear Range Studies	Annually, or whenever there are instrument changes, which might affect sensitivity.	Comparison to historical data	1) Repeat 2) Correct problem 3) Adjust upper calibration/quantitation limit	Used to determine the upper linear calibration range for the instrument. Reporting: Audit review
External PE Samples	Semi-annually, WS and WP study samples and internal double blind samples.	Within EPA specified interlaboratory control limits	1) Repeat 2) Correct problem	External review of analytical method accuracy. Historically, excellent performance. Reporting: Current study results available on www. energylab.com website.
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. or as needed	Data statistically within control limits.	1) Correct method problem 2) Adjust control limits	For statistical process control. Reporting: Audit review

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ATTACHMENT 17.2 METHOD QA/QC PARAMETERS VOLATILE ORGANICS BY PURGE AND TRAP GC/MS EPA Method SW-846 8260B for SOIL & WATER				
QA SAMPLE/ INDICATOR	**FREQUENCY**	**ACCEPTANCE CRITERIA**	**CORRECTIVE ACTION**	**COMMENTS**
Sample Preparation	Methods: Soils: Extracted by 5030B then analyzed by Purge & Trap Waters: 5030B Purge & Trap Surrogates added to all samples	Meet method QC criteria for the matrix.	1. Re-analyze sample.	Waters are introduced into the GC/MS using Purge & Trap. Soils are extracted into methanol and the methanol extract is added to water and analyzed by Purge and Trap/GC/MS.
Initial Calibration	7-point initial calibration Range: 1, 2,5,10, 15, 20 ug/L	If %RSD<15 use avg RF, alternatively use calibration curve. CCC= Continuing Calibration Check Compounds. Calibration curve (first or higher order), all analytes %RSD<30 then R2 >0.99, RF for SPCCs >0.3000 for Chlorobenzene and 1,1,2,2-Tetrachloroethane; >0.1 for Chloromethane and 1,1-dichloroethane, and Bromoform.	1. Perform instrument maintenance. 2. Recalibrate. 3. Prepare new Standards.	Establishes calibration curve over a range of analyte concentrations to quantify analytes of interest.
Tuning	BFB Initially and every 12 hours thereafter.	Meet method-tuning criteria.	1. Adjust instrument. 2. Recheck tune. 3. Until successful.	Evaluate mass sensitivity, mass resolution, isotope ratio, and baseline threshold.
Continuing Calibration Check (CCC)	Mid-level standard analyzed every 12 hours	RF ± 20% of IC for CCCs, 30% for all others. Internal Std areas R% = 50-150 of IC RF acceptance criteria for SPCCs same as for initial calibration.	1. Remake and rerun. 2. Re run instrument tune 3. Re-calibrate and re-analyze all samples since last valid calibration check.	Evaluates instrument drift throughout analytical sequence. Typically uses midpoint calibration standard or ICV.
Method Blank (MBLK)	Each batch of 20 samples/matrix or when there is a change of reagents, whichever is more frequent.	<½ PQL	1. Repeat analyses once. 2. Correct problem. 3. Re-extract and re-analyze all samples associated with failing method blank.	Evaluates overall method including possible contamination in reagents and glassware utilized in preparatory batch.

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ATTACHMENT 17.2 METHOD QA/QC PARAMETERS VOLATILE ORGANICS BY PURGE AND TRAP GC/MS EPA Method SW-846 8260B for SOIL & WATER				
QA SAMPLE/ INDICATOR	**FREQUENCY**	**ACCEPTANCE CRITERIA**	**CORRECTIVE ACTION**	**COMMENTS**
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	Each batch of 20 samples/matrix or when there is a change of reagents, whichever is more frequent.	% Recovery = LCS Statistical Control Limits RPD < 20%	1. Repeat analyses. 2. Re-extract and re-analyze MS, (if sufficient sample). 3. Evaluate LFB performance.	Evaluates affect of matrix on method performance.
Lab Fortified Blank (LFB) or Lab Control Sample (LCS)	Minimum 1/20 samples/matrix and each batch of samples, whichever is more frequent. Use second source standards to check calibration.	Statistical Control Limits	1. Repeat analyses. 2. Prepare new standards. 3. Recalibrate. 4. Re-extract and re-analyze all samples associated with failing LFB/LCS.	Evaluates overall method precision and accuracy. Method specifies 70-130.
Internal Standards (Samples and QC)	Monitor total areas in each analyses Bromochloromethane-d2 Fluorobenzene Chlorobenzene-d5 1,2-Dichlorobenzene-d5	Samples: Area% 50-150% of IC RT = ±30 sec of IC.	1. Repeat analyses. 2. Re-prepare samples. 3. Analyze different sample. 4. Re-analyze set of samples.	Measures instrument stability and sensitivity.
Surrogates	Present in all extracted samples (including QC) 1,2-Dichloroethane-d4 Toluene-d8 p-Bromofluorobenzene	Statistical Control Limits	1. Repeat analyses 2. Recalibrate with fresh fortification standard. 3. Re-extract samples.	Evaluates method performance on each individual sample analyzed.
Mass Spectra	Review all target analytes in standards, and also target compounds found in samples.	Spectra must be consistent with library database.	1.Verify calibration spectra and retention times. 2. Repeat analyses.	Used to qualitatively identify target compound hits in samples.
MDL Studies	MDL - Annually for water and soils and initially for each new instrument setup or analyst.	MDL< PQL	1. Repeat once 2. Correct problem	Evaluates overall method detection limits in clean sample matrix. Actual samples may have higher MDL.
LOD Verification Required for each analyte/method to verify calculated MDL.	Annually based on MDL Study frequency.	Positive Result, (Above background)	1) Examine method or preparatory steps, 2) Verify MDL study, 3) Repeat analysis 4) Consult QA	Spike at 2-3X calculated MDL.
External PE Samples	Semi-annually, WP and LPTP study samples.	PT sample defined acceptance limits (Must pass 2 out of last 3 PT studies)	1. Complete corrective action report. 2. Repeat with another make-up study (for failure of 2 out of 3).	External review of analytical method accuracy.

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ATTACHMENT 17.2 METHOD QA/QC PARAMETERS VOLATILE ORGANICS BY PURGE AND TRAP GC/MS EPA Method SW-846 8260B for SOIL & WATER				
QA SAMPLE/ INDICATOR	**FREQUENCY**	**ACCEPTANCE CRITERIA**	**CORRECTIVE ACTION**	**COMMENTS**
Control Charting and Proof of Competency	Annual, statistical review of method.	Data statistically within control limits.	1. Trend Analysis/ Method Review. 2. Correct method/instrument problem. 3. Replace analyst.	For statistical process control.

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TABLE 2.
BFB MASS - INTENSITY SPECIFICATIONS (4-BROMOFLUOROBENZENE)[a]

Mass	Intensity Required (relative abundance)
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	base peak, 100% relative abundance
96	5 to 9% of mass 95
173	less than 2% of mass 174
174	greater than 50% of mass 95
175	5 to 9% of mass 174
176	greater than 95% but less than 101% of mass 174
177	5 to 9% of mass 176

[a] Alternate tuning criteria may be used (e.g. CLP, Method 524.2, or manufacturers' instructions), provided that method performance is not adversely affected.

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METHOD QA/QC PARAMETERS
SEMIVOLATILE ANALYSES BY GC/MS
EPA Method 8270C

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
Sample Preparation Extraction	SW-846 Methods: Soils: 3550B or 3545 Waters: 3510C or 3520C Wastes: 3550B, 3545, 3580 Surrogates added to all samples	Meet method QC criteria for the matrix.	1) Re-analyze sample or re-extract sample. If re-extraction outside of holding time report both sets of data.	Minimum sample volume required per sample. (Additional recommend) Soils: 30 grams Water: 1 Liter
Instrument Initial Calibration (IC)	5 point initial calibration Range:20,50,75,100,150	See Note #1	1) Correct problem 2) Prepare new standards 3) Recalibrate	Calibration of instrument and check of response linearity. Reporting: Audit review
Tuning	DFTPP Initially and every 12 hours thereafter.	Meet method tuning criteria. (Table 3 SOP ELI 50-009)	1) Adjust instrument 2) Recheck tune 3) Until successful	Evaluate mass sensitivity, mass resolution, isotope ratio, and baseline threshold. Reporting: Audit review
(ICV) Initial Calibration Verification	Quarterly or with each new lot# of standards used for calibration.	R% = 85-115 of IC	1) Correct problem 2) Prepare new ICV or IC standards	Evaluates accuracy/bias in calibration standards. Reporting: In data validating report package
Continuing Calibration (CC)	Mid-level standard analyzed every 12 hours to update internal standard response factors (RF)	See Note #2	1) Correct problem -Reanalyze CC. 2) Re-run instrument tune 3) Re-calibrate and re-analyze all samples since last valid calibration check.	Verifies instrument calibration and stability throughout analyses. Reporting: In data validating report package
GC Performance Analyte Degradation	Each Tuning: Evaluate TIC areas of DDT breakdown products and chromatographic profile	<20% breakdown	1) Instrument maintenance 2) Re-check tune	Evaluates chromatographic system for reactivity. Reporting: Audit review
Method Blank	Each batch of 20 samples/matrix or when there is a change of reagents , whichever is more frequent.	<½ PQL excepting phthalates	1) Repeat analyses once 2) Correct problem 3) Re-extract and re-analyze all samples associated with method blank.	Measures and evaluates possible contamination in reagents and glassware used in method. Reporting: Routine data reporting package.
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	Each batch of 20 samples/matrix or when there is a change of reagents, whichever is more frequent.	CLP SOW 3/90 (Table 9 - SOP ELI 50-009) or statistical control limits. %RPD = See example QA Matrix Spike reports	1) Repeat analyses 2) Re-extract and reanalyze MS, (if sufficient sample). 3) Evaluate LFB performance. (See Note #3)	Evaluates affect of matrix on method performance. Reporting: Routine data reporting package.
Lab Fortified Blank (LFB) QC Check Sample	Minimum 1/20 samples/matrix and each batch of samples, whichever is more frequent.	(Table 6 - SOP ELI 50-009) or statistical control limits.	1) Repeat analyses 2) Prepare new standards 3) Recalibrate 4) Re-extract and re-analyze all samples associated with LFB.	Evaluates method precision and accuracy. Reporting: Routine data reporting package.
Internal Standards (Samples)	Monitor total areas in each analyses Acenapthene-d10 Phenanthrene-d10 Chrysene-d12 1,4 Dichlorobenzene-d4, Napthalene-d8, and Perylene-d12	Samples: Area% 50-150% of IC RT = +/- 30 sec of IC.	1) Repeat analyses 2) Correct Problem 3) Re-prepare samples 4) Analyze different sample 5) Re-analyze set of samples.	Measures instrument stability and sensitivity. Reporting: Audit review
Mass Spectra	Review all target analytes in standards and reported analytes in samples	Spectra must be consistent with library	1)Verify calibration spectra and retention times	Used to qualitatively identify target compound hits in samples.

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METHOD QA/QC PARAMETERS
SEMIVOLATILE ANALYSES BY GC/MS
EPA Method 8270C

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS/REPORTING
	in samples.	database	2) Repeat analyses	Reporting: Audit review
Surrogates	Present in all extracted samples (including QC)	CLP-SOW 3/90 (Table 8 - SOP ELI 50-009) or statistical control limits	1) Repeat analyses 2) Recalibrate with fresh fortification standard. 3) Re-extract samples	Evaluates method performance on each individual sample analyzed. Reporting: Routine data reporting package.
MDL Studies	MDL - Annually each for water and for soils, initially for each new instrument setup or analyst. Calculated from method validation study of QC check sample. %R=60-140, %RSD <30	MDL <0.2X of PQL PQL = 10ug/L or 0.33ug/g with exceptions (See Note #4)	1) Repeat once 2) Correct problem	Evaluates overall method detection limits in clean sample matrix. Actual samples may have higher reporting limit. Reporting: Audit review
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. Or as needed	Data statistically within control limits.	1) Correct method problem 2) Adjust control limits 3) Replace analyst	For statistical process control. Reporting: Audit review

Note #1 %RSD for CCC (Table 4 SOP ELI 50-009) <30. RF for SPCC's (N-nitroso-di-n-propyl amine, hexachlorocyclopentadiene, 2,4-Dinitrophenol, and 4-Nitrophenol) > 0.050. If % RSD for a compound is < 15, linearity is assumed and average RF is used. If % RSD > 15 (and less than 30 for CCC), use a calibration curve with correlation coefficient >= 0.990. Lower calibration levels are not used for certain compounds. PQL's are adjusted as appropriate.

Note #2 RF for SPCC>0.050, RF of CCC's must be <20% difference from IC. RF of all other compounds must be <30% difference from IC.

Note #3 If any analyte in the MS/MSD fails, QC limits for failed compounds must be within acceptable recovery limits for the blank spike laboratory control sample.

Note #4 PQL for Benzidine, 3,3' Dichlorobenzidine, and pyridine = 20ug/L. 4-Nitrophenol, Pentachlorophenol, 2,4-Dinitrophenol, 4,6-Dinitro-2-methylphenol = 50 ug/L.

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METHOD QA/QC Parameters Volatile Petroleum Hydrocarbons (VPH) per Massachusetts Method January 1998 Revision				
QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Sample Preparation	Soils: Methanol Preserved vials required. 10 grams Soil/10mL of methanol VPH Surrogates added to all samples before extraction. Waters: VOA Vials, preserve to a PH<2.	Meet all method QC criteria for the matrix.	1) Reanalyze sample	VPH surrogates added to all sample before extraction.
Instrument Calibration (IC)	5 Point calibration to precede analyses. Use average response factors. Certain compounds are selected for FID calibration and other compounds are used for PID calibration.	25% RSD of Mean Response Factors. Includes individual compound response factors and range response factors.	1. Repeat calibration 2. Correct problem 3. Recalibrate	Used to calibrate instrument response. Consists of a 13 component standard containing both aliphatic and aromatic hydrocarbons
Initial Calibration Verification (ICV)	Follows valid initial calibration (See Blank Spike)		1. Repeat once 2. Recalibrate 3. Prepare fresh standards	Second source standard to evaluate calibration standard biases.
Continuing Calibration Check (CCC)	Every 12 Hours and at the end of every analytical sequence	75-125% of Initial Calibration for the CCC preceding sample analyses.	1. Repeat once 2. Correct problem 3. Recalibrate 4. Reanalyze all samples since last valid calibration check.	Analyses of Mid-level calibration standard to measure drift in instrument sensitivity/method performance.
Method Blank	Minimum 1/20 Samples	½ of PQL for target analytes	1. Repeat once 2. Correct problem 3. Re-analyze all samples since last valid method blank.	Method blank evaluates glassware reagents, and methodology to be free of contamination. Soil method blanks use clean sand.
Matrix Spike and Matrix Spike duplicate (MS/MSD)	Minimum 1/20 samples	(Recommended) 70-130% Recovery. 20% RPD between duplicates.	1. Evaluate matrix, possibly repeat using higher spiking level. 2. Correct problem 3. Verify sample homogeneity for soils.	Evaluates affect of matrix on method performance. Soils are spiked at time of extraction.
Laboratory Fortified Blank (Blank Spike)	Minimum 1/20 samples Soils are prepared using a blank sand matrix.	R% = 70 - 130	1. Repeat once 2. Correct problem 3. Re-analyze all samples since last valid laboratory fortified blank.	Evaluates overall performance of method on a characterized matrix.
Surrogates	TFT spiked into all samples analyzed	Recovery 70-130%	1. Evaluate sample matrix and surrogate spike level. 2. Repeat once 3. Evaluate LFB performance	Evaluates method performance on each individual sample matrix.
Analyte Confirmation in Samples	Confirm target VPH analytes by GC/MS analyses.	Upon client request.	None	Analyte identifications in samples are not routinely confirmed. GC/MS confirmation done only per client request.

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METHOD QA/QC Parameters Volatile Petroleum Hydrocarbons (VPH) per Massachusetts Method January 1998 Revision				
MDL Studies	MDL - Annually for soils and water and initially for each new instrument setup or analyst.	MDL<0.3X of PQL	1. Repeat once 2. Correct problem 3. Until successful	Method Detection Limit (MDL) studies are used to verify the ability to measure analyte measurements at the minimum reporting level.
Proof of Competency	Statistical review of method QC data for each analyst.	Data statistically within control limits.	1. Correct method problem 2. Replace analyst	Review of each analyst QC data show them to be skilled competent analysts.
External PE Samples	None	Within interlaboratory control limits	1. Repeat 2. Correct problem	External PE samples are not utilized. Laboratory analyzes internal QC samples as per method.
Control Charting	Annually or as needed	Data statistically within control limits.	1. Correct method problem 2. Adjust control limits 3. Replace analyst	Surrogate, MS, LCBS %recovery, and RPD are done biannually. MS/MSD data not plotted.

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METHOD QA/QC PARAMETERS
Extractable Petroleum Hydrocarbons (EPH) per Massachusetts Method
January 1998 Revision

QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Sample Preparation	Methods: Soils: 3550 (30 grams to 1mL) Waters: 3510 or 3520 (1 Liter to 1 mL) 1mL of EPH extraction surrogates added to all samples prior to extraction. 1 ml of EPH separation surrogates added to extract just prior to separation.	Meet all method QC criteria for the matrix.	1) Re-analyze sample	Samples are extracted using Methylene chloride solvent and then the extract is concentrated. Following separation of extract into an aliphatic and aromatic fraction each fraction is independently analyzed by GC/FID. Sample amount and final extract volume may be adjusted based on analyte levels and/or sample matrix.
Fractionation Check	Per each Lot # of Separation Cartridges Used	Effective separation of target analytes into appropriate fraction. R%=40-140 except the more volatile target analytes with >20% recovery.	1. Repeat once 2. Correct problem (adjust elution volumes) 3. Prepare new standards 4. Recalibrate	Uses aliphatic and aromatic hydrocarbon standards in hexane. The more volatile aromatic and aliphatic compounds may have lower recoveries than method specified limits.
Initial Calibration (IC)	5 point initial calibration each for aliphatics and aromatics, external standardization option of method chosen. Aliphatic Standard Solution Aromatic Standard Solution Range: 5,50,200,500,and 1000 ug/mL. To precede sample analyses.	25% RSD MnRF 25%RSD each component.	1. Repeat once 2. Correct problem 3. Prepare new standards 4. Recalibrate	Used to Calibrate instrument, evaluates chromatographic separation effectiveness, and instrument response linearity. .
Chromatography	1) Each IC or CCC- Resolution is verified 2) Retention Time Windows –Use RRT and analyst discretion for instrument stability.	Chromatographic resolution: Monitored against historical performance levels. 50% separation of phenanthrene and anthracene.	1. Repeat once 2. Adjust column conditions 3. Perform instrument maintenance 4. Replace GC column	Verifies that gas chromatographic system is operating properly. Resolution criteria for two selected PAH pairs are not met as per method specifications.
Initial Calibration Verification (ICV)	Follows the IC, using second source calibration standards. DRO standard used to verify aliphatic IC standard and a separate PAH standard is used for aromatics.	+/- 25% of MnRF +/- 25% RF each component	1. Repeat once 2. Prepare fresh standards and reanalyze. 3. Recalibrate and re-analyze all affected samples.	Evaluates accuracy of calibration standards.
Continuing Calibration Check (CCC)	Mid-level standard analyzed every 12 hours and at the end of every analytical sequence	+/- 25% of MnRF +/- 25% RF each component	1. Repeat once 2. Correct problem 3. Re-calibrate and re-analyze all samples since last valid calibration check.	Verifies instrument calibration and stability throughout analyses. No QC criteria for the CC following sample analyses.
Method Blank	Each batch of 20 samples/matrix or when there is a change of reagents, whichever is more frequent.	<½ PQL	1. Repeat analyses once 2. Correct problem 3. Re-extract and re-analyze all samples associated with method blank.	Measures and evaluates possible contamination in reagents and glassware used in method.

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QA SAMPLE/ INDICATOR	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Instrument Blank	Each 12 hour sequence or as indicated, such as after a heavily contaminated extract. A method blank analyses can be substituted for an instrument blank.	<½ PQL	1. Repeat analyses once 2. Perform Instrument maintenance 3. Re-analyze all associated samples in sequence where contamination level may affect result.	Measures and evaluates possible contamination in gas chromatographic analysis system.
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	Each batch of 20 samples/matrix or when there is a change of reagents, whichever is more frequent. Fortified with 5 or more representative aliphatic and 5 or more aromatic compounds. Uses a second source standard.	%R = 40-140 except for the more volatile aromatic and aliphatic compounds which may have lower recovery. %RPD = 50% (advisory)	1. Repeat GC analyses 2. Re-extract and reanalyze MS/MSD, (if sufficient sample) or select another sample to MS. 3. Evaluate LFB performance.	Evaluates affect of individual matrix on method performance and method precision. Poor MS/MSD QC performance does not necessarily reject extraction batch group. Control limits are advisory due to sample matrix effects.
Blank Spike (BLKSPK)	Minimum 1/20 samples/matrix and each batch of samples, whichever is more frequent. Same spiking solution as for MS/MSD	%R = 40-140 .	1. Repeat analyses 2. Prepare new standards 3. Recalibrate 4. Re-extract and re-analyze all samples associated with LFB.	Evaluates method accuracy. Used for ongoing proof of competency.
Extraction Surrogates	Added to all samples prior to extraction (including QC). Ortho-Terphenyl (PAH fraction) and 1-Chloro-octadecane (Aliphatic fraction).	%R = 40-140 Control limits are advisory due to possible sample matrix effects.	1. Repeat analyses 2. Evaluate for matrix effects 3. Re-extract samples if method batch performance is suspected.	Evaluates extraction and separation method performance on each individual sample analyzed. Water samples containing sediment may have reduced analyte and surrogate extraction efficiency. Extraction performance alone can be evaluated from an EPH screening result.
Separation Surrogates	Surrogates added to sample extract prior to fractionation. 2-Bromonapthalene and 2-Fluorobiphenyl.	%R = 40-140 in Aromatic fraction. Control limits are advisory due to possible sample matrix effects.	1. Repeat analyses 2. Evaluate for matrix effects 3. Re-extract samples if method batch performance is suspected.	Evaluates the effectiveness of the aliphatic/aromatic separation step. Proportional Level of presence of either surrogate in the aliphatic fraction suggests incomplete separation of the more volatile PAH's from the aliphatic fraction.
EPH Screening	Analyses of extract prior to the separation step of the EPH method.	%R = 40-140 for extraction surrogates. Full EPH recommended if TEH result >0.1mg/L for waters or 50ug/g for soils.	1. Repeat analyses 2. Evaluate for matrix effects 3. Re-extract samples if method batch performance is suspected.	Evaluates method extraction performance on each individual sample analyzed. Target analyte levels in result are used to determine if full EPH analyses is necessary.
PAH Target Analyte Confirmations	Analyses performed by 8270 on Aromatic fraction if PAH target analytes are present above MTDEQ limits.	Meets 8270 analyses criteria	1. Repeat analyses to meet all 8270 method QC criteria	Confirms and accurately quantitates PAH levels in aromatic extract. 8270 method isconsidered less sensitive to false positives than the EPH method..
MDL Studies	MDL – Annually for water and soils and initially for each new instrument setup or analyst.	MDL< PQL	1. Repeat once 2. Correct problem	Evaluates overall method detection limits in clean sample matrix. Actual samples may have higher MDL.
External PE Samples	None	Within specified interlaboratory control limits	1. Repeat 2. Correct problem	External review of analytical method accuracy. See BLKSPK.
Control Charting and Proof of Competency	Annual, statistical review of method QC data for each analyst. or as needed	Data statistically within control limits.	1. Correct method problem 2. Adjust control limits 3. Replace analyst or extractionist	For statistical process control and demonstration of capability for analysts.

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APPENDIX C
General Radiochemistry QA/QC Parameter Table

Method QA/QC Parameters Radiochemistry Elements (Elements must be tailored to specific method) DW: Drinking Water Non-DW: Non-Drinking Water				
QA SAMPLE/ SAMP TYPE CODE	**FREQUENCY**	**ACCEPTANCE CRITERIA**	**CORRECTIVE ACTION**	**COMMENTS**
Initial Calibration	Prior to use of instrument – dependent upon type of instrumentation	Varied depending upon the instrument. Specific criteria accompany each calibration procedure.	1) Recount/recalibrate. 2) Perform instrument maintenance or service instrument, if needed.	
Instrument Background	Prior to and following each batch of samples (At least prior to each day of use)	Statistical control limits 3σ from continuing control chart	1) Recount on the detector that did not pass. 2) If the recount passes, recount all samples since last valid background on that detector. 3) If the recount fails, put detector out of service and determine cause of failure.	Establishes the background radiation inherent in the instrument. Must be counted as long as the sample count time. Used in conjunction with detector efficiency as part of the instrument performance check.
Detector Efficiency (Radionuclide specific to method)	Prior to or with each batch of samples (At least prior to each day of use)	Statistical control limits 3σ from continuing control chart	1) Recount on the detector that did not pass 2) If it passes, recount all samples since last valid efficiency on that detector. 3) If it fails, put detector out of service and determine cause of failure.	Evaluates instrument drift. Used in conjunction with instrument background as part of the instrument performance check.
Reagent Blank (RB) / Method Blank (MBLK)	1/ batch	<RDL (Required Detection Limit) (Value may be regulatory or client based)	1) Recount the RB/MBLK. 2) If recount fails, either qualify data, or 3) Evaluate reagents to assess if there is contamination, reprep samples and reanalyze	Monitors for potential contamination from several sources of interferences in the sample preparation in addition to the background of the detector used.
Water Laboratory Control Sample (LCS) / Laboratory Fortified Blank (LFB)	1/batch	DW (general): 90-110%, DW GrA/GrB & Ra-228: 80-120% (Limits may be set statistically for non-DW methods)	1) If LCS or LFB does not pass recount. 2) If recount does not pass, re-prep and rerun. 3) If LCS or LFB do not pass on second prep, re-calibrate and rerun.	Evaluates spiking technique and method performance.
Soil Laboratory Control Sample (LCS)	1/batch	Statistical control limits 3σ from continuing control chart	1) Recount the LCS 2) If LCS passes, recount all samples since the last successful LCS and report the newer results. 3) If LCS fails, Re-prep and re-analyze all samples associated with LCS	Evaluates overall method accuracy/bias for the Batch.

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Matrix Spike (MS/MSD)	DW: 1 MS/MSD pair/ 10 samples Non-DW: 1 MS/MSD pair / batch	DW (general): 80-120%, DW GrA/GrB & Ra-228: 70-130% (Limits may be set statistically for non-DW methods)	LCS/LFB must be passing 1) If matrix interference suspected report as found with qualifier and case narrative, or 2) Recount 3) Reprep the batch	Evaluates effect of matrix on method performance. MSD also evaluates method precision.
Duplicate Sample (DUP)	1/10 samples DW Or 1/20 samples non-DW methods	DW: 20% RPD RER for results ≤ 2 when average value is ≤ 5xMDC (Limits may be set statistically for non-DW methods)	1) Recount sample pair, evaluate for sample homogeneity 2) Reprep the sample/duplicate pair and reanalyze	Evaluates method precision. MSD duplicate analyses preferred on some methods.
External PE Samples	Semi-annually	PT sample defined acceptance limits established by supplier (Must pass 2 out of last 3 PT studies)	1) Complete corrective action report 2) Repeat with another make-up study (for failure of 2 out of 3)	External review of analytical method accuracy.
Method Sensitivity Study	As part of Initial Demonstration of Capability	Must meet method requirements	1) Evaluate method, technique, instrument setup 2) Repeat study	Spike level must be between the MCL and the required detection limit for that specific analyte
Minimum Detectable Concentration (MDC)	Determined for each sample based on count time and volume of sample used.	MDC is the primary method of determining the minimum detectable activity for radiochemistry samples (40 CFR 141.25(c)). The MDL procedure (40 CFR 136 App B) is required for Drinking Water per the Certification Manual. For DW samples, 40 CFR 141.25 Required Detection Limit (RDL) value must be achieved. Specifics for the MDL studies are given immediately below.		
MDL Studies (DW only)	Annually per method requirement for DW or whenever method changes might affect sensitivity	For DW samples, 40 CFR 141.25 Required Detection Limit value must be achieved.	1) Repeat if obvious problem occurs 2) Determine root causes. Repeat study.	Evaluates overall method detection limits in clean sample matrix.
Control Charting	Ongoing statistical review of method parameters	Statistical control limits 3σ from continuing control chart, or as required for DW samples	1) Determine root cause of trends, outliers, etc. for continual improvement.	Evaluates ongoing method performance
Demonstration of Capability	Annually	LCS must be within method specified criteria.	1) Trend Analysis/ Method Review 2) Correct method/instrument problem.	Documents analyst's capability to perform analysis for the specific method.
Batch Definition	20 samples	Must pass method QC criteria	Re-analyze batch or qualify results	A group of samples and associated QC
**Refer to specific SOPs for applicable QA Parameters/QC Elements for individual method.				

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APPENDIX D

Organizational Charts

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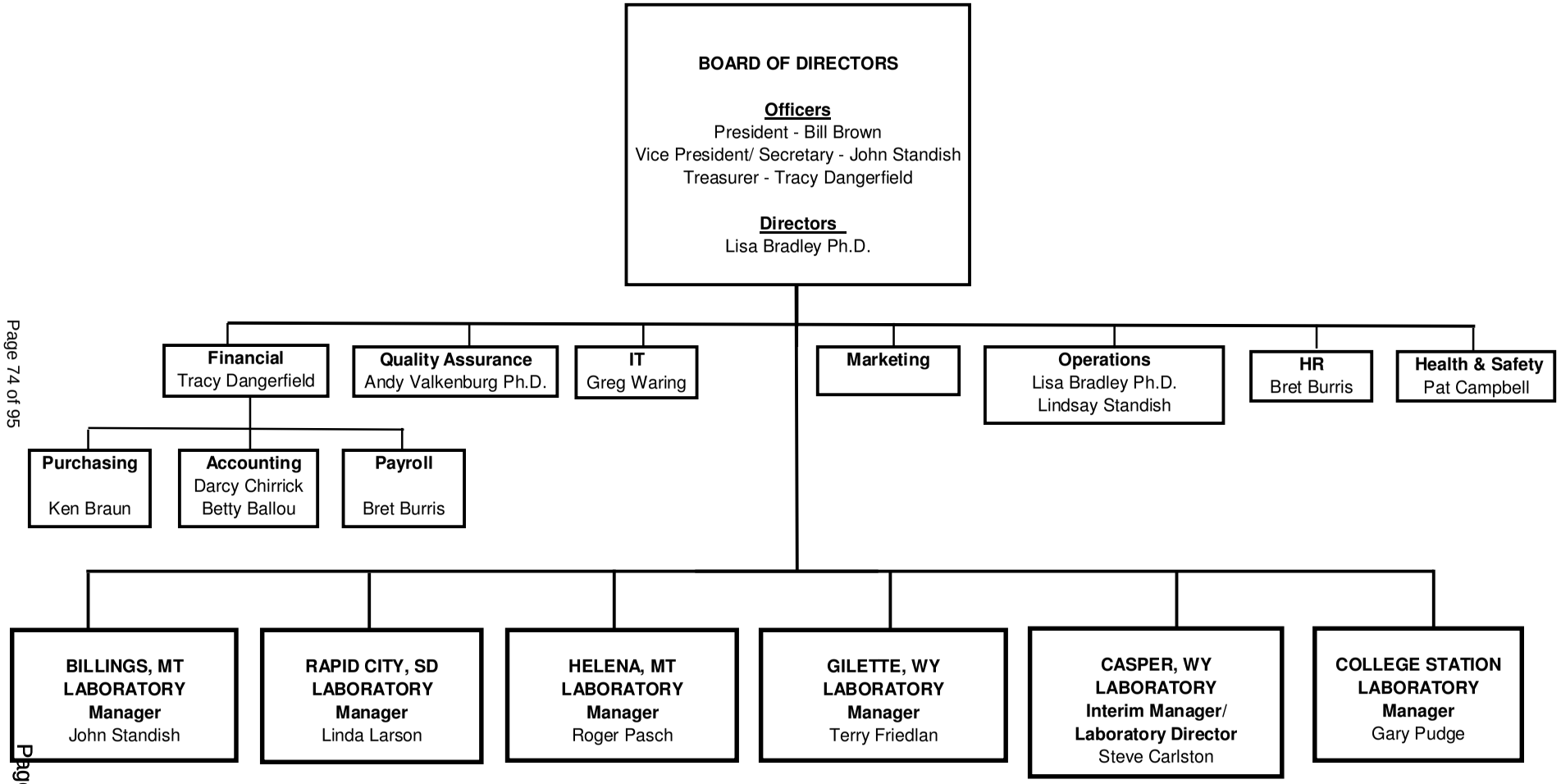
ATTACHMENT 7.2

Energy Laboratories, Inc.
Corporate Organizational Chart
June 2011



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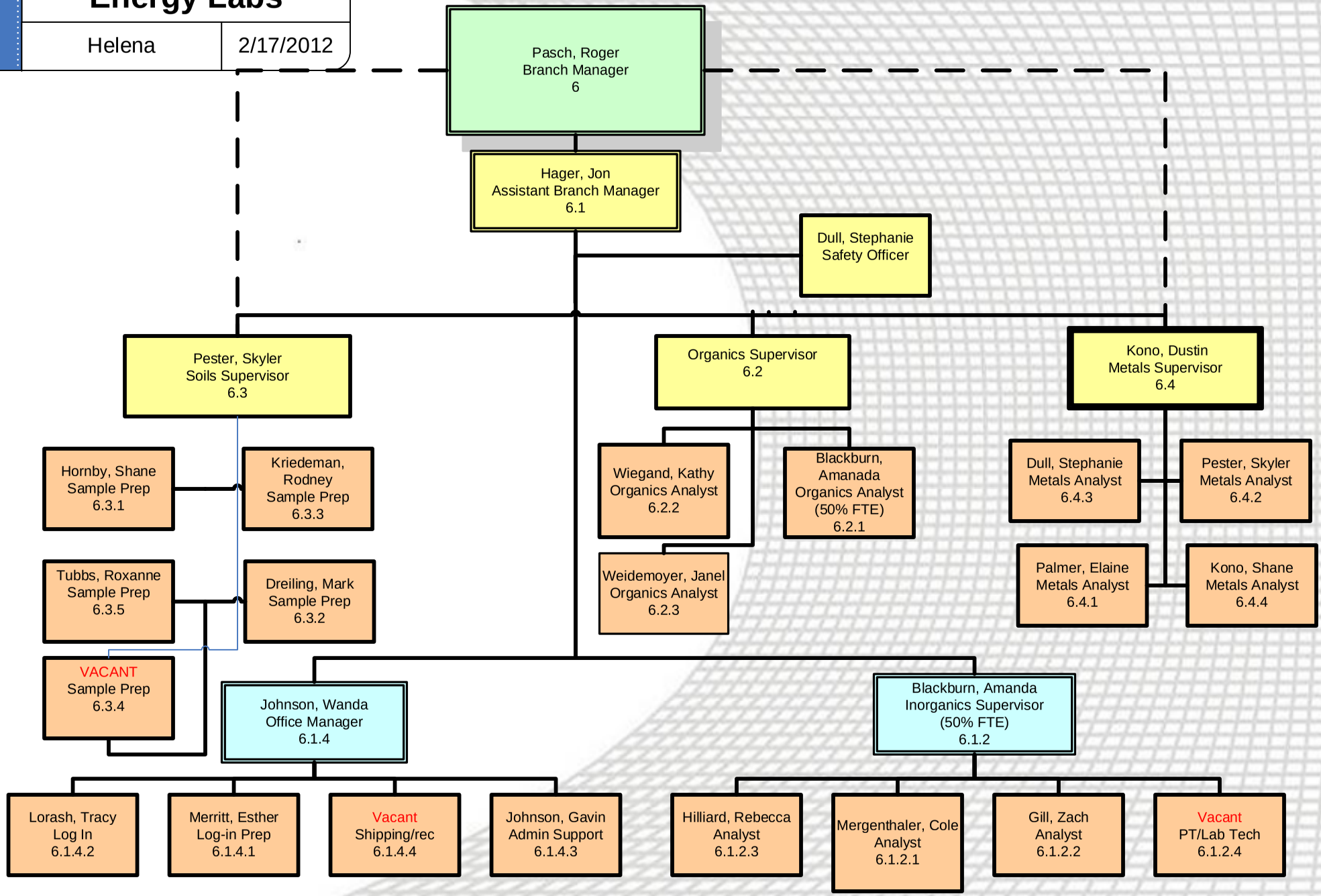
Energy Labs

Helena	2/17/2012



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ENERGY LABORATORIES

APPENDIX E

Curricula Vitae of Key Laboratory Personnel

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WILLIAM T. BROWN

President

Director Of Organic Analysis Department

Experienced in laboratory methods development, on-site sampling and analysis, and analytical chemistry.

Education & Academic Training

Bachelor of Science in Fish and Wildlife, Montana State University, Bozeman, MT, Management, 1977

Organic Chemistry and Analytical Instruments, Eastern Montana College, Billings, Montana. 1980

Operation and maintenance of Dionex Ion Chromatograph, Dionex Corporation, 1977.

Modern Techniques in Gas Chromatography, American Chemical Society Short Course, 1988.

Gas Chromatography Mass Spectrometry, American Chemical Society Short Course, 1989.

Finnigan Mat Company Gas Chromatograph Mass Spectrometry Training Course, 1989.

Analysis of Water & Waste Samples by U.S. EPA Methods, American Chemical Society Short Course, 1990.

Professional Experience

1986 to Present: President, Chemist - Energy Laboratories, Inc., Billings, Montana. In charge of the development of the trace organics analytical department. Develops test methods, selects equipment, and trains technical staff in the analysis of trace organic compounds in samples of environmental and commercial interest.

1981 – 1987: Manager - Energy Laboratories, Inc., Branch Laboratory, Gillette, Wyoming. Responsible for routine analysis and quality control of water, natural gas, and petroleum products. Involved in field on site sampling and testing, meter calibrations, and supervision of branch laboratory staff.

1979 – 1981: Laboratory Technician - Energy Laboratories, Inc., Billings, Montana. Responsible for the natural gas and petroleum products department of the lab including field natural gas testing. Also involved with various work in water and soil analysis including formal training in ion chromatography.

1977 – 1979: Fisheries Biologist - Water and Forests Department of the Government of Niger, Africa. While in the Peace Corps, responsible for developing fisheries management programs in a specific region including monitoring water quality by on-site testing.

JOHN M. STANDISH

Vice President

Experienced in the examination of many types of environmentally related samples including water, soil, coal, and air pollutants

Education and Academic Training

Bachelor of Science in Biology, College of Great Falls, Great Falls, MT, 1973

Managing the Chemical Analysis Laboratory, 32 hr seminar, 1979

Financial Management of the Closely Held Business, 8 hr seminar, 1985

Hiring and Firing, 8 hr seminar, 1986

MS-DOS Operating Systems, 16 hr class, 1986

Dale Carnegie Training, 14 week training 1986

Taking Control of Your Workday, 8 hr seminar, 1989

Pittsburgh Conference of Analytical Chemistry, 5 day conference, 1989 & 1992

Unix Operating Systems, 24 hr class, 1991

New Sample Preparation Methods for Chemical Analysis, American Chemical Society Short Course, 1992.

Professional Experience

1981 – Present: Lab Director/Chief Chemist - Energy Laboratories, Inc., Billings, Montana. Coordinates laboratory analysis with client contracts. Responsible for direction, training, and supervision of the analytical laboratory staff. Involved in new procedural and equipment development, quality assurance program, client relations, and report preparation.

1974 – 1981: Director of Chemical and Environmental Laboratory - Northern Testing Laboratories, Inc., Billings, Montana. Responsible for personnel training and supervision, laboratory schedules, client relations and analytical methodology development. Chief areas of analysis were soils, water, coal, air pollution, and meteorological monitoring.

Professional Organizations

American Society of Testing and Materials
Montana Mining Association
Montana Geological Society
Northwestern Mining Association

CORNELIUS A. VALKENBURG Ph.D.

Corporate Quality Assurance Officer

Education

Ph.D., Analytical Chemistry, Montana State University, Bozeman, Montana, 1987
Bachelor of Arts, Biology with minor in Chemistry, Carroll College, Helena, Montana, 1979
Technical Writing, University of Nevada, Las Vegas, Nevada, 1988
Emergency Medical Training, Hillsboro Medical Hospital, 1981
Mass Spectrometry, Oregon Graduate Center, 1981
Dale Carnegie Management Training, Billings, Montana, 1996
Dale Carnegie Graduate Assistant Training, Billings, Montana 1997

Professional Experience

1992- Present, Analytical Chemist/Quality Assurance Officer - Energy Laboratories, Inc., Billings, Montana. Corporate Quality Assurance Officer responsible for the Quality Assurance monitoring of laboratory operations. Performs method development, prepares and updates standard operating procedures, performs technical training, and involved with special projects. Manages laboratory solvent recycling program.

1989 - 1992, Senior Organic Analytical Chemist - ICF Kaiser Engineers, Las Vegas, Nevada. Provide supervisory and technical support in the design, preparation, analysis, and multi-laboratory certification of analytical method performance evaluation materials used to evaluate current and proposed EPA organic analytical procedures. Also review proposed EPA methods contracts for technical accuracy. Secondary duties as Laboratory Safety Officer.

1987 - 1989, Senior Scientist - Lockheed Engineering and Sciences Company, Environmental Programs (Organic Chemistry Section), Las Vegas, Nevada. Responsible for research and development projects as applied to improved methods for the analysis of EPA priority pollutants. Areas of study include: liquid-liquid extractions, solid-phase extraction, soil leachability modeling (TCLP), chemical derivatives for gas and liquid chromatography, production of performance evaluation materials, gas chromatographic methods, supercritical fluid chromatography and extraction, and laboratory automation.

1981 - 1987, Ph.D. Candidate, Graduate Research, Assistant - Montana State University, Department of Chemistry, Bozeman, Montana. Research in gas chromatographic detector design, modification, and characterization by computer modeling. Teaching of undergraduate laboratories in the areas of inorganic, organic, and analytical chemistry.

1981 - 1981, Research and Development Chemist - Falls Chemicals, Great Falls, Montana. Methods development for the analysis of raw materials and formulated products used or produced by Falls Chemicals. Performed optimization studies for plant chemical processes.

1980 - 1981, Research Technician - Oregon Graduate Center, Beaverton, Oregon. Synthesis and purification of polyamine dueterated analogues for their use as internal standards in mass spectrometry.

1978 - 1979, Field Technician and Student Researcher - State of Montana Water Quality Bureau and Carroll College, Helena, Montana. Evaluate the effects of subsurface drainage on saline seep areas.

Summer 1978, Lab Technician - American Chemet Corporation, East Helena, Montana. Quality control for the manufacture of CuO and CuO2, and the trace analysis of Pb. Methods used were wet chemistry, electrochemistry, and atomic absorption.

Professional Organizations
American Chemical Society
Environmental Employees Association

ROGER N. PASCH

Laboratory Manager

Experienced in the examination of many types of environmentally related samples including water, coal, and air pollutants, and specializing in soil analysis.

Education and Academic Training

Bachelor of Arts, Department of Natural Resources. Minor in Biology, University of Wisconsin, Stevens Point, 1973

Varian ICP/MS Course, 4 day seminar, 1999

TJA-ICP Training Course, 4 day seminar, 1992

Dale Carnegie Training, 14 week training, 1987

Interaction Management, 40 hr class, Billings, MT, 2008.

Professional Experience

2002 - Present, Chemist/Soil Scientist/Laboratory Branch Manager - Energy Laboratories, Inc., Helena, Montana. Set up laboratory in College Station, Texas for soil, water, and waste analysis. Responsible for laboratory layout, client contact, and equipment setup.

1979-2002, President – Inter-Mountain Laboratories, Sheridan, Wyoming. Coordinated development of environmental laboratories in four locations for air, water, and soil analysis. Chief areas of expertise in trace metal analysis and soil, overburden, and topsoil analysis. Worked with state and federal agencies, and private mining companies on method development for soil and overburden analysis.

JONATHAN D. HAGER

Assistant Laboratory Manager

Adept at inorganic analysis of water and soil matrices. Assists branch manager in operation and supervision of daily laboratory operations.

Academic Training

Bachelor of Arts in Biology, Chemistry Minor, Carroll College, Helena, MT, May 2003

GC/MS Training Seminar, Restek 8 hour seminar, Sept 2005.

Interaction Management, 40 hr class, Billings, MT, 2008.

Professional Experience

May, 2001-Present: Assistant Laboratory Manager/Quality Assurance Manager-Energy Laboratories, Inc., Helena, Montana. Responsible for assuring quality of all data and QA generated in the Helena branch lab, as well as generating and keeping training records of all individuals employed at the Helena branch. Skilled in all inorganic analyses, including analysis of Nitrate+Nitrite, Ammonia, Phosphorus, COD, Fluoride, pH, Conductivity, Chloride, Alkalinity, TSS, and TDS. Performed Analyses of metals by ICP in both soils and waters. Organics Department Supervisor: Involved in training and supervising of employees in the organic department and the soil department. Experience in organic analyses with a focus on GC/MS volatile analysis. Also skilled in numerous soil analyses such as CEC, pH, Conductivity, SAR, ESP, and PSA. As Project Manager, work with clients regarding sampling and setting up projects performed by Energy Labs. Also deal with questions soil clients have regarding reports and data.

Professional Organizations

American Chemical Society

WETA

Association for Environmental Health and Sciences (AEHS)

Alaska Miners Association

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AMANDA B. BLACKBURN

Quality Assurance Manager/Inorganics Supervisor

Experienced in the examination of many types of environmentally related samples including water, soil, and air pollutants.

Academic Experience

Bachelor of Arts in Chemistry, Carroll College, Helena, MT, May 2004
GC/MS Training Seminar, Restek 8 hour seminar, Sept 2005.
Interaction Management, 40 hr class, Billings, MT, 2008.

Professional Experience

May 2004-Present, Quality Assurance Manager/Inorganics Supervisor, Energy Laboratories, Inc., Helena, MT. Responsible for assuring quality of all data and QA generated in the Helena branch lab, as well as generating and keeping training records of all individuals employed at the Helena branch. Supervise Inorganics Department.

GC Analyst—Analyze for volatile contaminants by GC/MS. Analyze for volatiles in air method TO-17.

Inorganic Analyst—Analyze for parameters such as pH, conductivity, alkalinity, nitrates, etc. Knowledgeable in the analysis of common anions by Ion Chromatography.

Microbiology Analyst-Certified analyst for total coliform and E.Coli in both public and private water samples.

Sample Receipt/Login and Reporting—Coordinate client relations from bottle preparation and sample receipt through reporting and invoicing, and data review of technical reports issued to clients.

WANDA J JOHNSON

Office Manager

Adept at client relations, sample receipt and login, and data processing, including reporting of clients' data.

Education and Academic Training

HS Graduate, General Studies—Business Courses

Interaction Management, 40 hr class, Billings, MT, 2009.

Professional Experience

2002 - Present, Office Manager, Energy Laboratories, Inc., Helena, MT

Sample Receipt/Login Supervisor-Responsible for overseeing the login department. Manages the flow of sample receipt and ensures proper protocol is followed. Includes verification and signing of Chain of Custody, sample receipt conditions, entering of sample information into the sample database and delivery of samples to the proper department for analysis.

Reporting—Generates and mails client reports and invoices. Prepares, proofs, and mails public water system CCR reports each spring.

Client Relations—Creates new client accounts and updates Helena database with any changes to existing accounts from any of the branch labs.

Electronic Data Delivery—Creates and e-mails CSV, Excel, PDF, or EDD files for clients who request those formats.

Helena Accounting—Collects up-front client payment when applicable, and ensures delivery of all payments and invoices to the Energy Labs SBT accounting system at our corporate office.

1993-1999, Heritage Home Health, Helena, MT
Responsible for payroll and accounts receivable for 5 branch offices. Managed employee and contact personnel files to federal and state guidelines requirements. Reviewed medical records for appropriate coding to meet Medicare/Medicaid and insurance requirements.

1990-1993, Independent Home Health, Helena, MT
Responsible for payroll and accounts receivable for 5 branch offices. Managed employee and contact personnel files to federal and state guidelines requirements. Reviewed medical records for appropriate coding to meet Medicare/Medicaid and insurance requirements.

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STEPHANIE L. DULL

Safety Officer/ Chemist
Experienced in the administration of safety programs and analysis of environmental samples.
Proficient at running many inorganic analyses and assuring timely turnaround of samples.

Education:

Bachelor of Arts in Biology, Carroll College, Helena, MT, May 2003

Master of Science of Forensic Science - Advanced Investigation, University of New Haven, West Haven, CT, August 2004

Experience:

March 2005 – Present, Safety Officer/Chemist, Energy Laboratories, Inc., Helena, MT

Skilled in many inorganic analyses including alkalinity, chlorides, conductivity, pH, sulfate, TDS, and TSS and Nutrient Analysis.

Experienced in ICP analysis for metals in both water and soil matrices.

Implementation and maintenance of safety program in the Helena lab under the guidance of the Corporate Safety Officer.

SKYLER PESTER

Soil Laboratory Supervisor

Proficient at performing various soil analyses and analysis of major cations.

Education

Bachelor of Arts in Chemistry with a minor in Biology and Business Administration from Carroll College Helena MT (2008)

Professional Experience

April 2008-Present Energy Laboratories-Helena
Responsible for management of the soils department. Coordinates work flow and reviews data to ensure quality data and data integrity.

Skilled in nutrients analysis, Hg, Se, As and Chlorophyll Analysis on HPLC, metals analysis by Inductively Coupled Plasma.

Interaction Management (8 Hours)

Certifications

First Responder
Advanced Wilderness First Aid
CPR/AED
SAR Tech III
Swiftwater Rescue Tech I
Dive Rescue Tech I
Ice Rescue Tech
Hovercraft Pilot.

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DUSTIN KONO

Metals Supervisor

Skilled in metals analysis of soil and water with the goal of providing quality results and efficiency.

Education

Bachelor of Science in Biology, Chemistry Minor, MSU-Billings, Billings, MT, 2007

Professional Experience

December 2009 - Present, Analyst/Metals Supervisor, Energy Laboratories, Helena, MT
Experienced with ICP-MS analysis of soil and water samples. Supervise metals analyses including ICP, Mercury and Arsenic/Selenium speciation. Quality of data is monitored along with accuracy of associated methodologies in these areas.

May 2007 - November 2009, Chemist, Northern Analytical Laboratories, Billings, MT

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JANEL WEIDEMOYER

Organics Analyst/Assistant Quality Control Manager

Experienced in EPH analysis and assists in supervision of the Quality Control program.

Education

Bachelor of Science, Delaware Valley College of Science and Agriculture, Doylestown, PA, May 2000

Professional Experience

May 2011 - Present: Organics Analyst - Energy Laboratories, Inc., Helena, Montana. Perform extraction of soil and water samples and subsequent fractionation for EPH analysis. Operate and maintain gas chromatography instrumentation, and evaluate chromatograms.

2005 - 2010: QC Specialist II - GlaxoSmithKline Biologicals, Hamilton, Montana. Perform qualitative and quantitative test methodologies such as TLC, Karl Fischer moisture, wet chemistry assays, visual inspections and gravametric determinations for in-process, release and stability bulk product samples.

2004 - 2005: QC Associate Biochemist - GlaxoSmithKline (Medsource Professionals), King of Prussia, Pennsylvania. Perform immunoassays including ELISAs and western blots on biopharmaceutical products for in-process and release testing.

2003 - 2004: Laboratory Technician - Argus Research Laboratory (Charles River Laboratories), Horsham, Pennsylvania. Perform daily test article/substance administration, observation, and husbandry of rats, mice, and rabbits during routine reproductive toxicity, phototoxicity and neurotoxicity study designs.

ATTACHMENT 1

Record of Review/Revision

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ATTACHMENT 1
RECORD OF REVIEW/REVISION
HELENA, MONTANA
Quality Assurance Manual

Date of Review/ Revision	Revision Number	Performed By	QA Manager Approval Initials/Date	Action (Review with no changes/ Detailed modifications)
2/16/12	2/16/12	A. Blackburn		Replaced "EPA" with "USEPA". INTRO Section: Moved ELI commitment section to Introduction, removed Quality Policy Statement, moved "Relationship between Mgmt…and Quality System" paragraph to Ch 4 (Personnel Requirements). Added Client specific DQO information, Moved information @ "Written SOPs available at laboratory" to Ch1-Method QC Specifications. Ch1: Replaced "SOPs" with "Chapter 13 of this manual" includes recommended preventative maintenance…Added to Method QC Specifications Paragraph, "ELI SOPs are considered confidential proprietary information and ELI does not provide copies of SOPs off ELI premises." Moved "For radiochemical analyses, each method undergoes Method Validation as outlined in EPA's specific method and the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP), Chapter 6. " and "The required detection level (RDL) for radiochemical analyses of drinking water samples is calculated based on the requirements in 40 CFR 141.2~~7~~5(c), which is a sample specific determination. The equation is specific for each method and noted in the method-specific SOP." Updated ELI MDL SOP reference. CH 4: Added "and laboratory experience/training appropriate to the procedures they are performing" to analysts. Added electronic signature info to Approved signatories section. CH 5: Added: To ensure that drinking water analysis for radiochemistry are met, the requirements for sample handling, preservation, and instrumentation for radiochemical analysis are included in ELI SOP, "Sample Receipt, Log-In and Labeling". (For additional information, refer to "Manual for the Certification of Laboratories Analyzing Drinking Water, Table VI-2: Sample Handling, Preservation, and Instrumentation, EPA 5th Edition, January 2005)". Ch 7: Added to laboratory stock/working stds: "are derived from ISO 17025 and/or 9001 (or equivalent-certified)" commercially available. Removed "for drinking water samples" from MDL are determined according to EPA guidelines… and added (except for the few methods that are not amenable to MDLs)." Replaced MDL with "practical quantitation limits". Removed "General method detection limits are given

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Date of Review/ Revision	Revision Number	Performed By	QA Manager Approval Initials/Date	Action (Review with no changes/ Detailed modifications)
				in Appendix D". Ch 8: Added information @Record of Review/Revision page included on SOPs. Removed from Laboratory Notebooks, "Laboratory notebooks are controlled with unique identifiers. They are indexed and maintained at a commercial storage facility when completed". Added to Reporting section, "Clients are able to access their electronic files through ELI's secure website @ https://energysource.energylab.com/. CH 10: Removed, " Balances are checked monthly against a second set of NIST traceable ASTM Type I weights." Replaced "periodically" with annually for when SOPs are reviewed. CH 11: Replaced ELI's website "global compliance" with "Alert". CH 13: Added, "Repairs and maintenance are accomplished in-house by experienced laboratory personnel. Other than consumable equipment items, an inventory of spare parts is not maintained. Spare parts are available from outside vendors on an as needed basis. (To ensure method capability, some methods have more than one instrument available)." References Section: Added ASTM D7282-06 Radiochem reference.

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Date of Review/ Revision	Revision Number	Performed By	QA Manager Approval Initials/Date	Action (Review with no changes/ Detailed modifications)

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ATTACHMENT 2

Record of Acknowledgment

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Energy Laboratories-Helena, Quality Assurance Manual
Record of Acknowledgement

My signature below constitutes my acknowledgement that I have read, understand and will follow this Quality Assurance Manual.

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