Olympus Technical Services, Inc.

April 28, 2026

Patrick Skibicki
Montana Department of Environmental Quality
Brownfields and Federal Facilities Section
PO Box 200901
Helena, MT 59620-0901

Re: Corrective Action Work Plan Required for the Petroleum Release at MRL (Former Shell Oil Bulk Plant)
Milepost 40+0244, 701 East Pike Avenue
Columbus, Stillwater County, Montana
Facility ID No. 48-12059 (TID 17180), Release No. 4036
DEQ Work Plan ID No. 716835169
Olympus Work Order No. A4190

Dear Mr. Skibicki:

This letter presents a corrective action work plan for the Former Shell Oil Bulk Plant Facility (Site) located at BNSF Railway Company (BNSF) Milepost 40+0244, and address 701 East Pike Avenue, Columbus, Stillwater County, Montana as shown on **Figure 1**. Olympus Technical Services, Inc. (Olympus) has prepared this work plan on behalf of BNSF in response to a Montana Department of Environmental Quality (DEQ) letter issued March 27, 2026, requesting additional investigation and groundwater monitoring at the Site. Based on the March request letter and an on-site meeting on April 21, 2026, the following will be completed at the Site: additional soil investigation, installation of additional groundwater monitoring wells, groundwater monitoring, preparation of a Subsurface Investigation and Groundwater Monitoring Report, and an update to the Release Closure Plan (RCP) detailing the results of the investigation and path for closure of the Release. A Site Location Topographic Map and Site Plan Map are provided as **Figures 1 & 2**.

Proposed Scope of Work

Up to eight soil borings will be advanced at the Site, and up to 3 soil borings will be completed as monitoring wells to further delineate the lateral and horizontal extent of petroleum impacts in soil and groundwater. Proposed soil boring and potential well locations are presented on **Figure 3**. Two monitoring wells, JW-2 and JW-3, and one domestic well, Jess Wilson Well, have not been located or sampled in over seven years. A Site visit will be conducted to locate, repair, and redevelop these wells prior to the subsurface investigation fieldwork. Two groundwater monitoring events will be conducted at approximate seasonal low and high groundwater conditions. The results of the investigation will be presented in a Subsurface Investigation and Groundwater monitoring report, and RCP. A detailed summary of each task proposed to complete the scope of work is summarized below:

Task 1 – Work Plan

This work plan fulfills DEQ's request for a Corrective Action Work Plan.

Task 2 – Project Management

Project management will include coordination with DEQ, BNSF, and Petroleum Tank Release Compensation Board (PTRCB) personnel; preparation of the Site Health and Safety Plan; project planning; utility locate notifications; scheduling; coordination with subcontractors; oversight of project details, equipment, and personnel; setup of project files; reviewing historical reports, maps and data for the Facility; and other various tasks related to project management. The costs for project management are included in Task 2 of the cost estimate.

Task 3 – Mobilization

Task 3 in the cost estimate details mobilization costs out of our Billings, Montana office for:

- One roundtrip for a Technician III to locate and inspect monitoring wells JW-2, JW-3, and the Jess Wilson Well, as well as redevelop wells JW-2 and JW-3;
- One roundtrip for a Staff Scientist/Geologist to be present during ground-penetrating radar (GPR) survey;
- One roundtrip for a Staff Scientist/Geologist to provide oversight during soil borings and monitoring well installation;
- One roundtrip for a Staff Scientist/Geologist to dispose of collected purge water and escort the monitoring well surveyor;
- Two roundtrips for a Technician II and Technician III for drilling the soil borings and installing up to three monitoring wells;
- One roundtrip for a Technician II and Technician III to repair monitoring wells JW-7, JW-9, and JW-10; and,
- Four roundtrips for a Technician III to complete groundwater monitoring during each sampling event (2 events).

The drill rig and associated materials and equipment will be mobilized to the Site by Olympus personnel.

Task 4 – Fieldwork

Task 4 includes time for a Technician III to perform a Site visit to inspect the domestic well owned by Jess Wilson and monitoring wells JW-2 and JW-3. Wells JW-2 and JW-3 have been out of use for more than 7 years and will be redeveloped by a pumping and surging method in accordance with Olympus' Standard Operating Procedures (SOPs) and DEQ guidance. Due to BNSF policy, purge water will be containerized, stored onsite, and disposed at an approved facility. If significant damage is found in these wells, Olympus will discuss repairs, replacement, or abandonment prior to the soil boring fieldwork.

Task 4 in the cost estimate presents costs for a Staff Geologist to provide oversight during field activities, including private utility locates, well survey, soil boring and monitoring well installation, and sample collection during the subsurface investigation. The proposed soil boring locations are shown on **Figure 3**. During the advancement of the soil borings by a direct-push drill rig, cores will be continuously collected in five-foot intervals and logged by a Staff Geologist. A lithologic boring log for each soil boring will be prepared using the Unified Soil Classification System (USCS). Soil will be field screened using visual observations and a RAE Systems MiniRae^{TM} Lite photoionization detector (PID) to measure volatile organic compounds (VOCs), utilizing a headspace method. The PID will be calibrated daily using fresh air and span gas calibration points. The span gas will consist of isobutylene at a concentration of 100 parts per million (ppm).

The Staff Geologist will collect up to three soil samples from each boring representing the highest PID response, groundwater interface, and/or at the bottom of the boring. At least one sample from each boring will be collected from 0-10 feet below ground surface (bgs) to evaluate the DEQ direct contact construction exposure risk. Should no impacts be identified, one sample will be collected from the groundwater interface. All soil samples will be collected in laboratory-supplied containers, immediately placed on ice, and submitted to Energy Laboratories for analysis.

Task 5 – Soil Borings and Monitoring Well Installation

Task 5 includes labor, materials, and equipment costs associated with advancing up to eight soil borings, collecting up to twenty-four soil samples, and the installation of up to three monitoring wells. The cost is provided on a per-foot basis for drilling. Eight soil borings will be advanced to 15 feet bgs using Olympus' direct push Geoprobe® 7822 DT drill rig to complete the task as shown on **Figure 3**. Each boring will first be cleared for utility lines to a minimum of 5 feet bgs or the depth of the nearest utility via hand-auger. The locations of the soil borings will be collected by a Staff Geologist with a cm-grade Trimble Geo7x GPS unit.

The soil boring exhibiting the highest observed petroleum impacts, if any, from the former eastern tank location, based on field screening results, will be completed as a groundwater monitoring well to further evaluate source area conditions. Up to two additional monitoring wells may be installed based on field screening results; one well downgradient of the eastern tank location and one well between JW-5 and JW-7. These wells will only be installed if petroleum impacts are observed in the borings at these locations. The two-inch diameter monitoring well will be installed by a licensed Montana Monitoring Well Constructor (MWC). The well will be constructed with 5 feet of flush-threaded Schedule 40 polyvinyl chloride (PVC) casing and 10 feet of pre-packed screens, including screen points and locking plugs. The well will be backfilled with 10/20 silica sand to approximately 1-foot above the screened interval, bentonite pellets to approximately 2 feet bgs, and concrete to the surface. The well will be completed with a flush mount monument encased in a concrete collar, the well lid will be labeled, and the top of casing will be marked with the approximate north direction. The ground surface will be completed to match existing conditions. The well will be developed following a pumping and surging method before sampling according to Olympus' SOPs and DEQ guidance. Purge water will be containerized on-site and disposed at an authorized facility in accordance with BNSF policy. The well will not be sampled for at least one week following development.

The monitoring well installation report will be prepared by the MWC and submitted to the Montana Bureau of Mines and Geology (MBMG) Ground Water Information Center (GWIC) within 60 days of well installation.

Table 1, below, summarizes the borings, locations, and rationale.

Boring Number	Location	Rationale
1 through 3	Near former western tanks	Potential source area evaluation
4 & 5	Near former eastern oil tanks	Potential source area evaluation, potential monitoring well
6	Down-gradient of eastern tanks	Down-gradient delineation, potential monitoring well
7	Down-gradient of JW-7	Down-gradient delineation
8	Cross-gradient of former shell oil tanks	Cross-gradient delineation, potential well

Task 6 – Survey (Well)

The top of casing and well monument surfaces for the newly installed groundwater monitoring well will be surveyed for location using the Montana State Plane Zone 2500 coordinate system, and elevation by North American Vertical Datum of 2011 (NAVD 2011) in feet above mean sea level (amsl), by a registered Montana PLS. Task 6 in the cost estimate includes the costs for the subcontracted surveyor, Kehl Surveying.

Task 7 – Survey (Private Locate)

Prior to drilling activities, onsite utilities will be located and marked. Montana 811 (Montana One Call) will be notified a minimum of 72 hours before beginning drilling. A private utility locator will be subcontracted to locate private utilities, including a GPR and electromagnetic survey, and to locate and mark former UST excavation areas to facilitate boring placement. Utility location markings will be maintained throughout the project. Task 7 in the attached cost estimate details costs for private utility locates.

Task 8 – Monitoring (Groundwater)

Two groundwater monitoring events will be performed during approximate seasonal low and high groundwater conditions. Groundwater monitoring will be conducted a minimum of one week following well development activities to allow the aquifer to recover to steady-state conditions. Wells JW-2, JW-3, JW-7, JW-8, JW-9, JW-10, the newly installed wells, and the Jess Wilson Well, will be sampled for a total of up to 9 monitoring wells and one domestic well. Monitoring will include:

- Measurement of groundwater static water levels (SWLs) in all Site monitoring wells during each groundwater monitoring event using an electronic interface probe.

- Collection of groundwater samples, including a field duplicate, using low-flow methods in general accordance with DEQ's *Groundwater Sampling Guidance*. Groundwater samples will be collected with a peristaltic pump. Field measurements of groundwater quality parameters, including pH, oxidation-reduction potential, specific conductivity, dissolved oxygen, turbidity, and temperature will be recorded during groundwater sample collection. Depth to groundwater measurements will be recorded during the low-flow pumping and sampling procedure.

- All groundwater samples will be submitted for laboratory analysis of volatile petroleum hydrocarbons (VPH), extractable petroleum hydrocarbons (EPH) Screen, and Intrinsic Biodegradation Indicators (IBIs). The cost estimate assumes up to 50% of samples may require further fractionation of EPH compounds.

- Olympus' SOP for tap water sampling will be followed to sample domestic well Jess Wilson well. The well will be purged from the cold-water tap or exterior spigot/hose for a minimum of 10 minutes. Three rounds of field parameters will be collected in 3-minute intervals prior to sample collection. The sample will be analyzed for VOCs.

Task 8 in the cost estimate includes the costs for project setup, mobilization, and well sampling on a unit cost basis. It is anticipated that the wells will not be completed in a low yield aquifer. A groundwater monitoring worksheet is attached to this work plan.

Task 9 – Laboratory Analysis w/ Fee (Groundwater Monitoring and Jess Wilson Well)

Task 9 in the cost estimate presents the laboratory analytical costs for two groundwater monitoring events. Groundwater samples will be analyzed for VPH, EPH screen, and IBIs of sulfate, nitrate/nitrite, dissolved ferrous iron, and methane (1st event only). One duplicate groundwater will be collected from a monitoring well during each event and analyzed for VPH only. The cost estimate assumes up to 50% of collected samples may require further fractionation of EPH compounds. The Jess Wilson Well will be sampled during the first event only and submitted for analysis of VOCs by EPA Method 524.2. Samples will be submitted under chain-of-custody procedures to Energy.

Well ID	**Analysis**			
	VPH	**VOCs**	**EPH Screen[1]**	**IBIs[2]**
	MT Method	Method 524.2	MT Method	
JW-2, JW-3, JW-7 through JW-10 and newly installed wells	L/H		L/H	L
Duplicate	L/H			
Jess Wilson Well		L/H		

Notes:
L = Low Water
H = High Water
1 – EPH Fractions to be analyzed if EPH Screen is greater than 1,000 µg/L
2 – IBIs include sulfate (E300), nitrate/nitrite (E353.2), dissolved ferrous iron (E200.8) and methane (SW8015M)

Task 10 – Laboratory Analysis w/ Fee (Soil Sampling)

Up to three soil samples will be collected from each boring at the highest indications of impacts, at the groundwater interface, and/or at the bottom of the boring. At least one sample from each boring will be collected from 0-10 feet bgs to evaluate direct contact RBSLs. Should no impacts be identified, one sample will be collected from the groundwater interface. All soil samples will be collected in laboratory-supplied containers and immediately placed on ice and in coolers.

The samples will be transported under chain-of-custody procedures and submitted for analysis of VPH and EPH screen. The cost estimate assumes up to 50% of samples collected may require further fractionation of EPH compounds. Up to two duplicate soil samples will be collected and analyzed for VPH only. Duplicate samples will be collected on a frequency of 1 duplicate sample per 20 parent sample. Samples will be shipped to Energy Laboratories, Inc. in Billings, Montana (Energy). One duplicate will also be collected and analyzed for VPH only.

Task 11 – Disposal

This task includes disposal costs for containerized development water, purge water, and impacted soil cuttings.

Task 12 – DVSF

This task includes time for a Staff Scientist to complete DVSF summary forms for each laboratory report.

Task 13 – Reporting

This task includes data validation for three sampling events (soil borings and two groundwater monitoring events), preparation of a Subsurface Investigation and Groundwater Monitoring Report, and updating the Release Closure Plan (RCP). Task 13 of the cost estimate includes unit cost prices for completing these reports.

Task 14 – Miscellaneous (Well Repair)

JW-7, JW-9, and JW-10 are damaged and require repairs to maintain the integrity of the well monument and groundwater samples collected from each well. Task 14 includes time for a Tech III and Tech II to cut and remove each monitoring well monument and install a new monument encased in concrete.

Cost

The cost to complete the scope of work outlined above is estimated at $60,065.11, detailed on the attached cost schedule. The cost estimate is based on the following assumptions:

- Existing Facility wells do not require replacement or repair;
- Olympus' direct-push drill rig will be used to advance soil borings, and unit costs for drilling and monitoring well installation are provided in the attached cost estimate.
- Site conditions are amenable to direct-push borings.
- A total of eight soil borings will be advanced and up to three monitoring wells will be installed; and,
- Semi-annual groundwater monitoring of nine monitoring wells and one domestic well will be conducted for one year.

Schedule

Olympus appreciates the opportunity to assist you with this project. Site work will commence upon approval of the work plan by DEQ. The groundwater monitoring events are tentatively scheduled for fall 2026 and spring 2027 to correspond with seasonal low and high groundwater, respectively.

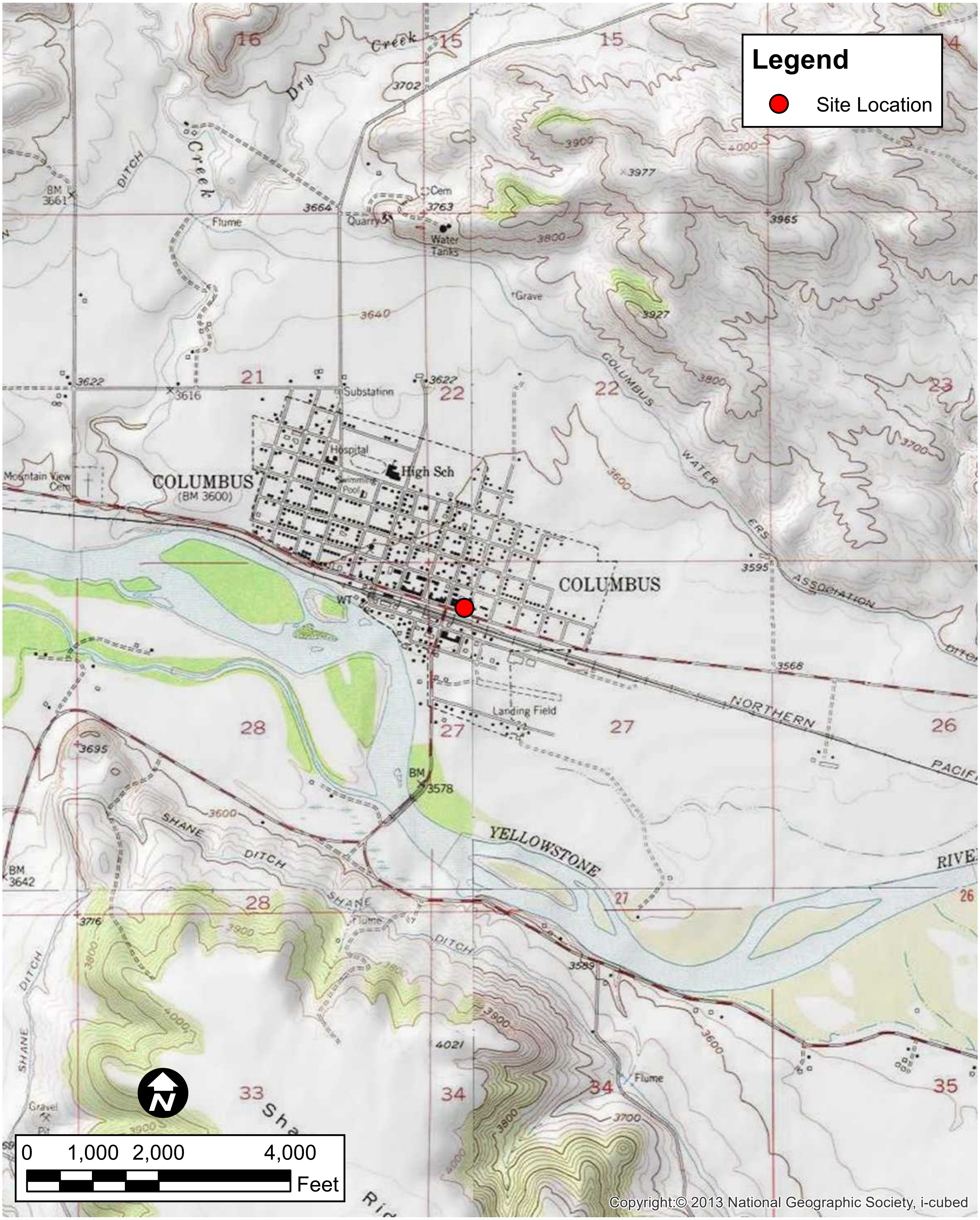
Please contact me if you have any questions regarding this plan.

Sincerely,

Ethan J. Perro, PG
Project Geologist

Attachments: Figure 1: Site Location Topographic Map
Figure 2: Site Plan Map
Figure 3: Proposed Soil Boring and Monitoring Well Locations
Work Plan Cost Estimate
Groundwater Monitoring and Sampling Unit Cost Worksheet
Soil Boring/Monitoring Well Installation Unit Cost Worksheet
SOPs

cc: Cody Johnson, BNSF, cody.johnson@bnsf.com



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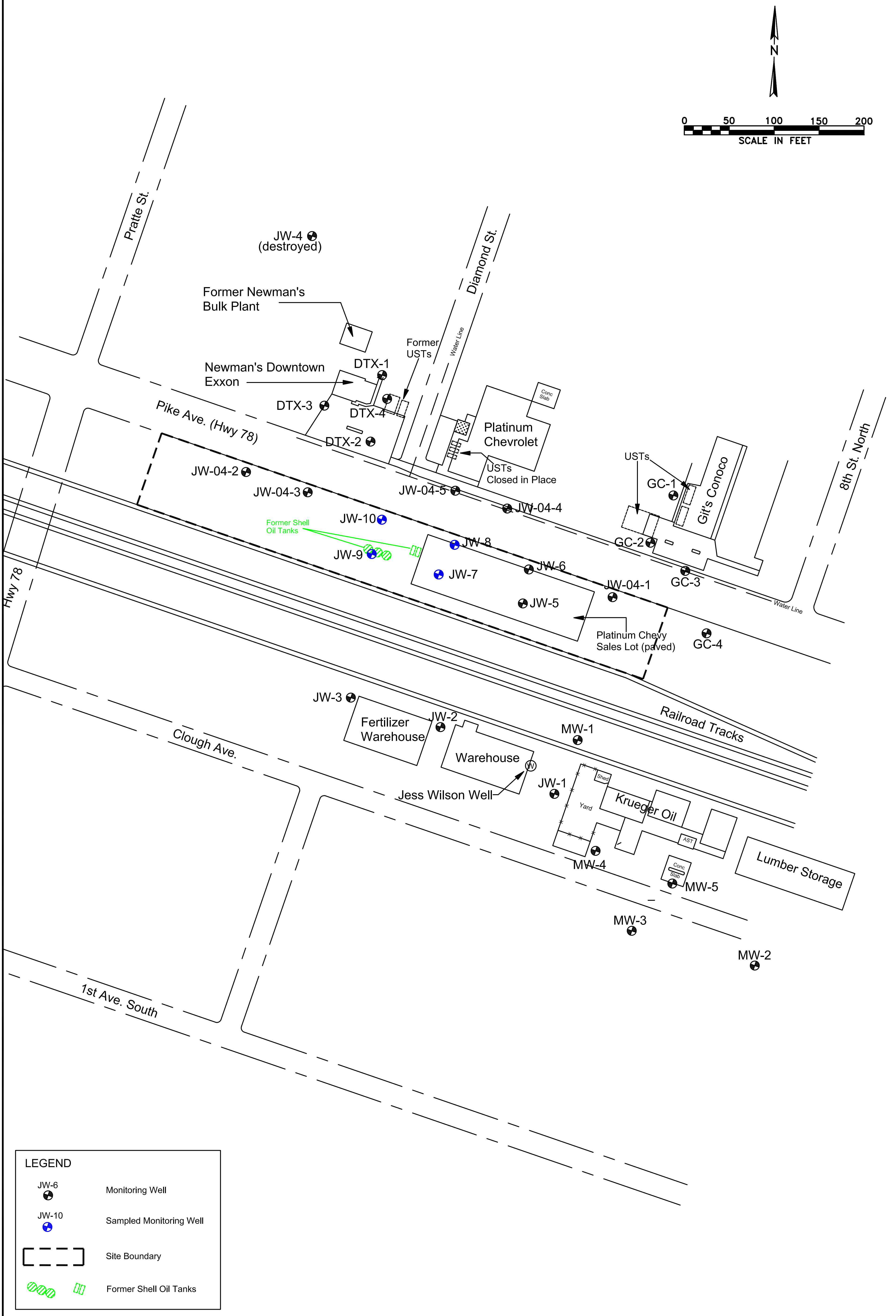
Olympus Technical Services, Inc.

Site Location
Topographic Map

FIGURE
1



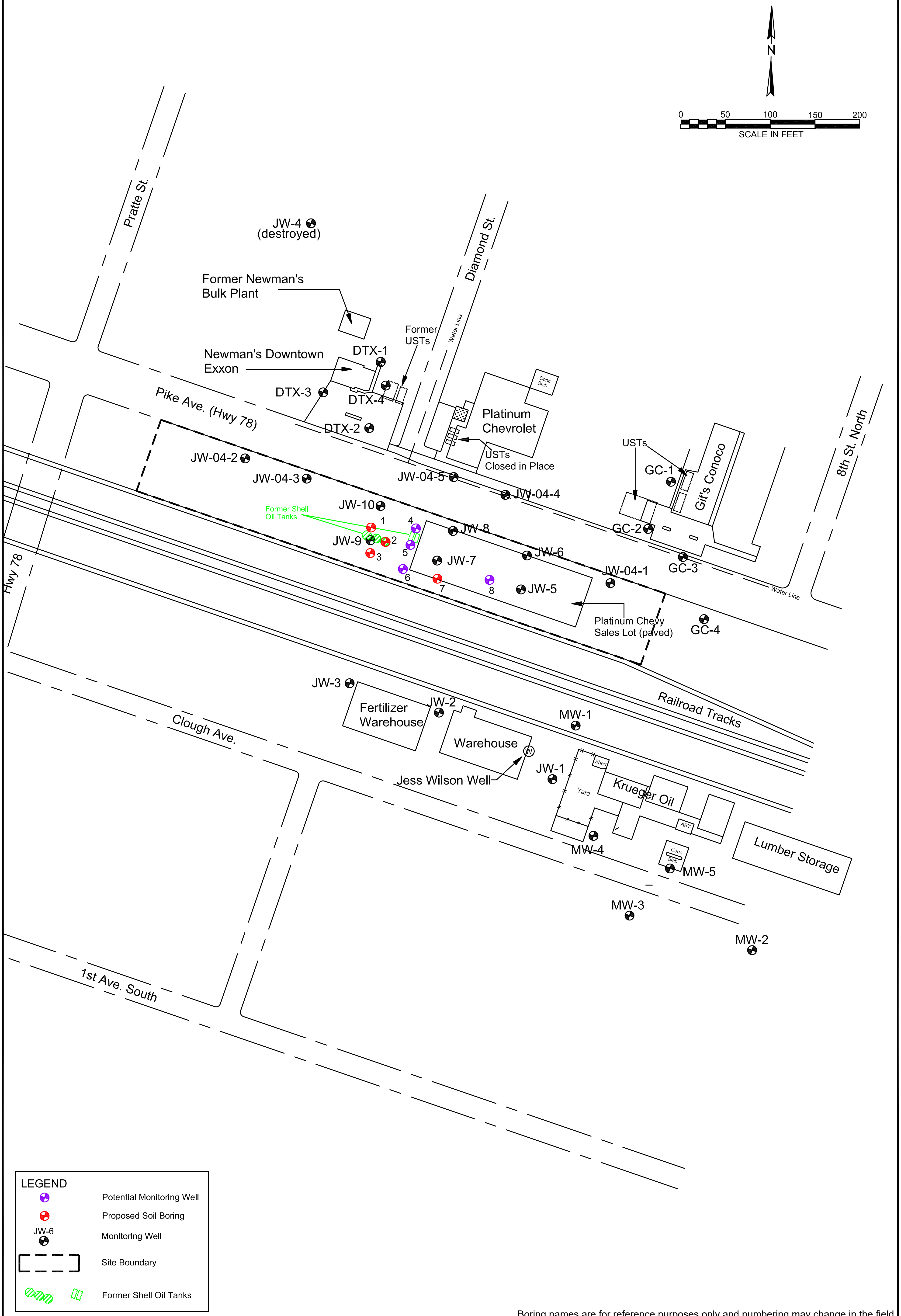
Olympus Technical Services, Inc.

Former Shell Oil Bulk Plant
Railroad Lease Property
Columbus, Montana

Site Plan Map

FIGURE
2

DESIGN:	DRAWN: KR	CHECKED: EP	APPROVED:	DATE: 03/06/25	JOB NO: A4190	SCALE: as shown	FILENAME: A4190 Site Map 03-25.dwg



Boring names are for reference purposes only and numbering may change in the field

Olympus Technical Services, Inc.

Former Shell Oil Bulk Plant
Railroad Lease Property
Columbus, Montana

Proposed Soil Boring and
Monitoring Well Locations

FIGURE
3

DESIGN:
DRAWN: KR
CHECKED: EP
APPROVED:
DATE: 04/24/2026
JOB NO: A4190
SCALE: as shown
FILENAME: A4190 Site Map 03-25.dwg

Olympus Technical Services, Inc. Cost Estimate **Date:** 4/9/2026

Client: BNSF
Project Name: Former Shell Oil Bulk Plant
Olympus Project/Proposal No.: A4190
ODC 7%

Task	Quantity	Unit	Rate	Cost
Task 1 - Work Plan				
Remedial Investigation, GWM WP	1	Each	$3,500.00	$3,500.00
			Task Total	**$3,500.00**
Task 2 - Project Management				
Project Geologist	30	Hours	$175.00	$5,250.00
			Task Total	**$5,250.00**
Task 3 - Mobilization				
Tech III (well recon and redevelopment)	70	Mile	$4.84	$338.80
Staff Scientist (Oversight borings, GPR, disposal)	210	Mile	$5.21	$1,094.10
Tech III (Drill Rig), 2 Trips	140	Mile	$6.75	$945.00
Tech III (Groundwater Monitoring), 4 Trips	280	Mile	$4.84	$1,355.20
Tech II (Support/Borings), 2 Trips	140	Mile	$5.63	$788.20
Tech III (Well Repairs)	70	Mile	$3.98	$278.60
Tech II (Well Repairs)	70	Miles	$3.83	$268.10
			Task Total	**$5,068.00**
Task 4 - Fieldwork				
Labor				
Tech III (MW Recon/Well Development)	4	Hour	$134.00	$536.00
Staff Scientist (Private Locate, Borings, Disposal)	24	Hour	$151.00	$3,624.00
Materials				
PID	2	Day	$122.10	$244.20
Trimble GPS	2	Day	$326.70	$653.41
			Task Total	**$5,057.61**
Task 5 - Soil Borings and Monitoring Well Installation				
Hand-Auger (Clear Borings)	40	Foot	$24.00	$960.00
Soil Borings	80	Foot	$29.00	$2,320.00
Monitoring Well Installation	45	Foot	$56.00	$2,520.00
Well Development	3	Well	$250.00	$750.00
			Task Total	**$6,550.00**
Task 6 - Survey (Well)				
Well Survey (Kehl)	1	Task	$900.00	$900.00
Subcontracted Services			7%	$63.00
			Task Total	**$963.00**
Task 7 - Survey (Private Locate)				
Private Locate (GeoSearch)	1	Task	$1,250.00	$1,250.00
Subcontracted Services			7%	$87.50
			Task Total	**$1,337.50**
Task 8 - Monitoring (Groundwater)				
Groundwater Monitoring	9	Well	$220.00	$1,980.00
Groundwater Monitoring Setup	1	Event	$150.00	$150.00
IBI Modifier	1	Each	$50.00	$50.00
Duplicate Modifier	1	Each	$50.00	$50.00
GW Filters	9	Each	$27.00	$243.00
Tap Water Sampling	1	Each	$50.00	$50.00
			Number of Events	2
			Task Total	**$4,996.00**

Olympus Technical Services, Inc. Cost Estimate **Date:** 4/9/2026

Client: BNSF
Project Name: Former Shell Oil Bulk Plant
Olympus Project/Proposal No.: A4190

ODC 7%

Task	Quantity	Unit	Rate	Cost
Task 9 - Laboratory Analysis w/Fee (Groundwater)				
VPH	18	Each	$145.00	$2,610.00
VPH (Duplicate QA/QC)	2	Each	$145.00	$290.00
EPH Screen	18	Each	$90.00	$1,620.00
EPH Fractionation	10	Each	$150.00	$1,500.00
IBIs	9	Each	$250.00	$2,250.00
VOCs 524.2	2	Each	$160.00	$320.00
Analytical Fee	20	Sample	$20.00	$400.00
			Task Total	**$8,990.00**
Task 10 - Laboratory Analysis w/ Fee (Soil)				
VPH	24	Each	$145.00	$3,480.00
VPH (Duplicate QA/QC)	2	Each	$145.00	$290.00
EPH Screen	24	Each	$90.00	$2,160.00
EPH Fractionation	12	Each	$150.00	$1,800.00
Analytical Fee	26	Sample	$20.00	$520.00
			Task Total	**$8,250.00**
Task 11 - Disposal				
Mountain States Environmental Services	1	LS	$1,500.00	$1,500.00
			Task Total	**$1,500.00**
Task 12 - Data Validation				
Staff Scientist	1	Hr	$151.00	$151.00
			Number of Reports	3
			Task Total	**$453.00**
Task 13 - Reporting				
Standardized RIR	1	Each	$5,200.00	$5,200.00
Update Release Closure Plan	1	Each	$1,000.00	$1,000.00
			Task Total	**$6,200.00**
Task 14 - Misc (Well Repairs)				
Well Repair	3	Well	$650.00	$1,950.00
			Task Total	**$1,950.00**

Comments/Notes:
1.
2.
3.

Total **$60,065.11**

Petroleum Tank Release Compensation Board
STATE OF MONTANA
P.O. Box 200902 • Helena, MT 59620-0902 • (406) 444-9710

Groundwater Monitoring and Sampling Unit Cost Worksheet

7/28/2022

Cost Estimate Expl. | Work Plan Tasks | Unit Cost Worksheet | Help

Contractor Information

Company Name:	Olympus Technical Services		
Address:	6809 King Avenue, Unit F		
City, State, Zip:	Billings, MT		
Cost Estimator/Print Name:	Ethan Perro	Phone:	406-430-1784
Signature:	Ethan Perro	Date:	4/9/2026

Project Information

Site Name:	Former	Facility ID#	48-12059
Address:	701 East Pike Avenue (Milepost 40+0244)	Release #	4036
City:	Columbus	WP ID#	716835169
		Treads ID#	17180

Petroleum Tank Release Compensation Board
STATE OF MONTANA
P.O. Box 200902 • Helena, MT 59620-0902 • (406) 444-9710

7/28/2022

Groundwater Monitoring and Sampling Summary Sheet

Cost Estimate Expl. | Work Plan Tasks | Unit Cost | Help

Monitoring Well Details

9	Total Number of Wells at Site
	Number of Fluid Level Measurements Only (2)
18	Number of Wells to be Monitored/Sampled (4-11)
2	Average Well Casing Diameter (inches)
10	Average Depth to Groundwater (ft)
16	Average Depth of Wells (ft)

of Events - Monitoring/Sampling Interval

Estimated Start Date: 7/1/2026

2	Semi-Annual
	Annual
	Bi-Annual
	Other
2	**Total Events**

18	< 25 ft total depth
	25 - 50 ft total depth
	50 - 75 ft total depth
	75 - 100 ft total depth
18	Total

Sampling Method

☑	Low-Flow
	Low Yield Aquifer
	No Purge
☐	Other (please specify)

Sampling Instrument

X	Peristaltic Pump
	Bladder Pump
☐	Submersible Pump
☐	Bailer
☐	Other (please specify)

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Cost Estimate Expl. | Site Information | Work Plan Tasks | Help

Groundwater Monitoring and Sampling Unit Cost Worksheet

Task	Events												Totals		
	1		2		3		4		5		6		Units	Unit Cost	Total Cost
	Units	Unit Cost	Units	Unit Cost	Units	Unit Cost	Units	Unit Cost	Units	Unit Cost	Units	Unit Cost			
Sampling Frequency	Semi-Annual		Semi-Annual												
Work Plan Type	AC-07														
Work Plan Preparation	1	$3,500.00											1	$3,500.00 /work plan	$3,500.00
Project Management	1	$5,250.00											1	$5,250.00 /hr	$5,250.00
Mobilization/Demobilization (1)	140	$4.84	140	$4.84									280	$4.84 /mile	$1,355.20
Field Work															
Fluid Level Measurements (2)														/well	
Groundwater Monitoring Setup (3)	1	$150.00	1	$150.00									2	$150.00 /day	$300.00
Groundwater Monitoring (<25ft total depth) - Peristaltic (4)	9	$220.00	9	$220.00									18	$220.00 /well	$3,960.00
Groundwater Monitoring (<25ft total depth) - Bladder (5)														/well	
Groundwater Monitoring (25-50ft total depth) - Bladder (5)														/well	
Groundwater Monitoring (50-75ft total depth) - Bladder (5)														/well	
Groundwater Monitoring (75-100ft total depth) - Bladder (5)														/well	
Groundwater Monitoring - No Purge (6)														/well	
Modifiers															
Groundwater Monitoring - Low Yield Modifier (7)														/well	
Groundwater Monitoring - IBI Modifier (8)	1	$50.00											1	$50.00 /well	$50.00
Groundwater Monitoring - Filters (9)	9	$27.00											9	$27.00 /filter/well	$243.00
Contaminated Purge Water - Offsite Disposal (10)	1	$1,500.00											1	$1,500.00 /each	$1,500.00
Duplicate Sample Modifier (11)	1	$50.00	1	$50.00									2	$50.00 /each	$100.00
Other Services															
Other Service (please specify) Tap Water Sampling	1	$50.00	1	$50.00									2	$50.00 /each	$100.00
Other Service (please specify)														/each	
Lodging & Per Diem (Lodging - actual only)															
Lodging: # of people														/night	
Food: # of people														/day	
(Breafast $8.25, Lunch $9.25, Dinner $16.00)															
Laboratory Analysis (12)	Semi-Annual		Semi-Annual												
Volatile Petroleum Hydrocarbons (VPH)	10	$145.00	10	$145.00									20	$145.00 /sample	$2,900.00
Extractable Petroleum Hydrocarbons (EPH)															
EPH "screen"	9	$90.00	9	$90.00									18	$90.00 /sample	$1,620.00
EPH "fractions"	5	$150.00	5	$150.00									10	$150.00 /sample	$1,500.00
Polycyclic Aromatic Hydrocarbons (PAHs)														/sample	
Lead Scavengers															
Ethylene dibromide (EDB)														/sample	
1,2-Dichloroethane (DCA)														/sample	
Drinking Water - EPA 524.2	1	$160.00	1	$160.00									2	$160.00 /sample	$320.00
Intrinsic Biological Indicator Analyses (IBI)	9	$250.00											9	$250.00 /sample	$2,250.00
Other Analytical Methods														/sample	
Other Service (please specify) Data Validation	1	$151.00	1	$151.00									2	$151.00 /each	$302.00
PTRCB sampling fee (13) ($10.00 allowed)	11	$20.00	11	$20.00									22	$20.00 /sample	$440.00
Report Preparation															
Groundwater Monitoring Report - Type (14-15)			AR-07												
Groundwater Monitoring Report - Base Cost (14)			1	$5,200.00									1	$5,200.00 /report	$5,200.00
IBI Modifier (16)														/event	
Additional Wells Modifier (17)														/event	
Release Closure Plan (RCP) Preparation (18)															
Create RCP														/RCP-C	
Update RCP			1	$1,000.00									1	$1,000.00 /RCP-U	$1,000.00
Monitoring & Sampling Subtotal:															**$31,890.20**

Additional Conditions/Comments/Costs:

Additional Costs Subtotal:

Grand Total: **$31,890.20**

If you require assistance, call 406-444-9710
Submit completed form with your Work Plan
Provide written comments to:
Petroleum Tank Release Compensation Board
PO Box 200902, Helena MT 59620-0902

Petroleum Tank Release Compensation Board
STATE OF MONTANA
P.O. Box 200902 • Helena, MT 59620-0902 • (406) 444-9710

7/28/2022 Cost Estimate Expl.

Work Plan Task List

Unit Cost Worksheet

Site Information

Help

Task	Total Cost
Work Plan Preparation	$3,500.00
Project Management	$5,250.00
Mobilization/Demobilization (1)	$1,355.20
Fluid Level Measurements (2)	$0.00
Groundwater Monitoring (4-6)	$4,260.00
Miscellaneous (Groundwater Monitoring Modifiers) (7-11)	$1,893.00
Lodging & Per Diem (Lodging - actual only)	$0.00
Laboratory Analysis (12-13)	$9,332.00
Report Preparation (14-17)	$5,200.00
Release Closure Plan (RCP) Preparation (18)	$1,000.00
Other Services	
Miscellaneous (Tap Water Sampling)	$100.00
Miscellaneous ()	$0.00
Monitoring & Sampling Subtotal:	**$31,890.20**
Additional Costs Subtotal:	**$0.00**
Grand Total:	**$31,890.20**

Petroleum Tank Release Compensation Board
Soil Boring/Monitoring Well Installation Unit Cost Worksheet

Contractor Information

Company Name: Olympus Technical Services
Address: 6809 King Avenue West, Unit F
City, State, Zip: Billings, MT 59106
Cost Estimator: Ethan Perro Phone: 406-430-1784

Signature: Date: 4/28/26

Project Information and Specifications

Site Name: Former Shell Oil Bulk Plant Facility ID # 48-12059
Address: 701 East Pike Avenue Release # 4036
City: Columbus WP ID # 716835169

Type of Drilling Equipment

☐ Hollow-Stem Augers
☐ Air Rotary
☑ Direct Push
☐ Other (please specify)

Monitoring Well Specifications

Number of Wells: 1
Surface: Concrete: ☑ Asphalt: ☑ Barren: ☑
Depth (per well): 15
Estimated Depth to Groundwater (ft): 10
Boring Diameter (inches): 3.75
Casing Diameter and type (inches): 2
Surface Completion: Flush Mount ☑ Aboveground ☐

Soil Boring

Number of Borings: 8
Boring Diameter (inches): 3.75
Depth (per boring - ft): 15
Surface: Concrete: ☑ Asphalt: ☑ Barren: ☑
Soil Disposal: Onsite: ☑ Stockpile: ☐ Drums: ☑
Abandonment: Bentonite: ☑ Soil Cuttings: ☑

Soil Sampling

☑ Continuous Soil Sampling
☐ Interval Soil Sampling
(specify interval)
☑ No Sampling

Cost Estimate Explanation:

[1] Mobilization/Demobilization: Includes all costs and mileage to transport equipment, materials, and personnel to and from the site location. More than one mobilization event of either the drilling rig or support vehicle will require justification and pre-approval by the DEQ-PTCS and Board staffs. This item should be estimated on a per mile unit rate.

[2] Soil Boring Installation: Includes all costs (labor, equipment, and materials) to drill, collect soil samples and abandon soil borings, as well as decontaminate equipment. Drilling costs should be estimated using a per foot unit rate. Unit cost should include handling of contaminated soil by stockpiling or placing in drums. Assume level "C" personal protective equipment.

[3] Monitoring Well Installation: Includes all costs (labor, equipment, and materials) to drill, collect soil samples, and complete monitoring well to specifications and according to Montana Well Drillers Board rules, as well as decontaminate equipment. Drilling costs should be estimated using a per foot unit rate. Unit cost should include handling of contaminated soil by stockpiling or placing in drums. Assume level "C" personal protective equipment.

[4] Drilling Standy: Drilling standby should be estimated on an hourly basis. Prior approval and justification for accumulating standby time is needed prior to billing.

[5] Well Development: Includes all costs (labor, equipment, and materials) to develop monitoring wells. This task should be estimated using a per well unit rate.

[6] Monitoring Well Abandonment: Includes all costs (labor, equipment, and materials) to properly abandon a well location according to the Montana Well Drillers Board rules. Abandonment costs should be estimated using a per well unit rate.

Soil Boring/Monitoring Well Installation Unit Cost Worksheet

TASK	UNIT COST	NUMBER OF UNITS	TOTAL COST
Mobilization/Demobilization (1)			
Mobilization/Demobilization: Drilling Rig	$6.75 /mile	140	$ $945.00
Mobilization/Demobilization: Support Vehicle	$5.63 /mile	140	$ $788.20
Soil Boring Installation (2)			
Drilling (0’-50’ range per boring)	$29.00 /foot	80	$ $2,320.00
Drilling (50’-100’ range per boring)	/foot		$ $0.00
Other (please specify) hand-auger	$24.00	40	$ $960.00
Monitoring Well Installation (3)			
Drilling (0’-50’ range per well)	$56.00 /foot	45	$ $2,520.00
Drilling (50’-100’ range per well)	/foot		$ $0.00
Other (please specify)			$ $0.00
Drilling Standby (4) -prior approval needed	/hour		$ $0.00
Well Development (5) Well Development	$250.00 /well	3	$ $750.00
Monitoring Well Abandonment (6) Abandonment	/well		$ $0.00
Lodging may only be paid at actual costs when documented by receipts.			
Per Diem			
Lodging: (number of individuals) ☐	/person per day		$0.00
Food: (number of individuals) ☐	/person per day		$0.00
Maximum Daily Per Diem allowed $30.50 (Breakfast $7.50, Lunch $8.50, Dinner $14.50)		**TOTAL PROJECT EXPENSE**	$ $8283.20

Additional Conditions/Comments/Costs:

If you require assistance, call 406-444-9710.
Submit completed form to:
Petroleum Tank Release Compensation Board
PO Box 200902, Helena MT 59620-0902

STANDARD OPERATING PROCEDURE

Groundwater Sampling (GW-1)

This Standard Operating Procedure (SOP) covers multiple volume purge and low-flow methods of groundwater sampling from a well.

1.0 Equipment:

Purge Water Containment*
Five Gallon Bucket
Electronic Water Level Probe or
Oil-Water Interface Probe*
Meters: pH, Specific Conductivity, Dissolved Oxygen (DO), Oxidation-Reduction Potential (ORP), Turbidity (low flow)
Pump (Peristaltic, Bladder)
Compressor or Compressed air cylinder for bladder pump
Power Supply (for pump)
Graduated cylinder or other calibrated container for measuring flow rate
Bailers with Line*
Tubing*
Filter(s) and accessories*
Sample Containers
Preservatives*
Decontamination Supplies
Coolers with Ice
Field Sampling Forms
Field Notebook
Chains-of-Custody
Indelible Ink Pen(s)
Personal Protective Equipment
Sampling and analytical plan (SAP)

*As required by site-specific SAP or Site conditions

2.0 Groundwater Sampling Sequence

The sampling sequence within a specific site should begin with the well containing the lowest anticipated analyte concentration. Successive samples will be obtained from wells anticipated to have increasing analyte concentration. If the relative degree of suspected concentrations cannot be reasonably assumed, wells will be sampled in order of increasing proximity to the suspected analyte source area, preferably from the perimeter towards the center of the site, and, if the groundwater flow direction is known, preferably in the order of up-gradient, cross-gradient, down-gradient, then in the vicinity of the suspected analyte source.

3.0 Instrument Calibration

Calibrate instruments at the beginning and end of each day following the appropriate SOP. Document calibration procedures in the field notebook.

4.0 Decontamination

All reusable sample equipment that comes into contact with groundwater shall be decontaminated prior to use at each well following the procedures in the site-specific SAP. This includes but is not limited to the static water level probe/cable and bladder pump barrel.

Decontamination is typically conducted using a phosphate-free soap (e.g. Alconox) water wash, distilled water rinse, isopropyl alcohol wash, nitric acid wash (if metals analysis is to be conducted) and final distilled water rinse procedure.

5.0 Water Level Measurements

Measure static water levels in the wells prior to sample collection and prior to installing the pump and tubing (if a dedicated pump is not already in place). If the well is equipped with a dedicated pump, then measure the static water level prior to purging. Because water levels may fluctuate on a short-term basis, measure the static water levels in all site wells within a relatively short period of time.

If non-aqueous phase liquid (NAPL) is suspected to be present, use an oil-water interface probe to test for its presence. Follow the meter-specific operating instructions for the measurement.

If NAPL is not suspected to be present, utilize an electronic water level probe. Check the operation of the meter by turning on the indicator signal switch and pressing the test button on the side of the reel. The buzzer should sound, and the indicator light should illuminate. If the water-level indicator signal(s) is not functioning properly, replace the batteries and/or use a different meter.

Holding the device atop the casing, lower the cable gradually into the well or piezometer until the indicator contacts the water surface. Contact with the water surface is indicated by a buzzer sound and illumination of the indicator light. Stop lowering the cable. Note the point on the graduated cable that corresponds to the measuring point at the top of the casing when the electronic circuit is first completed. If the measuring point is not designated on the well casing, then use the north side of the casing. Draw the cable at least one foot above the water level, then lower it until the indicator contacts the water surface. If the readings differ by more the 0.02 feet, then repeat until the measured readings stabilize. Record the water level to the nearest 0.01 feet.

6.0 Purging

Sampling can be performed via multiple volume or low flow methods, depending on the SAP requirements. Record all field measurements in a field notebook or field sampling form. Example field sample forms are attached to this SOP.

Multiple Volume Purging Procedure

a) Before purging each well, measure and record the depth to water from the designated measuring point on the well casing to the nearest 0.01 foot using an electronic water level meter.

b) Purge a minimum of three well volumes using a pump or bailer. The following equations can be used to calculate one well volume. The first equation gives the results in cubic feet (V1), and the second equation gives the results in gallons (V2):

$V1 = 0.0057 * (d*d) * W$ $V2 = 0.043 * (d*d) * W$

Where:

d = the well casing diameter in inches (in); and

W = the depth of water in the well casing measured in feet, calculated by subtracting the measured depth to water in the well from the total well depth.

Example: Monitoring well diameter = 4-in diameter
Water level = 25.5 ft below ground surface (bgs)
Well depth = 36.0 ft bgs

Therefore, the well has <u>10.5 ft</u> of water column.

Using equation 1:

$V1 = 0.0057 (4in*4in) * 10.5ft$
$V1 = 0.92$ cubic ft

Or using equation 2:

$V2 = 0.043 (4in*4in) 10.5ft$
$V2 = 7.2$ gallons

Therefore, 3 well volumes = 3 x 0.96 cubic ft = 2.86 cubic ft

or

3 well volumes = 3 x 10.5 gallons = or 21.5 gallons

would be the minimum <u>three well casing volumes</u> that need to be purged from the well.

c) When using a downhole down-hole DO meter, lower the DO meter into the well to the approximate level of the pump intake and start the meter.

d) The well will be purged and samples will be collected using a disposable hand-bailer, a peristaltic pump, a positive displacement (bladder) pump and/or a disposable polyethylene or Teflon-lined polyethylene tubing. If pump and tubing are not dedicated to the well, the bladder pump will be decontaminated and new tubing or bailers will be used for each subsequent well location. The pump intake should be placed within the well screen and near the middle of the water column. Field parameters (typically DO, pH, temperature, ORP, and specific conductance) should be measured at 1, 2, and 3 well volumes to ensure that all stagnant water has been removed from the well and that water quality parameters have stabilized.

Note: If a well is evacuated during purging, it will be allowed to recharge until the water level has recovered to 80 percent of the static level or for a period not exceeding 24 hours before sampling. If it has not recovered sufficiently to allow sampling after 24 hours, this well will be noted as "dry" during the sampling event.

e) Purge water will be handled in accordance with the site-specific SAP and SOP G-6.

Low Flow Purging Procedure

a) Samples will be collected with a peristaltic (for inorganics only) or bladder (for any analytes) pump. Use new disposable tubing and bladders for collection of each sample.

b) Non-disposable equipment that comes into contact with the sampled water (e.g. bladder pump body) must be decontaminated prior to collection of each sample.

c) Slowly lower the pump or disposable polyethylene tubing into the well until the pump intake is located approximately the midsection of the saturated screened interval. The depth interval of the well screen will be provided in the site-specific SAP. For wells with screens longer than 10 feet, the primary flow zones and target depth for the pump intake should be identified in the site-specific SAP.

d) The well will be pumped at a rate of 100 to 500 milliliters per minute and the water level monitored approximately every five minutes. A steady flow rate will be maintained that results in a stabilized water level, ideally with a drawdown of 0.3 feet or less. Monitor water levels at a minimum of 5-minute intervals and record the measurement on the field sampling form or in the field notebook.

e) Place meters in the flow through cell prior to initiating pumping and record every parameters at a minimum of 5-minute intervals; including, turbidity, pH, oxidation-reduction potential (ORP), temperature, specific conductance (SC), and dissolved oxygen (DO). Record the parameters in a data logger, on the field sampling form, or in the field notebook. The well will be considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:
<10 NTU (turbidity)for three consecutive readings or three consecutive readings within 10% of each other
±0.1 S.U. for pH
±3% for specific conductivity
± 10 millivolts ORP and
± 10% dissolved oxygen or three consecutive values less than 0.5 mg/L

Depending on site conditions, parameters may not stabilize during pumping. If parameters do not stabilize, contact the project manager to select an appropriate course of action. Actions recommended by Montana DEQ include:

- Purge the well for a minimum of four hours prior to sampling if the static water level was stable prior to pumping, or
- Purge three well volumes from the well prior to sampling, or
- Discontinue purging and do not collect a sample.

Lack of stabilization of parameters shall be documented in the field logbook.

7.0 Groundwater Sample Collection

a) Label each sample container with sample identification, date, time collected (military time), and preservative.

b) Don latex or nitrile gloves prior to collecting sample. Without moving or turning off the pump, groundwater samples should be collected in order from most to least volatile analytes directly from the pump discharge tubing into laboratory supplied sample containers (do not collect sample downstream from any inline-flow device/meter). The pump rate may be decreased for sample collection in order to fill sample containers (sometimes necessary to fill volatile organic compound (VOC) sample vials) but the pump rate may not be increased. Samples collected using a bailer will be poured directly from the bailer into the sample jar. Preserve samples according to analytical requirements in attached table or site-specific SAP.

c) Samples collected for volatile organic compounds (VOCs) are typically collected in 40-ml vials. Fill each sample bottle completely so the water forms a convex meniscus at the top to ensure that no air is trapped when sealing the sample container. No air bubbles should pass through the sample as the bottle is filled or be trapped in the sample when the bottle is sealed. Invert the sample container after it is preserved and sealed to verify the absence of air bubbles. If air bubbles are present, uncap the sample bottle, add more sample and repeat procedure. If air bubbles are still present, discard the bottle and re-sample. If air bubbles continue to be present in the sample bottle, it may be caused by the preservative reacting with alkaline water. In that case the sample may be collected without a preservative, but must be analyzed within 7 days of collection. For non-preserved samples, notify the laboratory as soon as possible that the samples will be delivered to them in an unpreserved condition and need to be analyzed within 7 days of collection. The laboratory will indicate when they will need to have the samples delivered by.

d) Collect filtered samples by attaching the in-line filter directly to the sample discharge tubing and pump the sample through the filter directly into the sample container.

e) Store samples on ice and submit for laboratory analysis according to chain of custody procedures specified in SOP G-4.

A list of common analytes and preservative requirements are described below.

Analysis	Number of Containers	Container Type	Preservation	Maximum Holding Time
VOCs	2	40 ml glass	4^0 C & HCL	14 days
SVOCs	2	1 liter glass	4^0 C	7 days
VPH	2	40 ml glass	4^0 C & HCL	14 days
EPH	2	1 liter glass	4^0 C & H_2SO_4	14 days
Metals	1	500 ml Plastic	4^0 C & HNO_3	6 months, 28 days Hg
Nutrients	1	500 Plastic	4^0 C & H_2SO_4	Varies (contact lab)
Common Ions	1	1 liter Plastic	4^0 C	7 days

STANDARD OPERATING PROCEDURE GW-3

MONITORING WELL DESIGN AND CONSTRUCTION

Standard Operating Procedure
Monitoring Well Design and Construction (GW-3)

A universal, 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 ground water. 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 and should be addressed in site-specific SAP and SOP.

Wells drilled for an RI/FS investigation will be designed to specifications suggested by the site being investigated, provided such design presents no conflict with investigation sampling objectives. The policy will permit the site to incorporate any new wells resulting from RI activities 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.

The method of well construction and the materials used in the casing and screen may affect the quality of the well, and its utility for ground water monitoring, throughout its lifetime. The elements of proper monitoring well construction presented in this SOP serve as guidelines for wells constructed for the ground water investigation. In addition, these guidelines can be applied to evaluate the adequacy of existing wells when RI sampling will be conducted from available wells. Typical well completion details are shown on Figure GW-3.1.

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, in unconsolidated formations, into which the casing is placed must be at least 4 inches larger than the casing to provide a minimum 2 inches of annular space for placement of sand pack and seal. The diameter of the borehole in consolidated formations shall also be a minimum of 4 inches larger than the casing if installation of the seal is expected.

Well Depth

Wells shall be constructed to be depth discrete, with the well screened in only one aquifer, zone, or layer. This allows the sampling of the area of interest without interference from other layers. This requires provisions for grouting above, and if necessary, below the well screen on the outside of the casing.

Well Casing/Screens

Well casings and screens will be constructed of materials with the least potential for affecting the quality parameters of the sample. Guidance regarding casing and screen materials selection criteria is presented in Table GW-3.1. Well casing and screen shall be steam cleaned and protected from contamination prior to their installation.

Well Drilling

Drilling method selection shall 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 shall be avoided. Advantages and disadvantages of various drilling methods are presented in Table GW-3.2.

Screen Zone Design

The screen zone of the monitor well shall be designed and constructed to: (1) allow sufficient ground water flow to the well for sampling; (2) minimize the passage of formation materials into the well; and (3) ensure sufficient structural integrity to prevent the collapse of the screen 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. 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 sand pack in each monitoring well. It is recommended that aquifer material from the screen zone be analyzed fro grain size in order to determine the correct sand pack and screen slot size.

Screen Size Selection

The screen slot size is determined after the filter pack material has been selected. The screen slot size for a well with a designed filter pack should be selected to retain 90 percent or more of the filter pack material. See the references at the end of the SOP for further detail.

Selecting the Filter Pack

The purpose of selecting the proper filter pack is to 1) stabilize the aquifer material around the well, 2) provide an annular zone with high permeability, and 3) permit the use of the largest possible size of screen openings.

The selection of the filter pack is a vital step in completing a usable well. The design and selection of a proper filter pack is an issue which has many factors to be considered and which cannot be given satisfactory explanation in this SOP. A person designing a well should select and read one of the excellent reference books available on the subject. See the reference list at the end of this SOP.

The following information gives the general guidelines used in selecting the well filter pack. For a detailed explanation of the filter pack selection, refer to the references provided at the end of this SOP.

1. Perform a sieve analysis on the natural aquifer material.
2. Select a filTer pack whose grain size is 4 to 10 times larger than the 30 percent of the finer natural aquifer material.
3. The filter pack grain size should have a uniformity coefficient around 2.5.
4. The filter pack material shall be a siliceous material such as quartz sand, have well-rounded grains, and contain less than 5 percent not-siliceous material.

Placement of the Filter Pack Material

The selected filter pack will be introduced into the annular space adjacent to the screen through a tremie pipe. A minimum 1 1/2-inch diameter tremie pipe is suggested. The end of the tremie pipe should be positioned within 5 feet of the bottom of the borehole before treming in the filter material. As the filter material is tremied into the annular space, the tremie pipe should be raised periodically but kept within 5 feet of the top of the filter pack. This 5-foot interval minimizes bridging and segregation of the filter pack as it is placed. The filter pack placement will continue until the filter pack is 3 feet above the top of the screen.

The top of the sand pack should be measured periodically and recorded in the bound logbook. The total volume of filter material used should also be recorded.

Annular Seal

The materials used to seal the annular space must prevent the migration of contaminants to the sampling zone from the surface to intermediate zones and prevent cross contamination between strata. The materials should be chemically compatible with the anticipated waste to ensure seal integrity during the life of the monitoring well and chemically inert so they do not affect the quality of the ground water 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 silica sand when in a saturated zone. The pellets are most appropriate in a saturated zone because they will swell in the column of water to create an effective seal. A cement and bentonite mixture or antishrink cement mixtures should be used as the annular sealant in the unsaturated zone above the bentonite pellet seal and below the frost line.

Cement-bentonite grout shall also be used to seal the annular space between the casing and borehole wall and between the surface formation and the conductor casing, if such is used. At the surface, the grout shall have positive slope away from the well or piezometer to prevent water from ponding and entering around the casing.

The grout shall be composed of Class B or G Portland cement, fresh water, and 2 to 4 percent bentonite. The grout shall be mixed in the following proportions: 6.5 gallons of water, 94 pounds (1 sack) of cement, and 2 percent (1.88 pounds, dry weight) of bentonite, or 7.8 gallons of water, 94 pounds (1 sack) of cement, and 4 percent (3.76 pounds, dry weight) of bentonite. The bentonite will improve the workability of the grout and reduce shrinkage as the cement sets.

Emplacement of the grout shall be by tremie pipe via gravity feed or pumping. The end of tremie pipe shall be set 5 feet above bottom of filled interval.

After installation of the cement slurry, a minimum of 24 hours of curing time shall elapse prior to resuming any construction operations at the particular borehole.

Well Head Installation

Wells may be constructed in either a "stick-up" or "flush-grade" completion. For a stick-up completion, the well or piezometer casing shall extend approximately 3 feet above ground surface. A vented casing cap with marked well or piezometer designation shall be placed on top of the surface casing. A steel protection casing shall be welded to the conductor casing and shall extend to at least 2 inches above the top of the casing cap. The protective casing shall be fitted with a locking cap and also marked with the well or piezometer designation. A concrete apron, extending at least 1 foot away from the casing and sloping away from the well, shall be constructed around the base of the protective casing. In high-traffic areas, four bumper guards shall be installed around the well. The bumper guards shall be brightly painted posts of 3-inch steel pipe filled with concrete and set in the concrete apron.

For a flush-grade completion, the top of the well or piezometer casing shall terminate at approximately four to six inches below ground surface. A vented casing cap with marked well designation shall be placed on top of the surface casing. A locking, protective steel monument shall be placed above the well casing. The top of the monument shall extend one to two inches above ground surface and the monument shall be cemented in place. A cement apron, extending at least six inches from the monument, and sloping away from the monument, shall be constructed around the monument.

Documentation of Well Design and Construction

Information on well design and completion will be documented when drilling and constructing the well, and will include, but not be limited to:

1. Date/time of construction.
2. Weather conditions.
3. Drilling method and drilling fluid used.
4. Sketch of well location.
5. Borehole diameter and well casing diameter.
6. Well depth (± 0.1 foot).
7. Drilling and lithologic logs.
8. Casing materials.
9. Screen materials and design.
10. Casing and screen joint type.
11. Screen slot size/length.
12. Filter pack material/size, grain analysis.
13. Filter pack volume calculations.
14. Filter pack placement method.
15. Sealant materials (percent bentonite).
16. Sealant placement method.
17. Date/time began grouting well.
18. Date/time of well completion.
19. Surface seal design/construction.
20. Well development procedure.
21. Type of protective well casing.
22. Ground surface elevation (0.01 ft).
23. Top of monitoring well casing elevation (0.01 ft).
24. Detailed drawing of well (include dimensions).

References:

F.G. Driscoll, Groundwater and Wells, Second Edition, St. Paul, Minnesota, Johnson Filtration Systems, Inc., 1986.

U.S. Department of the Interior, Ground Water Manual, Water Resources Technical Publication, 1977.

U.S. Environmental Protection Agency, Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells, National Water Well Association, 1989.

TABLE GW-3.1
WELL CASING AND SCREEN MATERIALS

Type	Advantages	Disadvantages
Polyvinyl chloride (PVC)	Excellent chemical resistance to weak alkalies, alcohols, aliphatic hydrocarbons and oils.	May absorb some constituents from ground water.
	Good chemical resistance to strong mineral acids, concentrated oxidizing acids and strong alkalies.	May react with and leach some constituents into ground water.
Polypropylene	Excellent chemical resistance to mineral acids.	May react with and leach some constituents into ground water.
	Good to excellent chemical resistance to alkalies, alcohols, ketones and esters.	May react with strong oxidizing acids.
	Good chemical resistance to oils.	
	Fair chemical resistance to concentrated oxidizing acids, aliphatic hydrocarbons, and aromatic hydrocarbons.	
Teflon (Teflon is a registered trademark of DuPont, Inc.)	Outstanding resistance to chemical attack; insoluble in all organics except a few exotic fluorinated solvents.	High cost relative to other materials.
Carbon steel	Strong and rigid, temperature sensitivity not a problem.	May react with and leach some constituents into ground water.
		Not as chemically resistant as stainless steel.
Stainless steel	Excellent resistance to corrosion and oxidation.	Heavier than plastics.
		May corrode and leach some chromium in very acidic waters.
		May act as a catalyst in some organic reactions.

TABLE GW-3.2
DRILLING METHODS FOR MONITORING WELLS

Type	Advantages	Disadvantage
Hollow stem auger	No drilling fluid is used, minimizing contamination problems. Formation waters can be sampled during drilling by using a screened lead auger or advancing a well point ahead of the augers. Hole caving can be overcome by emplacing screen and casing before augers are removed.	Can be used only in unconsolidated materials. Limited to depths of 100 to 150 feet, formation samples may not be completely accurate, depending upon how they are taken.
Mud rotary	Can be used in both unconsolidated and consolidated formations. Core samples can be collected. Capable of drilling to any depth. Casing not required during drilling. Flexibility in well construction.	Drilling fluid is required •Contaminants are circulated with the fluid. •The fluid mixed with the formation, water invades the formation, and is sometimes difficult to remove •Bentonite fluids may absorb metals and may interfere with some other parameters •Organic fluids may interfere with bacterial analyses and/or organic-related parameters No information on location of the water table and only limited information on water producing zones, is directly available during drilling. Formation samples may not be accurate.
Air rotary	No drilling fluid is used, minimizing contamination problems. Can be used in both unconsolidated and consolidated formations. Capable of drilling to any depth. Formation sapling ranges from excellent in hard, dry formations to nothing when circulation is lost in formations with cavities. Formation water is blown out of the hole along with cuttings making it possible to determine when the first water-bearing zone is encountered. Collection and field analysis of water blown from the hole can provide enough information regarding changes in water quality for parameters such as chlorides for which only large concentration changes are significant .	Casing is required to keep the hole open when drilling in soft, caving formations below the water table. When more than one water-bearing zone is encountered and hydrostatic pressures are different, flow and possible cross-contamination can occur from one water-bearing zone to another between the time drilling is completed and the hole can be properly cased and grouted off.
Cable tool	Only small amounts for drilling fluid (generally water with no additives) are required. Can be used in both unconsolidated and consolidated formation; well suited when caving, large gravel type formations with large cavities above the water table are encountered. Formation samples can be excellent with a skilled driller. When water is encountered, changes in potentiometric levels are observable. Relative permeabilities and rough water quality data from different zones penetrated can be obtained by skilled operators. Good seal between casing and formation if flush jointed casing is used.	Potential contamination by drilling fluid. Relatively large diameters are required (minimum 4-inch casing). Steel drive pipe must be used.

FIGURE GW-3.1
SCHEMATIC OF TYPICAL MONITOR WELL DESIGN

WELL NUMBER: MW2

PROJECT:
OWNER NAME:
ADDRESS:

WELL LOCATION
COUNTY:
SECTION:
TNSHP/RNG:

DATE:
HOLE DIA.: 8 in.
TOC ELEV.: ft.
GROUND ELEV.: ft.

LOGGED BY:
DRILL RIG:
SAMPLER TYPE:
GW DEPTH: ft.

DESCRIPTION

Black cinder ash.

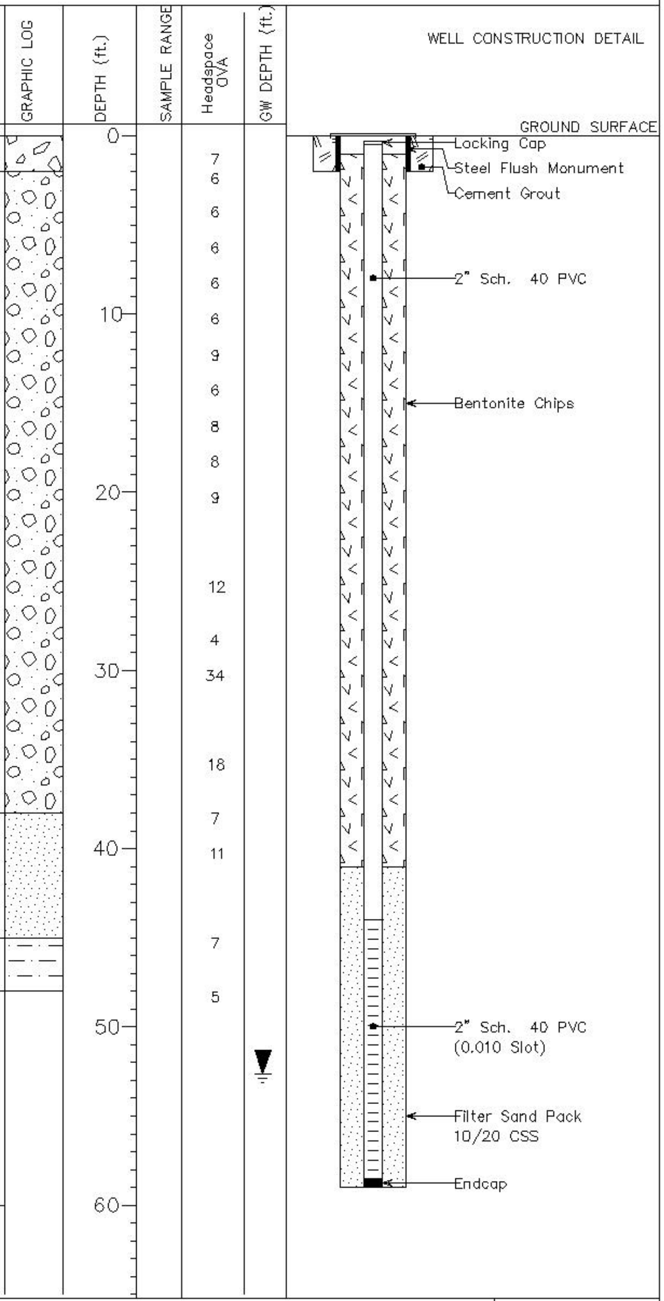
Brown, silty sand and gravel with minor clay from 2 to 2.5 feet. Then sand and gravel.

Fine to coarse grained sand.

Interbedded silt and sand.

No recovery.

Total boring depth at 60'.



Olympus Technical Services, Inc.

LICENSED WELL CONTRACTOR

LICENSE NO.:

PROJECT NO.

Page 1 of 1

STANDARD OPERATING PROCEDURE GW-4

WELL DEVELOPMENT

Standard Operating Procedure
Well Development (GW-4)

The monitoring wells, pumping wells, and piezometers shall be developed after construction is completed. The purpose of the development is to remove any remnants of drilling fluid and fine-grained material and to restore the natural permeability of the screened formation. At a minimum, the following development techniques shall be available to develop the wells.

1. Surging with plunger
2. High velocity jetting
3. Airlift pumping
4. Overpumping and backwashing with submersible pump
5. Bailing

The development methods will be selected in the field by the supervising hydrogeologist. This decision will be based primarily on the condition of each well after construction. A description of the methods is provided below.

The duration of the development process will be determined by the supervising hydrogeologist. The amount of turbidity in the discharge water will be used as a guide to determine that development is complete. In addition to turbidity, physical parameters including temperature, pH, and specific conductivity will be measured. Use of the field test equipment will be found in SOP H-3 for conductivity, SOP H-1 for temperature and SOP H-2 for pH. These parameters should be stabilized or changing by less than 10 percent between readings at the end of development. Visual observation may be used to determine that the discharge water is clear. Water produced during development will be discharged in accordance with the site-specific SAP. Personnel will wear protective clothing and use equipment specified in the site-specific Health and Safety Plan.

All procedures used and measurements taken during development will be recorded in the field logbook. This information will include time required, volume of water removed, turbidity readings, pumping rate, and observations made during the development process.

All development equipment must be decontaminated in accordance with SOP G-5.

SURGING WITH PLUNGER

The surging shall be done by solid surge plunger. The belting discs shall be cut to form a free fit in the casing.

Before starting to surge, water should be bailed or pumped from the well to make sure that some water will flow into the well. For operation, the surge plunger shall be lowered into the casing about 15 feet below the water level. The plunger shall be operated up and down in the well casing to exert equal or approximately equal force on the inward and outward movement of the water through the screen. A surge plunger should not be run in a plugged well. In no case shall the surge plunger be operated below the top of the screen. The surging shall be started slowly at first and the speed increased as the work progresses until it reaches the fastest limit at which the tools will drop and rise without excessive slap of the cable. Periodically, the plunger will be removed and the amount of fines accumulated at the bottom of the well will be measured using a weighted steel tape. If fines have been drawn into the well and have blocked 10 percent or more of the total screen length, the well shall be bailed or otherwise cleaned to the bottom between the surge plunger runs. The bottom of the well should be cleaned by bailer or air lift after surge development is completed.

HIGH-VELOCITY JETTING

This method should be used at the beginning of well development, so that any water introduced into the formation during jetting would be removed during later stages of the development. Development of the well shall be accomplished by high-velocity horizontal jetting with potable water of known chemistry. The jetting shall proceed from the bottom of the screen to the top. The outside diameter of the jetting tool shall be one inch less in diameter than the screen inside diameter. The maximum exit velocity of the jetting water at the jet nozzle shall be 150 feet per second. The jetting tool shall be rotated at a speed of less than one revolution per minute. It shall be positioned at one level for not less than two minutes and then shall be moved to the next level, moving more than 6 inches upward from the preceding jetting level.

AIR LIFT PUMPING

Development of the well shall be conducted by utilizing an air line and an air and water eductor pipe. The air line will be placed inside the eductor pipe with the end of the line near, but not extending below, the end of the pipe. Discharge of air from the air line shall always occur within the eductor pipe to prevent clogging of the filter pack and/or formation with air bubbles. Air lift development procedures should begin by determining that ground water can flow freely into the screen. Application of too much air volume in the well when the formation is clogged can result in a collapsed screen. To minimize the initial pumping rate, the air line and eductor pipe should be placed at shallow submergence. Once uninhibited flow to the screen has been established, the air line and eductor pipe should be lowered to approximately 5 feet above the bottom of the screen. Air will then be pumped through the air line causing displacement of the water in the eductor pipe and flow of water into the well. Development will continue by raising the air line/eductor pipe at approximately 5-foot intervals until the entire screen length has been pumped.

For the piezometers, which are not foreseen for sampling ground water, an alternate method of air lift may be used because of the small casing diameter. This method uses only an air line, and the well casing acts as the eductor pipe. The air line shall be placed at least 5 feet above the screen, or at the bottom of the well within the sump. At no time during development should the air line be moved within the screen area. Maintaining the air line above or below the screen prevents charging the filter pack and/or formation with air, which can cause clogging.

The compressors, air lines, hoses, fittings, etc. shall be of adequate size to pump the well by the air lift method. Pressurized air from air compressor(s) needs to be specifically filtered so that oil from the compressor does not contaminate the well.

Air lift pumping development produces best results when the submergence ratio of the air line is about 60 percent for wells 200 feet or less in depth (Ground Water and Wells, Johnson, 1972). The percent pumping submergence can be calculated as follows:

$$\textit{percent pumping submergence} = \frac{\textit{length of airline below pumping water level}}{\textit{total length of well airline}} \times 100$$

The desirable drawdown is from static water level to the top of screen. The pumping rate will be estimated from available drawdown and pumping submergences.

OVERPUMPING AND BACKWASHING WITH SUBMERSIBLE PUMP

The pumping shall be done with a submersible pump capable of pumping at rates up to two times the estimated well capacity (well yield per unit drawdown). The pumping should be carried out in at least five steps including pumping rates of 0.25, 0.5, 1, 1.5, and 2 times the estimated well capacity. Pumping shall be conducted in five-minute cycles and shall continue until acceptable standards as explained at the beginning of SOP are attained.

BAILING

Where the nature of the formation and/or well construction make development of the well infeasible using pumps or air lift, bailers shall be utilized to evacuate water and fine sediments and/or fine formation particles from the well. Bailers should be of diameter allowing free-fall inside the well casing and should be equipped with a check valve at the bottom. The frequency of bailing trips shall depend on the ability of the well to recover.

STANDARD OPERATING PROCEDURE SS-1

SAMPLE COLLECTION FROM SOIL BORINGS, EXCAVATIONS AND HAND-DUG PITS

STANDARD OPERATING PROCEDURE SS-1
SAMPLE COLLECTION FROM SOIL BORINGS, EXCAVATIONS, AND HAND DUG PITS

SOIL BORING PROCEDURES

The following procedures are designed to be used during the operation of auger type drill rigs during soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and drill operators based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook. **Prior to any subsurface work, have utilities (gas and electric, telephone, sewer, etc.) located by a regional one-call service or the utility companies as needed.**

1. Locate the site as directed in the site-specific Sampling and Analysis Plan (SAP).

2. Drillers prepare rig for operation. This includes; but is not limited to, decontamination of the drill rig tools and sampling equipment, leveling the rig, preparing the downhole tool, preparing the auger "flights", and establishing the drill over the location.

3. Mount the split tube to the drive stem.

4. Prior to using the split spoon sampler, sample the surface increment to a depth in accordance with the site-specific SAP.

5. Place split spoon sampler on the ground surface and advance sampler to the desired depth using the rig hammer.

6. After driving the split spoon sampler its entire length or upon refusal of advancement, recover the split spoon sampler. Refusal is defined as 100 blows with the rig hammer and less than 6 inches advancement of the split spoon sampler. Less than 100 blows may be defined as refusal if there is no split spoon advancement. This decision will be made at the discretion of the field sampler.

7. After recovery of the split spoon sampler, open the spoon and place the spoon containing the soil sample into a holding device, maintaining the intervals as sampled.

8. Sampling personnel will then describe the soil sample based on the site-specific SAP instructions, and fill out the appropriate bound file logbooks, field profile sheets, field site sheets, and quality assurance/quality control documentation.

9. Decontaminate the split spoon sampler.

10. Repeat steps 3 to 9 until sampling is completed.

11. The drill rig tools and sampling equipment will be decontaminated prior to moving onto the next site. The drill rig will be left in a safe and secure fashion at the end of each shift.

BACKHOE PIT EXCAVATIONS

The following procedures are designed to be used during the operation of backhoe equipment to excavate sites prior to soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and backhoe operators based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook.

1. Locate the site as directed in the site-specific SAP. Identify locations of underground utilities.

2. Place the backhoe tractor in a safe position. This will be based on the operators judgment and site conditions.

3. Begin backhoe excavation. Place excavated materials a sufficient distance from the excavation to prevent the return of excavated materials to the pit. Topsoil will be determined by the technical field support, removed, and segregated from the underlying soils.

4. Continue excavation of the pit to the required depth. This depth shall not exceed 5 feet from the ground surface unless the proper pit exit trenches, shoring, and sloping excavations have been excavated to prevent accidental burials of sampling crew and to meet or exceed all OSHA Construction Standards (29 CFR 1926; Appendix A) for entrance by sampling personnel. If OSHA Construction standards for entrance cannot be met, the sample will be obtained from the backhoe bucket.

5. Sampling personnel may enter the pit after all excavation is complete and the excavation is deemed safe to occupy. The site safety officer shall be the oversight authority and will determine what is safe and what is not safe. "Safe" for backhoe pit excavations is defined as meeting or exceeding all OSHA Construction Standards (29 CFR 1926; Appendix A), for entrance by sampling personnel.

6. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall using the Unified Soil Classification System.

7. Soil sampling will follow soil profile description and establishment of sampling intervals based on the site-specific SAP. Soil samples will be collected with decontaminated stainless steel or plastic sampling tools and bowls from the appropriate intervals. A sample collected from a depth increment shall be a representative composite of the entire interval and not biased by sample mass collected largely from the top or bottom of the increment.

8. All pertinent field quality assurance/quality control documentation, bound field logbooks, sample labels, profile sheets, and field site sheets shall be completed prior to refilling the pit.

9. After items 1 through 8 have been completed to the satisfaction of the lead sampler, the site pit shall be refilled with the previously excavated materials. The earthen materials are to be replaced in the same order they were excavated with topsoil placed on top of the filled pit. There will be some unavoidable mixing of soil during the excavation.

10. Decontaminate all sampling equipment, including the backhoe bucket.

11. Move to the next site. If the previous site was the last site of the day, decontaminate the backhoe bucket, secure, and park the backhoe tractor rig for the evening.

HAND DUG PITS

The following procedures are designed to be used during the operation of hand tools to excavate sites prior to soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and field personnel based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook.

1. Locate the site as directed in the site-specific SAP.

2. Select the appropriate orientation for the excavation. This is be based on the lead field sampler's judgment and site conditions.

3. Begin pit excavation. Place excavated materials a sufficient distance from the excavation to prevent the return of excavated materials to the pit. Topsoil is to be placed separately from the underlying soils. Placement of excavated materials on a sheet of plastic is recommended to facilitate returning excavated material to the pit.

4. Continue excavation of the pit to the required depth. This depth shall not exceed 24 inches from the ground surface.

5. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall using the Unified Soil Classification System.

6. Soil sampling will follow soil profile description and establishment of sampling intervals based on the site-specific SAP. Soil samples will be collected with decontaminated stainless steel or plastic sampling tools and bowls from the appropriate intervals. A sample collected from a depth increment shall be representative composite of the entire interval and not biased by sample mass collected largely from the top or bottom of the increment.

7. All pertinent field quality assurance/quality control documentation, bound field logbooks, sample labels, profile sheets, and field site sheets shall be completed prior to refilling the pit.

8. After items 1 through 7 have been completed to the satisfaction of the lead sampler, the site pit shall be refilled with the previously excavated materials. The earthen materials are to be replaced in the same order they were excavated with

topsoil placed on top of the filled pit. There will be some unavoidable mixing of the soil during the excavation.

9. Decontaminate all sampling equipment.

10. Move to the next site. If the previous site was the last site of the day, decontaminate the field sampling equipment, secure all equipment, and exit the site.

STANDARD OPERATING PROCEDURE SS-10

FIELD SCREENING SOIL

STANDARD OPERATING PROCEDURES
FIELD SCREENING SOIL PROCEDURE

FIELD SCREENING

The following procedures are designed to be used to field screen petroleum impacted soil using a photoionization detector (PID) for Volatile Organic Compounds (VOCs). This methodology was developed for field soil screening to generate consistency and reliability of results when using PID instruments. **Soil samples collected for field soil screening may not be used for laboratory analysis. Separate soil samples must be collected according to the soil sampling protocols outlined in this handbook.** This process will likely be used during drilling operations or excavations of petroleum impacted soils for determining if petroleum contamination is present in soils at the work Site.

1. PID instrument shall be operated and calibrated to yield “total organic vapors” in parts per million (PPM). PID instrument should be operated with a 10.2 eV lamp source. Calibration must be checked/adjusted daily. See SOPG-7 for MultiRAE and AutoRAE calibration procedures.

2. Using new nitrile gloves, half fill a plastic whirl pack or Ziplock® baggie with sample material. Whirl and zip-tie or zip to close the baggie.

3. Vigorously shake the sample bags for at least thirty (30) seconds once or twice in a 10-15 minute period to allow for headspace development.

4. If ambient temperatures are below 32^{O} Fahrenheit headspace development should be conducted in a heated vehicle or building.

4\. Open a small portion of the zip lock bag and insert the PID tubing, record the maximum meter reading (should be within the first 2-5 seconds). Erratic responses should be discounted as a results of high organic vapor concentrations or conditions of elevated headspace moisture.

5\. Record appropriate information about the sample collection in the bound field logbook. Any deviations from this method should be noted in the field logbook.