Scott L. MacDonald
Manager Environmental Remediation

BNSF Railway Company
605 Puyallup Ave. South
Tacoma, WA 98421

Ph: 206-625-6376
Fx: 206-625-6007
Email: Scott.Macdonald@BNSF.com

June 29, 2020

Sent via email

Tim Mullin
Site Manager
Toxics Cleanup Program
Washington Department of Ecology
300 Desmond Drive Southeast
Lacey, WA 98503
Tim.Mullin@ecy.wa.gov

Re: **Request for No Further Action Determination; Former Cummings Oil Lease Site, 908 Northwest Kerron Avenue, Winlock, Washington (VCP ID SW0775)**

Dear Mr. Mullin

BNSF Railway Company (BNSF) respectfully requests a No Further Action Determination for the BNSF Winlock site located in Winlock, WA.

Cleanup work at the Site was implemented under the Washington State Department of Ecology Voluntary Cleanup Program. BNSF enrolled in the VCP in 2006 and was assigned VCP No. SW0775 by Ecology's Toxics Cleanup Program. Cleanup actions at the site including UST, AST and excavation of impacted soils were completed in 2008. Soils were removed to the maximum extent practical and groundwater sampling performed to evaluate Monitored Natural Attenuation since the excavation.

Dissolved phase concentrations have been decreasing in impacted site wells for the past 24 sampling events. The last four consecutive quarters of groundwater monitoring have been conducted with results being non-detect or below the MTCA Method A Cleanup level for constituents of concern from Q2 of 2019 to Q1 of 2020. Decreasing trends have been observed at the site since completion of the remedial excavation. Based on the effectiveness of remedial actions performed to date, the requirements of MTCA for a permanent cleanup action per WAC 173-340-200 have been met. Groundwater at the standard points of compliance per WAC 173-340-720(8)(b) meets MTCA Method A cleanup levels.

Based on the analytical data and decreasing trends of petroleum hydrocarbons, BNSF believes it has met the requirements for site closure under MTCA and is requesting a No Further Action Determination for the Winlock Cummings Oil site (VCP ID SW 0775).

If you have any questions or would like to discuss this request further, please call me at (206) 625-6376.

Sincerely,

Scott MacDonald

Scott L. MacDonald
Manager Environmental Remediation

DEPARTMENT OF
ECOLOGY
State of Washington

Voluntary Cleanup Program

Washington State Department of Ecology
Toxics Cleanup Program

REQUEST FOR OPINION FORM

Use this form to request a written opinion on your planned or completed independent remedial action under the Voluntary Cleanup Program (VCP). Attach to this form the plans or reports documenting the remedial action. Please submit only one form for each request.

Step 1: IDENTIFY HAZARDOUS WASTE SITE

Please identify below the hazardous waste site for which you are requesting a written opinion under the VCP. This information may be found on the VCP Agreement.

Facility/Site Name: Former Cummings Oil Lease Site

Facility/Site Address: 905 NW Kerron Avenue, Winlock, Washington

Facility/Site No: 3151688	VCP Project No.: SW0775

Step 2: REQUEST WRITTEN OPINION ON PLAN OR REPORT

What type of independent remedial action plan or report are you submitting to Ecology for review under the VCP? Please check all that apply.

- ☐ Remedial investigation plan
- ☐ Remedial investigation report
- ☐ Feasibility study report
- ☐ Property cleanup* plan (* cleanup of one or more parcels located within the Site)
- ☐ Property cleanup* report
- ☐ Site cleanup plan
- ☐ Site cleanup report
- ☒ Other – please specify: Groundwater Monitoring Summary Report

Do you want Ecology to provide you with a written opinion on the planned or completed independent remedial action?

☒ Yes ☐ No

Please note that Ecology's opinion will be limited to:

- Whether the planned or completed remedial action at the site meets the substantive requirements of the Model Toxics Control Act (MTCA), and/or
- Whether further remedial action is necessary at the site under MTCA.

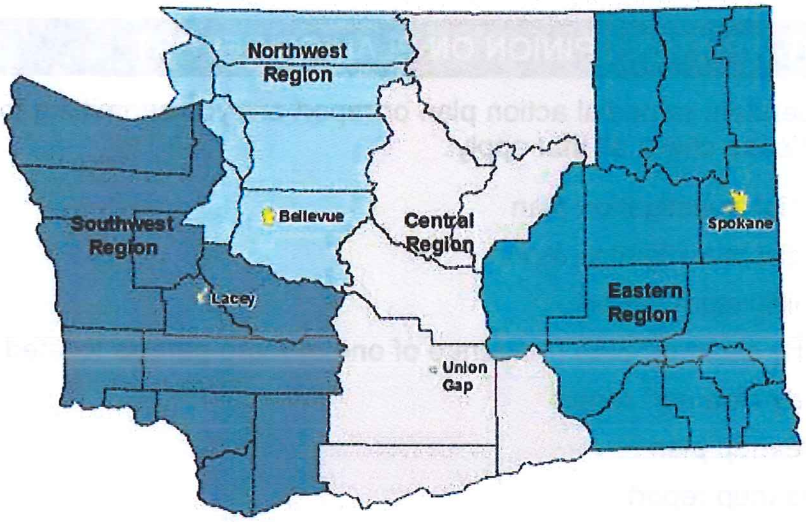
Step 3: REPRESENTATIONS AND SIGNATURE

The undersigned representative of the Customer hereby certifies that he or she is fully authorized to request services from Ecology under the Agreement for this VCP Project.

Name: Scott MacDonald		Title: Manager of Environmnetal Remediation
Signature: Scott Mc		Date: 6/12/2020
Organization: BNSF Railway Company		
Mailing address: 605 Puyallup Avenue South		
City: Tacoma	State: WA	Zip code: 98421
Phone: (206) 625-6376	Fax: (206) 625-6007	E-mail: Scott.MacDonald@BNSF.com

Step 4: SUBMITTAL

Please mail your completed form and the independent remedial action plan or report that you are requesting Ecology review to the site manager Ecology assigned to your Site. If a site manager has not yet been assigned, please mail your completed form to the Ecology regional office for the County in which your Site is located.



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

If you need this publication in an alternate format, please call the Toxics Cleanup Program at 360-407-7170. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

2019–2020 Groundwater Monitoring Summary Report

June 15, 2020

Facility/Site No. 3151688
Cleanup Site ID No. 2247
VCP No. SW0775
TRC Project No. 366391

Former Cummings Oil Lease Site, Winlock, Washington

Prepared For:

Washington State Department of Ecology
SWRO Toxics Cleanup Program
300 Desmond Drive Southeast
Lacey, Washington 98503

On Behalf Of:

BNSF Railway Company
605 Puyallup Avenue South
Tacoma, Washington 98421

Prepared By:

TRC Environmental Corporation
19874 141st Place Northeast
Woodinville, Washington 98072

Keith Wood

Prepared by:
Keith Woodburne, LG
Office Practice Leader

State of Washington
Licensed Geologist
2955
Keith L. Woodburne

Douglas Kunkel

Reviewed and Approved by:
Doug Kunkel, LG, LHG
Principal Hydrogeologist

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYM LIST

AST	Aboveground storage tank
BNSF	BNSF Railway Company
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
CUL	Cleanup level
COC	Constituent of Concern
DRO	Diesel-range organics
Ecology	Washington State Department of Ecology
GRO	Gasoline-range organics
MTCA	Model Toxics Control Act
NFA	No Further Action
ORO	Oil-range organics
RDL	Reported detection limit
SGC	Silica gel cleanup
Site	Former Cummings Oil Lease Site
SOP	Standard Operating Procedure
TPH	Total petroleum hydrocarbons
TRC	TRC Environmental Corporation
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
µg/L	Micrograms per liter
VCP	Voluntary Cleanup Program

1.0 Introduction

On behalf of the BNSF Railway Company (BNSF), TRC Environmental Corporation (TRC) is providing this *2019–2020 Groundwater Monitoring Summary Report* to the Washington State Department of Ecology (Ecology). This report summarizes the quarterly groundwater monitoring activities conducted between September 30, 2019 and February 20, 2020 at the Former Cummings Oil Lease Site (Site) located in Winlock, Washington.

It is TRC's opinion that the data and information contained herein demonstrate that actions at the Site are fully compliant with the requirements of the Model Toxics Control Act (70.105D RCW) and its implementing regulations (Washington Administrative Code [WAC] 173-340), collectively referred to as "MTCA." The data also demonstrate that the standard point of compliance has been met throughout the property. Accordingly, this report recommends the Site receive a No Further Action (NFA) determination from Ecology (see Section 4.0).

2.0 Site Background

2.1 Site Description

The Site is fully within the property located at 908 Northwest Kerron Avenue in Winlock, Washington (Figure 1). In 1925, Shell Oil Company (Shell) leased the property from BNSF for use as a bulk fuel storage facility. Cummings Oil Company (Cummings) served as operators of the bulk fuel storage facility from 1970 until it closed in 1976. All buildings and other aboveground features have since been removed and the property is currently undeveloped and unoccupied. The locations of historical features and current subsurface utilities are shown on Figure 2.

The Site enrolled into the Voluntary Cleanup Program (VCP) in 2006 and was assigned VCP No. SW0775 by Ecology's Toxics Cleanup Program. The current VCP Site Manager is Mr. Tim Mullin.

2.2 Summary of Cleanup Actions, Environmental Investigations and Regulatory Status

Subsurface investigations identified a 1,000-gallon capacity underground storage tank (UST), a 5,000-gallon capacity UST, three 13,000-gallon capacity aboveground storage tanks (ASTs), and a 25,000-gallon capacity AST used to store fuel oils (Farallon, 2006 and 2008). Total petroleum hydrocarbon (TPH) concentrations exceeding MTCA Method A cleanup levels (CULs) were detected in soil and groundwater samples collected in the proximity of the USTs and ASTs. The TPH impacts consisted of diesel-range organics (DRO), gasoline-range organics (GRO), oil-range organics (ORO), benzene, toluene, ethylbenzene, and xylenes (BTEX), naphthalenes, and carcinogenic polycyclic aromatic hydrocarbons (cPAHs), collectively referred to as constituents of concern (COCs).

Tank closure activities defined in the Cleanup Action Work Plan included delineating the nature and extent of COCs in groundwater, assessing monitored natural attenuation in groundwater, and excavation and off-Site disposal of impacted soil with COC concentrations exceeding Method A CULs (Farallon, 2008).

The UST and AST decommissioning and excavation activities completed in in 2008 remediated the petroleum-impacted soil to the extent practicable through excavation and off-Site disposal (Farallon, 2010). Confirmational testing during excavation demonstrated that soil conditions at the terminal limits of the remedial excavations complied with applicable CULs, with the exception of a limited volume of petroleum-impacted soil along the northern edge of the property where excavation was limited by the presence of a drainage ditch. Residual impacts to groundwater remained and those impacts have been the focus of subsequent environmental investigations and ongoing monitoring and reporting.

An assessment of the potential for natural attenuation via biodegradation processes to reduce concentrations of residual petroleum hydrocarbon constituents in groundwater was conducted during the December 27, 2010 groundwater monitoring and sampling event (Farallon, 2011) using geochemical indicators and the Ecology Guidance on Remediation of Petroleum Contaminated Groundwater by Natural Attenuation (Ecology, 2005). The results of the assessment projected with an 85 percent confidence level that DRO concentrations in samples from monitoring wells MW-1 and MW-3 would reach the MTCA Method A CUL through natural attenuation by January 2012 and March 2013, respectively.

Annual groundwater monitoring for DRO, ORO, and BTEX was initiated in 2011 to track the progress of natural attention.

Ecology issued an unsolicited Opinion of Proposed Cleanup dated August 12, 2013. Ecology identified the following concerns and requirements:

- Proposed cleanup plan (monitored natural attenuation) does not meet the substantive requirements of MTCA, Chapter 70.105D RCW, and its implementing regulations, Chapter 173-340 WAC (collectively substantive requirements of MTCA).
- Potential for the storm and sewer lines along the northern and western edge of the property to preferentially divert groundwater flow.
- Potential off-Site migration and influence of storm drains on groundwater flow along the western property boundary.
- Testing of groundwater for the MTCA Table 830-1 constituents, including naphthalene, methyl-tert-butyl ether (MTBE), 1-methyl-naphthalene, 2-methyl-naphthalene, 1,2-dibromoethane (EDB), and 1,2-dichloroethane (EDC).
- Completion of a Terrestrial Ecological Evaluation (TEE) in accordance with WAC 173-340-7490.

Ecology's concerns and requirements were addressed in a response to comments submitted to Ecology on January 7, 2014 (TRC, 2014) and through a supplemental subsurface investigation completed in 2014. The results of that investigation were documented in the *Annual 2014 Groundwater Monitoring and Supplemental Subsurface Investigation Report* submitted to Ecology on January 20, 2015 (Farallon, 2015).

Beginning in the third quarter of 2015 and based on results from the August 2015 annual monitoring event, BNSF temporarily increased the sampling frequency to quarterly to document that COC concentrations remained less than the MTCA Method A CULs for four consecutive quarters. After four quarters of COC concentrations less than the CULs, groundwater monitoring would have ceased. However, because DRO concentrations exceeded MTCA Method A CULs in samples from wells MW-2 and MW-3, and benzene in samples from well MW-2 during the first quarter 2016 monitoring event, TRC ceased quarterly monitoring. The sampling frequency was returned to semi-annual to continue assessing the progress of monitored natural attenuation.

Quarterly groundwater monitoring was resumed in 2018 with the addition of DRO and ORO analysis without silica gel cleanup (SGC), as required by Ecology. As documented in the *2018–2019 Annual Groundwater Monitoring Report* dated August 29, 2019, neither DRO nor ORO were detected at concentrations exceeding MTCA Method A CULs, with the exception of one DRO result during the first quarter of 2019 (TRC, 2019). DRO was detected at a concentration of 519 micrograms per liter (µg/L) in a single well, which was slightly greater than the MTCA Method A CUL of 500 µg/L.

In an email dated September 25, 2019 the Ecology VCP Site Manager recommended the following path to an NFA determination:

- Conduct one additional monitoring event for all wells for DRO and ORO only. Gauge all wells.
- Conduct additional monitoring at MW-3 for DRO and ORO without SGC until:
    I. Four consecutive events result in concentrations complying with the MTCA Method A CULs; or
    II. Sufficient monitoring events have been completed to use the statistical method for determining compliance as described in WAC 173-340-720(9).
- Discontinue analysis of groundwater for BTEX. Sufficient BTEX data in groundwater have been collected to demonstrate MTCA compliance.
- Confirm WAC 173-340-900, Table 830-1 and applicable footnotes to verify that all required groundwater analyses have been conducted.

BNSF had previously confirmed that all analyses required by WAC 173-340-900, Table 830-1 had been performed and that none of those analytes had been detected at a concentration exceeding an applicable CUL (Farallon, 2015).

To address the remaining Ecology recommendations, BNSF implemented the following:

- Quarterly groundwater monitoring for all wells during the third quarter 2019 monitoring event; and
- MW-3 was sampled for DRO and ORO with and without SGC during the fourth quarter of 2019 and first quarter of 2020.

The resulting data and findings are discussed below in Section 3.3. Based on the Ecology September 2019 email recommendations, implementing those recommendations and obtaining favorable data should qualify the Site for an NFA determination.

3.0 Groundwater Monitoring

Groundwater monitoring and sampling activities described below were performed on September 30, 2019, December 18, 2019, and February 20, 2020. Groundwater monitoring was conducted in accordance with TRC Standard Operating Procedures (SOPs), which are included as Appendix A.

3.1 Groundwater Elevations

Depth to water and total well depth were measured in monitoring wells MW-1 through MW-7 using an electronic water level probe accurate to 0.01 foot. Wells were opened and allowed to equilibrate with atmospheric pressure for a minimum of 15 minutes prior to measuring and recording depths to water. Prior to measurement at each well, the water level probe was decontaminated with a solution of Alconox™ and potable water followed by rinsing with deionized water. Depth-to-water measurements and calculated groundwater elevations for each well are summarized in Table 1.

Groundwater elevations have been relatively consistent from the initial investigations in 2005 to the most recent monitoring event in February 2020. Based on groundwater elevations recorded during the February 2020 monitoring event, the groundwater flow direction is generally to the west-southwest (Figure 3), which is consistent with previous monitoring results. The average groundwater gradient measured during the February 2020 event is approximately 0.03 feet per foot. Average groundwater gradients and groundwater flow directions have not varied significantly during the reporting period.

3.2 Groundwater Sampling Activities

During the September 2019 monitoring event, samples were collected from all seven monitoring wells. During the December 2019 and February 2020 sampling events original and field duplicate groundwater samples were collected from well MW-3 only.

Wells were purged using a peristaltic pump and dedicated polyethylene tubing at flow rates between 100 and 150 milliliters per minute. During the purging process, water quality parameters (temperature, pH, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity) were measured using a YSI water quality meter equipped with a flow-through cell and a portable turbidity meter. Following parameter stabilization in accordance with United States Environmental Protection Agency (USEPA) guidelines for low-flow sampling, the discharge tubing was disconnected from the flow-through cell and groundwater samples were collected directly into new, pre-labeled laboratory provided bottles. Final field stabilization water quality parameter measurements are presented in Table 2.

Additionally, blind duplicate samples were collected from monitoring wells MW-2 (September 2019) and MW-3 (December 2019 and February 2020). All groundwater samples were submitted to Pace Analytical of Mt. Juliet, Tennessee for analysis of:

- DRO and ORO using the Northwest Total Petroleum Hydrocarbons as Diesel (NWTPH-Dx) method with SGC; and
- DRO and ORO using the NWTPH-Dx method without SGC.

3.3 Groundwater Monitoring Results

3.3.1 Analytical Results

Copies of the laboratory analytical reports and chain-of-custody documentation for the September 2019, December 2019, and February 2020 sampling events are provided in Appendix B. Groundwater analytical results are summarized in Table 3 and on Figure 3 and are described below:

- **September 2019** (all seven wells sampled for DRO and ORO):

    - <u>All DRO concentrations were less than the MTCA Method A CUL of 500 µg/L.</u> DRO with SGC was not detected at the laboratory reported detection limit (RDL) in samples from any of the seven wells. DRO without SGC was detected at concentrations ranging from 289 µg/L at MW-1 to 426 µg/L at MW-3.
    - <u>All ORO concentrations were less than the MTCA Method A CUL of 500 µg/L</u>. ORO with SGC was not detected at the laboratory RDL in samples from any of the seven wells. ORO without SGC was detected in only one of the seven wells. The sample from MW-3 had an ORO concentration of 325 µg/L.
- **December 2019** (only MW-3 sampled for DRO and ORO):
    - <u>DRO concentrations were less than the MTCA Method A CUL.</u> DRO with SGC was not detected at the laboratory RDL. DRO without SGC was detected at concentrations of 357 µg/L and 407 µg/L in the original and duplicate samples, respectively.
    - <u>ORO concentrations were less than the MTCA Method A CUL.</u> ORO with SGC was not detected at the laboratory RDL. ORO without SGC was detected at concentrations of 261 µg/L and 339 µg/L in the original and duplicate samples, respectively.
- **February 2020** (only MW-3 sampled for DRO and ORO):
    - <u>DRO with SGC was not detected at the laboratory RDL</u>. DRO without SGC was detected at concentrations of 484 µg/L and 503 µg/L in the original and duplicate samples, respectively. The DRO concentration of the original sample is less than the MTCA Method A CUL. The DRO concentration in the duplicate sample is slightly greater than the CUL. The average DRO concentration of the original and duplicate samples without SGC is 494 µg/L.
    - <u>ORO was not detected at a concentration greater than the MTCA Method A CUL</u>. ORO with SGC was not detected at the laboratory RDL. ORO without SGC was not detected at the RDL in the original sample and detected at a concentration of 256 µg/L in the duplicate sample.

3.3.2 Concentration Trends

Concentrations of dissolved phase hydrocarbons in groundwater have been below the MTCA Method A Cleanup level in all site wells for a minimum of four consecutive groundwater monitoring events. Concentrations of DRO and ORO in all site wells have been decreasing since remedial activities were completed in 2008. Concentrations trends for MW-3 are presented on Figure 4.

4.0 Conclusions

The following conclusions are supported by the findings of the data presented herein:

- ORO has not been detected in groundwater samples from any of the seven wells at a concentration exceeding the MTCA Method A CUL since August 2013.
- DRO is not present in groundwater at a concentration exceeding the MTCA Method A CUL. DRO concentrations have not exceeded the CUL in samples from any well other than MW-3 since August 2016. Overall compliance with the CUL for DRO is demonstrated by the following:

1. The average DRO concentration without SGC in MW-3 between January 2019 and February 2020 is 442 µg/L. This average annual result is more indicative of the overall Site conditions than individual sample results.

2. DRO concentrations with SGC in samples from MW-3, when detected, demonstrate a clear decreasing trend. This finding is supportive of a conclusion indicating that no significant residual DRO source material remains and it is reasonable to conclude that concentrations will continue to decrease over time.

3. DRO concentrations with SGC in samples from MW-3 have not exceeded the MTCA Method A CUL since August 2016. This finding supports a conclusion that the residual groundwater impacts at MW-3 are highly degraded and subject to ongoing natural attenuation.

4. DRO concentrations in samples from well MW-7, located hydraulically downgradient of MW-3, have not been detected at the RDL since August 2015, which had a DRO concentration of 120 µg/L This finding, in combination with the decreasing concentrations at MW-3, confirm that the Site is very small in lateral extent and does not pose a threat to human health or the environment and that there are no realistic current or potential future receptors.

- The required analyses contained in WAC 173-340-900 Table 830-1 were previously performed and did not result in target analyte concentrations exceeding a MTCA CUL. Those results were presented in *Annual 2014 Groundwater Monitoring and Supplemental Subsurface Investigation Report* (Farallon, 2015).

Impacted soil in the source area has been removed to the maximum extent practicable, which is a permanent cleanup action per WAC 173-340-200. Groundwater at the standard point of compliance (throughout the Site) per WAC 173-340-720(8)(b) meets applicable MTCA CULs. Based on the information presented in this summary report, the Site meets the requirements under MTCA for a no further action determination.

5.0 References

Farallon Consulting, LLC (Farallon). 2006. *Supplemental Subsurface Investigation, BNSF Winlock, 908 Northwest Kerron Avenue, Winlock, Washington*. May 31.

———. 2008. *Cleanup Action Work Plan, Former Cummings Oil Lease Site, 908 Northwest Kerron Avenue, Winlock, Washington*. December 1

———. 2010. *Tank Closure Report, Former Cummings Oil Lease Site, 908 Northwest Kerron Avenue, Winlock, Washington*. March 11.

———. 2011. *Groundwater Monitoring Status Report, December 2010, Former Cummings Oil Lease Site, 908 Northwest Kerron Avenue, Winlock, Washington*. May 4.

———. 2015. *2014 Annual Groundwater Monitoring and Supplemental Subsurface Investigation Report, Former Cummings Oil Lease Site, 908 Northwest Kerron Avenue, Winlock, Washington*. January 19.

TRC Environmental Corporation (TRC). 2014. “Response to Washington State Department of Ecology Comments – August 12, 2013 Opinion.” January 7.

———. 2019. *2018-19 Annual Groundwater Monitoring Report, BNSF Former Cummings Oil Lease Site, Winlock, Washington*. August 29.

Washington State Department of Ecology (Ecology). 2005. *Guidance on Remediation of Petroleum-Contaminated Groundwater by Natural Attenuation, Version 1.0*. Publication No. 05-09-091. July.

———. 2013. Letter Regarding Opinion on Proposed Cleanup of the BNSF – Winlock Site, 908 Northwest Kerron Avenue, Winlock, Washington. From Thomas Middleton. To Stacy D. Patterson, Farallon Consulting, L.L.C. August 1.

———. 2019. Email correspondence from Tim Mullin, Toxics Cleanup Program, Southwest Region, RE: SW0775 - BNSF Winlock. September 25, 2019.

Tables

Table 1
Summary of Groundwater Elevation Data
Former Cummings Oil Lease Site
Winlock, Washington

Monitoring Well	TOC Elevation[a] (ft)	Date	Monitoring Well Screen Interval (feet bgs)	Depth of Monitoring Well (feet bgs)	Depth to Water (feet btoc)	Groundwater Elevation[a] (feet)
MW-1	313.00	12/23/2005	5-12	12	2.13	310.87
		8/18/2008			4.50	308.50
		3/11/2010			3.00	310.00
		6/8/2010			4.20	308.80
		10/20/2010			3.00	310.00
		12/27/2010			1.95	311.05
		3/22/2011			2.59	310.41
		8/17/2012			3.01	309.99
		8/1/2013			2.86	310.14
		8/14/2014			3.83	309.17
		8/6/2015			3.53	309.47
		12/23/2015			2.15	310.85
		3/28/2016			2.11	310.89
		8/18/2016			3.08	309.92
		1/18/2017			1.06	311.94
		8/31/2017			3.90	309.10
		1/17/2018			2.02	310.98
		8/30/2018			2.78	310.22
		11/15/2018			2.20	310.80
		1/22/2019			1.66	311.34
		4/17/2019			1.89	311.11
		9/30/2019			2.43	310.57
		12/18/2019			2.30	310.70
		2/20/2020			2.00	311.00
MW-2	312.98	12/23/2005	5-11	11	2.50	310.48
		8/18/2008			4.67	308.31
		3/11/2010			1.88	311.10
		6/8/2010			2.28	310.70
		10/20/2010			2.65	310.33
		12/27/2010			1.52	311.46
		3/22/2011			2.09	310.89
		8/17/2012			3.01	309.97
		8/1/2013			2.94	310.04
		8/14/2014			3.38	309.60
		8/6/2015			3.76	309.22
		12/23/2015			2.31	310.67
		3/28/2016			2.27	310.71
		8/18/2016			3.20	309.78
		1/18/2017			1.18	311.80
		8/31/2017			3.18	309.80
		1/17/2018			2.04	310.94
		8/30/2018			2.82	310.16
		11/14/2018			2.2	310.78
		1/22/2019			1.74	311.24
		4/17/2019			1.70	311.28
		9/30/2019			2.74	310.24
		12/18/2019			1.95	311.03
		2/20/2020			1.85	311.13
MW-3	312.75	12/23/2005	5-10	10	2.21	310.54
		8/18/2008			4.40	308.35
		3/11/2010			--	--
		6/8/2010			2.26	310.49
		10/20/2010			2.68	310.07
		12/27/2010			1.98	310.77
		3/22/2011			2.16	310.59
		8/29/2012			3.02	309.73
		8/1/2013			2.91	309.84
		8/14/2014			2.95	309.80
		8/6/2015			3.66	309.09
		12/23/2015			2.24	310.51
		3/28/2016			2.15	310.60
		8/18/2016			2.85	309.90
		1/18/2017			1.72	311.03
		8/31/2017			2.68	310.07
		1/17/2018			1.80	310.95
		8/30/2018			2.35	310.40
		11/16/2018			2.21	310.54
		1/22/2019			2.16	310.59
		4/17/2019			2.29	310.46
		9/30/2019			2.59	310.16
		12/18/2019			2.29	310.46
		2/20/2020			2.46	310.29
MW-4	314.89	12/23/2005	5-12	12	0.50	314.39
		8/18/2008			5.02	309.87
		8/18/2008			5.54	309.35
		3/11/2010			1.9	312.99
		6/8/2010			1.45	313.44
		10/20/2010			2.40	312.49
		12/27/2010			0.48	314.41
		3/22/2011			1.33	313.56
		8/29/2012			3.48	311.41
		8/1/2013			3.31	311.58
		8/14/2014			4.24	310.65
		8/6/2015			4.13	310.76
		12/23/2015			0.33	314.56
		3/28/2016			1.07	313.82

Table 1
Summary of Groundwater Elevation Data
Former Cummings Oil Lease Site
Winlock, Washington

Monitoring Well	TOC Elevation[a] (ft)	Date	Monitoring Well Screen Interval (feet bgs)	Depth of Monitoring Well (feet bgs)	Depth to Water (feet btoc)	Groundwater Elevation[a] (feet)
MW-4 (cont'd)	314.89	8/18/2016	5-12	12	--	--
		1/18/2017			0.10	314.79
		8/31/2017			6.00	308.89
		1/17/2018			1.45	313.44
		8/30/2018			5.32	309.57
		11/15/2018			1.89	313.00
		1/22/2019			1.29	313.60
		4/17/2019			1.90	312.99
		9/30/2019			3.01	311.88
		12/18/2019			1.45	313.44
		2/20/2020			2.39	312.50
MW-5	312.45	3/11/2010	5-10	10	3.29	309.16
		6/8/2010			4.00	308.45
		10/20/2010			5.25	307.20
		12/27/2010			3.17	309.28
		3/22/2011			4.51	307.94
		8/17/2012			5.47	306.98
		8/1/2013			5.52	306.93
		8/14/2014			5.12	307.33
		8/6/2015			5.68	306.77
		12/23/2015			3.63	308.82
		3/28/2016			4.65	307.80
		8/18/2016			5.31	307.14
		1/18/2017			2.68	309.77
		8/31/2017			5.40	307.05
		1/17/2018			4.67	307.78
		8/30/2018			4.30	308.15
		11/15/2018			3.63	308.82
		1/22/2019			1.90	310.55
		4/17/2019			2.11	310.34
		9/30/2019			3.67	308.78
		12/18/2019			2.05	310.40
		2/20/2020			2.78	309.67
MW-6	312.35	8/14/2014	5-10	10	3.36	308.99
		8/14/2014			5.51	306.84
		8/6/2015			3.94	308.41
		12/23/2015			2.92	309.43
		3/28/2016			2.93	309.42
		8/18/2016			3.81	308.54
		1/18/2017			2.59	309.76
		8/31/2017			3.77	308.58
		1/17/2018			3.01	309.34
		8/30/2018			3.28	309.07
		11/15/2018			2.79	309.56
		1/22/2019			1.84	310.51
		4/17/2019			1.94	310.41
		9/30/2019			2.98	309.37
		12/18/2019			2.02	310.33
		2/20/2020			2.19	310.16
MW-7	312.41	8/6/2015	5-9	9	5.67	306.74
		12/23/2015			4.75	307.66
		3/28/2016			5.00	307.41
		8/18/2016			5.56	306.85
		1/18/2017			4.70	307.71
		8/31/2017			5.71	306.70
		1/17/2018			5.23	307.18
		8/30/2018			5.26	307.15
		11/15/2018			4.79	307.62
		1/22/2019			4.39	308.02
		4/17/2019			4.55	307.86
		9/30/2019			5.12	307.29
		12/18/2019			4.58	307.83
		2/20/2020			4.72	307.69

ABBREVIATIONS:
TOC = top of casing
btoc = below top of casing
bgs = below ground surface
-- denotes depth not measured

FOOTNOTES:

[a] Elevations based on survey completed 8/14/14 Blum & Associates Land Surveyors, Inc. to Washington State Plane Coordinate System South Zone NAD 83, NAVD 88 elevations.

Table 2
Summary of Water Quality and Geochemical Parameters
Former Cummings Oil Lease Site
Winlock, Washington

Monitoring Well	Date Sampled	Water Quality Parameters						Geochemical Parameters											
		Temperature	pH	Conductivity	Turbidity	DO	ORP	Nitrate | Nitrite[a]	Sulfate	Sulfide	Total Iron	Ferrous Iron	Ferric Iron	Methane	Alkalinity	Dissolved Manganese	Total Manganese	Ethane	Ethene
		°C	--	mS/cm	NTU	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
MW-1	8/18/2008	17.6	6.03	0.221	--	0.92	-7.70	--	--	--	--	--	--	--	--	--	--	--	--
	3/11/2010	10.08	6.7	0.289	--	0.47	117.7	<0.20	74.4	--	--	--	--	289	--	--	--	--	--
	6/9/2010	14.21	6.21	0.348	--	0.42	11.1	0.012	59.4	--	--	9.8	--	520	--	--	--	--	--
	10/20/2010	16.2	6.13	0.234	--	0.64	12.1	<0.20	59.1	--	--	2.3	--	388	--	--	--	--	--
	12/27/2010	10.65	6.16	0.28	--	0.29	-1.2	<0.20	38.3	--	--	15.3	--	668	--	--	--	--	--
	3/22/2011	9.27	7.29	0.308	--	0.15	-61.9	0.080[c]	34.3	--	--	3.2	--	22.0	--	--	--	--	--
	12/23/2015	8.52	6.31	0.272	17.3	1.39	-21.4	--	--	--	--	--	--	--	--	--	--	--	--
	3/28/2016	13.06	6.17	0.252	44.2	1.11	-8.1	--	--	--	--	--	--	--	--	--	--	--	--
	8/18/2016	20.08	5.75	0.194	5.03	0.79	-0.4	--	--	--	--	--	--	--	--	--	--	--	--
	1/18/2017	10.1	6.3	0.1889	13.1	1.32	-70.9	--	--	--	--	--	--	--	--	--	--	--	--
	8/31/2017	20.36	6.03	0.136	8.94	2.24	-20.4	--	--	--	--	--	--	--	--	--	--	--	--
	1/17/2018	9.26	5.3	0.125	15.2	1.57	-166.4	--	--	--	--	--	--	--	--	--	--	--	--
	8/30/2018	Not Sampled						Not Sampled											
	11/15/2018	12.55	5.91	0.176	12.60	--	63.1	--	--	--	--	--	--	--	--	--	--	--	--
	1/22/2019	9.42	6.49	0.116	25.40	1.41	25.0	--	--	--	--	--	--	--	--	--	--	--	--
	4/17/2019	12.00	5.87	0.189	6.68	0.17	78.6	--	--	--	--	--	--	--	--	--	--	--	--
	9/30/2019	17.10	6.13	0.185	3.85	0.63	47.6	--	--	--	--	--	--	--	--	--	--	--	--
MW-2	8/18/2008	17.65	6.64	0.316	--	0.99	-77.20	<0.200	0.4	--	--	--	--	1,660	--	--	--	--	--
	3/11/2010	9.93	7.28	0.247	--	0.77	101.2	<0.20	30.3	--	--	--	--	1,620	--	--	--	--	--
	6/9/2010	14.48	6.84	0.277	--	1	75.8	<0.050	7.9	--	--	3.2	--	3,500	--	--	--	--	--
	10/20/2010	16.76	6.61	0.279	--	0.91	-50.3	<0.20	11.2	--	--	1.3	--	6,320	--	--	--	--	--
	12/27/2010	10.39	6.6	0.305	--	0.39	-78.5	<0.20	12.5	--	--	30.2	--	2,980	--	--	--	--	--
	3/22/2011	8.97	6.63	0.253	--	0.57	191.6	0.10[c]	8.3	--	--	1.8	--	1,160	--	--	--	--	--
	12/23/2015	10.34	6.55	0.189	32.6	3.38	-25.3	--	--	--	--	--	--	--	--	--	--	--	--
	3/28/2016	12.27	6.48	0.368	19.7	1.25	-88.5	--	--	--	--	--	--	--	--	--	--	--	--
	8/18/2016	21.45	5.96	0.273	5.21	0.3	-73.7	--	--	--	--	--	--	--	--	--	--	--	--
	1/18/2017	10.1	6.47	0.2124	45.6	2.25	-60.6	--	--	--	--	--	--	--	--	--	--	--	--
	8/31/2017	19.12	6.59	0.193	10.6	0.9	-64.2	<0.100	<5.0	<0.05	20.9	6.5[b]	14.4	3,650	125,000	377	372	<13.0	<13.0
	1/18/2018	7.57	5.87	0.156	29.3	1.31	-146.4	<0.100	<250	<0.05	22.6	3.0[b]	19.6	2,530	97,300	372	428	<13.0	<13.0
	8/30/2018	19.08	6.45	0.204	11.7	1.04	-82.4	<0.100	<5	<0.05	28.4	3.5[b]	24.9	2,230	106,000	413	443	<13.0	<13.0
	11/14/2018	13.63	6.21	0.205	29.9	--	-12.9	--	--	--	--	--	--	--	--	--	--	--	--
	1/22/2019	9.90	6.54	0.090	7.71	0.74	35.7	--	--	--	--	--	--	--	--	--	--	--	--
	4/17/2019	11.80	6.45	0.234	13.0	1.05	14.2	--	--	--	--	--	--	--	--	--	--	--	--
	9/30/2019	17.00	6.62	0.274	6.67	0.60	-78.3	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	8/18/2008	17.38	6.34	0.382	--	1.08	-75.60	--	--	--	--	--	--	—	--	--	--	--	--
	3/11/2010	Not Sampled						Not Sampled											
	6/9/2010	13.87	6.36	0.387	--	0.50	-6.80	<0.050	13.4	--	--	3.9	--	380	--	--	--	--	--
	10/20/2010	17.26	6.57	0.321	--	0.87	-33.4	<0.20	14.6	--	--	1.5	--	338	--	--	--	--	--
	12/27/2010	11.09	6.48	0.378	--	0.45	-50.8	<0.20	13.9	--	--	23.2	--	339	--	--	--	--	--
	3/22/2011	9.72	8.06	0.416	--	0.25	-78.2	0.073[c]	17.8	--	--	4.2	--	224	--	--	--	--	--
	12/23/2015	8.4	6.91	0.304	64.6	1.96	12.1	--	--	--	--	--	--	--	--	--	--	--	--
	3/28/2016	12.04	6.2	0.450	75.8	0.45	-14.7	--	--	--	--	--	--	--	--	--	--	--	--
	8/18/2016	23.04	6.08	0.392	52.2	0.34	-47.2	--	--	--	--	--	--	--	--	--	--	--	--
	1/19/2017	9.2	6.23	0.189	239.3	3.06	-4.5	--	--	--	--	--	--	--	--	--	--	--	--
	8/31/2017	21.10	6.22	0.285	33	1.51	-14.6	<0.100	32.9	<0.05	18.1	6.0[b]	12.1	137	131,000	571	574	<13.0	<13.0
	1/17/2018	8.56	5.60	0.201	>1,000	2.73	-74.2	<0.100	<250	<0.05	40.8	3.5[b]	37	140	111,000	511	698	<13.0	<13.0
	8/30/2018	20.09	6.13	0.258	17	0.96	-31.2	<0.100	17.2	<0.05	30.9	3.5[b]	27.4	197	137,000	572	630	<13.0	<13.0
	11/16/2018	14.58	6.06	0.318	32.1	--	9.3	--	--	--	--	--	--	--	--	--	--	--	--
	1/23/2019	11.19	7.40	0.312	6.97	0.18	-105.8	--	--	--	--	--	--	--	--	--	--	--	--
	4/17/2019	11.00	6.03	0.430	8.0	0.27	11.3	--	--	--	--	--	--	--	--	--	--	--	--
	9/30/2019	18.00	6.32	0.363	6.29	0.23	-41.9	--	--	--	--	--	--	--	--	--	--	--	--

Table 2
Summary of Water Quality and Geochemical Parameters
Former Cummings Oil Lease Site
Winlock, Washington

Monitoring Well	Date Sampled	Water Quality Parameters						Geochemical Parameters											
		Temperature	pH	Conductivity	Turbidity	DO	ORP	Nitrate | Nitrite[a]	Sulfate	Sulfide	Total Iron	Ferrous Iron	Ferric Iron	Methane	Alkalinity	Dissolved Manganese	Total Manganese	Ethane	Ethene
		°C	--	mS/cm	NTU	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
MW-3 (cont'd)	12/18/2019	11.70	6.36	0.465	2.46	0.21	-16.7	--	--	--	--	--	--	--	--	--	--	--	--
	2/20/2020	10.50	6.37	0.469	8.82	0.21	-58.0	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	8/18/2008	13.78	6.75	0.241	--	0.97	-74.90	<0.200	16.7	--	--	--	--	22.8	--	--	--	--	--
	3/11/2010	9.59	7.92	0.255	--	0.57	85.60	<0.20	17.6	--	--	--	--	47.6	--	--	--	--	--
	6/9/2010	12.42	7.16	0.26	--	0.51	85.5	0.011	12.5	--	--	1.2	--	93	--	--	--	--	--
	10/20/2010	12.96	7.42	0.206	--	0.66	-77.8	<0.20	14.1	--	--	0.52	--	16.9	--	--	--	--	--
	12/27/2010	10.84	6.11	0.205	--	0.49	53.5	<0.20	9.1	--	--	19.5	--	51.6	--	--	--	--	--
	3/22/2011	9.2	6.01	0.196	--	0.91	211.2	0.12[c]	14.3	--	--	2.2	--	<10.0	--	--	--	--	--
	12/23/2015	*Not Sampled*						*Not Sampled*											
	3/28/2016																		
	8/18/2016																		
	1/19/2017																		
	8/31/2017	15.31	6.79	0.163	41.3	1.13	-44.2	<0.100	15.7	<0.05	12.4	5.0[b]	7.4	27.2	89,500	504	499	<13.0	<13.0
	1/18/2018	9.09	5.89	0.12	70.1	1.00	-176.3	<0.100	8.28	<0.05	7.8	1.5[b]	6.3	34.6	76,200	412	440	<13.0	<13.0
	8/30/2018	16.38	6.47	0.167	28.3	0.28	-41.8	<0.100	14.90	<0.05	17.2	4.5[b]	12.7	32.9	85,700	527	545	<13.0	<13.0
	11/15/2018	14.11	6.09	0.210	15.9	--	-2.0	--	--	--	--	--	--	--	--	--	--	--	--
	1/23/2019	10.86	6.63	0.091	14.0	1.31	-23.0	--	--	--	--	--	--	--	--	--	--	--	--
	4/17/2019	11.60	5.39	0.140	11.4	0.26	127.5	--	--	--	--	--	--	--	--	--	--	--	--
	9/30/2019	14.90	6.76	0.222	12.0	0.39	-48.9	--	--	--	--	--	--	--	--	--	--	--	--
MW-5	8/18/2008	17.57	6.62	0.466	--	1.45	-31.60	--	8.0	--	--	--	--	40.6	--	--	--	--	--
	3/11/2010	10.3	7.63	0.067	--	5.66	107.9	0.61	3.2	--	--	--	--	<10.0	--	--	--	--	--
	6/9/2010	14.74	5.76	0.074	--	2.27	213.5	0.87	4.7	--	--	<0.17	--	<2.3	--	--	--	--	--
	10/20/2010	17.59	6.03	0.085	--	1.34	75.5	0.65	6.3	--	--	<0.20	--	<10.0	--	--	--	--	--
	12/27/2010	10.69	5.72	0.073	--	5.62	140.7	1.2	3.9	--	--	<0.20	--	<10.0	--	--	--	--	--
	3/22/2011	8.89	5.62	0.072	--	6.02	47.2	0.48[c]	7.0	--	--	0.50	--	<10.0	--	--	--	--	--
	12/23/2015	11.53	5.75	0.277	7.8	4.1	126.6	--	--	--	--	--	--	--	--	--	--	--	--
	3/28/2016	11.13	5.91	0.27	7.7	1.47	28.4	--	--	--	--	--	--	--	--	--	--	--	--
	8/18/2016	22.78	5.81	0.275	2.60	0.42	98.8	--	--	--	--	--	--	--	--	--	--	--	--
	1/18/2017	9.7	6.08	0.1609	10.50	7.92	31.1	--	--	--	--	--	--	--	--	--	--	--	--
	8/31/2017	19.71	5.88	0.182	2.07	1.09	64.8	--	--	--	--	--	--	--	--	--	--	--	--
	1/18/2018	9.34	6.14	0.209	3.33	2.99	-191.8	--	--	--	--	--	--	--	--	--	--	--	--
	8/30/2018	Not Sampled						Not Sampled											
	11/15/2018	15.57	5.68	0.147	7.51	--	208.1	--	--	--	--	--	--	--	--	--	--	--	--
	1/23/2019	10.36	6.28	0.090	--	1.46	15.2	--	--	--	--	--	--	--	--	--	--	--	--
	4/17/2019	11.90	5.54	0.127	2.66	1.07	183.4	--	--	--	--	--	--	--	--	--	--	--	--
	9/30/2019	18.90	6.09	0.152	2.43	0.34	175.9	--	--	--	--	--	--	--	--	--	--	--	--
MW-6	12/23/2015	9.8	6.59	0.332	11.60	1.11	-81.1	--	--	--	--	--	--	--	--	--	--	--	--
	3/28/2016	12.66	6.53	0.399	10.20	4.34	-99.1	--	--	--	--	--	--	--	--	--	--	--	--
	8/18/2016	21.17	6.29	0.309	8.84	0.29	-101.7	--	--	--	--	--	--	--	--	--	--	--	--
	1/18/2017	10.1	6.49	0.299	27.80	1.00	-72.8	--	--	--	--	--	--	--	--	--	--	--	--
	8/31/2017	20.00	6.66	0.211	9.24	0.78	-79	<0.100	<5	<0.05	20.6	6.0[b]	14.6	3,070	121,000	442	425	<13.0	<13.0
	1/18/2018	8.78	5.9	0.201	15.80	1.28	-132.2	<0.100	<5	<0.05	28.4	3.5[b]	24.9	3,960	131,000	486	574	<13.0	<13.0
	8/30/2018	19.77	6.52	0.241	4.21	1.40	-101.9	<0.100	<5	<0.05	30.7	3.0[b]	27.7	2,290	122,000	517	559	<13.0	<13.0
	11/15/2018	14.06	6.42	0.282	11.8	--	-90.5	--	--	--	--	--	--	--	--	--	--	--	--
	1/23/2019	10.98	7.07	0.157	4.21	0.19	-45.6	--	--	--	--	--	--	--	--	--	--	--	--
	4/17/2019	12.20	6.60	0.273	3.70	0.28	-84.6	--	--	--	--	--	--	--	--	--	--	--	--
	9/30/2019	16.10	6.71	0.218	6.65	0.49	-85.7	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	12/23/2015	9.35	7.12	0.254	16.00	1.66	-30.9	--	--	--	--	--	--	--	--	--	--	--	--
	3/28/2016	11.48	6.34	0.201	25.10	2.08	12.5	--	--	--	--	--	--	--	--	--	--	--	--
	8/18/2016	22.37	5.81	0.217	11.80	1.85	63.2	--	--	--	--	--	--	--	--	--	--	--	--
	1/18/2017	9.1	6.21	0.2261	19.40	3.50	13.2	--	--	--	--	--	--	--	--	--	--	--	--

Table 2
Summary of Water Quality and Geochemical Parameters
Former Cummings Oil Lease Site
Winlock, Washington

Monitoring Well	Date Sampled	Water Quality Parameters						Geochemical Parameters											
		Temperature	pH	Conductivity	Turbidity	DO	ORP	Nitrate | Nitrite[a]	Sulfate	Sulfide	Total Iron	Ferrous Iron	Ferric Iron	Methane	Alkalinity	Dissolved Manganese	Total Manganese	Ethane	Ethene
		°C	--	mS/cm	NTU	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
MW-7 (cont'd)	8/31/2017	20.33	6.28	0.232	7.76	1.15	24.9	--	--	--	--	--	--	--	--	--	--	--	--
	1/18/2018	9.14	6.12	0.179	15.10	2.78	-177.4	--	--	--	--	--	--	--	--	--	--	--	--
	8/30/2018	20.61	6.06	0.216	1.98	0.85	67.2	--	--	--	--	--	--	--	--	--	--	--	--
	11/15/2018	14.70	5.88	0.295	11.8	--	150.6	--	--	--	--	--	--	--	--	--	--	--	--
	1/23/2019	10.52	7.38	0.147	11.4	3.04	-95.3	--	--	--	--	--	--	--	--	--	--	--	--
	4/17/2019	12.00	6.08	0.225	4.6	5.17	183.6	--	--	--	--	--	--	--	--	--	--	--	--
	9/30/2019	17.80	6.31	0.297	8.31	0.77	78.0	--	--	--	--	--	--	--	--	--	--	--	--

ABBREVIATIONS:
°C = degrees Celcius
DO = dissolved oxygen
mS/cm = millisiemens per centimeter
mg/L = milligrams per liter
mV = millivolts
NTU = nephalometric turbidity units
ORP = oxidation reduction potential
-- = not analyzed
* = indicates possible sensor malfunction
< = not detected above laboratory reporting limit
µg/L = micrograms per liter
LNAPL = light non-aqueous phase liquid

FOOTNOTES:
[a] Total Nitrate/Nitrite analyzed by EPA Method 353.2.
[b] Ferrous Iron measured in the field.
[c] Total nitrogen analyzed.

Table 3
Summary of Groundwater Analytical Results
Former Cummings Oil Lease Site
Winlock, Washington

Analytical results in micrograms per liter (µg/L).

Monitoring Well	Date Sampled[a]	Total Organic Carbon[b]	Petroleum Hydrocarbon Ranges					Volatile Organic Compounds[f]			
			Diesel-Range Organics		Oil-Range Organics		Gasoline-Range Organics[e]	Benzene	Toluene	Ethyl-benzene	Total Xylenes
			SGC[c]	Without SGC[d]	SGC[c]	Without SGC[d]					
MTCA Method A CULs[g]			500	500	500	500	1,000 / 800	5	1,000	700	1,000
MW-1	12/23/2005	--	<238	--	<476	--	<50.0	<0.500	<0.500	<0.500	<1.00
	8/18/2008	--	**1,480**	--	**836**	--	<50.0	<0.500	<0.500	<0.500	<1.00
	3/11/2010	--	**590**	--	**540**	--	<50.0	<1.0	<1.0	<1.0	<6.0
	6/9/2010	--	**720**	--	<460	--	<50.0	<1.0	<1.0	<1.0	<3.0
	10/20/2010	--	**670**	--	<430	--	<50.0	<1.0	<1.0	<1.0	<3.0
	12/27/2010	--	**520**	--	<380	--	<50.0	<1.0	<1.0	<1.0	<3.0
	3/22/2011	--	**630**	--	<410	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/17/2012	--	470	--	<380	--	<50.0	<1.0	<1.0	3.1	4.2
	8/1/2013	--	490	--	**500**	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/14/2014	--	440	--	410	--	<50.0	<5.0	<5.0	<5.0	<10.0
	8/6/2015	--	320	--	330	--	--	<2.0	<2.0	<3.0	<3.0
	12/23/2015	--	260	--	<250	--	--	<2.0	<2.0	<3.0	<3.0
	3/28/2016	--	380	--	270	--	--	<2.0	--	--	--
	8/18/2016	--	470	--	370	--	--	<2.0	<2.0	<3.0	<3.0
	1/18/2017	--	<250	--	<500	--	--	<1.00	<1.00	<1.00	<3.00
	8/31/2017	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	1/17/2018	--	--	--	--	--	--	--	--	--	--
	8/30/2018	--	--	--	--	--	--	--	--	--	--
	11/15/2018	5,310	<200	413	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	1/22/2019	3,780	<200	214	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019	5,780	<200	235	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	9/30/2019	--	<200	289	<250	<250	--	--	--	--	--
MW-2	12/23/2005	--	<238	--	<476	--	465	**55.2**	2.84	3.46	35.6
	8/18/2008	--	**876**	--	<500	--	606	**30.6**	1.12	2.56	30.9
	3/11/2010	--	**660**	--	470	--	150	**27.7**	<1.0	<1.0	<6.0
	6/9/2010	--	**690**	--	440	--	116	**22.4**	<1.0	<1.0	<3.0
	10/20/2010	--	**810**	--	**590**	--	95.2	**10.6**	<1.0	<1.0	<3.0
	12/27/2010	--	400	--	<380	--	130	**18.6**	<1.0	<1.0	<3.0
	3/22/2011	--	**660**	--	<430	--	196	**47.8**	<1.0	<1.0	<3.0
	8/17/2012	--	**500**	--	<380	--	158	**12.6**	<1.0	5.2	9.6
	8/1/2013	--	**700**	--	**590**	--	260	**8.5**	<1.0	<1.0	4.1
	8/14/2014	--	460	--	300	--	220	**7.8**	<5.0	<5.0	<10.0
	8/6/2015	--	460	--	380	--	--	3.4	<3.0	<3.0	<3.0
	12/23/2015	--	220	--	<280	--	--	**5.9**	<2.0	<3.0	<3.0
	3/28/2016	--	**900**	--	360	--	--	**13**	--	--	--
	8/18/2016	--	**610**	--	310	--	--	**<20**	27	<30	36
	8/18/2016 (dup.)	--	**650**	--	360	--	--	<2.0	<2.0	<3.0	<3.0
	1/18/2017	--	<250	--	<500	--	--	**8.75**	<1.00	<1.00	<3.00
	1/18/2017 (dup.)	--	<250	--	<500	--	--	**9.05**	<1.00	<1.00	<3.00
	8/31/2017	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	8/31/2017 (dup.)	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	1/18/2018	--	302	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	1/18/2018 (dup.)	--	228	--	<250	--	--	1.26	<1.00	<1.00	<3.00
	8/30/2018	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	8/30/2018 (dup.)	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	11/14/2018	5,600	<200	365	<250	<250	109	<1.00	<1.00	<1.00	<3.00
	(dup.)	5,670	<200	361	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	1/22/2019	4,820	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	1/22/2019 (dup.)	4,890	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019	5,870	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019 (dup.)	5,340	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	9/30/2019	--	<200	347	<250	<250	--	--	--	--	--
	9/30/2019 (dup.)	--	<200	336	<250	<250	--	--	--	--	--
MW-3	12/23/2005	--	<238	--	<476	--	<50.0	<0.500	<0.500	<0.500	<1.00
	8/18/2008	--	**1,660**	--	**887**	--	<50.0	<0.500	<0.500	<0.500	<1.00
	3/11/2010	--	--	--	--	--	--	--	--	--	--
	6/9/2010	--	**830**	--	<400	--	<50.0	<1.0	<1.0	<1.0	<3.0
	10/20/2010	--	**900**	--	460	--	<50.0	<1.0	<1.0	<1.0	<3.0
	12/27/2010	--	**630**	--	<410	--	<50.0	<1.0	<1.0	<1.0	<3.0
	3/22/2011	--	**780**	--	<380	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/29/2012	--	**660**	--	<400	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/1/2013	--	**550**	--	**500**	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/14/2014	--	440	--	330	--	<50.0	<5.0	<5.0	<5.0	<10.0
	8/6/2015	--	440	--	430	--	--	<2.0	<2.0	<3.0	<3.0
	12/23/2015	--	<120	--	<270	--	--	<2.0	<2.0	<3.0	<3.0
	3/28/2016	--	**500**	--	340	--	--	<2.0	--	--	--
	8/18/2016	--	**580**	--	400	--	--	<2.0	<2.0	<3.0	<3.0
	1/19/2017	--	<250	--	<500	--	--	<1.00	<1.00	<1.00	<3.00
	8/31/2017	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	1/17/2018	--	201	--	<250	--	--	<1.00	<1.00	<1.00	<3.00

Table 3
Summary of Groundwater Analytical Results
Former Cummings Oil Lease Site
Winlock, Washington

Analytical results in micrograms per liter (µg/L).

Monitoring Well	Date Sampled[a]	Total Organic Carbon[b]	Petroleum Hydrocarbon Ranges					Volatile Organic Compounds[f]			
			Diesel-Range Organics		Oil-Range Organics		Gasoline-Range Organics[e]	Benzene	Toluene	Ethyl-benzene	Total Xylenes
			SGC[c]	Without SGC[d]	SGC[c]	Without SGC[d]					
MTCA Method A CULs[g]			500	500	500	500	1,000 / 800	5	1,000	700	1,000
MW-3 (cont'd)	8/30/2018	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	11/16/2018	5,540	<200	480	<250	428	<100	<1.00	<1.00	<1.00	<3.00
	1/23/2019	6,620	<200	**519**	<250	380	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019	8,740	<200	396	<250	358	<100	<1.00	<1.00	<1.00	<3.00
	9/30/2019	--	<200	426	<250	325	--	--	--	--	--
	12/18/2019	--	<200	357	<250	261	--	--	--	--	--
	12/18/19 (dup.)	--	<200	407	<250	339	--	--	--	--	--
	2/20/2020	--	<200	484	<250	<250	--	--	--	--	--
	2/20/2020 (dup.)	--	<200	**503**	<250	256	--	--	--	--	--
MW-4	12/23/2005	--	<238	--	<476	--	<50.0	<0.500	<0.500	<0.500	<1.00
	8/18/2008	--	<243	--	<485	--	<50.0	<0.500	<0.500	<0.500	<1.00
	3/11/2010	--	<78	--	<390	--	<50.0	<1.0	<1.0	<1.0	<6.0
	6/9/2010	--	<82	--	<410	--	<50.0	<1.0	<1.0	<1.0	<3.0
	10/20/2010	--	<86	--	<430	--	<50.0	<1.0	<1.0	<1.0	<3.0
	12/27/2010	--	<83	--	<420	--	<50.0	<1.0	<1.0	<1.0	<3.0
	3/22/2011	--	<85	--	<430	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/29/2012	--	<78	--	<390	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/1/2013	--	<120	--	<240	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/14/2014	--	<120	--	<240	--	<50.0	<1.0	<1.0	<1.0	<2.0
	8/6/2015	--	--	--	--	--	--	--	--	--	--
	1/19/2017	--	--	--	--	--	--	--	--	--	--
	8/31/2017	--	--	--	--	--	--	--	--	--	--
	1/18/2018	--	--	--	--	--	--	--	--	--	--
	8/30/2018	--	--	--	--	--	--	--	--	--	--
	11/15/2018	--	--	--	--	--	--	--	--	--	--
	1/23/2019	2,200	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019	4,200	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	9/30/2019	--	<200	<200	<250	<250	--	--	--	--	--
MW-5	8/18/2008	--	433	--	<481	--	<50.0	<0.500	<0.500	<0.500	<1.00
	3/11/2010	--	<82	--	<410	--	<50.0	<1.0	<1.0	<1.0	<6.0
	6/9/2010	--	<84	--	<420	--	<50.0	<1.0	<1.0	<1.0	<3.0
	10/20/2010	--	<85	--	<430	--	<50.0	<1.0	<1.0	<1.0	<3.0
	12/27/2010	--	<87	--	<430	--	<50.0	<1.0	<1.0	<1.0	<3.0
	3/22/2011	--	<75	--	<380	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/17/2012	--	<76	--	<380	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/1/2013	--	<120	--	<240	--	<50.0	<1.0	<1.0	<1.0	<3.0
	8/14/2014	--	<120	--	<240	--	<50.0	<1.0	<1.0	<1.0	<2.0
	8/6/2015	--	<100	--	<240	--	--	<2.0	<2.0	<3.0	<3.0
	12/23/2015	--	<110	--	<250	--	--	<2.0	<2.0	<3.0	<3.0
	3/28/2016	--	<110	--	<250	--	--	<2.0	--	--	--
	8/18/2016	--	150	--	<260	--	--	<2.0	<2.0	<3.0	<3.0
	1/18/2017	--	<250	--	<500	--	--	<1.00	<1.00	<1.00	<3.00
	8/31/2017	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	1/18/2018	--	--	--	--	--	--	--	--	--	--
	8/30/2018	--	--	--	--	--	--	--	--	--	--
	11/15/2018	2,780	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	1/23/2019	2,170	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019	2,390	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	9/30/2019	--	<200	<200	<250	<250	--	--	--	--	--
MW-6	8/14/2014	--	**520**	--	280	--	110	<5.0	<5.0	<5.0	<10.0
	8/6/2015	--	420	--	370	--	--	<2.0	<2.0	<5.0	<3.0
	12/23/2015	--	290	--	<260	--	--	<2.0	<2.0	<3.0	<3.0
	3/28/2016	--	**980**	--	470	--	--	**17**	--	--	--
	8/18/2016	--	**640**	--	<250	--	--	<2.0	<2.0	<3.0	<3.0
	1/18/2017	--	<250	--	<500	--	--	<1.00	<1.00	<1.00	<3.00
	8/31/2017	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	1/18/2018	--	218	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	8/30/2018	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	11/15/2018	7,650	200	463	<250	<250	179	<1.00	<1.00	<1.00	<3.00
	1/23/2019	5,970	<200	270	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019	6,710	<200	251	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	9/30/2019	--	<200	300	<250	<250	--	--	--	--	--
MW-7	8/14/2014	--	260	--	260	--	<50.0	<1.0	<1.0	<1.0	<2.0
	8/6/2015	--	120	--	<240	--	--	<2.0	<2.0	<3.0	<3.0
	12/23/2015	--	<110	--	<250	--	--	<2.0	<2.0	<3.0	<3.0
	3/28/2016	--	<110	--	<250	--	--	<2.0	--	--	--
	8/18/2016	--	<110	--	<250	--	--	<2.0	<2.0	<3.0	<3.0
	1/18/2017	--	<250	--	<500	--	--	<1.00	<1.00	<1.00	<3.00
	8/31/2017	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	1/18/2018	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	8/30/2018	--	<200	--	<250	--	--	<1.00	<1.00	<1.00	<3.00
	11/15/2018	3,170	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00

Table 3
Summary of Groundwater Analytical Results
Former Cummings Oil Lease Site
Winlock, Washington

Analytical results in micrograms per liter (µg/L).

Monitoring Well	Date Sampled[a]	Total Organic Carbon[b]	Petroleum Hydrocarbon Ranges					Volatile Organic Compounds[f]			
			Diesel-Range Organics		Oil-Range Organics		Gasoline-Range Organics[e]	Benzene	Toluene	Ethyl-benzene	Total Xylenes
			SGC[c]	Without SGC[d]	SGC[c]	Without SGC[d]					
MTCA Method A CULs[g]			500	500	500	500	1,000 / 800	5	1,000	700	1,000
MW-7 (cont'd)	1/23/2019	3,360	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	4/17/2019	3,190	<200	<200	<250	<250	<100	<1.00	<1.00	<1.00	<3.00
	9/30/2019	--	<200	<200	<250	<250	--	--	--	--	--

NOTES:

Bold indicates concentrations greater than or equal to applicable cleanup levels.

< = not detected at concentration greater than or equal to laboratory reporting limit.

-- = sample was not analyzed for this constituent.

Cleanup levels for gasoline-range organics presented first without detectable benzene and second with detectable benzene.

ABBREVIATIONS:

CUL = cleanup level

dup. = duplicate sample

MTCA = Model Toxics Control Act

FOOTNOTES:

[a] Analytical results prior to 8/18/2016 were collected by other consultants and obtained from Farallon Consulting.

[b] Analyzed by USEPA Method 9060A.

[c] Analyzed by Northwest Method NWTPH-Dx with Silica Gel Cleanup (SGC).

[d] Analyzed by Northwest Method NWTPH-Dx without Silica Gel Cleanup (SGC).

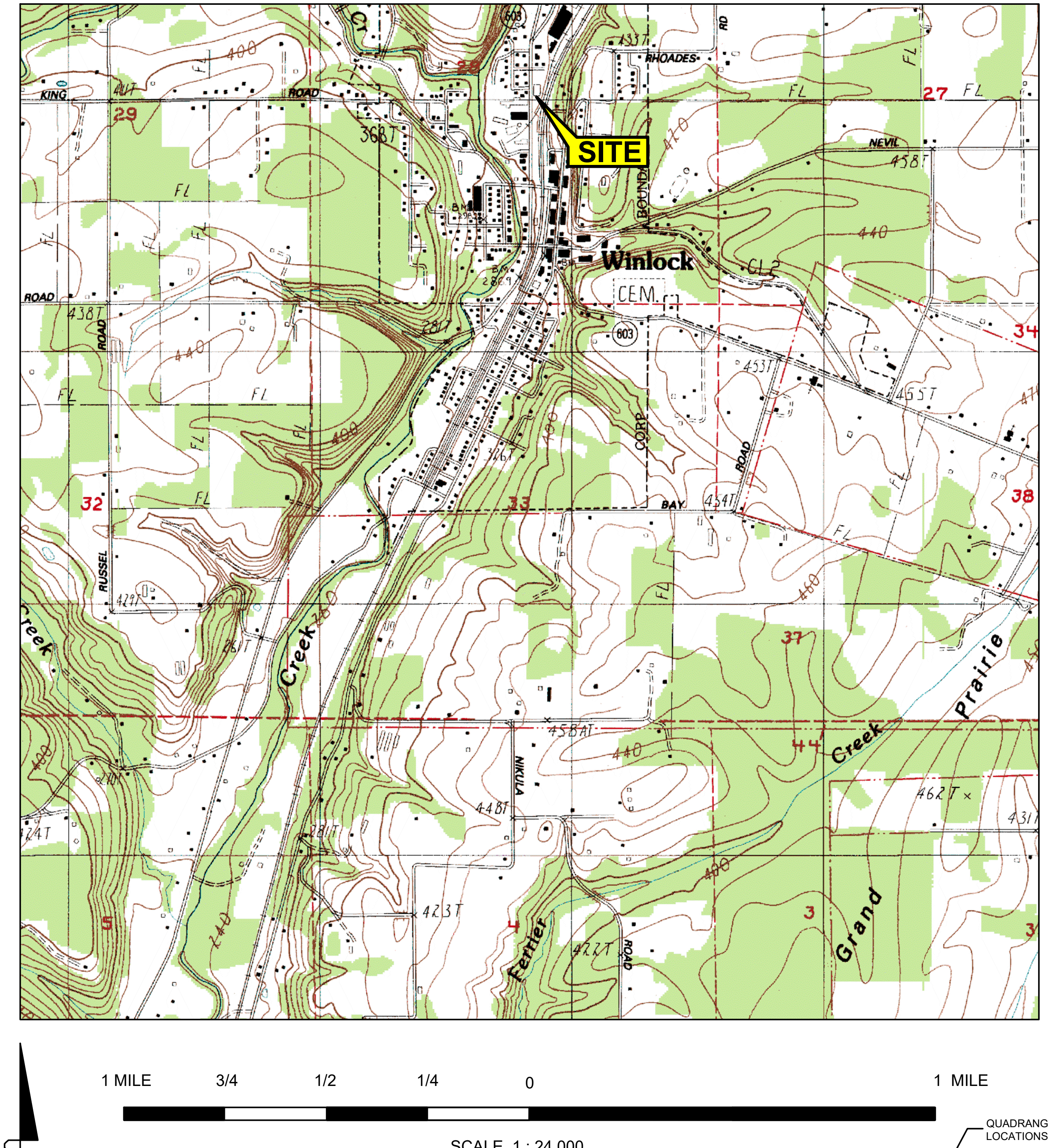
[e] Analyzed by Northwest Method NWTPH-Gx.

[f] Analyzed by U.S. Environmental Protection Agency (EPA) Method 8260B or 8260C.

[g] Washington State Department of Ecology, Model Toxics Control Act Regulation and Statute, MTCA Cleanup Regulation Chapter 173-340 WAC, Model Toxics Control Act Chapter 70.105D RCW, Uniform Environmental Covenants Act Chapter 64.70 RCW. Publication No. 94-06. Revised May 2019.

Figures

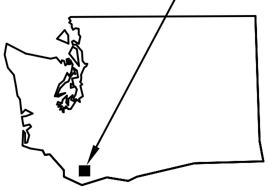
8.5x11 --- ATTACHED XREFS: --- ATTACHED IMAGES: BNSF-Winlock-Topo; TRC_Reversed Out Blue Logo;
DRAWING NAME: L:\Graphics\ProjectsbyName\BNSF Winlock\366391-TA02\ Winlock_Fig1_Vicinity Map.dwg --- PLOT DATE: April 16, 2020 - 1:46PM --- LAYOUT: 8x11



SOURCE:

United States Geological Survey
7.5 Minute Topographic Maps:
Winlock Quadrangles, Washington

QUADRANGLE LOCATIONS



TRC

19874 141st Place N.E.
Woodinville, WA 98072
Phone: 425.489.1938
www.trccompanies.com

PROJECT:

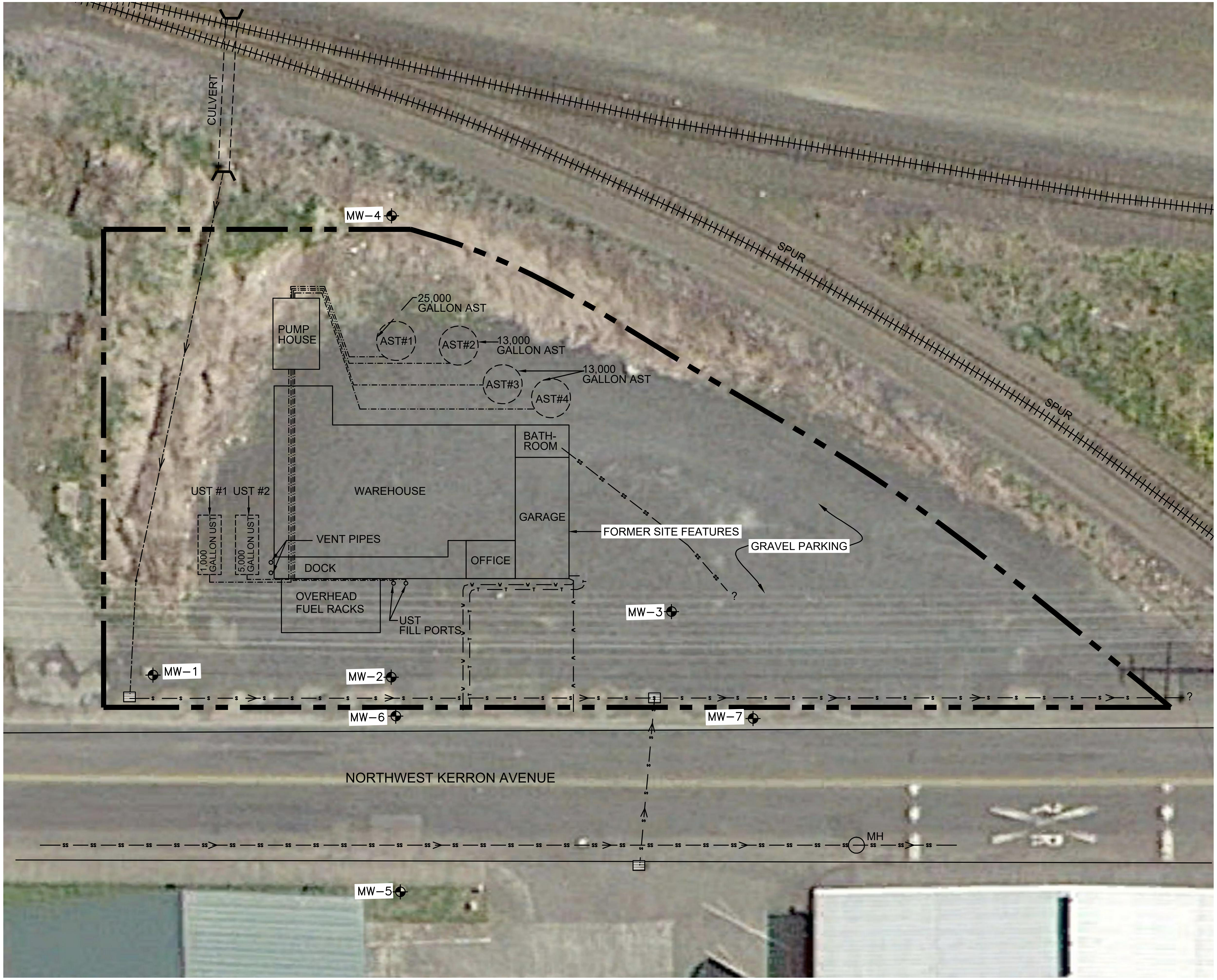
FORMER CUMMINGS OIL LEASE SITE
908 NORTHWEST KERRON AVENUE
WINLOCK, WASHINGTON

TITLE:

VICINITY MAP

DRAWN BY:	R. Collins
CHECKED BY:	E. Stata
APPROVED BY:	M. Piovesan
DATE:	April 2020
PROJ. NO.:	366391.0000.0000
FILE:	Winlock_Fig1_Vicinity Map.dwg

FIGURE 1



LEGEND

━ ▪ ━	PROPERTY BOUNDARY
┼┼┼┼┼	RAILROAD TRACKS
— s — s —	STORM LINE
— ss — ss —	SANITARY SEWER
— v — v —	FORMER LOCATION OF WATER LINE
— T — T —	FORMER LOCATION OF TELEPHONE LINE
— · — · —	FORMER LOCATION OF APPROXIMATE LOCATION OF ABOVE GROUND PIPING AT SITE
— — ← — —	DITCH AND DIRECTION OF FLOW
MW–3 ⊕	MONITORING WELL
1,000 GALLON UST	FORMER UNDERGROUND STORAGE TANK LOCATIONS
AST#1	FORMER LOCATION OF ABOVEGROUND STORAGE TANK
☐	CATCH BASIN

SOURCE:
Aerial base map provided by Google Earth Professional, dated 7/5/2012. Base map provided by Farallon Consulting, 12/10/2015. Survey provided by Bluhm & Associates Land Surveyors Inc., 8/14/2014.

N

SCALE (FEET)
0 20 40

PROJECT:
FORMER CUMMINGS OIL LEASE SITE
908 NORTHWEST KERRON AVENUE
WINLOCK, WASHINGTON

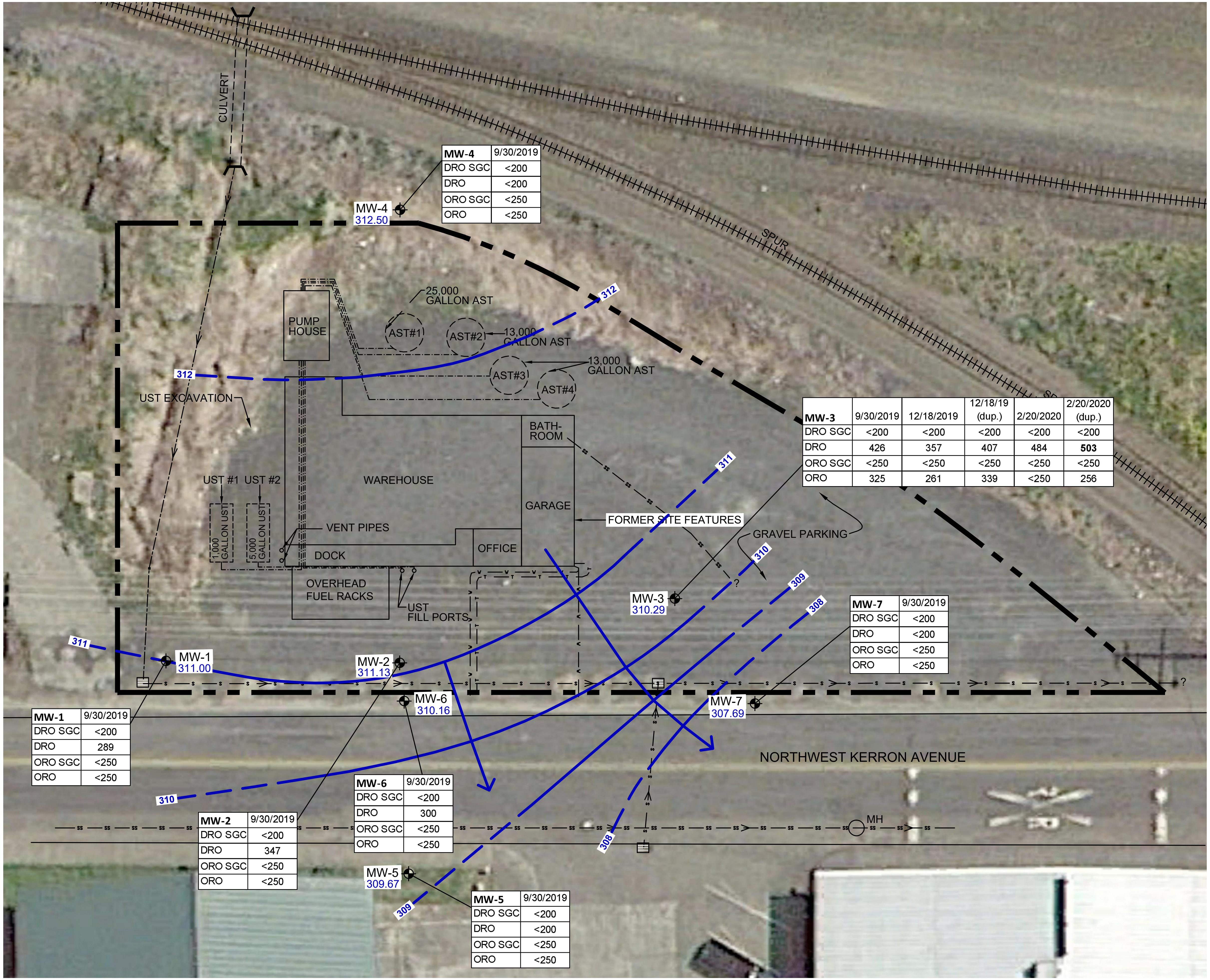
TITLE:
SITE PLAN

DRAWN BY:	R. Collins	PROJ NO.:	366391.0000.0000
CHECKED BY:	E. Stata	**FIGURE 2**	
APPROVED BY:	M. Piovesan		
DATE:	April 2020		

TRC
19874 141st Place N.E.
Woodinville, WA 98072
Phone: 425.489.1938
www.trccompanies.com

FILE NO.: Winlock_Fig2_Site Plan.dwg

11x17 --- ATTACHED XREF'S: 14-351 --- ATTACHED IMAGES: TRC_Reversed Out Blue Logo; Winlock-Aerial-7-2012; Winlock-Aerial2014-2;
DRAWING NAME: L:\Graphics\ProjectsbyName\BNSF Winlock\366391-TA02\ Winlock_Fig2_Site Plan.dwg --- PLOT DATE: April 16, 2020 - 1:49PM --- LAYOUT: 11x17_L



MW-4	9/30/2019
DRO SGC	<200
DRO	<200
ORO SGC	<250
ORO	<250

MW-3	9/30/2019	12/18/2019	12/18/19 (dup.)	2/20/2020	2/20/2020 (dup.)
DRO SGC	<200	<200	<200	<200	<200
DRO	426	357	407	484	**503**
ORO SGC	<250	<250	<250	<250	<250
ORO	325	261	339	<250	256

MW-7	9/30/2019
DRO SGC	<200
DRO	<200
ORO SGC	<250
ORO	<250

MW-1	9/30/2019
DRO SGC	<200
DRO	289
ORO SGC	<250
ORO	<250

MW-2	9/30/2019
DRO SGC	<200
DRO	347
ORO SGC	<250
ORO	<250

MW-6	9/30/2019
DRO SGC	<200
DRO	300
ORO SGC	<250
ORO	<250

MW-5	9/30/2019
DRO SGC	<200
DRO	<200
ORO SGC	<250
ORO	<250

LEGEND

PROPERTY BOUNDARY

RAILROAD TRACKS

DRAINAGE DITCH AND DIRECTION OF FLOW

STORM SEWER LINE AND DIRECTION OF FLOW

SANITARY SEWER AND DIRECTION OF FLOW

MH ○ MANHOLE

MW-3 MONITORING WELL (FARALLON 2006 AND 2014)

312.50 GROUNDWATER ELEVATION (FEBRUARY 2020)

312 GROUNDWATER ELEVATION CONTOUR LINE, DASHED WHERE INFERRED

GENERAL DIRECTION OF GROUNDWATER GRADIENT

☐ CATCH BASIN

ALL RESULTS IN MICROGRAMS PER LITER (µg/L)

DRO SGC = TOTAL PETROLEUM HYDROCARBONS (TPH) AS DIESEL-RANGE ORGANICS WITH SGC.

DRO = TPH AS DIESEL-RANGE ORGANICS.

ORO SGC = TPH AS OIL-RANGE ORGANICS WITH SGC.

ORO = TPH AS OIL-RANGE ORGANICS.

< = DENOTES ANALYTE NOT DETECTED AT OR EXCEEDING LABORATORY REPORTING LIMIT LISTED.

BOLD = Analytical result is greater than or equal to Model Toxics Control Act (MTCA) Method A cleanup levels for DRO (500 µg/L), and ORO (500 µg/L).

SOURCE:
Aerial base map provided by Google Earth Professional, dated 7/5/2012. Base map provided by Farallon Consulting, 12/10/2015. Survey provided by Bluhm & Associates Land Surveyors Inc., 8/14/2014.

N

SCALE (FEET)
0 20 40

PROJECT:
FORMER CUMMINGS OIL LEASE SITE
908 NORTHWEST KERRON AVENUE
WINLOCK, WASHINGTON

TITLE:
GROUNDWATER ELEVATION CONTOUR AND DISSOLVED-PHASE CONCENTRATIONS MAP
FEBRUARY 2020

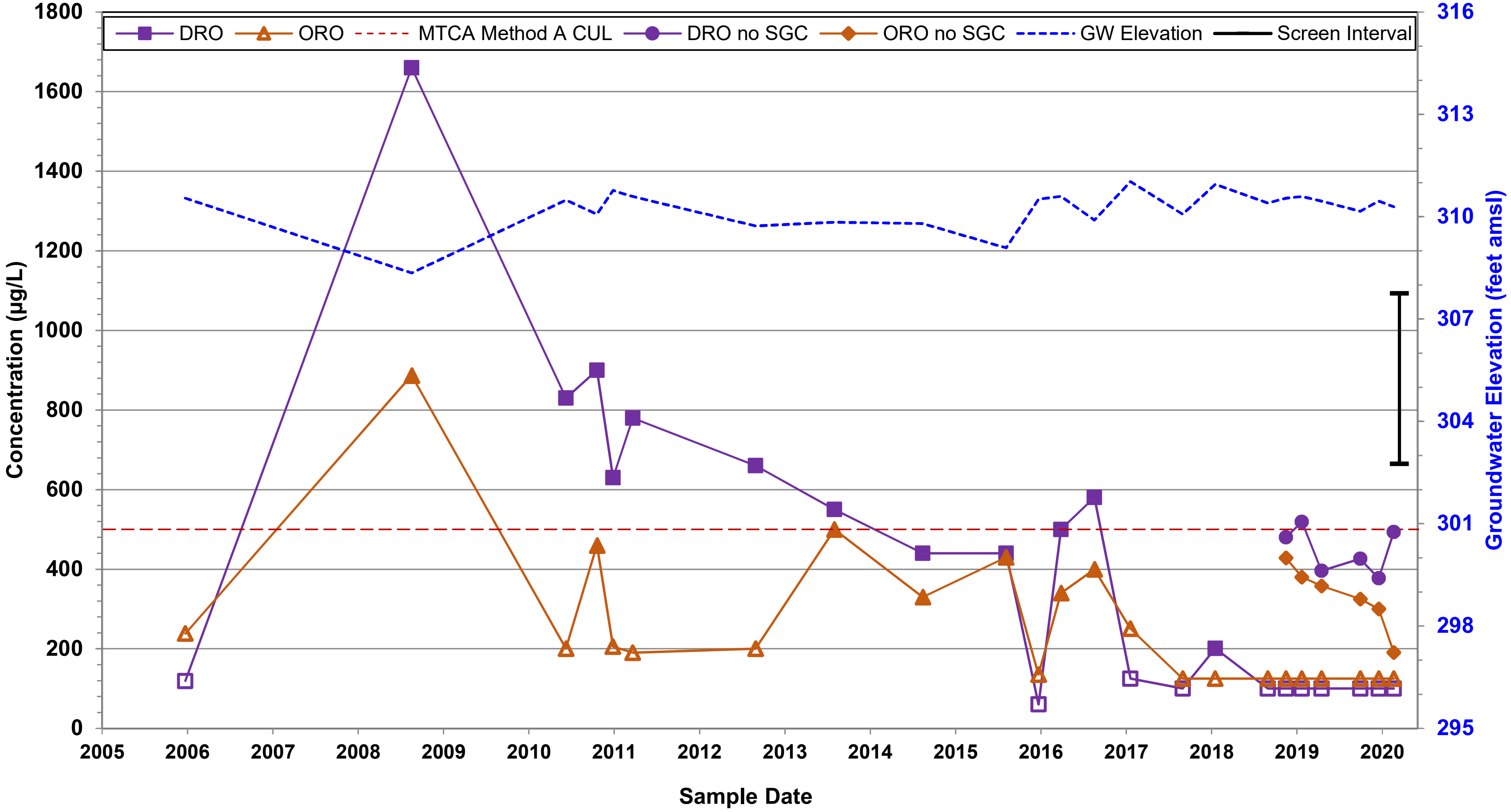
DRAWN BY:	R. Collins	PROJ NO.:	366391.0000.0000
CHECKED BY:	E. Stata	**FIGURE 3**	
APPROVED BY:	M. Piovesan		
DATE:	April 2020		

TRC
19874 141st Place N.E.
Woodinville, WA 98072
Phone: 425.489.1938
www.trccompanies.com

FILE NO.: Winlock_Fig3_GW_Feb2020.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES: Winlock - Aerial-2018; Winlock-Aerial-7-2012;
DRAWING NAME: L:\Graphics\ProjectsbyName\BNSF Winlock\366391-TA02\ Winlock_Fig3_GW_Feb2020.dwg --- PLOT DATE: April 16, 2020 - 1:54PM --- LAYOUT: 11x17_L

Figure 4
Groundwater Elevation versus DRO and ORO - MW-3
Former Cummings Oil Lease Site
Winlock, Washington



Notes:
1. Open markers indicated non-detect results. Non-detect (ND) results are shown at half the laboratory reporting limit.
2. Model Toxics Control Act (MTCA) Cleanup level for diesel-range organics (DRO) and oil-range organics (ORO) is 500 micrograms per liter (µg/L).
3. amsl = above mean sea level
4. SGC = Silica Gel Cleanup
5. Duplicate samples were collected 12/19/2019 and 2/20/2020. Concentrations are represented as the average of the original and the duplicate samples.

Appendix A

TRC Standard Operating Procedures

Title: **Chain-of-Custody Procedures**	Procedure Number: **ECR 002**
	Revision Number: **1**
	Effective Date: **January 2020**

Authorization Signatures			
		Elizabeth Denly	
Technical Review James Peronto	Date 1/1/20	Environmental Sector Quality Director Elizabeth Denly	Date 1/1/20

TABLE OF CONTENTS

Page No.

FIGURES

ATTACHMENTS

1.0 INTRODUCTION

1.1 Scope & Applicability

This Standard Operating Procedure (SOP) guides TRC personnel in proper Chain-of-Custody practices.

This SOP was prepared to direct TRC personnel in the sample custody procedure requirements associated with field sample collection. Other state or federal requirements may be above and beyond the scope of this SOP and will be followed, if applicable. Sample custody procedures are an important part of the field investigation program in order to maintain data quality and to be able to document proof of proper handling. Sample custody begins at the collection of the samples and continues until the samples have been analyzed. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files.

Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law or other evidentiary venue. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. An overriding consideration essential for the validation of environmental measurement data is the necessity to demonstrate that samples have been obtained from the locations stated and that they have reached the laboratory without alteration (i.e., representative of the identified sample media).

1.2 Summary of Method

Evidence of the sample tracking from collection to shipment, laboratory receipt, and laboratory custody (until proper sample disposal and the introduction of field investigation results as evidence in legal proceedings when pertinent) must be properly documented.

A sample or evidence file is considered to be in a person's custody if the item is:

- In a person's possession
- In the view of the person after being in a person's possession
- Secured and preserved so that no one can tamper with it after having been in a person’s possession
- In a secured area, restricted to authorized personnel

The Field Team Leader or designee is responsible for overseeing and supervising the implementation of proper sample custody procedures in the field. The Field Team Leader or designee is also responsible for ensuring sample custody until the samples have been transferred to a courier or directly to the laboratory. Once received by the laboratory, the samples proceed through an orderly processing sequence specifically designed to ensure continuous integrity of both the sample and its documentation.

1.3 Equipment

The following list is an example of items that may be utilized when implementing sample custody procedures in the field. Project-specific conditions or requirements may warrant the use of additional items or deletion of items from this list. Many of these items may be provided by the selected analytical laboratory for a given project.

- Chain-of-Custody forms
- Sample labels
- Sample tags
- Custody seals
- Computer
- Indelible/waterproof ink
- Printer

2.0 PROCEDURES

Sample custody and transfer procedures are summarized below. These procedures are intended to ensure that the samples will arrive at the laboratory with the Chain-of-Custody intact. The Chain-of-Custody procedures are initiated in the field immediately following sample collection. The procedures consist of four main components: (1) preparing and attaching a unique sample label to each sample collected, (2) completing the Chain-of-Custody (COC) form, (3) reviewing the COC form for accuracy and (4) preparing the samples for shipment and transfer of custody.

2.1 Specific Chain-of-Custody Procedures

2.1.1 Sample Labels

Field personnel are responsible for uniquely identifying and labeling all samples collected during a field investigation program. All labeling must be completed in indelible/waterproof ink and securely affixed to the sample container. Individual sample containers may be pre-labeled or labeled in the field at the time of collection. Sufficient sample information should be cross-referenced in the field documentation for tracking purposes.

Sample labels typically contain the following information:

- Unique sample identification
- Sample location and/or depth/description number, if different from above
- Sample matrix
- Type of analysis to be performed
- Type of chemical preservation used
- Grab or composite designation
- Filtered or unfiltered
- Sampling date and time
- Sampler's affiliation and initials
- Site and/or client name

An example of a sample label is provided in Figure 1.

2.1.2 Custody Seals

Custody seals may be secured across the shipping container to ensure content integrity. The seals contain both the date and the signature of the person affixing them and must be completed in indelible/waterproof ink. Custody seals are attached to the cover seal of the cooler and can be covered with clear plastic tape after being signed and dated by field personnel. An example of a custody seal is shown in Figure 1. The use of custody seals will be determined on a project-specific basis by the Project Manager.

2.1.3 Chain-of-Custody Form

For all analyses, COC forms must be completed for each sample set submitted. COC forms are initiated by the samplers in the field and maintained until samples are analyzed by the laboratory. If multiple laboratories are being used, a separate set of COC forms must be completed for each laboratory receiving samples to ensure proper transfer of custody from the time of sample collection to analysis. These forms serve as a record of sample collection, transfer, shipment, and receipt by the laboratory. These forms typically contain the following pertinent information:

- Project/site name and/or project number
- Carrier name, if applicable
- Air bill numbers(s), if known and applicable
- Laboratory name and address
- Sample identifications
- Sample matrix (e.g., soil, water)
- Type of sample (i.e., grab or composite)
- Date/time sample collected
- Size, type, and number of containers
- Preservative used
- Required analysis or method
- Turnaround time
- Names of individuals responsible for custody of samples
- Date shipped or otherwise transferred

Figure 2 provides an example COC form. It should be noted that this is an example format only. Laboratories typically provide their own laboratory-specific COC form. Other COC formats may be used as long as all of the applicable information is included. COC forms will be initiated in the field.

All entries on the COC form must be legible and must be made in blue or black permanent ink. No erasures or obliterations can be made. If an incorrect entry is made, the information must be crossed out with a single strike mark which is signed or initialed and dated by the person recording the information. The correction must be written adjacent to the error. The original entry should still be legible even though crossed out.

2.1.4 Transfer of Custody

Samples will be accompanied by a properly completed COC form during each step of custody transfer and shipment. When physical possession of samples is transferred, both the individual relinquishing the samples and the individual receiving them will sign, date, and record the time of transfer on the COC form.

All samples will be shipped directly to the laboratories by a TRC employee, an overnight commercial carrier, or a laboratory-supplied courier service.

In the case of sample shipment by an overnight commercial carrier, a properly prepared air bill, including the project number (Figure 3), will serve as an extension of the COC form while the samples are in transit. The COC forms will be sealed inside the sample cooler within a clear plastic bag and the custody seals, if used, will be completed on the outside of the cooler prior to shipment. Commercial carriers are not required to sign off on the custody forms since the forms are sealed inside the cooler prior to shipment so any custody seal remains intact. The original COC form will accompany the samples at all times. A copy of all COC forms submitted to the laboratory will be retained by the sampler along with field records/logbooks documenting sample collection and will be placed in the project files.

If at the completion of sampling the samples are not shipped directly from the field or point of collection to the analytical laboratory, the samples will be temporarily stored in an iced cooler at a secure location (e.g., locked vehicle, residence, office) or in a locked refrigerator at the TRC office. Access to the secure location and transfer of the sample containers for laboratory delivery shall only be provided by a TRC employee and such sample transfer shall be recorded on the COC form.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

Following sample collection, all samples will be brought to a location for batching and paperwork checks. At this location, labels and logbook information are cross-checked to ensure there is no error in sample identification or sample collection time and that all samples are accounted for. The sample information is transferred to the COC form. The samples are packaged to prevent breakage and/or leakage, and the shipping containers are labeled for transport.

The Field Team Leader has the responsibility of maintaining the COC and air bill documentation. Individual responsibilities may be delegated to other field staff, as appropriate. Quality control procedures will place emphasis on ensuring that appropriate samples were collected and submitted to the laboratory for the correct analyses. The COC forms will also be reviewed by the Field Team Leader or designee to ensure that all required information is clearly presented.

Many laboratories will provide a sample receipt confirmation via electronic mail upon request. COC forms should be cross-checked with laboratory sample receipt confirmations, if applicable, to ensure that all samples were received and logged-in correctly by the laboratory.

4.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Not applicable.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

The Project Manager or Field Team Leader will maintain an inventory of all COC forms completed during the program and will be responsible for ensuring that they are archived in the project files following the completion of the field work.

It is good practice to scan all completed COC forms at the conclusion of field activities and store the resulting electronic PDF files in the project directory.

6.0 REFERENCES

A Compendium of Superfund Field Operations Methods EPA/540/P-87/001. December 1987.

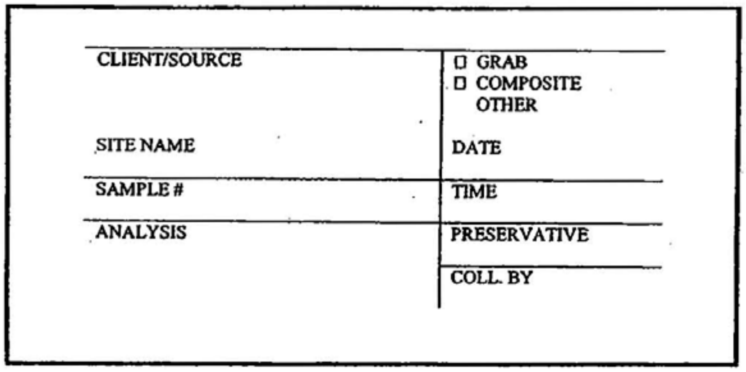
U.S. Environmental Protection Agency (EPA) Office of Enforcement and Compliance Monitoring – National Enforcement Investigations Center (NEIC) requirements (NEIC, 1986)

7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
0	MARCH 2013	NOT APPLICABLE
1	JANUARY 2020	TRC RE-BRANDING AND SOP RE-NUMBERING

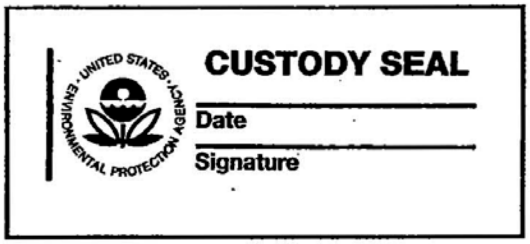
Figure 1 Example Sample Label and Custody Seal

Sample Label



CLIENT/SOURCE	☐ GRAB ☐ COMPOSITE OTHER
SITE NAME	DATE
SAMPLE #	TIME
ANALYSIS	PRESERVATIVE
	COLL. BY

Custody Seal

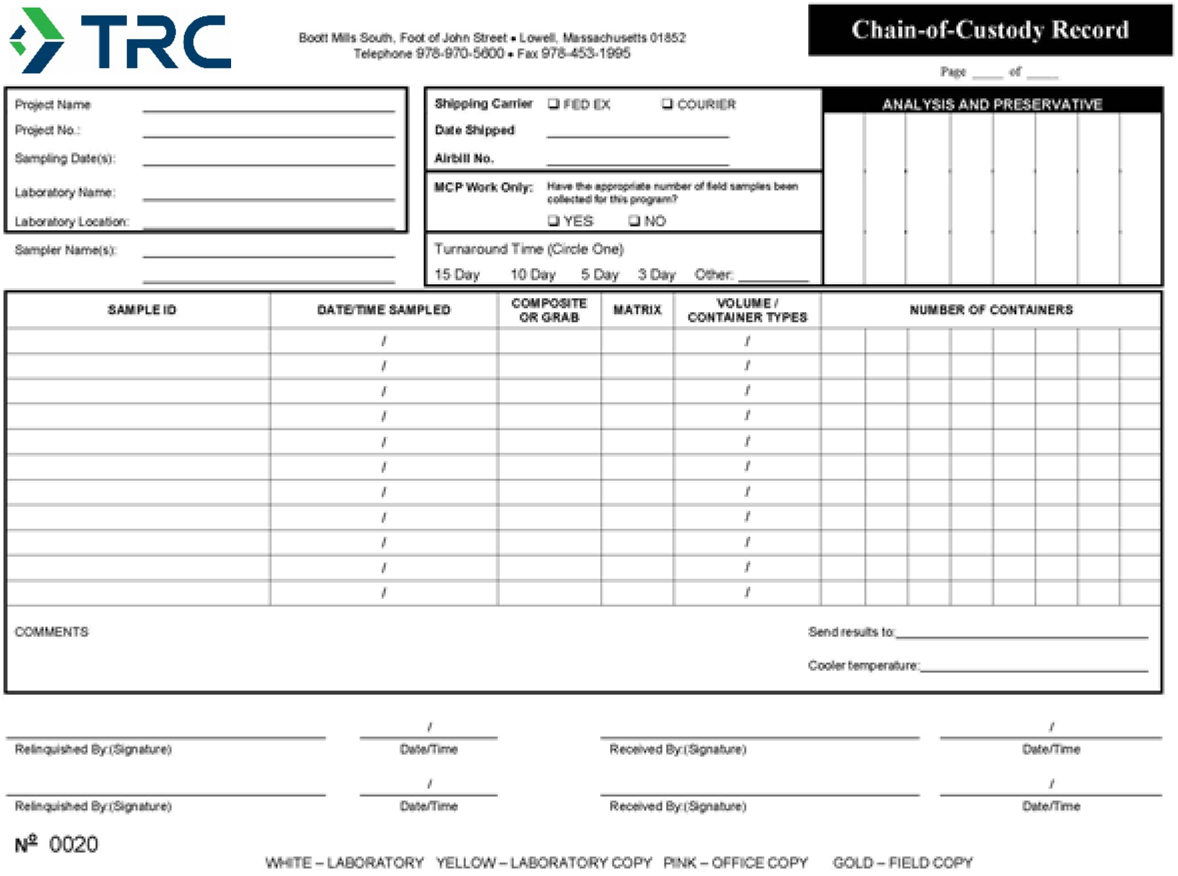


CUSTODY SEAL

Date

Signature

Figure 2 Example Chain-of-Custody Form



Boott Mills South, Foot of John Street • Lowell, Massachusetts 01852
Telephone 978-970-5600 • Fax 978-453-1995

Chain-of-Custody Record

Page ____ of ____

Project Name ______________
Project No.: ______________
Sampling Date(s): ______________
Laboratory Name: ______________
Laboratory Location: ______________
Sampler Name(s): ______________

Shipping Carrier ☐ FED EX ☐ COURIER
Date Shipped ______________
Airbill No. ______________

MCP Work Only: Have the appropriate number of field samples been collected for this program? ☐ YES ☐ NO

Turnaround Time (Circle One)
15 Day 10 Day 5 Day 3 Day Other: ________

ANALYSIS AND PRESERVATIVE

SAMPLE ID	DATE/TIME SAMPLED	COMPOSITE OR GRAB	MATRIX	VOLUME / CONTAINER TYPES	NUMBER OF CONTAINERS							
	/			/								
	/			/								
	/			/								
	/			/								
	/			/								
	/			/								
	/			/								
	/			/								
	/			/								
	/			/								
	/			/								

COMMENTS

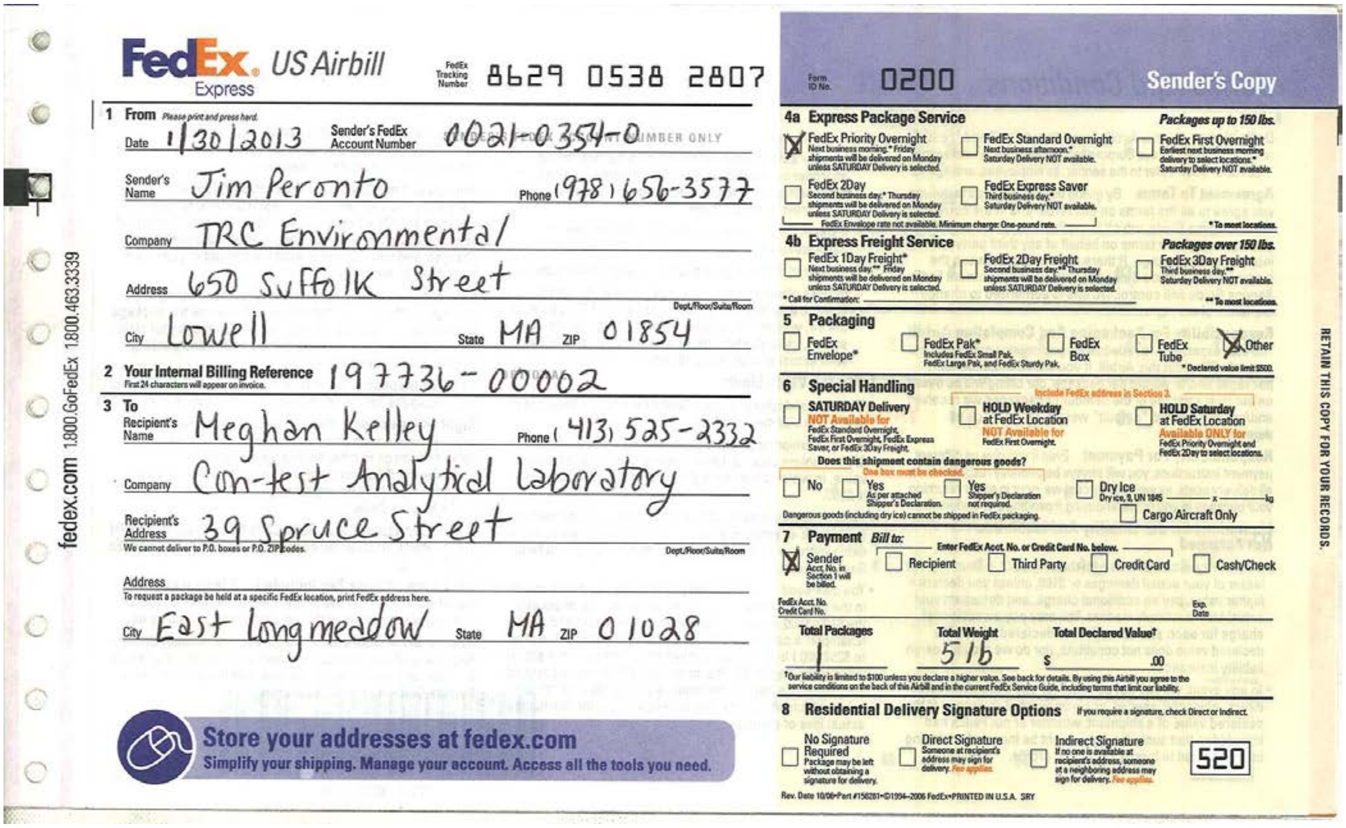
Send results to: ______________
Cooler temperature: ______________

Relinquished By:(Signature) ______________ Date/Time ____/____ Received By:(Signature) ______________ Date/Time ____/____
Relinquished By:(Signature) ______________ Date/Time ____/____ Received By:(Signature) ______________ Date/Time ____/____

№ 0020

WHITE – LABORATORY YELLOW – LABORATORY COPY PINK – OFFICE COPY GOLD – FIELD COPY

Figure 3 Example Federal Express Air Bill



FedEx Express US Airbill

FedEx Tracking Number 8629 0538 2807

Form ID No. 0200

Sender's Copy

fedex.com 1.800.GoFedEx 1.800.463.3339

1 From *Please print and press hard.*

Date 1/30/2013 Sender's FedEx Account Number 0021-0354-0

Sender's Name Jim Peronto Phone (978) 656-3577

Company TRC Environmental/

Address 650 Suffolk Street

Dept./Floor/Suite/Room

City Lowell State MA ZIP 01854

2 Your Internal Billing Reference 197736-00002

First 24 characters will appear on invoice.

3 To

Recipient's Name Meghan Kelley Phone (413) 525-2332

Company Con-test Analytical Laboratory

Recipient's Address 39 Spruce Street

We cannot deliver to P.O. boxes or P.O. ZIP codes.

Dept./Floor/Suite/Room

Address

To request a package be held at a specific FedEx location, print FedEx address here.

City East Longmeadow State MA ZIP 01028

Store your addresses at fedex.com

Simplify your shipping. Manage your account. Access all the tools you need.

4a Express Package Service *Packages up to 150 lbs.*

- ☒ FedEx Priority Overnight: Next business morning.* Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.
- ☐ FedEx Standard Overnight: Next business afternoon.* Saturday Delivery NOT available.
- ☐ FedEx First Overnight: Earliest next business morning delivery to select locations.* Saturday Delivery NOT available.
- ☐ FedEx 2Day: Second business day.* Thursday shipments will be delivered on Monday unless SATURDAY Delivery is selected.
- ☐ FedEx Express Saver: Third business day.* Saturday Delivery NOT available.

FedEx Envelope rate not available. Minimum charge: One-pound rate.

* To most locations.

4b Express Freight Service *Packages over 150 lbs.*

- ☐ FedEx 1Day Freight*: Next business day.** Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.
- ☐ FedEx 2Day Freight: Second business day.** Thursday shipments will be delivered on Monday unless SATURDAY Delivery is selected.
- ☐ FedEx 3Day Freight: Third business day.** Saturday Delivery NOT available.

* Call for Confirmation:

** To most locations.

5 Packaging

☐ FedEx Envelope* ☐ FedEx Pak* (Includes FedEx Small Pak, FedEx Large Pak, and FedEx Sturdy Pak.) ☐ FedEx Box ☐ FedEx Tube ☒ Other

* Declared value limit $500.

6 Special Handling

Include FedEx address in Section 3.

- ☐ SATURDAY Delivery: NOT Available for FedEx Standard Overnight, FedEx First Overnight, FedEx Express Saver, or FedEx 3Day Freight.
- ☐ HOLD Weekday at FedEx Location: NOT Available for FedEx First Overnight.
- ☐ HOLD Saturday at FedEx Location: Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations.

Does this shipment contain dangerous goods?

One box must be checked.

☐ No ☐ Yes (As per attached Shipper's Declaration.) ☐ Yes (Shipper's Declaration not required.) ☐ Dry Ice (Dry ice, 9, UN 1845 ___ x ___ kg) ☐ Cargo Aircraft Only

Dangerous goods (including dry ice) cannot be shipped in FedEx packaging.

7 Payment *Bill to:*

Enter FedEx Acct. No. or Credit Card No. below.

☒ Sender (Acct. No. in Section 1 will be billed.) ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check

FedEx Acct. No. / Credit Card No.

Exp. Date

Total Packages	Total Weight	Total Declared Value†
1	5 lb	$ .00

†Our liability is limited to $100 unless you declare a higher value. See back for details. By using this Airbill you agree to the service conditions on the back of this Airbill and in the current FedEx Service Guide, including terms that limit our liability.

8 Residential Delivery Signature Options If you require a signature, check Direct or Indirect.

- ☐ No Signature Required: Package may be left without obtaining a signature for delivery.
- ☐ Direct Signature: Someone at recipient's address may sign for delivery. Fee applies.
- ☐ Indirect Signature: If no one is available at recipient's address, someone at a neighboring address may sign for delivery. Fee applies.

520

Rev. Date 10/06•Part #158281•©1994–2006 FedEx•PRINTED IN U.S.A. SRY

RETAIN THIS COPY FOR YOUR RECORDS.

Attachment A: SOP Fact Sheet

CHAIN-OF-CUSTODY PROCEDURES

PURPOSE AND OBJECTIVE

Chain-of-Custody procedures have been developed to direct TRC personnel in the sample custody procedure requirements associated with field sample collection. Other state or federal requirements may be above and beyond the scope of this SOP and should be followed, if applicable. Sample custody procedures are an important part of the field investigation program to maintain data quality and to be able to document proof of proper handling. Sample custody begins at the collection of the samples and continues until the samples have been analyzed. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files.

WHAT TO BRING

- Chain-of-Custody (COC) forms
- Sample Labels
- Custody Seals (if required)
- Indelible/waterproof ink

ON-SITE

- Complete all sample labels with indelible/waterproof ink.
- At a minimum, sample labels should include: site name; unique sample identification; sample date and time.
- COC forms must be completed for each sample set and must be initiated in the field by the sampler.
- COC forms must be completed in blue or black permanent ink.
- At a minimum, the COC forms should include: site name; sample identification; sample matrix; type of preservative; type of analysis; sampling date; and sampler's name.
- Once sampling activity is completed and the COC form is filled out, place samples in sample coolers.
- Package samples to prevent breakage and/or leakage.
- The COC forms will be reviewed by the Field Team Leader or designee prior to relinquishing the samples.
- The original COC form must accompany samples to the laboratory.
- When samples are transferred from one person to another, both the relinquisher and the person receiving the samples should sign, date and record the date of transfer on the COC form.
- If samples are not sent directly to laboratory, samples need to remain on ice and be stored in a secure location.

Title: **Water Level and Product Measurements**	Procedure Number: **ECR 004**
	Revision Number: **2**
	Effective Date: **January 2020**

Authorization Signatures

Rebecca L. Armes		Elizabeth Denly	
Technical Reviewer Rebecca Armes	Date 1/1/20	Environmental Sector Quality Director Elizabeth Denly	Date 1/1/20

This document is proprietary property of TRC. It is to be used only by the person(s) to whom it has been provided and solely for the express purpose intended. Any reproduction or distribution, for purposes other than the intended, is forbidden without the express written consent of TRC.

TABLE OF CONTENTS

Page No.

ATTACHMENTS

Attachment A	Example Water and Product Level Monitoring Form
Attachment B	Example Field Book Documentation for Water Levels
Attachment C	SOP Fact Sheet
Attachment D	SOP Modifications for PFAS

1.0 INTRODUCTION

1.1 Scope and Applicability

This Standard Operating Procedure (SOP) was prepared to direct TRC personnel in the methods for conducting water level, separate-phase product, and/or total well depth measurements in monitoring wells, piezometers, and boreholes during field investigations.

1.2 Summary of Method

Depth-to-water (DTW) measurements are used to evaluate pressure and/or elevation changes within the aquifer. The procedure involves using a water level indicator capable of an accuracy of ±0.01 feet, or a similar piece of equipment, to measure the DTW in a monitoring well, piezometer, or borehole from a set reference point. When used in conjunction with an accurate site elevation survey, DTW data can be converted to potentiometric surface elevations to support groundwater flow direction analysis, as well as other aquifer characteristics. In addition, pressure changes recorded in a well during a slug, pumping, or packer test can be used to determine aquifer characteristics, such as hydraulic conductivity and storage parameters.

It is also a good practice to gauge the total depth of a monitoring well while taking water levels. This practice can help confirm: 1) the correct well in a cluster of wells screened at different depths; 2) that the well is clear of obstructions; 3) whether the well may be silting up and need further development; and 4) the correct purge volume for a well when sampling. Total depth measurements in a well may be necessary when TRC is taking over project work at a site with existing monitoring wells or the site wells have not been accessed for a significant amount of time.

The objective of separate-phase product measurements is to obtain measurements of the thickness of separate-phase product in the water column. The thickness of both dense non-aqueous phase liquid (DNAPL) and light non-aqueous phase liquid (LNAPL) can be determined using an oil/water interface probe. It should be noted that the thickness of LNAPL or DNAPL in a well (“apparent thickness”) most likely differs from the thickness in the formation (“actual thickness”).

- For LNAPL, the procedure involves measuring the depth to the separate-phase product and the depth to the underlying groundwater from a set reference point. The difference between these two measurements is the thickness of the LNAPL in the well.

- For DNAPL, the procedure involves measuring the depth to the separate-phase product and the depth to the bottom of the well, borehole, etc. The difference between these two measurements is the thickness of the DNAPL in the well.

1.3 Equipment

The following list of equipment may be utilized when conducting water level and separate-phase product measurements. Site-specific conditions may warrant the use of additional items or deletion of items from this list. For specialized sampling programs involving per- and polyfluorinated alkyl substances (PFAS), refer to Attachment D for further details.

- Appropriate level of personal protection
- Electronic water level indicator
- Oil/water interface probe
- Extra batteries for water level/interface probe
- Field book and monitoring form
- Well keys
- Socket-wrench
- Containers to hold water and isopropanol for calibration
- Tap water
- Isopropanol
- Previous measurement data (if available)
- Precision ruler or measuring tape
- Permanent marker (e.g., Sharpie®)
- Decontamination supplies

1.4 Definitions

Borehole	A hole drilled into the soil or bedrock using a drill rig or similar equipment.
Dense Non-aqueous Phase Liquid (DNAPL)	Separate-phase product that is denser than water and, therefore, sinks to the bottom of the water column.
Depth To Water (DTW)	The distance to the groundwater surface from an established measuring point.
Light Non-aqueous Phase Liquid (LNAPL)	Separate-phase product that is less dense than water and, therefore, floats on the surface of the water.
Monitoring Well	A well made from a polyvinyl chloride (PVC) pipe, or other appropriate material, with slotted screen installed across or within a saturated zone. A monitoring well is typically constructed with a PVC or stainless steel pipe in unconsolidated deposits and with steel casing in bedrock.
Non-aqueous Phase Liquid (NAPL)	Petroleum or other fluid that is immiscible in water and tends to remain as a separate liquid in the subsurface.
Piezometer	A well made from PVC or metal with a slotted screen installed across or within a saturated zone. Piezometers are primarily installed to monitor changes in the potentiometric surface elevation.
Potentiometric Surface	A surface representing the hydraulic head of groundwater.

Separate-phase Product	A liquid that does not easily dissolve in water. Separate-phase product can be more dense (i.e., DNAPL) or less dense (i.e., LNAPL) than water and, therefore, can be found at different depths in the water column.
Low-permeability Formation	A geologic formation that has very slow recharge and discharge rates due to small pore spaces in the formation material. A clay formation is considered to have low permeability and has a very slow recharge rate compared to a more permeable formation, such as sand or gravel.
Total Depth of Well	Distance from the measuring point to the bottom of the well.

1.5 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific health and safety plan (HASP). TRC personnel will use the appropriate level of personal protective equipment (PPE) as defined in the HASP.

When present, special care should be taken to avoid contact with LNAPL or DNAPL. The use of an air monitoring program, as well as the proper PPE designated by the site-specific HASP, can identify and/or mitigate potential health hazards.

1.6 Cautions and Potential Problems

Special care should be taken when using equipment if PFAS are known or suspected to be present. Please refer to Attachment D for details.

- DTW measurements of all wells in a water level survey should be collected within the shortest amount of time possible but, at a minimum, within a 24-hour period to ensure near contemporaneous data collection during a groundwater elevation recording event. However, note that certain conditions may produce relatively rapid changes in groundwater elevations, which might necessitate collecting readings over a shorter time period. Such conditions should be noted in the field book. Rapid groundwater elevation changes may occur due to:
    - Rapid changes in atmospheric pressure
    - Variable pumping of nearby wells
    - Precipitation events
    - Tidal influences
    - Rapid changes in nearby surface water levels (e.g., dam release, upstream thunderstorm)
- Allow water levels in newly installed wells to stabilize for approximately 24 hours before taking measurements for the purpose of a water level survey. Recovery might take longer in wells installed in low permeability formations.
- Because the tops of monitoring wells and piezometers are often cut unevenly, be sure to take DTW measurements from a pre-marked or notched spot on the well to ensure consistent data collection over time. Since land survey vertical elevation measurements are generally taken

from the highest point on the well casing (i.e., where survey rod rests), this point should also be marked and used for water level measurements. If the tops of the monitoring wells and piezometers are not marked, the DTW measurement should be taken from the north side of the riser and the location marked on the casing top edge.

- To limit the possibility of cross contamination, DTW measurements should be collected in order from the least to the most contaminated wells and piezometers when contamination is known or suspected. Be sure to decontaminate the entire length of the submerged tape between well measurements to reduce the potential for cross contamination. Refer to Attachment D and ECR SOP 010 for decontamination of PFAS. Some wells with NAPL or excessive condensation may have residues on the side of the riser that may also contaminate the tape.
- If the presence of NAPL is suspected at a site, an oil/water interface probe should be used to conduct water level measurements. When DNAPL is a suspected contaminant characteristic at a site, the interface probe should be lowered to the bottom of the well until DNAPL is encountered, if present.
- NAPL may foul the probe and could cause a delayed response when going from NAPL to water. Resolution may require taking repeated measurements by raising and/or lowering the probe through the interface.

- Most water level meters have a “sensitivity” setting, which is often located on the on/off dial. The sensitivity setting may need adjustment depending on the site water chemistry.

- Excessive condensation on the inside well materials may cause the tape to stick on the well casing and/or cause a false reading above the water level. This is especially true of deeper wells. Previous elevation data should be consulted to determine if a reading is consistent and plausible for that well. The above mentioned sensitivity adjustment can be used to compensate. In some cases, the line may have to be weighted to remedy the line sticking to the casing.

- Tight well caps and low permeability formations may not have allowed the potentiometric surface to equilibrate in the well after seasonal, tidal or other area groundwater level fluctuations. If this is the case, allow the wells to equilibrate before collecting measurements by taking readings several minutes after removing the well plug; in addition, re-measure the first well after the last well to verify that the water level is not fluctuating. Another round of water levels may need to be collected if a significant discrepancy from the first set of measurements is observed; this should be discussed with the Project Manager. If this is a concern, vented well caps or plugs may need to be used.

- In some instances, artesian well conditions may exist, where the potentiometric surface is higher in elevation than the top of the well casing (TOC). In these situations, it is pertinent to note the water level elevation as above the TOC or add a known length of riser pipe in order to measure an actual elevation. Once the water level has equilibrated in the riser pipe, the same procedures can be followed for measuring water level when separate-phase product is not suspected. Note that when converting the DTW measurement to an elevation, the riser pipe length needs to be added to the surveyed TOC.

- Groundwater gradients at some sites can be very shallow and if gradient and groundwater flow pattern (gradient direction) determination are part of the project objectives, it is critical that groundwater level measurements obtained from wells are as accurate as possible. Special care should be taken to allow the water level to equilibrate after removing sealing caps, and the same water level indicator should be used for all measurements if possible. All wells should be measured within the minimum possible time. This is particularly important in areas with potential tidal influences.

- If more than one measuring device must be used for multiple wells across an area with a shallow groundwater gradient, the "zero calibration check" (see Section 2.1.1) becomes especially important.

- If the monitoring well or piezometer is secured with an air- and water-tight lockable cap, caution should be taken when removing the cap due to the possible buildup of pressure in the well casing. Try to ease the cap off and relieve the pressure slowly in order to prevent injury. Do not stand or lean over top of well when releasing cap.

- Flush-mounted wells may be subject to water collection in the well can around the top of the riser pipe. In such instances, sufficient water should be evacuated from the well can prior to removing the well cap to ensure that ambient water does not enter the riser. The condition should be documented and the potential need for repair discussed with the Project Manager.

1.7 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project work plan. These requirements may include:

- OSHA 40-hour Health and Safety Training for Hazardous Waste Workers (HAZWOPER)
- 8-hour annual refresher training

2.0 PROCEDURES

To be useful for establishing groundwater gradient, the reference point should be tied with a known vertical datum, such as the National Geodetic Vertical Datum (NGVD), or a local datum (e.g., site-specific arbitrary datum).

Water levels should be allowed to equilibrate prior to measurement after removing sealing well caps. There are no set guidelines, and appropriate equilibration times can range from minutes to hours depending on well recharge, local geology, and project objectives.

If available, prior site water and product level measurement data should be reviewed and available to field personnel during the collection of new data for direct comparison to aid in identifying and resolving potential measurement errors while in the field.

When measuring well depths with an electronic water level indicator, measure and add the length of the probe beneath the circuit closing electrodes to the depth measured to obtain the true depth.

The following procedures must be followed during the collection of water level and product measurements. Procedures may vary depending on the equipment used and contaminants present at the site. Special care should be taken when using measurement equipment if PFAS are known or suspected to be present. Please refer to Attachment D for details.

2.1 Calibration and Operational Checks

Refer to the project's Quality Assurance Project Plan (QAPP) for calibration frequency and any site-specific calibration procedures for water and separate-phase product level meters. Calibration of the meters is optional; the need for calibration and the frequency of calibration will be dependent upon the meter used and project-specific data quality objectives. Operational checks of meters will be performed prior to use in the field at the start of each day and several times throughout the day, as appropriate.

2.1.1 Operational Check of Water Level Meters

1. Push the Start or Test button (typically provided) on the meter to test the battery and circuitry on the water level indicator. The meter audible indicator should sound and test light illuminate (if equipped).

2. Release the start/test button and lower the water level probe into a container filled with tap water until the meter audible indicator sounds or visual indicator light turns on. During this check, set sensitivity adjustment (if provided) to highest setting, then decrease if necessary (e.g., saline water).

Inspect the measuring tape and water level probe connection for any signs of visible damage (e.g., cuts, kinks, separating splices). If the tape appears damaged at the connection to the probe, while the meter is sounding, perform the procedure in Section 2.1.2.

2.1.2 Calibration of Water Level Meters

1. While the meter is sounding from the procedure used in Section 2.1.1, use a ruler or measuring tape to measure the distance between the water surface and the 1-foot increment mark on the water level tape.

2. Check that the 1-foot increment is actually 1 foot from the water surface. Note any discrepancy in the field book and discuss with the Project Manager. If necessary, repair and/or replace the water level meter.

2.1.3 Calibration and Operational Check of Oil/Water Interface Meters

1. Oil/water interface meters will have one distinguishing sound and/or colored light to represent detection of water and a separate distinguishing sound to represent detection of separate-phase product. Read the instrument manufacturer's operations manual to determine the instrument's audible sound or light differentiation for water and separate-phase product (e.g., continuous beep for product and intermittent beep for water).

2. Push the Start or Test button (typically provided) on the meter to test the battery and circuitry on the water level indicator. The meter audible indicator should sound and test light illuminate (if equipped).

3. Water Level Sensor Operational and Calibration Checks

   a. Lower the water level probe into a container filled with tap water until the appropriate sound for water is heard as determined in Step 1.
   b. While the meter is sounding, use a ruler or measuring tape to measure the distance between the water surface and the 1-foot increment mark on the water level tape.
   c. Check that the 1-foot increment is actually 1 foot from the water surface. Note any discrepancy in the field book and discuss with the Project Manager.

4. Oil Level Sensor Operational and Calibration Checks

   a. If the operation or calibration of the oil level probe is suspected to be faulty, consult with the meter manufacturer for additional troubleshooting.

2.2 Procedures for Measuring Depth to Water When Separate-phase Product is Not Suspected

If possible, and when applicable, start at wells that are least contaminated and proceed to those wells that are most contaminated. Additionally, allow sufficient time for each monitoring well or piezometer to equilibrate after removing the protective cap prior to taking readings.

1. Record the condition of the well (e.g., protective casing, concrete collar, lock in place, etc.), equipment being used, and the current weather conditions in the field book or on the water level monitoring form or well inspection report.

2. Use HASP-specified gloves. Stand upwind of the well and remove the well lid. Unlock and remove the well cap slowly to relieve pressure build up that may have occurred in the well casing. Follow HASP requirements for well head and breathing zone air monitoring.

3. Identify the previous measuring point marking or notch on the riser or casing (if present). If no previous measuring point exists, use a permanent marker to mark a location on the rim of the riser or casing (typically the highest point). Record this location in the field book or on the water level monitoring form (e.g., top of riser or top of casing).

4. Using a previously decontaminated water level meter, turn on the meter, check the audible/visual indicator (push the "Test" button), reel the electronic probe into the well riser (with the increments visible) slowly until the meter sounds.

5. Grasp the tape with hand, withdraw the tape, and lower it again slowly until the sound is again audible. Check the DTW on the tape and make a mental note of the depth to within 0.01 feet.

6. Lower the probe again slowly and repeat the measurement for precision. In the field book or on the water level monitoring form, record the DTW from the measuring point noted in

Step #3 to the nearest 0.01 feet. If measuring the total depth of the well, proceed to Section 2.4).

7. Decontaminate the probe and the entire length of the submerged tape in accordance with the manufacturer specifications. Refer to Attachment D and ECR SOP 010, Equipment Decontamination, for decontamination procedures for sites with known or suspected PFAS contamination.

2.3 Procedure for Measuring Depth to Water and Product Levels When Separate-phase Product is Suspected

If possible, and when applicable, start at wells that are least contaminated and proceed to those wells that are most contaminated. Additionally, allow sufficient time for each monitoring well or piezometer to equilibrate after removing the protective cap prior to taking readings.

1. Record the condition of the well (e.g., protective casing, concrete collar, lock in place, etc.), equipment being used, and the current weather conditions in the field book, water level monitoring form, or well inspection report.

2. Use HASP-specified gloves. Stand upwind of the well and remove the well lid. Unlock and remove the well cap slowly to relieve pressure build up that may have occurred in the well casing. Follow HASP requirements for well head and breathing zone air monitoring.

3. Identify the previous measuring point marking or notch on the riser or casing (if present). If no previous measuring point exists, use a permanent marker to mark a location on the rim of the riser or casing (typically the highest point). Record this location in the field book or on the water level monitoring form (e.g., top of riser or top of casing).

4. Using a previously decontaminated oil/water interface probe, turn on the meter, check the audible indicator, and slowly reel the electronic probe into the well riser (with the increments visible) until the appropriate sound for water or separate-phase product is heard as determined in Section 2.1.3.

5. If water is encountered first (as determined by the audible sound on the meter, which represents water), follow steps 5 and 6 from Section 2.2. In the field book or on the water level monitoring form, record the DTW from the measuring point noted in Step 3 to the nearest 0.01 feet.

6. If water is encountered first and DNAPL is suspected, continue lowering the probe until product is encountered (as determined by the audible sound on the meter, which represents product). In the field book or on the water level monitoring form, record the depth to product from the measuring point noted in Step #3.

7. Calculate the thickness of the DNAPL in the well using the following equation:

   (Total depth of well) - (Depth to product) = DNAPL thickness

8. If LNAPL is encountered before water, record the depth to product from the measuring point noted in Step #3 in the field book and continue lowering the probe until water is encountered.

   NOTE: For LNAPL, it is necessary to take both the air/product interface measurement on the way down into the product and the water/product interface measurement on the way back up. This is required when passing through product into water, since some product may adhere to the probe sensors due to surface tension and, as a result, a greater product thickness measurement may be erroneously obtained. Therefore, when LNAPL is detected, the probe should be lightly shaken or raised and lowered rapidly in a short vertical motion while the probe is within the water column to remove any product that may have been carried down with the probe. After passing through the product, the water/product interface should then be measured as the probe is raised very slowly back up from the underlying water into the product. Once the interface is detected, the probe can be raised and lowered in small increments to precisely determine the interface and obtain accurate measurements. Repeat these measurements as needed to confirm water/product interfaces and product thickness on multiple measurements.

9. In the field book or on the water level monitoring form, record the DTW from the measuring point noted in Step #3. If measuring the total depth of the well, proceed to Section 2.4.

10. Calculate the thickness of the LNAPL in the well using the following equation:

    (DTW) - (Depth to product) = LNAPL thickness

11. Decontaminate the probe and the entire length of the submerged tape in accordance with the manufacturer specifications. Refer to Attachment D for measurement equipment used at sites with known or suspected PFAS contamination and ECR SOP 010, Equipment Decontamination, for PFAS decontamination procedures.

2.4 Procedure for Measuring Total Well Depth

When measuring the total depth of a well, the water level and separate-phase product level, if present, should be determined first (see Section 2.2 or 2.3). It is recommended that the tone function of the instrument remain engaged during the total depth measurement.

1. After the water level and product level, if present, have been determined, continue reeling the electronic probe into the well riser (with the increments visible) until the probe encounters resistance. Resistance may be inferred when the probe appears to stop descending and the tape slackens against the side of the riser.

2. Determine whether the observed resistance likely represents the total depth of the well by raising and then lowering the probe to the level of the previously encountered resistance several times at different positions in the well. Then compare the observed level of resistance to available information about the total depth of the well, such as well log data or previous total depth measurements.

3. Measure the total depth of the well by: 1) noting the depth (to the nearest 0.01 feet) at which the probe first touches bottom before the tape begins to slacken; 2) adding the measured length from the bottom of the probe to the fluid level sensor in the probe; and 3) recording the combined lengths as the total depth.

4. In the field book or on the water level monitoring form, record the total depth of the well from the measuring point.

5. Also, note any observations about the conditions encountered in the well during the total depth measurement. A clear and distinct bottom reading would indicate little or no sediment in the bottom of the well. A soft and indistinct probe landing would indicate the presence of silt or sediment in the bottom of the well. A total depth measurement inconsistent with the well log or previous total depth measurements may indicate an obstruction in the well or significant sedimentation at the bottom of the well.

6. Decontaminate the probe and the portion of the tape inserted in the riser in accordance with the manufacturer specifications. Refer to Attachment D for measurement equipment used at sites with known or suspected PFAS contamination and ECR SOP 010, Equipment Decontamination, for PFAS decontamination procedures.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager.

Each project must consider investigation-derived waste disposal methods and have a plan in place prior to performing the field work. Provisions must be in place as to what will be done with investigation-derived waste. If investigation-derived waste cannot be returned to the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The following Quality Assurance/Quality Control procedures apply:

- Operate field instruments according to the manufacturers’ manuals.

- Calibrate field instruments at the proper frequency.

- Check the DTW at least two times in order to compare results. If results do not agree to within 0.02 feet, take a third measurement. If results still do not agree, check for possible equipment failure or review the cautions and potential problems listed in Section 1.6. Repeat the measurement when the cause of the precision nonconformance has been discovered and corrected.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

- Record water and separate-phase product level measurements on field forms or in a field book. See Attachment A for an example of a Water and Product Level Monitoring Form and Attachment B for an example of field book documentation.
- The following additional information may be recorded in the field book:
    - Well/piezometer or monitoring point identification number
    - Well/piezometer or monitoring point location (sketch of the sample point or reference to a location figure)
    - Visual or sensory description (e.g., odors, product, etc.)
    - Time and date measurements were taken
    - Personnel performing the task
    - Weather conditions during task
    - Other pertinent observations
    - Measurement equipment used
    - Calibration procedures used
    - Decontamination procedures used
    - Fixed measuring point used for DTW measurements

6.0 REFERENCES

Compendium of Superfund Field Operations Methods. EPA/540/P-87/001. December 1987.

U.S. EPA Environmental Response Team, Standard Operating Procedures, *Manual Water Level Measurements*, SOP 2043. February 11, 2000.

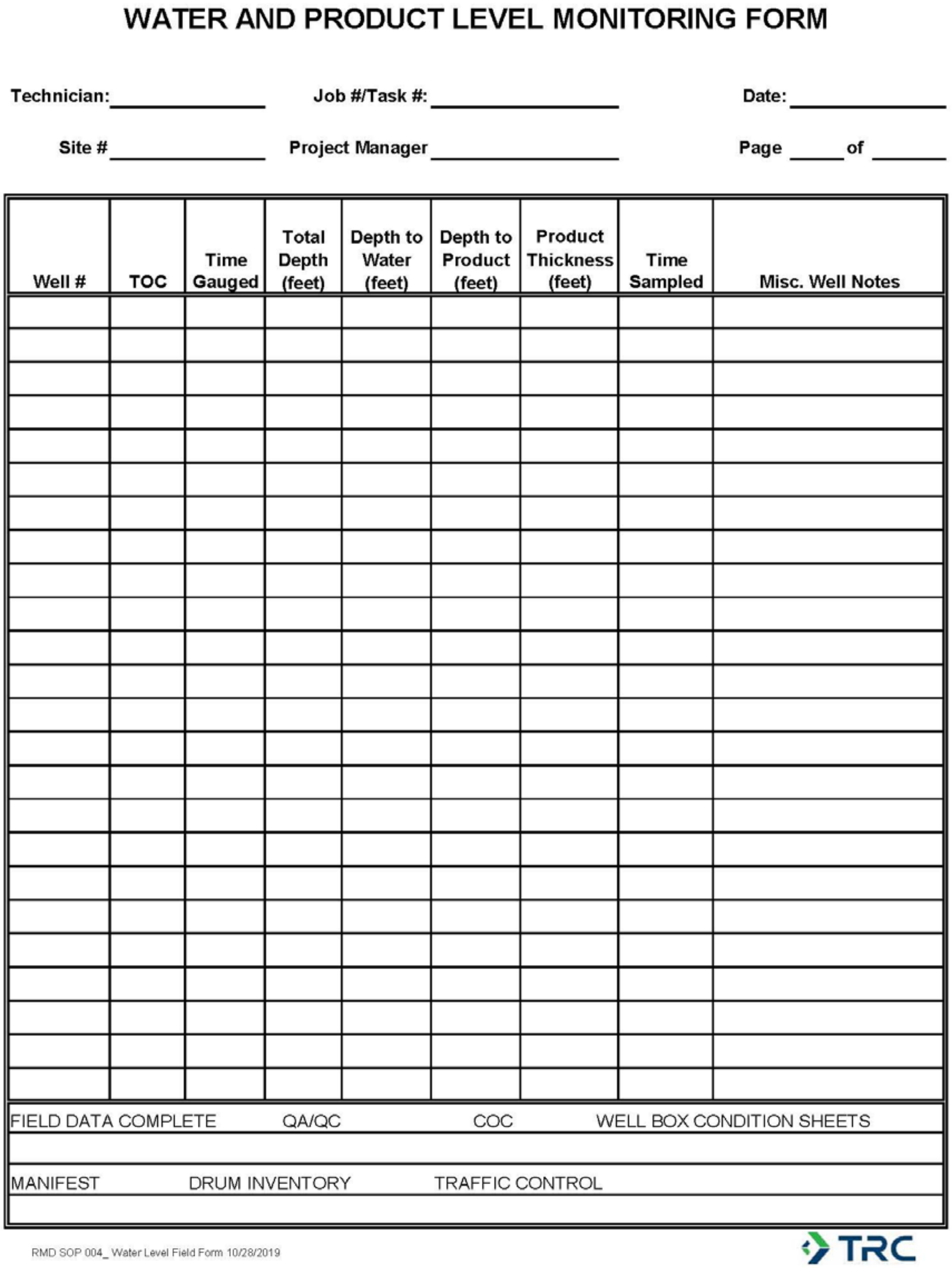
U.S. EPA Region 4. Science and Ecosystem Support Division (SESD) Operating Procedure, *Groundwater Level and Well Depth Measurement*, SESDPROC-105-R2. January 29, 2013.

7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
1	DECEMBER 2016	ADDED ATTACHMENT D TO ACCOMMODATE SOP MODIFICATIONS REQUIRED WHEN SAMPLING FOR PFAS; CHANGED NAMING CONVENTION FOR SOP FROM RMD TO ECR.
2	JANUARY 2020	TRC RE-BRANDING

ATTACHMENT A

EXAMPLE WATER AND PRODUCT LEVEL MONITORING FORM



WATER AND PRODUCT LEVEL MONITORING FORM

Technician: ______________ **Job #/Task #:** ________________ **Date:** ______________

Site # ______________ **Project Manager** ________________ **Page** _____ **of** ______

Well #	TOC	Time Gauged	Total Depth (feet)	Depth to Water (feet)	Depth to Product (feet)	Product Thickness (feet)	Time Sampled	Misc. Well Notes

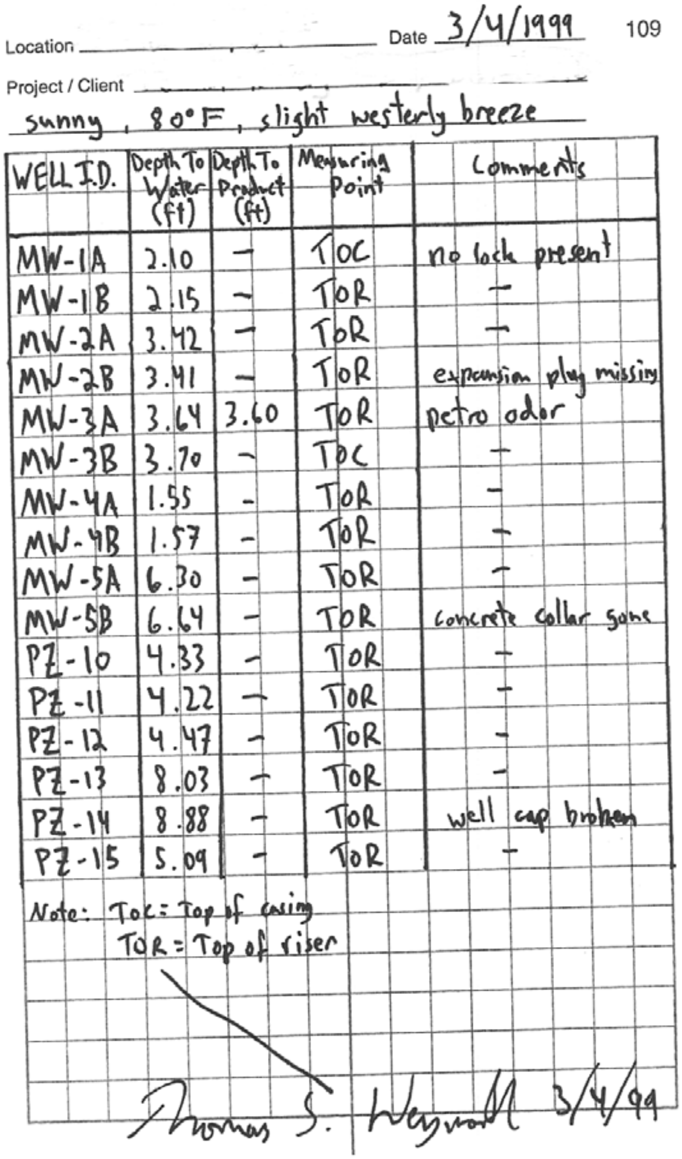
FIELD DATA COMPLETE QA/QC COC WELL BOX CONDITION SHEETS

MANIFEST DRUM INVENTORY TRAFFIC CONTROL

RMD SOP 004_ Water Level Field Form 10/28/2019

ATTACHMENT B

EXAMPLE FIELD BOOK DOCUMENTATION FOR WATER LEVELS



Location ______________ Date 3/4/1999 109

Project / Client ______________

sunny, 80°F, slight westerly breeze

WELL I.D.	Depth To Water (ft)	Depth To Product (ft)	Measuring Point	Comments
MW-1A	2.10	–	TOC	no lock present
MW-1B	2.15	–	TOR	–
MW-2A	3.42	–	TOR	–
MW-2B	3.41	–	TOR	expansion plug missing
MW-3A	3.64	3.60	TOR	petro odor
MW-3B	3.70	–	TOC	–
MW-4A	1.55	–	TOR	–
MW-4B	1.57	–	TOR	–
MW-5A	6.30	–	TOR	–
MW-5B	6.64	–	TOR	concrete collar gone
PZ-10	4.33	–	TOR	–
PZ-11	4.22	–	TOR	–
PZ-12	4.47	–	TOR	–
PZ-13	8.03	–	TOR	–
PZ-14	8.88	–	TOR	well cap broken
PZ-15	5.09	–	TOR	–

Note: TOC = Top of casing
TOR = Top of riser

Thomas S. Weymouth 3/4/99

ATTACHMENT C

SOP FACT SHEET

WATER LEVEL AND PRODUCT MEASUREMENT PROCEDURES

PURPOSE AND OBJECTIVE

The following water level and product measurement procedures have been developed to direct TRC personnel in the methods of collecting water levels and product measurements in the field. Other state or federal requirements may be above and beyond the scope of this SOP and should be followed, if applicable. Depth-to-water (DTW) measurements are used to evaluate pressure and/or elevation changes within the aquifer. The objective of separate-phase product measurements is to obtain measurements of the thickness of separate-phase product in the water column. Both of these measurements are very important as they drive remediation decisions.

WHAT TO USE

- Water level meter
- Oil/Water interface probe
- Extra batteries
- Well keys
- Socket set
- Decontamination supplies
- Field book
- Indelible/waterproof ink

ON-SITE WELL GAUGING

- Prior to well gauging, site water level measurement data should be reviewed for direct comparison to aid in identifying and resolving potential measurement errors while in the field.
- Conduct an operational check of the water level meter by pushing the Start or Test button on the meter to test the battery and circuitry on the water level indicator. The meter audible indicator should sound and test light illuminate.
- If possible and when applicable, start at wells that are least contaminated and proceed to those wells that are most contaminated.
- Prior to collecting a water level, record the condition of the well (e.g., protective casing, concrete collar, lock in place, etc.).
- Stand upwind of the well and remove the well lid. Unlock and remove the well cap slowly to relieve pressure buildup that may have occurred in the well casing. Allow the well time to equilibrate.
- Identify the previous measuring point marking or notch on the riser or casing (if present). If no previous measuring point exists, use a permanent marker to mark a location on the rim of the riser or casing (typically the highest point). Record this location in the field book.
- Grasp the tape with hand, withdraw the tape, and lower it slowly until the sound is audible. Check the DTW on the tape and make a mental note of the depth to within 0.01 feet. Lower the probe again slowly and repeat the measurement for precision.
- If total depth measurements were not recorded recently, advance the tape to the bottom of the well to record a total depth.
- Decontaminate the probe and tape between each well.

ON-SITE PRODUCT MONITORING

- Prior to product gauging, product measurement data should be reviewed for direct comparison to aid in identifying and resolving potential measurement errors while in the field.
- Using a previously decontaminated oil/water interface probe, turn on the meter, check the audible indicator, and slowly reel the electronic probe into the well riser (with the increments visible) until the appropriate sound for water or separate-phase product is heard (intermittent tone for water; steady tone for product).
- If water is encountered first (as determined by the audible sound on the meter, which represents water), record the DTW from the measuring point to the nearest 0.01 feet.
- If water is encountered first and dense non-aqueous phase liquid (DNAPL) is suspected, continue lowering the probe until product is encountered (as determined by the audible sound on the meter, which represents product). In the field book or on the water level monitoring form, record the depth to product from the measuring point. If light non-aqueous phase liquid (LNAPL) is encountered before water, record the depth to product from the measuring point and continue lowering the probe until water is encountered and record the depth to water.
- Decontaminate the probe and tape between each well.

WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager.

Each project must consider investigation-derived waste disposal methods and have a plan in place prior to performing the field work. Provisions must be in place as to what will be done with investigation-derived waste. If investigation-derived waste cannot be returned to the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

ATTACHMENT D

SOP MODIFICATIONS FOR PFAS

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross-contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. The following table highlights the required modifications to this SOP when sampling for PFAS.

Water Level and Product Measurement Protocols for PFAS	
SOP Section Number	**Modifications to SOP**
1.3	• Field notes should be recorded on loose paper field forms maintained in aluminum or Masonite clipboards. Waterproof field books, plastic clipboards and spiral bound notebooks should not be used. • Do not use Post-it® Notes. • Use new plastic buckets for wash and rinse water. • Do not use "tap" water for operational check of the water level sensor of the oil/water interface meter. • Ensure that PFAS-free water is used during the decontamination procedure. • Do not use a plastic ruler to check measurements. • Refer to SOP 010, Equipment Decontamination, for decontamination supplies.
1.5	Always consult the Site-specific Health and Safety Plan prior to conducting field work. The following considerations should be made with regards to procedures: • Tyvek® suits should not be worn. Cotton coveralls may be worn. • Boots and other field clothing containing Gore-Tex™ or other waterproof/resistant material should not be worn. This includes rain gear. Boots made with polyurethane and polyvinyl chloride (PVC) are acceptable. • Food and drink should not be allowed within the data measurement collection area. Bottled water and hydration drinks (e.g., Gatorade®) may be consumed in the staging area only. • Personnel involved with measurement data collection should wear a new pair of nitrile gloves between each well measurement. Avoid handling unnecessary items with nitrile gloves. • Avoid wearing clothing laundered with fabric softeners. • Avoid wearing new clothing (recommended six washings since purchase). Clothing made of cotton is preferred. • Avoid using cosmetics, moisturizers, hand creams, or other related products as part of cleaning/showering the morning of sampling and decontamination field work.
2.1.1	• Do not use potable "tap" water for operational check of the water level meter. Use deionized, distilled, or organic-free water.
2.1.2 and 2.1.3	• Do not use potable "tap" water for operational check of the water level sensor of the oil/water interface meter. Use deionized, distilled, or organic-free water. • Do not use a plastic ruler to check measurements.
2.2 (7) ; 2.3 (11); and 2.4 (6)	• Use only Alconox® or Liquinox® soap; do not use Decon 90. • Ensure that PFAS-free water is used during the decontamination

Water Level and Product Measurement Protocols for PFAS	
SOP Section Number	**Modifications to SOP**
	procedure.
5.0	- Field notes should be recorded on loose paper field forms maintained in aluminum or Masonite clipboards. Waterproof field books, plastic clipboards, and spiral bound notebooks should not be used.

Title: **Groundwater Sampling**	Procedure Number: **ECR 009**
	Revision Number: **3**
	Effective Date: **January 2020**

Authorization Signatures			
Darby Litz		Elizabeth Denly	
Technical Reviewer Darby Litz	Date 1/1/20	Environmental Sector Quality Director Elizabeth Denly	Date 1/1/20

TABLE OF CONTENTS

Page No.

ATTACHMENTS

Attachment A	Groundwater Field Parameter Stabilization Criteria for Selected Jurisdictions
Attachment B	Example Groundwater Field Data Records
Attachment C	SOP Fact Sheet
Attachment D	SOP Modifications for PFAS

1.0 INTRODUCTION

1.1 Scope & Applicability

This Standard Operating Procedure (SOP) was prepared to provide TRC personnel with general guidance in performing groundwater sampling activities. This SOP details equipment and sampling procedures for low-flow sampling, multi-volume purge sampling and passive diffusion bag sampling from monitoring wells. Various regulatory agencies and project-specific work plans may have specific requirements (e.g., equipment/instrument, flow rate, etc.) that may be applicable and take precedence, depending on the program.

The objective of groundwater sampling is to obtain a representative sample of water from a saturated zone or groundwater-bearing unit (i.e., aquifer) with minimal disturbance of groundwater chemistry. This requires that the sample being collected is representative of groundwater within the formation surrounding the well bore as opposed to stagnant water within the well casing or within the filter pack immediately surrounding the well casing.

1.2 Summary of Method

There are three general approaches to groundwater purging/sampling that can be used to obtain a representative groundwater sample for analysis: 1) the low-flow or micropurge method where the mixing of the stagnant water is minimized using low-flow pumping rates during the collection of the groundwater sample; 2) the multiple well volume removal approach in which the stagnant water is removed from the well and the filter pack prior to sample collection; and 3) the passive sampler procedure where water quality equilibration with the surroundings is achieved through deployment of the passive sampler for a sufficient amount of time prior to sampling.

For low-flow and multiple well volume removal, there are various types of equipment available to perform groundwater sampling. The most common of these are the submersible pump, peristaltic pump, and bailer. However, the equipment selected and the purge method used, if any, will depend on project goals, data quality objectives (DQOs), hydrogeologic conditions, and regulatory requirements. Care should be taken when choosing the sampling procedures and device(s), as some procedures have the potential to affect the representativeness of the sample more than others. For repeated monitoring events, the sampling methodology and operating equipment employed should be consistent to minimize potential variability due to sampling procedures. The type of sampling method utilized is dependent upon site-specific conditions and it is not within the scope of this document to recommend a specific methodology. For specialized sampling programs involving per- and polyfluorinated alkyl substances (PFAS), refer to Attachment D for further details. Information on applicability of sampling methods can be found on Interstate Technology & Regulatory Council (ITRC) and United States Environmental Protection Agency (EPA) websites.

1.3 Equipment

The following equipment is commonly used to collect groundwater samples from a monitoring well. Site-specific conditions may warrant the use of additional equipment or deletion of items from this list.

- Appropriate level of personal protective equipment (PPE) as specified in the site-specific Health and Safety Plan (HASP)
- Electronic water level indicator capable of measuring to 0.01 foot accuracy
- Oil/water interface probe
- Extra batteries for water level/interface probe
- Submersible pump with low-flow capabilities (less than 1 liter/min) constructed of inert materials (e.g., stainless steel and Teflon®), such as a bladder pump (with sufficient quantity of bladders, o-rings, grab plates, etc.)
- Peristaltic pump
- Source of power for use with submersible or peristaltic pump (e.g., 12-volt battery, compressor, generator, compressed gas tanks, etc.)
- Flow controller for use with submersible pump (varies depending on type of pump used)
- Bottom-filling bailer constructed of inert materials (i.e., polyethylene, polyvinyl chloride [PVC], stainless steel or Teflon®)
- Bailer cord or wire (recommended Teflon®-coated, stainless steel cable; bailer wire; or contaminant-free rope with a Teflon®-coated stainless steel leader to connect bailer and rope)
- Tubing (Teflon®, Teflon®–lined polyethylene, or high density polyethylene [HDPE], type dependent upon project objectives)
- Silicone tubing (only used for peristaltic pump head and/or flow-through cell connections)
- Water quality meter(s) capable of measuring parameters, such as pH, temperature, specific conductivity, oxidation-reduction potential (ORP), and dissolved oxygen (DO)
- Flow-through cell
- T-connector
- Turbidity meter
- Passive sampling device (and any device-specific accessories)
  - Passive diffusion bags (PDBs)
  - Tether (stainless steel cable or marine-grade polyethylene rope), well cap, and weights, unless already installed
  - Funnel (Fill kit)
  - PVC cable ties
  - Tool to cut cable ties
  - PVC discharge tubes
  - Tether reel

- Well lock keys
- Bolt cutters

- Appropriate tools for equipment and to open well box (e.g., socket wrench, pry bar, etc.)
- Containers with lids for purge water (i.e., 5-gallon buckets, drums, etc.)
- Stopwatch or timer
- Graduated measuring container appropriately sized to measure flow rate
- Sample bottle labels
- Laboratory-grade water (can request from lab – for equipment blanks)
- Chain-of-custody (COC) forms
- Sample cooler(s)
- Photoionization detector (PID) or flame ionization detector (FID) for well head monitoring
- Sample containers (may be supplied by the laboratory depending upon the regulatory program): The proper containers should be determined in conjunction with the analytical laboratory in the planning stages of the project. If not included in sample containers provided by laboratory, sample preservatives will need to be kept with sample containers, and added to sample containers prior to sample collection.
- Field book and/or Groundwater Field Data Record (multiple copies)
- Filtration equipment
- In-line filter (0.45 micron [µm]) or as otherwise required by the project-specific work plan.
- Bubble wrap/Bubble wrap bags
- Lint-free, non-abrasive, disposable towels (e.g., Kimwipes®)
- Indelible marking pens
- Plastic bags (e.g., Ziploc®)
- Ice
- Teflon® tape
- Plastic sheeting or large trash bags which can be cut open
- Umbrella, tent, or equivalent for shading equipment (particularly the flow-through cell) from sunlight or blocking rain
- Equipment decontamination supplies
- Container for bailing water out of water-logged road boxes or well vaults
- Map of well locations and well construction data
- Copy of field notes from previous sampling event for reference
- Project-specific work plan

1.4 Definitions

Bailer	A cylindrical device suspended from a rope or cable, which is used to remove water, non-aqueous phase liquid (NAPL), sediment or other materials from a well or open borehole. Usually equipped with some type of check valve at the base to allow water, NAPL, and/or sediment to enter the bailer and be retained as it is lifted to the surface. A bailer may be made in varying diameters; however a bailer that fits in a two-inch well is the most common. In some instances a < 1-inch diameter bailer (a.k.a. pencil bailer) is used for small diameter wells.
Borehole	A hole drilled into the soil or bedrock using a drill rig or similar equipment.
Dense Non-aqueous Phase Liquid (DNAPL)	Separate-phase product that is denser than water and, therefore, sinks to the bottom of the water column.
Depth To Water (DTW)	The distance to the groundwater surface from an established measuring point.
Drawdown	The response to purging/pumping a well resulting in the lowering of groundwater within the water column in the well or in a water-bearing zone.
FID	An instrument that uses a flame to break down volatile organic compounds (VOCs) into ions that can be measured.
Flow-Through Cell	The container used to immerse the multi-parameter probes in well purge water during pre-sampling well purging. The flow-through cell is usually made of transparent acrylic and is connected to the end of the discharge tubing creating an in-line, sealed container in which purge water circulates around the measurement probes. The discharge from the pump prior to the flow-through cell may be fitted with a check valve or T-connector for collection of water for turbidity measurement.
Flush Mount	The type of well completion where the riser terminates at or below grade. Flush-mounted wells are typically completed with a “curb box” which is an “at-grade” enclosure designed to protect the well riser.
Light Non-aqueous Phase Liquid (LNAPL)	Separate-phase product that is less dense than water and therefore floats on the surface of the water.

Monitoring Well	A well made from a PVC pipe, or other appropriate material, with slotted screen installed across or within a saturated zone. A monitoring well is typically constructed with a PVC or stainless steel pipe in unconsolidated deposits and with steel casing in bedrock.
PID	An instrument that uses an ultraviolet light source to break down VOCs into ions that can be measured.
Piezometer	A well made from PVC or metal with a slotted screen installed across or within a saturated zone. Piezometers are primarily installed to monitor changes in the potentiometric surface elevation.
Potentiometric Surface	A surface representing the hydraulic head of groundwater.
Protective Casing	The pipe installed around the well riser that sticks up from the ground (above-grade completions) or is flush with the ground (at-grade completions, e.g., curb box) in order to protect the well integrity. Protective casings are typically constructed of steel or aluminum and usually closeable with a locking cover/hasp to maintain well integrity between sampling events.
Recharge Rate	The rate at which groundwater returns to the water column in the well.
Separate-Phase Product	A liquid that does not easily dissolve in water. Separate-phase product can be more dense (i.e., DNAPL) or less dense (i.e., LNAPL) than water and, therefore, can be found at different depths in the water column.
Static Water Level	Level at which water resides in a well when the water level is at equilibrium with atmospheric pressure.
Well Cover	The cap or lid constructed at the end of the protective casing (above-grade completions) or flush-mounted curb box (ground surface completions) to secure access to the well. Well covers for stick-up wells are often equipped with a hasp to accommodate a padlock. Well covers for flush-mounted road boxes or vaults are opened and closed using a threaded bolt.
Well Filter Pack	A material composed of clean silica sand or sand and gravel of selected grain size and gradation that is placed in the annulus between the screened interval and the borehole wall in a well for the purpose of retaining and stabilizing the formation material.

Well Plug/Expansion Plug	The plug fashioned into a cap placed into the top of the well riser (e.g., J-Plug). Well plugs are usually designed with an expandable gasket that is activated by turning a locking wing nut or removable key latch, closing a snap cap or engaging a magnetic clutch cap to seal the well riser.
Well Riser	Sections of blank (non-slotted) pipe that extend from the well screen to or above the ground surface.
Well Screen	Pipe (typically PVC or stainless steel) used to retain the formation or filter pack materials outside of the well. The pipe has openings/slots of a uniform width, orientation, and spacing. The openings/slots can vary based on formation and filter pack material specifications.

1.5 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific HASP. TRC personnel will use the appropriate level of PPE as defined in the HASP.

The well head should be pre-screened using a PID/FID to avoid inhalation of contaminants venting from the well. If monitoring results indicate sustained elevated concentrations of organic contaminants, the level of PPE may need to be increased in accordance with the HASP or work could be conducted upwind of the well.

When present, special care should be taken to avoid contact with LNAPL or DNAPL. The use of an air monitoring program, as well as the proper PPE designated by the site-specific HASP, can identify and/or mitigate potential health hazards.

Implementing this SOP may require the use of reagents and/or compressed gases for the calibration and operation of field equipment. These substances may be hazardous and TRC personnel must appropriately handle, store, and dispose of them at all times. Skin contact with liquid from preserved sample bottles must be avoided as they may contain strong acids or bases. When filling bottles pre-preserved with acid (e.g., hydrochloric acid, nitric acid, sulfuric acid), vapors may be released and should not be inhaled. Do not allow bottles with acid to be exposed to elevated atmospheric temperatures or sunlight as this will facilitate fumes from the acids.

1.6 Cautions and Potential Problems

The following sections highlight issues that may be encountered and should be discussed with the Project Manager prior to mobilization into the field. Special care should be taken when sampling for PFAS. Please refer to Attachment D for details.

1.6.1 Pre-Sampling Issues

(a) Selection of equipment for groundwater sampling should consider multiple factors, including: DTW, well specifications (e.g., depth and length of well screen intervals), desired flow rate, possible weather conditions, type and concentration of contaminant(s), and remoteness/accessibility to the site. The benefits and limits of each type of groundwater sampling equipment should be fully reviewed during project planning or prior to mobilization if the project-specific work plan does not identify the required equipment. For example, peristaltic pumps are incapable of withdrawing water in wells in which the depth to water is greater than approximately 20-25 feet below ground surface (bgs).

(b) If the screen or open borehole is greater than 10 feet in length, consult the project-specific work plans for the target sampling interval. Generally, pumps are either placed in the middle of the saturated zone if the water level is below the top of the screen or in the middle of the screen interval if the water level is above the top of the screen.

(c) The need for redevelopment of the monitoring wells should be evaluated periodically in accordance with the project-specific requirements. This is assessed by comparing the measured total depth of the well with the constructed depth. If the measured depth is less than the constructed depth, this may indicate siltation of the well and/or the presence of an obstruction in the well. If it is determined that redevelopment is necessary, it should be performed in accordance with ECR SOP 006, *Well Development.* The time necessary for a well to restabilize after redevelopment will be determined on a project-specific basis and may depend on regulatory requirements.

(d) During the total well depth measurement, there is the potential for sediment, if present at the bottom of the well, to be disturbed, thereby increasing the turbidity of the groundwater. Therefore, the total well depth measurement should be collected the day prior to collecting groundwater samples, if possible.

(e) Use caution if using compressed gas cylinders (e.g., nitrogen, carbon dioxide) for purging/sampling of groundwater. Check for leaks around regulator connections by spraying soapy water on the connections. If a leak is discovered, the connection to the regulator should be disassembled, wrapped with Teflon® tape, and reconnected to the cylinder. If the leak continues, the regulator should be replaced. It should be noted that Department of Transportation (DOT) regulations apply to the transportation and handling of compressed gas cylinders (see 49 Code of Federal Regulations [CFR] 171). Never transport cylinders with the regulator attached. Replace the cylinder valve cover on the compressed gas cylinder before transport.

(f) All field personnel must be made aware of the water level measurement reference point being used for each well at a site (i.e., must be clearly marked) in order to ensure collection of comparable data between events.

(g) Bolt cutters may be necessary to remove rusted locks. Dipping rusted locks in a soapy solution may help with opening difficult locks. Oils and other products containing VOCs (e.g., WD-40) should not be used on locks as these compounds may cause contamination of water samples collected at the well. Replace cut locks and note in the field book.

(h) Prior to accessing the well, physical conditions around the well head should be assessed for situations that might result in cross-contamination or the introduction of foreign material/debris into the well. For example, flush-mounted wells may have water or road sand/salt/debris inside the curb box. Rodents and insects (e.g., bees, wasps) have been known to construct nests within the protective casing of a well. If bees, wasps, or other insects are encountered, insecticides should be used with caution as the chemicals may cause contamination of water samples collected at the well. If water or foreign material is introduced into the well, the Project Manager should be immediately notified.

1.6.2 General Purging and Sampling Issues

(a) Prior to installation of a submersible pump into a well, ensure that the tubing is properly sealed to the pump to avoid losing the pump down the well and to prevent escape of air or water from the pump, which could result in poor pump performance and the aeration of the well water. Do not do this by tugging on tubing. Never lower pumps into the well using only tubing; instead a security line attached to the pump is required to prevent potentially losing the pump down the well.

(b) A submersible pump should not be lowered to the bottom of the well to avoid stirring up any sediment at the bottom of the well and prevent getting the pump stuck (fine sediment accumulation in the bottom of the well can create a strong suction with a flat bottom pump such as a bladder pump, which may require jetting to retrieve the pump).

(c) Start with the lowest pumping rate possible and increase until a sustainable rate is reached. Avoid high pumping rates (> 1 liter/min), as this could lead to damage of the well filter pack, if present. Where practical and/or possible, refer to previous sampling events to establish consistent flow rates.

(d) Some regulatory agencies may have concern about the use of peristaltic pumps when sampling for VOCs due to the potential for loss of VOCs during sampling and alteration of other water quality parameters such as pH and alkalinity. Samplers should review the requirements in the project-specific work plan and/or regulatory guidelines prior to performing the work. Explicit approval to use a peristaltic pump for the collection of VOCs may be required by the governing regulatory agency. An option may be to use the “soda straw” method to collect the VOC sample which does not allow the water to go through the pump head:

  (1) After purging the well with the peristaltic pump, collect all fractions except VOCs from the outlet side of the pump (i.e., VOCs will be collected last instead of first).
  (2) Turn the pump off.
  (3) Change into clean gloves.
  (4) Disconnect the tubing coming out of the well from the inlet side of the pump and immediately put a finger over the end of this tubing to prevent water from draining out of the tubing.
  (5) Retrieve tubing from the well, coiling it in one hand as it is being retrieved (maintain finger over end of tubing).
  (6) Open VOC vials. Briefly remove finger from end of tubing to allow water to flow into vial. Replace finger on end of tubing to stop flow. Do this for remaining VOC vials.

(e) In the event that a well cannot be purged and sampled with a pump, the alternative to pumping may be the use of a bottom-filling bailer. The applicable regulatory agency requirements and the Project Manager should be consulted if in doubt about the appropriateness of using a bailer at a site or during a particular sampling event.

(f) During purging and sampling, the tubing should remain filled with water to minimize possible changes in water chemistry due to contact with the atmosphere. All flow-through cells should be shaded from direct sunlight to minimize the potential for off-gassing and temperature fluctuations.

(g) Ensure monitoring instruments (i.e., multi-parameter water quality instrument, turbidity meter, water level measuring device) are maintained in good condition and properly calibrated to ensure accurate readings. Be sure to have appropriate-sized extra batteries on hand.

(h) Adverse weather conditions may present challenges that need to be dealt with on a case-by-case basis. For example, air temperatures below 32°F may cause ice formation in the tubing, flow-through cell, and on the sampling equipment, or heavy rain could cause standing water issues with flush-mounted wells. Heavy rain can also impact electronic sampling equipment; preventative measures should be taken to keep electronic equipment dry.

(i) Observe and avoid any uncontrolled ambient/surrounding air conditions that could affect analytical results (e.g., truck/vehicle exhaust nearby, industrial building vents). Always ensure that vehicles are turned off during sampling to avoid introducing vehicle exhaust into the sample. If uncontrolled ambient/surrounding air conditions cannot be avoided, contact the Project Manager for further instruction; collection of a field blank sample may be warranted in this situation.

(j) Procedures should be established to minimize potential cross-contamination. For example:

- Wrap monitoring and sampling equipment with protective material (e.g., aluminum foil, polyethylene sheeting, Ziploc® bags) after decontamination and between sampling locations to minimize the potential for cross-contamination between well purging events at different locations.
- Use dedicated or disposable sampling equipment or new tubing at each sampling point when appropriate to minimize the need for decontamination.
- Protect sampling equipment and/or the open well head from blowing soil and dust by covering with plastic sheeting as needed.
- If a bailer and rope are used to purge and/or sample the well, then there is the possibility of contamination from the rope used to lower the bailer. New or dedicated rope should be used when appropriate. Alternatively, a decontaminated, Teflon®-coated stainless steel leader can be attached between the rope and the bailer. The leader acts as an extension to the rope and allows for the top of the bailer to enter the water column without immediately placing the rope into the water. It is important to keep the rope clean and not allow contact with the ground surface during bailing.

(k) Disposal of the groundwater collected during purging must be performed in accordance with all applicable regulations and the project-specific work plan.

(l) Clear tape should not be used to cover labels on containers used for certain analyses (e.g., 40-mL vials for VOC analysis) due to potential interference with analytical equipment.

(m) In cases where it is difficult to obtain sufficient sample volume for multiple analytical fractions as well as required quality control (QC) analyses (*e.g.*, field duplicates, matrix spike/matrix spike duplicate [MS/MSD] analyses), discuss this situation with the Project Manager and laboratory prior to sample collection. Laboratories can often "make do" with less volume, especially for inorganic parameters, or increase the reporting limit proportional to the sample volume obtained.

1.7 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project- and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project-specific work plan. These requirements may include:

- OSHA 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers
- 8-hour annual HAZWOPER refresher training.

2.0 PROCEDURES

Procedures for collecting groundwater samples from monitoring wells are described below. The project-specific work plan should also be consulted for specific details regarding sampling.

Sampling should always begin at the monitoring well with the least contaminated groundwater and systematically proceed to the well with the most contaminated groundwater, if possible.

2.1 Pre-sampling Activities

(a) It should be determined if there is the requirement to determine static water level measurements on all wells at the site prior to sampling, regardless if the well is being sampled.

(b) Prior to field activities, review historical groundwater sampling logs (if available) to maintain consistency for the current sampling event (e.g., equipment type, pump intake depth setting, flow rate, etc.)

(c) Organize monitoring, purging, and sampling equipment taking care not to allow cross-contamination. This can be accomplished by laying new polyethylene sheeting near the well or using new buckets, etc.

(d) Calibrate (or perform a calibration check on) all field monitoring equipment on the same day before collecting groundwater samples. Refer to TRC SOPs and manufacturer's equipment calibration instructions. A calibration check may also be required during or at the end of each sampling day. Consult the project-specific work plan.

(e) Unlock the well cover on the well.

(f) Record the sample location, time, and date in the field book and/or on the Groundwater Field Data Record.

(g) On the Groundwater Field Data Record, note the physical condition of the well, including damage, deterioration, and signs of tampering, if any. Collect photographic documentation of serious damage to present to the Project Manager.

(h) Open the well cap and expansion plug, and stay upwind of and not directly over the well. Note any unusual odors, sounds, or difficulties in opening the well and, if required, measure the organic vapor reading at the rim of the well with a suitable organic vapor screening device (e.g., PID or FID), and record the reading in the field book and/or on the Groundwater Field Data Record. If pressure or vacuum is noted or suspected in the well, allow sufficient time for the water level elevation in the well to equilibrate.

(i) Gently lower a clean, decontaminated water level measuring device into the well to determine the static water level. If appropriate for site conditions, check for the presence of LNAPL or DNAPL using an oil/water interface probe (refer to ECR SOP 004, *Water Level and Product Measurements*). If LNAPL or DNAPL is detected, contact the Project Manager before proceeding with purging and sampling activities. Record the information on depth to groundwater to the nearest 0.01 feet, depth to LNAPL or DNAPL, and/or thickness of NAPL in the field book and/or the Groundwater Field Data Record. Refer to ECR SOP 004, *Water Level and Product Measurements*, for proper procedures in performing these measurements.

(j) If required in the project-specific work plan, measure the depth to the bottom of the well to assist in calculating the well volume of the well. If possible, avoid making total well depth measurements on the same day as sampling due to the tendency to disturb sediment during this measurement. If NAPL is suspected, use a decontaminated oil/water interface probe. If the measured depth is less than the constructed depth, this may indicate that the well needs to be redeveloped (see ECR SOP 006, *Well Development*). Consult the project-specific work plan or Project Manager for further instructions.

2.2 Groundwater Purging Activities

Purging is conducted to ensure that representative groundwater is obtained from the water-bearing unit for analysis. The multiple-volume or low-flow purging approach may be used to remove water from the well and monitor the water in order to determine when a well has been adequately purged (i.e., stabilized); at a minimum, the pH, specific conductance and temperature of the groundwater removed during purging should be monitored and recorded in the field notes. Other parameters may be required in some regulatory jurisdictions (e.g., turbidity). Additionally, the purge volume should be monitored and recorded. In some instances, such as when monitoring at solid waste disposal facilities, simply removing an adequate volume of water (e.g., three well volumes) may be suitable for adequate purging, and sampling can commence. Check with the project-specific work plan and appropriate regulatory guidance to determine any specific purging requirements.

If the well has been previously sampled consistent with this SOP, then the prior purging strategy (e.g., method, pump intake depth and the flow rates) should be followed during subsequent sampling events to maintain consistency and minimize potential variability due to the sampling procedure.

2.2.1 Multiple-Volume Purging Approach

The multiple-volume purging approach is typically performed using bailers or submersible or peristaltic pumps. In the multiple-volume purging approach, there are two measurements used to determine adequate purge volume removal prior to sample collection: 1) purge volume and 2) field parameter stabilization. The field parameters should be recorded at regular volumetric intervals. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the calculated purge volume is small, the measurements should be taken frequently enough (e.g., every 3 to 5 minutes) to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes may be sufficient.

Purge Volume
Prior to purging a well, the amount of water inside the well riser and well screen (i.e., water column) should be determined, if possible. To do this, the diameter of the well should be determined and the water level and total depth of the well should be measured and recorded. The specific methodology for obtaining these measurements is included in ECR SOP 004 *Water Level and Product Measurements.*

Once this information is known, the well volume can be calculated using Equation 1:

Well Volume (V) = πr^2 h (cf) **Equation 1**
where:
π = pi (3.14)
r = radius of well in feet (ft)
h = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3.

The volume in gallons/linear foot (gal/ft) and liters/linear foot (L/ft) for common-size wells are as follows:

Well Inside Diameter (inches)	Volume (gal/ft)	Volume (L/ft)
1	0.0408	0.1529
2	0.1631	0.6174
3	0.3670	1.3892
4	0.6524	2.4696
6	1.4680	5.5570

If the volumes for the common-size wells above are utilized, Equation 1 is modified as follows:

Well volume = (h)(f) **Equation 2**
where:
h = height of water column (feet)
f = the volume in gal/ft or L/ft

For volumetric purging, an adequate purge is typically achieved when 3 to 5 well volumes have been removed. The field notes should reflect the single-well volume calculations or determinations according to one of the above methods and a reference to the appropriate multiplication of that volume, (i.e., a minimum of 3 well volumes) clearly identified as a purge volume goal.

For volumetric purging, it is suggested that field readings are collected every ½ well/well screen volume after an initial 1 to ½ well volumes are purged. The volume removed between readings can be adjusted as well-specific information is developed.

If removing a specified volume of water (e.g., 3 well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume. In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection. If, after 3 well volumes have been removed, the field parameters have not stabilized (see discussion in Section 2.2.3), additional well volumes (up to a total of 5 well volumes), should be removed. If the parameters have not stabilized within five well volumes, it is at the discretion of the Project Manager whether or not to collect a sample or to continue purging. If, after 5 well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible with respect to turbidity. The conditions of sampling should be noted in the field book.

2.2.2 Low-flow Purging Approach

The low-flow purging approach is typically performed using peristaltic pumps or submersible pumps. Low-flow purging (also referred to as low-stress purging, low-volume purging, or Micropurging®) is a method of well purging/sampling that minimizes the volume of water withdrawn from a well in obtaining a representative sample. The term low-flow refers to the low velocity with which water enters the pump intake during purging and sampling. The objective is to draw representative saturated zone water through the well screen to the pump intake while avoiding disturbance of the stagnant water above the well screen through minimizing drawdown of the water column in the well. To achieve this, the flow rate should be adjusted to less than 1 L/min (usually, this will be a rate less than 500 ml/min and may be as low as 100 ml/min). Once drawdown stabilizes, the sampled water is isolated from the stagnant water in the well casing, thus eliminating the need for its removal. This sampling method is based on the principle that water within the screened zone passes through continuously and does not mix with water above the screen. Water entering the pump can be considered representative of water in the formation after drawdown and indicator parameters have stabilized.

When performing low-flow purging and sampling, it is recommended that the pump intake be set in the center of the well screen interval (or center of the water column within the well screen if the water level is below the top of the well screen) to help prevent disturbance of any sediment at the bottom of the well. If known, the pump can be placed adjacent to the areas with the highest hydraulic conductivity or highest level of contaminants. Dedicated pumps can be utilized to minimize disturbance of the water column. Subsequent sampling events should duplicate as closely as possible the pump intake depth and the stabilized flow rate from the previous events.

To begin purging, the pump should be started at the lowest pressure/power flow rate setting (e.g., 100 mL/min) and then slowly increased until water begins discharging. Monitor the water level and slowly adjust the pump speed until there is little or no drawdown or drawdown has stabilized. The pump pressure/power may need to be increased for discharge to occur.

The stabilization of drawdown should be documented. Measure and record the flow rate and water level every 3 to 5 minutes during purging. The flow rate should be reduced if drawdown is greater than 0.3 feet over three consecutive 3 to 5 minute interval readings. Note any flow rate adjustments on the Groundwater Field Data Record. Once an appropriate purge rate has been achieved, record this information, continue purging until water quality indicator parameters have stabilized (see Section 2.2.3), and then sample the well.

Attempts should be made to avoid pumping a well dry. If drawdown cannot be maintained at less than 0.3 feet and the falling water level is approaching the top of the screened interval (or the top of the pump for sampling that began with the water level below the top of the screen), perform the following steps:

1. Reduce the flow rate, or turn the pump off and allow for recovery. (The pump must have a check valve to prevent backflow if it is shut off).
2. Begin pumping again at a lower flow rate.
3. If water draws down to the top of the screened interval again (or the top of the pump for sampling that began with the water level below the top of the screen), turn the pump off and allow for recovery.
4. If two tubing volumes (including volume of water in the pump and flow-through cell) have been removed during purging, sampling can proceed the next time the pump is turned on without waiting for indicator field parameters to stabilize. The project-specific work plan or Project Manager should be consulted for guidance.
5. If this procedure is used, this should be recorded in the field book and/or on the Groundwater Field Data Record.

2.2.3 Field Parameter Stabilization During Purging

Stabilization criteria may depend on project objectives or regulatory-specific requirements. Refer to Appendix A for some of the regulatory-specific requirements for field parameter stabilization. Generally, an adequate purge with respect to the ground water chemistry is achieved when, stability for at least three consecutive measurements is as follows:

- pH ± 0.1 standard unit (SU)
- specific conductance within 3%
- turbidity within 10% for values greater than 5 nephelometric turbidity units (NTUs). If three turbidity readings are less than 5 NTUs, the values are considered as stabilized

Other parameters, such as DO, may also be used as a stabilization parameter. Typical stabilization goals for DO are within 0.2 mg/L or 10% saturation, whichever is greater. DO measurements should be conducted using either a flow-through cell or an over-topping cell to minimize or reduce potential oxygenation of the sample.

Because groundwater temperature is generally not very sensitive in distinguishing between stagnant casing water and formation water and is subject to rapid changes during purging, its usefulness is subject to question for the purpose of determining parameter stability. Even if temperature is not used to determine stability during well purging, it is still advisable to record the sample temperature, along with the other groundwater chemistry parameters, during well purging, as it may be needed to interpret other parameter results.

ORP is not always used as a stabilization parameter since it may also be subject to rapid changes during the purging process; however, it may be measured and recorded during well purging.

2.2.4 Special Considerations During Purging

Wells Purged Dry/Purge Adequacy

For wells with slow groundwater recovery, attempts should be made to avoid purging the well dry. This may be accomplished by slowing the purge rate. As water enters a well that has been purged dry, the water may cascade down the sand pack and/or the well screen, potentially stripping VOCs that may be present and/or potentially mobilizing soil fines into the re-accumulating water column.

However, even with slower purge rates, in some situations, a well may be pumped or bailed dry (evacuated) during the purging process. In these situations, evacuation generally constitutes an adequate purge and the well may be sampled following sufficient recovery (enough volume to allow filling of all sample containers). **It is not necessary that the well be evacuated three times before it is sampled.** Purging parameters should be measured and recorded during sample collection to serve as the measurements of record for the sampling event.

It is particularly important that wells be sampled as soon as possible after purging to maintain sample representativeness. If adequate volume is available upon completion of purging, the well should be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. If possible, sampling of wells that have a slow recovery should be scheduled so that they can be purged and sampled in the same day after adequate volume has recovered. Wells of this type should, unless it is unavoidable, not be purged at the end of one day and sampled the following day.

Temporary Monitoring Wells

Procedures used to purge temporary groundwater monitoring wells may differ from permanent wells, because temporary wells are installed with different DQOs for immediate sample acquisition. Wells of this type may include standard well screens and risers placed in boreholes created by hand augering, power augering, or by drilling. Alternatively, they may consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15/16 sampler, or a Hydropunch® sampler.

Purging to address stagnant water may not necessarily apply to temporary wells, because stagnant water is not typically present. It is important to note, however, that the longer a temporary well is in place and not sampled, the more stagnant the water column may become, and the more appropriate it may be to apply, to the extent possible, standard permanent monitoring well purging criteria.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing saturated conditions, resulting primarily in increased turbidity. Therefore, the goal of purging, if conducted, may be to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low-stress purging techniques using variable-speed peristaltic pumps.

2.2.5 Equipment Considerations for Purging

Monitoring well purging is accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. The pump of choice is usually a function of the purging approach (e.g., multiple-volume vs. low-flow), well diameter, the DTW, the total depth of the well, the amount of water that is to be removed during purging, the specific analytical testing program for the well, and the equipment previously used during purging and sampling of the well. A peristaltic pump is appropriate for purging whenever the head difference between the sampling location and the water level is less than the limit of suction (approximately 25’ to 30’) and the volume to be removed is reasonably small. For wells where the water level is below the limit of suction, and/or where there is a large volume of water to be purged, the variable-speed electric submersible pump or adjustable-rate bladder pumps would be appropriate. Bailers may also be used for purging in appropriate situations (e.g., shallow wells with small purge volumes); bailers are not suitable for low-flow purging.

The following subsections describe well evacuation devices that are most commonly used. Other devices are available but are not discussed in this SOP due to their limited use. Site-specific operating procedures should be developed in the case that an uncommon purge device is used.

2.2.5.1 Purging with a Suction Pump

There are many different types of suction pumps. They commonly include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low-volume pump that incorporates a roller to squeeze flexible tubing, thereby creating suction. This tubing can be dedicated to a well for re-use or discarded. It is recommended that 1/4 inch or 3/8 inch (inner diameter) tubing be used to help ensure that the sample tubing remains filled with water and to prevent water from being aerated as it flows through the tubing. Purging procedures are as follows.

(a) Determine the volume of water to be purged as described in Section 2.2.1 or follow the low-flow approach described in Section 2.2.2 (applicable to peristaltic pumps only).
(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of pumps, tubing or other purging/sampling equipment with foreign materials.
(c) Assemble the pump, tubing and power source, if necessary, in accordance with manufacturer’s specifications.
(d) Ensure that the pump tubing is set at the pre-determined pump intake depth.
(e) Connect the discharge line from the pump to the flow-through cell for parameter measurements. Use a T-connection or valve prior to the flow-through cell to allow for collection of water for turbidity measurements. Direct the discharge line from the flow-through cell to a 5-gallon bucket (or equivalent) to contain the purge water for proper

disposal. Verify the end of the tubing is not submerged in the purge bucket. Manage purge water as specified in the project-specific work plan.

(f) Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, adjust the rate accordingly or, if consistent with the purging and sampling objectives, lower the tubing further into the well and continue pumping.

(g) Using the water quality meter, take an initial reading of the required indicator parameters. All measurements, except turbidity, must be obtained using a transparent flow-through cell unless an unforeseen situation makes this impractical or inadvisable. Initially, turbidity may be elevated. Once turbidity has decreased to a measurable range, begin monitoring indicator parameters at approximately every 3-5 minutes, or as appropriate. Please note that flow-through cell size should be taken into account in conjunction with the flow rate to determine the length of time between water quality parameter readings. At least one flow-through cell volume should be turned over between readings. For example, if the flow through cell size is 500 mL and the flow rate is 100 mL/min, then it would be appropriate to measure water quality parameters every 5 minutes.

(h) Record the readings on the Groundwater Field Data Record. The monitoring probes must be submerged in water at all times. Record the indicator parameters, along with the water level, as described in Step (g) above. If removing a specified volume of water (e.g., 3-5 well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume. In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection. Stabilization criteria are discussed in Section 2.2.3.

Particulate build-up in the flow-through cell may impact indicator parameters. If the cell must be cleaned during pumping operations, continue pumping and disconnect the cell for cleaning, then reconnect and continue monitoring. Record the start and stop times, and describe the cleaning steps in the field book.

If indicator parameter stabilization is required and parameters have not stabilized after 2-hours of purging (or other pre-determined length of time), one of three options may be taken after consultation with the Project Manager:

1) continue purging until stabilization is achieved;
2) discontinue purging, do not collect any samples, and record in the field book and/or on the Groundwater Field Data Record the stabilization conditions and steps taken to attempt to achieve stabilization; or,
3) discontinue purging, collect samples and document attempts to achieve stabilization.

NOTE: If parameters do not stabilize, or turbidity remains greater than 5 NTU within the project-determined time range (EPA recommends up to 2 hours), contact the Project Manager to develop a modified sampling approach.

(i) Record the volume of water purged on the Groundwater Field Data Record. Record the disposal method used for purge water in the field book.

(j) Once the required volume of water is removed (typically 3 to 5 well volumes) from the well and/or parameters are stabilized to the satisfaction of the project-specific work plan, proceed to Section 2.3, Post-purging Groundwater Sample Collection.

2.2.5.2 Purging with a Submersible Pump

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas. Electric pumps can be powered by a 12-volt DC rechargeable battery, or a 110- or 220-volt AC power supply. Those units powered by compressed gas (e.g., bladder pump) normally use a small electric controller that also needs a 12-volt DC battery or 110-volt AC power. They may also utilize compressed gas from bottles. Pumps differ according to the depth and diameter of the monitoring wells and the height of the potentiometric surface/water table (e.g., pressure head). It is recommended that 1/4-inch or 3/8-inch (inner diameter) tubing be used to help ensure that the sample tubing remains filled with water and to prevent water from being aerated as it flows through the tubing. Purging procedures are as follows.

(a) Determine the volume of water to be purged as described in Section 2.2.1 or follow the low-flow approach described in Section 2.2.2.

(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of pumps, tubing or other purging/sampling equipment with foreign materials.

(c) Assemble the pump, tubing and power source, if necessary, in accordance with manufacturer's specifications. If the pump itself is being lowered into the well, ensure a safety line is attached.

(d) Non-dedicated purge/sampling vs. dedicated purge/sampling systems.

<u>Dedicated systems:</u> Pump has already been installed. Refer to historical monitoring well information, and record the depth of the pump intake in the field book and/or on the Groundwater Field Data Record.

<u>Non-dedicated systems:</u> Determine the target depth of the pump intake. Note that this may be a historical intake depth; see well construction data or the project-specific work plan. If there is not an established intake depth, the center of the screened interval should be targeted. If the measured water level is lower than the top of the well screen, position the pump intake at the midpoint of the water column. The intake should be generally 1 to 2 feet above the bottom of the well to minimize potential mobilization of any settled sediment, the risk of the pumping suction being broken, or the entrainment of air in the pump tubing and resulting sample. Slowly lower the pump, safety line, and tubing into the well to the pre-determined pump intake depth. The tubing should be cut to the desired length to assist in installing the pump. Measure the depth of the pump intake while lowering the tubing/pump into location. Record the pump intake depth in the field book and/or on the Groundwater Field Data Record. For deeper wells and large diameter wells, two staff members may be necessary to accomplish this task.

(e) Connect the discharge line from the pump to the flow-through cell for parameter measurements. Use a T-connection or valve prior to the flow-through cell to allow for collection of water for turbidity measurements. Direct the discharge line from the flow-through cell to a 5-gallon bucket (or equivalent) to contain the purge water for proper disposal. Verify the end of the tubing is not submerged in the purge bucket. Manage purge water as specified in the project-specific work plan.

(f) Measure the flow rate of the pump with a graduated container and stop watch. The pump pressure may need to be increased for discharge to occur. Record the volume of water collected for a period of 1 minute and calculate the flow rate as follows.

$$Flowrate\,(mL\,/\,min) = \frac{volume\ collected\ (mL)}{1\,minute}$$

(g) Measure the water level and record the flow rate and the water level. This should be performed every 3 to 5 minutes during purging. For low-flow purging, the flow rate should be adjusted to result in a rate between 100 to 500 mL/min; however, if drawdown of the well is observed, a slower flow rate may be necessary. If using a bladder pump, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL volatile organic analysis (VOA) vial, if possible.

(h) Prior to recording the water quality indicator parameters, a minimum of one tubing volume should be purged. Note that this includes the volume of the flow-through cell.

(i) Proceed to steps (g) through (j) in Section 2.2.5.1.

2.2.5.3 Purging with a Bailer

(a) Determine the volume of water to be purged as described in Section 2.2.1.

(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of tubing or other purging/sampling equipment with foreign materials.

(c) Use a well-dedicated bailer (i.e., used exclusively for that well only), a decontaminated bailer or an unused, disposable bailer.

(d) Attach an appropriate length of (a) bailing line, (b) Teflon®-coated bailing wire or (c) rope with Teflon®-coated stainless steel leader to reach the bottom of the well. Secure a knot or series of knots to the top of the bailer. Be sure to have additional length of line to facilitate handling of the bailer at the surface (typically 10 ft).

(e) Lower the bailer gently into the well until it reaches the water column and fills with water from the bottom. Note: It is recommended that the bailer be lowered into the water to a depth that prevents the water from entering the top of the bailer. This is done to prevent excess turbulence caused by filling from the bottom and the top simultaneously. Controlling the line attached to the bailer as it is lowered into the well is also important to prevent degassing of the water as the bailer impacts the water. In shallow wells, controlling the line is not too difficult; however, for wells of greater depths it is common to utilize a hand-over-hand (windmill) approach using both hands to control longer lengths of line and prevent the loops in the line from tangling with one another. This procedure is simple to learn and saves a good deal of time by preventing tangles. Do not allow the bailing line or rope to become contaminated by surface soil.

(f) Once the bailer is full of water, gently withdraw the bailer from the well until it comes out of the top of the well. Be sure to control excess line in your hands to prevent the rope and bailer from touching the ground, and then grasp the bailer as it appears at the top of the well.

(g) Immediately pour the water into a vessel for water quality measurements, and record the measurements in the field book or on the Groundwater Field Data Record (at the project-required frequency). Otherwise, pour water into a 5-gallon bucket or other vessel to track the volume purged. As a general rule, standard 2-inch bailers are able to hold about 1 liter of water when full. This process will have to be repeated several times to complete adequate purging of the well (e.g., three to five well volumes).

(h) Record the volume of water purged on the Groundwater Field Data Record. Record the disposal method used for purge water in the field book.

(i) Once the required volume of water is removed (typically 3 to 5 well volumes) from the well and/or parameters are stabilized to the satisfaction of the project-specific work plan, proceed to Section 2.3, Post-purging Groundwater Sample Collection.

2.3 Post-purging Groundwater Sample Collection

(a) New, disposable gloves should be donned immediately prior to sample collection and should be changed at any point that their cleanliness becomes compromised during sample collection.

(b) If using a submersible or peristaltic pump, maintain the same flow rate as used during purging. Disconnect the pump tubing from the flow-through cell or sample from the T-connector, if used. Samples must be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. This is critically important to avoid cross-contamination between wells.

(c) If using bottom-filling bailers,

- Slowly lower the bailer into the well until it is submerged to the point where water does not enter the top (i.e., bottom-filling).
- Retrieve the bailer. The first bailer recovered after well purging must be used for sample collection.

2.3.1 Sample Collection Order

Fractions of the groundwater sample should be collected in the following order (i.e., decreasing volatility) unless otherwise specified in the project-specific work plan:

1. VOCs;
2. Semivolatile organic compounds (SVOCs);
3. Other organic parameters;
4. Unfiltered inorganic constituents (e.g., total metals);
5. Filtered inorganic constituents (e.g., dissolved metals); and
6. Other constituents.

During sample collection, allow the water to flow directly down the side of the sample container without allowing the tubing to touch the inside of the sample container or lid in order to minimize aeration and turbulence and maintain sample integrity. The tubing should remain filled with water.

2.3.2 VOC Sample Collection

<u>Collection of VOCs/Volatile Petroleum Hydrocarbons (VPH):</u> Samples for VOCs will be collected first unless they are being collected by the “straw” method described in Section 1.6.2 (d), and the sample vial must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, the vial should be topped off using a minimal amount of sample to re-establish the

meniscus. Care should be taken to not flush any preservative out of the vial when topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected. Note: Extra VOC vials should be obtained prior to the sampling event in case this situation occurs.

Note: When using a bladder pump, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 ml VOA vial, if possible.

When acid preservation is used for the collection of VOCs, the acid must be added to the vials before sample collection. However, in most cases 40-ml VOA vials come pre-preserved. If a pre-preserved vial effervesces upon the addition of sample, the acid preservative can be rinsed out of the vial with sample water and then used to collect the sample. The laboratory should be made aware that the affected sample will not be acid-preserved as this may affect the sample holding time. Note effervescence in the field book for future reference.

2.3.3 Non-VOC Sample Collection

Completely fill the remaining sample containers for all non-VOC analyses.

Preserve the non-VOC samples in accordance with method and project-specific requirements following sample collection if the sample containers are not pre-preserved. (**NOTE:** Pre-preserved vials may be supplied by the laboratory, depending on the program).

2.3.4 Field Filtering

Depending upon project requirements, field filtering may be performed for non-VOC analyses. An in-line filter should be fitted at the end of the discharge tubing and the sample should be collected after the filter. Pre-rinse the in-line filter by allowing a minimum of 0.5 to 1 liter of groundwater from the well to pass through the filter prior to sampling. Ensure the filter is free of air bubbles prior to collecting samples. Preserve the filtered water sample immediately or directly fill pre-preserved containers (if provided). Clearly note “filtered” or “dissolved” on sample label and COC document.

2.4 Groundwater Sample Collection Without Purging (Passive Sampling)

Passive sampling can be defined as the free flow of contaminants from the media being sampled to a receiving phase in a sampling device. Depending upon the sampler, the receiving phase can be a solvent (e.g., water), chemical reagent, or porous adsorbent (e.g., activated carbon). While there are many different types of passive samplers, most have a barrier between the medium being sampled and the receiving phase. The barrier determines the sampling rate that contaminants are collected at a given concentration and can be used to selectively permit or restrict various classes of chemicals from entering the receiving phase.

There are three generic forms of passive (no purge) samplers: thief (grab) samplers, diffusion (equilibrium) samplers, and integrating (kinetic) samplers. However, this SOP focuses on the more commonly used diffusion (equilibrium) samplers.

Passive samplers are deployed down a well to the desired depth within the screened interval or open borehole to obtain a discrete sample without using pumping or a purging technique. Most samplers are able to be stacked to obtain samples at multiple depths. Some samplers can also be used to measure contaminants in groundwater as it enters a surface water body.

Diffusion, or equilibrium, samplers are devices that rely on diffusion of the analytes to reach equilibrium between the sampler fluid and the well water. Samples are time-weighted toward conditions at the sampling point during the latter portion of the deployment period. The degree of weighting depends on analyte and device-specific diffusion rates. Typically, conditions during only the last few days of sampler deployment are represented. Depending upon the contaminant of concern, equilibration times range from a few days to several weeks. Diffusion samplers are less versatile than grab samplers as they are not generally effective for all chemical classes.

Both the diffusion and integrating samplers depend upon permeation or diffusion through barriers that hold the receiving phase. This diffusion process is chemical and barrier specific. Diffusion samplers are commonly known as PDBs or rigid porous polyethylene (RPP) samplers. PDBs may be used to sample for VOCs, and RPPs may be used to sample for various organic and inorganic constituents. PDBs must be allowed to remain in the well for a sufficient period of time to allow the deionized water in the sampler to come into equilibrium with the constituents in the ambient groundwater.

Some regulatory agencies allow groundwater samples to be collected without purging the well. This may be accomplished by suspending a passive sampler in the well for a period of time appropriate for the type of passive sampler being used. It is important to confirm that the chosen sampler is compatible with the contaminants of concern including all VOCs of interest at the site.

Diffusion passive samplers are used most commonly and the procedure for their use is as follows:

(a) Passive samplers are deployed at a predetermined depth across the well screen. Typically, the initial sampling event may deploy multiple passive samplers across 5-foot intervals of saturated well screen to observe any potential stratification. Long-term sampling depths typically target a zone of higher concentration, if present.

(b) New passive samplers are attached via PVC cable ties to a tether (a pre-made marine-grade polyethylene rope or stainless steel cable with a weight at the bottom) that is then suspended within the well. There should be sufficient well screen saturation within the well to completely cover the passive sampler. For VOCs, it is recommended that there should be several feet of groundwater above the top of the PDB.

(c) The passive sampler should be allowed to equilibrate with groundwater for an appropriate period of time (e.g., at least 2 weeks for PDB samplers). Longer equilibration times may be necessary in lower permeability formations. Once sufficient time for equilibration has passed, the PDB samplers can be retrieved when convenient.

(d) Raise the passive sampler to the surface using a tether reel. Examine the surface of the passive sampler for evidence of algae, iron, or other coatings, and for tears to the membrane. Note observations in the field book. If tears are present and water is leaking out, the sample is not considered viable. Contact the Project Manager.

(e) Detach the passive sampler from the tether.

(f) Remove excess beaded water from the passive sampler with a clean gloved hand, running top to bottom; this is to minimize the contact of beaded water with water in the passive sampler.

(g) Use a small diameter discharge tube (<0.15 inch diameter to reduce volatilization) and pierce near the bottom, allowing water to smoothly flow into the VOA vial. Tilting the passive sampler will control the flow rate. The VOA vials must be filled within the first several minutes of passive sampler retrieval. (Note that sample vials should be prepared and opened on a stable surface or holding device such as a foam pack. Decanting sample from passive samplers into containers requires techniques that may require some practice and patience.) Refer to Section 2.3.2 for special circumstances regarding the filling of VOA vials.

(h) A small amount of water may remain within the passive sampler after filling the VOA vials and can be used for field parameter measurements if required.

(i) Dispose of the passive sampler after use.

2.5 Post-sampling Activities

(a) Cease pumping and, if system is non-dedicated, disassemble and decontaminate the purging and sampling equipment. Verify the end of the tubing is not submerged in the purge bucket prior to turning off the pump.

(b) Dispose of the bailer (if disposable) and/or rope and/or other disposable equipment in accordance with the project-specific work plan, or store the bailer in a plastic bag for transport to the site decontamination area.

(c) Dispose of the empty passive sampler and/or rope and/or other disposable equipment in accordance with the project-specific work plan, or store the empty passive sampler in a plastic bag for transport to the site decontamination area

(d) Replace the well cap and well cover on the well and lock the outer casing (if present).

(e) Label each sample. If the labels are covered with clear tape, ensure this is not performed for VOA vials.

(f) Place all samples in a cooler with ice.

(g) Ensure samples are delivered to the laboratory well before the required holding time expires.

(h) Consult the project-specific work plan to determine if a calibration check is required at the end of the day for the water quality parameters.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager.

Each project must consider investigation-derived waste disposal methods and have a plan in place prior to performing the field work. Provisions must be in place as to what will be done with investigation-derived waste. If investigation-derived waste cannot be returned to the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The collection of QC samples is dependent upon the DQOs. Project-specific work plans should be consulted to determine the required frequency of QC sample collection.

4.1 Field Duplicates

The following procedures should be used for collecting field duplicates of groundwater samples:

(a) For QC purposes, each duplicate sample will be typically submitted to the laboratory as a “blind” duplicate sample, in that a unique sample identification not tied to the primary sample identification will be assigned to the duplicate (e.g., DUP-01). Standard labeling procedures used for groundwater sampling will be employed. However, a sample collection time will not be included on the sample label or the COC form. The actual source of the duplicate sample will be recorded in the field book and/or on the Groundwater Field Data Record.

(b) Each duplicate sample will be collected simultaneously with the actual sample by alternately filling sample and duplicate bottles. Following the order of collection specified for each set of containers (VOCs, SVOCs, other organic parameters, unfiltered inorganic constituents, and filtered inorganic constituents), the duplicate sample containers will be alternately filled with groundwater for each parameter.

(c) All collection and preservation procedures outlined for groundwater sampling will be followed for each duplicate sample.

4.2 Equipment Blanks

Equipment blanks include reagent water that is run through the bailer (if not disposable), rope, leader line, decontaminated pump, a representative section of the pump’s tubing, or any other piece of sampling equipment that may have come in contact with the sample. The equipment blanks are collected and preserved in the same sample containers as field samples. If dedicated or disposable systems are used, equipment blanks are not required, although an initial blank could be performed to demonstrate that the dedicated equipment is clean prior to use. If only dedicated tubing is used, the equipment blank will include only the pump in subsequent sampling events. A passive sampler is considered a dedicated device and no equipment blank is required.

Ideally, the reagent water should come from the laboratory and be certified clean. If not certified and/or if not from the laboratory performing the analyses, a separate water blank that has not run through the sampling equipment should be sent to the laboratory for analysis.

4.3 Trip Blanks

Trip blanks will be used to check for potential contamination of VOCs via migration during storage and shipping. Trip blanks typically consist of two to three 40 mL VOA vials filled with analyte-free water and preserved with hydrochloric acid (HCl) to pH <2 SU. Trip blank containers are usually supplied pre-filled by the laboratory. Trip blanks are typically submitted to the laboratory at a frequency of one per cooler for coolers that contain samples for VOC and/or VPH analysis. Trip blanks are analyzed by the laboratory for VOCs and/or VPH, depending on field sample analyses.

4.4 Field Blanks

Field blanks consists of analyte free water exposed to the atmosphere during field sample collection. The water is containerized in an appropriate bottle and preservative for the analytical suite and shipped to the laboratory with the other field samples. The results are used to assess whether or ambient/surrounding air conditions may have influenced analytical results.

4.5 MS/MSDs and MS/Duplicates

MSs are an additional analysis of a sample spiked by the laboratory with a subset or all of the target analytes and are used to demonstrate the accuracy of analytical methods for a given matrix. MSDs are an additional analysis of a sample spiked with a subset or all of the target analytes and are also used to demonstrate the accuracy of analytical methods for a given matrix. MS/MSDs also provide a measure of analytical precision for a given matrix. Duplicates are an additional analysis of a sample and are used to demonstrate the precision of analytical methods for a given matrix.

Triplicate volumes of a field sample must be collected in order for the laboratory to have enough volume to perform the MS/MSD analyses for organic parameters. Duplicate volumes of a field sample must be collected in order for the laboratory to have enough volume to perform MS/Duplicate analyses for inorganic parameters. The sample designated for MS/MSD or MS/Duplicate analyses should be noted in the Comments column of the COC document.

4.6 Temperature Blanks

Temperature blanks consist of a sample container filled with non-preserved water (potable or distilled) and typically are included in all coolers that contain samples that require temperature preservation. These may be added to the coolers by the field team if not provided by the laboratory. Temperature blanks must remain inside the coolers on ice during the sampling process.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

Record the sample location, sample identification, and date and time of collection in the field book and/or the Groundwater Field Data Record. The Groundwater Field Data Record (Attachment B) should be used to record the following information:

- Volume of each sample

- Sample identification number
- Sample location (sketch of the sample point)
- Time and date sample was collected
- Personnel performing the task
- Volume of water removed
- Purging time
- Flow rate during purging and sampling
- Weather conditions during sampling
- Field parameters such as water level, pH, temperature, conductivity, turbidity, ORP, and DO
- Sample collection equipment and method used
- Decontamination procedures
- Analytical parameters
- Preservation method and amount of preservative

All sample numbers must be documented on the COC form that accompanies the samples during shipment. Any deviations from the records management procedures specified in the project-specific work plan must be approved by the Project Manager and documented in the field book.

6.0 REFERENCES

Interstate Technology Regulatory Council (ITRC). March 2006. *Technology Overview of Passive Sampler Technologies.*

USEPA. November 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance*. EPA/530-R-93-001. USEPA Office of Solid Waste.

USEPA. April 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA Ground Water Issue. EPA/540-S-95-504. USEPA Office of Solid Waste and Emergency Response.

USEPA. May 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. EPA/542-S-02-001. USEPA Office of Solid Waste and Emergency Response.

USEPA. September 2004. Field Sampling Guidance Document #1220: Groundwater Well Sampling. USEPA Region 9 Laboratory Richmond, California.

USEPA, January 19, 2010. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells*. USEPA Region 1, Rev. 3.

USEPA. March 6, 2013. *Groundwater Sampling.* SESDPROC-301-R3. USEPA Region 4, Science and Ecosystem Support Division. Athens, Georgia.

USEPA. April 22, 2014. Passive (No Purge) Samples.
http://www.clu-in.org/characterization/technologies/default.focus/sec/Passive_%28no%20purge%29_Samplers/cat/Overview/

7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
0	AUGUST 2014	NOT APPLICABLE
1	JULY 2016	ADDED ATTACHMENT D TO ACCOMMODATE SOP MODIFICATIONS REQUIRED WHEN SAMPLING FOR PFCS; CHANGED NAMING CONVENTION FOR SOP FROM RMD TO ECR.
2	NOVEMBER 2016	ADDED ADDITIONAL INFORMATION REGARDING PFAS.
3	JANUARY 2020	TRC RE-BRANDING; ADDED FIELD BLANKS TO SECTION 4

Attachment A:

Groundwater Field Parameter Stabilization Criteria for Selected Jurisdictions

Jurisdiction	Information Source	Applicable Stabilization Criteria
USEPA Region 1	Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells; U.S. Environmental Protection Agency Region 1, January 19, 2010. http://www.epa.gov/region1/lab/qa/pdfs/EQASOP-GW001.pdf (for low flow PDF) http://www.epa.gov/region1/lab/qa/qualsys.html (for EPA's Quality System Documents)	pH: ±0.1 unit Specific Conductance: ±3% Temperature: ±3% Turbidity: ±10% if >5 NTUs; if three Turbidity values are <5 NTU, consider the values as stabilized Dissolved Oxygen: ±10% if >0.5 mg/L, if three Dissolved Oxygen values are <0.5 mg/L, consider the values as stabilized Oxidation/Reduction Potential: ±10 millivolts
USEPA Region 2	Groundwater Sampling Procedure: Low Stress (Low Flow) Purging and Sampling, SOP # SST-7, Revision No. 1, November 2010.	Same as above
USEPA Region 4	USEPA Region 4 SOPs: http://www.epa.gov/region4/sesd/fbqstp/index.html See Chemical Parameter Stabilization Criteria (section 3.2.1.1.2 of Groundwater Sampling SOP, revision 3/6/2013: http://www.epa.gov/region4/sesd/fbqstp/Groundwater-Sampling.pdf	pH: ±0.1 unit Specific Conductance: ±5% Temperature: Not used Turbidity: "Stabilized" (no criteria specified) if >10 NTUs ; if three Turbidity values are <10 NTUs, consider the values as stabilized Dissolved Oxygen (optional parameter): ±0.2 mg/L or ±10% of saturation, whichever is greater Oxidation/Reduction Potential: Not used
USEPA Region 5	Ground Water Forum Issue Paper (May 2002, Yeskis and Zavala) http://www.epa.gov/superfund/remedytech/tsp/download/gw_sampling_guide.pdf A minimum set of parameters would include pH, conductivity, and turbidity or DO. Puls and Barcelona, 1996 (pH, specific conductance, ORP, turbidity) Wilde et al., 1998 (pH, turbidity, DO)	pH: ±0.1 unit Specific Conductance: ±3% Temperature: Not used Turbidity: ±10% if >10 NTUs Dissolved Oxygen: ±0.3 mg/L Oxidation/Reduction Potential: ±10 millivolts
USEPA Region 9	See USEPA Region 1 (above)	
USEPA Region 10	See USEPA Region 5 (above)	
Alabama	Alabama Environmental Investigation and Remediation Guidance (section C.3.1) http://www.adem.state.al.us/MoreInfo/pubs/AEIRGInvestigation.pdf	pH: ±0.1 unit Specific Conductance: ±10% Temperature: "Constant" (no criteria specified) Turbidity: Stabilized (no criteria specified), or <10 NTUs Dissolved Oxygen: No criteria specified Oxidation/Reduction Potential: No criteria specified

Jurisdiction	Information Source	Applicable Stabilization Criteria
Indiana	Indiana Department of Environmental Management The Micro-Purge Sampling Option http://www.in.gov/idem/files/remediation_tech_guidance_micro-purge.pdf The parameters normally measured for stability (listed in increasing order of sensitivity) are pH, temperature, specific conductivity, oxidation-reduction potential, DO and turbidity. At least one of the last three listed must be used.	pH: ±0.1 unit Specific Conductance: ±3% Temperature: ±3% Turbidity: ±10% Dissolved Oxygen: ±10% Oxidation/Reduction Potential: ±10 millivolts (document says microvolts, but that may be an error)
Michigan	MDEQ Part 201 Op Memo 2, Attachment 5 http://www.michigan.gov/documents/deq/deq-rrd-OpMemo_2_Attachment5_249853_7.pdf	No specific values to determine stabilization are listed, but the Op Memo lists several other groundwater sampling guidance documents. If a valid reference exists, then it can be used to justify a sampling approach and stabilization parameters.
New Jersey	New Jersey Department of Environmental Protection http://www.state.nj.us/dep/srp/guidance/fspm/	pH: ± 0.1 unit Specific Conductance: ± 3% Temperature: ± 3% Dissolved Oxygen: ± 10% Turbidity: ± 10% for values greater than 1 NTU ORP/Eh: ± 10 millivolts
Ohio	Ohio EPA SOPs: http://www.epa.state.oh.us/portals/30/rules/FSOPs.pdf See Purging Stabilization Criteria (SOP 2.2.4, dated January 2, 2007, review in progress)	pH: ±0.1 unit Specific Conductance: ±3% Temperature: No criteria specified Turbidity: Below 10 NTUs ideal; ±10% if greater than 10 NTUs Dissolved Oxygen: ±0.3 mg/L Oxidation/Reduction Potential: ±10 millivolts
This table was last updated in July 2014.		

Attachment B:

Example Groundwater Field Data Records

TRC

Groundwater Field Data Record

Project: **Project No.:** **Date/Time:** **Sheet ___ of ___**

TRC Personnel: **Well ID:**

WELL INTEGRITY

	YES	NO
Protect. Casing Secure	☐	☐
Concrete Collar Intact	☐	☐
PVC Stick-up Intact	☐	☐
Well Cap Present	☐	☐
Security Lock Present	☐	☐

Sampling Equipment: ___

Flow-thru Cell Volume: ___

PID SCREENING MEAS.

Background	
Well Mouth	

Protective Casing Stick-up ___ ft. (from ground)

Riser Stick-up (from ground) ___ ft.

WELL DIAMETER ☐ 2 inch ☐ 4 inch ☐ 6 inch
Other: ___

WELL MATERIAL
☐ PVC ☐ SS
Other: ___

Well Depth ___ ft. ☐ top of riser ☐ top of casing ☐ ___ ☐ measured ☐ historical

Water Depth ___ ft.

LNAPL/DNAPL Depth = ___

NAPL Thickness = ___

Well Volume___

Depth of pump intake: ___

Static water level after pump put into well:

Initial purge Rate/ Water Level (100-400 ml/min):

Adjusted purge Rates/time/WL(record changes)

Flow rate at time of sampling:

Total volume of water purged:

FIELD WATER QUALITY MEASUREMENTS (record at appropriate intervals)

Time									
Temp. (°C)									
Conduct. (µmhos/cm)									
DO (mg/L)									
pH (su)									
ORP (millivolts)									
Turbidity (NTU)									
Flow (ml/min)									
Depth To Water (ft)									
Cumulative Purge Vol. (gal or L)									

Time					
Temp. (°C)					
Conduct. (µmhos/cm)					
DO (mg/L)					
pH (Std. Units)					
Eh/ORP (millivolts)					
Turbidity (NTU)					
Flow (ml/min)					
Depth To Water (ft)					
Cumulative Purge Vol. (gal or L)					

Stabilization Criteria*
<u>(3 consecutive readings)</u>
- Temperature: ± 3 %
- Conduct. (µmhos/cm): ± 3 %
- DO (mg/L): ± 10 % (for values >0.5 mg/L)
- pH (Std. Units): ± 0.1 SU
- ORP (millivolts): ± 10 mV
- Turbidity (NTU): +/- 10 % (for values >5.0 NTUs)
- Drawdown: < 0.3 ft (can be greater as long as water level stabilizes above well screen)

	Purge	Sample
Peristaltic Pump	☐	☐
Submersible Pump	☐	☐
Bladder Pump	☐	☐
Bailer	☐	☐
Other: ___	☐	☐

Comments: ___

___

___

___

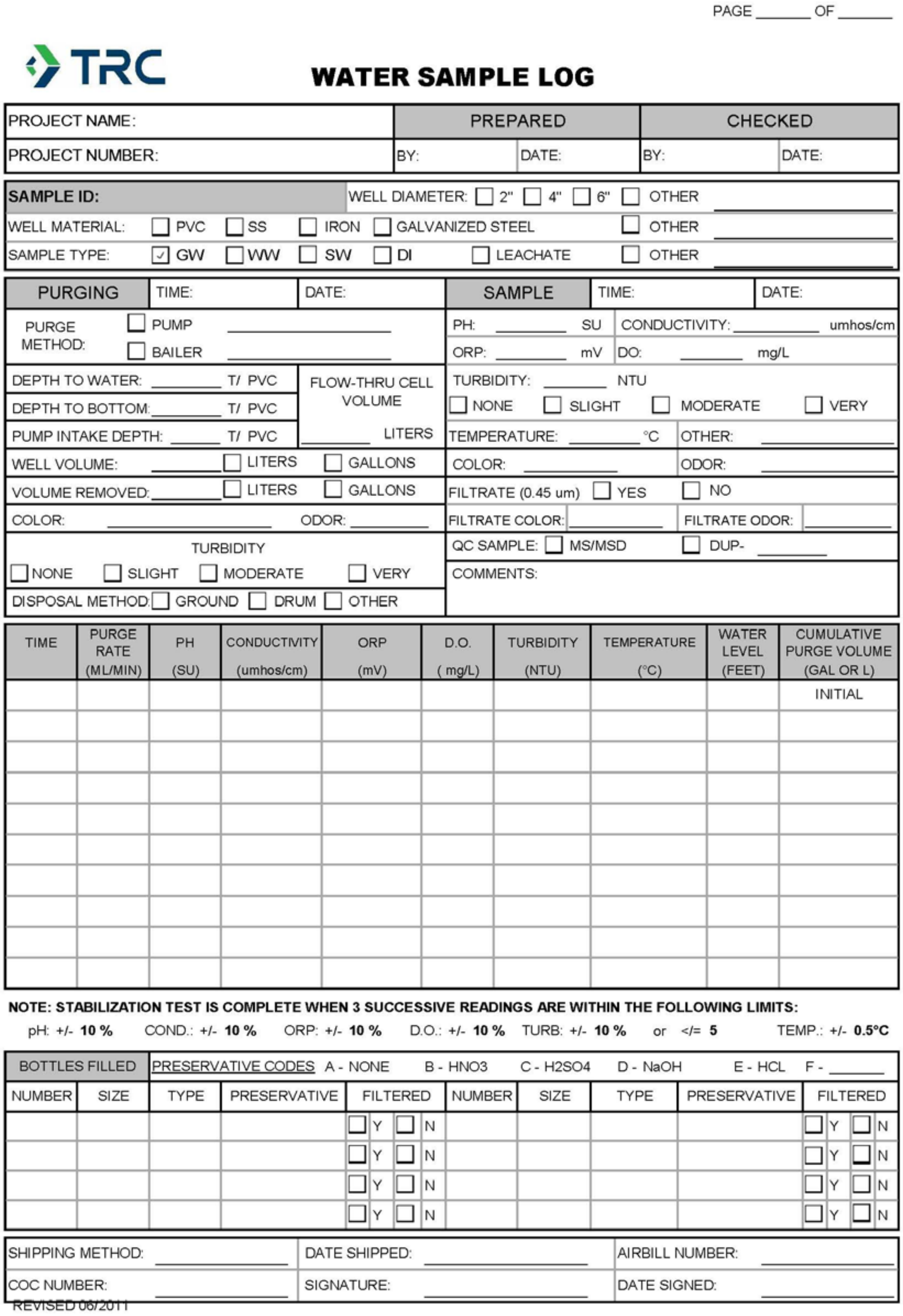
___

Analytical Parameter	Filtered (Y/N)	Preservation	# Bottles	Size/Type Bottles	Time Collected	QC	Sample #

- Consult the applicable regulatory guidance for the specific criteria.

Signed: ___

Rev: April 2014



PAGE ______ OF ______

WATER SAMPLE LOG

PROJECT NAME:	PREPARED		CHECKED	
PROJECT NUMBER:	BY:	DATE:	BY:	DATE:

SAMPLE ID: WELL DIAMETER: ☐ 2" ☐ 4" ☐ 6" ☐ OTHER ____________

WELL MATERIAL: ☐ PVC ☐ SS ☐ IRON ☐ GALVANIZED STEEL ☐ OTHER ____________

SAMPLE TYPE: ☑ GW ☐ WW ☐ SW ☐ DI ☐ LEACHATE ☐ OTHER ____________

PURGING · TIME: · DATE:		SAMPLE · TIME: · DATE:	
PURGE METHOD: ☐ PUMP ____________ ☐ BAILER ____________		PH: ________ SU ORP: ________ mV	CONDUCTIVITY: ________ umhos/cm DO: ________ mg/L
DEPTH TO WATER: ________ T/ PVC DEPTH TO BOTTOM: ________ T/ PVC	FLOW-THRU CELL VOLUME	TURBIDITY: ________ NTU ☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY	
PUMP INTAKE DEPTH: ________ T/ PVC	________ LITERS	TEMPERATURE: ________ °C	OTHER: ________
WELL VOLUME: ________ ☐ LITERS ☐ GALLONS		COLOR: ________	ODOR: ________
VOLUME REMOVED: ________ ☐ LITERS ☐ GALLONS		FILTRATE (0.45 um) ☐ YES	☐ NO
COLOR: ____________	ODOR: ________	FILTRATE COLOR: ________	FILTRATE ODOR: ________
TURBIDITY ☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY		QC SAMPLE: ☐ MS/MSD	☐ DUP- ________
DISPOSAL METHOD: ☐ GROUND ☐ DRUM ☐ OTHER		COMMENTS:	

TIME	PURGE RATE (ML/MIN)	PH (SU)	CONDUCTIVITY (umhos/cm)	ORP (mV)	D.O. (mg/L)	TURBIDITY (NTU)	TEMPERATURE (°C)	WATER LEVEL (FEET)	CUMULATIVE PURGE VOLUME (GAL OR L)
									INITIAL

NOTE: STABILIZATION TEST IS COMPLETE WHEN 3 SUCCESSIVE READINGS ARE WITHIN THE FOLLOWING LIMITS:

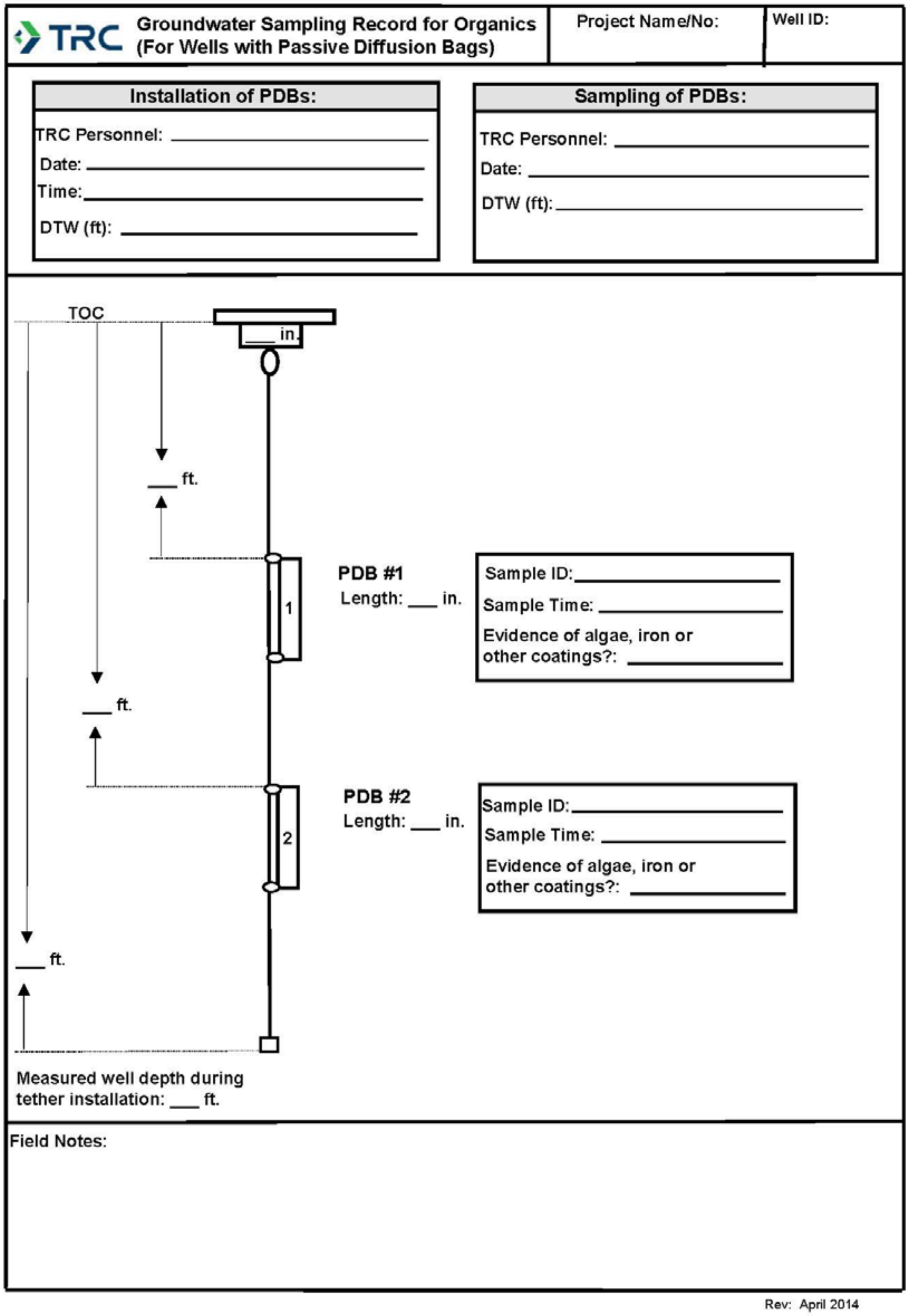
pH: +/- **10 %** COND.: +/- **10 %** ORP: +/- **10 %** D.O.: +/- **10 %** TURB: +/- **10 %** or </= **5** TEMP.: +/- **0.5°C**

BOTTLES FILLED — PRESERVATIVE CODES A - NONE B - HNO3 C - H2SO4 D - NaOH E - HCL F - ________

NUMBER	SIZE	TYPE	PRESERVATIVE	FILTERED	NUMBER	SIZE	TYPE	PRESERVATIVE	FILTERED
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N

SHIPPING METHOD: ____________	DATE SHIPPED: ____________	AIRBILL NUMBER: ____________
COC NUMBER: ____________	SIGNATURE: ____________	DATE SIGNED: ____________

REVISED 06/2011



Groundwater Sampling Record for Organics
(For Wells with Passive Diffusion Bags)

Project Name/No:

Well ID:

Installation of PDBs:

TRC Personnel: ____________________

Date: ____________________

Time: ____________________

DTW (ft): ____________________

Sampling of PDBs:

TRC Personnel: ____________________

Date: ____________________

DTW (ft): ____________________

PDB #1
Length: ___ in.

Sample ID: ____________________
Sample Time: ____________________
Evidence of algae, iron or other coatings?: ____________

PDB #2
Length: ___ in.

Sample ID: ____________________
Sample Time: ____________________
Evidence of algae, iron or other coatings?: ____________

Measured well depth during tether installation: ___ ft.

Field Notes:

Rev: April 2014

Attachment C: SOP Fact Sheet

GROUNDWATER SAMPLING

PURPOSE AND OBJECTIVE

The objective of groundwater sampling is to obtain a representative sample of water from a saturated zone or groundwater-bearing unit (i.e., aquifer) with minimal disturbance of groundwater chemistry. This requires that the sample being collected is representative of groundwater within the formation surrounding the well bore as opposed to stagnant water within the well casing or within the filter pack immediately surrounding the well casing.

There are three general approaches to groundwater purging/sampling that can be used to obtain a representative groundwater sample for analysis: 1) the low-flow or micropurge method where the mixing of the stagnant water is minimized using low-flow pumping rates during the collection of the groundwater sample; 2) the multiple well volume removal approach in which the stagnant water is removed from the well and the filter pack prior to sample collection; and 3) the passive sampler procedure where water quality equilibration with the surroundings is achieved through deployment of the passive sampler for a sufficient amount of time prior to sampling. All three approaches are summarized in this document.

WHAT TO BRING

- Site-specific HASP and field book
- Project-specific work plan
- Figure or site map showing well locations and table showing well construction details
- Field data sheets from previous sampling event
- Well wrenches, ratchet set, and turkey baster to remove standing water from flushmount manholes
- Bolt cutters, padlocks and keys
- Water level meter of sufficient length
- Decontaminated pump, control box, power source (i.e., battery, generator, etc.)
- Tubing (Teflon®, Teflon®–lined polyethylene, or HDPE, type dependent upon project objectives)
- Multi-parameter instrument and flow-through cell (typically should include: pH, temperature, conductivity, ORP, and DO)
- Turbidity meter
- Equipment decontamination supplies (refer to ECR SOP 010, *Equipment Decontamination*)
- Appropriate PPE
- Field book
- Sample bottleware, labeled cooler, ice, temperature blank and blank COC forms; may also need field blank bottles and reagent-grade water
- Zip-loc® plastic bags
- Groundwater field data records
- Graduated cylinder and stop-watch
- Rope for tying off pump at desired intake
- Indelible marking pens
- Bubble wrap
- 5-gallon bucket(s)

As Needed:

- Calibrated PID or FID for well mouth readings
- Oil/water interface probe of sufficient length
- Drums for purge water, grease pen and adhesive drum labels; appropriate crescent or socket wrench
- Filtration equipment, if required (0.45 micron filters, or as otherwise required for the project)
- Other non-routine PPE such as Tyvek coveralls or respirators
- Traffic cones
- Field calibration sheets and calibration solutions

OFFICE

- Prepare/update the site-specific HASP; make sure the field team is familiar with the most recent version.
- Review the project-specific work plan with the Project Manager and/or the field team leader. Discuss the following:
  - Communication procedures;
  - Sampling order and designation;
  - Collection and sample method;
  - Analytical parameters, holding times and turn-around times;
  - Laboratory (contact/shipping info, COC, billing references);
  - Purge water management (Drums? Discharge to ground?);
  - QC sample collection; and
  - Decontamination procedures.
- Verify that monitoring wells will be accessible and/or coordinate to have a site contact available to assist.
- Make sure that monitoring well sample designations and QC sample designations/frequency are understood.
- Confirm that all necessary equipment is available in-house or has been ordered. Rental equipment is typically delivered the day before fieldwork is scheduled. Prior to departure or mobilization to site, test equipment and make sure it is in proper working order. Have rental equipment supplier contact information available for use in field.
- Review sample bottle order for accuracy and completeness and damaged bottles.
- Discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager

ON-SITE

GROUNDWATER SAMPLING

- Review the HASP with all field personnel, sign acknowledgement form and conduct Health & Safety tailgate meeting. Check in security, site contact, or designated person per project-specific work plan or Project Manager.
- Make sure appropriate PPE is worn by all personnel and work area is safe (i.e., utilize traffic cones; minimize interference with on-site activities and pedestrian traffic, etc.)
- Calibrate equipment (if applicable) and record all rental equipment serial numbers in the field book.
- Open wells to allow equilibration and collect full round of water level gauging before sampling is started (unless otherwise noted in project-specific work plan). Record the following:
    - Well mouth PID/FID reading (if necessary);
    - Depth to product and water;
    - Total well depth (not required if free product is measured unless otherwise noted in project-specific work plan); and
    - Condition of wells (i.e., lid broken, pad cracked, rusted lock) and collect photographs if site allows camera use.

SAMPLING PROCEDURES: PRE-PURGE

- Decontaminate pump.
- Take water level measurements prior to pump installation.
- Connect sampling tubing to pump outlet and lower to sample depth; **ALWAYS USE ROPE TO SECURE PUMP TO SURFACE.**
- The pump intake depth(s) for each well should be specified in the project-specific work plan (either specific depth or mid-point of saturated well screen).
- For wells with screened or open borehole intervals greater than 10 feet in length, sampling of multiple intervals may be required.
- If samples are to be collected from multiple depths from an individual well, always collect a sample from the shallowest depth first and leave enough extra tubing coiled at the surface so the pump can be lowered to the next interval; always try to cover excess tubing present at the surface to prevent the air temperature from influencing the measurements and exposure to contaminants on the ground;
- Be careful not to let the pump hit the bottom of the well.
- If using Teflon®-lined tubing, be sure that the lining does not bunch up around the connection. This will restrict water flow and make the pump work harder than it has to.
- Calibrate (or perform a calibration check on) all field monitoring equipment on the same day before collecting groundwater samples. Refer to TRC SOPs and manufacturer's equipment calibration instructions. A calibration check may also be required during or at the end of each sampling day. Consult the project-specific work plan.

SAMPLING PROCEDURES: MULTIPLE-VOLUME PURGING

- The multiple-volume purging approach is typically performed using bailers or submersible or peristaltic pumps. In the multiple-volume purging approach, there are two measurements used to determine adequate purge volume removal prior to sample collection: 1) purge volume and 2) field parameter stabilization.
- The field parameters should be recorded at regular volumetric intervals. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters.
- Prior to purging a well, the amount of water inside the well riser and well screen (i.e., water column) should be determined, if possible. Once this information is known, the well volume can be calculated using the following equation:

  Well Volume (V) = $\pi r2\ h$
- For volumetric purging, an adequate purge is typically achieved when 3 to 5 well volumes have been removed.
- For volumetric purging, it is suggested that field readings are collected every ½ well/well screen volume after an initial 1 to ½ well volumes are purged. The volume removed between readings can be adjusted as well-specific information is developed.
- If removing a specified volume of water (e.g., 3 well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume.
- In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection.
- If, after 3 well volumes have been removed, the field parameters have not stabilized, additional well volumes (up to a total of 5 well volumes), should be removed.
- If the parameters have not stabilized within five well volumes, it is at the discretion of the Project Manager whether or not to collect a sample or to continue purging.

SAMPLING PROCEDURES: LOW-FLOW PURGING

- The low-flow purging approach is typically performed using peristaltic pumps or submersible pumps. Low-flow purging (also referred to as low-stress purging, low-volume purging, or Micropurging®) is a method of well purging/sampling that minimizes the volume of water withdrawn from a well in obtaining a representative sample.
- When performing low-flow purging and sampling, it is recommended that the pump intake be set in the center of the well screen interval to help prevent disturbance of any sediment at the bottom of the well.

GROUNDWATER SAMPLING

- To begin purging, the pump should be started at the lowest pressure/power flow rate setting (e.g., 100 mL/min) and then slowly increased until water begins discharging. Monitor the water level and slowly adjust the pump speed until there is little or no drawdown or drawdown has stabilized. The pump pressure/power may need to be increased for discharge to occur.
- The stabilization of drawdown should be documented. Measure and record the flow rate and water level every 3 to 5 minutes during purging. The flow rate should be reduced if drawdown is greater than 0.3 feet over three consecutive 3 to 5 minute interval readings.
- Attempts should be made to avoid pumping a well dry.

Field Parameter Stabilization During Purging

- Generally, an adequate purge with respect to the groundwater chemistry is achieved when stability for at least three consecutive measurements is achieved. See stability requirements in Appendix A of this SOP.

POST-PURGE GROUNDWATER SAMPLE COLLECTION

- New, disposable gloves should be donned immediately prior to sample collection and should be changed at any point that their cleanliness becomes compromised during sample collection.
- If using a submersible or peristaltic pump, maintain the same flow rate as used during purging. Disconnect the pump tubing from the flow-through cell. Samples must be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. This is critically important to avoid cross-contamination between wells.
- If using bottom-filling bailers, slowly lower the bailer into the well until it is submerged to the point where water does not enter the top (i.e., bottom-filling). Retrieve the bailer. The first bailer recovered after well purging must be used for sample collection.
- Collect groundwater samples in the following order:
  - VOCs;
  - SVOCs;
  - Other organic parameters;
  - Unfiltered inorganic constituents; and
  - Filtered inorganic constituents.
- Note that sample vials for VOCs must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, see Section 2.3.2 of this SOP.
- Preserve the non-VOC samples in pre-preserved vials supplied by the laboratory or if the sample containers are not pre-preserved, preserve the non-VOC samples in accordance with method and project-specific requirements.
- Depending upon project requirements, filtering may be performed. See procedures listed in Section 2.3.4 of this SOP. Clearly note "filtered" on the sample label and the COC.
- Make sure all sample bottles are appropriately labeled.
- Package the samples with bubble wrap and/or organic absorbent, as necessary. Place into shipping container and cool to 4°C and complete the COC.
- Decontaminate non-disposable sampling equipment between uses.

PASSIVE SAMPLING

- There are three generic forms of passive (no purge) samplers: thief (grab) samplers, diffusion (equilibrium) samplers, and integrating (kinetic) samplers. However, this SOP focuses on the more commonly used diffusion (equilibrium) samplers. Be aware of sample holding times, and arrange for samples to be in the laboratory's possession accordingly.
- Passive samplers are deployed at a predetermined depth across the well screen. Typically, the initial sampling event may deploy multiple passive samplers across 5-foot intervals of saturated well screen to observe any potential stratification. Long-term sampling depths typically target a zone of higher concentration, if present.
- New passive samplers are attached via PVC cable ties to a tether (pre-made marine-grade polyethylene rope or stainless steel cable with a weight at the bottom) that is then suspended within the well.
- The passive sampler should be allowed to equilibrate with groundwater for an appropriate period of time (e.g., at least 2 weeks for PDB samplers).
- Raise the passive sampler to the surface using a tether reel. Examine the surface of the passive sampler for evidence of algae, iron, or other coatings, and for tears to the membrane. Note observations in the field book. If tears are present and water is leaking out, the sample is not considered viable. Contact the Project Manager.
- Detach the passive sampler from the tether.
- Remove excess beaded water from the passive sampler with a clean gloved hand, running top to bottom; this is to minimize the contact of beaded water with water in the passive sampler.

GROUNDWATER SAMPLING

- Use a small diameter discharge tube (<0.15 inch diameter to reduce volatilization) and pierce near the bottom, allowing water to smoothly flow into the VOA vial. The VOA vials must be filled within the first several minutes of passive sampler retrieval.
- A small amount of water may remain within the passive sampler after filling the VOA vials and can be used for field parameter measurements if required.
- Dispose of the passive sampler after use.
- Note that sample vials for VOCs must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, see Section 2.3.2 of this SOP.
- Make sure all sample bottles are appropriately labeled.
- Package the samples with bubble wrap and/or organic absorbent, as necessary. Place into shipping container and cool to 4ºC and complete the COC.

DOS AND DO NOTS OF GROUNDWATER PURGING AND SAMPLING

DOs:

- DO have the following items when going into the field: site-specific work plan; site-Specific HASP; appropriate PPE (steel-toed boots, safety glasses, etc.) as required by the Site-Specific HASP; field book and a water-proof ball-point pen; business cards; nitrile gloves; well keys; copies of well installation forms and field data forms from previous sampling event.
- DO make sure that the equipment is set up properly and the bottleware is nearby and ready to be filled. There is little time between taking parameters.
- DO look at the water quality parameters from the previous round of sampling. If there is a large deviation from the previous round's measurements, make sure the meters are properly calibrated and the parameter units are the same. Otherwise, consult the Project Manager or field team leader.
- DO fill sample bottles slowly to make sure that they are not overfilled and that preservative does not become diluted. If collecting filtered samples, fill all non-filtered first, then fill filtered samples - if water is very silty, more than one filter might be required to fill sample bottles.
- DO record the time that purging begins and ends. "Purge Stop" and sample start time are the same.
- DO call your Project Manager or field team leader if unexpected conditions are encountered or at least daily to update them. It is also recommended to call when sampling is winding down for the day to make sure that the project-specific work plan has been fully implemented and there are no additional tasks to complete. Provide shipping tracking numbers to the Project Manager and laboratory contact.
- DO have the numbers for laboratory, vehicle rental and equipment rental providers readily available while in the field.
- DO record sample locations and parameters in the field book and the Groundwater Field Data Records as you purge.
- DO check on the purging setup frequently to make sure proper equipment function is maintained.
- DO bring ice to the site in the morning so that samples are kept cool throughout the entire event. Storing samples in a warm cooler can invalidate sample results and may result in re-sampling on your own time.

DO NOTs:

- DO NOT sign anything in the field. This includes disposal documentation, statements, etc.; call the Project Manager if this is an issue.
- DO NOT allow the pump or sampling equipment to hit the bottom of the well - If the pump hits the bottom of the well, it can stir up mud. Remember, the goal of low-flow sampling is to collect non-turbid samples.
- DO NOT use non-indelible ink to label samples or record field notes – if the field book gets wet, notes become illegible.
- DO NOT leave air bubbles in VOA vials.
- DO NOT pour any extracted water back down into the well.
- DO NOT lean over wells with pens, keys, cell phones, tools, etc. in your pocket.
- DO NOT use clear tape to cover labels on certain analyses (e.g., 40-mL vials for VOC analysis) due to potential interference with analytical equipment.

Attachment D: SOP Modifications for PFAS

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross-contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. The following table highlights the required modifications to this SOP when sampling for PFAS.

PFAS Sampling Protocols	
SOP Section Number	**Modifications to SOP**
1.3	• Do not use equipment utilizing Teflon® or low density polyethylene (LDPE)[1] during sample handling or mobilization/demobilization. This includes bailers, tubing, bladders, bailer cord/wire, waterproof/resistant paper products, certain personal protective equipment (PPE) (see below), and Teflon® tape. High density polyethylene (HDPE) or silicone tubing should be used in lieu of Teflon® or Teflon®-lined tubing. • Passive diffusion bags (PDBs) should not be used due to the presence of LDPE material in PDBs. • Blue Ice® (chemical ice packs) must not be used to cool samples or be used in sample coolers. Regular ice in Ziploc® bags can be used. • Do not use LDPE or glass sample containers or containers with Teflon-lined lids. HDPE or polypropylene containers are acceptable for sample storage. HDPE or polypropylene caps are acceptable. • Do not use aluminum foil. • Field notes should be recorded on loose paper field forms maintained in aluminum or Masonite clipboards. Waterproof field books, plastic clipboards and spiral bound notebooks should not be used. • Do not use Post-It Notes during sample handling or mobilization/demobilization. • Refer to TRC's SOP ECR-010 Equipment Decontamination for PFAS-specific decontamination protocols. Ensure that PFAS-free water is used during the decontamination procedure.
1.5	Always consult the Site Specific Health and Safety Plan prior to conducting field work. The following considerations should be made with regards to field preparation during PFAS sampling: • Tyvek® suits should not be worn during PFAS sampling events. Cotton coveralls may be worn. • Boots and other field clothing containing Gore-Tex™ or other waterproof/resistant material should not be worn. This includes rain gear. Boots made with polyurethane and polyvinyl chloride (PVC) are acceptable. • Stain resistant clothing should not be worn. • Food and drink should not be allowed within the exclusion area. Pre-wrapped food or snacks should not be in the possession of sampling personnel during sampling. Bottled water and hydration drinks (e.g., Gatorade®) may be consumed in the staging area only.

PFAS Sampling Protocols	
SOP Section Number	**Modifications to SOP**
	• Personnel involved with sample collection and handling should wear nitrile gloves at all times while collecting and handling samples or sampling equipment. Avoid handling unnecessary items with nitrile gloves. A new pair of gloves must be donned prior to collecting each sample. • Wash hands with Alconox or Liquinox and deionized water after leaving vehicle before setting up to sample a well.
1.6.1	• Avoid wearing clothing laundered with fabric softeners. • Avoid wearing new clothing (recommended 6 washings since purchase). Clothing made of cotton is preferred. • Avoid using cosmetics, moisturizers, hand creams, or other related products as part of cleaning/showering on the day of sampling. • Avoid using sunscreens or insect repellants that are not natural or chemical free.
2.2.5	Tubing used to purge and sample groundwater for PFAS must not be LDPE or Teflon®. HDPE and silicone are acceptable.
2.3 and 2.3.3	LDPE and/or glass containers should not be used for sampling. Teflon®-lined caps should also not be used during sample collection. Instead, HDPE or polypropylene containers are acceptable for sample storage. HDPE or polypropylene caps are acceptable.
2.4	Due to LDPE material in PDBs, PDBs cannot be used for PFAS sampling.
2.5 (e)	Avoid using waterproof labels for sample bottles. The use of paper labels covered with clear tape or placed in Ziploc® bags to avoid moisture on the sample label is acceptable.
2.5 (f)	Samples for PFAS analysis must be shipped at <10°C. Standard coolers are acceptable.
4.3	Due to low reporting limit requirements for PFAS, trip blanks for PFAS analysis should be included in sample coolers if PFAS are being analyzed for in the associated groundwater samples.

Notes:

[1] – PFAS have been used as an additive in the manufacturing of LDPE to smooth rough surfaces and, in the case of LDPE tubing, to allow for less turbulent flow along the surface of the tubing.

Title: **Equipment Decontamination**	Procedure Number: **ECR 010**
	Revision Number: **2**
	Effective Date: **January 2020**

Authorization Signatures

		Elizabeth Denly	
Technical Reviewer	Date	Environmental Sector Quality Director	Date
James Peronto	1/1/20	Elizabeth Denly	1/1/20

This document is proprietary property of TRC. It is to be used only by the person(s) to whom it has been provided and solely for the express purpose intended. Any reproduction or distribution, for purposes other than the intended, is forbidden without the express written consent of TRC.

TABLE OF CONTENTS

Page No.

ATTACHMENTS

Attachment A	SOP Fact Sheet
Attachment B	SOP Modifications for PFAS

1.0 INTRODUCTION

1.1 Scope & Applicability

This Standard Operating Procedure (SOP) was prepared to direct TRC personnel in the procedures needed for decontamination of equipment used in the field during environmental investigations (e.g., sediment, soil, groundwater investigations). Other state or federal requirements may be above and beyond the scope of this SOP and will be followed, if applicable. In all instances, the actual procedures used should be documented and described in the field notes. Preventing or minimizing potential cross-contamination of samples is important for the collection of representative samples, avoiding the possible introduction of sampling error into sample results, and for protecting the health and safety of site personnel.

Removing or neutralizing potential contaminants that may have accumulated on equipment and vehicles ensures protection of personnel, reduces or eliminates potential transfer of contaminants to clean areas, and minimizes the likelihood of sample cross-contamination.

The use of dedicated, disposable, new sampling equipment (e.g., disposable liners, plastic spoons, plastic or aluminum bowls) should be considered as an alternative to equipment decontamination and the subsequent generation of decontamination fluids.

1.2 Summary of Method

Equipment decontamination is used to remove potential contaminants from a sampling device or piece of field equipment prior to and between the collection of samples and is also used to limit personnel exposure to residual contamination that may be present on used field equipment.

Contaminants can be physically removed from equipment or deactivated by sterilization or disinfection. Gross contamination of equipment requires physical decontamination, including abrasive and nonabrasive methods. These include the use of brushes, air and wet blasting, and high-pressure water, followed by a wash/rinse process using appropriate cleaning solutions. A solvent rinse may be required when organic contamination is present, and an acid rinse may be required when metals are parameters of interest. Equipment decontamination procedures can vary depending on the media being sampled and the type of sampling equipment being used. Disposal of decontamination fluids will be handled on a project-specific basis and will be in accordance with all applicable regulations.

1.3 Equipment

The following equipment may be utilized when decontaminating equipment. Project-specific conditions or requirements may warrant the use of additional equipment or deletion of items from this list. For specialized sampling programs involving per- and polyfluorinated alkyl substances (PFAS), refer to Attachment B for further details.

- Appropriate level of personal protective equipment (PPE) as specified in the site-specific Health and Safety Plan (HASP)

- Alconox®, Liquinox® or other nonphosphate concentrated laboratory-grade soap
- Simple Green® or other nontoxic biodegradable cleaner
- Deionized, distilled, or organic-free water, as appropriate (may be supplied by the laboratory or purchased from commercial vendors depending on project requirements)
- Pump sprayer
- Pressure sprayer
- Squeeze bottle filled with pesticide-grade hexane (option for organic analyses)
- Squeeze bottle filled with pesticide-grade methanol (option for organic analyses)
- Squeeze bottle filled with pesticide-grade isopropanol (option for organic analyses)
- Squeeze bottle filled with 10 percent nitric acid (option for metals analyses and stainless-steel equipment)
- Squeeze bottle filled with 1 percent nitric acid (option for metals analyses)
- Container (squeeze bottle to 5-gallon bucket) filled with potable water and a nonphosphate, laboratory-grade soap (approximately 1 tablespoon of soap to 5 gallons of water)
- Extra quantities of above listed liquids
- Potable water
- Containers, such as buckets or wash basins (the type and number of containers is dependent on the procedure)
- Scrub brushes
- Small wire brush
- Aluminum foil
- Polyethylene sheeting
- A container for decontamination of pumps and associated tubing.

1.4 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific HASP. TRC personnel will use the appropriate level of PPE as defined in the HASP.

Samples containing chemical contaminants may be handled during implementation of this SOP. Certain decontamination fluids, including solvents and/or acids, are considered hazardous materials, and TRC employees will appropriately handle and store them at all times. Appropriately manage chemicals that pose specific toxicity or safety concerns, and follow any other relevant requirements as appropriate. Hazardous substances may be incompatible or may react to produce heat, chemical reactions, or toxic products. Some hazardous substances may be incompatible with clothing or equipment and can permeate or degrade protective clothing or equipment. Also, hazardous substances may pose a direct health hazard to workers through inhalation or skin contact or if exposed to heat/flame and they combust. Safety data sheets for chemicals handled by TRC personnel should be maintained in a designated location at the project site.

1.5 Cautions and Potential Problems

Special care should be taken when decontaminating equipment used for sampling for PFAS. Please refer to Attachment B for details.

- The use of deionized, distilled or organic-free water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been certified by the vendor as analyte-free and/or meets the project-specific requirements.

- Alconox®, Liquinox®, or other nonphosphate, concentrated, laboratory-grade soap may contain trace quantities of perchlorate.

- Avoid using an excessive amount of soap during decontamination procedures, as this could result in difficulty rinsing the soap residue off of the equipment. Typically the soap solution is prepared using 1 tablespoon of soap to 5 gallons of water.

- Use sufficient amount of decontamination fluid (e.g., acid or solvent rinses) so that the fluid flows over the equipment and runs off. Spraying the equipment with a minimal amount of decontamination fluid that does not run off is ineffective.

- Spent decontamination solutions are considered investigation-derived waste (IDW) and must be managed as directed by the site-specific field program. Project and regulatory requirements, chemical compatibility, ambient conditions and professional judgment should be used to determine the appropriate decontamination process with respect to combining and/or segregating decontamination fluids. Section 3 of this SOP provides more guidance on the disposal procedures.

- Several procedures can be established to minimize the potential for cross-contamination or analytical interference by decontamination fluids. For example:

    - The use of methanol in the decontamination procedure may not be appropriate if methanol is a contaminant of concern.

    - Isopropanol may be used as a substitute for methanol but may not be appropriate when collecting samples for volatile organic compound (VOC) analyses. Residual isopropanol on the equipment may cause substantial interferences in subsequent VOC analyses and may result in unnecessary dilutions and/or false positive results if isopropanol is not removed in subsequent decontamination steps. It should also be noted that the application of isopropanol to hot metal surfaces (e.g., a steam-cleaned split spoon) may cause oxidation of the isopropanol to acetone.

  - If hexane is used in the decontamination procedure, caution should be used to ensure that the hexane is completely volatilized and the equipment is subsequently rinsed when samples are to be analyzed for VOCs and volatile petroleum hydrocarbons (VPH). Residual hexane on equipment could interfere with the VOC and VPH analyses and may result in unnecessary dilutions and/or false positive results.

  - Cover monitoring and sampling equipment with protective material (i.e., aluminum foil, polyethylene sheeting, or Ziploc® bags) to minimize potential re-contamination after decontamination.

  - Use disposable sampling equipment when appropriate to minimize the need for decontamination. Although disposable sampling tools are encouraged in order to minimize the generation of decontamination fluids, it should be noted that plastic tools may not be appropriate for collection of samples to be analyzed for semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). Potential phthalate contamination may cause significant interferences in the subsequent analyses and may result in unnecessary dilutions and/or false positive results.

- After decontamination, equipment should be handled only by personnel wearing clean disposable powder-free nitrile gloves to prevent recontamination.
- If equipment decontamination is performed in the field, the equipment should be moved away (preferably upwind) from the decontamination area to prevent recontamination.
- Equipment that is not decontaminated properly may result in potentially high biased results in field samples. **Note:** Equipment blank collection may be appropriate after decontamination of equipment used to collect highly contaminated samples.

1.6 *Personnel Qualifications*

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project work plan. These requirements may include:

- Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers
- 8-hour annual HAZWOPER refresher training.

2.0 PROCEDURES

Refer to the site-specific sampling plan and/or Quality Assurance Project Plan (QAPP), if applicable, for site-specific procedures. Other state or federal requirements may be above and beyond the scope of this SOP and will be followed if applicable. In all instances, the actual procedures used should be documented and described in the field notes.

2.1 General

All personnel, sample containers, and equipment leaving the contaminated area of a site must be decontaminated. Various decontamination methods will either physically remove contaminants by abrasive and/or washing actions, inactivate contaminants by disinfection or sterilization, or both. Decontamination procedures should be documented in the field book.

2.2 Physical Decontamination Procedures

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques appropriate for equipment decontamination can be grouped into two categories: abrasive methods and nonabrasive methods. In general, heavy equipment decontamination is conducted by drilling and construction subcontractors and not by TRC personnel. However, TRC personnel will typically need to document such decontamination efforts as part of project work.

ABRASIVE CLEANING METHODS APPROPRIATE FOR DRILLING EQUIPMENT (DRILLING RIGS, ETC.)

Abrasive cleaning methods involve rubbing and wearing away the top layer of the surface containing the contaminant. The following abrasive methods are available but are not commonly used:

- *Mechanical:* Mechanical cleaning methods use brushes of metal or nylon. The amount and type of contaminants removed will vary with the hardness of bristles, length of brushing time, and degree of brush contact.

- *Air Blasting:* Air blasting is used for cleaning large equipment, such as bulldozers, drilling rigs, or auger bits. The equipment used in air blasting employs compressed air to force abrasive material through a nozzle at high velocities. The distance between the nozzle and the surface cleaned, as well as the pressure of air, the time of application, and the angle at which the abrasive material strikes the surface, determines cleaning efficiency. Air blasting has several disadvantages, including it is unable to control the amount of materials removed, it can aerate contaminants, and it generates large amounts of waste.

- *Wet Blasting:* Wet blasting, also used to clean large equipment, involves use of a suspended fine abrasive delivered by compressed air to the contaminated area. The amount of materials removed can be carefully controlled by using very fine abrasives. One disadvantage of this method is the generation of a large amount of waste.

NONABRASIVE CLEANING METHODS APPROPRIATE FOR FIELD EQUIPMENT (DRILLING AUGERS AND RIGS, ETC.)

Nonabrasive cleaning methods involve forcing the contaminant off of a surface with pressure. In general, less of the equipment surface is removed using nonabrasive methods. Special care should be taken during decontamination procedures following sampling for PFAS. Please refer to Attachment B for details. The following non-abrasive methods are available:

- *High-pressure Potable Water:* This method consists of a high-pressure pump, an operator-controlled directional nozzle, and a high-pressure hose. Flow rates typically range from 20 to 140 liters per minute.

  This procedure is used the majority of the time and is more appropriate for equipment with painted surfaces.

- *Ultrahigh-Pressure Potable Water:* This system produces a pressurized water jet. The ultrahigh-pressure spray removes tightly adhered surface film. The water velocity ranges from 500 meters per second (m/sec) to 900 m/sec. Additives can enhance the method. This method is not applicable for hand-held sampling equipment.

  This procedure is not commonly used but would be appropriate for carbon steel drilling rods and augers.

2.3 Procedure for Sampling Equipment

Sampling equipment, such as split-spoon samplers, shovels, hand augers, trowels, spoons, spatulas, bailers, tethers, dippers, and pumps, will be cleaned using the following procedure. Special care should be taken during decontamination procedures following sampling for PFAS. Please refer to Attachment B for details. **Note:** The overall number of containers needed for collection of decontamination fluids may vary depending on chemical compatibilities, project and regulatory requirements, and ultimate disposal methods for these fluids.

1. Lay out sufficient polyethylene sheeting on the ground or floor to allow placement of the necessary number of containers (e.g., plastic wash basins or buckets) and an air drying area. The number of decontamination steps and designated containers should be determined prior to field sampling based on the site-specific sampling plan. At a minimum, one container should be designated for the detergent wash. A second container should be designated for water rinsing. A third container may be designated for nonwater rinsing. If more than one, the nonwater rinsate fluids may need to be separated. Nonwater rinsate fluids should not be combined with the detergent wash during decontamination. Place the containers on the polyethylene sheeting. The decontamination line should progress from “dirty” to “clean”.

   Note: In instances where acid or solvent rinses are required, additional containers may be needed to manage collection and subsequent disposal of the spent decontamination fluids.

2. Fill the first container with potable water. Add sufficient nonphosphate concentrated laboratory-grade soap to cause suds to form in the container. Do not use an excessive amount of the soap (approximately 1 tablespoon of soap to 5 gallons of water), or rinsing the soap residue off of the equipment will be difficult.

3. Brush any visible dirt off of the sampling equipment into a designated area before getting equipment wet.

4. Using a clean, coarse scrub brush, submerge and wash the sampling equipment in the soap solution in the first container, removing all dirt or visible hydrocarbons. Allow excess soap to drain off the equipment into the container when finished. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

5. Rinse the equipment with potable water over an appropriate container, using a coarse scrub brush or pressure sprayer to aid in the rinse if necessary. If an additional acid or solvent rinse is not required, proceed to Step 8.

6. ******If sampling for metals and if required by the project, rinse the equipment with nitric acid over an appropriate container. Consider using a container dedicated to acidic solutions to minimize the volume of liquid that needs to be neutralized later. A 10 percent nitric acid solution is used on stainless steel equipment. A 1 percent nitric acid solution is used on all other equipment. If not required, this step may be omitted.

   Rinse the equipment over an appropriate container using deionized, distilled or organic-free water. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

7. ******If sampling for organic parameters and if required by the project, rinse the equipment over an appropriate container using pesticide-grade methanol or isopropanol (see Cautions and Potential Problems). If oily, a pesticide-grade hexane rinse should follow the methanol/isopropanol rinse, or as an alternative, Simple Green® can be used if approved by the Project Manager. Consider using an appropriate container dedicated to volatile solvents to minimize the volume of liquid that subsequently needs to be managed as IDW. If not required, this step may be omitted.

   Allow the equipment to completely air dry prior to proceeding to the next step.

   **** Steps 6 and 7 are optional and may be used on a site-specific basis. The site-specific sampling plan or QAPP, if available, should be consulted. In the absence of a sampling plan or QAPP, the Project Manager will decide upon the necessity of these steps.**

8. Rinse the equipment over an appropriate container using deionized, distilled or organic-free water. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

9. Allow the equipment to completely air dry on a clean surface (e.g., polyethylene sheeting or a clean container) (See*NOTE).

   ***NOTE** that if temperature or humidity conditions preclude air drying equipment, sufficient spares, if possible, should be available so that no item of sampling equipment need be used more than once. If an ample amount of spare equipment is not available and the equipment will not completely air dry, additional rinses with deionized, distilled or organic-free water should be used. The inability of equipment to air dry and the usage of additional rinses should be recorded in the field book or on the appropriate form.

10. Reassemble equipment, if necessary, and wrap completely in clean, unused, protective material. Reuse of equipment on the same day without wrapping in protective material is acceptable.

11. Spent decontamination fluids are considered IDW and must be managed as directed by the site-specific field program.

12. Record the decontamination procedure in the field book or on the appropriate form.

2.4 Procedure for Measuring Equipment

Measuring equipment, such as pressure transducers, water level indicators, oil/water interface probes, and soil moisture/pH meters will be cleaned using the following procedure, unless it conflicts with the manufacturer's recommendations. Special care should be taken during decontamination procedures following sampling for PFAS. Please refer to Attachment B for details.

1. Fill two clean containers (e.g., plastic wash basins or buckets) with potable water.

2. Add sufficient nonphosphate concentrated laboratory-grade soap to one container to form a thin layer of soap suds. If oily residues are apparent, the use of Simple Green® may be required.

3. Brush any visible dirt off of the measuring equipment before getting the equipment wet.

4. Either spray rinse the device with the soap solution over the first container, or for heavily soiled equipment, immerse the device in the container containing soap and gently agitate. Scrub device if it is soiled. Do not submerse any electrical controls or take-up reels. Submerse only that portion of the device that came in contact with potential contaminants.

5. Immerse the device in the container containing the potable water and gently agitate. Do not submerse any electrical connectors or take-up reels. Submerse only that portion of the device that came in contact with potential contaminants.

6. Spray rinse equipment with deionized, distilled, or organic-free water over the last container used.

7. Allow the equipment to air dry if time allows.

8. Record the decontamination procedure in the field book or on the appropriate form.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for IDW disposal with the Project Manager.

Each project must consider IDW disposal methods and have a plan in place prior to performing the field work. Provisions must be in place regarding what will be done with IDW. If IDW cannot be returned to the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

One type of quality control sample specific to the field decontamination process is the equipment blank. The equipment blank provides information about the effectiveness of the decontamination process employed in the field. An equipment blank can detect contamination that may arise from potentially contaminated equipment or equipment that has not been decontaminated effectively.

Equipment blanks consist of a sample of analyte-free (i.e., deionized, distilled, organic-free) water that is poured over and through a decontaminated sampling device and placed in a clean sample container. Ideally, the reagent water should come from the laboratory and be certified as clean. If the blank water is not certified as clean and/or not supplied by the laboratory performing the analyses, a separate water blank that has not run through the sampling equipment should also be sent to the laboratory for analysis.

Equipment blanks are typically collected for all parameters of interest at a minimum rate of 1 per 20 samples for each parameter. The frequency of equipment blank collection will vary from project to project, depending upon the data quality objectives, and will be specified in either the site-specific sampling plan or QAPP. Equipment blanks are typically not required if dedicated sampling equipment is used.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

All reagents used must be documented in the field book or on the appropriate form. Any deviations from the decontamination procedures specified in the sampling plan or QAPP must be approved by the Quality Assurance (QA) Officer and Project Manager and documented in the field book. The lot number and vendor of each reagent used should be documented in the field book. Refer to ECR SOP 001 for field documentation procedures.

6.0 REFERENCES

USEPA. December 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001.

USEPA. January 1991. *Compendium of ERT Groundwater Sampling Procedures*. OSWER Directive 9360.4-06. PB91-9211275.

USEPA. November 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance*. EPA/530-R-93-001. USEPA Office of Solid Waste.

USEPA. January 1999. *Compendium of ERT Groundwater Sampling Procedures*. EPA/540/P-91/007. OSWER Directive 9360.4-06. PB91-921275.

USEPA. December 20, 2011. *Field Equipment Cleaning and Decontamination*. SESDPROC-205-R2. Region 4. Science and Ecosystems Support Division. Athens, Georgia.

7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
1	DECEMBER 2016	ADDED ATTACHMENT B TO ACCOMMODATE SOP MODIFICATIONS REQUIRED WHEN SAMPLING FOR PFAS; CHANGED NAMING CONVENTION FOR SOP FROM RMD TO ECR.
2	JANUARY 2020	TRC RE-BRANDING

Attachment A: SOP Fact Sheet

EQUIPMENT DECONTAMINATION

PURPOSE AND OBJECTIVE

Removing or neutralizing potential contaminants that may have accumulated on equipment and vehicles ensures protection of personnel, reduces or eliminates potential transfer of contaminants to clean areas, and minimizes the likelihood of sample cross-contamination. Preventing or minimizing potential cross-contamination of samples is important for the collection of representative samples, avoiding the possible introduction of sampling error into sample results, and for protecting the health and safety of site personnel.

WHAT TO BRING

- Field book
- Appropriate PPE
- Site-specific HASP
- Alconox®, Liquinox® or other nonphosphate concentrated laboratory-grade soap
- Simple Green® or other nontoxic biodegradable cleaner
- Deionized, distilled, or organic-free water, as appropriate
- Potable water (or water containers if potable water source on site or nearby)
- Pump or pressure sprayer
- Squeeze bottles filled with appropriate decontamination chemicals (e.g., organic solvents, nitric acid)
- Containers, such as buckets or wash basins (type and number is dependent on the procedure)
- Scrub brushes
- Aluminum foil
- Polyethylene sheeting

OFFICE

- Prepare/update the site-specific HASP; make sure the field team is familiar with the latest version.
- Review site-specific sampling plan/QAPP for decontamination procedures and procedures for management of investigation-derived waste (IDW) (e.g., used decontamination solutions).
- Confirm all required decontamination supplies are in stock or order as needed.

ON-SITE

- Verify project HASP including safety data sheets for decontamination chemicals used on site.
- Conduct daily Health & Safety tailgate meetings, as appropriate.
- Establish a designated equipment and personnel decontamination area.
- Provide for the proper collection and management of all IDW.
- Verify that appropriate PPE is worn by all site personnel (including subcontractors) and the work area is safe.

SAMPLING EQUIPMENT DECONTAMINATION - PROCEDURES

Sampling equipment, such as split-spoon samplers, shovels, hand augers, trowels, spoons, spatulas, bailers, tethers, dippers, and pumps, will be cleaned using the following procedure. **A more simplified procedure for decontamination of measuring equipment is presented in the SOP.** Note: The overall number of containers needed for collection of decontamination fluids may vary depending on chemical compatibilities, project and regulatory requirements, and ultimate disposal methods for these fluids.

1. Lay out sufficient polyethylene sheeting on the ground or floor and the necessary number of containers (e.g., plastic wash basins or buckets) and an air drying area. At a minimum, one container should be designated for the detergent wash. A second container should be designated for water rinsing. A third container may be designated for nonwater rinsing. Nonwater rinsate fluids should not be combined with the detergent wash during decontamination. The decontamination line should progress from "dirty" to "clean".
   Note: In instances where acid or solvent rinses are required, additional containers may be needed to manage collection and subsequent disposal of the spent decontamination fluids.
2. Fill the first container with potable water. Add sufficient nonphosphate concentrated laboratory-grade soap to cause suds to form in the container.
3. Brush any visible dirt off of the sampling equipment before getting equipment wet.
4. Using a clean, coarse scrub brush, submerge and wash the sampling equipment in the soap solution in the first container.

EQUIPMENT DECONTAMINATION

5. Rinse the equipment with potable water over an appropriate container. If an additional acid or solvent rinse is not required, proceed to Step 8.
6. **If sampling for metals and if required by the project, rinse the equipment with nitric acid over an appropriate container. Consider using a container dedicated to acidic solutions to minimize the volume of liquid that needs to be neutralized later. A 10 percent nitric acid solution is used on stainless steel equipment. A 1 percent nitric acid solution is used on all other equipment. If not required, this step may be omitted.
7. **If sampling for organic parameters and if required by the project, rinse the equipment over an appropriate container using pesticide-grade methanol or isopropanol (see Caution and Potential Problems). If oily, a pesticide-grade hexane rinse should follow the methanol/isopropanol rinse, or as an alternative, Simple Green® can be used if approved by the Project Manager. Consider using an appropriate container dedicated to volatile solvents to minimize the volume of liquid that subsequently needs to be managed as IDW. If not required, this step may be omitted.
   Allow the equipment to completely air dry prior to proceeding to the next step.
   ** Steps 6 and 7 are optional and may be used on a site-specific basis. The site-specific sampling plan or QAPP, if available, should be consulted. In the absence of a sampling plan or QAPP, the Project Manager will decide upon the necessity of these steps.
8. Rinse the equipment over an appropriate container using deionized, distilled or organic-free water.
9. Allow the equipment to completely air dry on a clean surface (e.g., polyethylene sheeting or a clean container).
   *NOTE that if temperature or humidity conditions preclude air drying equipment, sufficient spares, if possible, should be available so that no item of sampling equipment need be used more than once. If an ample amount of spare equipment is not available and the equipment will not completely air dry, additional rinses with deionized, distilled or organic-free water should be used. The inability of equipment to air dry and the usage of additional rinses should be recorded in the field logbook or on the appropriate form.
10. Reassemble equipment, if necessary, and wrap completely in clean, unused, protective material. Reuse of equipment on the same day without wrapping in protective material is acceptable.
11. Spent decontamination fluids are considered IDW and must be managed as directed by the site-specific field program.

INVESTIGATION DERIVED WASTE (IDW) DISPOSAL

Field personnel should review the project work plan and ensure project-specific IDW management documentation and containerization requirements are specified or discussed with the Project Manager before going to the project site.

DATA MANAGEMENT AND RECORDS MANAGEMENT

All reagents used must be documented in the field book or an appropriate field form. Any deviations from the decontamination procedures specified in the work plan, sampling plan or QAPP must be approved by the Quality Assurance (QA) Officer and Project Manager and documented in the field book. The lot number and vendor of each reagent used should be documented in the field logbook. Refer to ECR SOP 001 for field documentation procedures.

DOs AND DO NOTs OF EQUIPMENT DECONTAMINATION

DOs:

- DO call the Project Manager or field team leader if unexpected conditions are encountered or at least daily to update them on site work.
- DO manage and collect IDW in accordance with project requirements.
- DO use deionized, distilled or analyte free water that is provided by the laboratory, is certified analyte-free, and/or meets project requirements.
- DO use sufficient amount of decontamination fluids so that the fluid flows over the equipment and runs off.
- DO use new wrapped disposable dedicated sampling equipment when appropriate to minimize the need for decontamination.

DO NOTs:

- DO NOT use an excessive amount of soap during decontamination.
- DO NOT sign anything in the field unless authorized in writing by client. This includes waste disposal documentation, statements, etc.; call PM if this issue arises.

Attachment B: SOP Modifications for PFAS

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross-contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. The following table highlights the required modifications to this SOP when sampling for PFAS.

PFAS Equipment Decontamination Protocols	
SOP Section Number	**Modifications to SOP**
1.3	• Use only Alconox® or Liquinox® soap; do not use Decon 90. • Use new plastic buckets for wash and rinse water. • Ensure that PFAS-free water is used during the decontamination procedure. • Do not use aluminum foil.
1.5	Always consult the Site-specific Health and Safety Plan prior to conducting field work. The following considerations should be made with regards to decontamination procedures: • Tyvek® suits should not be worn. Cotton coveralls may be worn. • Boots and other field clothing containing Gore-Tex™ or other waterproof/resistant material should not be worn. This includes rain gear. Boots made with polyurethane and polyvinyl chloride (PVC) are acceptable. • Food and drink should not be allowed within the decontamination area. Bottled water and hydration drinks (e.g., Gatorade®) may be consumed in the staging area only. • Personnel involved with decontamination should wear a new pair of nitrile gloves after each decontamination procedure when handling equipment to avoid re-contamination. Avoid handling unnecessary items with nitrile gloves. • Do not store on or cover equipment with aluminum foil after decontamination. Use of polyethylene sheeting is acceptable. • Avoid wearing clothing laundered with fabric softeners. • Avoid wearing new clothing (recommended six washings since purchase). Clothing made of cotton is preferred. • Avoid using cosmetics, moisturizers, hand creams, or other related products as part of cleaning/showering the morning of sampling and decontamination field work.
2.2	• New nylon or metal bristle brushes should be used for mechanical cleaning methods. • If high-pressure water is used, it must be tested prior to use for presence of PFAS.
2.3	• Ensure that PFAS-free water is used during the decontamination procedure.
2.4	• Ensure that PFAS-free water is used during the decontamination procedure.

Title: **Calibration of Field Instruments for Water Quality Parameters**	Procedure Number: **ECR 011**
	Revision Number: **1**
	Effective Date: **January 2020**

Authorization Signatures			
Darby Litz		Elizabeth Denly	
Technical Review Darby Litz	Date 1/1/20	Environmental Sector Quality Director Elizabeth Denly	Date 1/1/20

TABLE OF CONTENTS

LIST OF ATTACHMENTS

Attachment A	Oxygen Solubility at Indicated Pressure
Attachment B	Example Field Instrument Calibration Logs
Attachment C	SOP Fact Sheet

1.0 INTRODUCTION

1.1 Scope and Applicability

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for ground water and surface water. Water quality instruments addressed in this SOP include those that measure temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, oxidation-reduction potential (ORP), and turbidity.

1.2 Summary of Method

All monitoring instruments must be calibrated before they are used to measure environmental samples. This SOP outlines the general methods for field instrument calibration, calibration documentation requirements, and corrective action procedures that will be implemented during field activities. Calibration procedures are different for each field instrument used and these procedures should be provided by the instrument manufacturer. The manufacturer's instruction manual (including the instrument specifications) should accompany the instrument into the field.

At a minimum, calibration and/or a calibration check must be performed at the beginning of each day prior to use. Site-specific work plans should be consulted for required calibration frequency. Note: The initial calibration may be performed in the office prior to the field event or by the equipment supplier; however, calibration checks should be performed on site prior to use on the day of the fieldwork.

1.3 Equipment

The following equipment may be utilized when calibrating water quality parameter measuring equipment. Project-specific conditions or laboratory requirements may warrant the addition or deletion of items from this list.

- Appropriate level of personal protective equipment (PPE), as specified in the site-specific Health and Safety Plan (HASP).
- Water quality meter capable of measuring one or more of the following based on project scope: pH, temperature, DO, specific conductivity, and ORP (e.g., YSI 600XL, Horiba U-50, Hydrolab Quanta/QED MP-20, or equivalent)
- Turbidity meter (e.g., LaMotte Model 2020e, Hach 2100P, or equivalent)
- Deionized water
- Flow-through cell
- Ring stand with clamp
- Paper towels
- Soft tissue (e.g., Kimwipes®)
- Cuvettes

- Buffer solutions at pH 4, 7 and 10 standard units (SU)*. Commercially available solutions that have been validated by comparison to National Institute of Standards and Technology (NIST) standards are recommended for routine use.
- Conductivity solution (potassium chloride, typically 1,413 micromhos/centimeter [µmhos/cm])*
- ORP calibration solution (e.g., Zobell)*
- Turbidity standards (0, 1, 10 nephelometric turbidity units [NTUs] or StablCal Kit)*
- Zero DO solution (0.0 milligrams per liter [mg/L])*
- DO membrane kit (electrolyte solution, membranes)
- NIST thermometer (0.2ºC accuracy)*
- Small glass or polyethylene jars to hold the calibration standards (4-8 oz.)
- Field book
- Field instrument calibration logs
- Cup or spray bottle for the deionized water

*Dependent on the project-specific requirements and the instrument manufacturer

1.4 Definitions

Not applicable

1.5 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific HASP. TRC personnel will use the appropriate level of PPE as defined in the HASP.

Implementing this SOP will require the use of calibration solutions. The following health and safety precautions must be taken with the pH, conductivity, turbidity, zero DO and ORP solutions: Avoid inhalation, skin and eye contact, and ingestion.

Maintenance of the instruments will require the use of liquid cleaners. Although these substances are not hazardous materials, TRC will appropriately handle and store them at all times in accordance with manufacturer's instructions.

1.6 Cautions and Potential Problems

General cautions and potential problems are discussed below. Specific issues for individual parameters are discussed in Section 2.

- Prior to calibration, all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erroneous measurements. Rental instruments are routinely maintained by the vendor but should be checked for residues upon receipt.

- Prior to using calibration standards, check and record all expiration dates and lot numbers for the solutions on the field instrument calibration log. Discard any calibration standards that are past their expiration date.

- Avoid storing calibration solutions in extremely hot or cold temperatures to maintain solution integrity and prevent calibration errors.

- The volume of the calibration solutions must be sufficient to cover both the probe being calibrated and the temperature sensor (see manufacturer's instructions for additional information).

- Pre-rinse the sensor and calibration cup with a small amount of calibration solution to minimize dilution or cross-contamination.

- If desired, use a ring stand and clamp to secure the sonde in an upright position. This will prevent the sonde from falling over and damaging the probes.

- While calibrating or performing sample measurements, make sure there are no air bubbles lodged between the probe and the probe guard.

- Do not immerse the sensors in sea water or other highly saline water, alcohol or organic solvents.

- Problems during calibration may indicate the need to clean or replace sensors, electrodes or membranes or replace the calibration solutions.

- Have several clean absorbent paper towels or cotton cloths available to dry the probe between rinses and calibration solutions. Shake excess water off of the probes and dry off the outside of the probe sensors.

- All meters may have different relative accuracy, which will be specified in the instrument manual. Confirm that the meter being used meets the project's accuracy requirements.

1.7 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project- and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project work plan. These requirements may include:

- OSHA 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers
- 8-hour annual HAZWOPER refresher training

2.0 PROCEDURES

Prior to use, instruments that will be used during field activities will be inspected to ensure they are clean, checked for possible malfunctions, and calibrated in accordance with manufacturer's procedures. Often, equipment provided by a rental company is calibrated prior to shipment, and a calibration certificate is provided with the equipment. Review the calibration certificate provided by the equipment supplier.

Calibration checks (or verifying that instrument readings fall within an acceptable range of a standard without running through the full instrument calibration steps) will be performed on field instruments prior to their initial use, at least once daily, or whenever indications of faulty readings or instrument malfunction occurs. Some instruments or certain project scopes may require more frequent calibration checks depending on project quality objectives. In general, instrument selection and calibration will include the following steps:

- Determine which instruments are needed for the specific field tasks. Record the make, model number, and serial number of the instrument on the field instrument calibration log or in the field book.
- Obtain the necessary instruments and standard solutions for calibration. Check expiration dates on standard solutions and replace if out of date. Record the manufacturer, true value, lot number and expiration date of the standard solutions on the field instrument calibration log or in the field book.
- Assemble the instrument and turn it on allowing the instrument to warm up.
- Check battery charge, and charge or replace if necessary.
- Clean instrument (if necessary).
- If applicable, program the multi-probe instrument so that the applicable parameters to be measured will be displayed.
- Calibrate the instrument prior to field use in accordance with manufacturer's procedures. (Note: If applicable, calibrate DO and conductivity first, because these parameters may affect the other calibrations).
- Document all calibration activities and results on the field instrument calibration log or in the field book.
- If the instrument malfunctions and cannot be corrected, obtain a replacement.
- Clean and decontaminate the instrument after use and before storage.
- Conduct calibration checks at least once per day or as needed.

The subsections that follow provide additional details and guidance regarding calibration for specific parameters; however, since every field instrument is different, refer to the specific instrument's manual for appropriate operating and calibration procedures.

2.1 Temperature

Most instrument manuals state that calibration of the temperature sensor is not required, but this SOP recommends that the temperature sensor be checked to verify its accuracy. This accuracy check should be performed at least once per year and the accuracy check date/information should be kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was performed over a year prior to the date of use, it is recommended that the temperature sensor accuracy be checked at the beginning of the sampling event. If the instrument contains multiple temperature sensors, each sensor should be checked. Accuracy checks may be performed by the manufacturer/equipment supplier or in the field. Review the calibration certificate provided by the equipment supplier.

In the event of suspect temperature readings, the following verification procedure can be performed.

FIELD VERIFICATION PROCEDURE

1. Record the manufacturer, model number, and the certification number of the NIST thermometer being used to check the instrument's temperature sensor on the field instrument calibration log or in the field book. Allow a container filled with water to equilibrate to ambient temperature.

2. Place an NIST thermometer and the instrument's temperature sensor into the water, and wait approximately 2 to 3 minutes for both temperature readings to stabilize.

3. Record the temperature displayed by the thermometer and the temperature sensor on the field instrument calibration log or in the field book.

4. Compare the two measurements. The instrument's temperature sensor must agree with the NIST thermometer measurement within the accuracy of the sensor (typically ±0.15ºC). If the measurements do not agree, determine the correction factor to be applied to any subsequent temperature measurements made with this instrument. This correction factor must be applied to all readings made with the temperature sensor of this instrument.

   Correction Factor = NIST thermometer value – temperature sensor value

5. Record the date the temperature sensor check was performed and the correction factor that was determined, if applicable, on the field instrument calibration log or in the field book.

2.2 Dissolved Oxygen

DO is the volume of oxygen that is dissolved in water and is typically measured using an electrochemical membrane sensor.

CAUTIONS AND POTENTIAL PROBLEMS WITH DO MEASUREMENTS

- The DO probe's membrane and electrolyte solution should be checked prior to the sampling period and replaced if needed. If wrinkles or air bubbles are present under the membrane, if the membrane is torn or dirty, or if the electrolyte solution looks contaminated, replace both the membrane and electrolyte solution prior to calibration. Failure to perform this step may lead to erratic or erroneous measurements.
- Rental instruments are routinely maintained by the vendor, but the membrane should be checked for signs of wear upon receipt.
- If the probe reading shows the error message, "value out of range", the instrument probe must be recalibrated at a minimum. If the error persists, replace the sensor membrane and recalibrate.
- Most meters will allow you to calibrate the meter in air or against a wet sponge, which gives a "saturated air" calibration. Like pH, conductivity, and ORP, DO is heavily dependent on temperature. DO is also dependent upon barometric pressure. Typically DO is calibrated by entering the barometric pressure (usually in mm of mercury). Barometric pressure is dependent upon elevation, so be aware of substantial differences in elevation between your sampling location and the location from which you are

obtaining the barometric pressure reading. Use the Oxygen Solubility at Indicated Pressure chart in Attachment A for comparison to your calibrated reading.

- Barometric pressure should be corrected to local altitude for DO calibration:

  True BP (mm Hg) = [Corrected BP (mm Hg)] – [2.5 * Local Altitude (ft. above sea level)/100]

- If the calibration cup is used for DO, ensure the cup is loose to allow for pressure equilibration.
- Wait 3 to 5 minutes for the air in the cup to saturate with water during DO calibration.
- If calibrating in air, remove water droplets from the membrane by shaking the probe prior to inserting it into the calibration environment.
- Allow the temperature to stabilize completely in the calibration environment.
- Always keep the sensor clean of biofouling, such as bacteria or algae growth which may generate or consume oxygen resulting in erroneous readings.
- Keep the sensor free of oil, which could clog the membrane and prevent oxygen from diffusing to the sensor.
- Store the probe in a moist environment to keep the membrane from drying out, but do not store it in water which could encourage algae growth on the probe.

CALIBRATION PROCEDURE

1. Gently dry the temperature sensor according to manufacturer's instructions.

2. Place a wet sponge, a wet paper towel, or 1/8 inch of water on the bottom of the DO calibration container that comes with the instrument. (The protective cover of the probe assembly also serves as the container used for the DO calibration.)

3. Place the DO probe in the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit loosely in the container to ensure it is vented to the atmosphere.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 3 to 5 minutes as temperature becomes stable). During this time, turn on the instrument to allow the DO probe to warm up (may require at least 10-20 minutes warm-up time).

5. Record the barometric pressure (usually in mm of mercury) from the instrument's onboard sensor, if available. If the instrument does not have an onboard barometer, this measurement can also be determined from an on-site barometer if a weather station is on site and manually entered into the meter. It is recommended that the barometric pressure not be obtained from the local weather service unless the pressure is corrected for the elevation of the sampling location and this is the only source of barometric data. [**Note:** inches of mercury times 25.4 mm/inch mercury equals mm of mercury].

6. Record the DO reading in mg/L and percent and compare this reading to the Oxygen Solubility at Indicated Pressure chart in Attachment A. For example, if the barometric

pressure is 750 mm Hg and the temperature inside the calibration cup is 25°C, the DO in mg/L reading should be 8.13 mg/L. Record this value on the field instrument calibration log.

7. If the values recorded on the field instrument calibration log for DO in mg/L do not agree with the published values from Attachment A and are not within the accuracy of the instrument (such as ± 0.2 mg/L and ± 2%, depending on the reading), repeat calibration. If this does not work, change the membrane and electrolyte solution and repeat calibration.

8. Remove the probe from the container, rinse it with deionized water, pat it dry with a towel, and place it into a zero (0.0 mg/L) DO standard if being used as part of the calibration. Fill the protective cup with the fresh zero DO standard. Pour the zero DO standard into the protective cup; the standard should be close enough to the top, so that the DO probe fits tightly into the container (no headspace). Check and record the unit's temperature reading.

9. Wait until the "mg/L DO" readings have stabilized. The instrument should read between -0.5 and +0.5 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L) within 3 minutes. Record this value on the field instrument calibration log. If the instrument does not reach this value, it may be necessary to clean the probe and change the membrane and electrolyte solution. Repeat the zero DO step if the value obtained is not acceptable. If this does not work, prepare a new 0.0 mg/L standard. If these procedures do not work, consult the equipment vendor for troubleshooting or equipment replacement.

   NOTE: For Zero DO checks: The solution used for this check contains sodium meta-bisulfite or sodium sulfite, which are harmful to the sensor and membrane. It is common practice to recalibrate the meter to 100% saturation after conducting a zero DO check to confirm that the sensor is still operating correctly. A zero DO check is not performed every day the instrument is in use for this reason, but a check should be performed at a minimum of once per sampling event. If conducting this check, be sure to record the manufacturer, true value, lot number, and expiration date of the solution on the field instrument calibration log.

2.3 pH

The pH is the measure of the degree of the acidity or alkalinity of a solution as measured on a scale of 0 to 14 SU. The pH of a sample is determined electrometrically using a glass electrode. All pH measurements are in SU.

CAUTIONS AND POTENTIAL PROBLEMS WITH PH MEASUREMENTS

- Choose the appropriate buffered standards that will bracket the expected values at the sampling locations. For ground water, the pH will usually be close to 7 SU. A minimum of two standards are typically needed for the calibration: one close to 7 SU, one at least two pH units below 7 SU or at least two pH units above 7 SU. The instrument will need to be re-calibrated if the water sample's pH is outside the range defined by the two standards used in the initial calibration, either by adding a third calibration point (if the meter will allow) or by selecting two new pH standards that bracket the water sample's pH.
- Regardless if performing a two- or three-point calibration, always calibrate with pH 7 buffer first.

CALIBRATION PROCEDURE

1. Allow the buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the buffered standards to ensure the pH probe and temperature sensor are completely submerged.

3. Remove the cover of the probe, rinse the probe in a cup filled with deionized water or use a spray bottle, and blot the probe dry with a soft tissue.

4. Enter the value of the first pH buffer solution (e.g., pH 7), immerse the probe in the standard, and allow at least 1 minute for temperature equilibration before proceeding. Record the temperature on the field instrument calibration log.

5. Enter the buffered solution value (7) into the pH calibration menu of the instrument. Allow the pH reading to stabilize for approximately 30 seconds, and if the reading does not change, finish the calibration and record the calibrated value on the field instrument calibration log. The calibration values after adjustment shall be within the accuracy of the instrument, or as required by the project. For example, if the accuracy of the meter is ±0.1 SU, then the calibration values after adjustment shall be between 6.9 and 7.1 SU. If the calibration values after adjustment are outside of this range, recalibrate. If readings continue to fluctuate or readings do not stabilize after recalibration, consult the equipment vendor for troubleshooting or equipment replacement (e.g., may need a new pH electrode).

6. Remove probe from the initial buffer solution, rinse in a cup filled with deionized water or use a spray bottle, and blot dry with soft tissue. Dispose of the used buffer solution.

7. Immerse probe into the second buffer solution (e.g., pH 4). Repeat step #5, substituting “4” into the pH calibration menu instead of “7”.

8. Remove probe from the second buffer solution, rinse in a cup filled with deionized water or use a spray bottle, and blot dry with soft tissue. Dispose of the used buffer solution.

9. Immerse probe in third buffer solution (e.g., pH 10) or continue to step #11 if only a two-point calibration is being performed. Repeat step #5, substituting “10” into the pH calibration menu instead of “7”.

10. Remove probe from the third buffer solution, rinse in a cup filled with deionized water or use a spray bottle, and blot dry with soft tissue. Dispose of the used buffer solution.

11. To perform the instrument pH check, select monitoring/run mode, (ensure that the initial buffer solution temperature [pH 7] has not changed), and immerse the probe into the buffer solution. Wait for the reading to stabilize. The instrument should read the initial standard value (7 SU) within the accuracy of the instrument, or as required by the project. Record the pH 7 check reading on the field instrument calibration log. If the reading is not within the acceptance criteria, then re-calibrate the instrument. If re-calibration does not correct the instrument reading, then the calibration range may be too wide. Reducing the calibration range by using standards that are closer together may improve the instrument’s accuracy.

2.4 Specific Conductance

Conductivity is used to measure the ability of an aqueous solution to conduct an electrical current. Specific conductance is the conductivity value corrected to 25ºC. Calibrating an instrument for specific conductance automatically calibrates the instrument for conductivity and vice-versa.

CAUTIONS AND POTENTIAL PROBLEMS WITH SPECIFIC CONDUCTANCE MEASUREMENTS

- Most instruments are calibrated against a single standard that is near the specific conductance of the environmental samples. A second standard that is above the environmental sample specific conductance can be used to check the linearity of the instrument in the range of measurements. However, a single-point calibration standard is adequate to assess the accuracy and operation of the sensor.
- Calibrate the conductivity with a standard near the anticipated conductivity of the water. For fresh water, a 1 mS/cm standard is appropriate.
- For some meters, it is important that the top vent hole of the conductivity sensor be immersed during the calibration. Review the instrument manual to determine if this is required.
- Specific conductance/conductivity can have different units (e.g., mmho/cm, mS/cm, µmho/cm, µS/cm), especially on auto-ranging instruments. Note: mhos/cm = Siemens/cm. Check with the Project Manager or database manager to determine if field measurements should be restricted to a consistent unit (e.g., µmhos/cm or µS/cm, not mmhos/cm or mS/cm) so that conversion is not necessary when importing data into a database.
- Be aware of meters which autocorrect for temperature and how to enter the calibration value per the procedures in the instrument's manual. To calibrate instruments that autocorrect for temperature, enter the calibration value of the solution (µmhos/cm at 25°C). For instruments without automatic temperature compensation, the solution's conductivity value must be corrected for the temperature that the sensor is reading before entering the value into the meter. In some cases, you may be able to adjust the temperature of the calibration solution to near 25°C, such that the standard calibration value is applicable; otherwise an adjustment for temperature needs to be accounted for. Additionally, if calibrating for conductivity instead of specific conductance, the solution's conductivity value must be corrected for the temperature that the sensor is reading.

CALIBRATION PROCEDURE

1. Allow the calibration standard to equilibrate to the ambient temperature.

2. Remove probe from its storage container, rinse the probe with a small amount of deionized water, and pat dry the sensor with a soft tissue.

3. Lower the sensor into the conductivity standard. Gently move the probe up and down in the solution to remove any air bubbles from the sensor if present. Allow the probe to sit in the solution for at least 30 seconds to allow values to equilibrate before proceeding.

4. Enter the calibration value of the solution (e.g., 1,413 µmhos/cm at 25°C). Record the temperature of the solution on the field instrument calibration log, and allow the specific conductance reading to stabilize for approximately 30 seconds. Record the calibrated value after stabilization on the field instrument calibration log. The reading should be within ±5% of the true value. If the reading is not within this range, recalibrate. If readings continue to fluctuate significantly after a recalibration, consult the equipment vendor for troubleshooting or equipment replacement.

5. Remove probe from the standard, rinse the probe with deionized water, and replace the protective cover over the sensors.

2.5 Oxidation-Reduction Potential (ORP)

The oxidation-reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent.

CAUTIONS AND POTENTIAL PROBLEMS WITH ORP MEASUREMENTS

- Note that ORP is not usually the same as Eh. Eh is ORP measured relative to a standard hydrogen electrode (SHE). Typical ORP reference electrodes used in the field are Ag/AgCl electrodes, not SHEs. The difference is that Eh would be approximately 200mV higher than ORP measured against a Ag/AgCl reference electrode. See Standard Methods 2580B and YSI Tech Note (2005) for more details.
- Some meters allow you to calibrate ORP, but many do not allow calibration. Testing solutions are available to verify your ORP reading but they are not accurate enough to be used as calibration standards.
- ORP is temperature dependent. Look up the millivolt (mV) calibration value at the measured temperature from the millivolt versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. It may be necessary to interpolate millivolt values between temperatures.

CALIBRATION OR VERIFICATION PROCEDURE

1. Allow the calibration standard (e.g., a Zobell solution) to equilibrate to ambient temperature.

2. Remove the cover of the probe, and place it into the standard.

3. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.

4. Look up the millivolt (mV) value at this temperature from the millivolt versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. It may be necessary to interpolate millivolt values between temperatures. Enter the temperature-corrected ORP value, and calibrate the instrument. Record the values on the field instrument calibration log.

5. The reading should remain unchanged within manufacturer's specifications. If it changes, re-calibrate. If readings continue to change after calibration, consult the manufacturer.

6. If the instrument instruction manual states the instrument is factory calibrated, then verify the factory calibration against the standard. If the reading does not agree with the standard within the accuracy of the instrument, the instrument will need to be re-calibrated by the manufacturer.

2.6 Turbidity

Turbidity refers to how clear the water is and is a measure of relative sample clarity. The greater the amount of total suspended solids in the water, the higher the measured turbidity. The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidity meter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed 90 degrees to the path of the light source. Turbidity values are recorded in NTUs.

CAUTIONS AND POTENTIAL PROBLEMS WITH TURBIDITY MEASUREMENTS

- Some instruments will only accept one standard. For these instruments, the standards will serve as check points.
- Some regulatory agencies will not allow turbidity measurements through a flow-through cell, and require a stand alone turbidity meter. Verify that the selected meter will meet project objectives prior to use.
- For the greatest accuracy during the calibration procedure, ensure that after the meter is blanked and the blank is scanned as a sample, the reading is 0.00 NTU. If not, re-zero the meter and scan the blank again until it reads 0.00 NTU. When scanning the calibration standards as the sample, scan the calibration standard three times removing the tube from the chamber after each scan. The readings should be consistent. Use the last consistent reading to calibrate the meter. If the readings are not consistent, avoid using an aberrant reading to calibrate the meter.
- The meter should be placed on a surface that is free from vibrations. Vibrations can cause high readings.
- Gently mix the sample by inverting before taking a reading, but avoid introducing air bubbles.
- Scratches, fingerprints, and water droplets on the outside of the cuvettes can cause additional light scatter, leading to inaccurate readings. If necessary, wipe the outside of the cuvette with a soft tissue. If the cuvette is scratched or dirty, discard.
- Ensure that the cuvette is always placed in the chamber in the same orientation, as differences in orientation can cause differences in results. Proper cuvette orientation may be indicated by a mark or arrow on both the cuvette and the instrument.

CALIBRATION PROCEDURES – STAND ALONE TURBIDITY METER

NOTE: Sometimes standards are provided in the cuvette with the meter.

1. Rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe the inside of the cuvette, because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.

2. Place the 0.0 NTU standard into the instrument and scan the sample (measure the standard). Record the reading on the field instrument calibration log. The 10.0 NTU standard can be measured after the 0.0 NTU standard is scanned.

3. Select the 10.0 NTU standard and scan the sample (measure the standard). The reading should be within ±10% of the true value. Record the reading on the field instrument calibration log. If the reading is within the acceptance criteria, then move on to step # 5. If not, calibrate the instrument to 10.0 NTU. Record the reading and any significant changes on the field instrument calibration log.

4. After adjusting the calibration, re-read the 10.0 NTU standard to ensure it is now meeting accuracy requirements. If not, repeat step #3. Otherwise, continue to step #5.

5. Repeat step #3, if needed, for the 1.0 NTU standard.

6. After adjusting the calibration, re-read the 1.0 NTU standard to ensure it is now meeting accuracy requirements (±10% of the true value). If not, repeat step #3. Otherwise, continue to step #7.

7. As a final check of the instrument, scan the blank (0.0 NTU standard). The unit display should read very close to zero. Record the reading on the field instrument calibration log.

   NOTE: If during the calibration procedure, you find the value of the standard is >50% from the expected value (e.g., 0.49 NTU for the 1.0 NTU standard), scrolling to the true value (e.g., 1.0 NTU) and attempting to calibrate will result in an error code, because the value to which you have changed it is >50% of the expected value of the standard. In this case, it is necessary to re-calibrate the unit from the beginning starting with a blank. If this fails to produce adjustable and reproducible values for the 1.0 and 10.0 NTU standards, re-calibrate using new standards and discard the current standards. If the meter still fails to calibrate following repeated attempts at calibration, consult the equipment vendor for troubleshooting or equipment replacement.

   NOTE: If only performing a two-point calibration (depending on project requirements), the 0.0 NTU and 10 NTU (or comparable NTU level) standards should be used.

CALIBRATION PROCEDURES – MULTI-PARAMETER METER WITH FLOW-THROUGH CELL

This is a two point calibration with a standard and turbidity free water. The standard can be formazin, polymer beads, or a meter-specific quick calibration solution. Turbidity free water can be obtained by filtering distilled or deionized water through a 0.1, 0.3, or 0.45 micron filter.

1. Rinse the calibration cup and sensors with the turbidity free water. Fill the cup with enough water so that the turbidity sensor is covered (sensors pointed down).

2. Scan the sample (measure the standard). After the reading has stabilized, enter the zero turbidity value into the meter in accordance with manufacturer directions and record the reading on the field instrument calibration log.

3. Rinse the calibration cup and sensors with the standard solution. Fill the cup with enough standard solution so that the turbidity sensor is covered (sensors pointed down).

4. Scan the sample (measure the standard). After the reading has stabilized, enter the standard solution turbidity value into the meter in accordance with manufacturer directions and record the reading on the field instrument calibration log. If the reading is within the acceptance criteria, calibration is complete. If not, recalibrate the instrument. Record the reading and any significant changes on the field instrument calibration log.

   NOTE: If during the calibration procedure, you find the value of the standard is outside of the range acceptable by the meter and attempting to calibrate results in an error code, it is necessary to re-calibrate the unit from the beginning starting with a blank/turbidity free water. If this fails to produce acceptable and reproducible values for the standards, re-calibrate using new standards and discard the current standards. If the meter still fails to calibrate following repeated attempts at calibration, consult the equipment vendor for troubleshooting or equipment replacement.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager.

Each project must consider investigation-derived waste disposal methods and have a plan in place prior to performing the field work. Provisions must be in place as to what will be done with investigation-derived waste. If investigation-derived waste cannot be returned to the site, consider material containment, such as a composite drum or roll-off bin, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

In addition to checking the calibration of instruments prior to measurements, calibration checks may also be required at other times of the day. If there are significant temperature fluctuations or erroneous readings, a calibration check may be required. Some programs require a post-calibration check at the conclusion of the day to ensure that instrument drift has not occurred. Refer to the site-specific work plan for calibration frequency.

Comparing current values with historical values at the same measuring location can be helpful in assessing instrument and calibration reliability.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

All work must be dated and signed by the analyst. Any changes should be crossed out with a single line, initialed, and dated.

Prior to calibrating, the field equipment and calibration standard information should be recorded on a field instrument calibration log and/or in the field book. For field equipment, the information recorded should include the make, model number, and the serial number of the instrument. Each instrument can be assigned an identification number that can be referenced in future field notes or when filling out the field instrument calibration log.

For calibration standards, the information recorded should include the manufacturer, expiration date, true value, and any other description, such as lot number. Each calibration standard can also be assigned an identification number that can be referenced in future field notes or when filling out the field instrument calibration log. If standards are not supplied with an expiration date, the standards should be initialed and dated when received and when opened (not applicable for standards supplied with the rental equipment).

The calibration records provided by the equipment vendor and the certificates of analysis for each standard will be maintained in the project files.

All calibration measurements must be documented in the field book or on a separate field instrument calibration log. Example field instrument calibration logs are presented in Attachment B. At a minimum, the field instrument calibration log must include the instrument information described above, calibration standard information described above, calibration date, and the instrument calibration results.

6.0 REFERENCES

USEPA. January 19, 2010. *Standard Operating Procedure, Calibration of Field Instruments*, Revision No. 2. USEPA Region I.

American Public Health Association, American Water Works Association, and Water Environment Federation. January 2012. *Standard Methods for the Examination of Water and Wastewater*, 22nd Edition.

YSI Environmental. 2005. *Measuring ORP on YSI 6-Series Sondes: Tips, Cautions and Limitations*. YSI Environmental Tech Note. http://www.ysi.com/media/pdfs/T608-Measuring-ORP-on-YSI-6-Series-Sondes-Tips-Cautions-and-Limitations.pdf.

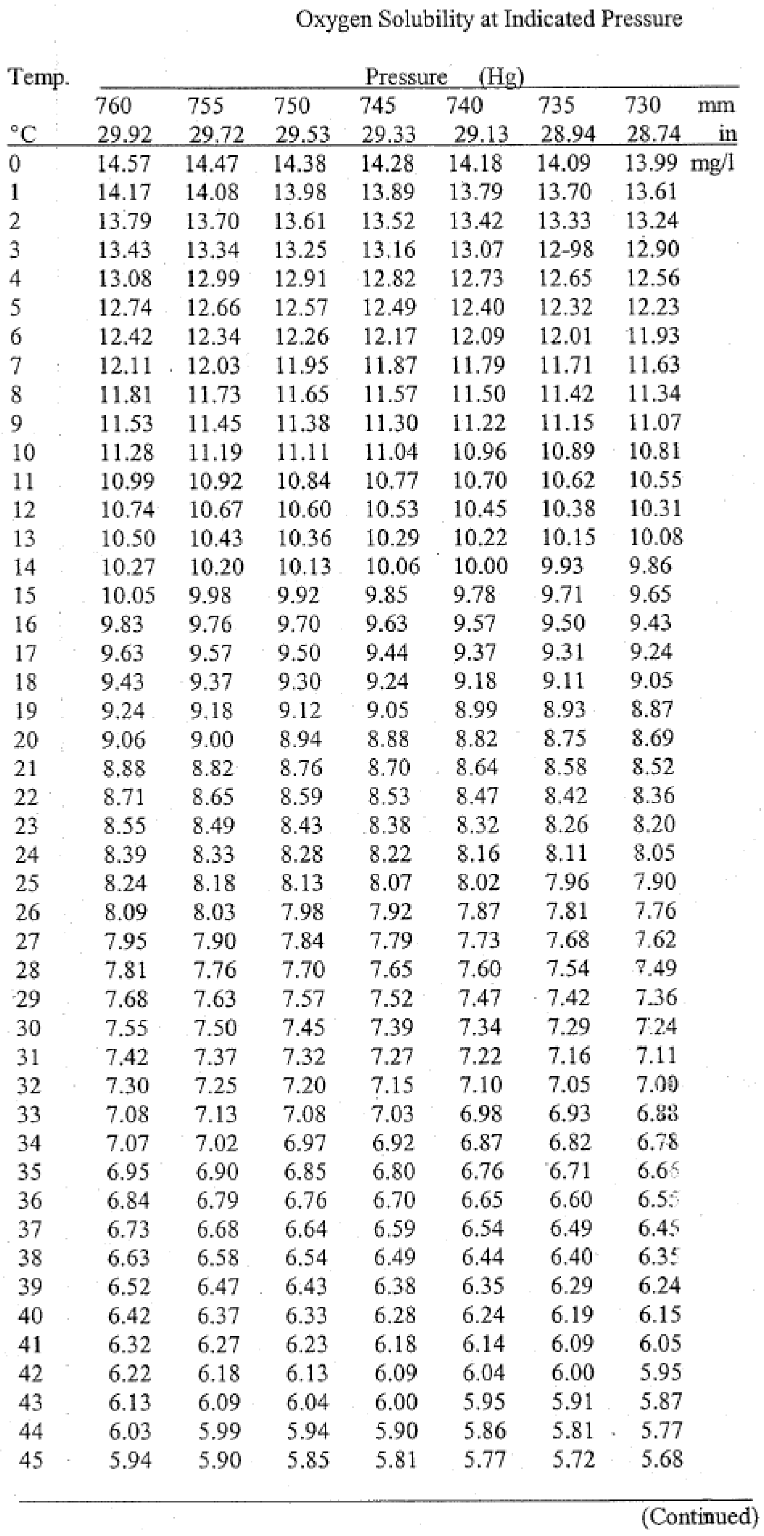
7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
0	NOVEMBER 2014	NOT APPLICABLE
1	JANUARY 2020	TRC RE-BRANDING AND SOP RE-NUMBERING

Attachment A

Oxygen Solubility at Indicated Pressure

Attachment A (page 1 of 2)



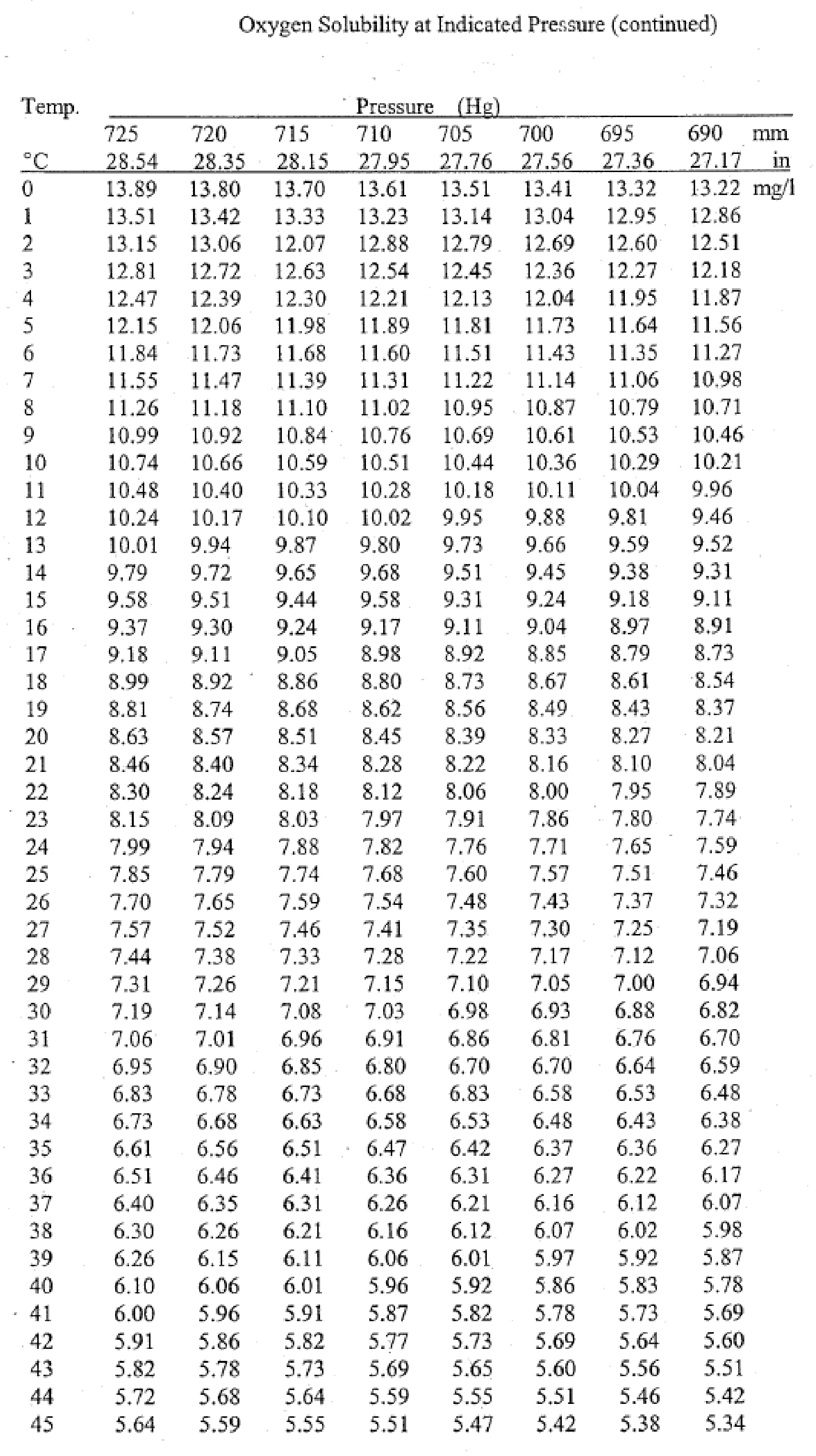
Oxygen Solubility at Indicated Pressure

Temp.	Pressure (Hg)							
	760	755	750	745	740	735	730	mm
°C	29.92	29.72	29.53	29.33	29.13	28.94	28.74	in
0	14.57	14.47	14.38	14.28	14.18	14.09	13.99	mg/l
1	14.17	14.08	13.98	13.89	13.79	13.70	13.61	
2	13.79	13.70	13.61	13.52	13.42	13.33	13.24	
3	13.43	13.34	13.25	13.16	13.07	12-98	12.90	
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56	
5	12.74	12.66	12.57	12.49	12.40	12.32	12.23	
6	12.42	12.34	12.26	12.17	12.09	12.01	11.93	
7	12.11	12.03	11.95	11.87	11.79	11.71	11.63	
8	11.81	11.73	11.65	11.57	11.50	11.42	11.34	
9	11.53	11.45	11.38	11.30	11.22	11.15	11.07	
10	11.28	11.19	11.11	11.04	10.96	10.89	10.81	
11	10.99	10.92	10.84	10.77	10.70	10.62	10.55	
12	10.74	10.67	10.60	10.53	10.45	10.38	10.31	
13	10.50	10.43	10.36	10.29	10.22	10.15	10.08	
14	10.27	10.20	10.13	10.06	10.00	9.93	9.86	
15	10.05	9.98	9.92	9.85	9.78	9.71	9.65	
16	9.83	9.76	9.70	9.63	9.57	9.50	9.43	
17	9.63	9.57	9.50	9.44	9.37	9.31	9.24	
18	9.43	9.37	9.30	9.24	9.18	9.11	9.05	
19	9.24	9.18	9.12	9.05	8.99	8.93	8.87	
20	9.06	9.00	8.94	8.88	8.82	8.75	8.69	
21	8.88	8.82	8.76	8.70	8.64	8.58	8.52	
22	8.71	8.65	8.59	8.53	8.47	8.42	8.36	
23	8.55	8.49	8.43	8.38	8.32	8.26	8.20	
24	8.39	8.33	8.28	8.22	8.16	8.11	8.05	
25	8.24	8.18	8.13	8.07	8.02	7.96	7.90	
26	8.09	8.03	7.98	7.92	7.87	7.81	7.76	
27	7.95	7.90	7.84	7.79	7.73	7.68	7.62	
28	7.81	7.76	7.70	7.65	7.60	7.54	7.49	
29	7.68	7.63	7.57	7.52	7.47	7.42	7.36	
30	7.55	7.50	7.45	7.39	7.34	7.29	7.24	
31	7.42	7.37	7.32	7.27	7.22	7.16	7.11	
32	7.30	7.25	7.20	7.15	7.10	7.05	7.00	
33	7.08	7.13	7.08	7.03	6.98	6.93	6.88	
34	7.07	7.02	6.97	6.92	6.87	6.82	6.78	
35	6.95	6.90	6.85	6.80	6.76	6.71	6.66	
36	6.84	6.79	6.76	6.70	6.65	6.60	6.55	
37	6.73	6.68	6.64	6.59	6.54	6.49	6.45	
38	6.63	6.58	6.54	6.49	6.44	6.40	6.35	
39	6.52	6.47	6.43	6.38	6.35	6.29	6.24	
40	6.42	6.37	6.33	6.28	6.24	6.19	6.15	
41	6.32	6.27	6.23	6.18	6.14	6.09	6.05	
42	6.22	6.18	6.13	6.09	6.04	6.00	5.95	
43	6.13	6.09	6.04	6.00	5.95	5.91	5.87	
44	6.03	5.99	5.94	5.90	5.86	5.81	5.77	
45	5.94	5.90	5.85	5.81	5.77	5.72	5.68	

(Continued)

Table taken from EPA Region I SOP, Calibration of Field Instruments, January 10, 2010.

Attachment A (Page 2 of 2)



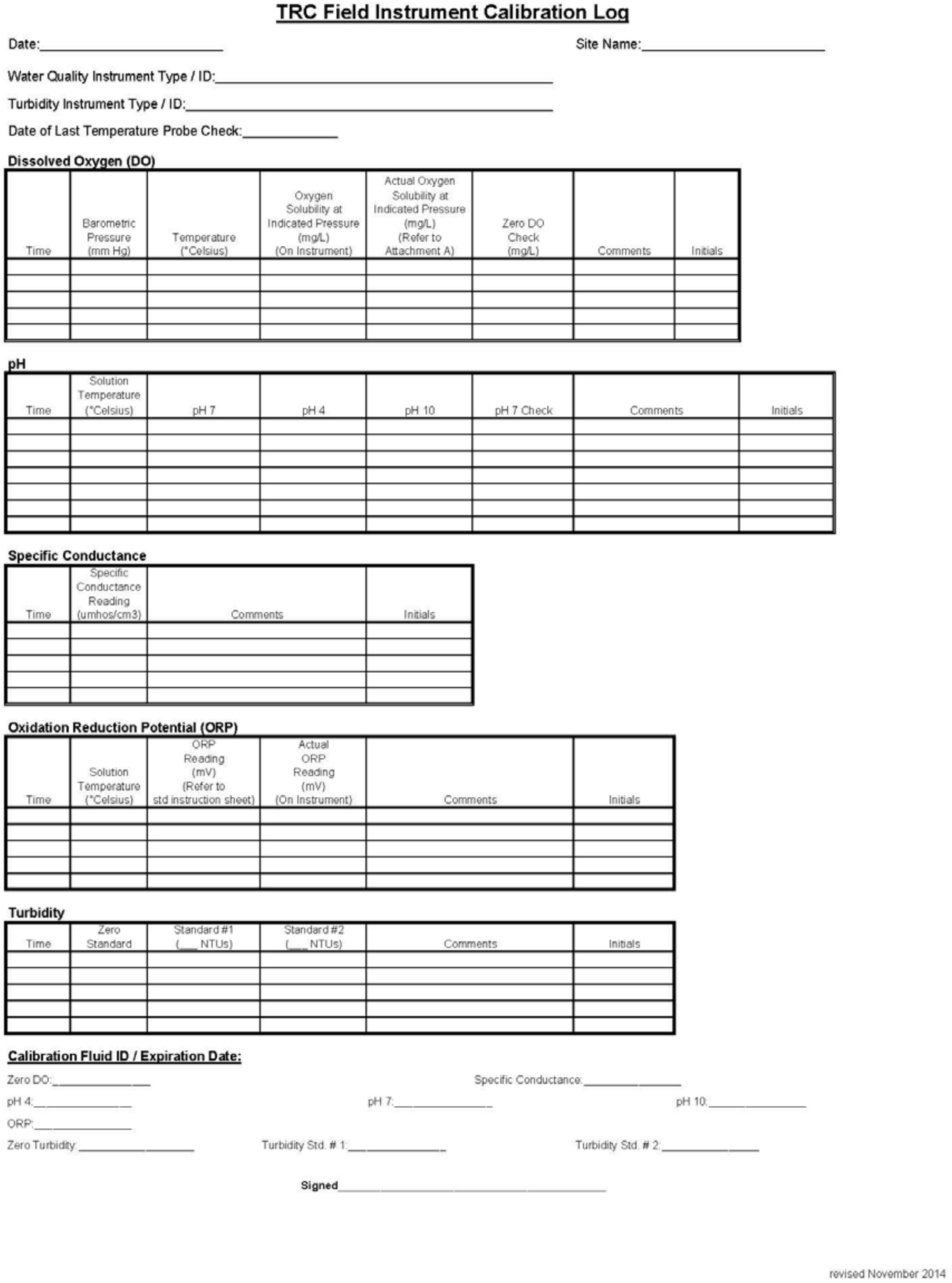
Oxygen Solubility at Indicated Pressure (continued)

Temp.	Pressure (Hg)								
	725	720	715	710	705	700	695	690	mm
°C	28.54	28.35	28.15	27.95	27.76	27.56	27.36	27.17	in
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22	mg/l
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86	
2	13.15	13.06	12.07	12.88	12.79	12.69	12.60	12.51	
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18	
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87	
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56	
6	11.84	11.73	11.68	11.60	11.51	11.43	11.35	11.27	
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98	
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71	
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.46	
10	10.74	10.66	10.59	10.51	10.44	10.36	10.29	10.21	
11	10.48	10.40	10.33	10.28	10.18	10.11	10.04	9.96	
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.46	
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52	
14	9.79	9.72	9.65	9.68	9.51	9.45	9.38	9.31	
15	9.58	9.51	9.44	9.58	9.31	9.24	9.18	9.11	
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.91	
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.73	
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54	
19	8.81	8.74	8.68	8.62	8.56	8.49	8.43	8.37	
20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21	
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04	
22	8.30	8.24	8.18	8.12	8.06	8.00	7.95	7.89	
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74	
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59	
25	7.85	7.79	7.74	7.68	7.60	7.57	7.51	7.46	
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32	
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19	
28	7.44	7.38	7.33	7.28	7.22	7.17	7.12	7.06	
29	7.31	7.26	7.21	7.15	7.10	7.05	7.00	6.94	
30	7.19	7.14	7.08	7.03	6.98	6.93	6.88	6.82	
31	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.70	
32	6.95	6.90	6.85	6.80	6.70	6.70	6.64	6.59	
33	6.83	6.78	6.73	6.68	6.83	6.58	6.53	6.48	
34	6.73	6.68	6.63	6.58	6.53	6.48	6.43	6.38	
35	6.61	6.56	6.51	6.47	6.42	6.37	6.36	6.27	
36	6.51	6.46	6.41	6.36	6.31	6.27	6.22	6.17	
37	6.40	6.35	6.31	6.26	6.21	6.16	6.12	6.07	
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98	
39	6.26	6.15	6.11	6.06	6.01	5.97	5.92	5.87	
40	6.10	6.06	6.01	5.96	5.92	5.86	5.83	5.78	
41	6.00	5.96	5.91	5.87	5.82	5.78	5.73	5.69	
42	5.91	5.86	5.82	5.77	5.73	5.69	5.64	5.60	
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51	
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42	
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34	

Table taken from EPA Region I SOP, Calibration of Field Instruments, January 10, 2010.

Attachment B

Example Field Instrument Calibration Logs



TRC Field Instrument Calibration Log

Date:_________________________ Site Name:_________________________

Water Quality Instrument Type / ID:____

Turbidity Instrument Type / ID:____

Date of Last Temperature Probe Check:_____________

Dissolved Oxygen (DO)

Time	Barometric Pressure (mm Hg)	Temperature (°Celsius)	Oxygen Solubility at Indicated Pressure (mg/L) (On Instrument)	Actual Oxygen Solubility at Indicated Pressure (mg/L) (Refer to Attachment A)	Zero DO Check (mg/L)	Comments	Initials

pH

Time	Solution Temperature (°Celsius)	pH 7	pH 4	pH 10	pH 7 Check	Comments	Initials

Specific Conductance

Time	Specific Conductance Reading (umhos/cm3)	Comments	Initials

Oxidation Reduction Potential (ORP)

Time	Solution Temperature (°Celsius)	ORP Reading (mV) (Refer to std instruction sheet)	Actual ORP Reading (mV) (On Instrument)	Comments	Initials

Turbidity

Time	Zero Standard	Standard #1 (___ NTUs)	Standard #2 (___ NTUs)	Comments	Initials

Calibration Fluid ID / Expiration Date:

Zero DO:_______________ Specific Conductance:_______________

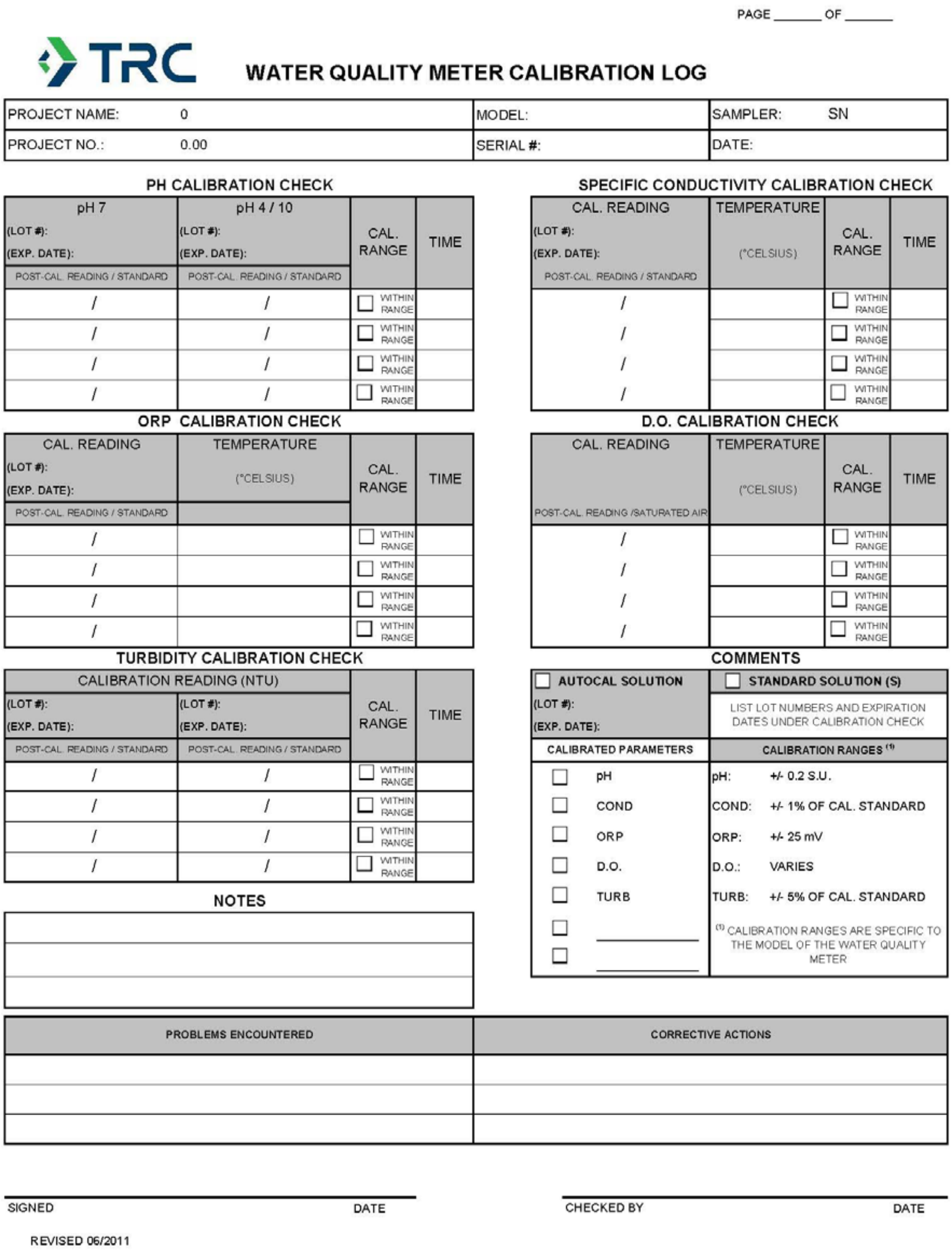
pH 4:_______________ pH 7:_______________ pH 10:_______________

ORP:_______________

Zero Turbidity:__________________ Turbidity Std. # 1:_______________ Turbidity Std. # 2:_______________

Signed____

revised November 2014



PAGE ______ OF ______

WATER QUALITY METER CALIBRATION LOG

PROJECT NAME:	0	MODEL:		SAMPLER:	SN
PROJECT NO.:	0.00	SERIAL #:		DATE:	

PH CALIBRATION CHECK

pH 7 **(LOT #):** **(EXP. DATE):** POST-CAL. READING / STANDARD	pH 4 / 10 **(LOT #):** **(EXP. DATE):** POST-CAL. READING / STANDARD	CAL. RANGE	TIME
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	

SPECIFIC CONDUCTIVITY CALIBRATION CHECK

CAL. READING **(LOT #):** **(EXP. DATE):** POST-CAL. READING / STANDARD	TEMPERATURE (°CELSIUS)	CAL. RANGE	TIME
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	

ORP CALIBRATION CHECK

CAL. READING **(LOT #):** **(EXP. DATE):** POST-CAL. READING / STANDARD	TEMPERATURE (°CELSIUS)	CAL. RANGE	TIME
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	

D.O. CALIBRATION CHECK

CAL. READING POST-CAL. READING /SATURATED AIR	TEMPERATURE (°CELSIUS)	CAL. RANGE	TIME
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	

TURBIDITY CALIBRATION CHECK

CALIBRATION READING (NTU)		CAL. RANGE	TIME
(LOT #): **(EXP. DATE):** POST-CAL. READING / STANDARD	**(LOT #):** **(EXP. DATE):** POST-CAL. READING / STANDARD		
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	

COMMENTS

☐ **AUTOCAL SOLUTION** **(LOT #):** **(EXP. DATE):**		☐ **STANDARD SOLUTION (S)** LIST LOT NUMBERS AND EXPIRATION DATES UNDER CALIBRATION CHECK	
CALIBRATED PARAMETERS		**CALIBRATION RANGES (1)**	
☐	pH	pH:	+/- 0.2 S.U.
☐	COND	COND:	+/- 1% OF CAL. STANDARD
☐	ORP	ORP:	+/- 25 mV
☐	D.O.	D.O.:	VARIES
☐	TURB	TURB:	+/- 5% OF CAL. STANDARD
☐	____________	(1) CALIBRATION RANGES ARE SPECIFIC TO THE MODEL OF THE WATER QUALITY METER	
☐	____________		

NOTES

PROBLEMS ENCOUNTERED	CORRECTIVE ACTIONS

SIGNED DATE

CHECKED BY DATE

REVISED 06/2011

Attachment C

SOP Fact Sheet

WATER QUALITY PARAMETER INSTRUMENT CALIBRATION

PURPOSE AND OBJECTIVE

Before a meter is utilized in the field, it will be calibrated and checked in accordance with this SOP to ensure proper operation. Water quality instruments addressed in this SOP include those that measure temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, oxidation-reduction potential (ORP), and turbidity for the purposes of field screening and field measurements.

WHAT TO BRING

- Appropriate Level of PPE
- Field book
- Field instrument calibration logs
- Water quality meter capable of measuring one or more of the following based on project scope: pH, temperature, DO, specific conductivity, and ORP (e.g., YSI 600XL, Horiba U-50, Hydrolab Quanta/QED MP-20, or equivalent)
- Deionized water
- Flow-through cell
- Ring stand with clamp
- Paper towels
- Soft tissue (e.g., Kimwipes®)
- Cuvettes
- Buffer solutions at pH 4, 7 and 10 standard units (SU)*
- Conductivity solution (potassium chloride, typically 1,413 µhos/cm)*
- ORP calibration solution (e.g., Zobell)*
- Turbidity standards (0, 1, 10 nephelometric turbidity units [NTUs] or StablCal Kit)*
- Zero DO solution (0.0 mg/L)*
- DO membrane kit (electrolyte solution, membranes)
- NIST thermometer (0.2°C accuracy)*
- Small glass or polyethylene jars to hold the calibration standards (4-8 oz.)
- Cup or spray bottle for the deionized water

*Dependent on the project-specific requirements and the instrument manufacturer

OFFICE

- Review project work plan and confirm what field measurements are required based on the scope of work
- Confirm that all necessary equipment (including necessary calibration solutions) are available in-house or order if necessary.
- All meters may have different relative accuracy, which will be specified in the instrument manual. Confirm that the meter being used meets the project's accuracy requirements.
- Confirm that a copy of the manufacturer's instruction manual is available to accompany the instrument into the field.
- Properly clean/decontaminate the instrument before storage or returning equipment to rental vendor.

CALIBRATION PROCEDURES

- Prior to use, inspect instruments to ensure instruments are clean, check for possible malfunctions, and calibrate in accordance with manufacturer's procedures. Note: The initial calibration may be performed in the office prior to the field event or by the equipment supplier; however, calibration checks should be performed on site prior to use on the day of the fieldwork.
- Calibration checks (or verifying that instrument readings fall within an acceptable range of a standard without running through the full instrument calibration steps) will be performed on field instruments prior to their initial use, at least once daily, or whenever indications of faulty readings or instrument malfunction occurs. Some instruments or certain project scopes may require more frequent calibration checks depending on project quality objectives.
- In general, instrument selection and calibration will include the following steps:
    1. Determine which instruments are needed for the specific field tasks. Record the make, model number, and serial number of the instrument on the field instrument calibration log or in the field book.
    2. Obtain the necessary instruments and standard solutions for calibration. Check expiration dates on standard solutions and replace if out of date. Record the manufacturer, true value, lot number and expiration date of the standard solutions on the field instrument calibration log or in the field book.
    3. Assemble the instrument and turn it on allowing the instrument to warm up.
    4. Check battery charge, and charge or replace if necessary.
    5. Clean instrument (if necessary).
    6. If applicable, program the multi-probe instrument so that the applicable parameters to be measured will be displayed.
    7. Calibrate the instrument prior to field use in accordance with manufacturer's procedures. (Note: If applicable, calibrate DO and conductivity first, because these parameters may affect the other calibrations).
    8. Document all calibration activities and results in the field instrument calibration log or field book.
    9. If the instrument malfunctions and cannot be corrected, document the issues, qualify any erroneous data, and obtain a replacement.
    10. Clean and decontaminate the instrument after use and before storage.

11. Conduct calibration checks at least once per day or additionally as needed.

INVESTIGATION-DERIVED WASTE (IDW) DISPOSAL

Field personnel should review the project work plan and ensure project-specific IDW management documentation and containerization requirements are specified or discussed with the Project Manager before going to the project site.

DATA MANAGEMENT AND RECORDS MANAGEMENT

- Prior to calibrating, the field equipment and calibration standard information should be recorded on a field instrument calibration log and/or in a field book. For field equipment, the information recorded should include the make, model number, and the serial number of the instrument. Each instrument can be assigned an identification number that can be referenced in future field notes or when filling out the field instrument calibration log.
- For calibration standards, the information recorded should include the manufacturer, expiration date, true value, and any other description, such as lot number.
- The calibration records provided by the equipment vendor and the certificates of analysis for each standard will be maintained in the project files.
- All calibration measurements must be documented in a field logbook or on a separate field instrument calibration log. At a minimum, the field instrument calibration log must include the instrument information described above, calibration standard information described above, calibration date, and the instrument calibration results.

DOs AND DO NOTs OF WATER QUALITY PARAMETER INSTRUMENT CALIBRATION

DOs

- DO wear appropriate PPE (i.e., chemical resistant gloves and safety glasses) when cleaning and calibrating water quality instruments.
- DO confirm what field measurements are required, and what accuracy is required based on the scope of work.
- DO ensure you have the instrument instruction manual available if needed, as well as contact information for the manufacturer or rental company for troubleshooting questions.
- DO properly document calibration procedures and calibration checks performed.
- DO note when erroneous readings/equipment malfunctions are observed and any troubleshooting and/or corrective measures taken.
- DO conduct calibration checks at least once per day or additionally as needed.
- DO properly store the calibration standard solutions. Avoid extreme hot/cold temperatures. Frozen solution is useless and extreme temperatures can make calibration difficult and/or calibration may not work at all.

DO NOTs

- DO NOT use expired calibration solutions.
- DO NOT immerse the sensors in sea water or other highly saline water, alcohol, or organic solvents.
- DO NOT forget to clean and decontaminate the instrument after use and before storage.
- DO NOT store the sensors improperly (e.g., avoid storing in extreme hot or cold temperatures, make sure appropriate storage solutions are being used per manufacturer's recommendations).

Appendix B

Laboratory Analytical Reports
and
Chain-of-Custody Documentation

ANALYTICAL REPORT

October 09, 2019

1 Cp	
2 Tc	
3 Ss	
4 Cn	
5 Sr	
6 Qc	
7 Gl	
8 Al	
9 Sc	

TRC - BNSF Region 1

Sample Delivery Group:	L1145696
Samples Received:	10/02/2019
Project Number:	319583
Description:	BNSF - Winlock, WA
Site:	WINLOCK
Report To:	Eric Stata 19874 141st Pl NE Woodinville, WA 98072

Entire Report Reviewed By:

Mark W. Beasley
Project Manager

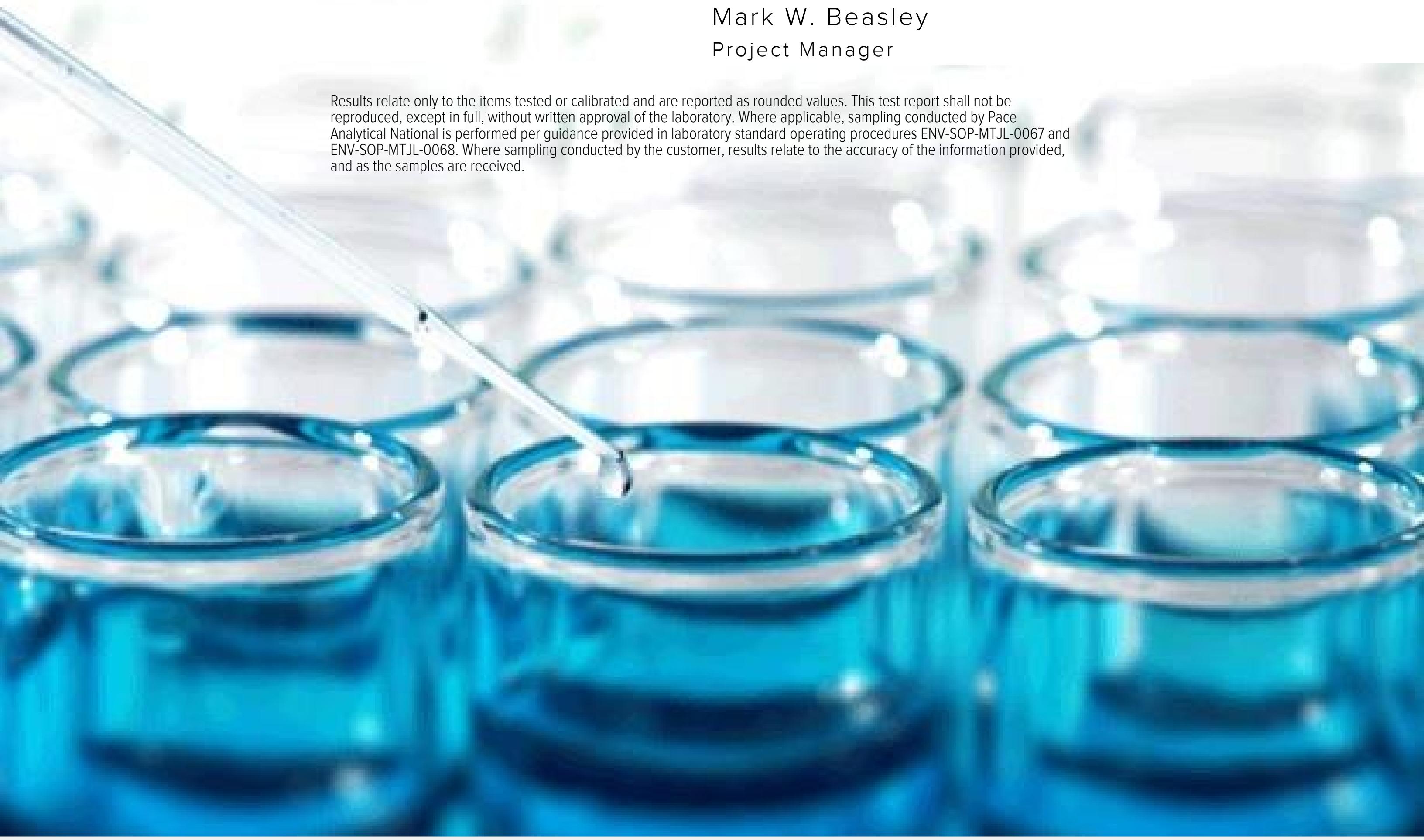


TABLE OF CONTENTS

MW1-0919 L1145696-01 GW

Collected by	Collected date/time	Received date/time
Eric Stata	09/30/19 12:30	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 11:18	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 13:49	JN	Mt. Juliet, TN

MW2-0919 L1145696-02 GW

Collected by	Collected date/time	Received date/time
Eric Stata	09/30/19 11:15	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 12:18	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 14:10	JN	Mt. Juliet, TN

MW3-0919 L1145696-03 GW

Collected by	Collected date/time	Received date/time
Eric Stata	09/30/19 14:20	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 12:39	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 14:30	JN	Mt. Juliet, TN

MW4-0919 L1145696-04 GW

Collected by	Collected date/time	Received date/time
Eric Stata	09/30/19 13:35	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 12:59	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 14:50	JN	Mt. Juliet, TN

MW5-0919 L1145696-05 GW

Collected by	Collected date/time	Received date/time
Eric Stata	09/30/19 16:50	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 13:19	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 15:10	JN	Mt. Juliet, TN

MW6-0919 L1145696-06 GW

Collected by	Collected date/time	Received date/time
Eric Stata	09/30/19 10:15	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 13:39	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 15:30	JN	Mt. Juliet, TN

MW7-0919 L1145696-07 GW

Collected by	Collected date/time	Received date/time
Eric Stata	09/30/19 15:40	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 13:59	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 15:50	JN	Mt. Juliet, TN

MW10-0919 L1145696-08 GW	Collected by	Collected date/time	Received date/time
	Eric Stata	09/30/19 11:20	10/02/19 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1356886	1	10/03/19 20:54	10/06/19 14:19	JN	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1358351	1	10/07/19 10:43	10/08/19 16:10	JN	Mt. Juliet, TN

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Project Manager

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	289		200	1	10/06/2019 11:18	WG1356886
Residual Range Organics (RRO)	ND		250	1	10/06/2019 11:18	WG1356886
(S) o-Terphenyl	*67.4*		*52.0-156*		*10/06/2019 11:18*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 13:49	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 13:49	WG1358351
(S) o-Terphenyl	*60.0*		*52.0-156*		*10/08/2019 13:49*	WG1358351

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	347		200	1	10/06/2019 12:18	WG1356886
Residual Range Organics (RRO)	ND		250	1	10/06/2019 12:18	WG1356886
(S) o-Terphenyl	*77.9*		*52.0-156*		*10/06/2019 12:18*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 14:10	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 14:10	WG1358351
(S) o-Terphenyl	*61.6*		*52.0-156*		*10/08/2019 14:10*	WG1358351

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	426		200	1	10/06/2019 12:39	WG1356886
Residual Range Organics (RRO)	325		250	1	10/06/2019 12:39	WG1356886
(S) o-Terphenyl	*79.5*		*52.0-156*		*10/06/2019 12:39*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 14:30	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 14:30	WG1358351
(S) o-Terphenyl	*60.5*		*52.0-156*		*10/08/2019 14:30*	WG1358351

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

	Result	Qualifier	RDL	Dilution	Analysis	Batch
Analyte	ug/l		ug/l		date / time	
Diesel Range Organics (DRO)	ND		200	1	10/06/2019 12:59	WG1356886
Residual Range Organics (RRO)	ND		250	1	10/06/2019 12:59	WG1356886
(S) o-Terphenyl	*72.6*		*52.0-156*		*10/06/2019 12:59*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

	Result	Qualifier	RDL	Dilution	Analysis	Batch
Analyte	ug/l		ug/l		date / time	
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 14:50	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 14:50	WG1358351
(S) o-Terphenyl	*58.9*		*52.0-156*		*10/08/2019 14:50*	WG1358351

MW5-0919

Collected date/time: 09/30/19 16:50

SAMPLE RESULTS - 05

L1145696

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

	Result	Qualifier	RDL	Dilution	Analysis	Batch
Analyte	ug/l		ug/l		date / time	
Diesel Range Organics (DRO)	ND		200	1	10/06/2019 13:19	WG1356886
Residual Range Organics (RRO)	ND		250	1	10/06/2019 13:19	WG1356886
(S) o-Terphenyl	*74.2*		*52.0-156*		*10/06/2019 13:19*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

	Result	Qualifier	RDL	Dilution	Analysis	Batch
Analyte	ug/l		ug/l		date / time	
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 15:10	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 15:10	WG1358351
(S) o-Terphenyl	*60.5*		*52.0-156*		*10/08/2019 15:10*	WG1358351

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	300		200	1	10/06/2019 13:39	WG1356886
Residual Range Organics (RRO)	ND		250	1	10/06/2019 13:39	WG1356886
(S) o-Terphenyl	*76.3*		*52.0-156*		*10/06/2019 13:39*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 15:30	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 15:30	WG1358351
(S) o-Terphenyl	*55.8*		*52.0-156*		*10/08/2019 15:30*	WG1358351

MW7-0919
Collected date/time: 09/30/19 15:40

SAMPLE RESULTS - 07

L1145696

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	10/06/2019 13:59	WG1356886
Residual Range Organics (RRO)	ND		250	1	10/06/2019 13:59	WG1356886
(S) o-Terphenyl	*73.2*		*52.0-156*		*10/06/2019 13:59*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 15:50	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 15:50	WG1358351
(S) o-Terphenyl	*60.0*		*52.0-156*		*10/08/2019 15:50*	WG1358351

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	336		200	1	10/06/2019 14:19	WG1356886
Residual Range Organics (RRO)	ND		250	1	10/06/2019 14:19	WG1356886
(S) o-Terphenyl	*73.2*		*52.0-156*		*10/06/2019 14:19*	WG1356886

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	10/08/2019 16:10	WG1358351
Residual Range Organics (RRO)	ND		250	1	10/08/2019 16:10	WG1358351
(S) o-Terphenyl	*61.1*		*52.0-156*		*10/08/2019 16:10*	WG1358351

Method Blank (MB)

(MB) R3458266-1 10/06/19 02:42

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Residual Range Organics (RRO)	U		83.3	250
Diesel Range Organics (DRO)	U		66.7	200
(S) o-Terphenyl	*76.5*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3458266-2 10/06/19 03:02 • (LCSD) R3458266-3 10/06/19 03:23

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	1500	1340	1370	89.3	91.3	50.0-150			2.21	20
(S) o-Terphenyl				*92.0*	*93.0*	*52.0-156*				

L1145696-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1145696-01 10/06/19 11:18 • (MS) R3458266-4 10/06/19 11:38 • (MSD) R3458266-5 10/06/19 11:58

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	1430	289	1550	1580	88.2	90.3	1	50.0-150			1.92	20
(S) o-Terphenyl					*87.9*	*86.3*		*52.0-156*				

Method Blank (MB)

(MB) R3458715-1 10/08/19 00:51

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*64.0*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3458715-2 10/08/19 01:11 • (LCSD) R3458715-3 10/08/19 01:31

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	1500	1250	1250	83.3	83.3	50.0-150			0.000	20
(S) o-Terphenyl				*74.5*	*74.0*	*52.0-156*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Results Disclaimer - Information that may be provided by the customer, and contained within this report, include Permit Limits, Project Name, Sample ID, Sample Matrix, Sample Preservation, Field Blanks, Field Spikes, Field Duplicates, On-Site Data, Sampling Collection Dates/Times, and Sampling Location. Results relate to the accuracy of this information provided, and as the samples are received.

Abbreviations and Definitions

MDL	Method Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
	The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

ACCREDITATIONS & LOCATIONS

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660
Alaska	17-026
Arizona	AZ0612
Arkansas	88-0469
California	2932
Colorado	TN00003
Connecticut	PH-0197
Florida	E87487
Georgia	NELAP
Georgia [1]	923
Idaho	TN00003
Illinois	200008
Indiana	C-TN-01
Iowa	364
Kansas	E-10277
Kentucky [1] [6]	90010
Kentucky [2]	16
Louisiana	AI30792
Louisiana [1]	LA180010
Maine	TN0002
Maryland	324
Massachusetts	M-TN003
Michigan	9958
Minnesota	047-999-395
Mississippi	TN00003
Missouri	340
Montana	CERT0086

Nebraska	NE-OS-15-05
Nevada	TN-03-2002-34
New Hampshire	2975
New Jersey–NELAP	TN002
New Mexico [1]	n/a
New York	11742
North Carolina	Env375
North Carolina [1]	DW21704
North Carolina [3]	41
North Dakota	R-140
Ohio–VAP	CL0069
Oklahoma	9915
Oregon	TN200002
Pennsylvania	68-02979
Rhode Island	LAO00356
South Carolina	84004
South Dakota	n/a
Tennessee [1] [4]	2006
Texas	T104704245-18-15
Texas [5]	LAB0152
Utah	TN00003
Vermont	VT2006
Virginia	460132
Washington	C847
West Virginia	233
Wisconsin	9980939910
Wyoming	A2LA

Third Party Federal Accreditations

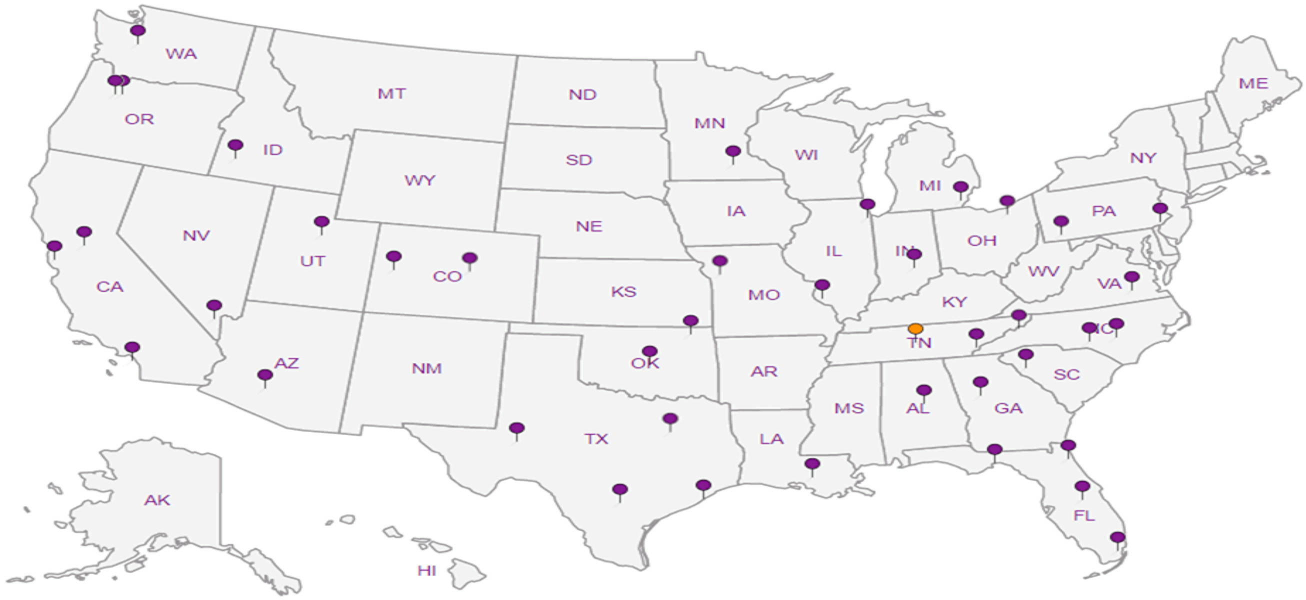
A2LA – ISO 17025	1461.01
A2LA – ISO 17025 [5]	1461.02
Canada	1461.01
EPA–Crypto	TN00003

AIHA-LAP,LLC EMLAP	100789
DOD	1461.01
USDA	P330-15-00234

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.



TRC - BNSF Region 1

19874 141st Pl NE
Woodinville, WA 98072

Billing Information:
Accounts Payable
19874 141st Place NE
Woodinville, WA 98072

Pres Chk

Chain of Custody Page 1 of 1

Pace Analytical®
National Center for Testing & Innovation

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to: Eric Stata

Email To: EStata@trccompanies.com
KWOODBurne@ J

Project Description: BNSF - Winlock, WA

City/State Collected: Winlock, WA

Please Circle: PT MT CT ET

Phone: 425-489-1938
Fax:

Client Project # 319583

Lab Project # BNSF1TRC-WINLOCK

SDG # L1145696
C146

Collected by (print): ERIC STATA

Site/Facility ID # WINLOCK

P.O. # 319583

Acctnum: BNSF1TRC
Template: T156637
Prelogin: P732245
PM: 134 - Mark W. Beasley
PB:
Shipped Via:

Collected by (signature): E. Stata

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SGT 40mlAmb-HCl-BT	NWTPHDXLVI w/o SGT 40mlAmb-HCl-BT	~~NWTPHGX 40mlAmb HCl~~	~~TOC 250mlHDPE-HCl~~	~~V8260BTEXC 40mlAmb-HCl~~						Remarks	Sample # (lab only)
MW1-0919	N/A	GW	X	9-30-19	1230	4	X	X										-01
MW2-0919	N/A	GW	X		1115	4	X	X										-02
MW3-0919	N/A	GW	X		1420	4	X	X										-03
MW4-0919	N/A	GW	X		1335	4	X	X										-04
MW5-0919	N/A	GW	X		1650	4	X	X										-05
MW6-0919	N/A	GW	X		1015	4	X	X										-06
MW7-0919	N/A	GW	X		1540	4	X	X										-07
MW10-0919	N/A	GW	X		1120	4	X	X										-08
		GW																

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other_________

Remarks: DRO/ORO with ~~and~~ w/o SGC *ONLY*

pH ______ Temp ______
Flow ______ Other ______

Samples returned via:
__ UPS __ FedEx __ Courier ___________

Tracking # 1145 2231 0371

Sample Receipt Checklist
COC Seal Present/Intact: ✓ NP __Y __N
COC Signed/Accurate: ✓ Y __N
Bottles arrive intact: ✓ Y __N
Correct bottles used: ✓ Y __N
Sufficient volume sent: ✓ Y __N
If Applicable
VOA Zero Headspace: __Y __N
Preservation Correct/Checked: __Y __N
RAD Screen <0.5 mR/hr: ✓ Y __N

Relinquished by : (Signature) E. Stata
Date: 10/01/19
Time: 0830
Received by: (Signature)

Trip Blank Received: Yes / [✓ No]
HCL / MeoH
TBR

Relinquished by : (Signature)
Date:
Time:
Received by: (Signature)

Temp: A3°C
0.4-.3=0.1
Bottles Received: 32 VP

If preservation required by Login: Date/Time

Relinquished by : (Signature)
Date:
Time:
Received for lab by: (Signature)
Date: 10-2-19
Time: 0845

Hold:

Condition: NCF / [✓ OK]

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

December 30, 2019

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

TRC - BNSF Region 1

Sample Delivery Group:	L1173101
Samples Received:	12/20/2019
Project Number:	366391
Description:	BNSF - Winlock
Site:	WINLOCK
Report To:	Mathieu Piovesan 19874 141st Pl NE Woodinville, WA 98072

Entire Report Reviewed By:

Olivia Studebaker
Project Manager

TABLE OF CONTENTS

	Collected by	Collected date/time	Received date/time
MW3-121819 L1173101-01 GW	Eric Stata	12/18/19 14:10	12/20/19 09:30

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1401883	1	12/24/19 20:08	12/27/19 13:42	SHG	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1401313	1	12/23/19 08:32	12/24/19 01:29	JN	Mt. Juliet, TN

	Collected by	Collected date/time	Received date/time
MW33-121819 L1173101-02 GW	Eric Stata	12/18/19 15:10	12/20/19 09:30

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1401883	1	12/24/19 20:08	12/27/19 14:03	SHG	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1401313	1	12/23/19 08:32	12/24/19 01:55	JN	Mt. Juliet, TN

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Olivia S

Olivia Studebaker
Project Manager

MW3-121819
Collected date/time: 12/18/19 14:10

SAMPLE RESULTS - 01

L1173101

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	357		200	1	12/27/2019 13:42	WG1401883
Residual Range Organics (RRO)	261		250	1	12/27/2019 13:42	WG1401883
(S) o-Terphenyl	*89.5*		*52.0-156*		*12/27/2019 13:42*	WG1401883

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	12/24/2019 01:29	WG1401313
Residual Range Organics (RRO)	ND		250	1	12/24/2019 01:29	WG1401313
(S) o-Terphenyl	*63.2*		*52.0-156*		*12/24/2019 01:29*	WG1401313

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	407		200	1	12/27/2019 14:03	WG1401883
Residual Range Organics (RRO)	339		250	1	12/27/2019 14:03	WG1401883
(S) o-Terphenyl	*98.9*		*52.0-156*		*12/27/2019 14:03*	WG1401883

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	12/24/2019 01:55	WG1401313
Residual Range Organics (RRO)	ND		250	1	12/24/2019 01:55	WG1401313
(S) o-Terphenyl	*66.3*		*52.0-156*		*12/24/2019 01:55*	WG1401313

Method Blank (MB)

(MB) R3486048-1 12/26/19 12:19

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*74.5*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3486048-2 12/26/19 12:39 • (LCSD) R3486048-3 12/26/19 13:00

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	1500	1460	1510	97.3	101	50.0-150			3.37	20
(S) o-Terphenyl				*121*	*123*	*52.0-156*				

Method Blank (MB)

(MB) R3485527-1 12/23/19 13:50

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*61.0*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3485527-2 12/23/19 14:16 • (LCSD) R3485527-3 12/23/19 14:42

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	1500	1260	1300	84.0	86.7	50.0-150			3.12	20
(S) o-Terphenyl				*76.0*	*74.0*	*52.0-156*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Results Disclaimer - Information that may be provided by the customer, and contained within this report, include Permit Limits, Project Name, Sample ID, Sample Matrix, Sample Preservation, Field Blanks, Field Spikes, Field Duplicates, On-Site Data, Sampling Collection Dates/Times, and Sampling Location. Results relate to the accuracy of this information provided, and as the samples are received.

Abbreviations and Definitions

MDL	Method Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
	The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

ACCREDITATIONS & LOCATIONS

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660
Alaska	17-026
Arizona	AZ0612
Arkansas	88-0469
California	2932
Colorado	TN00003
Connecticut	PH-0197
Florida	E87487
Georgia	NELAP
Georgia [1]	923
Idaho	TN00003
Illinois	200008
Indiana	C-TN-01
Iowa	364
Kansas	E-10277
Kentucky [1 6]	90010
Kentucky [2]	16
Louisiana	AI30792
Louisiana [1]	LA180010
Maine	TN0002
Maryland	324
Massachusetts	M-TN003
Michigan	9958
Minnesota	047-999-395
Mississippi	TN00003
Missouri	340
Montana	CERT0086
Nebraska	NE-OS-15-05
Nevada	TN-03-2002-34
New Hampshire	2975
New Jersey–NELAP	TN002
New Mexico [1]	n/a
New York	11742
North Carolina	Env375
North Carolina [1]	DW21704
North Carolina [3]	41
North Dakota	R-140
Ohio–VAP	CL0069
Oklahoma	9915
Oregon	TN200002
Pennsylvania	68-02979
Rhode Island	LAO00356
South Carolina	84004
South Dakota	n/a
Tennessee [1 4]	2006
Texas	T104704245-18-15
Texas [5]	LAB0152
Utah	TN00003
Vermont	VT2006
Virginia	460132
Washington	C847
West Virginia	233
Wisconsin	9980939910
Wyoming	A2LA

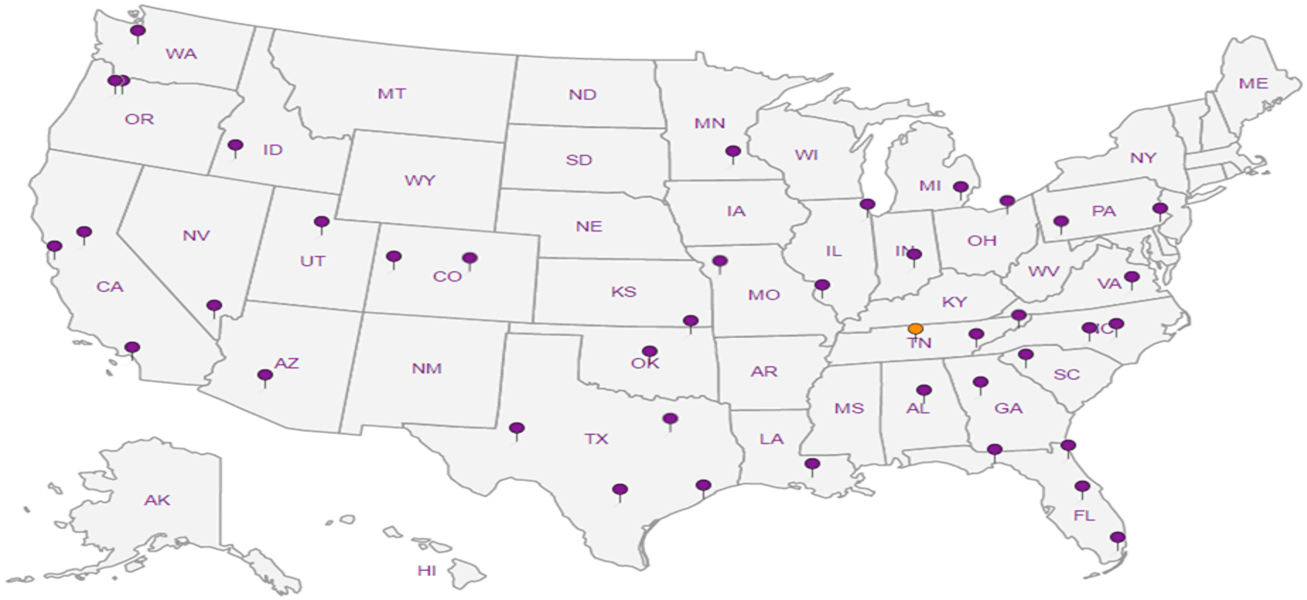
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01
A2LA – ISO 17025 [5]	1461.02
Canada	1461.01
EPA–Crypto	TN00003
AIHA-LAP,LLC EMLAP	100789
DOD	1461.01
USDA	P330-15-00234

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.



Chain of Custody Page 1 of 1

ESC
L·A·B S·C·I·E·N·C·E·S
YOUR LAB OF CHOICE

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L1173101
E130

Acctnum:
Template:
Prelogin:
TSR:
PB:
Shipped Via:

Company Name/Address:
TRC
19874 141st Pl NE
Woodinville, WA 98072

Billing Information:
TRC- Accounts Payable
19874 141st Pl NE
Woodinville, WA 98072

Report to: Mathieu Piovesan

Email To: mpiovesan@trccompanies.com

Project Description: BNSF - Winlock, WA

City/State Collected: Winlock WA

Phone: 425.219.2221
Fax:

Client Project # 366391

Lab Project # BNSF1TRC-WINLOCK

Collected by (print): Eric Stata

Site/Facility ID # WINLOCK

P.O. #

Collected by (signature): E. Stata

Immediately Packed on Ice N ____ Y ✓

Rush (Lab MUST Be Notified)
____ Same Day 200%
____ Next Day 100%
____ Two Day 50%
____ Three Day 25%

Date Results Needed

Email? ___No ✓ Yes
FAX? ___No ___Yes

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SGT 40mlAmb-HCl-BT	NWTPHDXLVI w/o SGT 40mlAmb-HCl-BT	Rem./Contaminant	Sample # (lab only)
MW3-121819		GW		12/18/2019	1410	4	X	X		-01
MW33-121819		GW		12/18/2019	1510	4	X	X		02

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other GW

Remarks: 4794 8843 7918

pH ________ Temp ________
Flow ________ Other ________

Samples returned via: ○ UPS ○ FedEx ○ Courier ○ ______

Hold #

Condition: (lab use only)

RAD SCREEN: <0.5 mR/hr

COC Seal Intact: ___Y ___N ✓ NA

pH Checked:
NCF:

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
E. Stata	12/19/19	11:00	

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)

Temp: 0.3-.1=0.2 °C
Bottles Received: 8

Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)	Date:	Time:
				12/20/19	0930

Pace Analytical National Center for Testing & Innovation
Cooler Receipt Form

L1173101

Client: BNSFITRC

Cooler Received/Opened On: 2/20/19 Temperature: .2

Received By: Tristin Corson

Signature:

Receipt Check List	NP	Yes	No
COC Seal Present / Intact?			✓
COC Signed / Accurate?		✓	
Bottles arrive intact?		✓	
Correct bottles used?		✓	
Sufficient volume sent?		✓	
If Applicable			
VOA Zero headspace?		✓	
Preservation Correct / Checked?			

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

March 04, 2020

TRC - BNSF Region 1

Sample Delivery Group:	L1192232
Samples Received:	02/22/2020
Project Number:	
Description:	BNSF - Winlock, WA
Report To:	Mathiew Piovesan 19874 141st Pl NE Woodinville, WA 98072

Entire Report Reviewed By:

Mark W. Beasley
Project Manager

TABLE OF CONTENTS

MW3-02202020 L1192232-01 GW

Collected by	Collected date/time	Received date/time
Eric Stata	02/20/20 13:00	02/22/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1435890	1	02/27/20 14:03	03/02/20 01:21	JDG	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1436943	1	02/27/20 14:03	03/03/20 16:48	JN	Mt. Juliet, TN

MW33-02202020 L1192232-02 GW

Collected by	Collected date/time	Received date/time
Eric Stata	02/20/20 13:30	02/22/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT	WG1435890	1	02/27/20 14:03	03/02/20 01:47	JDG	Mt. Juliet, TN
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1436943	1	02/27/20 14:03	03/03/20 17:14	JN	Mt. Juliet, TN

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Project Manager

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	484		200	1	03/02/2020 01:21	WG1435890
Residual Range Organics (RRO)	ND		250	1	03/02/2020 01:21	WG1435890
(S) o-Terphenyl	*94.7*		*52.0-156*		*03/02/2020 01:21*	WG1435890

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	03/03/2020 16:48	WG1436943
Residual Range Organics (RRO)	ND		250	1	03/03/2020 16:48	WG1436943
(S) o-Terphenyl	*73.7*		*52.0-156*		*03/03/2020 16:48*	WG1436943

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-NO SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	503		200	1	03/02/2020 01:47	WG1435890
Residual Range Organics (RRO)	256		250	1	03/02/2020 01:47	WG1435890
(S) o-Terphenyl	*91.6*		*52.0-156*		*03/02/2020 01:47*	WG1435890

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	ND		200	1	03/03/2020 17:14	WG1436943
Residual Range Organics (RRO)	ND		250	1	03/03/2020 17:14	WG1436943
(S) o-Terphenyl	*74.2*		*52.0-156*		*03/03/2020 17:14*	WG1436943

Method Blank (MB)

(MB) R3504291-1 02/29/20 15:49

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*87.5*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3504291-2 02/29/20 16:14 • (LCSD) R3504291-3 02/29/20 16:40

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	1500	1590	1600	106	107	50.0-150			0.627	20
(S) o-Terphenyl				*92.5*	*95.5*	*52.0-156*				

Method Blank (MB)

(MB) R3505064-1 03/03/20 21:35

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*77.5*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3505064-2 03/03/20 22:00 • (LCSD) R3505064-3 03/03/20 22:26

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	1500	1300	1290	86.7	86.0	50.0-150			0.772	20
(S) o-Terphenyl				*75.5*	*78.0*	*52.0-156*				

GLOSSARY OF TERMS

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Results Disclaimer - Information that may be provided by the customer, and contained within this report, include Permit Limits, Project Name, Sample ID, Sample Matrix, Sample Preservation, Field Blanks, Field Spikes, Field Duplicates, On-Site Data, Sampling Collection Dates/Times, and Sampling Location. Results relate to the accuracy of this information provided, and as the samples are received.

Abbreviations and Definitions

MDL	Method Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
	The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

ACCREDITATIONS & LOCATIONS

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN-03-2002-34
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	n/a
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1,6]	90010	South Carolina	84004
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1,4]	2006
Louisiana [1]	LA180010	Texas	T104704245-18-15
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	TN00003
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	460132
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA

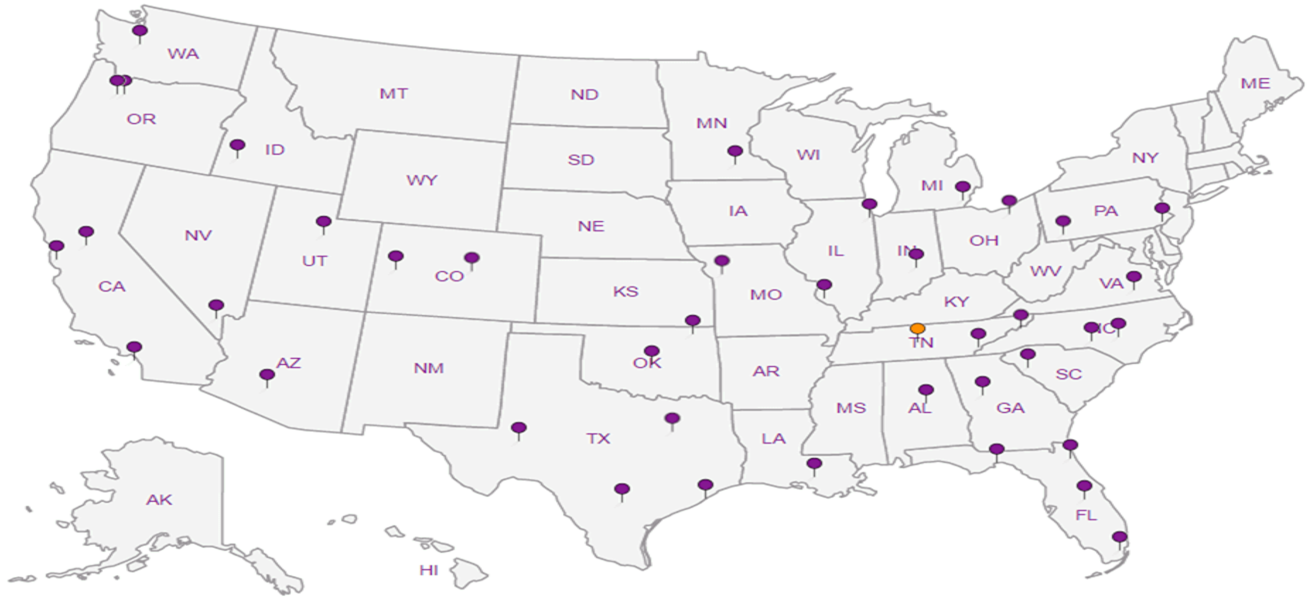
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.



TRC – BNSF Region 1

19874 141st Pl NE
Woodinville, WA 98072

Billing Information:
Accounts Payable
19874 141st Place NE
Woodinville, WA 98072

Pres Chk

Analysis / Container / Preservative

Chain of Custody Page 1 of 1

Pace Analytical® National Center for Testing & Innovation

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to: ~~Eric Stata~~ Mathiew PIOVESAN

Email To: mpiovesan@trccompanies.com;EStata@trccompan

Project Description: **BNSF - Winlock, WA**

City/State Collected: WINLOCK WA

Please Circle: [✓ PT] MT CT ET

Phone: **425-489-1938**
Fax:

Client Project #

Lab Project # **BNSF1TRC-WINLOCK**

Collected by (print): ERIC STATA

Site/Facility ID #

P.O. # **319583**

Collected by (signature): E. Stata

Quote #

Immediately Packed on Ice N___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Date Results Needed

SDG # L1192232
F238

Acctnum: **BNSF1TRC**
Template: **T163298**
Prelogin: **P756464**
PM: **134 - Mark W. Beasley**
PB:
Shipped Via:

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SGT 40mlAmb-HCl-BT	NWTPHDXLVI w/o SGT 40mlAmb-HCl-BT								Remarks	Sample # (lab only)
MW3-02202020	—	GW	—	2/20/2020	1300	4	X	X									-01
MW33-02202020	—	GW	—	2/20/2020	1330	4	X	X									-02
		GW															
		GW															
		GW															

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other________

Remarks:

pH ______ Temp ______
Flow ______ Other ______

Samples returned via:
__ UPS __ FedEx __ Courier ________

Tracking # ~~1382 4817 5534~~ 1411 1752 2801

Sample Receipt Checklist
COC Seal Present/Intact: __NP __Y __N
COC Signed/Accurate: ✓Y __N
Bottles arrive intact: ✓Y __N
Correct bottles used: ✓Y __N
Sufficient volume sent: ✓Y __N
If Applicable
VOA Zero Headspace: ✓Y __N
Preservation Correct/Checked: ✓Y __N
RAD Screen <0.5 mR/hr: ✓Y __N

Relinquished by : (Signature) E. STATA
Date: 2/20/2020
Time: 1445
Received by: (Signature)

Trip Blank Received: [✓ Yes] / No 1
HCL / MeoH
TBR

Relinquished by : (Signature)
Date:
Time:
Received by: (Signature)

Temp: 4.7+.3=5.0 °C
Bottles Received: 8

If preservation required by Login: Date/Time

Relinquished by : (Signature)
Date:
Time:
Received for lab by: (Signature)
Date: 2/22/20
Time: 08:45

Hold:

Condition: NCF / [✓ OK]