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October 10, 2018

Mr. Daniel Lanners, P.E.
New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway
Albany, New York 12233-7014

RE: Work Plan – Sampling/Testing for Emerging Contaminants
Harrison Sub-Residency Landfill and Petroleum Spill Area
West Harrison, New York

Dear Mr. Lanners:

On behalf of the New York State Department of Transportation (NYSDOT), TRC Engineers, Inc. (TRC) has prepared this Work Plan for Groundwater and Surface Water Sampling for Emerging Contaminants at the Harrison Sub-Residency Landfill and Petroleum Spill Area (the “Site”) located at the intersection of New York Route 120 and King Street (Refer to the attached Figure 1). This Work Plan was prepared in response to the New York State Department of Environmental Conservation (NYSDEC) Letter dated September 21, 2018 (refer to Attachment A) which requires the collection of representative groundwater and surface water samples from the Site for analysis of 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS).

Groundwater and Surface Water Sampling Scope of Work

During the 5th Quarter Monitoring Program planned for the subject Site, additional samples will be collected from all existing monitoring wells, including LMW-2, LMW-4, PC-1, PC-2, PC-3, and MW-11, and all existing surface water sampling locations, including SW-1, SW-2, SW-3, and SW-4 for the laboratory analysis of the above-referenced emerging contaminants specified by NYSDEC. The groundwater monitoring well and surface water sampling locations are shown on the attached Figures 2 (for the Sub-Residency portion of the Site) and 3 (for the Petroleum Spill portion of the Site).

The groundwater sampling techniques are outlined in TRC’s Groundwater Sampling Standard Operating Procedure (which includes an Attachment D SOP Modifications for PFAS) which is provided as Attachment B. The proposed emerging contaminant sampling, analysis and reporting activities consist of the following:

- On the day of groundwater sampling and prior to initiation of sampling activities, a round of water level measurements will be collected and each well will be gauged for non-aqueous phase liquid. Additionally, a headspace reading will be collected, using a photoionization detector (PID) from each monitoring well location. Although not anticipated, if light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL) is encountered, groundwater from that well will not be sampled and analyzed.
- Prior to sampling, groundwater will be purged via peristaltic pump utilizing high-density polyethylene tubing until field parameters have stabilized in accordance with United States Environmental Protection Agency (USEPA) Low-Stress (Low-Flow) sampling procedures. A turbidity level of 5 NTUs or less is the well purging goal. Other field parameters including temperature, conductivity, oxidation reduction potential (ORP), pH, and dissolved oxygen (DO) will also be monitored and, prior to sampling, field parameters should generally be within $\pm 10\%$ for three consecutive readings, three to five minutes apart. Ideally, pumping rates will be maintained between 100 and 500 milliliters per minute (ml/min) so that no drawdown of the groundwater level occurs (i.e., pumping rate is less than recharge rate). During purging, TRC will actively monitor and track the volume of water purged and the field parameter readings. Field measurements will be recorded in a field logbook. Once groundwater conditions have stabilized and groundwater levels have recovered, the samples will be collected.
- Prior to surface water sample collection, field surface water quality parameters including temperature, turbidity, conductivity, pH, and dissolved oxygen concentration will be measured directly in the stream at each location and recorded in a field logbook. At each of the four (4) locations, a surface water sample will be collected first to minimize turbidity within the collected water sample. Furthermore, to minimize stream turbidity, surface water and sediment sampling will proceed from downstream (SW/SD-4) to upstream (SW/SD-1). Surface water samples will be collected directly into laboratory-supplied unpreserved PFAS-free laboratory-supplied sample containers. Following the collection of the surface water sample and sediment sample, approximate stream flow and water depth will be measured and recorded at the location. In the event that a stream sample location is dry, no samples will be collected from the location and no field water quality data will be recorded.
- Groundwater and surface water samples will be analyzed for 1,4-dioxane via USEPA Method 8270 (with explicit sampling dilution to achieve a reporting limit of 0.25 micrograms per liter) and per- and polyfluoroalkyl substances (PFAS) via USEPA Method 537 Modified (Low Level) to achieve 2 ng/L (ppt) reporting limits.. The 1,4-dioxane sample analyses will be conducted by Hampton-Clarke/Veritech, Inc. of Fairfield, New Jersey,, a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified analytical laboratory.

The PFAS sample analyses will be conducted by TestAmerica, Inc. located in West Sacramento, California, a NYSDOH ELAP certified lab for PFAS analysis. The specific PFAS compounds that will be analyzed for and their respective reporting limits are listed on Attachment C. Additionally, one duplicate groundwater sample, one duplicate surface water sample, one groundwater sampling equipment rinsate blank sample, and one matrix spike/matrix spike duplicate sample will be collected for analysis for 1,4-dioxane and PFAS.

- Groundwater and surface water samples will be containerized in laboratory-supplied PFAS-free containers, labeled, sealed, and placed in a chilled cooler for shipment to the laboratory. Groundwater and surface water samples will be analyzed by an ELAP-certified laboratory approved by the New York State Department of Health (NYSDOH). NYSDEC ASP Category B data deliverable packages and NYSDEC EQuIS EDD(s) will be provided.
- Decontamination water and purge water will be drummed and staged on the Site, pending receipt of the laboratory results. Following the receipt of the laboratory results, the decontamination water and purge water will be transported off-site for disposal at a facility properly permitted to accept the waste.

Data Validation

Third-party data validation will be completed for all 1,4-dioxane and PFAS sample results. All emerging contaminant laboratory results will be validated by Environmental Data Services, Inc. (EDS) of Newport News, Virginia. The data validation will include preparation of a NYSDEC Data Usability Summary Report (DUSR) consistent with USEPA Region II Data Validation Standard Operating Procedures (SOPs) and the New York State Department of Environmental Conservation Draft DER-10 Technical Guidance for Site Investigation and Remediation dated December 2002.

Electronic Data Deliverable

After completion of the data validation, the PFAS and 1,4-dioxane EQuIS EDDs will be submitted electronically to NYSDEC via NYENVDATA@dec.ny.gov. Upon request, electronic copies of the full laboratory data report and DUSR will be provided to NYSDEC.

Schedule

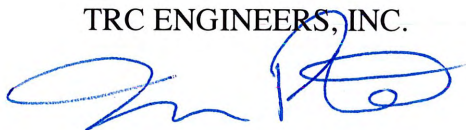
The 5th quarter Site monitoring field sampling program including that for emerging contaminants is scheduled to begin on October 15, 2018.

**Work Plan – Groundwater and Surface Water Sampling for Emerging Contaminants
Harrison Sub-Residency and Petroleum Spill Area, West Harrison, New York
Page 4 of 4**

If you have any questions or require additional information, please contact me at
jperonto@trcsolutions.com or call (860) 292-6233.

Sincerely,

TRC ENGINEERS, INC.



James Peronto, PE
Principal Engineer

Attachments:

Figure 1 – Site Location Map

Figure 2 – Harrison Sub-Residency Site Plan

Figure 3 – Harrison Petroleum Spill Site Plan

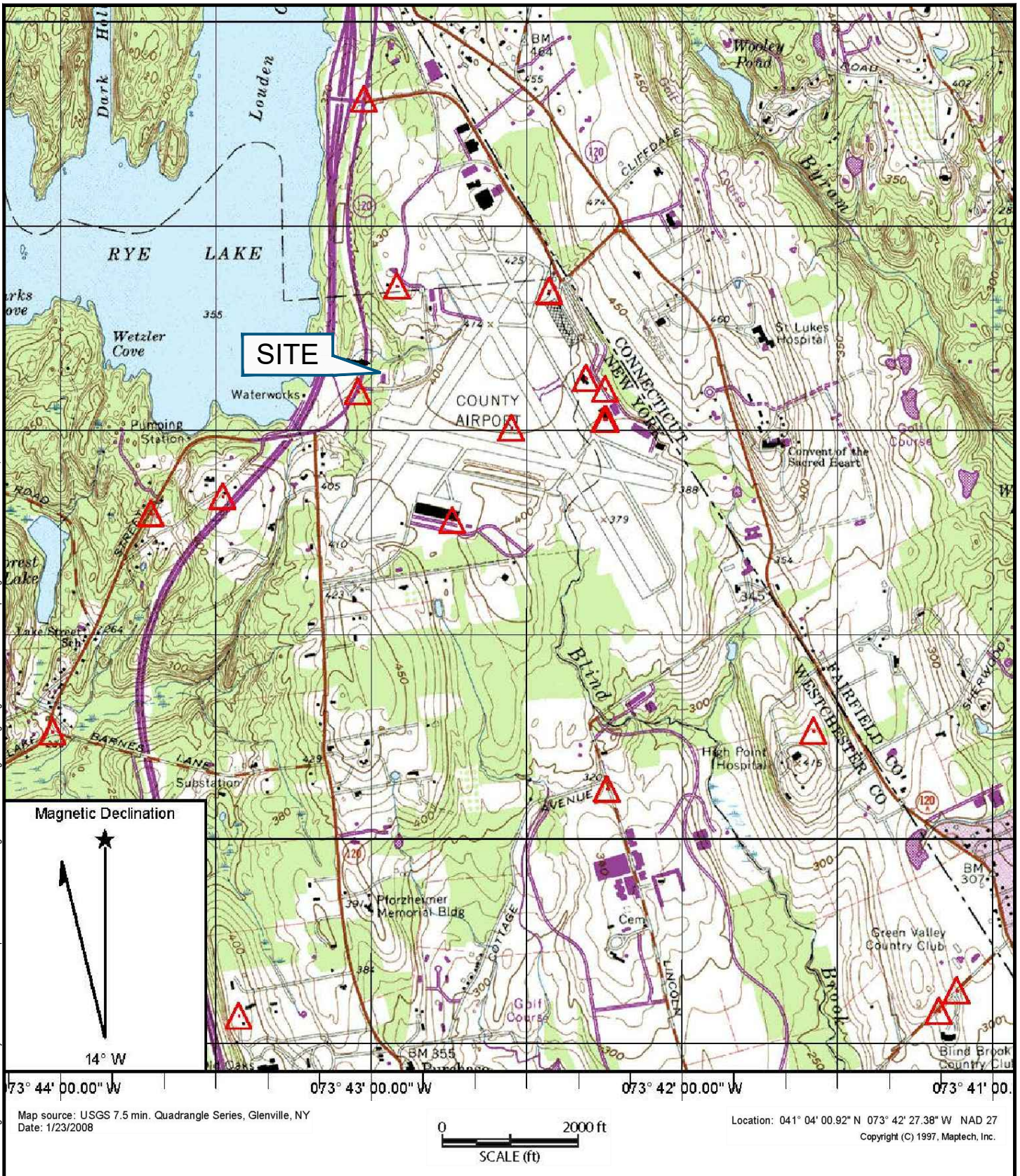
Attachment A – NYSDEC Request for Sampling for Emerging Contaminants Letter

Attachment B – TRC Groundwater Sampling Standard Operating Procedure

Attachment C – PFAS Analyte List and Lab Reporting Limits

cc: Gretchen Fitzgerald – NYSDOT Region 8

8.5x11 - ATTACHED XREFS - ATTACHED IMAGES: Harrison Landfill Figures, Page 1: DRAWING NAME: I:\Projects\NYSDOT - D03137\Assignments\2 - 3 - Bryant Pond + Harrison\Reports\Harrison Landfill\Figures\TRC Working Drawings\Figure 1 - Site Location Map.dwg - PLOT DATE: October 24, 2017 - 7:07PM - LAYOUT: 8.5x11P



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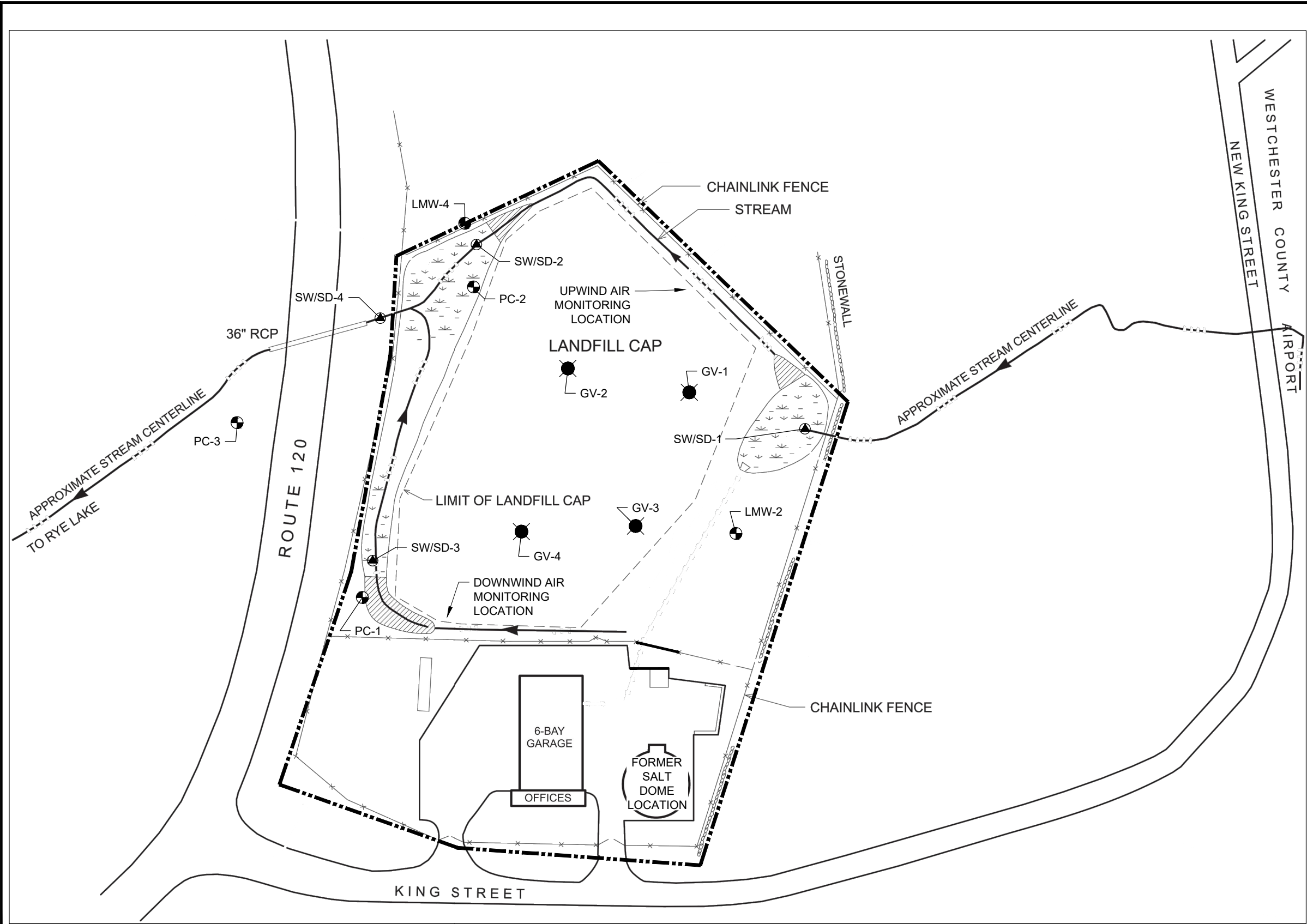
PROJECT: **NEW YORK STATE DEPARTMENT OF TRANSPORTATION
PIN 8806.51.101 - HARRISON LANDFILL AREA
HARRISON SUB-RESIDENCY
WEST HARRISON, NEW YORK**

TITLE: **SITE LOCATION MAP**

DRAWN BY:	H. DELGADO
CHECKED BY:	J. ROBINSON
APPROVED BY:	J. PERONTO
DATE:	OCTOBER 2017
PROJ. NO.:	280089.0001.0000
FILE:	Figure 1 - Site Location Map.dwg

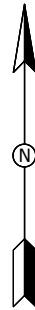
FIGURE 1

11x17 - ATTACHED XREFS: --- ATTACHED IMAGES: Harrison Sub-Residency - D03 37 1 Assignments #2 +3 - Bryant Pond + Harrison Reports Harrison Landfill Figures TRC Working Drawings Figure 2 - Site Map and Sampling-Monitoring Locations.dwg --- PLOT DATE: October 25, 2017 - 12:35 PM --- LAYOUT: 11x17L
DRAWING NAME: I:\Projects\NYSDOT - D03 37 1 Assignments #2 +3 - Bryant Pond + Harrison Reports Harrison Landfill Figures TRC Working Drawings Figure 2 - Site Map and Sampling-Monitoring Locations.dwg



LEGEND (SYMBOLS NOT TO SCALE):

- SITE BOUNDARY
- LMW-X OR PC-X MONITORING WELL LOCATION AND IDENTIFICATION NUMBER
- SW/SD-X SURFACE WATER AND SEDIMENT SAMPLING LOCATION AND IDENTIFICATION NUMBER
- GV-X LANDFILL GAS VENT LOCATION AND IDENTIFICATION NUMBER



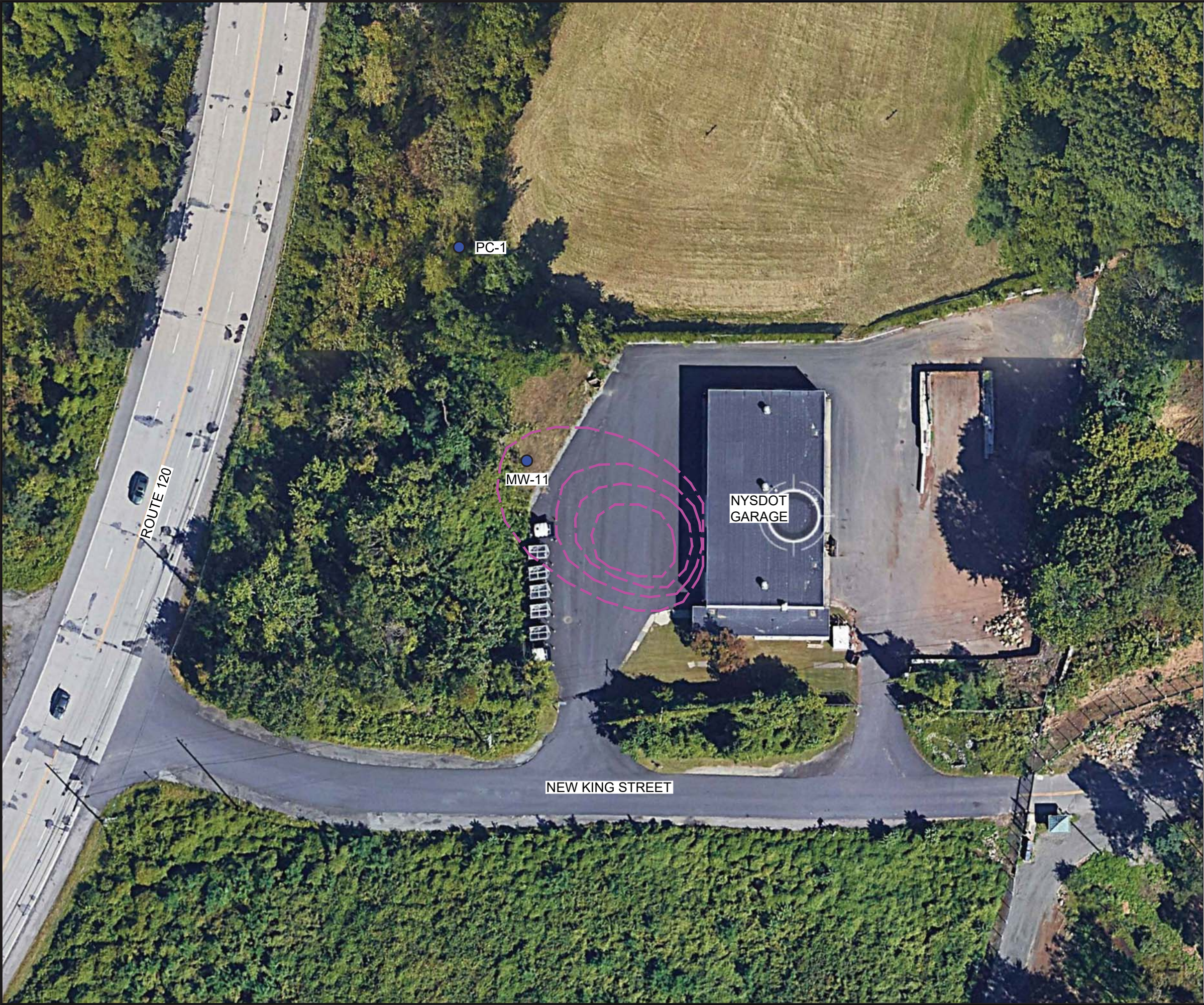
NOTES:

- FIGURE SOURCE: HDR ENGINEERING, INC. 5TH QUARTER MONITORING REPORT DATED JUNE 1, 2016.



PROJECT: NEW YORK STATE DEPARTMENT OF TRANSPORTATION PIN 8806.51.101 - HARRISON LANDFILL AREA HARRISON SUB-RESIDENCY WEST HARRISON, NEW YORK			
TITLE: SITE MAP AND SAMPLING/MONITORING LOCATIONS			
DRAWN BY:	H. DELGADO	PROJ NO.:	280089.0000.0000
CHECKED BY:	J. ROBINSON	FIGURE 2	
APPROVED BY:	J. PERONTO		
DATE:	OCTOBER 2017		
1430 Broadway 10th Floor New York, NY 10018 Phone: 212.221.7822		FILE NO.: Figure 2 - Site Map and Sampling-Monitoring Locations.dwg	

1317 -- ATTACHED XREFS: -- ATTACHED IMAGES: Harrison Spill GEPRD-100FT;
DRAWING NAME: I:\Projects\NYS DOT - D03137\Assignments #2 +3 - Bryant Pond + Harrison\Reports\Harrison Spill\Figures\TRC Working Drawings\ Figure 2 - Spill Site Monitoring Well Locations r1.dwg --- PLOT DATE: October 10, 2017 - 5:55PM --- LAYOUT: 11X17L



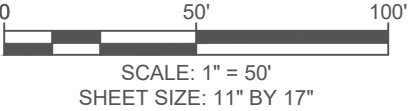
LEGEND (SYMBOLS NOT TO SCALE):

- GP-XX
OR
MW-XX

GROUNDWATER
MONITORING WELL
LOCATION AND
IDENTIFICATION
NUMBER
- APPROXIMATE PLUME
LOCATION



- SOURCES:
- AERIAL IMAGE FROM GOOGLE EARTH PRO, DATED APRIL 16, 2016.
 - APPROXIMATE PLUME LOCATION FROM HDR ENGINEERING, INC.



PROJECT: NEW YORK STATE DEPARTMENT OF TRANSPORTATION PIN 8807.31.101 - HARRISON SPILL SITE (SPILL #94-07349) HARRISON SUB-RESIDENCY WEST HARRISON, NEW YORK			
TITLE: MONITORING WELL LOCATION MAP			
DRAWN BY:	H. DELGADO	PROJ NO.:	280089.0000.0000
CHECKED BY:	A. CHALMERS	FIGURE 3	
APPROVED BY:	K. MYERS		
DATE:	OCTOBER 2017		
		1430 Broadway 10th Floor New York, NY 10018 Phone: 212.221.7822	
FILE NO.:		Figure 2 - Spill Site Monitoring Well Locations r1.dwg	

Attachment A
NYSDEC Request for Sampling for Emerging Contaminants Letter

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Environmental Remediation, Remedial Bureau C

625 Broadway, 11th Floor, Albany, NY 12233-7014

P: (518) 402-9662 | F: (518) 402-9679

www.dec.ny.gov

September 21, 2018

Ms. Gretchen Fitzgerald
Construction Environmental Coordinator
New York State Department of Transportation, Region 8
4 Burnett Boulevard
Poughkeepsie, NY 12603

**Re: Request for Sampling of Emerging Contaminants
Harrison Sub-Residency Site
NYSDEC Site No.: 360035
Harrison, Westchester County, NY**

Dear Ms. Fitzgerald:

The New York State Department of Environmental Conservation (DEC) is undertaking a Statewide evaluation of remediation sites to better understand the risk posed to New Yorkers by 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS). PFAS have historically not been evaluated at remediation sites, and 1,4-dioxane has not been evaluated at the levels that are now thought to represent a health concern. This initiative is being undertaken as a result of these "emerging contaminants" having been found in a number of drinking water supplies in New York. Accordingly, the DEC is requiring groundwater at the above-referenced site be tested for these chemicals. To accommodate this requirement, a select number of existing monitoring wells, representative of the potential of the site to be a source of these emerging contaminants, must be sampled. DEC recommends that at least one of these wells should be upgradient of the site.

The attached guidance provides information on the analytical methods and reporting requirements. A second guidance document describes special precautions that need to be considered when sampling for PFAS.

Please prepare a draft letter work plan that identifies the wells proposed for sampling, a brief description of the sampling methods, and anticipated sampling date within the next 60 days, or prior to the next sampling event. If you wish to discuss the scope of the requested water testing, please contact me at (518) 402-9652, or e-mail at daniel.lanners@dec.ny.gov.

Sincerely,



Daniel R. Lanners, P.E.
Project Manager
Remedial Bureau C, Section D
Division of Environmental Remediation



Department of
Environmental
Conservation

ec w/ encl: Amen Omorogbe, NYSDEC
Daniel Lanners, NYSDEC
Maureen Schuck, NYSDOH
Anthony Perretta, NYSDOH
Gretchen Fitzgerald, NYSDOT R8 (gretchen.fitzgerald@dot.ny.gov)
Jim Peronto, TRC Solutions (jperonto@trcsolutions.com)
DECDocs

Groundwater Sampling for Emerging Contaminants

July 2018

Issue: NYSDEC has committed to analyzing representative groundwater samples at remediation sites for emerging contaminants (1,4-dioxane and PFAS) as described in the below guidance.

Implementation

NYSDEC project managers will be contacting site owners to schedule sampling for these chemicals. Only groundwater sampling is required. The number of samples required will be similar to the number of samples where “full TAL/TCL sampling” would typically be required in a remedial investigation. If sampling is not feasible (e.g., the site no longer has any monitoring wells in place), sampling may be waived on a site-specific basis after first considering potential sources of these chemicals and whether there are water supplies nearby.

Upon a new site being brought into any program (i.e., SSF, BCP), PFAS and 1,4-dioxane will be incorporated into the investigation of groundwater as part of the standard “full TAL/TCL” sampling. Until an SCO is established for PFAS, soil samples do not need to be analyzed for PFAS unless groundwater contamination is detected. Separate guidance will be developed to address sites where emerging contaminants are found in the groundwater. The analysis currently performed for SVOCs in soil is adequate for evaluation of 1,4-dioxane, which already has an established SCO.

Analysis and Reporting

Labs should provide a full category B deliverable, and a DUSR should be prepared by an independent 3rd party data validator. QA/QC samples should be collected as required in DER-10, Section 2.3(c). The electronic data submission should meet the requirements provided at: <https://www.dec.ny.gov/chemical/62440.html> ,

The work plan should explicitly describe analysis and reporting requirements.

PFAS sample analysis: Currently, ELAP does not offer certification for PFAS compounds in matrices other than finished drinking water. However, laboratories analyzing environmental samples (ex. soil, sediments, and groundwater) are required, by DER, to hold ELAP certification for PFOA and PFOS in drinking water by EPA Method 537 or ISO 25101.

Modified EPA Method 537 is the preferred method to use for groundwater samples due to the ability to achieve 2 ng/L (ppt) reporting limits. If contract labs or work plans submitted by responsible parties indicate that they are not able to achieve similar reporting limits, the project manager should discuss this with a DER chemist. Note: Reporting limits for PFOA and PFOS should not exceed 2 ng/L.

PFAS sample reporting: DER has developed a PFAS target analyte list (below) with the intent of achieving reporting consistency between labs for commonly reportable analytes. It is expected that reported results for PFAS will include, at a minimum, all the compounds listed. This list may be updated in the future as new information is learned and as labs develop new capabilities. If lab and/or matrix specific issues are encountered for any particular compounds, the NYSDEC project manager will make case-by-case decisions as to whether particular analytes may be temporarily or permanently discontinued from analysis for each site. Any technical lab issues should be brought to the attention of a NYSDEC chemist.

Some sampling using this full PFAS target analyte list is needed to understand the nature of contamination. It may also be critical to differentiate PFAS compounds associated with a site from other sources of these chemicals. Like routine refinements to parameter lists based on investigative findings, the full PFAS target analyte list may not be needed for all sampling intended to define the extent of contamination. Project managers may approve a shorter analyte list (e.g., just the UCMR3 list) for some reporting on a case by case basis.

1,4-Dioxane Analysis and Reporting: The method detection limit (MDL) for 1,4-dioxane should be no higher than 0.35 µg/l (ppb). Although ELAP offers certification for both EPA Method 8260 SIM and EPA Method 8270 SIM, DER is advising the use of method 8270 SIM. EPA Method 8270 SIM provides a more robust extraction procedure, uses a larger sample volume, and is less vulnerable to interference from chlorinated solvents.

Full PFAS Target Analyte List

Group	Chemical Name	Abbreviation	CAS Number
Perfluoroalkyl sulfonates	Perfluorobutanesulfonic acid	PFBS	375-73-5
	Perfluorohexanesulfonic acid	PFHxS	355-46-4
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanessulfonic acid	PFOS	1763-23-1
	Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluoroalkyl carboxylates	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	PFHpA	375-85-9
	Perfluorooctanoic acid	PFOA	335-67-1
	Perfluorononanoic acid	PFNA	375-95-1
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUA/PFUdA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTriA/PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTA/PFTeDA	376-06-7
Fluorinated Telomer Sulfonates	6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2
	8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4
Perfluorooctane-sulfonamides	Perfluorooctanesulfonamide	FOSA	754-91-6
Perfluorooctane-sulfonamidoacetic acids	N-methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6

Bold entries depict the 6 original UCMR3 chemicals

Collection of Groundwater Samples for Per- and Polyfluoroalkyl Substances (PFAS) from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by Modified (Low Level) Test Method 537.

The sampling procedure used must be consistent with the NYSDEC March 1991 Sampling Guidelines and Protocols http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE) and polypropylene. Additional materials may be acceptable if proven not to contain PFAS. **NOTE: Grunfos pumps and some bladder pumps are known to contain PFAS materials (e.g. Teflon™ washers for Grunfos pumps and LDPE bladders for bladder pumps).** All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer. Standard two step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFAS materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials must be avoided. Many food and drink packaging materials and “plumbers thread seal tape” contain PFAS.

All clothing worn by sampling personnel must have been laundered multiple times. The sampler must wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory.

1. Fill two pre-cleaned 250 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at $4 \pm 2^{\circ}$ Celsius.

Collect one equipment blank for every sample batch, not to exceed 20 samples.

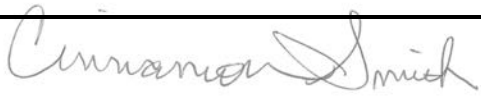
Collect one field duplicate for every sample batch, not to exceed 20 samples.

Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples.

Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

Attachment B
TRC Groundwater Sampling Standard Operating Procedure



Title: Groundwater Sampling		Procedure Number: ECR 009	
		Revision Number: 2	
		Effective Date: November 2016	
Authorization Signatures			
			
Technical Reviewer Cinnamon Smith	Date 11/14/16	ECR Practice Quality Coordinator Elizabeth Denly	Date 11/14/16

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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

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- 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 RMD 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 RMD 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 SOP 004 *Water Level and Product Measurements*.

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

$$\text{Well Volume (V)} = \pi r^2 h (\text{cf})$$

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:

$$\text{Well volume} = (h)(f)$$

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 $\frac{1}{2}$ well/well screen volume after an initial 1 to $\frac{1}{2}$ 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:

- $\text{pH} \pm 0.1$ 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.

Dedicated systems: 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.

Non-dedicated systems: 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.

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

- (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

Collection of VOCs/Volatile Petroleum Hydrocarbons (VPH): 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 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.

4.5 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

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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.

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: $\pm 3\%$ Temperature: $\pm 3\%$ Turbidity: $\pm 10\%$ if > 5 NTUs; if three Turbidity values are < 5 NTU, consider the values as stabilized Dissolved Oxygen: $\pm 10\%$ 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: $\pm 5\%$ 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 $\pm 10\%$ 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: $\pm 3\%$ Temperature: Not used Turbidity: $\pm 10\%$ 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: $\pm 10\%$ 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: $\pm 3\%$ Temperature: $\pm 3\%$ Turbidity: $\pm 10\%$ Dissolved Oxygen: $\pm 10\%$ 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: $\pm 3\%$ Temperature: $\pm 3\%$ Dissolved Oxygen: $\pm 10\%$ Turbidity: $\pm 10\%$ 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: $\pm 3\%$ Temperature: No criteria specified Turbidity: Below 10 NTUs ideal; $\pm 10\%$ 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

 Groundwater Field Data Record		Project: _____ Project No.: _____		Date/Time: _____		Sheet ____ of ____	
		TRC Personnel: _____		Well ID: _____			

WELL INTEGRITY <table style="width: 100%;"> <tr> <td style="width: 50%;"></td> <td style="width: 5%; text-align: center;">YES</td> <td style="width: 5%; text-align: center;">NO</td> <td style="width: 40%;"></td> </tr> <tr> <td>Protect. Casing Secure</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td></td> </tr> <tr> <td>Concrete Collar Intact</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td></td> </tr> <tr> <td>PVC Stick-up Intact</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td></td> </tr> <tr> <td>Well Cap Present</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td></td> </tr> <tr> <td>Security Lock Present</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td></td> </tr> </table>			YES	NO		Protect. Casing Secure	☐	☐		Concrete Collar Intact	☐	☐		PVC Stick-up Intact	☐	☐		Well Cap Present	☐	☐		Security Lock Present	☐	☐		Protective Casing Stick-up _____ ft. (from ground) _____ Riser Stick-up _____ ft. (from ground) _____ WELL DIAMETER ☐ 2 inch ☐ 4 inch Other: _____ ☐ 6 inch WELL MATERIAL ☐ PVC ☐ SS Other: _____		Well Depth _____ ft. ☐ top of riser ☐ measured ☐ top of casing ☐ historical Water Depth _____ ft. LNAPL/DNAPL Depth = _____ Well Volume _____ NAPL Thickness = _____ 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: _____	
	YES	NO																											
Protect. Casing Secure	☐	☐																											
Concrete Collar Intact	☐	☐																											
PVC Stick-up Intact	☐	☐																											
Well Cap Present	☐	☐																											
Security Lock Present	☐	☐																											

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							Stabilization Criteria* (3 consecutive readings) - 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)			
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)										

	Purge	Sample	Comments:
Peristaltic Pump	☐	☐	
Submersible Pump	☐	☐	
Bladder Pump	☐	☐	
Bailer	☐	☐	
Other: _____	☐	☐	

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

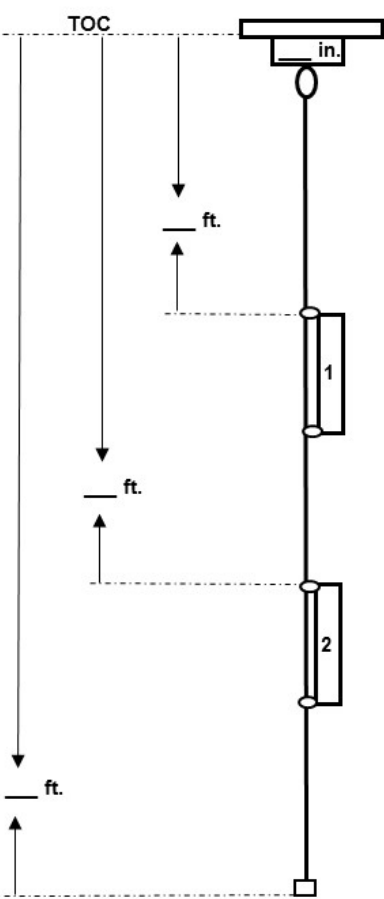
* Consult the applicable regulatory guidance for the specific criteria.

Signed: _____

Rev: April 2014



Groundwater Sampling
Procedure No: ECR 009
TRC Controlled Document

 Groundwater Sampling Record for Organics (For Wells with Passive Diffusion Bags)		Project Name/No: _____	Well ID: _____				
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="background-color: #e0e0e0; padding: 5px;">Installation of PDBs:</th> </tr> <tr> <td style="padding: 5px;"> TRC Personnel: _____ Date: _____ Time: _____ DTW (ft): _____ </td> </tr> </table>		Installation of PDBs:	TRC Personnel: _____ Date: _____ Time: _____ DTW (ft): _____	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="background-color: #e0e0e0; padding: 5px;">Sampling of PDBs:</th> </tr> <tr> <td style="padding: 5px;"> TRC Personnel: _____ Date: _____ DTW (ft): _____ </td> </tr> </table>		Sampling of PDBs:	TRC Personnel: _____ Date: _____ DTW (ft): _____
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?: _____							
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

- | | |
|--|--|
| <ul style="list-style-type: none"> • 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 RMD SOP 010, <i>Equipment Decontamination</i>) • Appropriate PPE • Field book | <ul style="list-style-type: none"> • 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) <p>As Needed:</p> <ul style="list-style-type: none"> • 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

- | | |
|---|--|
| <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> ○ 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. | <ul style="list-style-type: none"> • 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

- | | |
|---|--|
| <ul style="list-style-type: none"> • 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 | <p>at the surface to prevent the air temperature from influencing the measurements and exposure to contaminants on the ground;</p> <ul style="list-style-type: none"> • 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

- | | |
|--|--|
| <ul style="list-style-type: none"> • 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:
 $\text{Well Volume (V)} = \pi r^2 h$ • For volumetric purging, an adequate purge is typically achieved when 3 to 5 well volumes have been removed. | <ul style="list-style-type: none"> • 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. |
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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 4°C 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 bottle/ware 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. - Personnel involved with sample collection and handling should wear

PFAS Sampling Protocols	
SOP Section Number	Modifications to SOP
	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.

Attachment C
PFAS Analyte List and Lab Reporting Limits

TestAmerica Burlington
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Prepared for:

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Prepared by Scott, Aidan J
Date 9/1/2018
Expiration Date 10/31/2018
Est. Start Date

Project: Harrison Sub Residency

Quote Number: 20008163 - 0

Groundwater Samples + QC Samples

Matrix	Method	Test Description	Analyte	RL	MDL	Units
Water	537 (modified)	PFAS (NYS 21 Analytes)	Perfluorobutanoic acid (PFBA)	2.00	0.410	ng/L
			Perfluoropentanoic acid (PFPeA)	2.00	0.750	ng/L
			Perfluorohexanoic acid (PFHxA)	2.00	0.240	ng/L
			Perfluoroheptanoic acid (PFHpA)	2.00	0.320	ng/L
			Perfluorooctanoic acid (PFOA)	2.00	0.320	ng/L
			Perfluorononanoic acid (PFNA)	2.00	0.380	ng/L
			Perfluorodecanoic acid (PFDA)	2.00	0.380	ng/L
			Perfluoroundecanoic acid (PFUnA)	2.00	0.250	ng/L
			Perfluorododecanoic acid (PFDoA)	2.00	0.350	ng/L
			Perfluorotridecanoic Acid (PFTriA)	2.00	0.240	ng/L
			Perfluorotetradecanoic acid (PFTeA)	2.00	0.450	ng/L
			Perfluorobutanesulfonic acid (PFBS)	2.00	0.440	ng/L
			Perfluorohexanesulfonic acid (PFHxS)	2.00	0.260	ng/L
			Perfluoroheptanesulfonic Acid (PFHpS)	2.00	0.820	ng/L
			Perfluorodecanesulfonic acid (PFDS)	2.00	0.530	ng/L
			Perfluorooctanesulfonic acid (PFOS)	2.00	0.760	ng/L
			Perfluorooctane Sulfonamide (FOSA)	2.00	0.560	ng/L
			N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	20.0	0.450	ng/L
			N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	20.0	0.700	ng/L
			6:2 FTS	20.0	1.00	ng/L
			8:2 FTS	20.0	0.560	ng/L

Isotope Dilution

13C8 FOSA
13C4 PFBA
13C5 PFPeA
13C2 PFHxA
13C4-PFHpA
13C4 PFOA
13C5 PFNA
13C2 PFDA
13C2 PFUnA
13C2 PFDoA

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Groundwater Samples + QC Samples

Matrix	Method	Test Description	Analyte
Continued		Isotope Dilution	
			13C2-PFTeDA
			13C3-PFBS
			18O2 PFHxS
			13C4 PFOS
			d3-NMeFOSAA
			d5-NEtFOSAA
			M2-6:2FTS
			M2-8:2FTS